NAVAL AIR TRAINING COMMAND

NAS CORPUS CHRISTI, TEXAS **CNATRA P-819 (01-14)**

FLIGHT TRAINING INSTRUCTION

ADVANCED STRIKE PROCEDURES T–45C

2014

DEPARTMENT OF THE NAVY
CHIEF OF NAVAL AIR TRAINING
250 LEXINGTON BLVD SUITE 102
CORPUS CHRISTI TX 78419-5041

CNATRA P-819
N712
6 Jan 14

CNATRA P-819 (REV. 01-14)

Subj: FLIGHT TRAINING INSTRUCTION, ADVANCED STRIKE PROCEDURES, T-45C

1. CNATRA P-819 (Rev. 01-14) PAT, "FLIGHT TRAINING INSTRUCTION, ADVANCED STRIKE PROCEDURES, T-45C" is issued for information, standardization of instruction, and guidance for all flight instructors and student aviators within the Naval Air Training Command.

2. This publication shall be used as an explanatory aid to support the Advanced Strike Fighter UMFO Curriculum. It will be the authority for the execution of all flight procedures and maneuvers herein contained.

3. Recommendations for changes shall be submitted via CNATRA TCR form 1550/19 in accordance with CNATRAINST 1550.6E.

4. CNATRA P-819A (Rev 06-97) PAT is hereby cancelled and superseded.

M. B. TATSCH CAPT, USN
By direction

Distribution:
CNATRA Website

FLIGHT TRAINING INSTRUCTION

FOR

ADVANCED STRIKE PROCEDURES

T-45C

P-819

LIST OF EFFECTIVE PAGES

Dates of issue for original and changed pages are:

Original…0…(dates for original and previous revision(s) to be inserted by CNATRA)
Revision…1…19 Jun 97
Revision…2…06 Jan 13

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 296 CONSISTING OF THE FOLLOWING:

Page No.	Change No.	Page No.	Change No.
COVER	0	7-1 – 7-18	0
iii-xii	0	8-1 – 8-32	0
1-1 – 1-22	0	A-1 – A-4	0
2-1 – 2-43	0		
2-44 (blank)	0		
3-1 –3-26	0		
4-1 – 4-24	0		
5-1 – 5-75	0		
5-76 (blank)	0		
6-1 – 6-38	0		

INTERIM CHANGE SUMMARY

The following Changes have been previously incorporated in this manual:

CHANGE NUMBER	REMARKS/PURPOSE

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

INTERIM CHANGE NUMBER	REMARKS/PURPOSE	ENTERED BY	DATE

TABLE OF CONTENTS

TABLE OF FIGURES

CHAPTER ONE
STRIKE ROUTE PROCEDURES

100. INTRODUCTION

WEAPONS ON TARGET, ON TIME, FIRST TIME

The objective in most strike missions is to put weapons on target, on time, on the first pass. The Strike stage is designed to provide you with the basic skills necessary to accomplish that goal.

In VT-86, prospective Strike Fighter Naval Flight Officers will fly as single aircraft or in sections of two aircraft on a strike route over simulated enemy territory. They will be responsible to avoid enemy surface-to-air threats by minimizing radar detection. Their goal is to successfully attack their assigned target and then return home safely. The basic skills required to accomplish this mission are the same whether flying as a single aircraft, as a section, or as a division of strikers.

This chapter will provide the procedures and techniques required to accomplish these tasks in an efficient manner. Although there are many scenarios in which strike missions may occur, for the purposes of this chapter we will refer to routes in the context of a Military Training Route (MTR), as the MTR will constitute the majority of the training in the Strike stage. These missions will require extensive preparation and planning, to include the completion of strip charts, which will be discussed in the next chapter.

101. HIGH LEVEL TIMING

Timing is important to mission success because strike missions are always conducted in coordination with other assets. Student performance will be determined, in large part, by how well they are able to arrive at the target on time. We will plan and execute two time management game plans. The first time management game plan covers the transit, from takeoff to the route entry point; the second time management game plan is the timing of the route itself. The first time management game plan is called “high-level timing.”

1. Planning

    a. High level timing plans will be constructed at the same time that the strike route is planned and strip charts are constructed.

    b. Calculate the total distance from the launch airfield to the route entry point.

        i. The routing of flight may be provided in the Stan Notes or you may need to determine it yourself (See the Strike Stage planning guide for more information).

ii. When planning the route, use the shortest distance to the entry point to include normal departure routing. Ensure the route of flight is clear of MOAs and Restricted Areas. Do not plan to descend through Class B or C airspace.

c. Add 10 nm to your first leg to account for vectoring by Departure Control.

d. Use standard altitudes for cruise altitude based on distance from the CTW-6 In-Flight Guide (IFG).

i. Adjust altitudes based on direction of travel (east or west).

e. Calculate times, fuels, and distances for standard climbs and descents from the IFG and PCL.

i. Using the remaining distance (distance in nm flown at cruise altitude), divide the cruise range (nm) by MAX R speed to determine time at altitude.

f. Add the times to get total time from takeoff to route entry. This is your planned time en route to the entry point.

g. Determine the no earlier than (NET) and no later than (NLT) takeoff times.

h. Consider cases where a ROLEX may apply.

2. NET Takeoff Time

a. Compute the minimum airspeed.

i. **IAS:** 200 KIAS is the minimum airspeed for high level timing (airspeeds less than 200 KIAS make it difficult for the wingman to maintain formation). TAS will vary depending on altitude, so plan accordingly.

ii. **TAS:** Take your altitude in thousands of feet and multiply it by 5, then add the IAS to get TAS (10k x 5 = 50 kts + 250 KIAS = 300 KTAS).

iii. **GS:** Determine the average winds at altitude and apply them to your TAS to get the minimum GS for high level timing.

b. Use the above calculated minimum ground speed and apply it to the timing matrix using the planned route of flight.

c. The AP-1B entry time window is ±4 minutes from the preflight entry time. Therefore, subtract 4 minutes from the time calculated in the previous step. The result is the NET takeoff time.

3. NLT Takeoff Time

a. Compute the maximum airspeed.

i. ***TAS:*** A maximum of 420 TAS (.70 IMN) will be used for planning at VT-86 due to fuel consumption.

ii ***GS:*** Determine winds at altitude and apply them to your TAS to get GS.

b. Use the above calculated maximum ground speed and apply it to the timing matrix using the shortest route of flight between the launch airfield and the route entry point.

c. The AP-1B entry time window is ±4 minutes from the preflight entry time. Therefore, add 4 minutes to the time calculated in the previous step. This is the NLT takeoff time.

d. Calculate out how much additional fuel will be consumed with this new A/S. Confirm this still meets MCF requirements.

e. ***Rule of Thumb:*** Use IFG to determine fuel consumption during all 3 profiles. If any of the profiles arrive at the entry point below MCF, the route of flight or airspeeds may need to be changed. Ensure you take into account the difference in flight time (NLT timing routes should be shorter, so fuel consumption might be the same or better).

NOTE

Holding ***is not*** an acceptable timing solution and ***shall not be authorized during these events***, unless safety of flight dictates otherwise.

4. Pre-Flight

a. The first step in the planning process is to get the takeoff time from the VT-86 schedule (start checking TIMS or the schedule early).

b. Work with the scheduled wingman during the planning process.

c. Quickly determine an exact entry and target time in Zulu. Most of the timing plan can be done at this point.

i. Ensure you are scheduled for the route (See Chapter 2 MTR).

ii. Contact the schedules writer or the instructor immediately if the route is in question or not scheduled.

iii. Add the planned "on time" high level timing to the "on time" route timing to the scheduled take off time to get the target time.

d. Once normal timing and fuel planning is complete, start preparing for the remainder of the flight.

i. Calculate exact take-off, NLT, and NET times.

ii. Chair fly communications and procedures.

iii. Study route imagery and strip chart.

Preflight Timing Example

You're scheduled for a 0800L takeoff and a 0820L entry time. If it takes 15+30 from takeoff to entry and 22+35 to fly the route, then your target time would be 0838+05L. Verify fuels with jet log.

Using this exact time, round your target time to the nearest ten minutes (0840L) and adjust your take off and entry time.

Given a 0820 entry time, you have an entry window from 0816+00 to 0824+00.

The new "on time" takeoff time is 0801+55 and the new "on time" route entry time is 0817+25.

If flying the high level route at 200 KCAS takes 21+18, then the NET takeoff time is 0754+42.

If flying the high level route at 420 KTAS (0.70 IMN) with a short cut takes 10+05, then the NLT takeoff time is 0813+55.

e. Walk time to takeoff

i. The standard amount of time allotted for walking, preflight, and startup is 45 minutes (This includes time required for donning flight gear, reading ADB, walking to the aircraft, conducting preflight inspections, strapping in, starting the jet and entering flight data).

f. Aircrew should walk on time unless a delay is expected. Reasons for delay include…

i. Excessive on deck time due to a large number of waypoints or data to enter following startup.

ii. A larger than normal number of aircraft expected at takeoff.

iii. Inexperienced aircrew.

iv. Weather on route of flight requires additional flight time due to anticipated vectoring by ATC.

5. Execution

a. During taxi QA current time compared to planned takeoff.

i. If early or late timing is anticipated, inform the IP and determine the appropriate course of action.

b. When climbing on route to the first or second waypoint:

i. Determine the difference between the actual takeoff and planned takeoff times.

ii. Estimate how much of the 10 nm timing buffer was used.

iii. Estimate how early or late you are based on takeoff time, runway, and departure routing.

iv. Set an airspeed to start correcting the timing problem as soon as the aircraft levels off (if required).

(a). Use round numbers to make math easier.

(b). If you are more than 4 minutes early, set 200 KCAS.

(c). If you are more than 4 minutes late, set 0.70 IMN.

(d). These times may change, depending on the time remaining to the entry point.

Airborne Timing Example

You depart NPA 2 minutes late, flying toward TEEZY for the VR-1024. You took off on Runway 25L and were immediately cleared to TRADR.

You should estimate that you are about on time and set MAX R at level off.

However, if you departed on Runway 7R and were vectored around traffic, then you should estimate that you are about 4-5 minutes late and set 0.70 IMN.

c. Upon reaching transit altitude and at requested airspeed verify system groundspeed.

i. Time how long it takes to go 1 nm via TACAN radial tracking or use HSI bearing and range to the next waypoint.

ii. Convert to nm per minute and compare to the navigation system readout.

d. Determine ground speed required to get to the entry point on time.

e. Total Distance/Total Time (primary method of timing control):

i. Total Distance (nm) / Total Time (Min) = GS in nm/min = IMN

ii. ***Advantages****:* Spreads the throttle correction out over as long a time as possible. Time out will be at entry so you don't have to remember to take out.

iii. ***Disadvantage****:* You may be so far off time that you will exceed aircraft limits. (i.e., you need to use geometry) Math can be cumbersome. Use nearest whole minute to simplify.

f. Gate Method:

i. The Gate Method is an easy way to calculate Total Distance/Total Time (TD/TT). It is based on fractional math (e.g., 30 min is 1/2 of an hour so at 30 minute to go, you can simply take your Total Distance, multiply it by 2 to determine the ground speed required to arrive on time). If you are controlling your time to the descent point, no modification is required. TD (to descent point) x 2 = GS. If you are controlling your time to the entry point, add 10 nm to your distance. (TD + 10) x 2 = GS. This can be applied to any fraction of an hour.

ii. Gate Method to the Entry Point Examples

30 Min Gate: (TD + 10) x 2 = GS
20 Min Gate: (TD + 10) x 3 = GS
15 Min Gate: (TD + 10) x 4 = GS
10 Min Gate: Distance = IMN
6 Min Gate: Distance = GS

g. Real World Times:

i. Having your real world times (preflight times) at each intermediate point will allow you to judge quickly if you are on timeline or not. For example, you planned to be at McComb VORTAC at 1223 and you mark on top at 1226, you can quickly ascertain that you are three minutes early and need to adjust, either with throttles or geometry, in order to arrive on time. Real world times are to be notated on the planning diagram.

ii. For high level timing the student may not request less than 200 KIAS or more than .75 IMN (.70 IMN for NLT planning purposes).

102. ROUTE ENTRY PROCEDURES

Workload increases for aircrew prior to route entry. Prior to route entry aircrew must cancel IFR (considerations must be made for weather and traffic), perform a G-warm, and make appropriate FSS radio calls (for MTR routes). In addition, aircrew must conduct FENCE checks, acquire the entry point, make a two minute prior call, and verify timing. These procedures should be well rehearsed so that they are fast and accurate. A well rehearsed flight enables flexibility and adaptability for aircrew to handle any unplanned situation.

1. Route Entry Considerations

   a. Cancel IFR (VR routes):

      i. Below FL180 and clear of traffic.

      ii. When aircrew is confident that they can proceed VFR without weather interference.

      iii. About 5 minutes prior to entering route, or as briefed.

      iv. Begin FENCE checks after canceling IFR.

   b. Lead SNFO (PRI): "*Houston Center, Rocket 415, cancel IFR.*"

   c. Houston Center: *"Rocket 415, Houston Center, cancellation received, frequency change approved, squawk VFR."*

   d. Lead SNFO (PRI): *"Rocket 415, switching."*

   e. Lead SNFO (AUX): "*Knight, button 29 PRI, fence-in.*"

   f. Wing SNFO (AUX): *"Knight-12."*

   g. Conduct G-Awareness Maneuver (G-warm). This maneuver is designed to acclimate the body to high G forces that may be experienced along the route. The maneuver calls for 4 G's for 90 degrees of turn followed by 90 degrees of turn in the opposite direction, with a spike to 6 G's, and then easing to 4 G's.

   h. Lead IP (AUX): "*Knight reference 180, accel, G-warm.*"

   i. Wing IP (AUX): "*Knight 12.*"

   j. Lead IP (AUX): "*Knight, 90 right for 4, go.*"

   k. Lead IP (AUX): "*Knight resume.*"

2. FENCE-in

a. This call is made to tell the flight that it is time to set up all systems for the tactical portion of the flight. The following will be complete prior to calling "FENCED IN."

i. Select A/G master mode.

ii. Set Displays IAW Strike Stan, ensuring proper display set up as well (range, gain etc.):

(a). Horizontal Situation Indicator (HSI) or ADI/HUD on left MFCD.

(b.) Situation Awareness (SA) or Radar Attack Display on right MFCD (or as briefed).

(c.) A/A TACAN

(d) LAW: as briefed

(e.) Recorders: SNFO will select Record in the aft cockpit.

b. Upon completing the FENCE-in (steps above) and the G-warm, the Lead SNFO will ask if the IP is fenced in. When the IP reports fenced, the Lead SNFO will verify the flight is FENCED-in.

c. Lead SNFO (AUX): "*Knight 11, fenced-in, 1.9.*"

d. Wing SNFO (AUX): "*Knight 12, fenced-in, 1.8.*"

NOTE

Aircrew must also verify both aircraft are on the safety of flight frequency on PRI ***prior to entering the route***.

e. Lead SNFO (AUX): *"Knight check PRI."*

f. Lead SNFO (PRI): *"Knight-11."*

g. Wing SNFO (PRI): *"Knight-12."*

3. FSS Radio Call

a. The Lead SNFO will inform the FSS just prior to route entry (this call is only required before entering a VR route).

b. Lead SNFO (PRI BTN29): *"Anniston radio, Rocket 415, flight of 2 T-45s, entering the VR-1031 point A, 1800Z, exiting point G, 1825Z, 500 feet, 360 knots."*

NOTE

SNFO shall use the appropriate FSS name (i.e., Anniston radio, etc.) when making this call. This will require appropriate preflight planning. It is unprofessional and unacceptable to call "Any Radio."

c. This call should occur 2-3 minutes prior to entering the route. Aircrew must make an important mentality shift prior to entering the strike route environment. .

103. ROUTE ENTRY POINT ACQUISITION

Locating the route entry point is vital and sometimes it is as easy as selecting the appropriate waypoint. The SNFO should utilize all available systems to locate the entry point on VR and IR routes. These include the HSI, radial/DME cuts, A/G radar, and eyes. Once the point is located, direct the IP to the set up for route entry.

a. Designate the entry point on the radar for High Altitude Target Acquisition (HATA) routes based on the range and bearing to the appropriate waypoint on the HSI or SA display. Generally, the point will be very close to your flight path Figure 1-1.

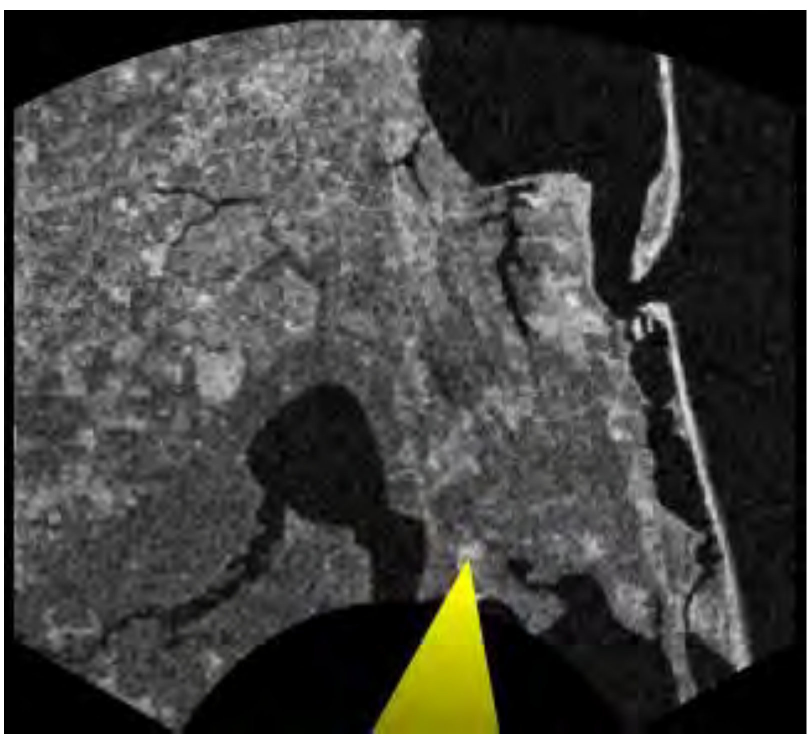


Figure 1-1 Entry Point

b. Provide the IP with a description of the entry point for VR routes. Look outside the aircraft for funneling features or landmarks to identify the entry point itself. Once the entry point is acquired, ensure the IP has contact. Figure 1-2 shows a page from a strip chart depicting an entry point and the arrow below indicating the direction of arrival. The tip of the peninsula is relatively easy to visually identify, so focus should shift to completing the entry checklist, required UHF communications, and timing.

Figure 1-2 First Leg on Trip Chart

104. DISPLAY MANAGEMENT

Being familiar with various displays and where to find information will allow aircrew to process information efficiently. To aid in gaining an efficient scan, it's important to have a standard setup.

1. Setup

    a. HATA routes

        i. Left MFCD – HSI

        ii. Right MFCD – A/G Radar

    b. Low-level routes

        i. Left MFCD – HUD

        ii. Right MFCD – SA or HSI / A/G Radar

105. TURN POINT PROCEDURES

Turn point procedures are designed to cover the appropriate aviate and navigate steps required on a strike route, as well as develop a good scan pattern. Basic turn point procedures will be utilized on all flights in the Strike stage that fly a route. For planning purposes, anytime a navigation point on a route or a target acquisition point is approached, the SFNO will be required to make call to include two minutes prior, mark on top, and wings level over the ICS.

These calls will vary slightly depending on the type of flight and route flown. For example, IR routes and MOA flights will normally maintain a constant altitude. During these flights, turn point calls will be challenging as they are integrated into the basic radar target acquisition procedures discussed later. They are just as challenging on low-level routes due to the terrain/checkpoint correlation involved. Each of these calls is outlined later in this chapter.

The SNFO will be responsible for incorporating the effects of wind into navigation and target acquisition. The HSI alleviates much of the work for the SNFO, as it displays wind direction and speed in the middle of the compass display. The HSI also displays the wind-corrected ground track at the top of the HSI display. If operating with a degraded system, the IP will provide the winds and the SNFO must calculate the correct heading and airspeed. In addition to the wind, the HSI "time to go" to the next waypoint is provided and should only be used as back up when making airspeed corrections for timing. A degraded system could possibly remove or make this information inaccurate (GINA, SADS Failure).

Turn point procedures begin approximately two minutes before the route entry or turn point. These calls should also be well rehearsed, so that the SNFO is able to conduct other flight requirements in addition to verbalizing these calls on ICS (significant attention is needed for route SA, radar mechanics, and timing).

These steps will be internalized to some extent in the fleet, but they are required to be verbalized during the HATA and Low-level routes at VT-86. During strike routes you will only need to verbalize fuel and timing analysis for the wings level call, but continue to assess flight parameters internally.

1. Required Calls

a. Two Minutes Prior – Based on 360 kts ground speed (6 nm/minute), call should be made about 12 nm prior to the turn point. Call will include:

i. 12 nm prior to the turn point – *"Two Minutes Prior to PT. B."*

ii. Turn point description (and any hazards) – *"PT B is a highway bridge. There is a 450 foot tower one mile beyond the bridge."*

iii. Outbound heading – *"Outbound heading 045."*

iv. Outbound airspeed – *"360 Ground."*

v. Outbound altitude – *"500 feet"* (only verbalized if altitude changes).

vi. Recommend engagement turn (section only) – *"Recommend TAC right."*

b. Mark on Top – Once over turn point.

i. Command turn – *"Right 045."*

ii. Mark time in minutes and seconds – *"Time 21+32."*

iii. Clear turn – check for hazards along flight path.

iv. Direct new altitude if appropriate.

v. Update navigation – *"TACAN changes to Monroeville."*

vi. In section, update divert – *"Nearest divert is Maxwell."*

vii. Reset Radar (URG) – Undesignate, Range to 40 nm, Gain to 5

c. Wings Level – When wings level outbound from turn point

i. Verify heading – *"045."*

ii. Verify altitude – *"500 feet."*

iii. Verify airspeed – *"400 knots."*

iv. Fuel analysis – *"Fuel is 2.1, 100 pounds above MCF, continue."*

v. Wingman location (section only) – *"Wingman is at 3 o'clock level."*

vi. DR designation.

vii. Timing analysis – "*We were 8 seconds late, updated ETA to PT. C is 25+32."*

d. Fuel analysis, timing analysis and DR cursor will be discussed later in this chapter, and will need to be considered for successful mission accomplishment. A good understanding of these steps will build your situational awareness.

106. ROUTE SITUATIONAL AWARENESS

Maintaining SA during any mission is a vital skill to develop and hone. Aircrew must incorporate all available information to ensure they know where they are in space and time. In modern fighter aircraft, the amount of information can become overwhelming. Interpreting and manipulating displays while reading a chart, looking outside, listening to multiple radios, analyzing course time and winds, executing an air-to-ground timeline, and practicing good crew coordination are all things that must be juggled while flying at low altitude and high speed with a wingman. Even the most seasoned aviators cannot do all of these things at the same time. Prioritization and task management are critical, as priorities are always changing. If too much time is spent on a single task, inputs from other sources are ignored and task overload will soon follow. This section is designed to provide you with some techniques for building and maintaining SA during the strike mission.

1. Keys to Success

a. Success hinges on prioritizing tasks.

i. Know your position in space and time using all available resources.

ii. Arrive at the entry point with high SA and strive to keep it through the route.

iii. Being on the black line doesn't equate to high SA and being off the black line doesn't equate to low SA. The SNFO should strive to know their position at all times.

b. Funneling navigation.

i. This refers to a method of scanning. Work big to small when trying to locate a point.

ii. Use large, prominent land features and man-made objects.

iii. Build a mental map of points along the route during chart study.

iv. This applies to radar and visual navigation. It is used specifically when entering the route, trying to locate a point or target, and when lost or see something not expected.

c. Task shedding/management

i. Recognizing task overload and when to ask for help is a skill aircrew must develop. It allows a task-saturated crew member to pass responsibilities to the other crew member.

ii. Some items can be skipped, abbreviated, delayed, or handed off to the pilot. Never forget the basics ***aviate***, ***navigate***, ***communicate***, ***checklists***.

iii. Items that can be given to the pilot include radio communications and navigation. Remember to take them back when you are no long task saturated.

iv. Items that can be abbreviated or delayed include turn point procedures (may be skipped on the target leg), wind analysis, and updating ETA to the next point.

d. Dead reckoning (DR)

i. Method of using the radar attack display to aid in your navigation

ii. Place the cursor close to the next turn point/target. Used when next waypoint is close to the turn point. Use the BRA from HSI to match the radar cursor BRA and place a designation.

iii. Calculate the distance traveled along the course (30 seconds = 3 nm).

iv. When level on planned course, designate at the distance remaining on the leg. (for a 24 nm leg, designate on the nose for 21 nm). Used when overflying a known point and pointing at the turn point. Move the designation to the range from your chart.

v. Always analyze how position, heading, and airspeed affect timing.

107. ROUTE TIMING

When position is known, the next priority is timing. Navigation systems in fleet aircraft compute timing for a given waypoint or target at the touch of a button. It’s the aircrew’s responsibility to ensure that information is accurate. If the coordinates were entered incorrectly into the system or the system is set to the wrong waypoint, the jet will provide inaccurate information.

In the Strike stage at VT-86, we will be using "real world" timing. This means the time on target and the time to the entry point or turn point will be communicated in the brief in Zulu (Z) time. For example, with a preplanned time on target of 18:20:00Z (annotated1820+00 or 20 00 on the MFCD) and an actual over-flight of the target at 1819+40, the SNFO has calculated he or she is 20 seconds early. The GPS time in the aircraft is the primary time reference. Timing corrections can be easy, but require practice to master in the hot seat.

1. Timing Considerations

   a. Compare actual arrival time at the turn point to the preflight time.

      i. Early - Slow down. Deviate from the course line (within the route corridor). Calculate the amount of time you will need to use with simple math (discussed later).

      ii. Late - Speed up. Consider the effects on fuel consumption. Cut corners and calculate the amount of time you will save using simple math (discussed later).

      iii. Standard speed corrections are used as a rule of thumb to fix timing problems. A standard speed correction for a given amount of time will yield similar results (the base airspeed is 360 KGS).

      iv. An increase or decrease in ground speed of 40 knots will increase or decrease approximately 6 seconds of mission timing for every minute the speed correction is in.

Example 1

Hammer-11 is 22 seconds late at Point B. Ground speed should be set to 400 KGS for 3+40 (3 minutes and 40 seconds.)

      v. SNFO (ICS): *"We're 22 seconds late, set 400 ground, time in: 12+15, time out: 15+55, updated ETA to point Delta is 22+30."*

Example 2

Rage-11 is 14 seconds early at the entry point. Ground speed should be set to 320 KGS for 2+20. Speed corrections are not required if +/- 12 seconds from the predicted time unless on the target leg.

      vi. Update the ETA to the next turn point. Speed corrections that continue beyond the next turn point require an updated estimated time of arrival (ETA). A 400 KGS correction that ends one minute after the next turn point would increase the turn point ETA by 6 seconds. A speed correction that ends prior to the next turn point will result in an on time ETA.

vii. There are several ways to calculate the amount of time saved or made up if utilizing geometry to fix a timing problem.

Example 3

Doom-11 is approaching the next turn point with a 90 degree turn and the ground speed is 360 (6 nm/min). A turn 6 nm early (before the turn point) will make up 1 minute. A turn 6 nm late (after the turn point) will lose 1 minute. 3 nm will make up or lose 30 seconds.

An adjustment of heading coming into a turn point such that the turn point is passed 6 nm abeam will result in 1 minute earlier timing (inside the turn) and 1 minute later timing (outside the turn). 3 nm will make up or lose 30 seconds.

viii. Memorization of all the possible geometry timing scenarios is not required at VT-86. Common sense applies to figuring out timing based changes to geometry. Try to round numbers and use multiples to make math easier.

108. HIGH ALTITUDE TARGET ACQUISITION (HATA)

The objective on a HATA route is to find all associated turn points and the target. These procedures will outline the steps necessary for air-to-ground (A/G) radar target acquisition. It also explains all the information that is provided by A/G radar. Mission planning is critical to success. Chart and imagery study of the points and surrounding area helps the SNFO to match the picture on the A/G radar with the target. The steps required for target acquisition on the A/G radar are similar to the steps required for the VR route. Working big to small, finding correlation points and identifying limiting features are just a few techniques to be considered.

Some targets and turn points, such as the bridge in Figure 1-3, are easy to find using the A/G radar. The coastlines and bays are easy to identify because of the contrast they provide. The designation can be placed based on these and other correlating points. There are times when points may be "late breakers," meaning they will not be positively identified until at close range, usually less than 10 nm. Correlation points are required for such points. The procedures for finding a point are the same for each leg.

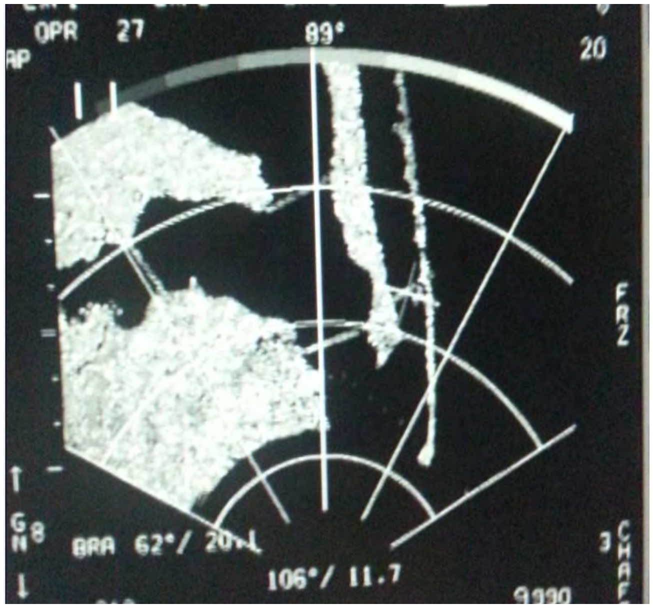


Figure 1-3 Bridge

1. Air-to-Ground Designation Procedures: (MAP) Mode

   a. Match the bearing and range on the HSI waypoint with the BRA information on the radar attack display. Consider radar correlation points to help guide the designation.

   b. Allow the radar picture to build. Adjust gain to see contrast (bright and dark returns). Use the entire radar picture to find the target area. Coast lines, cities, lakes, etc. should yield prominent returns. Correlate those returns to the strip chart.

   c. To update the designation, box FRZ (PB 13). This will stop the radar display from updating while the radar continues to scan.

      i. Pull the trigger to the second detent and hold.

      ii. Move the acquisition cursor with the designator controller (DC) to the desired location and release the trigger.

      iii. Unbox FRZ.

Figure 1-4 Bridge on the 10 Mile Scale **Figure 1-5 Bridge on the 5 Mile Scale**

iv. Hard to find points will break late (5-10 nm). Radar auto ranges down with a designation only.

v. When the designation is on the intended point, report "Captured" on ICS (single), AUX (section). In section, the second aircraft to capture the point reports on ICS only.

Figure 1-4 (10 nm scale) and 1-5 (5 nm scale) shows the bridge break out as range decreases.

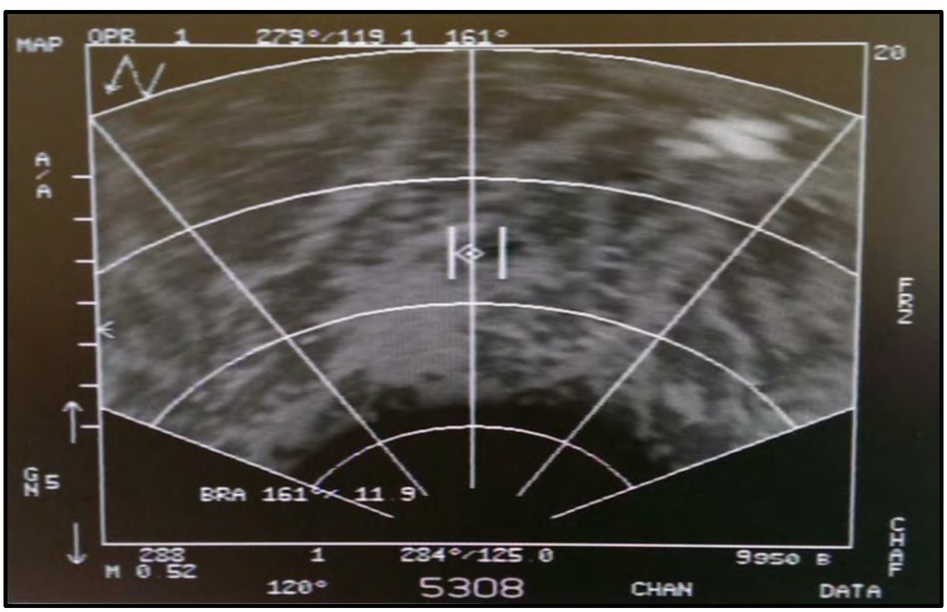


Figure 1-6 Initial Stabilized Designation

Here is an example of a HATA leg. The turn point is the center of a small lake that is about 10 nm NE of a magenta town.

NOTE

The town appears beyond and to the right of the designation. The lake has no return and is identified by the dark area (shadow) near the designation in Figure 1-6. The two minute prior call should occur here, approximately 12 miles from the turn point.

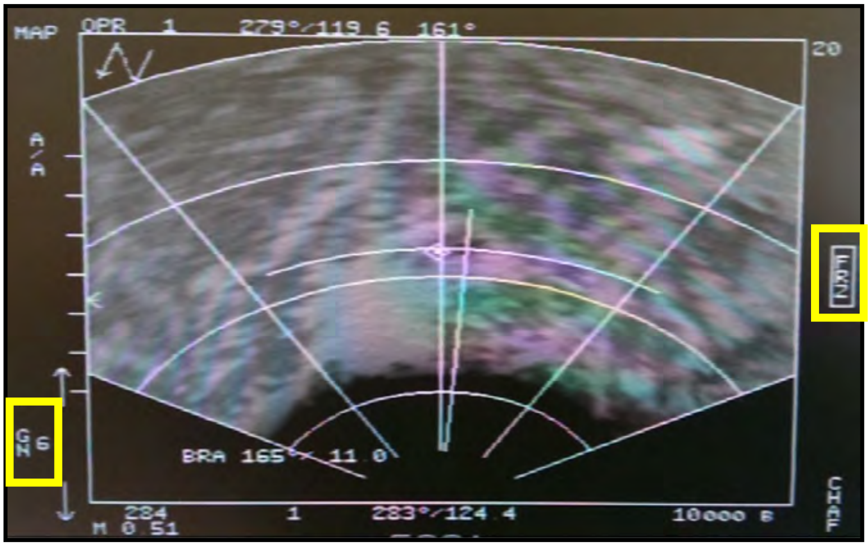


Figure 1-7 Updating Designation

Adjusting the gain will help break out the lake Figure 1-7. Increasing the gain level will intensify the return brightness off all returns. A lake will normally have no radar return, thus making it easier to identify among all returns. With the lake identified, box FRZ and update the designation to center of lake, then un-box FRZ.

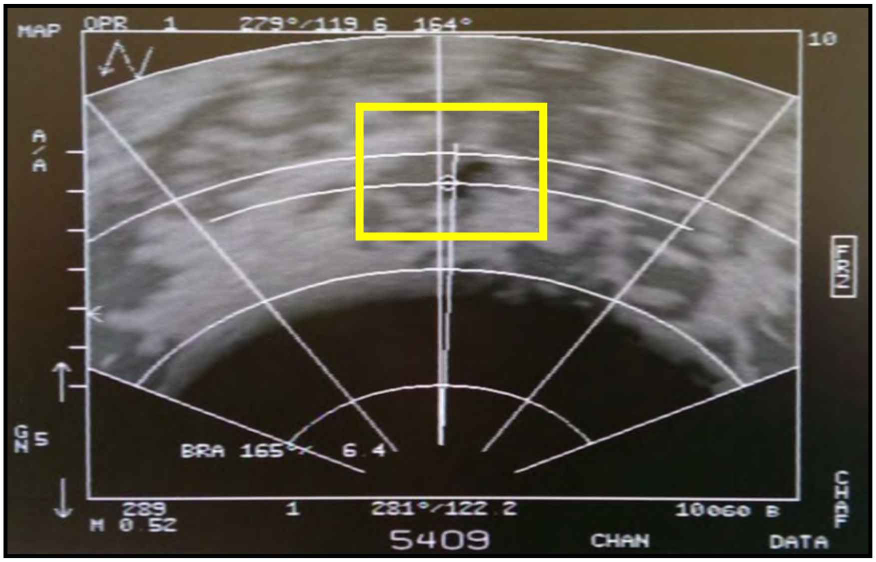


Figure 1-8 Update on the 10 Mile Scale

As the distance to the turn point decreases, the radar automatically ranges down. Continue to refine the designation if it drifts off the turn point. Note the designation is no longer in the middle of the lake after the radar ranges.

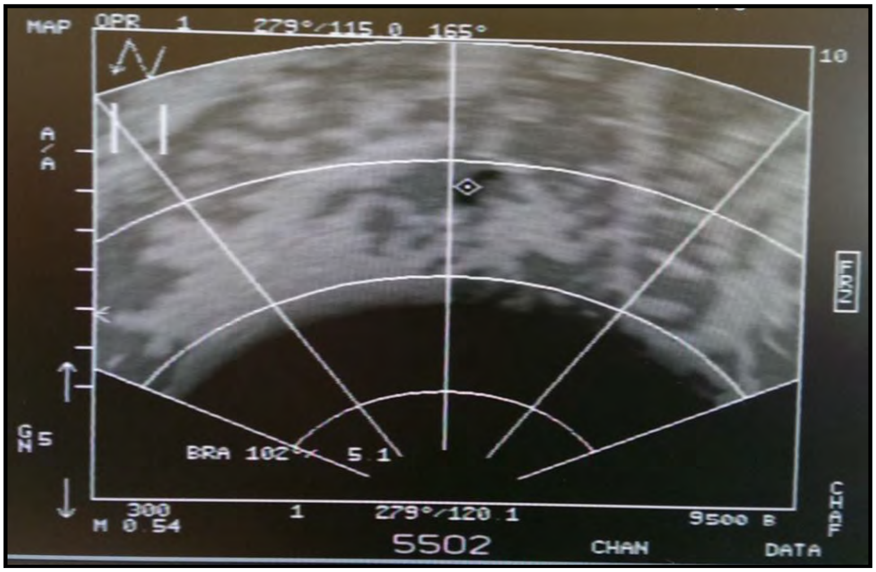


Figure 1-9 Refined Designation

Figure 1-9 shows the final designation, approximately one minute from the turn point. Note the altitude hole located at the bottom of the tactical display. The turn point will no longer be able to be identified in approximately 3 nm; however, the system will continue to hold the designation coordinates.

2. Air-to-Ground Designation Procedures: Expand (EXP) Modes

The following will detail the procedures for using EXP modes in the OFT. In addition to Real Beam Ground Map (RBGM), the OFT has expanded map modes. Expand modes further refine the A/G radar display with a series snap shots. Think of EXP modes as enhanced zoom on a camera lens. The lens zooms in from EXP 1 to EXP 2 to EXP 3. It's important that these EXP modes be used close to the intended point of designation. Fishing for a turn point in EXP modes is not recommended, doing so is the equivalent of trying to find a needle in a haystack while looking through a soda straw. The general target area must always be identified using RBGM before selecting EXP.

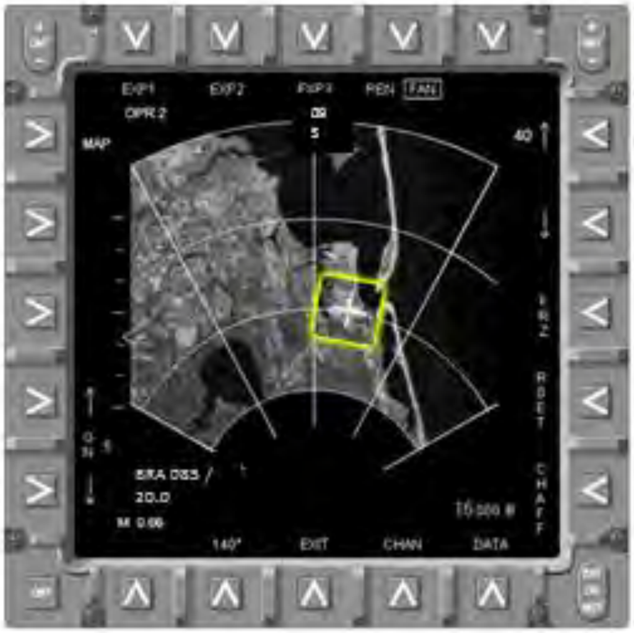


Figure 1-10 Stabilized Cue on Target Area

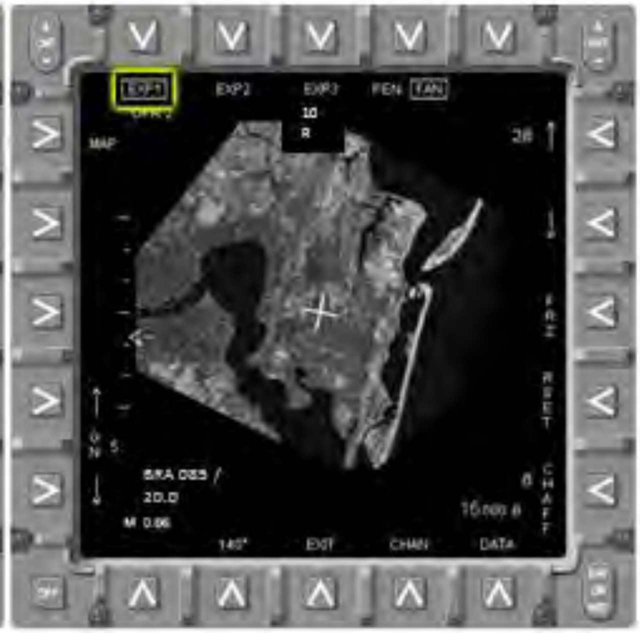


Figure 1-11 EXP 1 Picture of Target Area

The target is a small building southeast of the intersection of runways at NAS Pensacola. A building this small would be impossible to break out using RBGM. Figure 1-10 shows a designation in RBGM. Notice the correlating features that can be use to find the general vicinity of the airfield. Figure 1-11 shows the designation in EXP 1. After designating in RBGM, EXP 1 can be selected to build the map. EXP 1 allows further break out of correlating features such as roads or large buildings. Squint angle must be accounted for when using EXP modes.

Figure 1-12 EXP 2 Updated Designation Cue

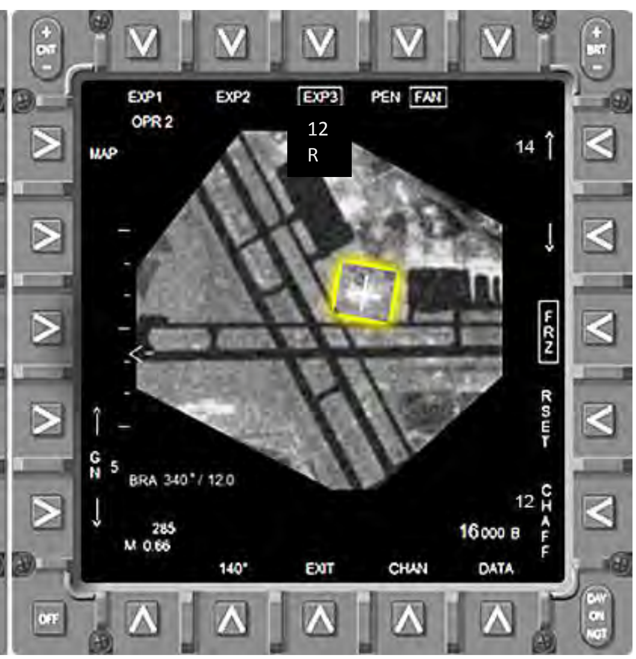


Figure 1-13 EXP 3 Stab. Cue on Target

Figure 1-12 shows further refinement in EXP 2. Here we can break out runways, taxi ways, roads, and buildings. Further enhancement to EXP 3 in Figure 1-13 can break out even smaller targets, such as the small building to the southeast of the runway intersection.

The procedures for using expand modes is similar to designating in RBGM. After making a designation, refine the designation in the next EXP mode (note it can take up to 20 seconds to build these detailed maps). Similar to RBGM designation procedures, box FRZ when the point is identified and update the designation. If the point is not identified in any EXP mode, back out to the previous mode to cross check the designation placement.

109. ROUTE EXIT AND RETURN TO BASE (RTB)

The mission is not complete until engine shutdown. It's important to be familiar with the administrative procedures associated with safely getting back home.

1. RTB Considerations

    a. Initiate and maintain a VMC climb on a heading to your next navigational point. Be cognizant of Class B or C airspace and other working areas. Select the appropriate NAVAID on the HSI and be sure the pilot changes the squawk to 1200.

    b. Check off the route with FSS.

    c. Initiate the FENCE-out checks.

        i. Lead SNFO (AUX): *"Hammer, button 19 PRI, FENCE out."*

        ii. Wing SNFO (AUX): *"Hammer-12."*

    d. Obtain IFR clearance or remain VFR if briefed.

    e. Confirm FENCE-out

        i. Lead SNFO (AUX): *"Hammer-11, FENCED out, 1.1."*

        ii. Wing SNFO (AUX): *"Hammer-12, FENCED out, 1.0."*

    f. Complete Battle Damage checks.

    g. Clear wingman and get ATIS at the briefed point.

CHAPTER TWO
MISSION PLANNING

200. INTRODUCTION

Primary and intermediate Student Naval Flight Officer (SNFO) training provided the basic knowledge and skills necessary for the successful planning and execution of flights. The T-45C advanced syllabus will build upon these skills with the introduction and practice of section procedures, and coordinated tactical target attacks with simulated or inert ordnance delivery. Emphasis during the Strike stage will be on strike route procedures, target acquisition, situational awareness, air-to-ground timeline awareness, and crew coordination. As with any syllabus flight, basic contact flight procedures will be the bedrock of every successful event. The student's proficiency in the operation of the communications and navigation equipment will be emphasized.

In a hostile environment, modern-day strike tactics generally entail precision ordnance delivery from a high-altitude sanctuary. Technology provides strike aircraft with the capability for long-range accuracy from high altitude. However, low-altitude tactics and ordnance deliveries are sometimes required due to system degradations, tactical requirements such as "close air support" (CAS), and enemy Integrated Air Defense Systems (IADS). The VT-86 Strike syllabus is designed to expose the SNFO to both high- and low-altitude tactics and procedures.
Before executing either of these deliveries, the target must be acquired. When planning radar-aided navigation or target area ingress, it is critical to understand the echo potential, or reflectivity, of a given object or geographical feature. The following variables affect echo potential (Figure 2-1):

1. Aspect angle or angle of incidence with which the radar energy strikes the contact

2. Radar power output

3. Distance between own ship and target

4. Target shape

5. Composition of target; a steel target has more "echo potential/reflectivity" than a wooden target.

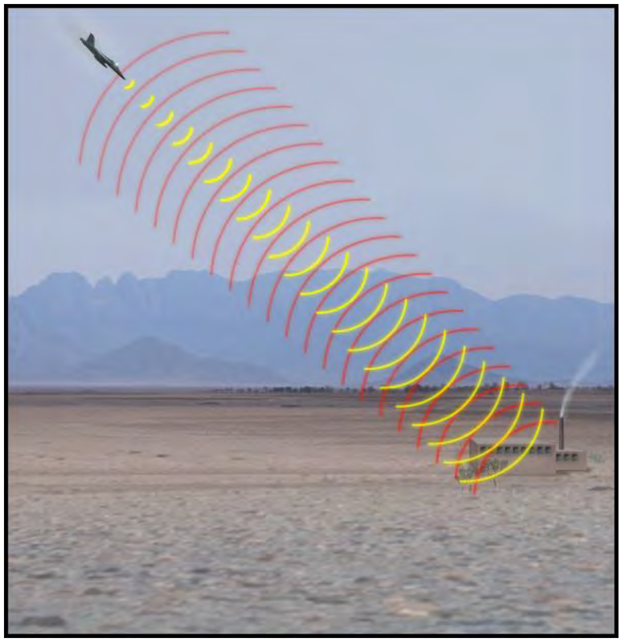


Figure 2-1 Echo Potential for a Target

Man-made metal objects with a vertical rise are very radar significant; they show up as hard, white returns on the radar. Large, extended cultural or natural features are also radar significant. For example, a beachfront or the edge of a lake will be radar significant. The water beyond the shoreline will be seen as a dark shadow. Mountain ridges are easily seen as they cast a shadow over the ground behind them. Towns and cities will show returns as bright white due to all the man-made structures. From a distance, the city may appear as one large white radar return.

As the aircraft gets closer and the radar picture is expanded to show more fidelity, the roads and structures begin to be individually distinguishable. Runways, due to their length, concrete composition and extended straight lines are easily distinguished on a radar picture; roads and concrete show up as dark shadows. Figure 2-2 provides examples of radar returns in a mountain range, around a shoreline/lake with nearby city/town hard white returns and an expanded view of an airport to illustrate dark runway and white airport building returns.

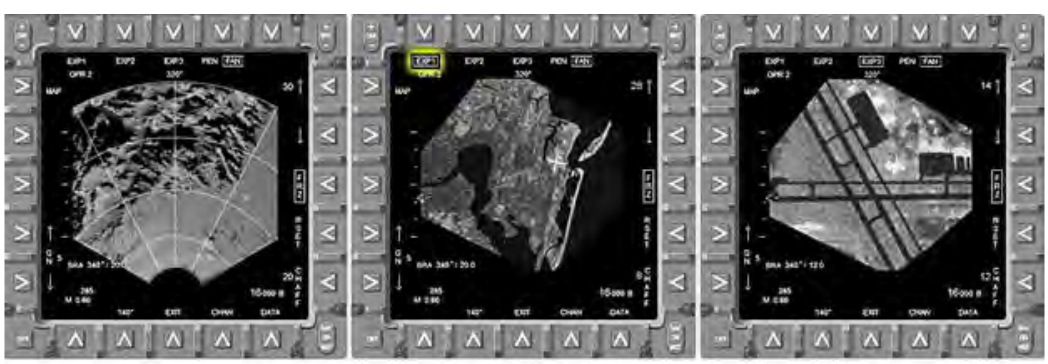


Figure 2-2 Mountains (Left), Shoreline/Lake (Middle), Airport (Right)

201. CHART PLANNING

As with all facets of aviation, pre-flight planning is paramount. The SNFO will be required to plan the flight from start to shutdown, including all administrative and tactical procedures. Contingency planning must be incorporated into each flight. It is rare for a flight or strike to go perfectly according to plan; therefore, "what if" scenarios must be considered. Weather, Air Traffic Controller (ATC), enemy forces, aircraft emergencies, weapon failures, etc., are a few of the issues encountered on any given flight. Thorough contingency planning will provide the flexibility to handle deviations from the plan and still accomplish the mission.

1. Charts

The Lambert Conformal Chart is the most common type of aeronautical chart. A straight line on this chart approximates a great circle route. Lambert charts have the following general characteristics (Figure 2-3):

a. Shortest path between two points across the surface of the earth

b. Used for distances greater than several hundred miles

c. Scale from a point is the same in all directions throughout a single chart.

d. Angles are correctly represented and small shapes correctly proportioned.

e. Long range charts are for high altitude.

f. Short-range charts are for low altitude.

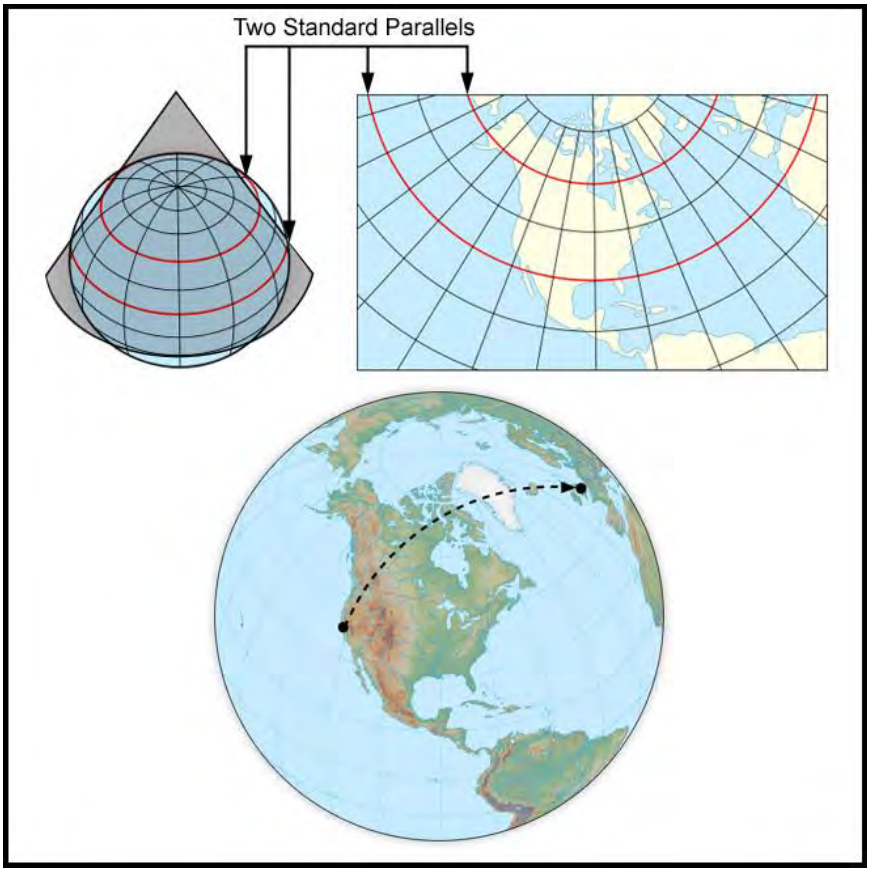


Figure 2-3 Lambert Conformal Chart

To tactically operate in airspaces, different charts will be used to provide detail and fidelity. The following charts are the most commonly used for aviation (Figure 2-4).

a. Global Navigation Chart (GNC) – 1:5,000,000 scale. Used for long-range preflight planning (Chart 1 in Figure 1-2).

b. Jet Navigational Chart (JNC) – 1:2,000,000 scale, long-range (three JNCs cover the same area as one GNC) (Chart 2 in Figure 1-2).

c. Operational Navigation Chart (ONC) – 1:1,000,000 scale, medium-range (25 ONCs cover one GNC); the ONC will be used to make the divert chart for any given route (Chart 3 in Figure 1-2).

d. Tactical Pilotage Chart (TPC) – 1:500,000 scale, planning and in-flight below 18,000 feet (four TPCs cover one ONC); the TPC will be used for strip chart production (Chart 4 in Figure 1-2).

e. Joint Operations Graphics (JOG) – 1:250,000 scale, used for tactical air support/assault missions.

From a tactical perspective at VT-86, the ONC and the TPC are the charts most applicable to the UMFO syllabus and are therefore the most commonly utilized.

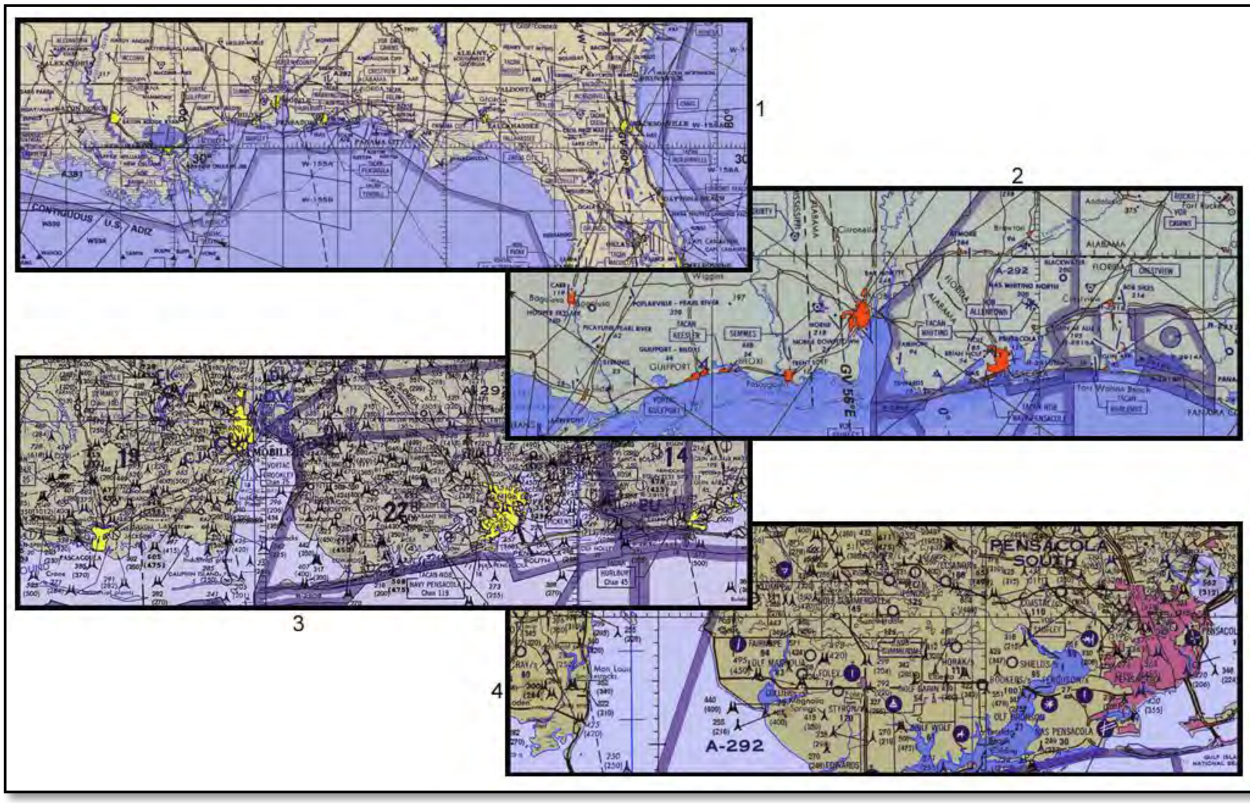


Figure 2-4 Chart Types

The chart scale is the ratio between the dimensions of the chart and the dimensions represented by the chart. An ONC scale of 1:1,000,000 means one inch on the chart equals 1,000,000 inches (approximately 14 miles on the ground). On a TPC chart, one chart inch equals 500,000 inches (approximately 7 miles). Lower scales equate to higher detail on the chart.

2. Chart Information

The TPC chart relief depicts the physical feature related to the differences in elevation of the land surface. The basic contour level is 500 feet, the intermediate level is 250 feet, and the auxiliary level is 100 feet. There are also spot elevations and three-dimensional relief shading in the charts. The following are specific features detailed in the TPC:

a. Hydrography – detailed drainage patterns or shorelines

b. Culture – same as ONC, plus pipelines or features selected for rapid recognition

c. Vegetation – perennial vegetation shown by symbol

d. Aeronautical – aerodromes and vertical obstructions 200 feet or more AGL

e. Contour lines connect points of equal elevation (Figure 2-5)

   i. Lines closer together indicate steep slopes, further apart indicate gentle slopes.

   ii. Depression contours are indicated with ticks added on the downward slope.

f. Elevations (Figure 2-5)

   i. Maximum elevation features (MEF) are computed by the National Imagery and Mapping Agency (NIMA) and take into account both terrain and obstacles.

   ii. If the highest feature within a lat/long grid is terrain or a man-made vertical obstruction, NIMA adds 200 feet to the terrain elevation, plus the vertical accuracy of the point, rounded to the nearest 100 foot value.

g. Transportation Lines (Figure 2-5)

   i. Dual-lane highways

   ii. Primary roads

   iii. Bridges

   iv. Power transmission lines

   v. Railroad tracks

   vi. Funneling features into towns/cities

Figure 2-5 Contour Lines/Spot Elevations/Transportation Lines

3. Cultural Features

Man-made structures appearing on charts are cultural features. The true representative size and shape of larger cities/towns are shown. The main factors dictating the amount of detail given to cultural features include (Figure 2-6):

a. Chart scale

b. Intended use of the chart

c. Area covered

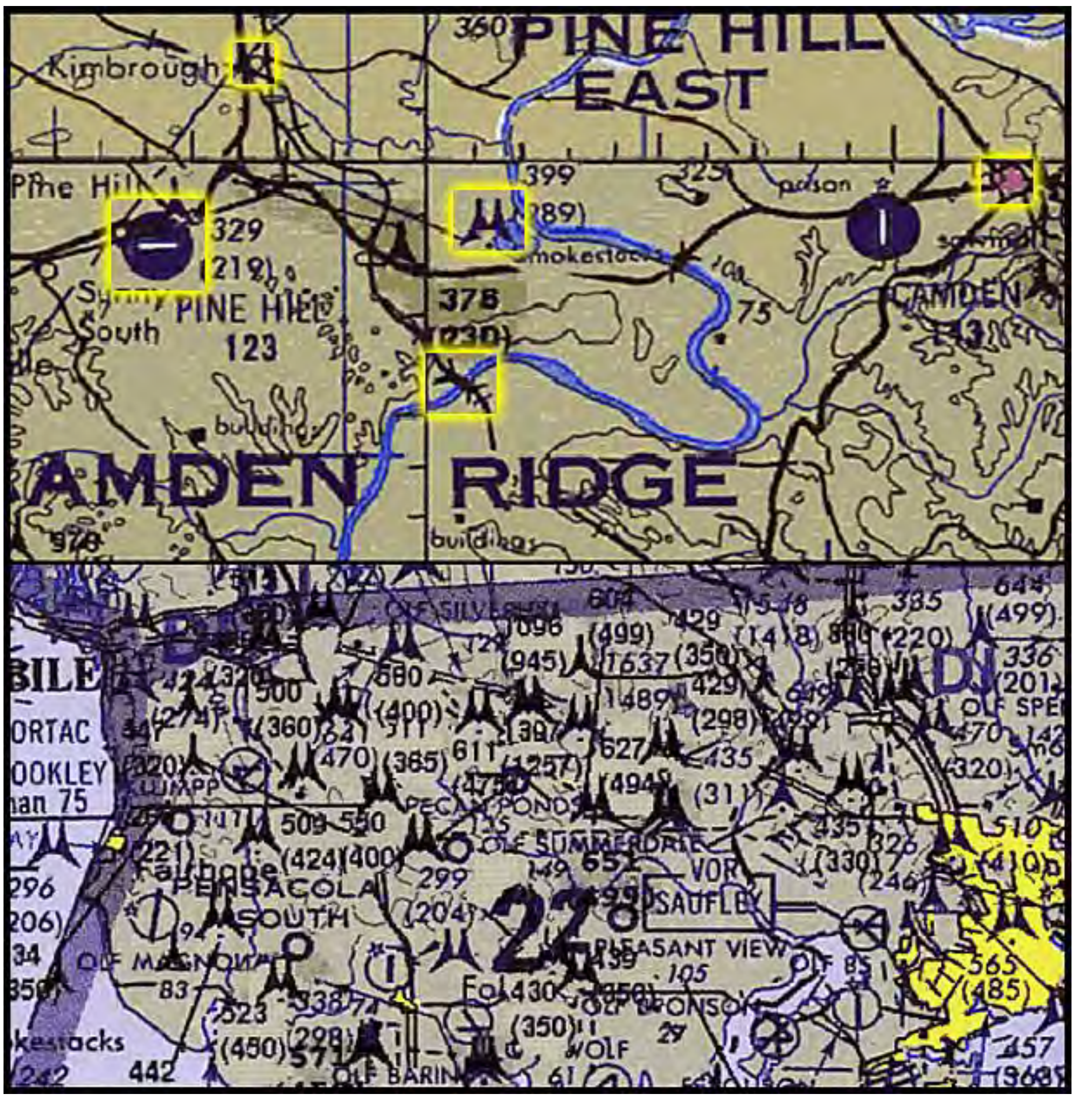


Figure 2-6 Cultural Features on a Chart

202. MILITARY TRAINING ROUTES (MTR)

The missions in the Strike phase will use the following types of airspace:

a. Military Training Routes (MTRs)

   i. Visual Routes (VR)

   ii. Instrument Routes (IR)

b. Military Operating Areas (MOAs)

c. Warning Areas (W)

d. Restricted Areas (R)

MTRs are designed to give military aircraft an area in which to practice both navigation and tactical procedures. While there are several different types of routes, VT-86 primarily utilizes VR and IR routes. Military aircraft utilizing these routes are exempted from the 250 KIAS airspeed limitation below 10,000 feet. To exercise this privilege safely, it is crucial to always squawk the appropriate transponder codes while on the route. Care should be taken to not exceed the 250 KIAS airspeed limit until established on a published route.

The routes listed in AP/1B are the official DoD/FAA approved routes. Each of the listed routes includes a route description consisting of:

a. Latitude/longitude of each point along the route

b. TACAN radial and DME fix identification for each point on the route

c. Altitude blocks

d. Avoidance areas

e. Special Operating Procedures

f. Originating and Scheduling Activities

All routes must be scheduled at least ***two hours*** prior to the desired entry time. This is an FAA requirement and should be coordinated appropriately. Events will be scheduled for either a stereo route or a DD-175. Schedule officers will normally provide a stereo route for scheduled events. If a stereo route is not to be used, they will annotate DD-175 in the flight schedule notes. The SNFO is responsible for checking the web-based Route Manager to confirm the time and route.

MOAs, Warning Areas, and Restricted Areas have detailed entry/exit procedures, operating procedures, area constraints, and scheduling procedures. In addition to this information, the SNFO is also responsible for knowing the vertical and horizontal constraints of the scheduled area, as well as frequencies and general operating procedures.

1. IR Route Planning

The IR routes will be used during the early strike stage events, with a focus on basic radar acquisition skills. The SNFO may also expect the same flights to be accomplished in a MOA. The A/G timeline will be referenced but not as heavily emphasized in later stage events. The SNFO will be required to file and fuel-plan these route/MOA flights in the same manner as the low-level routes. To the maximum extent possible, 360 kts groundspeed should be planned during these target acquisition events. See the strike stage planning guide for a list of all routes that will need to be prepared for both HATA and low level routes.

The strip chart planning for IR routes will be the same as the VR route chart procedures detailed later in this chapter, with the exception of using ECHUM. Since the routes will be flown at higher altitudes, the ground obstructions associated with ECHUM are not needed and will clutter the chart. However, the SNFO will be responsible for all other route instructions, procedures, and restrictions listed in the AP/1B. For the initial high altitude radar target acquisition (HATA) flights, the IR-37 and the IR-40 are normally used. Any locally generated NPA route or a flight into the Gator or Desoto MOA could also be utilized for these early stage events. In these events, SNFOs will be provided ample time and materials in order to prepare for the flight. For the IR-37 and IR-40 routes, Figure 2-7 and Figure 2-8 list the AP/1B points to be used.

PT	DESCRIPTION	TACAN CUT	LAT./LONG.
A	DAM	SJI099002	N3043/W8819
B	RD BRIDGE	GPT027033	N3053/W8846
C	LEAKESVILLE	LBY107043	N3109/W8834
D	HESSLER-NOBLE APT	LBY025017	N3140/W8910
E	RIVER BEND (Leftmost)	PCU353026	N3100/W8945
F	LAKE	PCU055009	N3038/W8935
G	AIRPORT	GPT	N3024/W8905

Figure 2-7 IR-37 Points

PT	DESCRIPTION	TACAN CUT	LAT./LONG.
A	PENINSULA	SJI169022	N3022/W8819
B	DAM	SJI099002	N3043/W8819
C	CITRONELLE	GCV084013	N3105/W8814
D	WAYNESBORO	LBY061039	N3141/W8838
E	HESSLER-NOBLE APT	LBY025017	N3140/W8910
F	RICHTON	LBY096021	N3121/W8856
G	LEAKESVILLE	LBY107043	N3109/W8834
H	BRIDGE	GPT027033	N3053/W8846

Figure 2-8 IR-40 Points

2. VR Route/Low-Level Standard Operating Procedures (SOP)

The following procedures are considered SOP for all low-levels at VT-86:

a. Aircrew shall enter the low-level route no earlier than (NET) 30 minutes after sunrise and shall exit the low-level route NLT 30 minutes prior to sunset.

b. Brief and abide by Low Altitude Training Rules as published in the TW-6 In-flight Guide.

c. G-warm maneuvers will be performed at 300 KIAS above 5000 feet AGL when practical, but in no case lower than 2000 feet AGL.

d. Bird/Wildlife Aircraft Strike Hazard (BASH)

  i. Aircrew will check the U.S. Bird Avoidance Model (BAM) and Avian Hazard Advisory System (AHAS) forecasts prior to briefing low-levels.

  ii. The BASH can be found at the US AHAS website (http://www.usahas.com/home/) or via the Naval Safety Center links.

Figure 2-9 Bird Strike; Check the BASH!

e. Weather and Turbulence

  i. Minimum acceptable weather conditions for conducting low altitude training is 3000 feet AGL ceiling, visibility of at least 5 SM, and a defined horizon.

ii. Check weather along route in addition to destination and divert fields.

iii. VT-86 T-45C aircraft shall not be flown in areas where greater than moderate turbulence is forecasted.

iv. If aircrew experience greater than moderate turbulence in the low-level environment, low-level flight shall be discontinued.

v. Low-level flights in designated mountainous terrain shall not be flown if moderate or greater turbulence is forecast or experienced.

f. DD-175 – Required if no stereo route scheduled

i. Final copy needs to be completed with no mistakes and ready to enter on the Flight Weather Briefer by brief time.

ii. DD-175 entry and exit points must use the actual AP/1B defined points.

iii. If SNFO desires to deviate from stereo route for RTB, a DD-175 is required.

iv. DD-175-1 Weather Brief (hard copy) is required for each event.

(a). Primary method is via Naval Weather Briefer (http://fwb.navo.navy.mil/fwb11/).

(b). Can be via phone (call and fax from Weather Shop), extension – 3644, VT-86 fax is extension – 3020

(c). Naval Station Norfolk main WX info, 1-888-PILOT-WX

(d). If flight delayed, call Weather Shop for an update.

203. LOW-LEVEL PLANNING

Do not plan routes until completion of Joint Mission Planning System (JMPS) class, but be familiar with the Strike Stage Planning Guide. Bring all applicable charts to each event (with completed jet cards). JMPS may be utilized, but charts are to be constructed using flip-style format on card stock. Students are required to prepare original HATA and low-level strip charts IAW the Strike Segment Planning Guide. The following guidelines apply:

1. Charts are not allowed to be in clear kneeboard sleeves.

2. No “comm script” is permitted on low-level chart.

Students are responsible for preparing briefing boards for each event; portable briefing boards are not authorized. Briefing boards will be written by hand with the following exceptions:

1. Charts depicting route of flight

2. JMPS depictions of low-level or CAS charts

Joker fuel will be set in the Bingo bug for all events. Wingman will advise Lead when Joker state is reached, and Lead will acknowledge. Do not rely on the flashing "BINGO" cue for fuel state awareness; a vigilant scan shall be implemented to stay aware of fuel state.

Several routes cross the VR-1021 and VR-1024; therefore, SNFOs are required to contact the route scheduling authority for route de-confliction. Approaching all route intersections ***(for example PT C and E on VR-1021)*** the SNFO will make an advisory call on the FSS frequency. SNFO will follow all directives on the AP-1/B, strike notes and strike segment planning guide.

The T-45C low-levels will be flown at 360 kts ground speed, 500 feet AGL. ***VR-1021 Minimum Altitude will be 1500 AGL until PT B***. After PT B, 500 feet AGL and AP/1B instructions apply.

Overall, SNFO low-level expectations are:

1. Successfully transit to and from the low-level route in accordance with standard section and contact flight procedures.

2. Make recommendations, working with your pilot, to maneuver the flight within the confines of the route boundaries to maintain SA and adjust timing.

3. Arrive at route entry point during low-level flight evolution +/-4 min. of scheduled entry time.

4. Visually identify and arrive on target during low-level flight within +/-1/2 nm and +/-30 seconds.

5. Make the appropriate ICS and UHF comms along the route.

6. Execute standard turn point procedures during flight evolution without error.

7. Recognize winds and groundspeed as required to maintain SA and time.

204. STRIP CHART LAYOUT AND PREPARATION

1. Divert Chart

You will be required to create two types of charts at VT-86; the strip chart (sometimes called a flip chart that will be discussed next), and the other is a divert chart that will be on a single page kept with your strip chart.

Divert charts will be created with an ONC chart (Figure 2-10) and will contain an overview of the route with divert data. This chart is designed to be used as a quick reference in the cockpit.

It is typically used for reference while transiting to and from the route, as well as any time your aircraft is in extremis while on the route. Divert chart data will include:

a. Divert airfields

b. Divert airfield information

c. Entire route from entry to exit

d. Highlighted boundaries of all SUA's and class B, C, and D airspaces near route

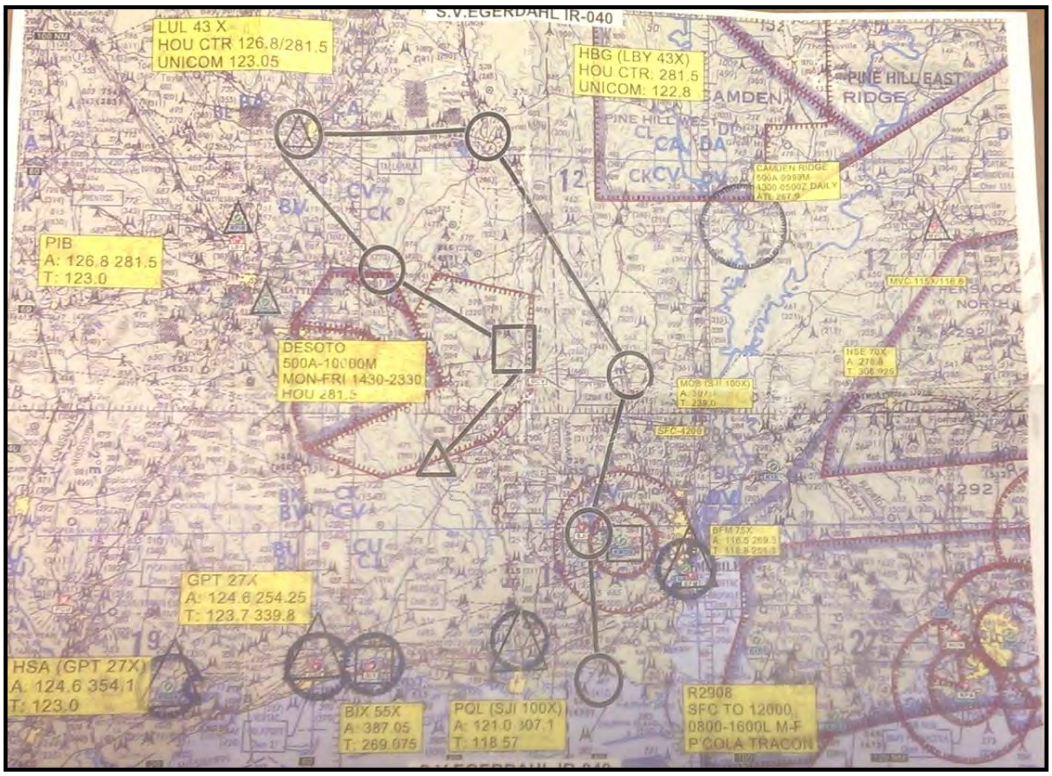


Figure 2-10 ONC Used for Divert Charts

On the divert chart, a minimum of two military fields and two civilian fields should be present. The following information should be listed:

a. Military airfields annotated with a square

b. Civilian airfields annotated with a triangle

c. Field identifier

d. Corresponding TACAN/VOR

e. Approach and tower control frequencies (yellow highlighted info boxes)

Additionally, the SNFO should be familiar with the published instrument approaches available at the divert airfields.

2. Preparation area

   The chart planning room and JMPS room, located in the VT-86 academic (TnC) building, contain all of the equipment necessary to prepare any and all routes required in the Strike syllabus. The final product, a route strip chart, should be approximately kneeboard size when closed. Larger strip charts are difficult to manage in the tight confines of a T-45C cockpit. The divert chart should be of sufficient size to cover the operating area of the route.

3. All charts will adhere to the following standards:

   a. Chart size will be approximately kneeboard sized when closed.

   b. Signature with a black ball point pen on the outside corner of the chart

   c. Name, class number, NPA-XXX, VR-XXXX (with black felt tip pen on the outside)

   d. ECHUM date (annotated on the back)

   e. Name printed on each JMPS page

   f. Glue copies of:

      i. AP/1B route (on strip chart cover)

      ii. Strike Stage Guide route information

      iii. Route Entry Checklist

      iv. "Z" diagrams adjusted for terrain elevation for second block events only (depicted in margin near target and annotated in MSL altitudes)

SNFO will reference the current strike stage planning guide for a list of all required strip charts. The SNFO will incorporate the following into each chart:

   a. Plot the official AP/1B points.

   b. Using JMPS, annotate the exact AP/1B points (A, B, C, etc.).

   c. Draw the corridor. Reference the special operating procedures to help determine the route structure. JMPS should allow you to easily depict these corridors.

   d. Plot the geographically significant points from strike segment planning guide.

e. Plot each turn point with the 360-knot circle.

f. Plot a turn radius for every turn greater than 30 degrees.

g. The target triangle is a 5 nm equilateral triangle.

h. Place time ticks every minute based on 6 nm per minute at a speed of 360 kts to the target.

   i. Select minor tick marks on right side of centerline.

   ii. Select major tick marks, every third tick mark, right side of centerline, with clock time shown.

i. Place major distant ticks on left side of centerline every 6 miles from each turn point.

j. Assume no wind for planning purposes. The SNFO will obtain forecast winds prior to takeoff. If route winds are forecast to be 20 kts or greater:

   i. Adjust no-wind headings and base airspeed, as necessary, to maintain preplanned course and time.

   ii. If winds are less than 20 kts, fly pre-planned headings and airspeed.

k. The strip chart should encompass the area at least 10 nm on either side of the route centerline; this allows adequate chart reference in the event the flight is off course.

   i. Flight outside the route corridor is not authorized.

   ii. If outside or above the route below 10k for any reason, maintain 250 KIAS and squawk 1200.

l. Label each turn point (TP) or target (TGT) with the appropriate LETTER and time.

   i. Orient the information parallel to the inbound course.

   ii. JMPS will measure distances to each turn point to the nearest tenth of a mile. This means times will be labeled to the nearest second.

m. If a TP is within 6 nm of the AP/1B point, it will be designated with the same letter. If a TP falls between AP/1B points, it will be numbered sequentially using the letter of the preceding AP/1B point. For example, if a TP falls between PT B and PT C, it will be labeled 1B. A subsequent TP between B and C would be 2B. (Figure 2-11)

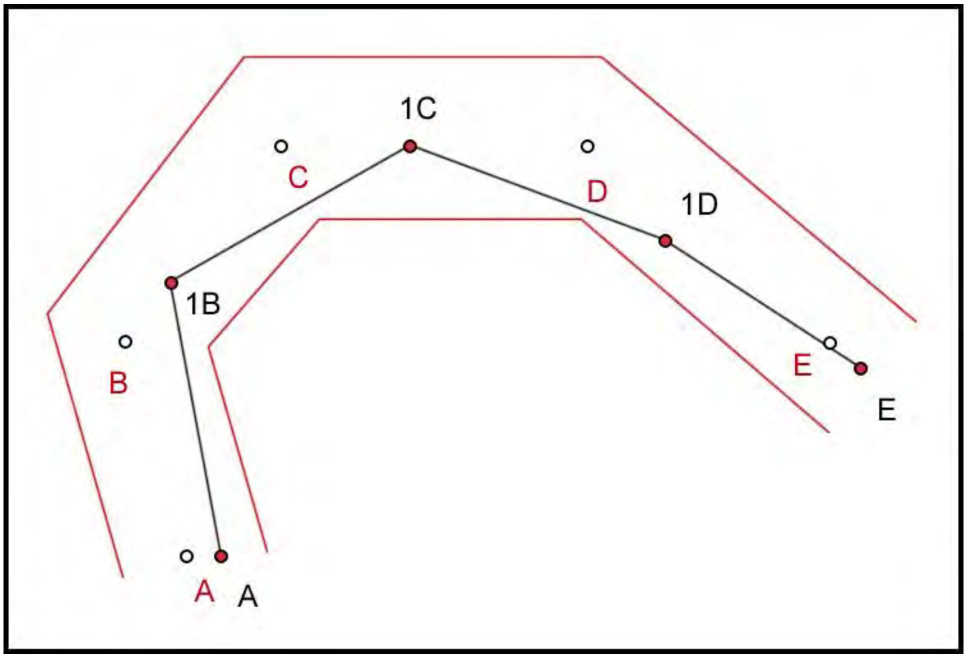


Figure 2-11 Route Point Naming Convention

n. Special use airspace such as Restricted Areas and MOAs shall be highlighted and annotated on the chart.

   i. Annotate all areas within 20 nm of course.

   ii. Include altitudes, operating times, and any frequencies that require transmission.

   iii. Annotate all class "B" and"C" airspace by drawing a circle around the airfield.

o. Hazards to flight shall be annotated on all charts. Hazards include or may be found in the following:

   i. All towers and obstructions within 5 nm of course whose altitude is 400 feet AGL or greater. These must be verbalized on the route as a hazard as well.

   ii. Hard surfaced airports within 5 nm of course. These should be avoided by 3 nm or 1500 feet. Annotate on JMPS with a red 3 nm diameter circle.

   iii. Crossing routes:

      (a). Use VFR sectional map to locate conflict routes identified in the AP/1B.

      (b). Draw a single labeled arrow in green using JMPS to indicate the direction of the conflicting route (this arrow should be outside route corridor).

      (c). A call on 255.4 during the flight is required at route conflict points.

Hazards may be found in the following:

1. NOTAMs and TFRs

2. STAN notes and Strike Segment Planning Guide

   a. A photocopy of the AP/1B route description will be glued to the strip chart cover. "Z" diagrams (to be addressed later) will be adjusted for terrain elevation, depicted in the margin near the target and annotated in MSL altitudes for the second block of strike flights only.

   b. There are several noise sensitive areas on the local routes. The SNFO will annotate these and avoid them as necessary as per the instructions in the AP/1B or CHUM. Crossing routes are not required on VT-86 charts, but solid situational awareness will require familiarity of such potential hazards.

Figure 2-12 lists the geographically significant points that will be used for TPs or TGTs on the VR-1021 A-E and VR-1024 H-M routes:

VR1021		VR1024	
Point	Description	Point	Description
A	Tip of Peninsula	H	Bay Springs
B	Highway Bridge Over Small River	I	Town of DeSoto
C	Power Plant (South End)	J	Dam on a Lake
D	Abandoned Mine on River	K	325’ Tower
1D	Lock and Dam	L	Town of Deer Park
E	RR Trestle Over Creek	M	RR Bridge Over River

Figure 2-12 VR 1021 and VR 1024 TPs or TGTs

All charts will include doghouses filled in with the appropriate data. Required doghouse data will include (Figure 2-13):

1. MC – Magnetic Course to next turn point

2. DIST – The total leg distance to the next turn point (measured to the nearest tenth)

3. ETE – Estimated Time Enroute. This is the leg time to the next turn point (measured to the nearest second)

4. ESA – Emergency Safe Altitude. This is an MSL altitude specific to each leg that will provide at least 500 feet vertical clearance from the highest obstruction within 10 nm. Minimum altitude to climb to in the event of disorientation or entry into inadvertent IMC conditions on the route. Calculate the ESA as follows:

    a. Take the highest MEF (block altitude) along the leg and add 500 feet.

    b. If there is any CHUM tower within 10 nm of leg course line, round its altitude up to the next 100 feet and add 500 feet.

    c. Pick the higher of the two figures and this is the ESA for that leg.

    d. TACAN Radial and DME to the turn point (not necessarily the AP-1/B point).

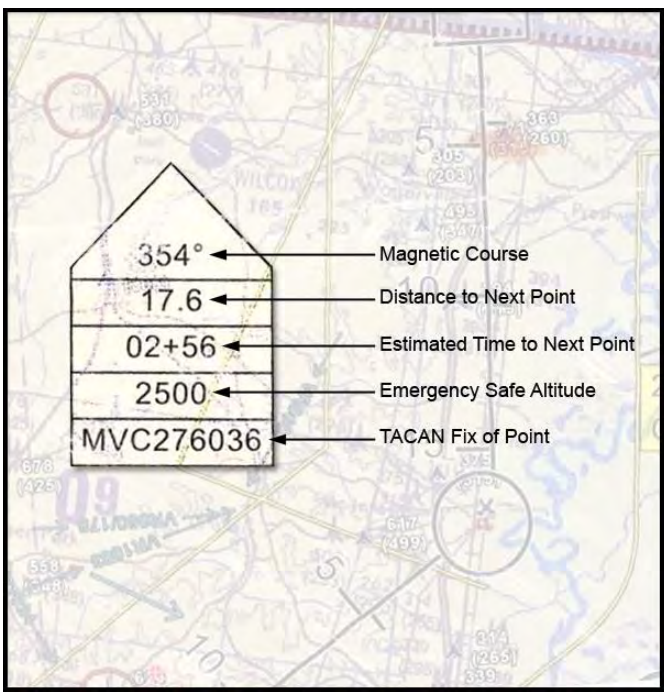


Figure 2-13 Doghouse Information

205. FUEL PLANNING

Obviously, fuel requirements are a chief concern in mission planning. In addition to having enough fuel for the engine start and taxi, transit to the target area, RTB and approach, the tactical portion of the strike must be taken into consideration. Tactical strikes often require higher burn rates due to tactical airspeeds.

SNFO will be required to set the fuel alerter (Bingo bug) to a state that they determine during planning. Those fuel states will be called Joker, Bingo and Divert fuel states. Joker is used as a buffer or a warning fuel to aircrew and is 200 pounds above Bingo. This gives aircrew time to think about the decisions that must be made before Bingo fuel state is reached. Joker will be set into the alerter before takeoff, once the flight has reached that fuel state, they will reset the alerter to the Bingo fuel. The value set into the alerter for Bingo shall be the Bingo fuel for the farthest point on the route to the planned destination. When Bingo fuel state is reached the Divert fuel state will be entered into the alerter. This value is set to let the aircrew know that they will need to decide whether to continue to their destination or discontinue the approach and proceed to their alternate.

T-45C strike routes will be flown at 360 kts groundspeed in the tactical arena. The SNFO is responsible for creating a viable fuel plan to include contingency fuel considerations for each flight. The chart in Figure 2-14 should be used as the T-45C fuel planning guide. JMPS will also calculate fuels, but these will only be used to help the SNFO validate his fuel calculations.

At each turn point on the strip chart, the SNFO will ensure that Emergency Divert fuel has been calculated and annotated on the chart. Each turn point will include Leg Fuel (fuel burn calculated for that leg of the route) and Estimated Fuel Remaining (EFR), in addition to the above listed requirements.

In the margins of the strip chart, at each turn point, there will be an information box that will have all of the fuels information on it. The EFR and MCF should be entered in pencil.

A blank example of the information box is provided here:

Leg Fuel____________
EFR @______________
MCF @_____________
Bingo_______________
Emerg Divert_________

NOTE

> The @ symbol is used to minimize confusion by letting you know that the EFR/MCF is the fuel for that turn point, not the next turn point.

Example:

Leg Fuel 125
EFR @ 1.1
MCF @ 0.9
Bingo 090/52 nm/18K/700 lbs
Emerg Divert 310/24 nm/5K/420 lbs

STANDARD T-45C FUEL PLANNING DATA

Based on T-45C NATOPS flight manual. Actual performance will vary with nonstandard temperature, winds, and varying gross weights. For initial planning only.

Total usable fuel	2938 lbs
Start/Taxi/Takeoff	200
Penetration approach	250
GCA	250
Reserve (20 min @ 10,000 FT MSL)	300

LOW LEVEL

360 KGS, 12K GW = 6.6 lbs/NM and 2,375 PPH
300 KGS, 12K GW = 5.0 lbs/NM and 1500 PPH

JP-4 = 6.5 lbs/Gal **JP-5 = 6.8 lbs/Gal** **JP-8 = 6.7 lbs/Gal**

CLIMB OUT (Using climb schedule: 250 KIAS to 10K, 300 KIAS to intercept .72 IMN)

ALTITUDE	KIAS	NM	TIME	FUEL USED
5,000	250	04	0+01	60 lbs
10,000	250	10	0+02	120
15,000	300	20	0+04	190
20,000	300	28	0+06	260
25,000	292/.72	38	0+08	360
30,000	263/.72	53	0+10	440
35,000	235/.72	70	0+12	540
40,000	209/.72	80	0+16	600

ENROUTE

ALTITUDE	#/NM	IMN	CAS	#/HR	TAS
5,000	5.21	.43	260	1460	280
10,000	4.72	.45	250	1345	285
15,000	4.08	.49	245	1245	305
20,000	3.69	.52	240	1180	320
25,000	3.46	.56	230	1160	335
30,000	3.24	.61	225	1165	360
35,000	2.90	.65	220	1090	375
40,000	2.84	.68	200	1110	390

DESCENT

ALTITUDE	KIAS	NM	TIME	FUEL USED
5,000	195	12	0+03	25 lbs
10,000	195	28	0+07	80
15,000	195	39	0+10	90
20,000	195	53	0+14	125
25,000	195	68	0+17	150
30,000	195	85	0+21	175
35,000	195	100	0+24	210
40,000	195	116	0+26	225

OPTIMUM ALTITUDE and SPEED

GROSS WEIGHT	IMN	ALT	#/NM
13,000	.68	36,800 ft	3.08
12,000	.68	38,400 ft	2.86
11,000	.68	39,600 ft	2.63

Figure 2-14 T-45C Fuel Planning Chart

1. Leg Fuel – Amount of fuel (in lbs) used on that leg is calculated during mission planning.

2. EFR – Estimated Fuel Remaining is calculated during mission planning.

3. MCF – Amount of fuel required to complete the route, return to planned destination via standard routing (including approaches for training or weather), and arrive with the following fuel:

    a. VMC: SOP minimum fuel (500 lbs) on deck or fuel to proceed to alternate and arrive above SOP emergency fuel (400 lbs), whichever is higher.

    b. IMC: SOP minimum fuel (500 lb.) on deck after approach, or fuel to proceed to alternate IAF for duty runway, fly approach and arrive above SOP emergency fuel (400 lbs), whichever is higher.

4. BINGO – Amount of fuel required to fly from that point to the planned destination using standard routing to arrive with:

    a. VMC: SOP minimum fuel (500 lbs) on deck or fuel to proceed to alternate and arrive above SOP emergency fuel (400 lbs), whichever is higher.

    b. IMC: SOP minimum fuel (500 lbs) on deck after approach, or fuel to proceed to alternate IAF for duty runway, fly approach and arrive above SOP emergency fuel (400 lbs), whichever is higher.

    c. The information provided in the box will include heading and distance from that point to the planned destination, altitude you would use for that distance (see in-flight guide), and the fuel used from chart above.

5. EMERGENCY DIVERT: Emergency fuel required to fly a Bingo profile from that point to the nearest suitable divert, arriving with the published NATOPS reserve fuel (300 lbs).

    a. The information provided in the box will include heading and distance from that point to the nearest suitable divert, altitude and fuel needed to fly the Bingo profile.

NOTE

Reference the Gear up – Flaps Up page of the blue section of the PCL for Emergency Divert Fuel and Flight Profiles.

206. CHECKPOINT SELECTION

In addition to turn points and targets, various checkpoints along the route will be used for timing and course corrections. These checkpoints are radar significant ground features or visually significant points that facilitate route navigation in terms of time and distance. Vertical developments and terrain contrasts generally make for good checkpoints. Choose checkpoints that are easy to find such as:

1. Communication Towers

2. Fire Towers

3. Buildings (towns/cities)

4. Significant Terrain

    a. Mountains/Ridges

    b. Valleys

    c. Lakes

5. Horizontal Checkpoints/Lines of Communication

    a. Roads

    b. Rivers

    c. Railroads

    d. Power Lines

The chart in Figure 2-15 depicts various features that could be selected for checkpoints. It is recommended that these checkpoints are highlighted, and you must have at least one intermediate check point per leg. Information about that check point will be provided in the margin of the strip chart adjacent to the check point.

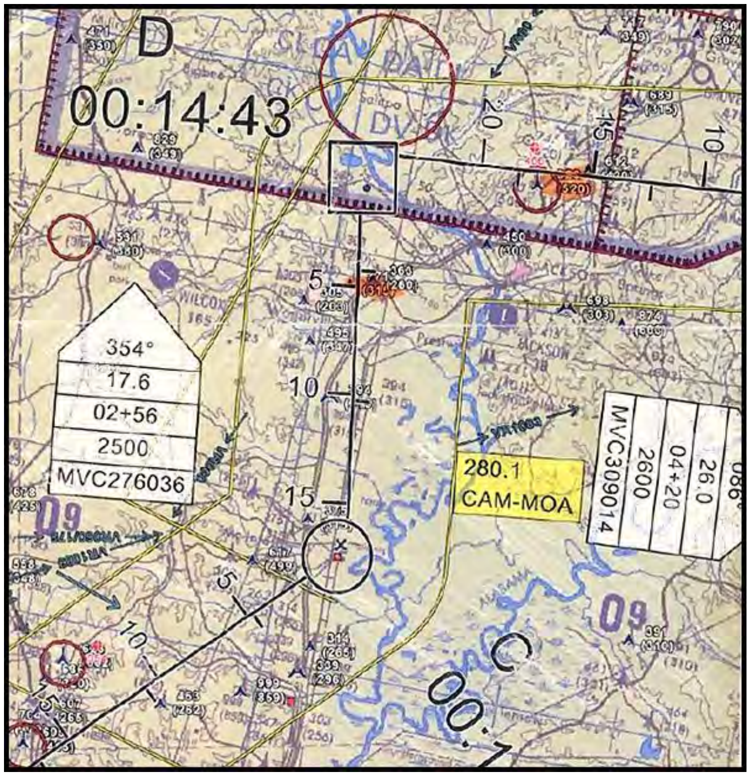


Figure 2-15 Checkpoint Selection

When selecting checkpoints, adhere to the following:

1. Annotate all checkpoints by labeling time to the nearest second.

2. Do not select anything inside the turn point circle, as this is redundant.

3. While no minimum number of checkpoints is prescribed, one every 2-3 minutes is advisable.

4. Look for funneling features and "get-well" points.

5. Be prepared to defend checkpoint selection.

Once airborne and on the route, there is no requirement to find a certain percentage of checkpoints. However, you should use all information available to maintain course and time.

207. JMPS PLANNING

This section is designed as a quick reference and supplement to the JMPS lecture. The SNFO is responsible for making sure the JMPS product adheres to the chart standards listed in the previous section.

1. Initial Joint Mission Planning System (JMPS) Conditions and Preferences

Chart preparation will utilize the standards set forth in the JMPS lecture. The JMPS classroom is located in the academic building and is governed by the following rules:

a. No eating or drinking in the planning rooms (keep it clean).

b. The most recently checked-in class is responsible for cleaning the JMPS room at least once a week.

c. Last one out for the evening must ensure the door is locked (after COB).

d. Store personal planning files on the designated student drive.

Prior to building charts, verify the following initial conditions in JMPS by selecting Graphical View/Options/Preferences:

a. Single Page

i. Category – CADRG

ii. Scale – ONC 1:1M

iii. Non-polar Projection – Equal arc

iv. Scale Factor – 100%

v. Labeling options (deselect all checkmarks and delete Annotation text)

b. Strip Chart

i. Category – CADRG

ii. Scale – TPC 1:500K

iii. Orientation – Follow route

iv. Non-polar Projection – Equal arc

v. Scale Factor – 100%

vi. Page Overlap – 1.94 in.

vii. Virtual Page Setup

(a). Rows – 1

(b). Columns – 2

(c). Horizontal/vertical spacing – 0.25, landscape

viii. Labeling options – deselect all checkmarks and delete annotation text.

c. DAFIF

i. Airports

(a). Min. use runway – 5000

(b). Civ, Mil, Joint Use – ON

(c). Hide airports above – 1:1M.

(d). Hide airport labels above – 1:250K.

ii. Airspace Boundaries

(a). Airspace type – NONE

(b). Airspace class – B, C, D

(c). Polygon type: edged, background – ON

(d). Enable tooltip – ON

(e). Hide airspace boundaries above – 1:2M.

(f). Hide airspace boundaries labels above – 1:250K.

d. Military Training Routes

i. Deselect all route options.

ii. Hide routes above 1:500K.

iii. Hide labels above 1:250K.

iv. Display route options – display route corridor – ON

v. Line color – yellow

vi. Display route points – OFF

vii. VR and IR Routes – ON

(a). Display route points – OFF

viii. Remove all "Routes Displayed."

e. NAVAIDs

i. VOR and TACAN – ON

ii. Hide Nav above 1:2M.

iii. Hide labels above 1:2M.

f. SUAS Boundaries

i. SUAS filter – select prohibited, restricted, warning, MOA, temp.

ii. Polygon type – edged, background – ON

iii. Display threshold

(a). Hide SUAS boundary above 1:2M.

(b). Hide SUAS boundary labels above 1:250K.

g. Electronic CHUM (ECHUM)

i. Blue-based icons and power lines

ii. Line width – thin

iii. Use height-specific icons – ON.

iv. Use yellow icons to show out of synch items – OFF.

v. Highlight New ECHUM – 2 months.

vi. Hide CHUM labels above – 1:500K.

h. Forms – Form: Calc point display (clear all)

i. Manual CHUM

 i. Blue-based icons and power lines

 ii. Line width: thin

 iii. Hide manual CHUM above 1:500K.

 iv. Hide chum labels above 1:500K.

j. Routes

 i. Arrival gate preferences – Change Gate ID to KNPA.

 ii. Calculate point displays.

  (a). Forms – clear all.

  (b). Graphical editor – clear all.

  (c). Tabular editor – clear all.

 iii. Default vehicle – Change to Generic 01 Aircraft.

 iv. Departure point – Change Point ID to KNPA.

 v. Graphical editor – Corridor: deselected ON.

 vi. Doghouses

  (a). Hide doghouses above 1:500K.

  (b). Doghouse, dividing line, bind to leg ON

  (c). Side of route – right

  (d). Initial distance up route leg – ½

  (e). Color – white

  (f). Shading – 69.9%

  (g). Font – Arial, regular, 20, outline, background: white, foreground: black

vii. General

(a). Deselect all under route point labels.

(b). Line thickness – 3

(c). Leg style – solid

(d). Symbol size – 40

(e). Route color – black

(f). Deselect hide route legs and points.

k. Route Rehearsal – OFF

i. Tick Marks

(a). Display Threshold – 1:500K

(b). Tick mark length – full right

ii. Distance Marks Tab

(a). Distance marks – ON

(b). Major tick spacing – 6 nm

(c). Minor tick spacing – None

(d). Units – nm

(e). Side of route – Left

(f). Font – 22, outline, background: white, foreground: black

(g). Minor tick marks every 1 nm – OFF

iii. Time Hacks

(a). Display threshold – 1:500K

(b). Time hacks – ON

(c). Font – 72, outline, background: white, foreground: black (d). Type – clock time

(e). Show ETA at end of route leg – OFF

(f). Lock time hack labels – OFF

l. Vehicle Preferences – Generic 01 Aircraft

i. Configuration Preferences

(a). Min fuel – 500

(b). Recovery fuel – 500

(c). Bingo – 500

(d). Climb/descent altitude difference – 50,000

ii. Standard Aircraft Preferences

(a). Min MSL – 0

(b). Max MSL – 28,000

(c). Bank angle – 30 or 60 for low levels

(d). Airspeed – 360 GS (ground speed)

iii. STTO Preferences – Fuel per STAN

m. Scale Bar

i. T-45

ii. Font size – large

iii. Units – nautical miles/yards

iv. Background: white, foreground: black

n. Session Preferences – coordinate options.

i. Coordinate format – Primary Lat/Long H DD MM .M.

ii. General – Deselect save session layout automatically on exit.

o. View Preferences – Map background: Center – N 30 21.10/W 087 18.70

2. JMPS Chart Building

After verifying the initial conditions are properly set, SNFOs will build strip charts using the following procedures.

a. Open a New Route and go to Tabular View

i. Enter your route points.

ii. Verify airspeed, bank angle, and altitude.

(a). Airspeed (G for ground, T for true)

(b). Bank angle

iii. Change point types for TPs, IP, and TGT.

b. Switch back to Graphical View.

i. Zoom in as appropriate and adjust route points.

(a). Select the route editor.

(b). Click a turn point and drag it.

(1). To delete a point, click it and hit delete.

(2). To add a point, click where it is desired.

ii. Save your .rte file – File/Save As and select thumb drive/save the route as – Last Name VR-XXXII.

c. To re-label points and calculate – switch back to tabular view.

i. In the fix/point box, label points.

(a). Put a "." in front of TP label (.A, .B, .C, etc.).

(b). Do this for each TP (this will be the Pt ID from the AP/1B or Strike Segment Planning Guide).

ii. In the desc box, enter the Radial DME from the Strike Segment Planning guide or the appropriate waypoint information.

(a). To figure the TACAN cut, put an "@" in the fix/point box.

(b). Enter that data in the desc box to have it display in the doghouse.

iii. Enter time hacks as appropriate.

iv. Calculate route and fix any errors (do not continue if route does not calculate properly).

v. Save your .rte file.

d. Build an Overview Chart.

i. Switch back to Overview Chart.

ii. Turn ON Applicable Overlays.

(a). Airports

(b). Airspace Boundaries

(c). NAVAIDs

(d). SUAS Boundaries

iii. Change route line thickness.

(a). Select Overlay/Overlay Options and select your .rte file.

(b). Change line thickness to 6.

(c). Change symbol size to 20.

iv. Turn ON the Scale Bar – Overlay: Scale Bar.

v. Brighten Map – Click the Sun 2 times.

vi. Open the Divert Drawing file.

(a). Click File/Open/Drawing and OK.

(b). Select Desktop/change file type to ".drwll" and select Overview1.drw.

(c). Setup Overlay Layers.

(1). Select Overlay/Overlay Manager.

(2). Move the Drawing file above everything except the Scale Bar.

e. Print an Overview Chart.

i. Select Chart Tool/Single page.

ii. Click in the middle of route and adjust the size and layout as appropriate.

iii. Select Chart Tool Generation Preferences (right side).

iv. Select Labeling Options.

(a). Uncheck everything.

(b). Select Security Administration Options.

(1). Delete everything.

(2). Uncheck Banner Print Override.

(c). Under Annotation Text – Last Name IR/VR-XXXII

v. Select print preview and check work before selecting print.

vi. Select Print.

(a). Select Downgrade.

(b). Check – Suppress Classification on printouts.

vii. Print Overview.

f. Modify or undo items specific to Overview Charts.

i. Remove the Chart Tool from Open Planning Data (left side) – Right click to close.

ii. Turn OFF Applicable Overlays – Airports and NAVAIDS.

iii. Change route line thickness.

(a). Select Overlay/Overlay Options, and then select your .rte file.

(b). Change line thickness to 3.

(c). Change symbol size to 40.

iv. Turn OFF the scale bar – Overlay, scale bar.

v. Close the divert drawing file.

(a). File close

(b). Overview1.drw – OK

(c). Do Not Save.

vi. Dim map 2 clicks

g. JMPS Overlays and Doghouses (Figure 2-16)

i. Turn ON and set up Applicable Overlays (Airspace, electronic CHUM, MTRs, SUAS, boundaries).

(a). Set MTRs to show Route Corridor.

(b). Select Overlay/Overlay Options/MTRs and type route name under "Available Routes" and click OK.

ii. Set up doghouses

(a). Select Overlay/Overlay Options and select your .rte file.

(b). Template Select: choose the applicable doghouse template.

(c). Zoom into the TPC Scale and adjust the location of doghouses.

(1). Select the Route editor.

(2). Move doghouses.

iii. Save your .rte file.

h. JMPS Turn point labels and times (Figure 2-16)

i. Select the Drawing editor/Text tool and draw a text box.

ii. Right click on the text box and select Edit properties for drawing text.

iii. Type the required text (Use Ctrl + Enter to move to the next line).

(a). For example, PT labels and times:

```
 A        B
__:__    __:__
```

(b). Get the times from JMPS and Write the time in pencil (make sure the correct time is entered, if the route is changed at all, these times will be wrong)

iv. Color: black, background: white

v. Background: outline

vi. Font: 48

vii. Angle: leg heading

viii. Scale to map, rotate with map

ix. Position the text box outside your route corridor.

x. Copy and paste as required for each leg.

xi. Save your .drx file.

(a). File/Save As/select thumb drive.

(b). Save the drawing file as: Last Name VR-XXXII.

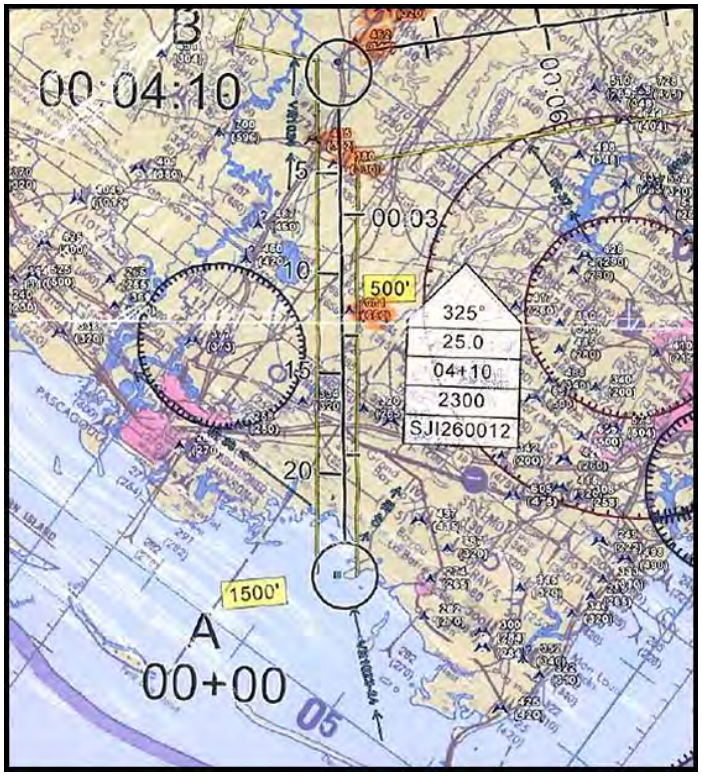


Figure 2-16 Doghouse, TP Labels, and Times

i. JMPS Informational text boxes (Figure 2-17) – Build for MOA calls, altitude changes, FSS calls, and other Strike Segment Planning Guide info.

i. Select the Drawing editor/Text tool and draw a text box.

ii. Right click on the text box and select Edit properties for drawing text.

iii. Type the required text (Use Ctrl + Enter to move to the next text line).

iv. Color: black, background: yellow

v. Font 28

vi. Angle: leg heading

vii. Scale to map, rotate with map

viii. Position the text box outside route corridor; copy and paste as required.

ix. Save all.

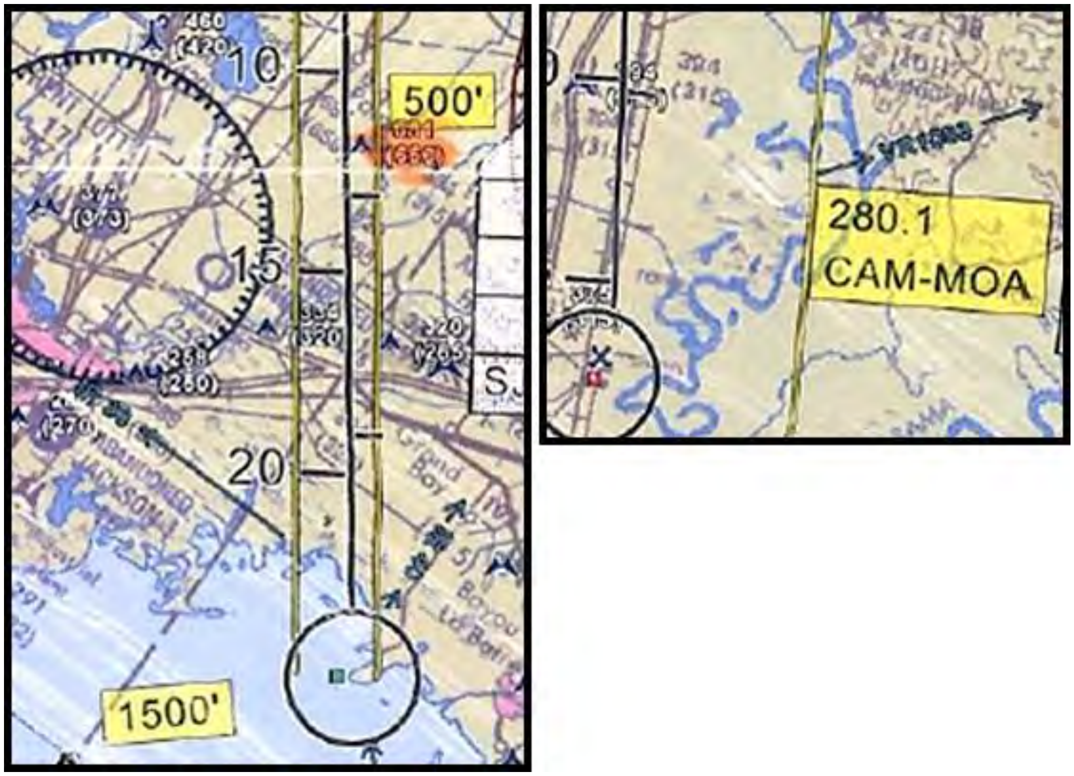


Figure 2-17 Info Text Boxes

j. JMPS Ellipses – Build for NSAs, Airfields, No Fly Areas, and other AP/1B info (Figure 2-18)

   i. Select the Drawing Editor, select the Ellipses Tool and draw an ellipse.

   ii. Right click and edit properties for drawing ellipse.

   iii. Click circle and adjust size in nm.

   iv. Select location and adjust the Lat/Long as required (Cut and paste from PDF of AP/1B is desired).

   v. Save all.

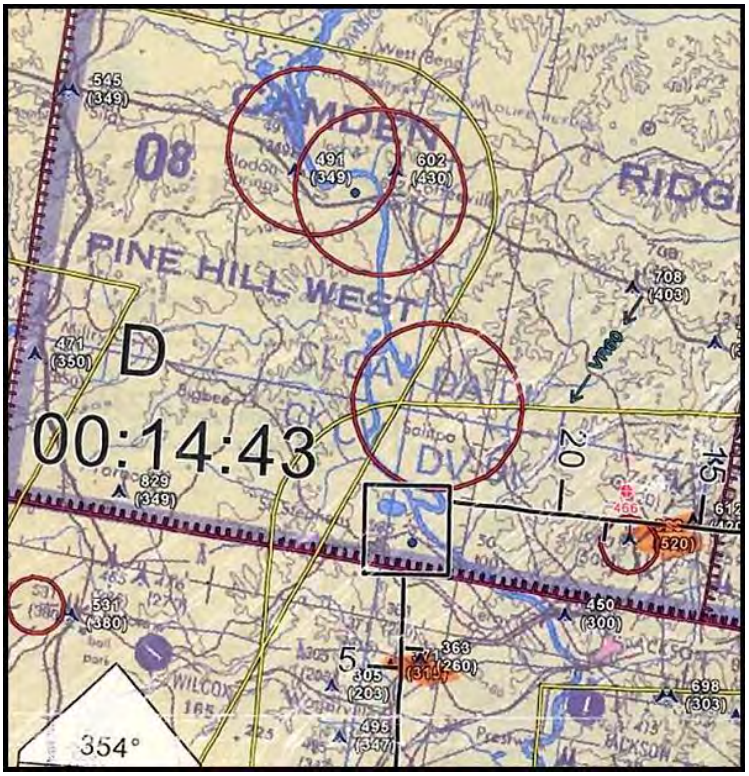


Figure 2-18 Ellipses

k. JMPS Manual CHUM

i. Used for towers from the Special Operating Procedures Cautions in the AP/1B

ii. Select GO TO (up top) and type in Lat/Long (remember to convert to decimal vice seconds) to center the JMPS on the area of concern.

iii. Turn on ECHUM and confirm whether a Manual CHUM Update is required. If the tower in the Cautions sections is already there, do not add a new one.

iv. Select Manual CHUM Editor, add manual CHUM point, and select Single Tall Unit Tower (or Multiple if required), drag and drop the tower onto graphical editor in TPC scale.

v. Right click and edit Manual CHUM info if the edit box did not automatically appear.

vi. Add in AGL and MSL altitudes for tower.

vii. Repeat as necessary.

viii. Save all.

l. JMPS Low-Level Crossing Routes – used to draw in all routes that conflict with the route to be flown

i. Crossing routes will be found in the AP/1B under Conflicts and Cautions

ii. Center the Graphical editor on the applicable leg.

iii. Select Overlay/Overlay Options/Military Training Route (if not there, reselect MTRs under Overlays).

iv. Displayed Route Options/All Route

(a). Centerline: blue

(b). Route Corridor: yellow

v. Displayed Point Options/All Available Routes

vi. Ensure your LL route is on Routes Displayed and the crossing route from the Conflicts section of the AP/1B appears.

vii. Select drawing editor/line tool and draw a line on the route center line of the conflicting route leading to your route corridor.

viii. Right click on the line and edit properties for drawing line.

(a). Color: bright green

(b). Style single arrow (reverse if pointing the wrong direction)

(c). Scale to map

(d). Embedded text, center, font: Arial, Regular, 44

(e). Background: solid rectangle

(1). background: white

(2). foreground: bright green

(f). Type in Route Name VR-XXXX.

ix. If your label disappears, it will print. To see the label, make the arrow longer. Copy and paste as required. Adjust the direction of the arrow after pasting by grabbing the tip or tail of the needle with the mouse and move it. Clicking on the center of the line will drop another point in the line.

x. After completing all required arrows for crossing routes, return to Overlay/Overlay Options/Military Training Route/Displayed Route Options/Display Route Corridor Only/Route Corridor: yellow.

xi. Go to displayed Point Options/Deselect All Routes Displayed. Ensure only your LL route is ON.

xii. Save All.

m. JMPS Strip Chart Generation

i. Zoom out to JNC.

ii. Add a few legs so that there will be enough strip charts – Select Route Editor/select your last target/add a few legs.

iii. Select Chart Tool – Select Generate Strip Charts/Snap to Route Leg/Align to Route Leg.

iv. Move your strip charts.

(a). Start from the front of your route and place a strip on each leg.

(b). Ensure a strip for each leg.

v. Delete extra strip charts if required - click on the extra strip and hit delete.

vi. Delete extra route legs – Select the Route Editor, click on the extra TP and hit delete.

vii. Set up Overlay – Overlay/Overlay Manager: set Overlays in following order:

(a). .cht file

(b). .jrt file

(c). .drx file

(d). Electronic CHUM

(e). MTRs

(f). Airspace Boundaries

(g). SUAS boundaries

viii. Set up Labeling Options – Select Chart Tool/Chart Tool Generation Preferences (right side).

(a). Select Labeling Options.

(b). Uncheck everything.

(c). Delete annotation text.

(d). The file name of your .rte file will be printed on strip charts.

n. JMPS Strip Chart Printing Prep

i. Select Security Administration Options.

(a). Delete Everything.

(b). Uncheck Banner Print Override.

ii. Brighten MAP if it was dimmed after making Overview – Click the sun two times.

iii. Print Preview strip charts.

(a). Select Chart Tool/Print Preview.

(b). Look at each leg and verify a strip chart exists for each leg and that route point labels are viewable (Route times, doghouses and text boxes).

(c). Double check each leg to make sure no information was cut off. Also check that each leg has some amount of chart displayed past the turn point in order to use it for correlation.

(d). If a single leg won't fit on a page, sacrifice information from the last point and move forward. Eliminating more than 5 nm of any leg should not be necessary.

iv. Double check to make sure the applicable items appear on your chart:

(a). Route Corridor – yellow

(b). SUAS – ON

(c). Airspace Boundaries – ON

(d). ECHUM – ON

(e). MTR Route Points – ON

o. JMPS Strip Chart Printing

i. After everything is checked and ready to print, it is recommended to find a JMPS instructor or a PA to review it prior to printing.

ii. Select Print Preview Screen/Print/Downgrade – Check Suppress Classification on printouts.

p. JMPS File Saving

i. Save your .cht file – File/Save As/select your thumb drive/save the drawing file.

ii. Save All.

q. Open saved data.

i. When re-opening JMPS, it will default to the Master Permissions and open a new .rte file. Close this file before opening your saved data.

(a). Click File/Close .rte/Close.

ii. Now open saved .rte, .drx, .cht files.

(a). File Open/Route and select your .rte file.

(b). File Open/Draw and select your .drx file.

(c). File Open/Chart and select your .cht file.

NOTE

Do not have multiple, same type files open at the same time; JMPS will crash.

r. Strip Chart Miscellaneous

i. Paste the route name, TP descriptions and pertinent notes to the cover (Figure 2-19).

ii. Paste the strip chart on the left side to leave room on the right for notes, fuel stamps, times (Figure 2-20).

iii. Build a pocket in the last page of chart to hold overview chart.

iv. The best adhesive to use is spray (i.e., 3M Type 77)

(a). Rubber cement and other wet glues will cause chart to bleed and become unusable.

(b). Stick glues may work.

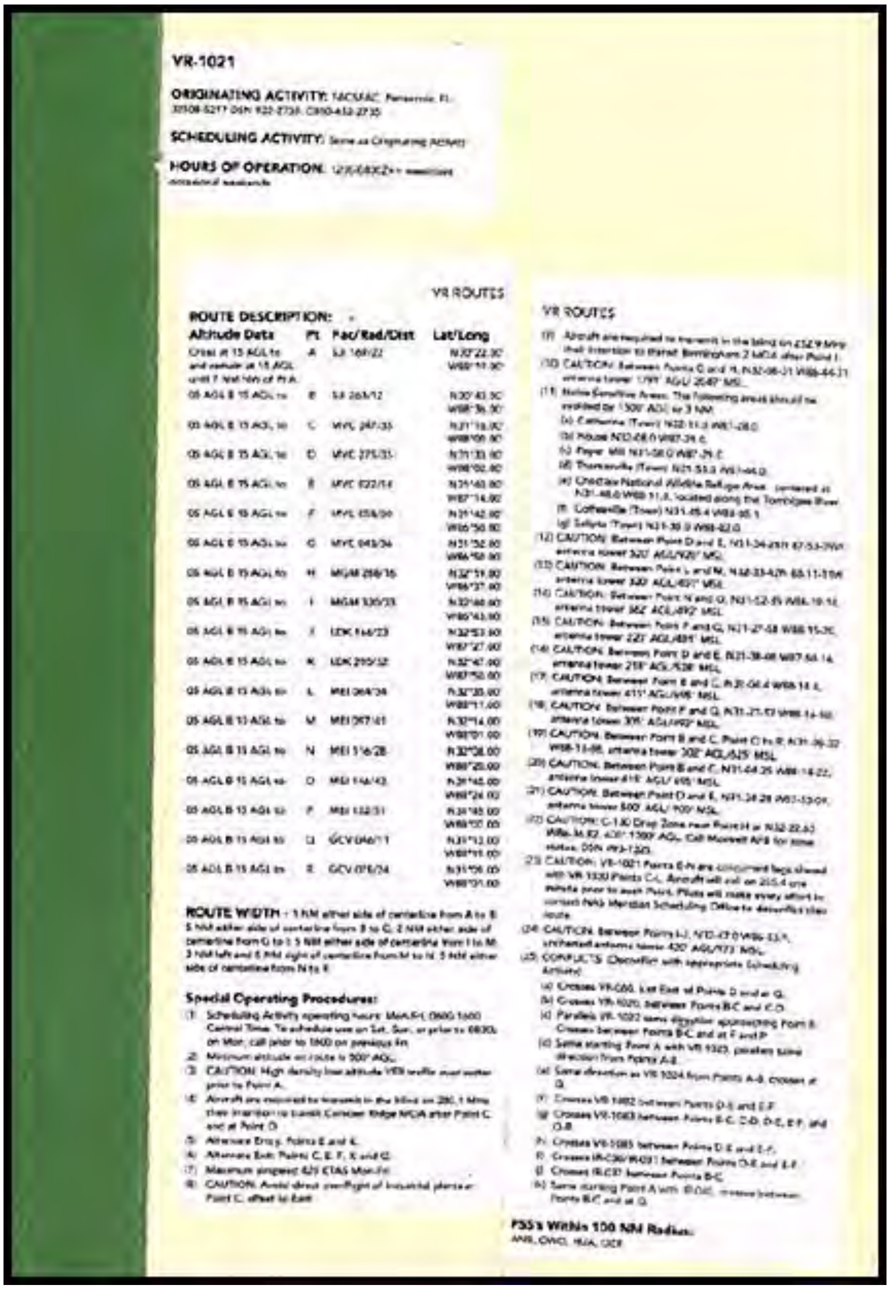


Figure 2-19 Strip Chart Cover Final Product

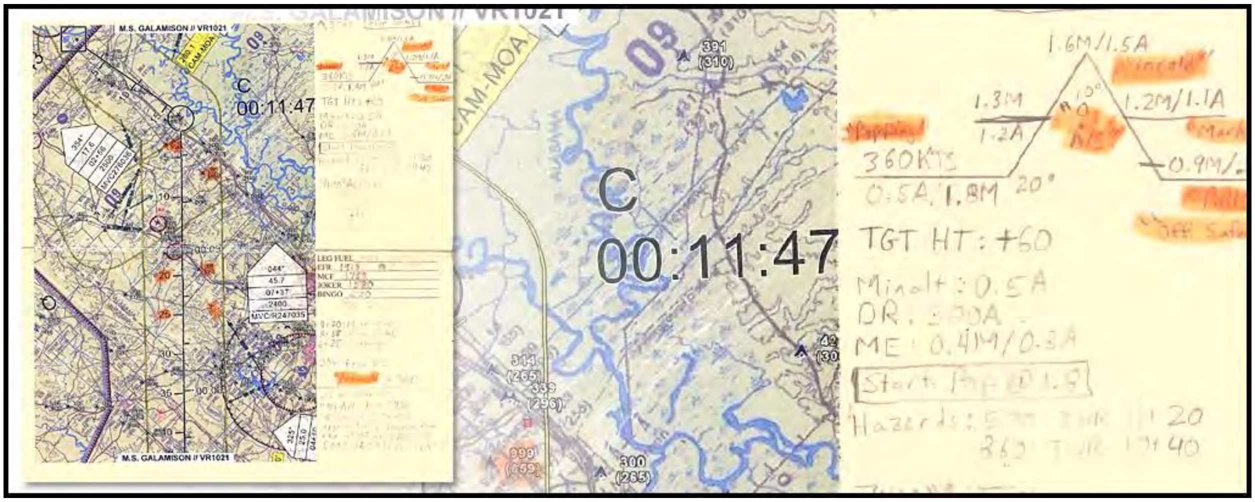


Figure 2-20 Strip Chart Final Product

NOTE

Issued charts are not necessarily up to date. The CHUM manual is the best source for new hazards and obstructions, such as recently erected towers and power lines. THE MANUAL IS THE FINAL WORD when updating charts. The use of such items as E-CHUM is not adequate for route planning purposes. Students will CHUM all low-level charts within 10 nm of course.

THIS PAGE INTENTIONALLY LEFT BLANK

CHAPTER THREE
STANDARD SECTION FORMATION PROCEDURES

300. INTRODUCTION

Formation flying is essential to tactical military flying. It serves many purposes, from the expeditious recovery of aircraft at the carrier to tactical mutual support in a high-threat environment. It provides aircrews with several tactical advantages including mutual support, concentration of firepower and enhanced command and control. Good formation flying requires solid procedural knowledge and attention to detail, and is the mark of a superior aviator. A Naval Flight Officer's role in formation flying is critical to the safe completion of the mission. While SNFOs are not expected to become experts in formation flight, it is important to have a working knowledge of the various types of formations. Recognizing each type of formation and being familiar with the associated procedures is the training goal.

301. BASIC FORMATION DEFINITIONS

There are two basic types of tactical flight formations: sections and divisions. A section is the smallest formation unit, and is composed of two aircraft: a lead and a wingman. A division is the next larger sized formation, and is composed of two sections. Larger formations can be made by adding sections or divisions as required. Both section and division formation procedures will be covered in the advanced syllabus.

Disciplined formation flight involves much more than multiple aircraft going "the same way the same day." There are numerous types of formations, and it is the responsibility of the SNFO to understand the differences and uses. In general, formations can be separated into Administrative Formations and Tactical Formations.

1. Administrative Formations

Administrative (Non-Tactical) formations are typically utilized when operating in friendly airspace where there is little or no enemy threat. The two most basic Administrative Formations are Parade and Cruise.

2. Parade Formation

Parade formation is the standard multi-plane formation. It is a close aboard formation that is utilized when the flight can be critically viewed from the ground. This is most common during section takeoffs and section breaks. Parade formation is also utilized when a flight encounters IMC conditions.

In parade formation, the wingman (Dash Two) maintains a 30-degree bearing line with 5-feet of step-down and 3-feet of lateral separation (Figure 3-1). The sight picture for proper positioning is:

a. Wing looking down the leading edge of lead's wing (fore/aft positioning)

b. Equal amounts of top and bottom of lead's wing visible (step-down positioning)

c. lead's tailpipe slightly visible (lateral positioning)

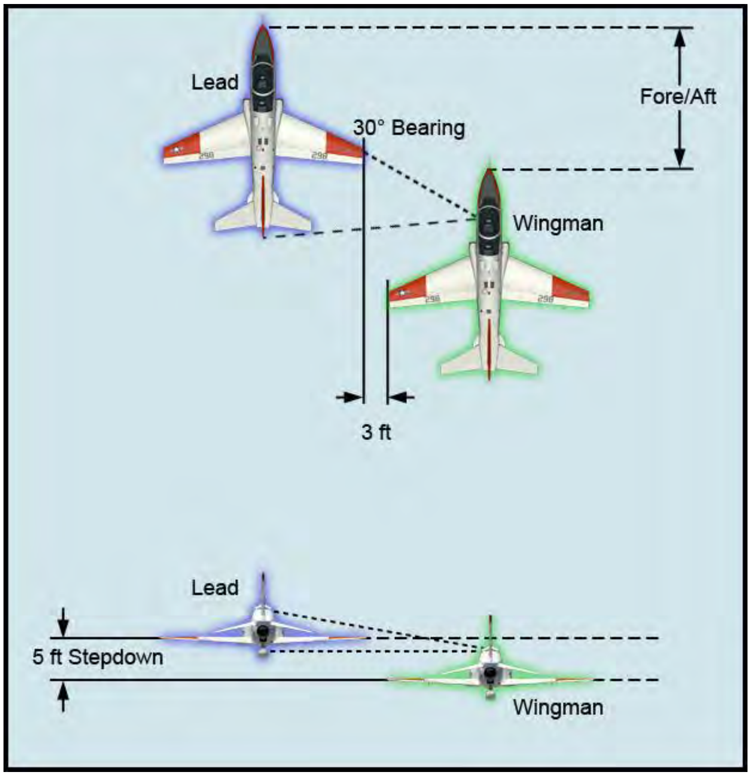


Figure 3-1 Proper Parade Positioning and Sight Picture

The close proximity of aircraft in parade formation allows for the penetration of instrument conditions while maintaining section integrity. The primary tactical limitation of the parade formation is the lack of dynamic flight maneuverability. Smooth, coordinated control inputs are vital for safe parade formation. The wingman must be constantly attentive to the lead aircraft, which can be fatiguing over prolonged periods of time. Additionally, parade formation is not very fuel efficient as the wingmen must constantly adjust the throttle position to stay in the proper position.

Turn radius plays a key role in the Wing's ability to maintaining proper position. During turns into the wingman, power must be reduced as a result of the smaller turn radius as compared to Lead. During turns away from the wingman, power must be added to account for the larger turn radius as compared to Lead.

3. Cruise Formation

To improve maneuverability and when conditions permit, cruise formation is utilized. Cruise formation is a looser version of parade formation, and is normally used for the enroute portions of the flight when there is no potential enemy threat. The increased distance between aircraft in the cruise formation permits greater maneuverability for the flight and allows for an increased "inside scan" for the wingman.

In the cruise position, the wingman maintains a bearing line of approximately 45 degrees with 15-feet of step-down and 20-feet of nose to tail separation (Figure 3-2). Wing maintains proper positioning by:

a. Aligning the star on the lead's fuselage with the lead's inboard wingtip

b. Sighting along the leading edge of lead's horizontal stabilizer

c. Approximately 1-3 plane-widths laterally spaced

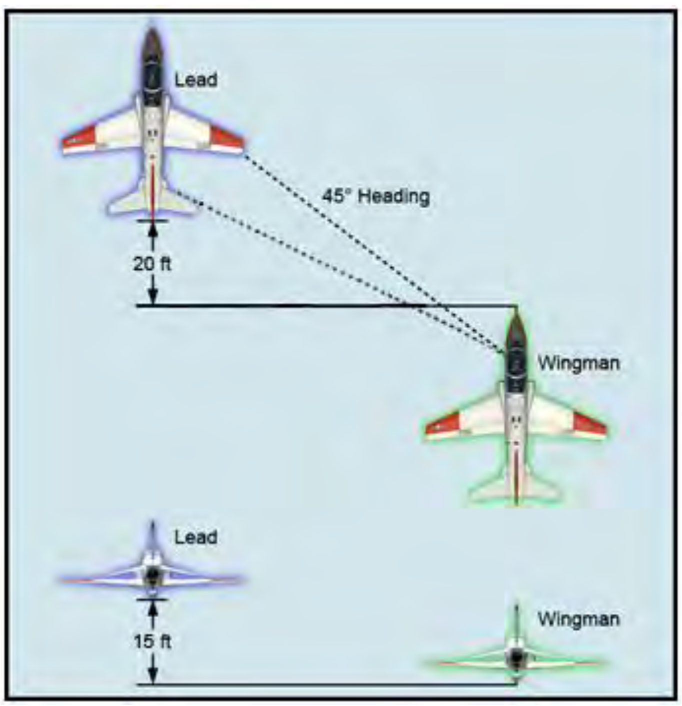


Figure 3-2 Proper Cruise Positioning and Sight Picture

The cruise formation is less fatiguing, and provides greater fuel efficiency for the wingman by eliminating the excessive power corrections required to maintain parade formation. The basic principle of cruise is that all flight members will maintain position by sliding to the inside of the lead's radius of turn in order to minimize throttle movements. By using this freedom of relative motion, the wing aircraft can use turn radius as an advantage and thereby maximize fuel efficiency.

4. Tactical Formations

Parade and cruise formations are the basic building blocks of formation flying and provide mutual support in low-threat environments. However, war-fighters must be able to complete missions in high-threat arenas. In these environments, Tactical Formations will be used.

The specific formation selected in a given arena will depend on a multitude of factors including mission objective, expected enemy threat (both air-to-air and surface-to-air), weather and terrain. The Strike syllabus is primarily concerned with Combat Spread and Tac Wing.

5. Combat Spread

Combat spread is a highly effective section formation that offers both maneuverability and mutual support. In the low-level environment, combat spread is a defensive formation that provides increased mutual support within the section. In this formation, Wing will fly on Lead's 90-degree bearing line (abeam) at a distance of approximately 1.0 nm (Figure 3-3). The two aircraft are spaced far enough abeam to maximize maneuverability, yet close enough together to provide mutual support. Additionally, this positioning allows aircrew the ability to devote more time to cockpit tasks and, more importantly, visual lookout.

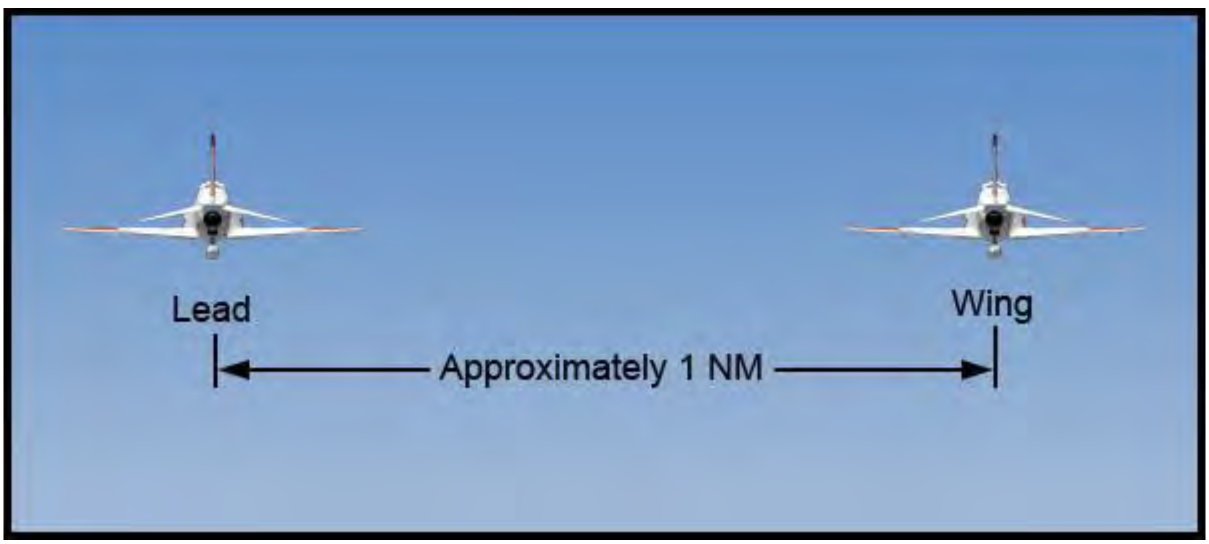


Figure 3-3 Combat Spread

Combat spread provides the following advantages:

a. Excellent lookout capability

b. Increased enemy detection through visual cross coverage against both air-to-air and surface-to-air threats

c. Separation between the aircraft allows each aircraft to seek lines of least resistance and best concealment.

d. Commitment by air enemy threat early in an engagement to one aircraft

e. Reduced exposure to a given defensive threat as compared to a trail type formation

f. Visual acquisition problems of both aircraft by an enemy

From a tactical perspective, combat spread offers the most mutual support. Figure 3-4 depicts the lookout responsibilities for each crewmember.

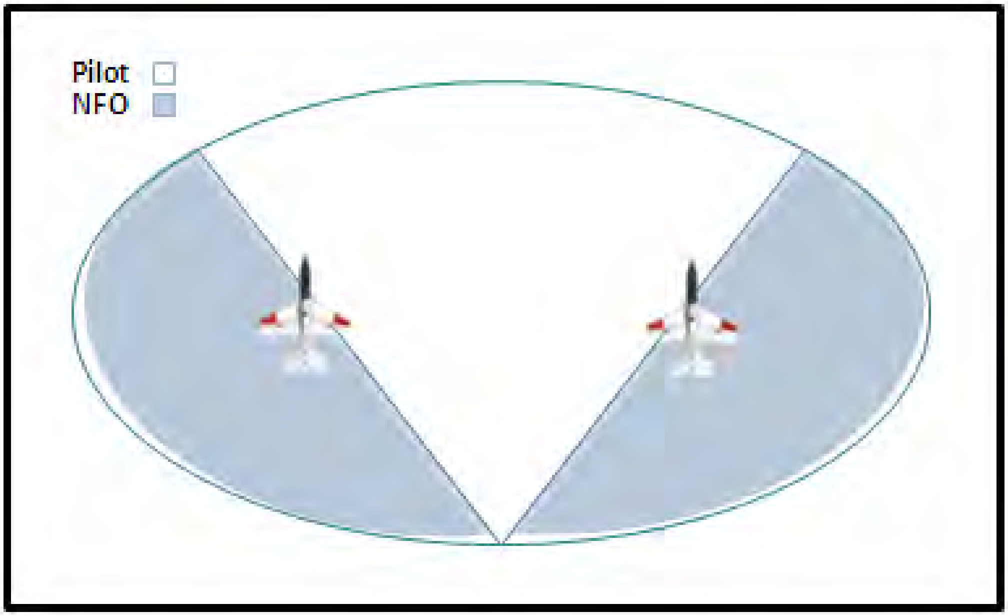


Figure 3-4 Lookout Responsibilities

While the specifics of a solid lookout doctrine will be covered in depth in Basic Fighter Maneuvers, it is important to recognize that there are no gaps in the lookout coverage area for either aircraft. SNFOs prioritize the outside of the formation and Pilots have inside of the formation. SNFO's lookout coverage area is from 2 o'clock to 8 o'clock on the right side of the formation and 10 o'clock to 4 o'clock on the left side of the formation. SNFOs should spend about 75% of their outside scan outside the formation and 25% inside the formation, vice versa for pilots.

6. Tac Wing

Tac Wing (Figure 3-5) is an extremely fluid formation designed to provide:

a. Reduced workload for the wingman (ease in position keeping)

b. Ease in maneuvering a section through rough terrain

c. Aircraft in close formation can amass firepower while at the same time avoid the fragmentation ("frag") pattern of the other aircraft (i.e., during air-to-ground weapons delivery).

In the Tac Wing position, the wingman flies in a "cone" 20- to 60-degrees off the lead's tail, on either side. Proper nose to tail separation extends from 500 feet to 3000 feet. Normally, Wing will be either co-altitude or slightly above Lead.

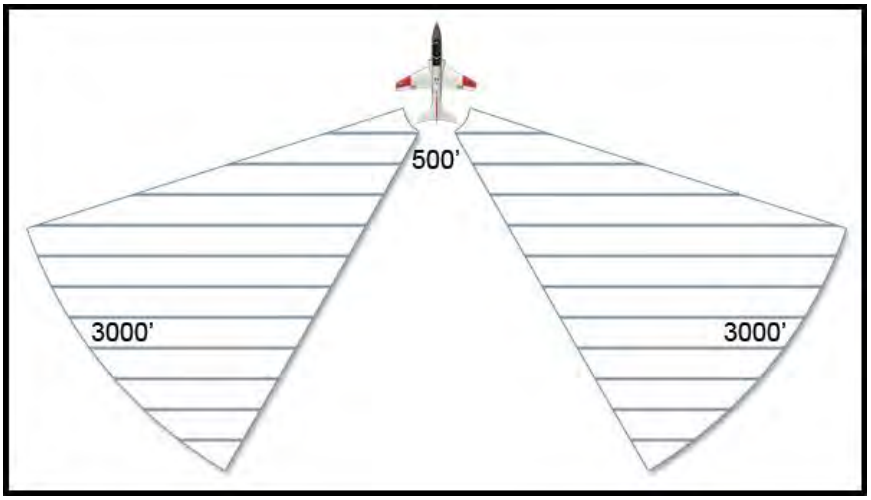


Figure 3-5 Tac Wing

The primary disadvantage of Tac Wing is the lack of mutual support for the wing aircraft. Because the wingman is well aft of Lead, threats approaching from the rear of the formation will be very difficult to spot.

302. FLIGHT DISCIPLINE

Discipline, in reference to formation flying, involves the conduct of the flight members as individuals and as part of a team. This includes individual operations such as taxi, takeoff, pattern procedures, landing, adherence to course rules and radio procedures. As a member of a team in which individual errors affect the overall performance of the flight, each member of the flight must perform to make the flight function as a unit.

1. Lead Responsibilities

The formation leader, or Lead, is the primary attitude reference point for the wingman. Lead's position is considered fixed. Therefore, any movement within the formation is considered to be movement by the wingman. Lead carries the primary responsibility of conducting the sequence of maneuvers in an orderly manner. Lead is responsible for the overall conduct of the flight and has the primary responsibility for communications; Lead must always keep the following in mind:

a. Keep the flight clear of other aircraft.

b. Keep the flight clear of clouds, if possible.

c. Keep the flight within the proper operating areas and comply with local course rules.

d. Provide a stable platform for the wingman to reference (be predictable).

e. Always be aware of the wingman's position.

Specifically, the Lead SNFO is required to:

a. Monitor wingman's status and position.

b. Execute sound radio discipline and make all necessary calls.

c. Direct the mission and maintain area management.

2. Wing Responsibilities

The wingman is primarily responsible for flight integrity. In addition to backing up Lead's responsibilities, the Wing must:

a. Maintain position and avoid collision with the Lead.

b. Provide mutual support.

c. Maintain sight of Lead at all times.

d. Monitor Lead's aircraft configuration.

Back up the Lead's navigation and maintain situational awareness. Wing must always be prepared to assume the flight lead's responsibilities at any point, if required.

Additionally, Wing must promptly answer all hand signals and radio calls from Lead. The Wing SNFO must:

a. Back up the Lead at all times.

b. Promptly comply with all frequency changes and execute sound radio discipline.

c. Be ready at any moment to take the lead.

303. FORMATION COMMUNICATION PROCEDURES

As with single ship flight, clear communications within a formation is essential for mission accomplishment. Formation communications include both verbal and nonverbal (hand signals) communications.

1. Verbal Communication

The section will always have two call signs:

a. The administrative ("admin") call sign. This is the ROKT call sign (from the flight schedule), and will be used whenever talking to base, maintenance and ATC.

b. The tactical call sign. This call sign (such as "Hammer") will be used whenever communicating within the section or with GCI (e.g., "Hammer, break left."). Do not use the tactical call sign in the plural form (i.e., Hammers). Always use the singular form of the tactical call sign even in multi-plane events.

2. PRI/AUX Usage

UHF 1 is the primary radio (Pri) and UHF 2 is the auxiliary radio (Aux). ATC communication is conducted on Pri, whereas section admin is conducted on Aux. When operating on a discrete Pri frequency (e.g., W-155A, R4401), all tactical communications will be performed on Pri. When monitoring a common frequency (e.g., PNSS MOA, Low Levels) on Pri, all tactical communications will be performed on Aux.

3. Frequency Pushes

Flight lead will positively "push" wingman to frequencies when ATC does not assign a specific frequency:

a. On Pri:

i. ATC - *"ROKT 409, switch approach."*

ii. Lead SNFO - *"ROKT 409, switching approach."*

b. On Aux:

i. Lead SNFO - *"Hammer, switch button 6.*"

ii. Wing SNFO - *"Hammer 12."*

If ATC specifies a frequency, the entire flight is expected to switch to the new frequency on Pri without any further coordination:

a. On Pri:

i. ATC - *"ROKT 409, switch approach 357.0."*

ii. Lead SNFO - *"ROKT 409, switching 357.0."*

NOTE

On all radio frequency switches, the wingman must ensure to signal a thumbs-up after switching the appropriate radio to the new frequency. This signal must be given high up on the canopy and with a back and forth motion to facilitate its visibility to the lead. Maintain this thumbs-up signal until Lead is heard on the new frequency and Lead returns a thumbs up or head nod in acknowledgement. Lead must be sure to look for this signal and respond with a thumbs-up.

There are a few automatic frequency changes. After ATIS and clearance on start-up, SNFOs are expected to automatically switch to Base frequency on Pri and put Tac Freq in Aux as soon as you start up, and wait for switch to Ground for taxi. SNFOs are expected to automatically switch to Tower after the last taxiway prior to the hold-short. Exiting the runway after landing, each SNFO in the flight will automatically switch to Ground frequency.

4. Positive Check-ins

Positive check-ins will be executed in the following situations:

a. On deck, once both aircraft have been final checked, Lead SNFO will verify the thumbs-up from Wing and initiate a check-in on Tac Freq (Aux):

i. Lead SNFO (Aux) - *"Hammer check-in, Hammer-11."*

ii. Wing SNFO (Aux) - *"Hammer-12."*

b. On any safety of flight/common frequency check-in:

i. Low Levels: Btn 29 (FSS)

ii. PNSS MOA: Btn 18

iii. W-155A: SEABREEZE assigned discrete frequency

iv. R4401: Btn 23/24

(a). Lead SNFO (Aux) - *"Viper check Pri."*

(b). Lead SNFO (Pri) - *"Viper-21."*

(c). Wing SNFO (Pri) - *"Viper-22."*

c. For any Chattermark (switch from current Tac Freq to back-up Tac Freq):

i. Lead SNFO (Aux) - *"Viper, Chattermark, Chattermark."*

ii. Wing SNFO (Aux) - *"Viper 12."*

iii. Lead SNFO (Aux) - *"Viper check, Viper-21."*

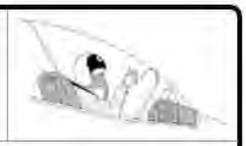
iv. Wing SNFO (Aux) - *"Viper-22."*

5. Hand Signals

Good formation discipline depends upon the proper use and execution of visual signals. The hand signals cover most maneuvers encountered and lessen the need for airborne radio transmissions. The Lead must give the signal in such a manner as to be easily seen and understood. A wingman must fly in a position so that the lead's signals may be visible. Typically, front and back seat crewmembers signal each other respectively. Front seat signals are directed at the front seat of the wing aircraft and vice versa. The following table (Figure 3-6) and images (Figure 3-7) describe and illustrate the typical hand signals utilized in formation.

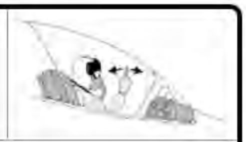
SIGNAL	MEANING
Thumbs-up/down	Self-explanatory
Forearm vertical, 1 through 5 fingers extended	Numbers 1 through 5
Forearm horizontal, 1 through 5 fingers extended	Numbers 6 through 9
Clenched fist	Zero
Arm raised in circular cranking motion	Preparatory gear signal
Exaggerated head nod	Execute signal
Head nod left or right	Turn in that direction
Hand raised palm down, left to right motion	Level off
Hand raised palm down, fore and aft motion	Climb
Two fingers raised in turn-up signal	Break up signal
Kiss off	I'm breaking
Forearm raised vertically with clenched fist	Wingman cross under
Forearm raised vertically with clenched fist and pumping motion	Section cross under
Hand raised in chopping motion	Roll out
Hand raised palm down, patting glare shield	Cleared to land
Forearm raised, fingers facing aft in opening and closing motion	Speed brake preparatory signal
Forearm raised palm down, pointing down	Descent
Thumbs-up pointing over alternating shoulders	Wingman take cruise position
Lead holds hand with thumb and little finger extended in front of face as if drinking	Fuel check
Lead pats shoulder or porpoises aircraft	Wingman join in parade
Frequency changes; Lead taps earphone followed by new frequency with hand signals	Wingman switch to appropriate frequency

Figure 3-6 Formation Visual Signals



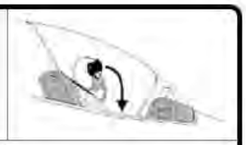
Signal	Thumbs-up or head nod
Meaning	Affirmative
Response	As appropriate

Signal	Thumbs-down or head shake
Meaning	Negative/do not understand
Response	As appropriate



Signal	Raises two fingers in back/forth motion
Meaning	Perform normal engine run-up
Response	Wingman repeats signal and executes run-up and responds with a thumbs-up

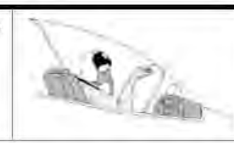
Signal	Section leader raises arm vertically
Meaning	Preparatory: take-off path clear
Response	N/A



Signal	Section leader drops arm smartly below canopy rail
Meaning	I am commencing section take-off
Response	Wingman executes section take-off

Signal	Rotary movement of clenched fist as if cranking wheels, followed by nod
Meaning	Raise/lower gear and flaps
Response	Execute at nod

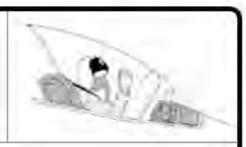

Signal	Hand opened flat and palm down, simulating dive or climb
Meaning	I am going to descend/climb
Response	Prepare to follow suit



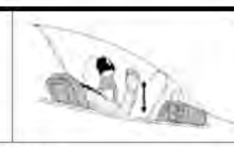
Signal	Hand moved horizontally above glare shield, palm down
Meaning	Leveling off
Response	Wingman prepare to execute

Signal	Head nodded right/left
Meaning	I am turning right/left
Response	Prepare to execute

Signal	Open hand held up, fingers together, moved in fore and aft sawing motion (by Lead)
Meaning	Roll out of turn
Response	Wingman prepare to execute



Signal	Lead holds up right/left forearm vertically with clenched fist
Meaning	Wingman crossunder to right/left
Response	Execute



Signal	Leader holds up right/left fore-arm vertically with clenched fist and double pump
Meaning	Section crossunder to right/left echelon
Response	Dash-3 relays to Dash-4, then execute

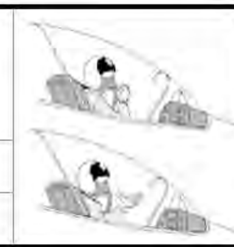
Figure 3-7 Hand Signals

Signal	Open and close four fingers and thumb
Meaning	Extend/retract speed brakes, as appropriate
Response	Repeat signal. Execute when Lead nods head or fans speed brakes in or out

Signal	Raised fist with thumb extended in drinking position
Meaning	How much fuel do you have?
Response	Indicate remaining fuel in hundreds of pounds by finger numbering

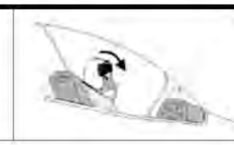
Signal	Lead describes back and forth motion with two fingers
Meaning	Breakup
Response	Wingman: Prepare for breakup kiss-off. Dash-2 relay signal to Dash-3. Dash-3 to Dash-4 as required.

Signal	Lead blows kiss to wingman (bunch fingers, then spread)
Meaning	I'm leaving formation
Response	N/A



Signal	Head moved backward
Meaning	Reduce power
Response	Execute

Signal	Head moved forward
Meaning	Add power
Response	Execute



Signal	Lead pats self on head, points to wingman
Meaning	Lead change
Response	Wingman pats self on head, looks and points straight ahead, then takes lead

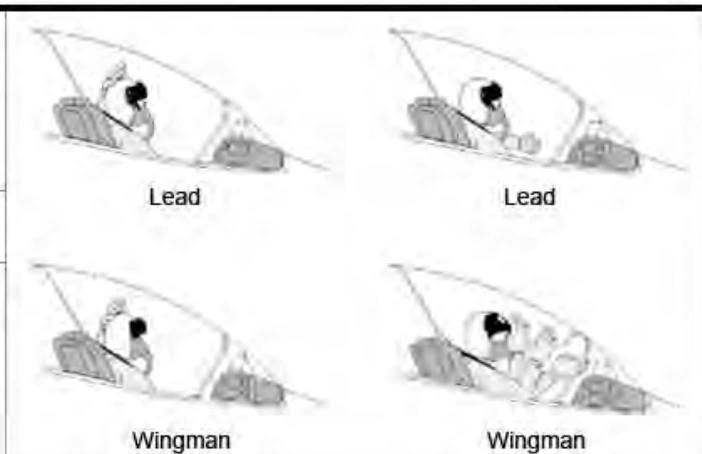


Figure 3-8 Hand Signals (continued)

Additionally, in the event of an aircraft malfunction, HEFOE signals can be used (Figure 3-9). Each letter in HEFOE corresponds to a major aircraft system. For example, the third letter in HEFOE is F, which would represent a fuel system problem.

HEFOE SIGNALS	
Forearm covering face followed by:	**Indicates:**
One Finger	Hydraulic
Two Fingers	Electrical
Three Fingers	Fuel
Four Fingers	Oxygen
Five Fingers	Engine

Figure 3-9 HEFOE Signals

304. GROUND/DEPARTURE PROCEDURES

From the moment the crewmembers arrive at the briefing, they are part of the formation. A successful formation flight begins in the briefing and carries over to the ground operations and throughout the flight until landing and debriefing. Coordination begins in the line with the start and sets the tone for the remainder of the flight.

1. Section Line Procedures

Start up and line procedures are identical to those used in the contact stage. Once complete with final checks, a thumbs-up will be passed to the lead. It is important to note the side number and location of the wingman on the ramp so that a "thumbs-up" can be passed to the correct jet at the appropriate time.

Radios shall be set to the pre-briefed frequencies for each radio. On start-up both aircraft will cycle through ATIS (Btn 1), Clearance Delivery (Btn 2), and then Ground Control (Btn 3) on Pri; AUX will be set to the Base frequency after start. This procedure will ensure that aircrews can be contacted by Base, Lead, or wingman. As always, take care of the aircraft first and then attend to formation responsibilities on the deck.

The Lead SNFO is responsible for obtaining flight clearance for the entire flight, but wingmen are expected to listen to clearance after getting their own ATIS. After final checks are completed for each aircraft, a thumbs-up is passed to Lead, signaling the aircraft are ready to proceed as a section or a division. After the thumbs up, Lead will then initiate a positive check-in on Aux, Btn 30. The initial check-in will occur as follows (pay particular attention to speaking on the appropriate radio and frequency):

a. Lead SNFO (Aux) - *"Hammer check Tac, Hammer-11."*

b. Wing SNFO (Aux) - *"Hammer-12."*

c. Lead SNFO (Aux) - *"Hammer, NAV check Rosie, 160, 28.5."*

d. Wing SNFO (Aux) - *"Hammer 12."*

e. Lead SNFO (Pri) "*Base, ROKT 401, taxi, side 603,604."*

If wingmen did not copy the clearance, then the initial check in on Aux should include "negative clearance." Lead will pass the clearance before calling for taxi.

a. Wing SNFO (Aux) *"Hammer-12, Negative Clearance."*

b. Lead SNFO (Aux) - *"Hammer cleared on NPA-13, 1 DME right 150, 3K, expect 14k in 10, 270.8, squawk 5402."*

c. Wing SNFO (Aux) - *"Hammer-12."*

2. NAV Checks

To ensure both section navigation systems correlate, Lead SNFO will initiate a "NAV Check" after check-in on Tac Freq. The NAV Check should be to the first filed navigation point, or as briefed.

Lead SNFO will conduct the NAV Check by reading azimuth and range to the NAV point from present position (off the HSI). Wing azimuth and range should correlate within 3 degrees and 0.5 nm. Wingmen shall respond with "*Two*" if the point correlates within tolerances. If the tolerance is exceeded, wingmen respond with the bearing and range shown on their HSIs. In this case, both SNFOs are required to double-check the waypoint selection and the waypoint coordinates.

3. Section Taxi

After the flight has checked out with base, checked in on Tac Freq, and completed the Alpha check, Lead will call for taxi clearance with Ground Control.

a. Lead SNFO (Pri) - *"Ground, ROKT 407, flight of two, taxi with Bravo."*

Jet aircraft, taxiing in close interval, increase the risk of "foreign object damage" (FOD). To minimize this risk, squadron Standard Operating Procedure (SOP) will define the approved taxi interval. Additionally, it is customary to taxi formations on opposite sides of the taxiway centerline (when adequate taxiway width is available). While a prudent taxi distance provides the desired separation for FOD prevention, it is essential that formation integrity be maintained. Every effort should be made to prevent other aircraft from taxiing between the formation's elements. All checklists, taxi reports, and radio frequency switches will be conducted in accordance with the "Student In-flight Guide."

Passing the last active taxiway, the SNFO may automatically switch to tower (i.e., ***no*** positive check-in on tower frequency at the hold-short). At the hold short, the crewmembers of each aircraft will check the other aircraft for integrity and configuration. Wing SNFO will give Lead a thumbs-up when the lead aircraft has been checked and tower frequency is set in Pri. Lead SNFO will check the wing aircraft in return and pass a thumbs-up indicating that the section is ready to call for takeoff.

a. Lead SNFO (Pri) - *"Tower, ROKT 407, flight of two, takeoff."*

Once cleared by Tower to take the duty runway (line up and wait or cleared for takeoff), students will clear the groove and check the strobes, squawk, pitot-heat and landing lights. Lead should have the strobes off while the Wing will have the strobes on; Lead should squawk normal, Wing squawk standby. The flight will switch to departure control on Pri after takeoff clearance has been issued or as directed by Tower.

a. Lead SNFO (Pri) - *"ROKT 407, cleared for takeoff 7R, switching departure."*

Crossing the hold short to take the runway, each SNFO will report on ICS:

a. Lead/Wing SNFO (ICS) - *"Groove clear, check strobes on/off, squawk normal/stby, pitot heat and landing light on."*

4. Section Takeoff

The purpose of a section takeoff is to get the formation airborne in the safest and most expeditious manner. Many factors go into determining the best method for getting a section airborne. Weather, standing water/ice/slush on the duty runway, 90° crosswind component greater than 10 knots limitation, like-aircraft configurations (e.g., flap settings and fuel states [within 400 lbs]), and long-field gear are several of the deciding factors. To takeoff as a section, the weather must be above circling minimums (or in the absence of an approach with circling minimums, 1000 feet/3). If the weather is below circling minimums, the flight cannot take off as a section and must get individual clearances to launch as singles. A rendezvous plan should be covered in the brief in the event the section has to launch as singles and join up airborne.

Section takeoffs may be accomplished in one of two ways:

a. Section Go: Both aircraft roll and rotate in formation.

b. Interval Go: Wing aircraft initiates takeoff roll after a set time delay (SOP defined).

5. Section Go

Both aircraft will lineup centered on their respective half of the runway with lead taking the downwind side. The wing aircraft will be aligned with lead's horizontal stabilizer leading edge and there should be no wing overlap when properly positioned. When both aircraft are set in position on the runway and cleared for take-off, Wing will give a thumbs-up to Lead, whereupon the Lead IP will signal to run-up the engines. Both IPs will initiate a run-up for the MRT checks. As in Contact Flight Procedures, each SNFO will ensure their aircraft is ready for takeoff and make the appropriate report on ICS. Additionally, each SNFO will give one last check to the other aircraft and look for any obvious damage, un-secure panels, leaks, etc. The IPs will do the same. Once the thumbs-ups have been appropriately passed, the Lead IP will initiate the takeoff with a hand signal:

a. The "chopping" hand signal will be given for a Section go.

b. The "kiss-off" signal will be given if a section interval go is executed.

During the takeoff roll, it is important that SNFOs keep their head out of the cockpit as much as possible. Both aircraft will proceed down the runway together during a section go. The wingman will essentially "fly form" on the runway, maintaining the proper bearing line. The Lead and Wing SNFOs will have different responsibilities during a section go.

The Lead SNFO's primary responsibility is to monitor the position of the wing aircraft in relation to the lead. If Wing is sucked (aft of the initial bearing line) or acute (forward of the initial bearing line), the Lead SNFO will verbalize the deviations to the lead pilot on ICS, "sucked" or "acute." If Wing is in position, "in position" is the correct call. No more than two position calls should be necessary during the takeoff roll. The IP will make the standard ICS calls as described in Contact Flight Procedures.

The Wing SNFO will monitor trim and flap position, as well as airspeeds, and will make the same standard ICS calls as described in Contact Flight Procedures. At approximately 120 KIAS, lead pilot gives the "Go fly" signal.

When safely airborne, the Lead SNFO will report "Two's airborne" to his pilot on the ICS. At 140 KIAS, an exaggerated head nod from the lead pilot will prompt both aircraft to raise gear and flaps simultaneously. SNFOs should scan for a clean aircraft prior to gear speed and ensure the other aircraft in the flight is clean. The wing IP will give a thumbs-up to Lead that his aircraft is clean. When both aircraft are clean, the Lead SNFO will call "flight clean at 195 (or as indicated)" on the ICS and then check in with departure control.

6. Interval Go

The initial position on the runway is the same as for a section go. After run-up checks are completed and the thumbs-up is passed, the Lead will "kiss-off" the Wing with a hand signal and release the brakes. The Wing will wait the SOP-mandated interval (approximately 8 seconds) and initiate the takeoff roll. Procedures during the Lead and Wing takeoff rolls are the same as for a contact takeoff. Once the wing aircraft is clean, the Wing SNFO will call "Two's airborne" on Tac Freq. Unlike a section go, this call on Aux must be made since the Wing may not be in the lead's field of view. Once the "Two's airborne" call is made, the Lead SNFO can check in with departure control. The Wing SNFO's primary responsibility is to monitor the rendezvous and report airspeeds to the pilot over the ICS until within two wingspans of Lead, stabilized in parade, or the IP reports "I got it."

7. Individual Take-off

If weather precludes either a section go or an interval go (i.e., the weather at the departure field is less than circling minimums), a third option is to split the section and perform individual take-offs. Lead SNFO will request separate clearances for both aircraft. The flight will taxi as a section and follow section procedures to the hold short. Following the thumbs-ups at the hold short, each aircraft will call tower in sequence for individual takeoffs. Takeoff procedures are identical to contact flight procedures. Both aircraft will follow ATC directions until able to proceed to a predetermined TACAN position or waypoint to join.

305. ENROUTE/SECTION RECOVERIES

1. Enroute

During the enroute portion of the flight, the section will fly in cruise position. As previously stated, with clear weather, cruise is the best position to travel from point to point for both Lead and Wing. The formation may "tighten up" into parade formation if hand signals need to be passed or weather dictates. As a rule, the wingman should fly in a position such that he is clearly visible to the lead at all times.

2. Section Recovery

Upon completion of the tactical portion of the flight, the section will rejoin and return to base (RTB). The type of recovery conducted is dependent upon the weather and fuel states. The lowest fuel state in the section becomes the fuel state of the flight. Weather may preclude the break or even a section PAR. Individual PARs may be necessary if the ceiling is too low (below circling mins or 1000/3 in the absence of a circling approach) to allow safe separation of the aircraft after the landing environment is in sight.

3. VFR Recovery

A VFR course rules recovery for a section is almost identical to a single aircraft recovery. Wing will most likely be in cruise until just short of the initial. Approximately 3-5 miles prior to the initial, both SNFOs will inform their pilots which side of the formation the Wing should be on for the break. At this point, the Wing will close to parade position on the correct side.

Upon initial check-in with the tower, the Lead SNFO will give the flight's position relative to the initial in the same manner as a contact flight. Approaching the numbers for the break, it is a good idea to report the numbers slightly early to ensure break clearance is received at, or slightly before the numbers. When cleared to break, and with proper interval on other aircraft in the pattern, the Lead IP will initiate the break with the appropriate hand signal, as briefed.

There are several different types of section breaks (fan break, 2- or 4-second interval break, etc.). To execute a fan break, Lead will pass the "fan" signal. Lead and Wing will smoothly roll together. Once established at the correct bank angle, Lead will increase the pull while Wing will float the turn slightly. Lead will maintain power or go to MRT while Wing will go to idle. This will establish the necessary separation on downwind. For an interval break, Lead will pass the kiss-off signal and break. Wing will wait the briefed interval and then execute a break. Regardless of the type of break selected, it will be covered in the brief.

Following the break and established on downwind, the Lead SNFO will report the abeam position and obtain clearance to land for the flight. Upon completion of the landing checklists, the SNFOs will report "three down and locked" in flight order to the tower. The Wing SNFO will wait until the Lead has made his "three down and locked" call before making the "Dash-2 three down and locked" call. Each aircraft will land on centerline and drift inboard to provide a clear lane for the aircraft behind to go around if required.

An example of proper radio calls for a course rules recovery is shown below (Tower, Pri):

a. Lead SNFO - *"Tower, ROKT 407 flight of two, 10 miles southeast, for the break."*

b. Tower - *"ROKT 407, report the numbers 7R."*

c. Lead SNFO - *"ROKT 407."*

Approaching the numbers:

a. Lead SNFO - *"ROKT 407, numbers."*

b. Tower - *"ROKT 407, right break approved."*

Approaching the abeam:

a. Lead SNFO - *"ROKT 407, abeam, gear, full stop."*

b. Tower - *"ROKT 407, cleared to land 7R."*

c. Lead SNFO - *"ROKT 407, cleared to land 7R."*

d. Wing SNFO - *"Dash 2, gear."*

e. Tower - *"Roger."*

4. IFR Recovery

A section recovery in IMC conditions may be required for multiple situations. First, a section recovery in IMC conditions is utilized to expedite the recovery of a formation. Another reason to execute a section instrument approach is to bring a NORDO aircraft back for recovery.

Weather is the most important consideration for a section recovery. Landing field weather must be circling minimums or better to attempt a section GCA. If the weather is below circling minimums, individual instrument approaches will be performed. The LAW should be set for 10 percent below HAA (for circling minimums) IAW the Contact Procedures chapter.

Procedures are basically the same for all possible types of section recoveries: PAR, ASR, TACAN, and Visual Straight-in. The primary consideration is to comply with the controller's directions or the printed approach plate. All contact flight procedures for an individual approach apply (e.g., navigation, altitude calls, penetration checks, etc.). The Wing SNFO will continuously back up the section navigation while also completing internal checklists.

On a precision approach, the Lead SNFO should call “slow to gear speed” over ICS within 10 nm and 30-degree heading of the final approach course. On a non-precision approach, this call will be initiated 5-7 nm from the Final Approach Fix. Although these procedures are identical to the instrument procedures previously covered in the Contact Flight Procedures chapter, special emphasis must be made on the above ranges due to the limited maneuverability inherent in a formation.

At this point, the Lead IP will slow the formation to configure. After passing the preparatory gear and flap signal to the wingman (at or below gear speed), the Lead IP will give a head nod for execution and configure in the following order:

a. Gear handle down

b. Flaps to half

c. Speed brakes in (if extended)

The Lead SNFO will ensure the pilot stabilizes the approach speed at 150 KIAS to allow ample room for the wingman to maintain parade position without sacrificing maneuverability or safety of flight.

When each aircraft has three down and locked, the Wing SNFO will pass a thumbs-up to the Lead SNFO. With the Landing Checklist complete, the Lead SNFO will report “six down and locked” to the controller. On a PAR or ASR, the “down and locked” call to ATC is permitted before the Landing Checklist is complete. The speed brakes will be extended at the final approach fix, or glidepath, via hand signal and head nod. This initiates the final descent to MDA/DH/touchdown while maintaining 150 KIAS (half flaps) until flight separation occurs.

When executing a section approach, ATC controllers will expect the formation to take its own separation on final. At the discretion of the Lead IP, and with the runway environment in sight, the Lead IP will detach the Wing with the “kiss-off” signal. Once detached, the wingman will immediately slow to on-speed by lowering flaps to FULL and decelerating accordingly. The Lead will maintain airspeed until the appropriate point then slow to on-speed for touchdown.

At fields where parallel runways are available, the Lead SNFO may request to “split the duals,” if briefed. In this case, Lead will ensure the Wing is on the side of the formation that correlates to the approach runway (i.e., if the approach is to 25 right, the Wing should be on the right side). This allows an easy transition from formation flying to landing for the wing pilot.

5. Post Landing

During landing rollout, each SNFO will make the appropriate "board and speed" ICS calls as in contact flights. Additionally, the Wing IP will make a "two's slow" call on Tac Freq once the Wing's brakes have been checked, Wing has slowed to a controllable speed, and de-confliction with Lead is assured. After clearing the runway, Lead SNFO will auto-switch to GROUND and request clearance to taxi (while waiting for Wing to clear the runway):

a. Lead SNFO (Pri) - *"Ground ROKT 403, taxi 2."*

Unlike a Contact flight, "cleared of the duty" will not be part of the call above since the wingman may not have cleared the runway at this point. Once the wingman is clear of the duty runway, ***the Wing SNFO will automatically switch to ground frequency***. The section will proceed to the line area and complete the required cockpit checklists. Once in the line/hot brake area, ***the Lead SNFO will positively switch the flight to BASE*** on Aux (monitor Ground on Pri):

a. Lead SNFO (Aux) - *"Viper, Switch Base."*

b. Wing SNFO (Aux) - *"Viper-12."*

If wingman has any maintenance issues he will report them to Lead on AUX at this time. Lead will then call base and report the event status, aircraft status, and event time (using the ROKT call sign):

a Lead SNFO (Aux) - *"Base, ROKT 407, back, 2 complete, 1.2."*

306. FUEL MANAGEMENT

1. Fuel Checks

Both SNFOs are responsible for fuel management within their own cockpits. Additionally, the Lead must always be aware of the fuel state of other jets in the flight. The lowest fuel state within the flight becomes the flight's fuel state. For example, if one aircraft in the section reaches Bingo fuel, the section is considered to be at Bingo state and will RTB accordingly. Due to the "jockeying" of the throttles required to maintain position in formation, the wingman will tend to be less efficient with fuel than the Lead. The Lead SNFO will be responsible for initiating all fuel checks on the Tac Freq:

a. Lead SNFO (Aux) - *"Turbo One, 2.0."*

b. Wing SNFO (Aux) - *"Turbo Two, 1.9."*

Fuel checks will be performed:

a. After every lead change

b. After the wingman makes the "Off, safe, visual" call following an attack

c. As part of the Fence Checks

In addition to the above, the Lead may request a fuel check (either by radio or hand signal) anytime the fuel state of the flight is in question. It is a good idea to keep track of all fuel checks on the kneeboard card to analyze any trends. As the "mission commander" for the flight, the Lead SNFO must analyze fuel states and determine when it is appropriate to RTB.

307. COMBAT CHECKS - FENCE IN/OUT

1. G-warm

CNATRA Low Altitude Training Rules require the performance of a G Awareness Maneuver prior to section low altitude training. The G-warm will be conducted for a minimum of 4 Gs for 180-degrees of turn (90 each direction) at a minimum of 300 KIAS. To facilitate introduction of the G Awareness maneuver, it will be demonstrated by the IPs on the first section Strike event.

2. Fence In/Fence Out

A strike fighter aircraft's role is to be employed tactically in order to execute an Air-to-air or an Air-to-ground mission objective. Since these objectives will more than likely be executed away from home base (ship or airfield), a section of aircraft will need to administratively transit (Admin leg) from their point of departure to the area of operation and then back to home base. Since these are Admin legs that do not entail a tactical objective, there must be a way to change this administrative mindset to one that will enable us to carry out the mission.
"Fence In/Fence Out" calls serve this purpose. They enable the flight lead (Lead SNFO in VT-86) to plan and brief predetermined points at which the flight will transition to a tactical mindset and then back to an administrative one when the tactical mission is complete. In the Training Command, these checks are covered by the Combat checks found in the Student In-Flight Guide: A/A and A/G Combat Checks. During the Strike, BFM, CAS and AWI flights in VT-86, all SNFOs will be responsible to fence in and out at the appropriate time as directed by the Lead.

The checks will initially consist of switching to the briefed A/A TACAN game-plan, directing IP to squawk appropriate code (4000 for the route), verifying recorders on, LAW set as required, verifying initial A/G setup on the stores page, setting up the MFCD as necessary, and setting the NAV mode as simulation for the A/A radar during Self-Escort Strike (SES) missions. You will notice that these Fence checks are a combination of the A/A and the A/G Combat checks found in the in-flight guide.

When the tactical portion of the mission is complete, the flight will transition back into an administrative mindset for the transit and RTB. Fencing out accomplishes this task, and is performed by running the previously mentioned Fence checks in reverse order. Essentially, “undo” everything that was previously “done” on the Fence in.

3. Battle Damage Check (BDC)

After all tactical flights, the potential exists for aircraft damage or hung ordnance. Upon conclusion of the tactical conduct, the section shall conduct a battle damage check by visually inspecting each aircraft for hung bombs and damage such as loose panels, leaks, or any other discrepancy that may affect the RTB. The BDC is normally executed after the fence out checks to ensure that the master arm switch is safe. This provides a layer of safety in the event of an inadvertent activation of the weapons release button or the gun trigger.

When fence out checks are reported complete, the Lead IP will pass the BDC signal at an appropriate time by extending the index finger and the thumb straight up in the shape of a pistol and simulating the cocking of the hammer. The Wing IP will then visually inspect the lead’s aircraft by elevating to check the top portion on the current side the wingman is on. The wingman will then lower the aircraft to cross under the lead, while inspecting the bottom of Lead’s aircraft and elevating again to inspect the opposite top portion. If any discrepancies are noted, the Wing IP will notify Lead on Tac Freq; otherwise, a thumbs-up will be passed to the lead. The Lead IP will then “pass the lead” to the Wing IP so that his aircraft can be inspected.

Upon completion of the final visual inspection, the Lead will be passed back to the Lead IP as the flight continues on its RTB. If anything out of the ordinary is noted, the crew will take appropriate action to recover the aircraft safely by following SOP and NATOPS procedures.

Although this is a check that is coordinated and executed by the IPs, it is the SNFOs’ responsibility to ensure that BDCs are executed as soon as practical after the fence out. This will ensure ample time for coordination if damage or hung ordnance occurs.

308. EMERGENCIES

1. Aborts

Sympathetic aborts may be used during interval takeoffs as the wingmen should be able to safely stop behind the lead. If Lead aborts, Wing aborts. The eight-second delay on an interval takeoff will normally ensure the Wing is at a slow speed (< 50 knots), making it easy to stop. Wing will transmit “clear” over the radio to allow the lead aircraft to use the long field arresting gear.

When a Section takeoff is executed, sympathetic aborts do not apply. Instead, both aircraft shall maintain their takeoff lane. The non-aborting aircraft shall continue the takeoff roll and get clear of the runway. Once the good aircraft is clear, the aborting aircraft can move to the centerline of the runway and engage the long field arresting gear as necessary.

In the unlikely event of a dual high-speed abort scenario, the first aircraft to the arresting gear has to pass it up unless "clear" is heard on the radio from the second (trailing) aircraft. The "clear" call tells the down range aircraft that the aircraft behind is under control and de-conflicted and that it is safe to move to centerline and take a long field arrestment. In this situation, an "Aborting" call is crucial so that the wingman knows the Lead is aborting. After that, only good news (e.g., "clear") will be transmitted over the radio to preclude the down range aircraft mistaking the intent of the transmission. Absent a "clear" call, both aircraft must maintain their respective takeoff lanes. In no case will the trailing aircraft transmit anything other than "clear" following a dual high speed abort.

2. In-Flight Emergencies

When any member of a flight develops an emergency that requires landing, the instructional portion of the flight will be terminated. The aircraft with the emergency will proceed directly to its point of intended landing (home field or divert field as necessary), escorted by the other aircraft if possible. The emergency aircraft has the option of being Lead or Wing as the situation warrants. The escort will provide assistance wherever possible (or as requested) such as reading out emergency procedures or making radio reports, etc. However the non-emergency aircraft will not attempt to provide assistance unless requested by the emergency aircraft.

3. IMC Lost Sight - Two Plane Procedures

In the event that Wing loses sight of the lead, Wing will transition to instrument flight, turn away from the lead (or roll wings level if the turn is away from the wingman), and transmit "lost sight." The objective is to establish a 30-degree heading differential for one minute, then turn so that both aircraft are on a parallel heading. If in a climb or descent, the wingman shall level off momentarily while the Lead continues a climb or descent to the assigned altitude; the goal being to establish a 1000-foot altitude buffer between the aircraft until VMC or an ATC clearance can be obtained. All headings and altitudes should be coordinated over the radio to expedite a join-up once VMC and to avoid a collision. All aircraft should do their best to maintain sight and formation integrity with the aircraft ahead of them to minimize these lost-sight situations.

4. Communication Failure (NORDO)

The aircraft with the communication failure will become the Wingman. This is a minor emergency when flying in formation. The aircraft with the good radio will be given the Lead via standard hand signals and perform a standard recovery in accordance with the weather conditions. If in VMC, the flight should maintain VFR and return for the break. As Lead, perform a normal break and request landing clearance for the flight. A touch-and-go executed by the Lead will signify clearance to land for the Wingman. Additionally, the Lead may request the ALDIS lamp for the NORDO aircraft to provide visual indication of landing clearance. In the event that the NORDO aircraft is unable to touchdown, or goes around for any reason, the NORDO aircraft will follow the lead. The Lead will continue to coordinate with tower until fuel permits or landing is executed. Once on deck, the first aircraft to land will clear the runway and wait for the second aircraft to join up. Lead will then obtain clearance for the flight to taxi to the line.

If in IMC, the Lead will have to recover the NORDO aircraft with a 150 KIAS, half-flap section instrument approach. Standard section approach procedures will be utilized. At approximately 500 feet AGL, with a centered ball and in a position for a safe landing, the Lead will pat the dash (meaning the Wing is cleared to land), point at the runway the Wingman is cleared to land on, and "kiss" the Wingman off. The Wingman should then make a normal approach and landing. The Lead will continue at 500 feet AGL and 150 KIAS to be in position for the Wingman to rejoin if required. If the Wingman does a touch-and-go or does a missed approach, he should visually acquire the Lead at the 10 o'clock or 2 o'clock position at pattern altitude (or below the ceiling). The Wing may rejoin the Lead for another approach. After the aircraft are rejoined, the aircraft will cleanup together prior to reentering IMC conditions. With the Wingman safely on deck, the Lead may circle to land or proceed with another instrument approach.

If lost communication and lost sight of the Wingman (lost-comm/lost-sight), flight de-confliction will be in accordance with the preceding paragraphs. A standard lost-comm/lost-sight rendezvous point will always be briefed to affect an expeditious join-up for RTB.

5. Down Aircraft (SAR)

If any aircrew in a flight is forced to eject, the responsibility of coordinating Search and Rescue (SAR) will be the responsibility of the senior aircrew in the flight. The senior aircrew will coordinate the SAR effort in accordance with the On Scene Commander checklist in the PCL.

On the local appropriate frequency, or 282.8, the downed aircrew location will be passed to ATC. The On-Scene Commander aircrew can use a TACAN cut or drop a "Mark" with the NAV system over the downed aircrew to get precise coordinates. Assistance will be requested and a brief explanation of what has happened will be passed. It is essential that names are not given.

Although getting aid to the downed crew is important, the safe conduct of the remaining members of the flight is equally important. The On-Scene Commander may designate a high- and low-orbit. The low-orbit will check on the condition of the downed crew and crash scene. The high-orbit will act as a radio relay for information. When any aircraft reaches a predetermined low fuel state, the On-Scene Commander will RTB or divert as appropriate. Every effort should be made to pass the On-Scene Commander responsibility to a more capable airborne asset.

6. Mid-Air Collision

The first consideration after a mid-air collision is to regain control of the aircraft if it can be flown or eject if the aircraft is out of control. The elements of the formation will separate and not rejoin.

Each crew will execute controllability checks of the damaged aircraft close to the landing field above 10,000 feet AGL; remain over water or unpopulated areas if possible. Slow the aircraft in increments of 10 kts, drop the gear at 200 kts or below, and evaluate the slow flight characteristics (flaps may be lowered if wing damage is not suspected). Continue to slow the aircraft in 10 KT increments to on-speed or until the aircraft control becomes suspect. The pilot will make shallow turns in both directions to determine landing characteristics. In the final analysis, the pilot of the damaged aircraft must decide whether ample angle of bank and pitch authority exists to land the aircraft safely. Proceed directly to the nearest suitable divert or home field.

CHAPTER FOUR
SECTION LOW ALTITUDE TACTICS AND PROCEDURES

400. INTRODUCTION

Low altitude tactical flight training is designed to optimize terrain masking, facilitate threat detection and avoidance, and minimize terrain hazards. The advantage of surprise and detection avoidance comes with the threat of terrain/obstacle impact. The purpose of the low-level weapons portion of the advanced syllabus is to demonstrate the low altitude tactical environment in a multi-plane, heavy task load scenario.

401. LOW ALTITUDE AWARENESS TRAINING (LAAT) PRINCIPLES

Low altitude awareness training (LAAT) emphasizes the importance of standardization and understanding LAAT concepts for operations in a low altitude environment. The LAAT environment is dynamic and unforgiving; safety considerations, visual illusions, aerodynamic factors and training rules apply to every low-altitude flight.

The most difficult aspect of low altitude flying is the constant task management. The goal of LAAT is to maximize tactical capability while mitigating the risk of ground impact. Setting a minimum altitude is not enough; a process oriented, task management approach is critical to success. The laws of physics and aerodynamics are absolute. It is our perception of safety, risk, and comfort level that are subject to gross error.

1. Safety Considerations and Theory

A USAF study tracked all Tactical Air Force accidents over an eight-year period, and found that only 10% of total mission hours involved low-altitude flying, yet 57% of all aircrew fatalities occurred during low altitude operations. A further breakdown revealed that 86% of these fatalities occurred during turns or vertical maneuvering down low. It also revealed that experienced aircrew are at the same risk as younger, inexperienced aircrew.

In order to mitigate this risk, the Navy and Marine Corps squadrons use the instructional concepts first developed by the 162nd Tactical Fighter Group. These concepts include:

a. The “Bucket” concept

b. Terrain Clearance Tasks (TCT)

c. Mission Tasks (MT)

d. Mission Cross-Check Time (MCT)

e. Knock It Off (KIO)

f. Climb To Cope (CTC)

g. Dive Recovery Rules

In addition to these concepts, CNATRA training requires all aircrew to read Low Altitude Training Rules prior to each low-level flight. These can be found in the VT-86 In-Flight guide or the COMTRAWINGSIXINST 3710.17.

2. The "Bucket" Concept

Task saturation in a high speed, low altitude environment happens quickly. High workload combined with high risk is potentially dangerous. Aircrews can be overtaken with task saturation and have no awareness of the threat. Momentary indecision, wasted movements, missed tasks and checklists, or erratic basic air work can all cause task saturation. Communication breakdowns and loss of overall situational awareness are also contributing factors. Poor task management is a function of not knowing or forgetting: What to look for, when to look for it, where to find it, and how to use it.

The Bucket is an illustrative reference used to describe the finite capacity aircrew has for input and subsequent action. When aircrews get overtasked, buckets may run over. The inside of the bucket represents the limit of human capacity; that capacity is subdivided into categories of prioritized tasking (Figure 4-1, left image):

a. Terrain Clearance Tasks (TCT) – Any mental or physical tasks that establish, maintain, or predict ground/obstacle clearance. TCTs are the first tasks in the bucket and the last out; they are the top priority.

   i. Aerodynamic control – Keep the aircraft flying.

   ii. Vector Control – Process of assessing and modifying the aircraft vector in elevation, azimuth, and velocity relative to the terrain. Vector control includes attitude (pitch and roll) and is the key TCT crosscheck variable.

   iii. Time Control – Mentally controlling the frequency and duration of MCT relative to TCT requirements. Knowing how long to "ignore" Vector and AGL control in order to accomplish MT.

b. Mission Tasks (MT) – All tasks required for mission accomplishment; MTs are subdivided into CT and NCT.

   i. Critical Tasks (CT) – Tasks that demand IMMEDIATE attention and successful accomplishment for mission success.

   ii. Non-Critical Tasks (NCT) – Tasks that DO NOT immediately affect mission accomplishment.

   iii. MTs include Communications, Fuel Checks, Navigation, Timing, Weapon System Operations, Formation and Threat Countermeasures.

The bucket concept, once understood, is normally modified by incorporating all Mission Tasks into the Mission Cross-Check Time construct (MCT). MCT becomes the portion of the bucket available for accomplishing MTs (Figure 4-1, right image).

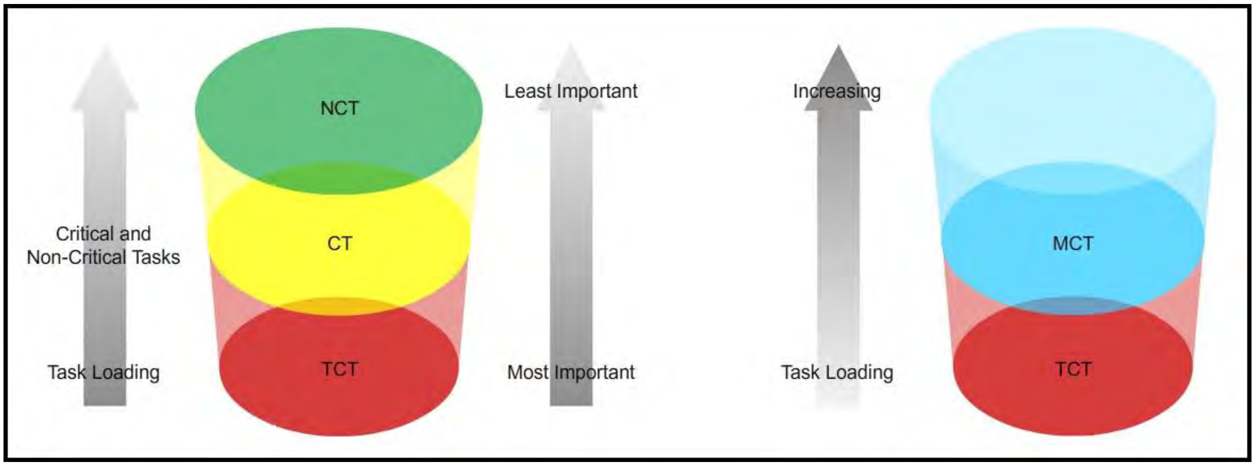


Figure 4-1 The Bucket/MCT Applied to Bucket

Certain tasks can be critical at one point during the mission and non-critical at another. MCT dictates how much time aircrew are allowed to focus solely on MTs. More specifically, how long can aircrew go without devoting time to TCTs? Basic MCTs are as follows:

a. 5 seconds for straight and level flight at low altitude

b. 1 second for flight in a turn at low altitude

Task Management timelines can be applied to low altitude as a means of methodically forcing aircrews to practice proper scan and MCT techniques. Figure 4-2 illustrates the application of MCTs based on a change in flight regime. The MCT goes from 5 seconds straight and level, down to 1 second in a turn, and then back to 5 seconds upon returning to straight and level. It is important to note that during smaller MCTs, CTs are the only tasks with priority. Also, when a tasking conflict arises, NCTs are the first to go and can never be prioritized over a CT.

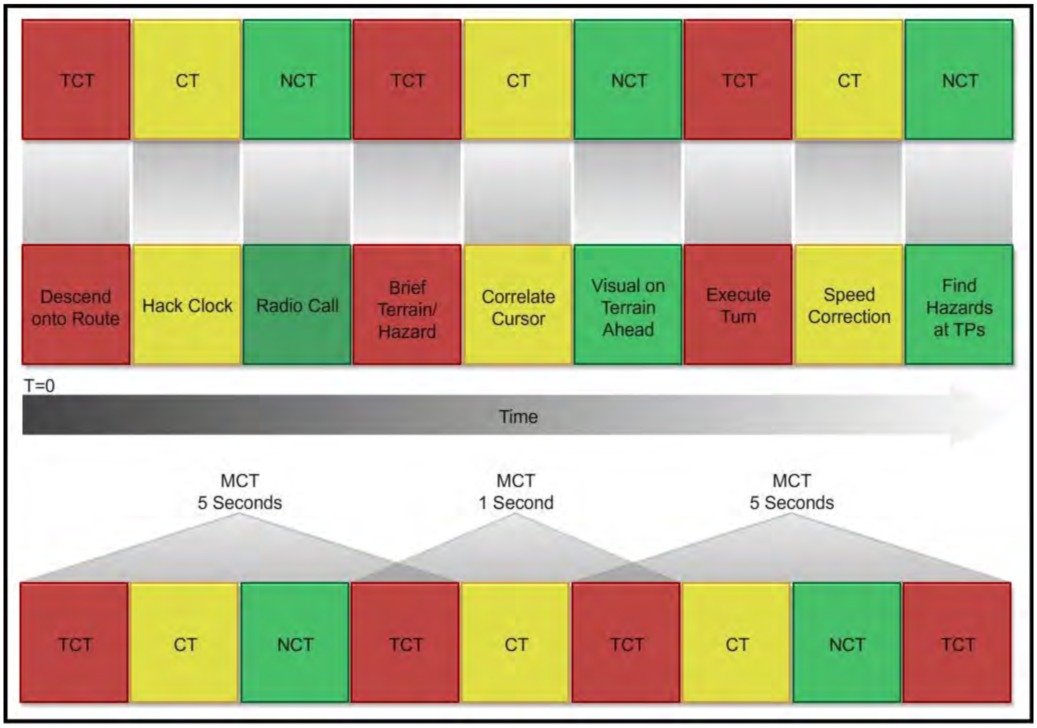


Figure 4-2 Task Management Timeline with MCT

In addition to time and task management, aircrews have to learn their limits and be able to immediately recognize when the bucket is overflowing. Even with a good scan and proper MCT, the bucket can still overflow. When it does, the following options are available:

a. Slow Down.

b. Shed some Mission Tasking.

c. Knock It Off (KIO).

d. Abort.

e. Climb to Cope (CTC).

It is important to note that a climb to cope does not necessarily mean mission failure. Once CTC has been utilized, the mission may continue and proceed back to the LAAT environment. LAAT reference altitudes and associated tasking priority should be briefed and used when appropriate (Figure 4-3).

a. Minimum Altitude (MA) – The altitude at which accomplishment of TCT demands the full use of aircrew's capabilities; it depends on aircrew experience and proficiency.

b. Critical Tasking Altitude (CTA) – The altitude where accomplishment of the CT and TCT demands all available aircrew capability.

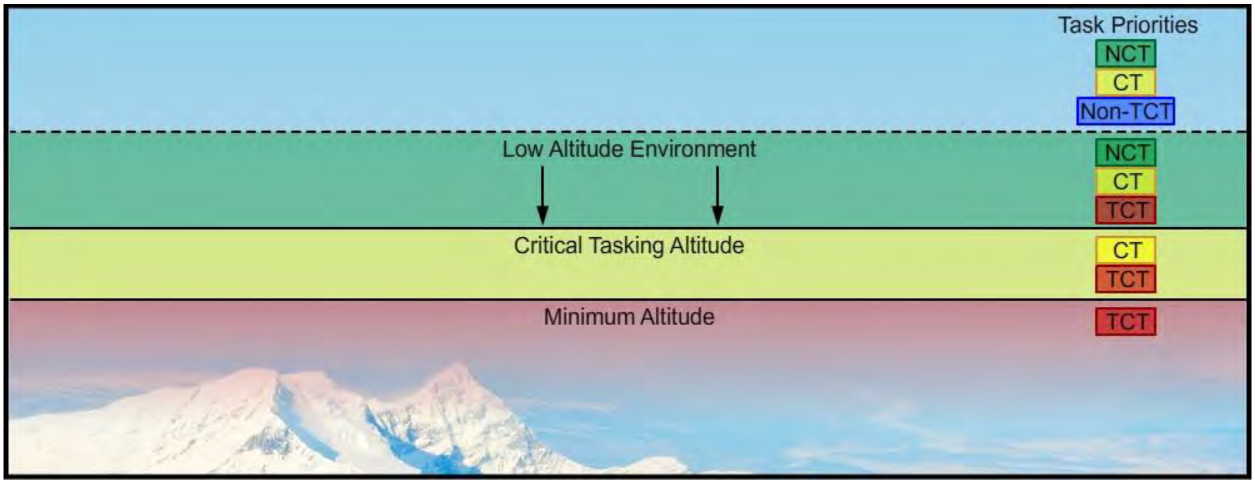


Figure 4-3 Reference Altitudes

When building reference altitudes, aircrew must also consider the reason a low altitude flight was chosen. Enemy threat capability may drive tactics to the low altitude environment. The reduction in visual or radar acquisition by the enemy is a huge advantage for striking aircraft; however, bird strike potential is increased, radar and visual acquisition of enemy targets is decreased, fuel flow rates increase, and terrain avoidance becomes an issue. The threat, advantages and disadvantages, must all be considered and weighed when choosing low altitude tactics.

3. Visual Illusions

There are three main visual illusions that can negatively affect aircrew: optical flow, speed rush baseline, and environmental factors. The human eye is a passive sensor that relies on reflected light; it does not actively measure distance or direction. Only relative distance and direction estimates are produced from the images transmitted to the brain. Therefore, the eye is not a reliable sensor for flight path angle or AGL altitudes.

a. Optical flow – The perception of all visible objects' movements as a result of aircraft velocity.

b. Speed rush baseline – Establishes a relative optical flow reference from which subsequent evaluations of altitude and speed are based.

c. Environmental factors – The low altitude environment also plays a critical role in establishing optical flow intensity, and the four main characteristics are density, terrain profile, unacquired vertical obstacles, and sky/weather factors.

There are two interacting components of visual perception: Central Vision and Peripheral Vision. Central Vision is the primary informational component of our visual system. It provides cues and information about what is out there. Characteristics of central vision include:

a. High acuity

b. Specific focal point chosen when you consciously "slave" eyes to objects of interest

c. Small field-of-view

d. High G tolerance

e. Very limited in determining altitude

Peripheral Vision provides data about where we are in general. Characteristics of peripheral vision include:

a. Low acuity

b. Used for overall motion detection or attitude information (enters the brain subconsciously)

c. Much wider field-of-view

d. Low G tolerance (during grayout to blackout or tunnel vision, peripheral goes first)

Since the human brain primarily relies on visual input for interpretation analysis, it can be catastrophic when the visual inputs are not reliable or accurate. In order to balance or counter the relative values of visual perceptions, aircraft instruments must be trusted to maintain accurate TCT control and response. The HUD scan of the velocity vector (VV) and the RADALT are the two most important instruments in low-level flight, providing a reliable source for accurate measurement of flight path angle or AGL altitude.

4. Aerodynamics and Physics

The VV cannot be emphasized enough in the low altitude environment. Where the aircraft is actually going is much more important than where the nose is pointed. Figure 4-4 shows an aircraft in the same relative position but with two completely different VV placements; one will clear the ridge (right image), one will not (left image).

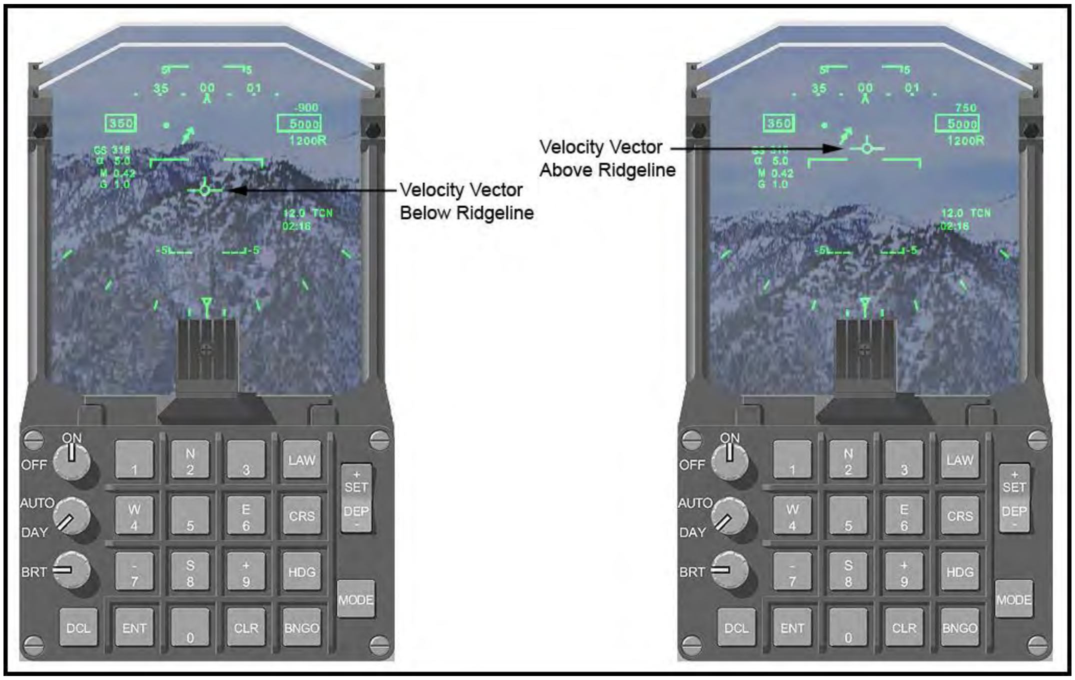


Figure 4-4 Velocity Vector Placement Relative to Ridgeline

The flight path angle (FPA) is the angle (in degrees) of climb or dive that the aircraft's VV makes relative to the ground plane. Time to Impact (TTI) is the time in seconds to ground impact measured from a beginning vector and an initial AGL altitude position. For obvious reasons, keeping TTI as high as possible is desired.

The chart depicted in Figure 4-5 illustrates various TTIs for given altitudes and FPAs.

TTI for 250 KTAS (seconds)

	-1 FPA	-2 FPA	-3 FPA	-4 FPA
500' AGL	68	34	23	17
1500' AGL	202	101	68	50

TTI for 300 KTAS (seconds)

	-1 FPA	-2 FPA	-3 FPA	-4 FPA
500' AGL	56	28	19	14
1500' AGL	170	85	57	42

TTI for 350 KTAS (seconds)

	-1 FPA	-2 FPA	-3 FPA	-4 FPA
500' AGL	48	24	16	12
1500' AGL	145	72	48	36

Figure 4-5 Time to Impact Chart

As the chart demonstrates, doubling the FPA will reduce the TTI by half. Additionally, an airspeed increase will also decrease TTI. The important point to note is that TTI is:

a. Directly proportional to altitude

b. Inversely proportional to both FPA and airspeed

Aircrew should pay particular attention to the drastic decrease in TTI that occurs only 1000 feet lower, 100 KTAS faster and with a -3 greater FPA.

When aircrews are aware of a negative FPA, the descent rate can be controlled and mitigated; however, there is one particular situation where an undetected negative FPA is common: nose slice. A nose slice is when the aircraft starts a negative FPA during a turn, and defines the horizon in motion relative to the aircraft. Figure 4-6 illustrates how the nose of the aircraft falls from above the terrain to below the terrain in only 40 degrees of heading change. In this situation, the RADALT does not act as a safety net because of the bank angle. Environmental factors such as haze/fog, calm lakes or minimal horizon features degrade nose slice detection. Aircrew must actively scan the horizon and the HUD to catch this situation early and correct it.

Figure 4-6 Nose Slice In a Turn

To transition to the low altitude environment, fleet aircraft have dive recovery rules that allow them to aggressively descend. However, these rules have not been tested for CNATRA aircraft, so Training Command squadrons will adhere to the “minute to live” rule. CNATRA also requires that Low Altitude Training Rules (LATR) be briefed prior to every low altitude flight. SNFOs are responsible for bringing a copy of the LATR to briefings when required.

402. LOW LEVEL PROCEDURES

1. Low-Level Briefing

Risk mitigation for terrain avoidance starts with a thorough briefing and understanding of Air-to-ground training rules, SOPs, LAAT procedures and NATOPS. ***Detailed route preparation and study are required***. Recall from the Chapter One planning discussion, that SNFOs must prepare a briefing board (Figure 4-7) and bring the following items to the low-level briefing:

a. SNFO Junk Jacket

b. Applicable Publications

c. Jet Log

d. All Charts

e. Pocket Checklist (PCL)

f. Strike Briefing Guide

g. Target Imagery for Route Targets

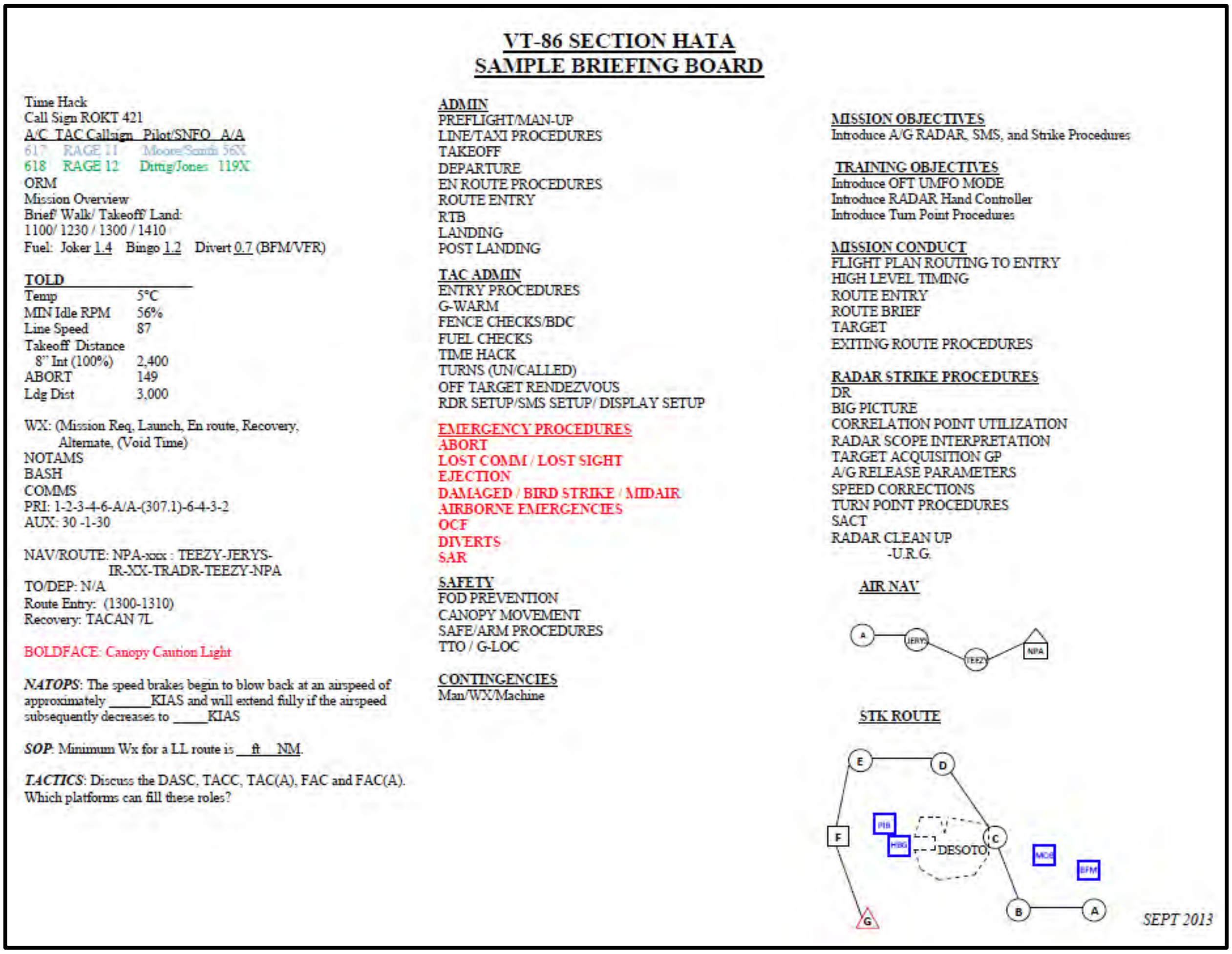


Figure 4-7 Section HATA Briefing Board

2. Enroute Procedures and Route Entry

Low-level flights begin with the standard section administrative procedures detailed in the previous chapter. Once level at altitude and enroute to the low-level, SNFOs will check timing and adjust airspeed as necessary to ensure route entry is within +/- 4 minutes of scheduled time. As the flight approaches the route, Lead SNFO will take charge and:

a. Descend the flight to 2000 feet.

b. Cancel IFR.

c. Switch to FSS and call for “fence in.”

d. Positively check-in on FSS.

e. Monitor the G-warm.

f. Make the FSS call.

g. Report “fenced-in.”

h. Call the time hack at route entry.

Tactical flight regimes and the associated maneuvers differ from normal flight operations. The switch from the administrative portion of the flight to the tactical portion requires a mindset change. Fence-In checks will be accomplished at a pre-briefed point, and are designed to ready the jet and aircrew for combat.

Fence-Out checks are completed at the end of the tactical portion of the flight, and are designed to transition back into the administrative mindset and jet configuration. These checks are covered by VT-86 Combat Checks found in the Student In-Flight Guide. Depending on the mission, there are separate checks for A/G and A/A.

A G awareness maneuver (G-warm) is also required by all CNATRA aircraft prior to conducting A/G or A/A tactical flight. The G-warm consists of a 180-degree turn (90-degrees in each direction) performed at a minimum of 300 KIAS and 4Gs. In VT-86, aircrew will accomplish the G-warm as follows:

a. Weather must be VMC below 17.5k.

b. With no traffic between the section and Point A, initiate fence-in, descent, and acceleration to 300 KIAS.

c. Conduct G-warm VFR above 5000 AGL to maximum extent possible, but in no case below 2000 AGL.

d. After completion of G-warm and combat checks, the flight will report “Fenced-In” with alibis and fuel state.

In addition to the G-warm, SNFOs shall accomplish the following A/G combat checks for low-level ingress prior to reporting “Fenced-In”:

a. A/A TACAN – As briefed

b. Direct IP to squawk appropriate code (1200 VFR, 4000 on route).

c. Tapes – ON

d. LAW – Set as required after verified operational at 5000' AGL.

e. A/G Stores Page – SET UP

f. MFCD – SET UP HSI/SA page as required (Figure 4-8).

i. SEQ 1 boxed

ii. AUT 1 boxed

iii. 10 nm scale for low-level

g. Set NAV mode

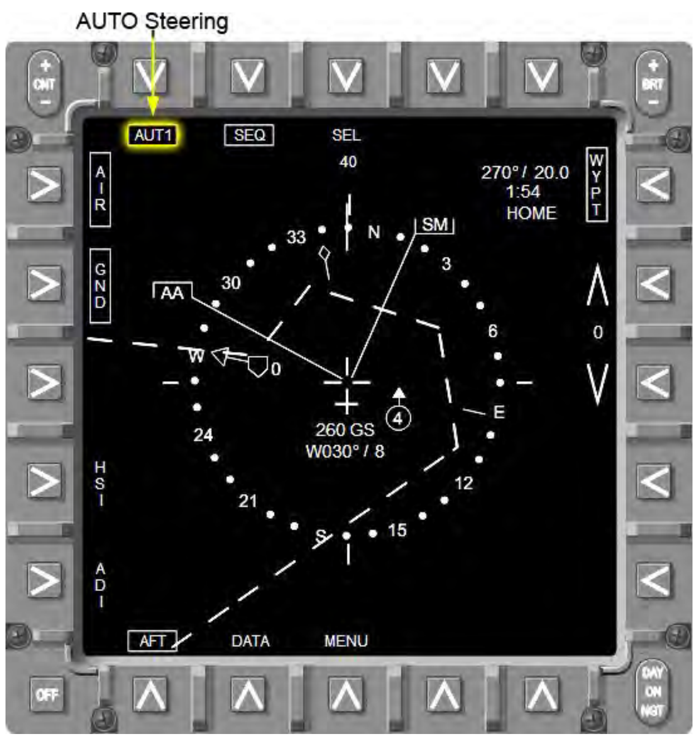


Figure 4-8 10 NM Scale, SEQ Boxed with AUT1 Boxed

Automatic sequential steering is used to keep the waypoint navigation system up-to-date along the route. The correct sequence for the route must be built and selected before the AUTO option appears; only include the low-level route points in your tactical sequence. The HSI will also be in PLAN mode for the route. On deck, build the sequence, box SEQ 1, scale out and check it before takeoff. If the sequence does not look correct, check the waypoints and the sequence string.

When approaching TRADR for VR-1021, the communications for the route entry and Fence-In checks are as follows:

a. Lead SNFO (Pri) - *"Mobile Approach, ROKT 401 request 2000."*

b. ATC - *"ROKT 401, Mobile Approach, Descend and maintain 2000."*

c. Lead SNFO (Pri) - *"Mobile Approach, ROKT 401, leaving 10,000 for 2000, cancel IFR."* (with good weather and traffic no factor)

d. ATC - *"ROKT 401, cancellation received, squawk appropriate code, frequency change approved."*

e. Lead SNFO (Pri) - *"ROKT 401."*

Squawk 1200/Lead IP pushes Wing to Combat Spread formation

a. Lead SNFO (Aux) - *"Hammer switch 29, fence-in."*

b. Wing SNFO (Aux) - *"Hammer-12."*

c. Lead SNFO (Aux) - *"Hammer, check Pri."*

d. Lead SNFO (Pri) - *"Hammer-11."*

e. Wing SNFO (Pri) - *"Hammer-12."*

f. Lead IP (Aux) - *"Hammer, accel G-warm."*

g. Wing IP (Aux) - *"Hammer-12."*

h. Lead IP (Aux) - *"Hammer, 90 left go."*

i. Lead IP (Aux) - *"Hammer, 90 right go."*

j. Lead SNFO (Pri) - *"Anniston Radio, Anniston Radio, Rocket 401, two T-45s entering VR 1021, PT A at time ____, Exiting PT E at time____, 500 feet, 360 knots."*

Just prior to entering the route, both aircraft will change the squawk to 4000. Upon completion of G-warm, RADALT Check at 5000' AGL, and fence-in checks with alibis:

a. Lead SNFO (Aux) - *"Hammer-11, fenced-in, 2.4."*

b. Wing SNFO (Aux) - *"Hammer-12, fenced-in, 2.4, negative yardstick."*

Approaching Pt A, Lead SNFO will give IP an outbound airspeed and heading.

3. Route Procedures

The goal for a low-level is to scan outside of the cockpit 90% of the time. The scan is clock-chart- ground. Always be mindful of MCT, especially in turns. It is very easy to concentrate too much on the HSI and remain heads down for too long. For visual references, keep the following in mind for flights at 500' AGL:

a. The horizon is approximately 18 nm away and about 3 minutes out at 360 kts.

b. Halfway up the horizon is approximately 6 nm away and about 1 minute out.

c. Looking down the wingtip to the ground is approximately .25 - .5 nm.

Pre-flight chart study is imperative. For route study and for choosing checkpoints, use the following tools:

a. VFR Sectional information is more current than TPC.

b. Joint operations graphics (JOG)

c. Google Earth/Maps or Bing Maps

d. "Intel"

Remember to pick the easy, obvious ground references for your checkpoints and turn points. There is no requirement to find a set number of your selected turn points or checkpoints. Overall SA and timing on the route is the focus. Also keep in mind that objects on a TPC may be as much as a mile from their actual location. Checkpoints are designed to keep NAV and timing within standards. Use funneling features and work from large to small when finding checkpoints/turn points/targets. Prior to flight/takeoff, confirm or check the following:

a. Assess effects of wind (verify wind off HSI airborne and adjust with ground track symbology).

b. Assess fuel requirements.

c. Review/update hazards.

d. Verify forecast weather minimums of 3000 foot ceiling and 5 nm visibility.

SNFOs are required to brief all low-level hazards to include obstructions, BASH, airfields on the route (to be avoided by 3 nm or 1500 AGL), VR crossing routes and other route specific information.

403. LOW-LEVEL FORMATIONS/MANEUVERING

Low altitude tactical formations are designed to optimize terrain masking, facilitate threat detection and avoidance, and minimize terrain hazards. As discussed in the previous chapter, the two basic section formations utilized in the low altitude environment are Combat Spread and Tac Wing. On the route, Combat Spread will be the preferred formation, weather and terrain permitting. In the target area, Tac Wing may be preferred depending on the specific target attack profile.

1. Combat Spread

The majority of the low-level will be flown in the combat spread formation. Recall that Combat Spread is a defensive formation (Figure 4-9) designed to provide:

a. Increased enemy detection

b. Separation between aircraft

c. Early commitment by enemy air threat

d. Less exposure of a section of aircraft to a given threat

e. Visual acquisition problems of both aircraft by an enemy

Combat spread formation in the low altitude environment is defined as follows (Figure 4-9):

a. 90 (270) degree bearing line

b. Approximately 1 nm lateral separation (dependent on threat status and weather)

c. Wing shall never fly lower than Lead's altitude.

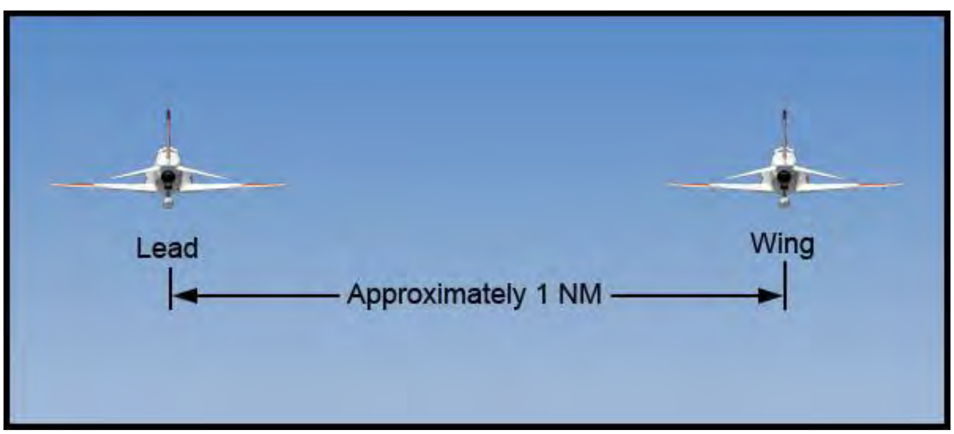


Figure 4-9 Combat Spread

2. Low Altitude Section Maneuvering

The benefits of combat spread in the low-level environment have been discussed. Now we address how to maneuver a section in combat spread in order to meet the ever-changing tactical scenario.

Three distinct section turns are used in the low altitude environment while flying in combat spread. These turns are:

a. Check turns – 0-30 degrees

b. Tac Turns – 31-120 degrees

c. Shackle Turns

Other turns possible in the low-level environment include cross turns and in-place turns; however, these will not be covered in detail due to their specificity to a hostile environment. All turns in the training environment will be called over Tac Freq (turns called by IP with students recommending turns over the ICS).

All turns during section maneuvering are considered level turns and should be executed with precision. The workload will be higher than normal due to the close proximity of another aircraft. The main priority during the turns is to track the turn and avoid the ground. Crewmembers should not exceed more than one second mission crosscheck time (MCT).

3. Check Turns (0-30 Degrees)

The check turn is a turn of less than 30 degrees that is designed to slightly change the heading of the formation, reposition the formation, or aid in visually checking the section's 6 o'clock (Figure 4-10). During Check Turns, the Lead will generally use small angle-of-bank turns to affect the heading change desired. This will prevent the Wingman from misinterpreting the turn as a wing flash. The wingman will use power to maintain proper formation. No communication is required for this turn, although the Lead may make a courtesy call on Tac Freq.

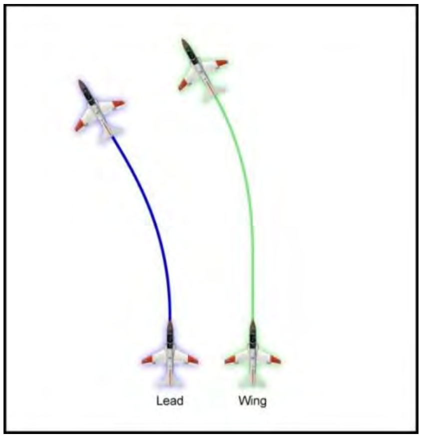


Figure 4-10 Check Turn

4. Tac Turns (31–120 Degrees)

The Tac Turn is designed to turn the section approximately 90-degrees for navigation or threat engagement. There are two types of Tac Turns:

a. Tac Turns Away from the wingman

b. Tac Turns Into the wingman

TAC Turn Away (Figure 4-13)

a. Lead will initiate with a UHF call.

b. Wingman initiates the turn into the Lead for 90-degrees of heading change and then rolls out.

c. As the wingman approaches Lead's 4 or 8 o'clock (extended wingline), Wing will visually clear the Lead's 6 o'clock, then execute a turn to the new heading and roll out.

d. The wingman may need to execute a small repositioning turn to reacquire the bearing.

e. Primary lookout doctrine should be to track the turn with an occasional scan for any obstructions. Once wings are level, each aircraft should check the section's new 6 o'clock position.

f. The wingman ensures deconfliction (Wingman will always pass above the Lead).

g. Example communications flow is as follows:

i. Lead IP (Aux) - *"Hammer, TAC Left."*

ii. Wing IP (Aux) - *"Hammer 12."*

iii. Lead IP (Aux) – *" Hammer flow 270."* (Only if rolling out on heading other than 90 degrees of original heading)

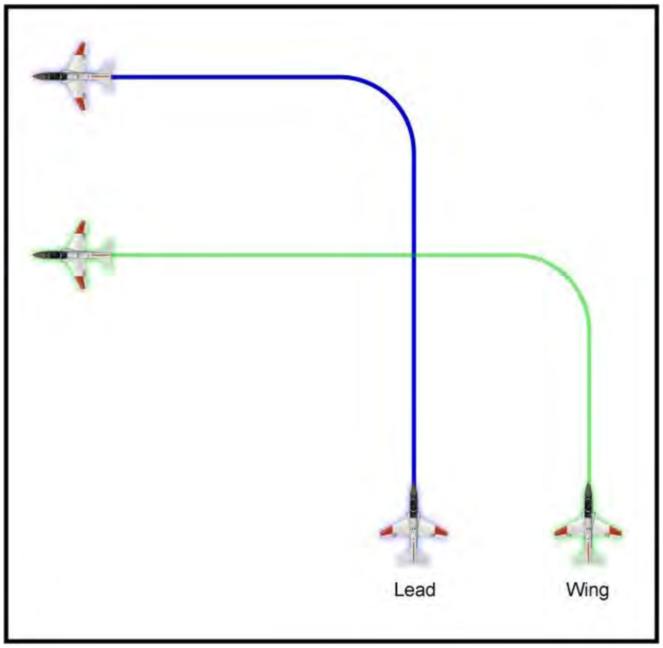


Figure 4-11 TAC Turn Away

TAC Turn Into (Figure 4-14)

a. Lead will initiate the appropriate UHF call, turning into the wingman to roll out on course.

b. As Lead approaches the wingman’s 4 or 8 o'clock (extended wingline), the wingman visually clears the flight’s 6 o'clock and executes a turn to the new heading.

c. The wingman may need to execute a repositioning turn to reacquire the proper bearing.

d. Primary lookout doctrine should be to track the turn with an occasional scan for any obstructions. Once wings are level, each aircraft should check the section’s new 6 o'clock position.

e. The wingman ensures deconfliction (Wingman will always pass above the Lead).

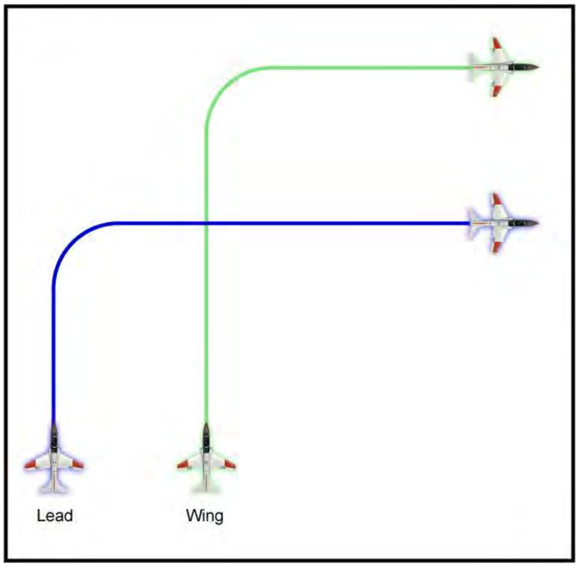


Figure 4-12 TAC Turn Into

5. Shackle Turn

A Shackle Turn (Figure 4-15) is normally used to correct for timing, or to redress the section following a turn or attack.

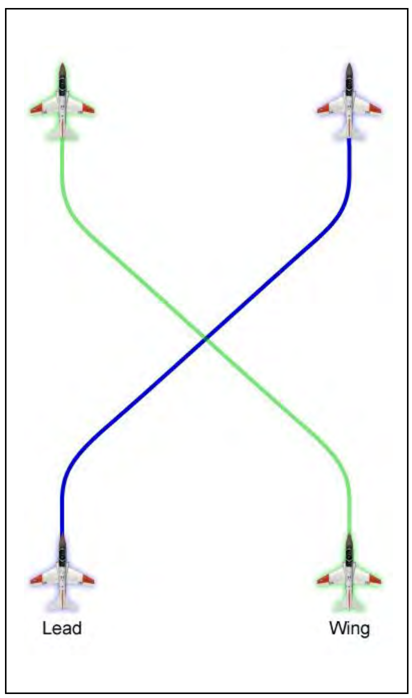


Figure 4-13 Shackle Turn

Shackle turns will be executed as follows:

a. Lead will initiate a shackle turn with a UHF radio call.

b. The wingman will respond by starting a turn into the Lead.

c. As Lead sees the wingman start his turn, Lead will then commence a turn into wingman for 45-degrees and then roll wings level.

d. As the wingman observes Lead roll wings level, the wingman will stop his turn. As the aircraft cross, the wingman will always pass above the Lead. (wingman ensures de-confliction.)

e. The 45-degree headings are maintained until the two aircraft are nearing the 5000 foot abeam position. Both aircraft then perform a turn toward each other until the initial heading is reached and an appropriate combat spread formation is attained.

f. Example communications flow is as follows:

   i. Lead IP (Aux) - *"Hammer, Shackle."*

   ii. Wing IP (Aux) - *"Hammer 12."*

The above shackle turn procedures will result in proper formation bearing if both aircraft were in proper formation initially.

In cases where a shackle turn is used to redress a section out of position, the aircraft will be maneuvered so that the sucked aircraft will be able to regain proper bearing (Figure 4-16).

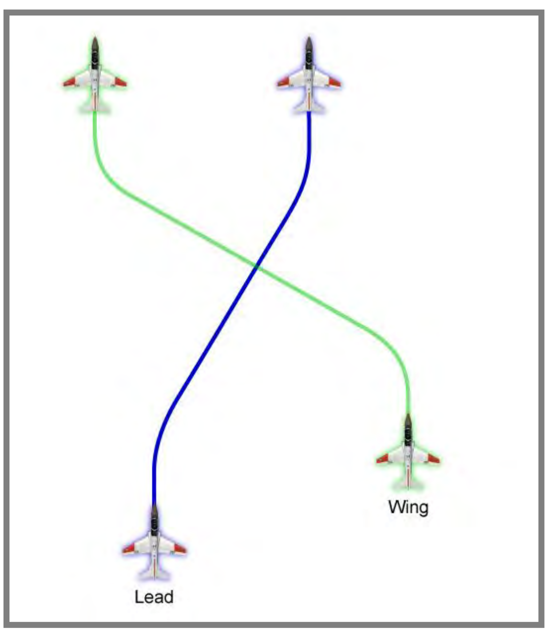


Figure 4-14 Shackle Turn to Redress Section

Primary lookout doctrine should be to track the turn while in an angle of bank with an occasional scan for obstructions. Once wings level in the 45-degree heading change, both aircraft should check the mutual 6 o'clock of the section. As always, the wingman is responsible for de-confliction.

6. Low Altitude Maneuvering Summary

It is imperative that all aircrew master the concept of task management: First and foremost, avoid the dirt, deconflict and then execute the mission. The workload at low altitude is extremely high. It is critical that the basics discussed are learned correctly and proper habit patterns are practiced from the beginning of your low altitude training. If safety is ever in doubt while in the low altitude environment, initiate an immediate climb to the planned Emergency Safe Altitude (ESA).

404. ROUTE CORRECTIONS/DISORIENTATION

While established on the low-level route, the Lead and Wing students will be mutually responsible for navigating the route. As previously stated, the Lead will navigate as close to the route center as possible while the Wingman can expect to be 1 nm off centerline. Lead may be required to correct either course drift or route timing during the low-level.

1. Course Corrections

Course corrections are made much easier with the HSI course line; the overall concept is that the Lead SNFO must take the wingman into consideration. Smaller corrections for longer periods of time are preferred. Make the appropriate corrections to keep the flight inside of the route corridor, while maintaining SA of your surroundings and the time.

2. Timing Corrections

Timing corrections follow the same overall procedures described in Chapter 1. As Wing, you will monitor timing and if the Lead does not make a correction, you can recommend one on AUX or tell Lead that you show the flight xx seconds early/late. Precise heading and airspeed control throughout the route will avoid the need for drastic corrections during the target leg.

3. Route Disorientation

When disorientation occurs, the crew must review progress from the last known position and determine the cause and extent of the error. Causes include errors in heading, airspeed control, timing or navigational planning, malfunction of instruments or navigational aids, wind, and/or deviations around weather or enemy defenses.

Check the clock immediately. Timing may be a factor in determining the extent of disorientation and the correction required. Check the fuel state and compare with MCF and Joker fuel states. The disorientation may have caused more problems than just navigation. If completely lost, remember the “Five Cs:”

a. Confess

b. Climb

c. Communicate

d. Conserve

e. Conform

Do not complicate matters. Decide upon a temporary plan and avoid wandering aimlessly around at low altitude while deciding what to do. In most cases, continue flying preplanned headings and time while climbing to a higher altitude to increase visibility. In unusual circumstances, enter holding (orbit) or fly toward a known landmark. If practical, climb to conserve fuel, or if holding, slow to maximum endurance speed.

The next step is to reorient. The crew must find landmarks and identify them on the chart. Care must be taken to avoid following a hunch or making a decision based on uncertain information. The crew must comply with FAA speed restrictions if they suspect that they have exceeded the applicable route widths or top of the route structure described in the AP/1B. A water tower with the town's name painted on the side has reoriented more than one naval aviator in the past.

Next, make a correction to get back on course. Once oriented, correct on course using the techniques discussed previously. These procedures will not be possible unless the crew's charts include sufficient area coverage to account for disorientation.

405. OFF TARGET PROCEDURES/RETURN TO BASE

With the tactical portion of the flight now complete, the section must shift back to an admin mindset. As with the transition from an admin mindset to a tactical mindset, the transition back to the admin mindset is procedurally structured.

1. Route Exit

At the completion of the final target attack, the Lead will initiate a VFR climb on course and commence the RTB. The Wing will complete his target attack and commence an off-target running rendezvous. During the off-target rendezvous, the Lead and Wing will prioritize their respective tasks as conditions warrant. The order of these tasks may vary, but they do not change from the overall priorities of Aviate, Navigate, and Communicate. Lead and Wing each have very specific responsibilities during the off-target phase of the flight:

a. Lead SNFO

i. Initiate and maintain a VMC climb, squawk 1200.

ii. Ensure Wing calls "Hammer-12 off safe, visual."

iii. Initiate the fence-out checks.

iv. Check off the route with FSS.

v. Switch flight to appropriate ATC frequency/obtain IFR clearance.

vi. Conduct Fence-out report with fuel check.

vii. Ensure Battle Damage Checks are completed.

viii. Complete 10k and 18k checks.

ix. Update navigation.

b. Wing SNFO

i. Monitor running rendezvous (provide airspeed calls to IP over ICS).

ii. Follow Lead's frequency changes (secure squawk).

iii. Fence-out on Lead's direction (after rendezvous).

iv. Ensure Battle Damage Checks are completed.

v. Complete 10k and 18k checks.

vi. Back up Lead with navigation.

After the final target attack, the comm flow will be as follows:

a. Lead IP (Aux) - *"Hammer-11, off safe."*

b. Lead SNFO (ICS) - *"Right 210, climb VFR, squawk 1200."*

c. Wing IP (Aux) - *"Hammer-12, off safe visual."*

d. Lead SNFO (Aux) - *"Hammer, switch button 20, fence-out."* (if wingman outside 3000 feet)

e. Wing SNFO (Aux) - *"Hammer-12."*

f. Wing SNFO (ICS) - *"380....350....320."* (call airspeeds until safely joined.)

g. Lead SNFO (Pri) - *"Anniston Radio, Rocket 401 exiting VR1021, PT E at this time."*

h. Lead SNFO (Aux) – "Hammer, 288.15 Pri."

i. Lead SNFO (Pri) - *"Houston Center, Rocket 401."*

j. ATC - *"Rocket 401, Houston Center, go ahead."*

k. Lead SNFO (Pri) - *"Houston Center, Rocket 401, flight of 2 T-45s VFR over Monroeville, request IFR Navy Pensacola."*

l. Lead SNFO (Aux) - *"Hammer-11, fenced-out, 1.1."* (after wingman joined)

m. Wing SNFO (Aux) - *"Hammer-12, fenced-out, 1.1."*

Fence-out is accomplished by reversing the fence-in combat checklist. SNFOs are required to change NAVAIDs and MFCDs back to Admin settings for RTB.

Completion of the fence-out checks will be automatically followed by the Battle Damage Checks (BDC). To initiate the BDC, Lead IP will extend the index finger and thumb in the shape of a pistol and simulate the cocking of a hammer. The Wing IP will check the lead's jet for any battle damage. The flight will execute a lead change so the Lead can check the Wing jet for battle damage and then reassume the Lead. The fence-out and BDC mark the transition from the tactical portion of the flight back to Admin. The section should plan to RTB for course rules (weather permitting).

2. Approach and Recovery

The section will recover in accordance with the standard section procedures detailed in the previous chapter. The order of precedence for recovery is:

a. Course Rules

b. Section Visual Straight-in

c. Section GCA (PAR or ASR)

d. Individual GCAs

406. LOW ALTITUDE EMERGENCIES

The first concern for low altitude emergencies is aircraft controllability. Because of the close proximity to the ground, the aircrew must immediately determine whether or not the aircraft is controllable. If the aircraft is uncontrollable, or the aircrew is incapable of controlling it (due to injury from birdstrike for example), eject immediately because the aircraft may not be in the ejection envelope very long. If the aircraft is controllable, aircrew must climb away from the ground (climb to cope).

For an engine failure, trade airspeed for altitude and execute NATOPS immediate action items. SNFOs should always be ready with snap vectors to the nearest suitable airfield.

In the case of a bird strike, climb to cope and monitor engine performance while proceeding to the nearest divert. SNFOs should be aware of the potential for IPs to be unconscious or incapacitated from a bird strike. If in this situation, take control, level the wings and get the aircraft flying away from the ground if possible. If an ejection is required with the IP unconscious, ensure the eject select is in BOTH prior to pulling the ejection handle.

For Lost Comm/Lost Sight on the route, proceed to the next point or a prebriefed point and altitude, and orbit (Lead at 3000 feet, Wing at 2000 feet); squawk 1200. Determine a bingo fuel state. If still lost comm/lost sight at that fuel state, squawk 7600 and proceed to a suitable airfield utilizing normal lost communication procedures.

CHAPTER FIVE
AIR TO GROUND ATTACKS

500. INTRODUCTION

Air-to-ground (A/G) attacks make up a large percentage of the work Navy and Marine Corps aircraft will do over the near- and long-term future. The systems involved are increasingly complex and lethal. Precision and timeliness are the benchmarks; aircrew will be required to deliver ordnance on time, with accuracy, and without collateral damage. In order to meet this challenge, a thorough understanding of systems, ordnance, and deliveries is required.

501. ARMAMENT SYSTEM GENERAL

Weapons data entry is critical for mission accomplishment. Laser codes and coordinates, as well as weapon and aircraft recognition, are just a few of the items to be checked prior to man-up, during start-up, and prior to release or fire.

The armament system and stores displays of the T-45C VMTS and OFT provide excellent training for the F/A-18 Hornet and Super Hornet. The following section will provide descriptions, details, and differences of the T-45C VMTS/OFT armament systems and ordnance.

1. Armament System and Ordnance

The T-45C armament system consists of equipment and components, which provide for carriage, jettison, sighting, gun firing simulation, and controlled release of external stores.

a. Simulated and actual delivery of A/G ordnance is accomplished by selecting the A/G master mode

b. Simulated firing of the A/A gun and Short- and Medium-Range Missiles (SRMs and MRMs) is accomplished by selecting the A/A master mode or by selecting SRM/MRM/Gun via the weapons select switch on the right hand controller (RHC).

The T-45C is capable of carrying a variety of ordnance on inboard pylons that can be attached to each wing (Figure 5-1):

a. LAU-68 rocket launcher with provisions for seven 2.75-inch folding fin aircraft rockets (FFAR)

b. Practice multiple bomb rack (PMBR) with provisions to carry six Mk 76 or BDU-33D/B (25 lb.) practice bombs

The centerline pylon is only capable of carrying a baggage container.

With the capability of carrying six Mk-76 (Figure 5-2) or BDU-33D/B practice bombs, the T-45C provides an ideal platform for teaching non precision or “dumb” bombing.

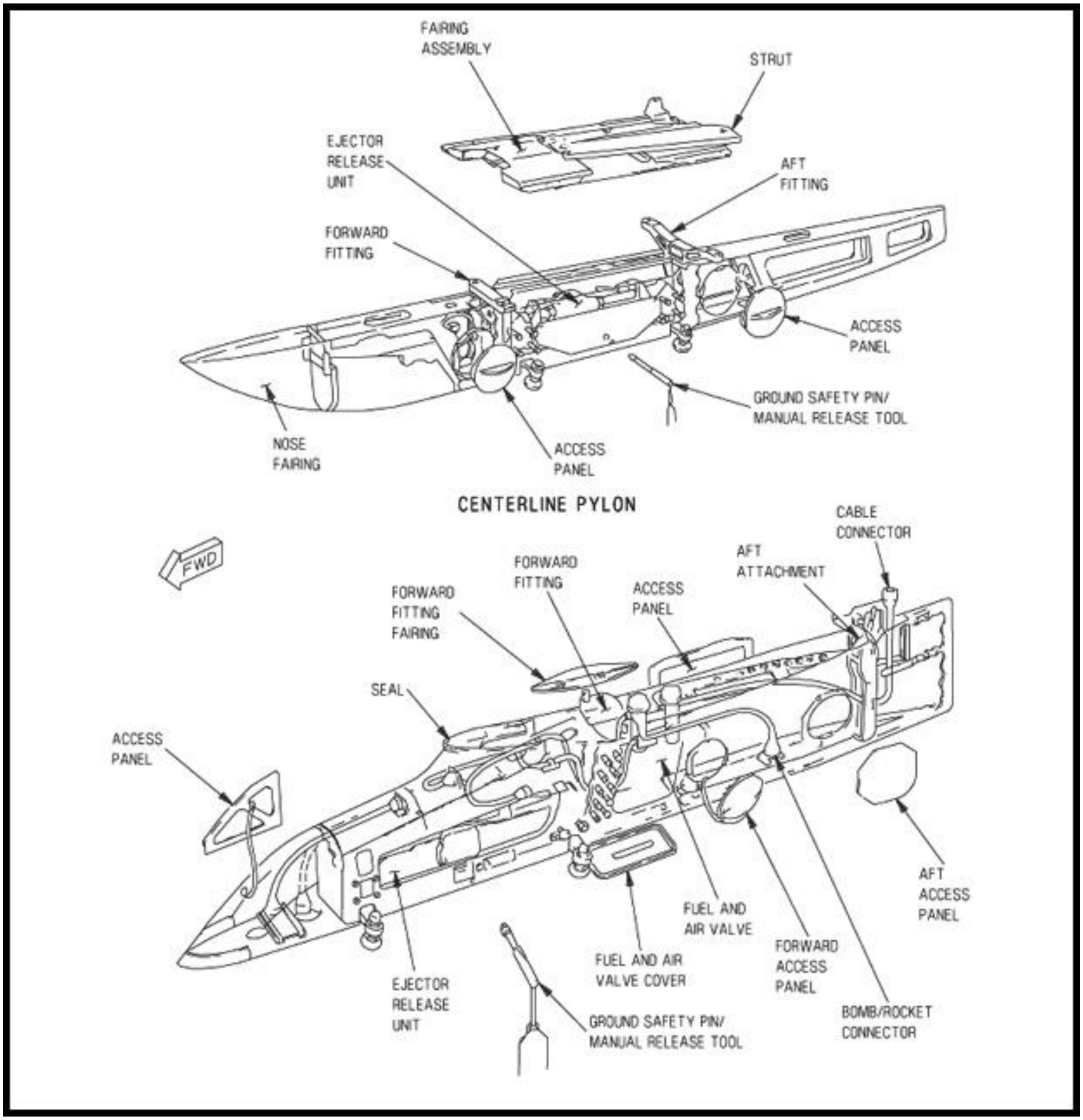


Figure 5-1 T-45C Centerline/Inboard Pylons

"Dumb" bombs are simply unguided, ballistic munitions in which the accuracy depends on the delivery parameters, winds and environment as they fall from the aircraft.

a. Aircrew do everything possible to get the proper release parameters (airspeed, altitude, dive angle) for a direct hit, but once the bomb is released, aircrew have no further control over its trajectory.

Figure 5-2 Mk-76 or BDU-33D/B Practice Bomb

Although the T-45C does not carry precision-guided practice bombs, the VMTS/OFT system now provides a great opportunity to train to those tactics. Guided or "smart" bombs are munitions that can be guided by aircrew, ground forces, or technology after release from the aircraft. They have target guidance capabilities that allow them to home in on the desired impact point and hit the target. More detail about precision-guided weapons is provided later in this chapter, but they generally include:

a. Laser guided

b. GPS/INS/Radar guided

c. Radio frequency (RF) trackers

2. Armament System Function, Components, and Controls

Both cockpits in the T-45C have the ability to control the armament systems; however, they are slightly different. The forward cockpit has the following controls:

a. Emergency jettison button

b. HUD

c. Two MFCDs

d. DEP (Data Entry Panel)

e. Master Arm Switch

f. Control Stick Weapons Release Button and Gun Trigger

The master armament switch is a two-position, pull to unlock, toggle switch marked MASTER ARM and SAFE. All armament circuits are controlled by the master armament switch, with the exception of emergency jettison of external stores.

With the master armament switch in the MASTER ARM position, armament circuits are energized, and the master armament red indicator light, MSTR ARM, is illuminated in the aft cockpit. The SAFE position de-energizes armament circuits and extinguishes the MSTR ARM light.

The armament controls for the aft cockpit are very similar in appearance to the forward cockpit. The list below highlights the differences. One major difference is the master armament override switch (aft cockpit) instead of the master arm switch (forward cockpit). Figure 5-3 illustrates this difference.

The master armament override switch is a safety feature that allows the armament system to be disabled when SAFE is selected. The switch has a solenoid that holds the toggle in the SAFE position until electrical power is removed from the solenoid. When power is removed, the switch returns to the FORWARD position, which allows for front cockpit control of the armament system. Power to the solenoid can be removed by setting the master armament switch to MASTER ARM, or when the weight-on-wheels switch is activated. The switch can also be manually switched back to the FORWARD position.

The aft cockpit has the following controls:

a. Emergency jettison button

b. Master arm override switch/master arm light

c. Two MFCDs

d. DEP

e. Reticle light switch

f. Gunsight – Mils depression knob and readout

g. Control stick weapons release button and gun trigger

h. RHC – A/A and A/G weapon release button

i A/A weapon select switch

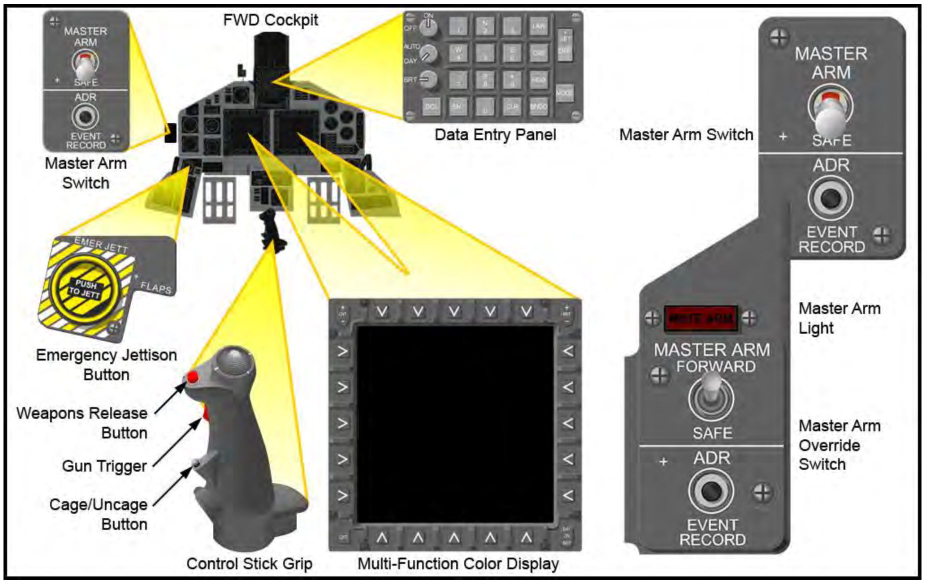


Figure 5-3 Mstr. Arm Switch/Fwd Cockpit Armament Controls/Master Arm Override

The emergency jettison button is powered by the 28 VDC essential bus and is placarded PUSH TO JETT (Figure 5-4). Pressing the EMER JETT button in either cockpit releases external stores from both wing stations simultaneously, regardless of the selected weapon on the stores display, master armament or master armament override switches.

a. Emergency jettison release requires aircraft weight-off-wheels and either normal or battery power on the aircraft.

b. External stores located on the centerline pylon will not jettison

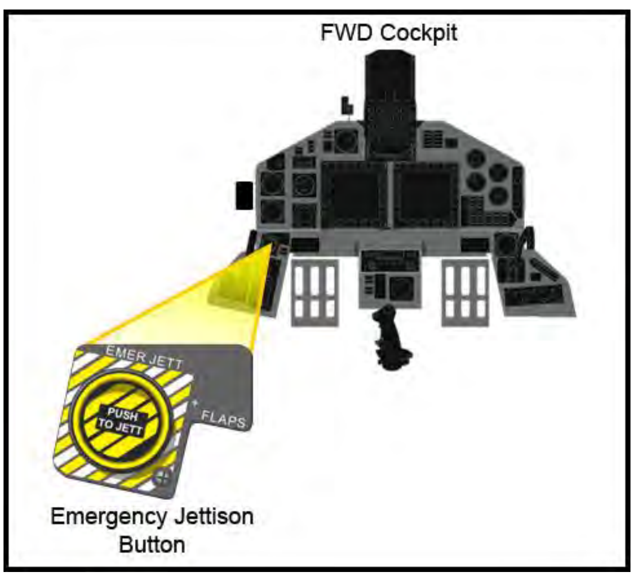


Figure 5-4 Emergency Jettison Button location

The weapons release button, often referred to as the bomb "Pickle" button, is located on the upper left side of the control stick grip in both cockpits. This button is used to release ordnance from the wing stations.

a. The button functions only when the 28 VDC generator bus is powered, and can be disabled from the aft cockpit with the master armament override switch.

b. With the master arm switch in the MASTER ARM position and a wing station selected on the stores display, pressing the button releases the bomb(s) or fires the rocket(s).

c. In the aft cockpit, the RHC A/A and A/G weapon release switch functions to release simulated ordnance.

The A/A weapon release (gun trigger) is located on the front of the control stick grip in both cockpits and is used to fire the simulated gun when MASTER ARM is armed. It is also powered by the 28 VDC generator bus, and can be disabled from the master armament override switch. Figure 5-5 shows the throttle A/G release, control stick A/A release, and the RHC A/A and A/G release.

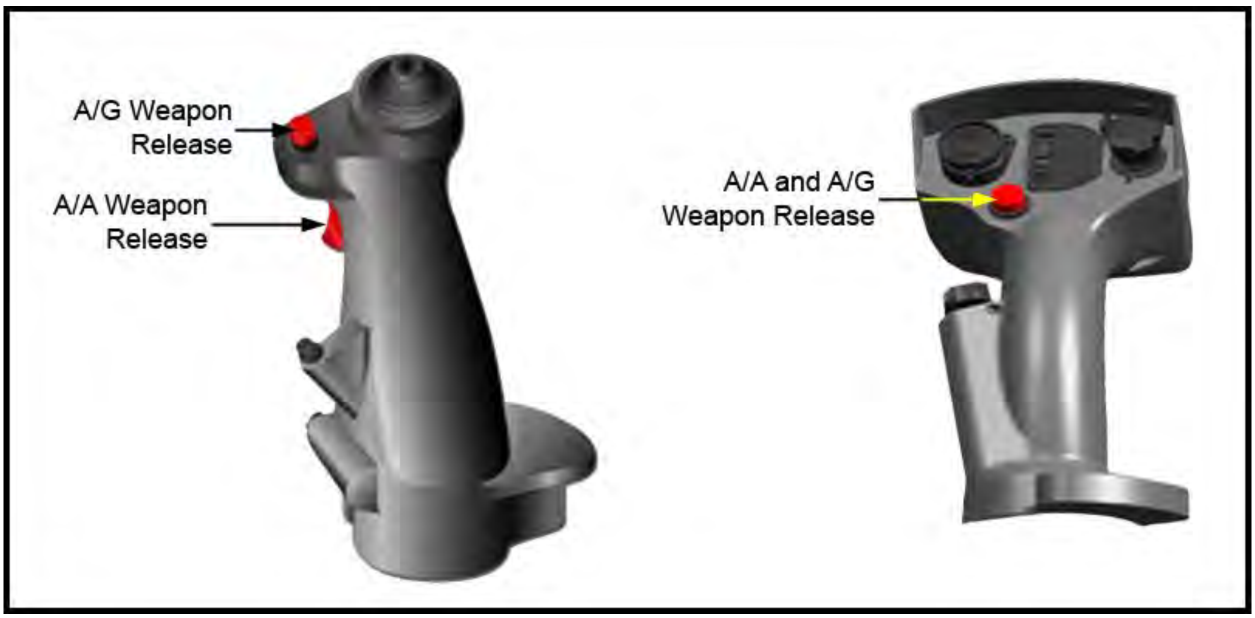


Figure 5-5 Control Stick Weapon Releases/RHC Weapon Release

3. VMTS Stores (STRS) Display Procedures

The VMTS stores display is selected by actuating STRS on the MENU display (Figure 5-6).

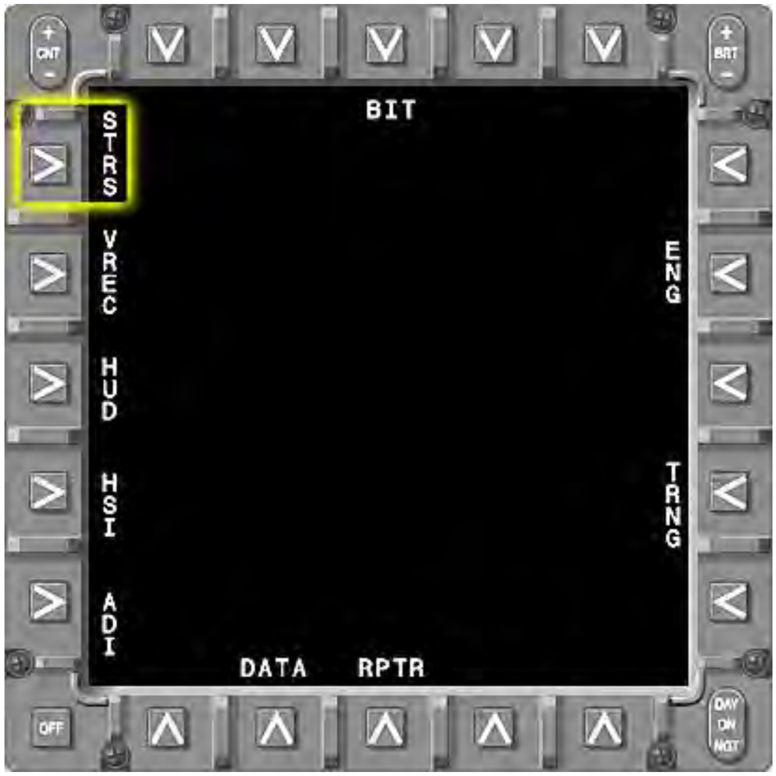


Figure 5-6 STRS Option On The MENU Display

The A/G master mode is selected from either cockpit by actuating (boxing) the A/G option on the Stores display options, or actuating the MODE button on the DEP to cycle to the A/G master mode (Figure 5-7). A/G weapons capability and modes are the same as the basic aircraft, except the addition of SIM mode and associated VMTS hands on throttle and stick (HOTAS) functions.

a. The RHC is incapable of releasing real aircraft stores.

b. VMTS provided controls and cues for A/G inventory management and employment via the Stores display and the aircraft audio system.

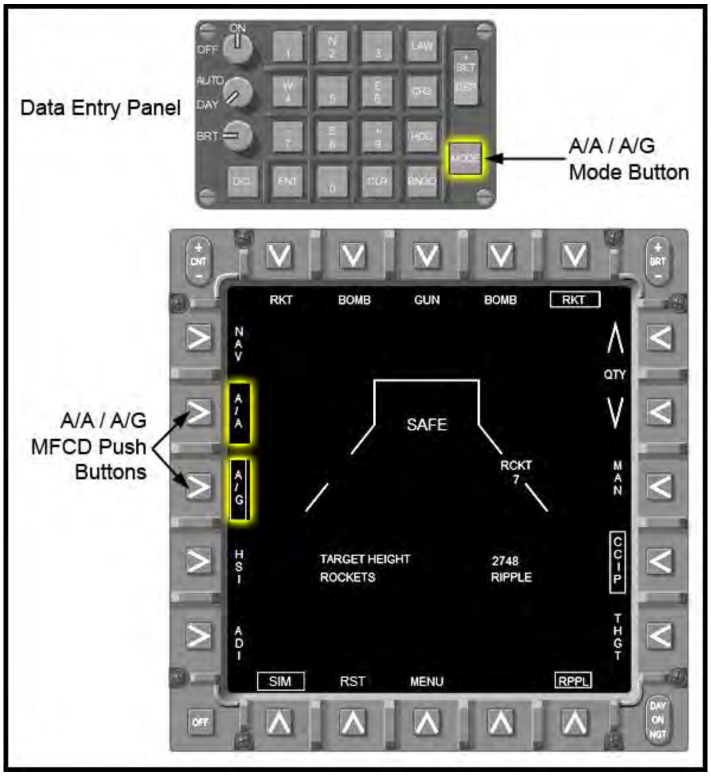


Figure 5-7 Data Entry Panel (DEP)/A/G Selection VMTS

The selection logic for simulated A/G weapons in SIM mode is unchanged from that used for actual stores, except for the following options provided on the A/G stores display (Figure 5-8):

a. SIM – Enables/disables SIM mode and RHC/HOTAS control of simulated A/G weapons in order to provide RHC and control stick HOTAS controls for A/G release with associated aural and display cues.

   i. Boxing SIM displays the simulated A/G stores and initializes the A/G weapon inventory to the maximum count and single rockets. It also inhibits energizing station select relays for actual stores with the Master Arm switch ARMED.

   ii. Unboxing SIM restores the actual aircraft stores display

   iii. If SIM is unboxed while the Master Arm switch is ARMED, the station options are nonfunctional until the Master Arm switch is cycled back to SAFE.

b. RST – Resets the rocket (RKT) and BOMB inventories to the last selected programmed quantities, or to the default quantities if not previously changed. RST is not displayed if SIM is unboxed.

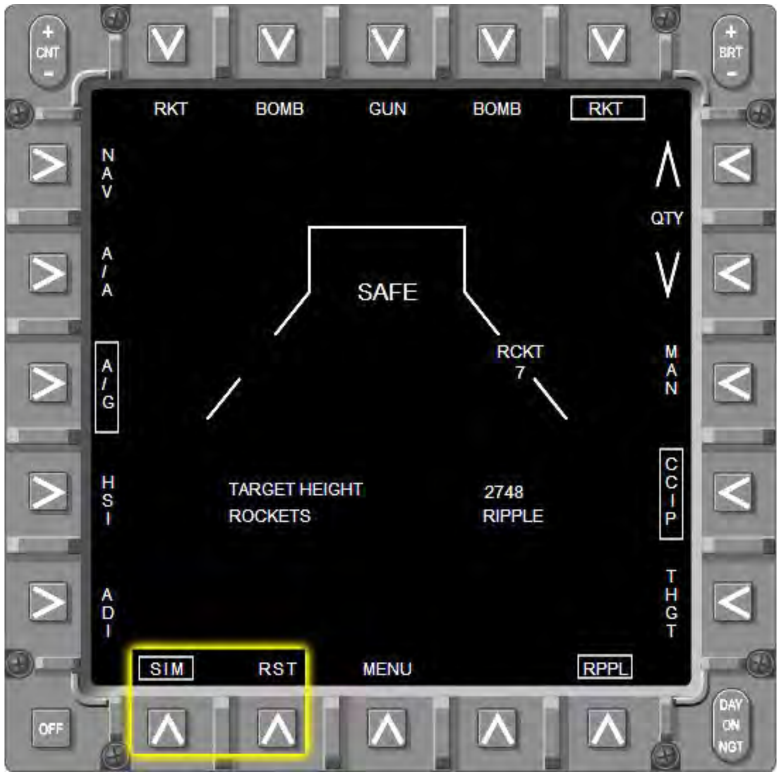


Figure 5-8 VMTS SIM Mode and RST Options

Along the top row of the A/G stores display, the RKT and BOMB options on either side of the GUN option (left or right) are used to select the weapon of choice from the wing station (Figure 5-9). When the weapon type and wing station are "boxed," the previous weapon and wing station are "unboxed." The selected weapon and quantity will be displayed on the wing form.

The BOMB/ROCKET quantity options along the right side of the Stores display are used to adjust the number of bombs or rockets displayed on the stores page (Figure 5-9). The aircraft weapon stations ***do not interface*** with the stores page, so if actual bombs are released, aircrews manually decrement the quantity after release. The MAN (manual) option unboxes CCIP and displays mil dep setting on the Stores Display and HUD.

CCIP mode unboxes MAN and displays Target Height (THGT). The THGT option is used to enter the target height in AGL for the target. Both MAN and CCIP modes will be discussed in more detail later in this chapter. RPPL option, when selected and the pickle button is pressed, fires all rockets and decrements quantity to zero.

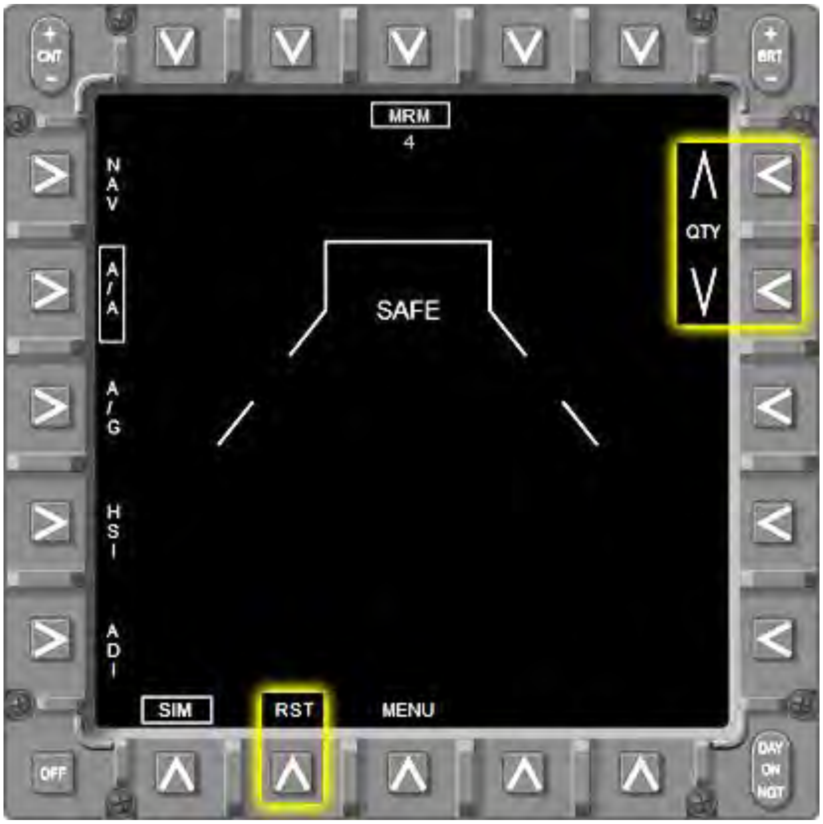


Figure 5-9 A/G Stores Display Weapon Options

If the A/A option is boxed from the STRS display, VMTS adds a simulated medium-range missile (MRM) and short-range missile (SRM) to complement the GUN. The system supports maximum inventories of four MRM and two SRM, and provides a capability to conveniently reload inventories to the maximum quantities.

VMTS provides controls and cues for A/A inventory management and employment via the stores and HUD displays and the aircraft audio system. The currently selected A/A weapon, via the A/A weapon select button on the control stick, is displayed as MRM, SRM or GUN. The VMTS A/A stores display push button functionality is as follows (Figure 5-10):

a. QTY – Increases selected A/A missile inventory up to maximum allowable with wraparound to 0. It decreases selected A/A missile inventory down to 0 with wraparound to maximum quantity. QTY is not displayed with GUN selected.

b. RST – resets all MRM and SRM missile inventories to the last selected programmed quantities or to the default quantities if not previously changed.

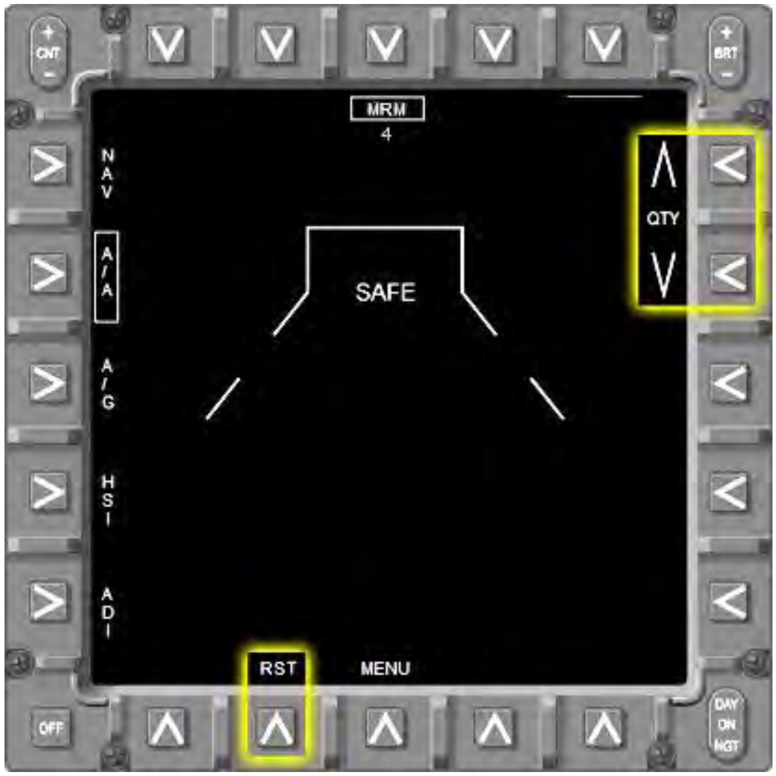


Figure 5-10 A/A STRs Display Options, QTY and RST

4. OFT Stores Management System (SMS) Display Procedures

The OFT has additional features and weapons not available in the VMTS aircraft. OFT SMS is entered by moving the transfer mode control switch (TMC) forward. The following options are available in the OFT:

a. Master modes

b. Weapon selection and programming

c. EW page

When A/G master mode is selected, the radar will enter MAP mode, and the stores display will allow for selection of A/G weapons (Figure 5-11, left display). Weapons are loaded via the Integrated Operating System (IOS) pre-mission. The following options are available and must be boxed to select the weapon:

a. Bomb – simulates a Mk-80 series unguided "dumb" munition.

   i. When selected, the quantity of bombs remaining is displayed below the weapon selection (Figure 5-11, right display). Selected weapon may be released by the IOS or by the SNFO via the weapon release switch.

ii. Although a CCIP (Constantly Computed Impact Point) cross is generated at the IOS, a CCIP cross is not indicated at the student station.

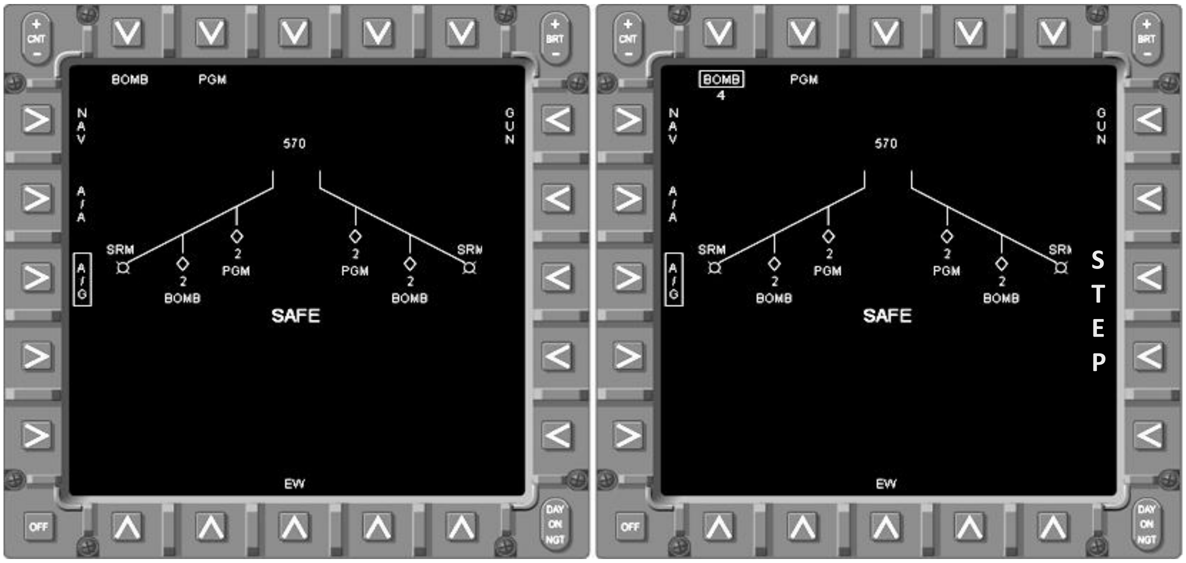


Figure 5-11 OFT SMS With A/G Selected/Bomb Selected With Quantity Remaining

b. GUN – selects the gun for air to surface use.

c. STEP – will step through the available weapons for the selected type.

d. PGM – simulated GPS guided "smart" precision munitions (Figure 5-12)

i. When PGM is selected, the TGT POINT option appears. When TGT POINT is selected, the PGM programming display is shown. From the PGM programming display, preplanned target waypoints can be programmed into the PGM via the up/down arrows and SELECT option.

ii. For targets of opportunity (TOO) missions, the A/G radar designation can be transferred to the selected weapon by selecting the A/G DESIG option.

iii. For Pre-Planned (PP) missions, the selected waypoint coordinates can be transferred to the weapon by pressing the SELECT option.

iv. STEP will cycle through available PGMs allowing for the programming of more than one weapon at the same time.

v. To program a target point from a pre-planned waypoint, select the waypoint number. Waypoint information will appear in the bottom center of the screen.

vi. The weapon program box lists which weapon, on which station, is currently being programmed; the programmed status of the weapon (as NOT

PROGRAMMED or TARGET POINT PROGRAMMED), and the weapon's current programmed LAT, LONG, and ELEV.

vii. RTN returns the SMS display once programming is complete.

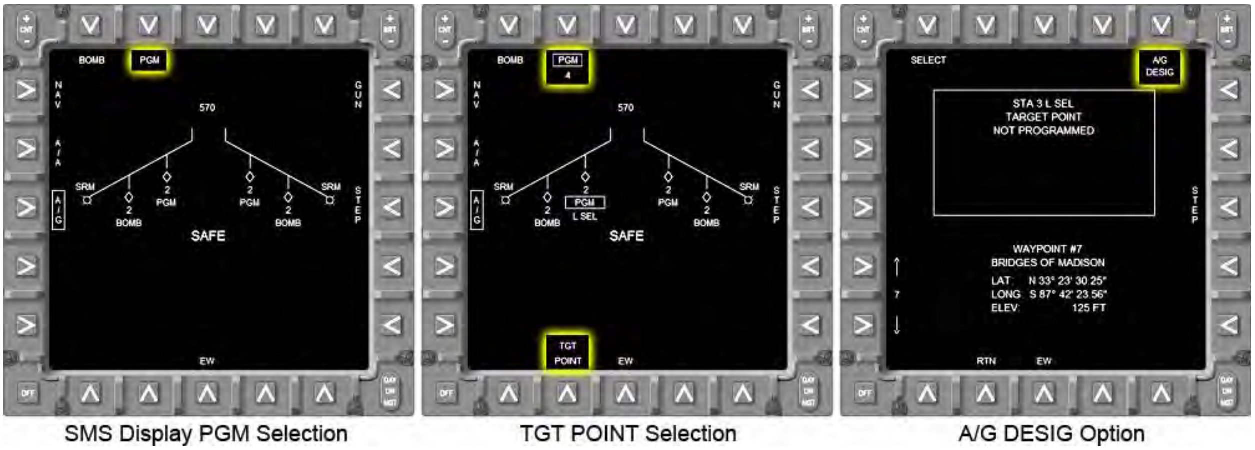


Figure 5-12 OFT SMS, PGM Selection With TGT POINT or A/G DESIG

viii. Once a PGM is programmed, the RTN button will return to the SMS page and display the heading and range to reach a PGM Launch and Release window (LAR) (Figure 5-13). The SNFO should direct the pilot to fly the indicated heading to employ the PGM.

ix. IN LAR will be displayed once the aircraft enters LAR. The weapon can then be released with the weapon release switch, however releasing before being IN LAR will likely result in the weapon not hitting the target.

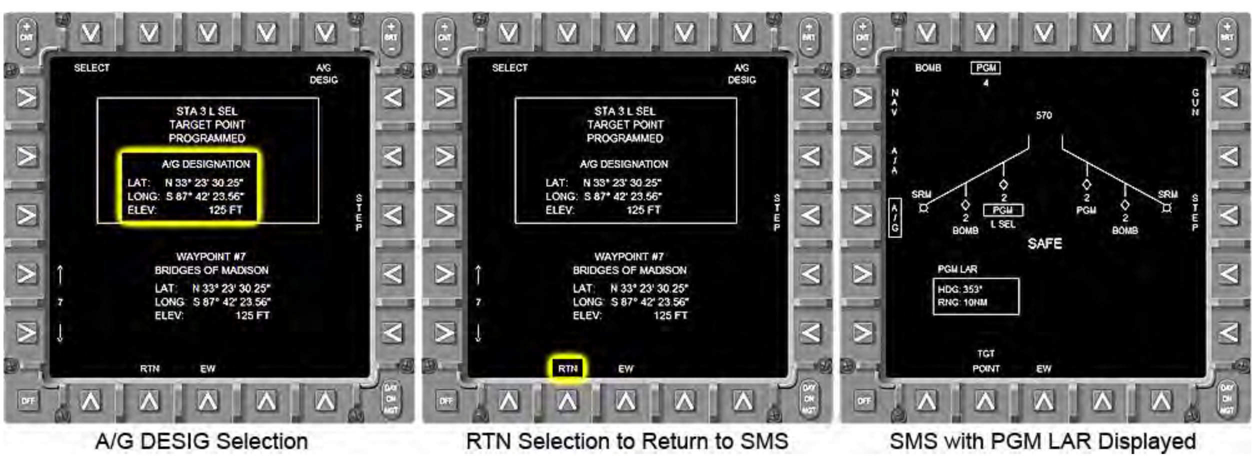


Figure 5-13 SMS Page With LAR Displayed

A/A weapons are selected using the RHC weapon select switch. Selection of an A/A weapon will automatically transition the system to A/A master mode. Selection of A/A master mode will default the system to SRM with the left wingtip (Station 1) SRM selected.

STEP will select the next weapon of the selected type. Subsequent actuations of the weapon select switch for the currently selected weapon will also step the weapon station. Weapon select sequence for A/A weapons generally follows an outward in logic sequence. A/A weapons, procedures and employment will be discussed in a future stage.

502. AIR TO GROUND WEAPONS

Accurate A/G delivery of ordnance on surface targets is one of the primary missions of Navy and Marine aviation. Mastery of A/G concepts, procedures, and skills is critical to A/G mission success and to the ground forces that depend on aircrew to put bombs on target (Figure 5-14).

The SNFO's knowledge of weapons concepts and procedures provides the foundation for developing accuracy and consistency in the skills introduced in the Training Command.

Figure 5-14 Laser Guided Bomb (LGB), On Target

1. Conventional Weapons

The term "conventional weapons" generally refers to weapons that are widely dispersed and used, but do not fall into the category of Weapons of Mass Destruction (WMD).

Conventional weapons are guided by:

a. Free fall

b, Laser guidance

c. Global Positioning System/Inertial Navigation System (GPS/INS)

Specifically, conventional bombs include:

a. Mk 80 series bombs

b. Laser guided bombs (LGBs)

c. Joint Direct Attack Munitions (JDAM) GPS/INS

d. BLU-109

Green or gray bombs are live. Blue bombs are inert and used for training. Bombs may have a thermal coating to make them more resistant to heat/fire (aircraft on carrier flight deck). The three main components of a bomb include (Figure 5-15):

a. Body – casing containing explosive material

b. Fuze section – determines the timing of the explosion and can be located either in the nose or tail.

c. Tail section (fins) – determines how the bombs travel through the air.

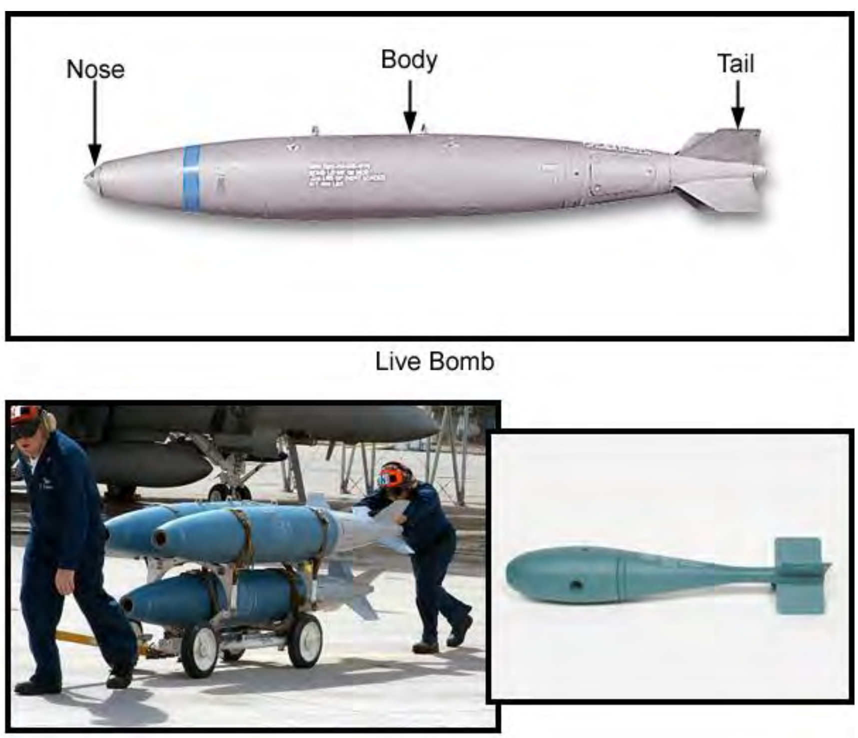


Figure 5-15 Basic Bomb Components/Training vs. Live Bombs

2. Bomb Fuzes/Fins

Bomb fuzes can be mechanical or electrical, and located in either the nose or tail of the bomb. Both types of fuzes typically allow for functional delays between impact and detonation to maximize the weapon's effectiveness against a certain type of target.

a. Mechanical Fuzes – typically use the bomb's impact to trigger the detonation. Arming vanes ensure safe separation from the aircraft by spinning a certain number of times before the bomb is armed.

b. Electrical Fuzes – use electrical impulses to set the arming time and signal for detonation.

Bomb fins are used to give bombs stability in flight and to control the type of flight the bomb will have. The two main types of fins are (Figure 5-16):

a. High-drag fins – used to quickly slow bombs down, allowing for low altitude and level laydown releases.

b. Low-drag fins – used to help the bomb fly a true ballistic arc; specifically used for medium and high altitude releases.

High-Drag Fins

Low-Drag Fins

Figure 5-16 High Drag Fins (Top), Low Drag Fins (Bottom)

3. Free Fall Ordnance

General Purpose (GP), "dumb," or free fall ordnance is aimed by the releasing aircraft prior to separation (dropping). Once a GP bomb is released, it falls along a ballistic trajectory until impact, with no terminal correction capability.

Mk 80 series bombs are GP bombs that are the building blocks for the majority of other bombs. The Mk 80 series are identified by their weight and include (Figure 5-17):

a. Mk 82 – 500 lbs

b. Mk 83 – 1000 lbs

c. Mk 84 – 2000 lbs

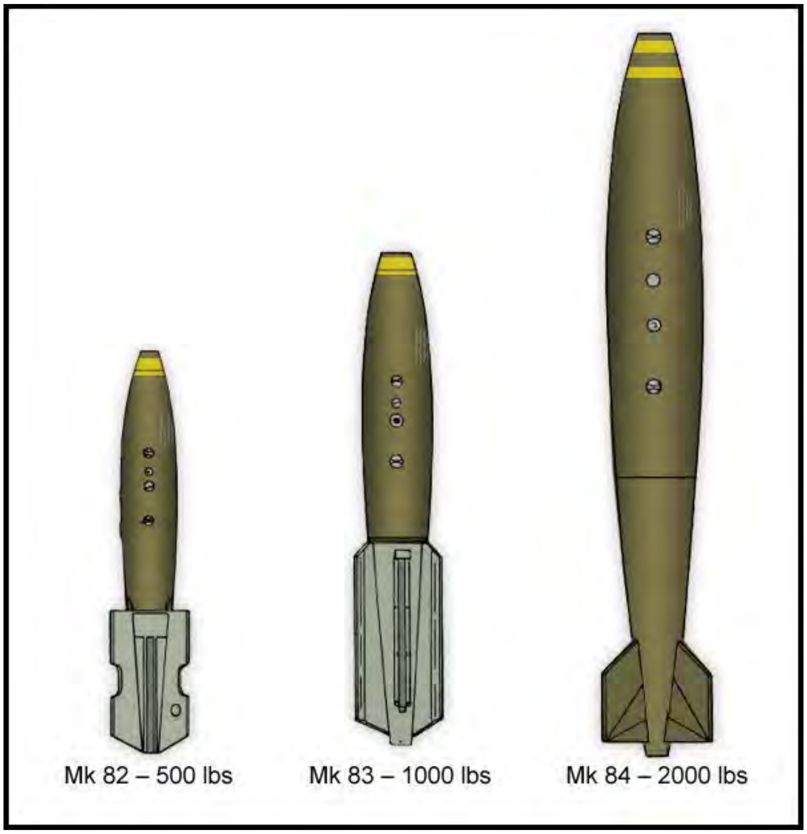


Figure 5-17 Mk 80 Series Bombs

4. Laser-Guided Bombs (LGBs)

LGBs are basically GP "dumb" bombs with a guidance package called the Paveway system added to them. They were first deployed during the Vietnam War in 1972 when F-4s carried Paveway LGBs on strike missions; Paveway I was the first LGB designation. Characteristics of an LGB include:

a. Designed to have a Circular Error of Probability (CEP) within 15 feet

b. Can be dropped in level, dive, or climbing (loft) deliveries

c. Delivery altitudes range from low-level ingress loft to high altitude release

d. Only criteria LGBs need for a good hit include:

   i. Ability to arrive at a point in the sky to detect the reflected laser energy (the "basket")

   ii. Sufficient energy (altitude and airspeed) to complete the terminal flight adjustments to target impact

LGB types include (Figure 5-18):

a. GBU-12 – 500 lbs (Mk 82 and Paveway II)

b. GBU-16 – 1000 lbs (Mk 83 and Paveway II)

c. GBU-10 – 2000 lbs (Mk 84 or BLU-109 and Paveway II)

d. GBU-24 – 2000 lbs (Mk 84 or BLU-109 and Paveway III)

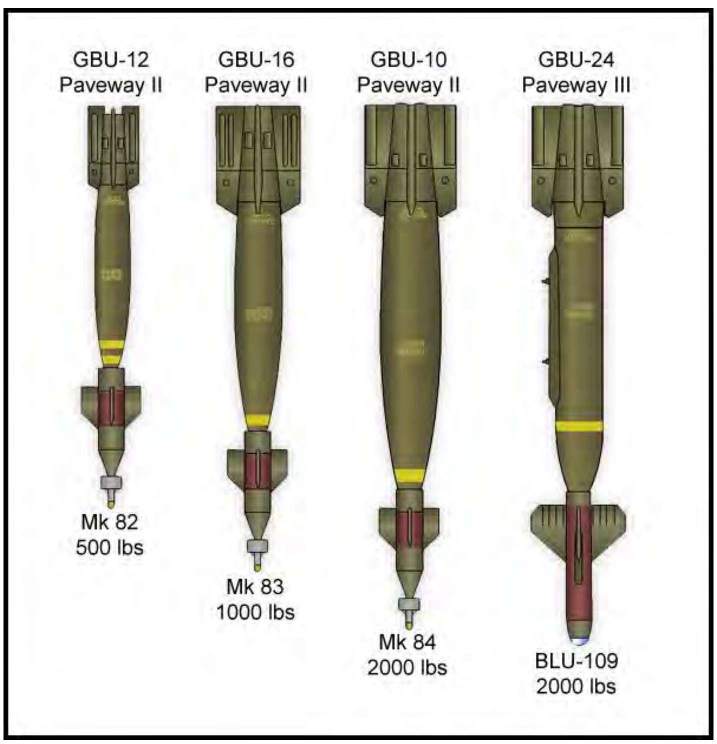


Figure 5-18 LGB Types

Figure 5-19 is a BLU-109 body with a Paveway III guidance unit on it (GBU-24). A BLU-109 is a 2000 lb. penetrating bomb used against hardened targets such as bunkers; BLU-109s can be fitted to either LGB kits or JDAM kits.

Figure 5-19 BLU-109 with LGB Kit

5. Laser Guidance Systems

Laser guidance systems allow bombs to be steered to their targets. The U.S. Navy and Marine Corps use Paveway series guidance. A Paveway system uses a seeker head to detect laser energy reflected off the designation target; it then commands steering fins on the weapon to guide in on the laser reflection. Continual upgrades over the years have led to Paveway IIIs; however, most LGBs in the inventory are Paveway II. Paveway III guidance can be used on GBU-24s.

Forward Looking Infra Red (FLIR) systems are typically used to acquire the target and point the laser. Laser PRF codes are programmed into the FLIR (or other designator) and also programmed into the seeker head system. PRF codes allow for:

a. An LGB to look only for that discrete code

b. Multiple bombs to be employed against multiple targets

As a safety note, tactical lasers are invisible to the naked eye, but can cause eye damage within 15 nm of the laser source.

The guidance kit of a Paveway system includes (Figure 5-20):

a. Nose laser seeker

b. Airfoil group

c. Tail fuze

d. Wing assembly

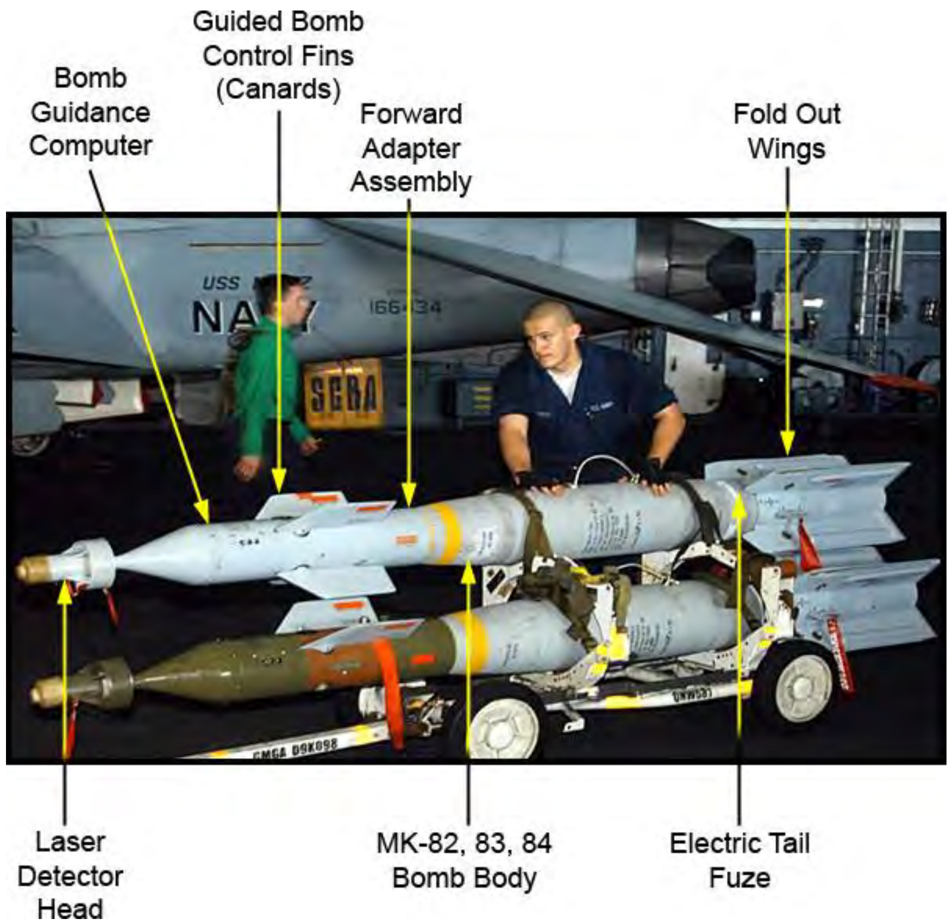


Figure 5-20 LGB Kit Components

6. Laser Guidance Principles

Laser energy usually reflects off a target in all directions (Figure 5-21), but it can be masked or blocked by the sides of a target. Some considerations and limiting factors for laser designations are:

a. Lasers cannot burn through objects

b. Thin cloud coverage could prevent laser energy from reaching the target

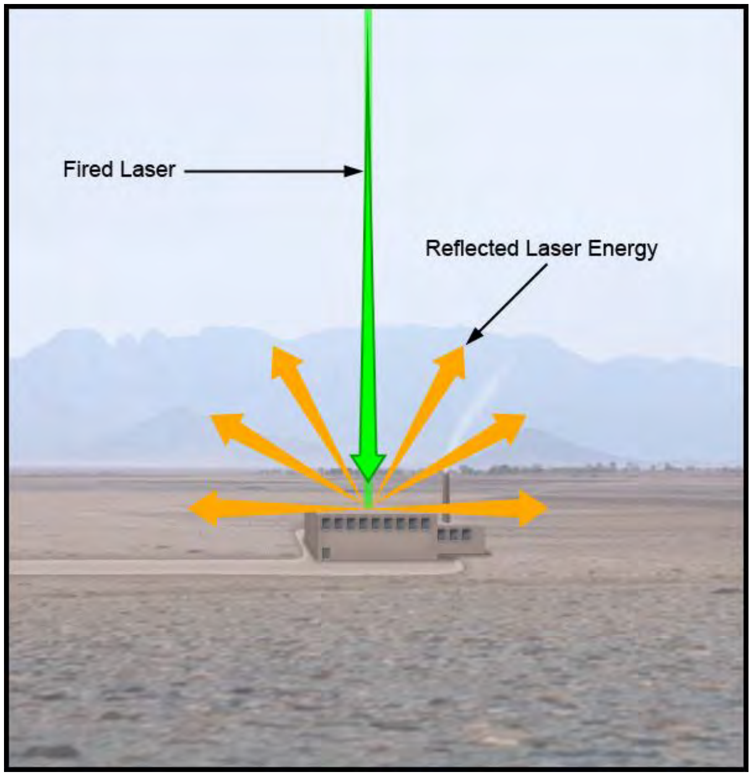


Figure 5-21 Laser Energy Reflection

c. Thick haze, dust/sand storms, cloud coverage, or precipitation can scatter the beam enough to render it unusable by an LGB; this may prevent the laser energy from reaching the target.

d. Spot elevation – may cause a perfectly good LGB to hit short of the target.

  i. LGBs have a tendency to ride on the low side of the Line-of Sight (LOS) to the laser spot.

  ii. Can be reduced by laser designating the top of a target

e. Podium effect – occurs when self-lasing; flying over the target may cause the radar beam to move to a different face/angle of the target (for example, the radar energy goes from one side of a building, to the top, and then to the other side). This new angle may cause the seeker head to lose the reflected laser energy.

f. Reflectivity – related to the size, shape, distance, and surface material of the target

i. Targets' reflectivity and aircraft run-in can prevent the bomb from "seeing" the laser spot.

ii. Strongest reflected laser energy occurs along the source axis (self-lasing usually best LGB acquisition results).

g. Spot size error – caused by the inherent characteristics of the laser beam. As the beam emanates from the source, it diverges; the further the target is from the source, the greater the spot size error.

i. F/A-18 laser has a .4 mil dispersion, so at 10,000 feet slant range the error would be 4 feet.

ii. Can be reduced by designating closer to the target or elevating the designator (overhead)

The three basic methods of laser designating include (Figure 5-22):

a. Self-lase – the aircraft dropping the weapon does the laser designation as well.

b. Buddy lase – another aircraft does the designation for the striker.

c. Ground lase (MULE) – ground forces lase the target for striking aircraft.

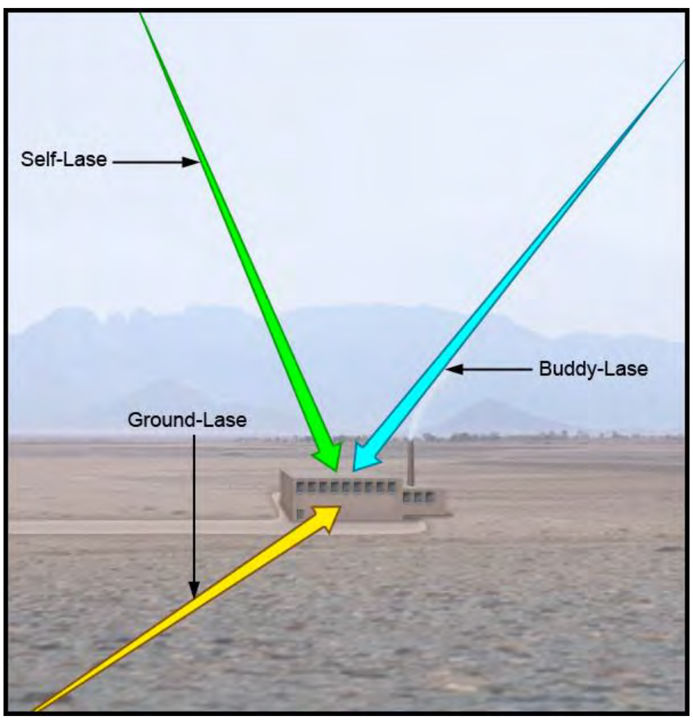


Figure 5-22 Lasing Options For Striking Aircraft

7. GPS/INS Guidance Systems

Precision-guided munitions (PGMs) are "smart" weapons that use GPS/INS guidance for targeting very precise coordinates. The U.S. military uses Joint Direct Attack Munitions (JDAM) guidance kits on their PGMs. The following are important considerations for PGMs:

a. PGMs are all-weather capable and allow a single aircraft to target multiple sites simultaneously.

b. PGMs do not require laser designation pods, and do not need support after aircraft release (fire and forget).

c. High-altitude level delivery is usually best for success.

d. Longer time of fall (TOF) increases GPS accuracy.

e. Bomb-on-coordinates determine accuracy of bomb placement (garbage in/garbage out).

f. Limitations include:

  i. Inability to retarget once released

  ii. Susceptibility to GPS jamming

JDAM GPS/INS guided bombs consist of Mk 80 series or BLU-109 bomb bodies with a JDAM kit attached. A JDAM works by getting downloaded coordinates from the jet prior to launch. Once the weapon is launched, it acquires satellites in flight and then guides to the target. The different types of JDAM are (Figure 5-23):

a. GBU-38 – Mk 82 (500 lbs) with JDAM kit

b. GBU-32 – Mk 83 (1000 lbs) with JDAM kit

c. GBU-31 – Mk 84 (2000 lbs) with JDAM kit

d. EGBU-24 – BLU-109 (2000 lbs) with JDAM kit

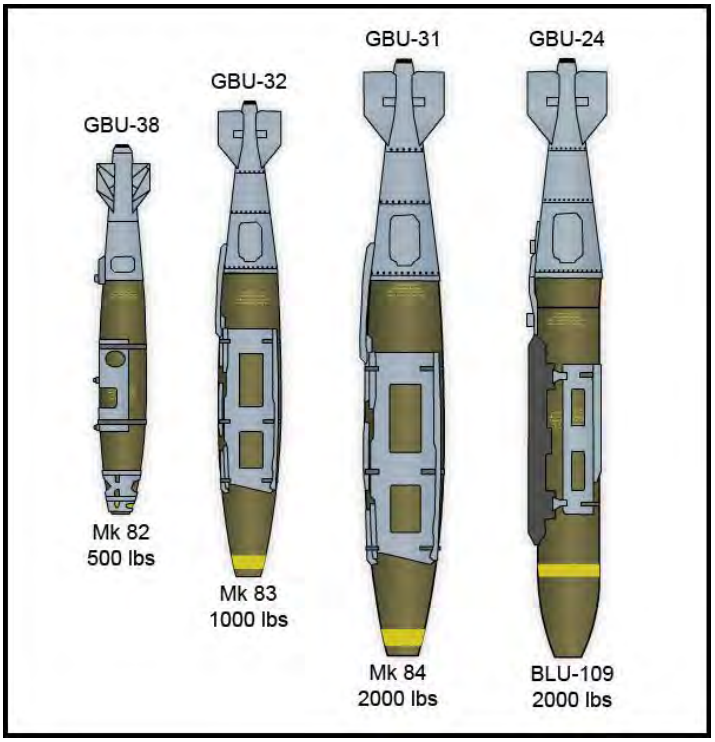


Figure 5-23 JDAM Inventory

A JDAM kit consists of the following components (Figure 5-24):

a. Bomb Body

b. Nose and/or tail fuzes

c. Body strakes for aerodynamic flight

d. Tail assembly with guide fins

e. GPS Antenna

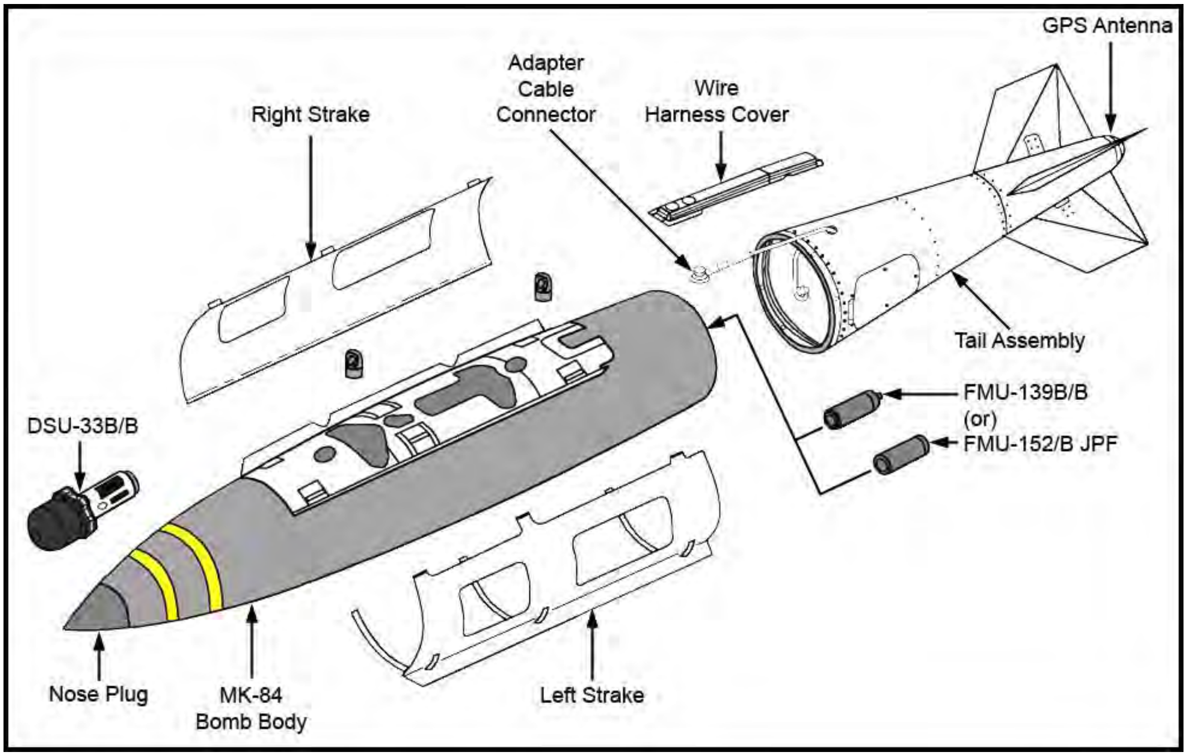


Figure 5-24 JDAM Kit Components

JDAM can carry the DSU-33B/B nose fuze, the FMU-139(C)B/B fuze, or the FMU-152/B Joint Programmable Fuze (JPF), which is an extremely versatile fuze. Both the 139 and 152 fuzes have arming and delay options. The ARM controls dictate how long it takes for the bomb to arm after leaving the aircraft. The DLY controls dictate the detonation delay after bomb impact.

Figure 5-25 is a depiction of a JDAM flight profile from release to impact.

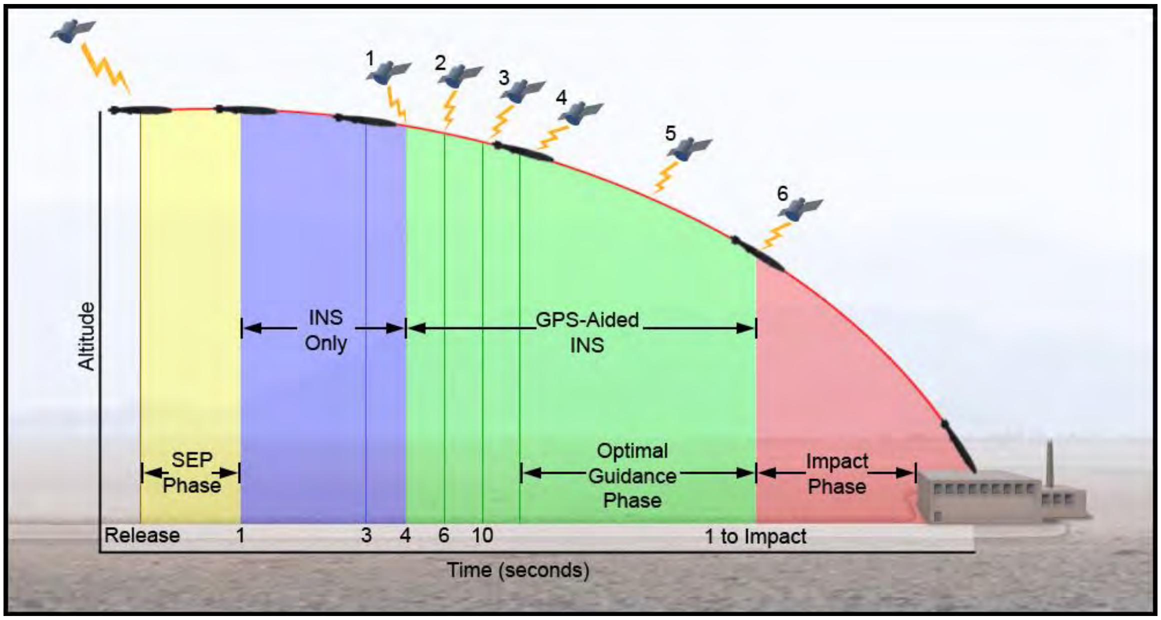


Figure 5-25 JDAM Flight Profile

There are considerable advantages to using "smart" bombs, but there are also some disadvantages:

a. Advantages

i. Ease of employment

ii. Stand-off capability – weapon can be employed at greater distances from target defenses.

iii. Collateral damage minimized – military targets are "surgically" destroyed with minimal surrounding damage.

iv. Efficiency – targets are often destroyed on the first attempt.

v. Battle damage assessment (BDA) is often immediate.

b. Disadvantages

i. Expensive (but LGBs are relatively big bang for the buck)

ii. May require excessive preflight planning and in-flight coordination.

iii. Degraded weather may reduce effectiveness and employment envelope of some smart weapons.

8. Cluster Bombs/M61A2 Gatling Gun

Cluster bombs are air dropped or ground launched explosive weapons that eject smaller submunitions (cluster of up to 2000 bomblets). They use either mechanical time or proximity fusing, which allows the munitions to be dispersed at a predetermined height above the target. Cluster bombs are effective against troops and or equipment in an open area.

The gun is the most widely used and simplest A/A or A/G weapon. The F/A-18F M61A2 Vulcan cannon fires at 4000 or 6000 rounds per minute and generally carries about 350 rounds on a given mission. The weapon is 52 lb. (20%) lighter compared to the M61A1. The entire system weighs 672 lb. with 400 rounds weighing 226 lb. The gun is mounted in the F/A-18F nose, so weight is a big concern. The A/A gun envelope will be discussed in later chapters. Figure 5-27 is a diagram of the M61A2.

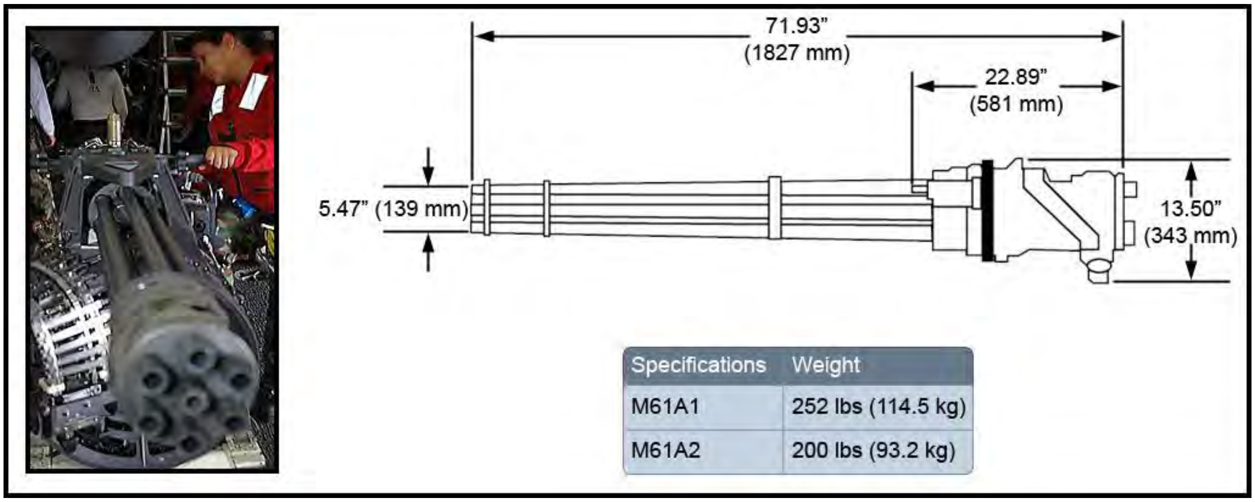


Figure 5-26 M61A2 Vulcan Cannon

503. WEAPONS DELIVERIES

1. T-45 Delivery Modes

As briefly mentioned earlier in this chapter, the T-45C has two modes available on the stores page for bombing: Manual (MAN) mode and Constantly Computed Impact Point (CCIP) mode. The MAN mode is a basic mode that puts more emphasis on the aircrew arriving at the exact parameters or sight picture in order to successfully bomb a target. In MAN mode, environmental factors such as wind must be incorporated to aircrew procedures. Figure 5-28 is a depiction of the HUD in MAN mode.

MAN incorporates a Depressed Sight Line (DSL) aiming reticle, for which mil depression angles set using the ± SET DEP rocker switch on the DEP. DSL defaults to 12 mils for gun, 30 mils for rockets, and 140 mils for bombs. Specific mil numbers are stored for each type weapon. The reticle indicates where the selected weapon will strike, given the weapon ballistic characteristics, aircraft airspeed, altitude, angle-of-attack, and direction of flight at the required release parameters. The reticle inner ring is 25 mils and outer ring is 50 mils. Outside the rings are two additional mil marks along the pitch ladder centerline: 75 and 100 mils.

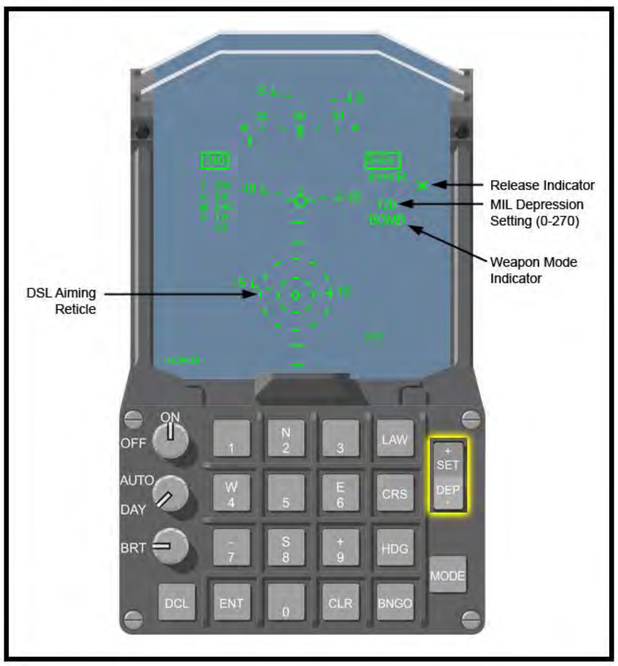


Figure 5-27 MAN Mode HUD Symbology

CCIP compensates a weapon release solution based on current aircraft dive angle, bank angle, airspeed, altitude, and release altitude wind to display a continuously computed impact point for a selected weapon.

In CCIP mode, the HUD displays a continuously predicted impact point under the pipper, a cruciform symbol (Figure 5-29). A Displayed Impact Line (DIL) is drawn from velocity vector to the pipper, sometimes called a Bomb Fall Line (BFL). It is only available in A/G BOMB mode, not in RKT or GUN. The bomb fall line is an azimuth reference between the pipper and the velocity vector that indicates wind and speed effects on the weapon. When the target and CCIP pipper are coincident, aircrews command bomb release.

The CCIP delivery mode uses the radar altimeter for its height above target (HAT) computation. When the radar altimeter is off (e.g., when above 5000' AGL, becomes invalid, or turned off), the system uses BARO altitude minus either the active/selected waypoint elevation or the entered TGHT, whichever was selected or entered last, for the HAT computation. An "X" overwriting BOMB or CCIP indicates that the Master Arm switch on the Armament Control Panel is in the SAFE position. The "X" is removed when ARM is selected.

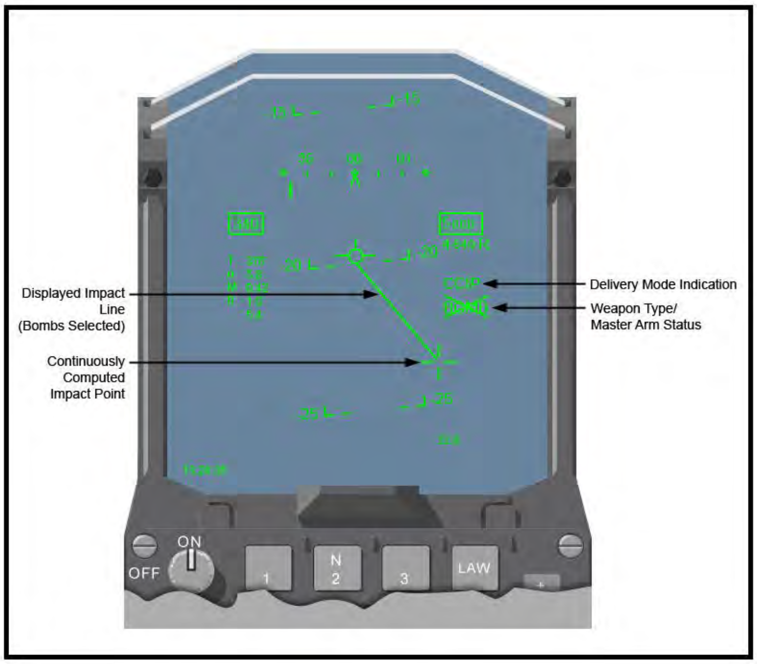


Figure 5-28 CCIP Mode HUD Symbology

2. Bombing Basics

There are some basic principles and definitions that apply to bombing. These basics must be generally understood and applied to the overall concept of A/G strikes. As mentioned before, "dumb" bombs are unguided, ballistic munitions whose accuracy depends upon proper, strict release parameters plus winds and environment. Aircrews have no control once the bomb is released.

"Smart" bombs, on the other hand, are still affected by winds and the environment, but they are either guided by laser designations, GPS/INS, or Radio Frequency homing (RF trackers). Many of these weapons may be employed against moving targets. Smart bombs allow for more flexibility regarding release point parameters. Smart bombs need only be released IN LAR or in the "basket" to be effective.

All bombs have a particular Circular Error of Probability (CEP). CEP is the average bomb miss distance for a particular weapon and delivery method. Based on CEP, strike planners can accurately predict a bomb's lethality, which is its killing effectiveness against certain targets.

A fuze initiates bomb detonation at a predetermined time and under the desired circumstances (fuzing). The detonation may cause destruction, injury or death within the blast radius. The blast causes three distinct, yet inter-related phenomena:

a. Fragmentation ("Blast Frag") – occurs when fragments of specially scored cases break into predictable sized pieces; traveling at high velocity, these fragments cause damage.

b. Shock wave – a high pressure force emanating from the detonation point of origin

c. Thermal wave – there is normally an exothermic reaction following a shock wave.

In addition to these three, another characteristic is bomb penetration. Penetration is the weapon's ability to pass into or through targets. Penetration is achieved by either the entire projectile's kinetic energy or the effects of a shaped charge. Figure 5-30 displays images of "Blast Frag," shock wave, thermal wave, and bomb penetration.

Figure 5-29 Bomb Penetration, Blast Frag, Shock Wave, Thermal Wave

3. Bombing Triangle/Delivery Basics

The bombing triangle (Figure 5-31) is created at weapon's release. It is composed of ***altitude, slant range*** from the aircraft to the target, and the ***down-range travel*** of the weapon. In the Training Command, the referenced bombing triangle is created with release altitude, the flight path of the aircraft, and the distance over the ground from the aircraft to the point on the ground where the flight path intersects.

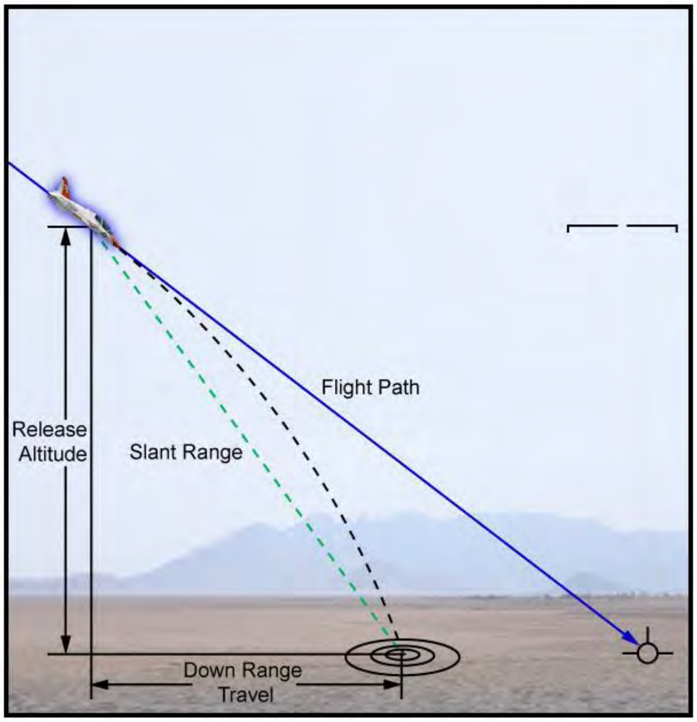


Figure 5-30 Bombing Triangle Components

If we extend the flight path up to roll-in altitude, we can reference this line as being on, below, or above the bombing triangle. Some refer to this planned flight path as being "the wire."

4. Bombing Definitions

In order to successfully prosecute A/G targets, SNFOs need to be familiar with the following definitions (Figure 5-32):

a. Flight Path - The three dimensional track or path of the aircraft through the air; also defined by the Velocity Vector in the HUD

b. Flight Path Angle - Angle between the horizon and the Flight Path of the aircraft

c. Dive Angle - The angle between the Flight Path and the ground; or the angle between the horizon and tangent line across the top of the airspeed and altitude boxes or waterline "W" symbol in the HUD

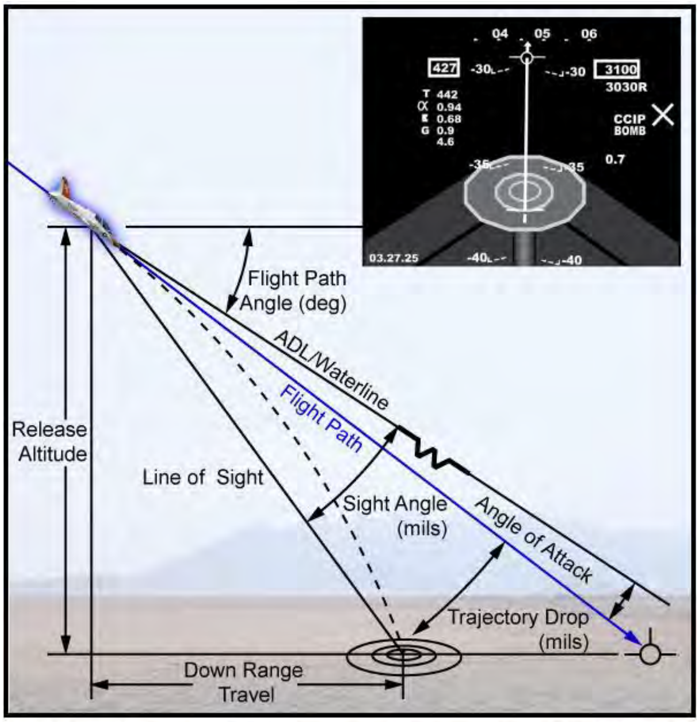


Figure 5-31 Bombing Triangle Definitions

d. Line of Sight - A line transcribed from the pilot's eye through the pipper. This line does not normally pass through the target until release.

e. Armament Datum Line (ADL) - Origination of the sight angle; it is a fixed reference line on the aircraft and will parallel the flight path at planned release airspeed (450 KTAS).

   i. At other than release airspeed, ADL will vary from parallel.

   ii. Angle between flight path and ADL is called the ADL angle of attack (different from aircraft AOA).

   iii. This angle ideally decreases to zero as the aircraft accelerates to 450 KTAS, so flight path (Velocity Vector) and ADL are the same at release airspeed.

f. Sight Angle (Sight Depression Angle) - The angle between the ADL and the line of sight

   i. With a sight angle of zero, the line of sight is parallel to the ADL.

   ii. With any depressed sight angle, the line of sight will be below the ADL.

   iii. The sight angle is set with the SET DEP rocker on the data entry panel of the HUD.

g. Trajectory Drop - The amount the weapon falls during its ballistic time of flight due to gravity effect, measured in mils. This can be found in the delivery data table.

h. MIL - A unit of angular measurement defined as 1/6400 of a circle. 1 mil = 1 foot at 1000 feet. There are 17.45 mils to every 1 degree.

i. Pipper - The bombsight used to determine the point at which to drop the bomb; if on parameters, the pipper will be on the target at the release point.

j. Time of Fall (TOF) - The length of time between release of a weapon and its impact with the ground. This is the time during which gravity acts on the weapon to bend its trajectory below the aircraft line of flight.

k. Aim-Off Distance - The distance measured from the target to a point where the flight path intersects the ground (Figure 5-33).

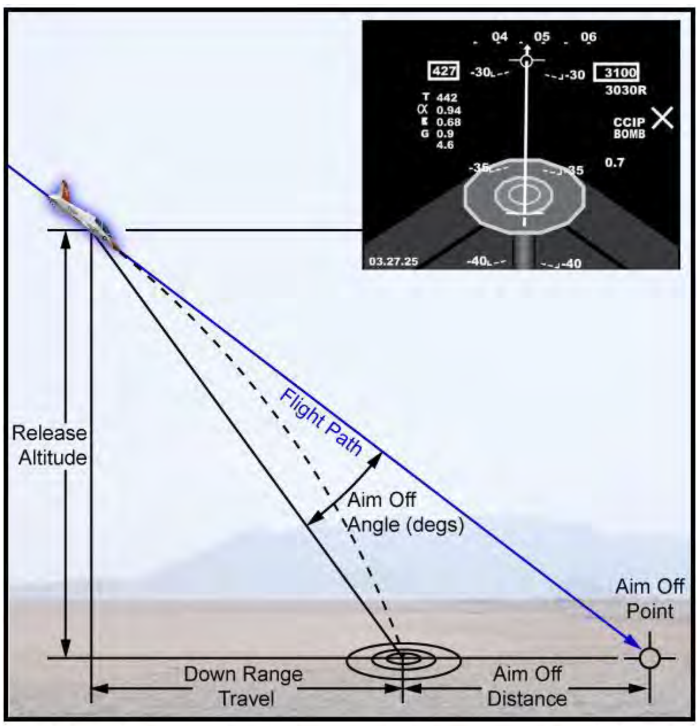


Figure 5-32 Aim-Off Distance

l. Aim-Off Point - A ground feature or point on the ground that represents the aim-off distance

m. Aim-Off Angle - The angle created between the flight path angle and line of sight to the target

n. Target Depression Angle - The angle created between the horizon and line of sight to the target. It is the number of degrees the target is depressed below the horizon, the sum of the flight path angle and target placement angle.

o. Target Placement Angle (TPA) - The angle between the flight path and the line of sight to the target derived for checkpoint altitude. Ensuring the TPA is set at checkpoint altitude will provide a reasonable weapons solution very close to planned release altitude. If the aircraft is on the bombing triangle, setting the TPA results in the Velocity Vector overlaying the Aim-Off Point.

p. Initial Target Placement (ITP) - The initial placement of the Velocity Vector above the target upon roll-out at the beginning of the tracking run

q. Attack Cone Distance (ACD) - The optimal distance (planned Z diagram) from the target from which the roll-in maneuver is commenced. If the roll-in is accomplished on the planned roll-in altitude, the aircraft should be established on the bombing triangle at the beginning of the tracking run. This point is sometimes referred to as the Roll-In Point or "RIP" (Figure 5-34).

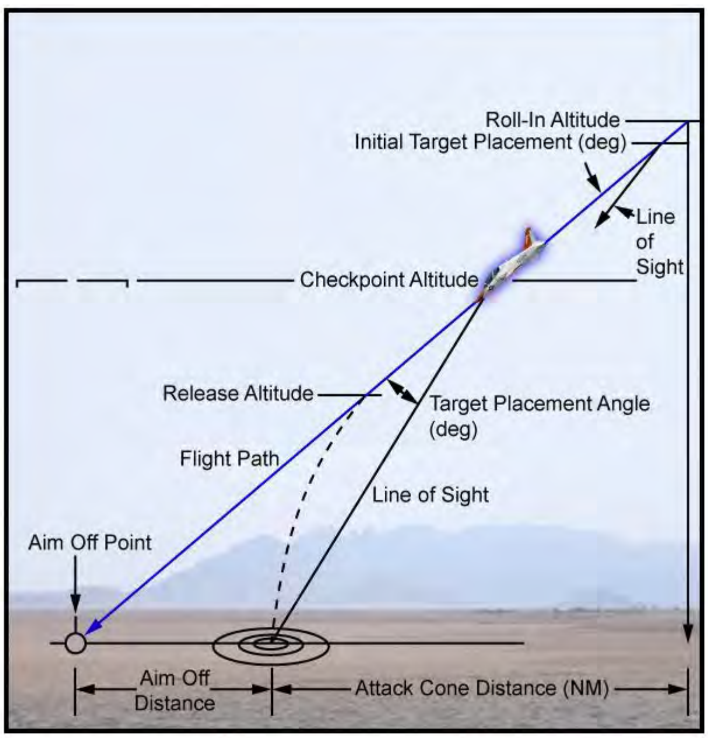


Figure 5-33 Attack Cone Distance and Target Placement Angle

r. Ballistics - The science of mechanics that deals with the flight, behavior, and effects of projectiles (especially bombs, bullets, and rockets). Understanding the factors that influence the path and eventual detonation or impact point allows aircrew to deliver ordnance accurately to assigned targets.

s. Impact Point - The point at which a bomb or rocket intersects with a solid target

t. Impact Angle - The angle of the weapon's flight path relative to the ground at impact. A weapon striking at too shallow an angle may ricochet or broach and fail to penetrate the intended target. Impact angle will also determine fragmentation spray pattern, thus affecting the type and extent of damage inflicted (Figure 5-35).

u. Impact Velocity - The speed of the projectile at impact will affect its ability to penetrate a target, especially a hardened or underground target.

Figure 5-34 Impact Point with Steep Impact Angle

5. Trajectory Factors

As can be inferred, the impact trajectory of a bomb is critical to its effectiveness. There are numerous factors affecting trajectory; each of these must be considered when choosing which weapons can achieve the damage required for different types of targets.

a. Wind-Effect – Although wind may impact the velocity and range of a projectile, wind-effect on trajectory is assumed to be from crosswinds impacting the horizontal movement of the bomb.

b. Glide – Extends the down-range travel between the release point and the point of impact.

c. Drag – Weapons experience drag just as anything else traveling through air; drag is calculated proportionally to weapon velocity.

d. Release Altitude – Assuming the aircraft is on the planned release dive angle and airspeed, releasing a bomb higher or lower than the intended release point will increase or decrease the time of fall of the weapon accordingly.

   i. High releases will cause a bomb to hit short (if on planned dive angle, airspeed).

   ii. Low releases will cause a bomb to hit long (if on planned dive angle, airspeed).

e. Release Airspeed – Deviations from planned airspeed will cause a false sight picture when bombing manually with a mil setting.

   i. Fast release will decrease AOA and bring the pipper short of the impact point, but cause the bomb to hit long.

   ii. Slow release will show the pipper long and cause a short hit.

   iii. Airspeed also has an effect on the weapon's time of fall.

f. Dive Angle – Deviations from the planned dive angle will also cause a false sight picture.

   i. Steep dive will cause a long hit (if released at planned altitude).

   ii. Shallow dive will cause a short hit (if released at planned altitude).

g. G at release – Proper G-loading at release depends on the dive angle.

   i. 10-degree dive requires almost 1 G to maintain a straight flight path.

   ii. 30-degree dive requires about 0.87 G.

   iii. 60-degree dive (not used in Training Command) would require 0.50 G.

h. Bank Angle at release - Because of the depression of the sight line below the line of flight, any bank will cause a false sight picture.

   i. Error is caused by the "pendulum effect."

   ii. A roll right will make the pipper appear to move to the left; if the bomb is released with the pipper on target in a right bank, the hit will be to the right and short. The converse is true for a left-bank angle.

504. DELIVERY PROCEDURES

Having discussed the factors that affect the path of a weapon, we can now introduce the procedures and techniques for a weapons run. The following procedures will apply to all patterns and ordnance used in the Training Command (except where noted).

When executing dive attacks in the Training Command, SNFOs will learn about the procedures and concepts involved with these three delivery methods:

a. Straight-Path Tracking

b. Curvilinear Tracking

c. Curvilinear/Straight-Path Tracking

1. Straight Path-Tracking

Straight-Path tracking has the following characteristics:

a. Constant dive angle maintained.

b. Pipper tracks to aimpoint.

c. G-load will become slightly less than 1 G.

d. With wings level after roll-in, dive angle and pipper placement are most important and require they be scanned first.

e. Pipper should be short of the final aimpoint (target) after roll-in with wings level.

f. Make corrections for pipper position early in the run.

g. Note deviations from expected dive angle.

h. During tracking, cross-check.

    i. Pipper motion control

    ii. Altitude

    iii. Airspeed

    iv. Dive Angle

i. Altitude becomes increasingly important as it decreases towards planned release.

j. As release altitude approaches, scan:

i. Pipper and altitude on HUD

ii. Occasional reference to dive angle and airspeed

k. Pipper should reach final aimpoint (bullseye, no wind) just as the aircraft arrives at release altitude of 3000 feet AGL (Figure 5-36)

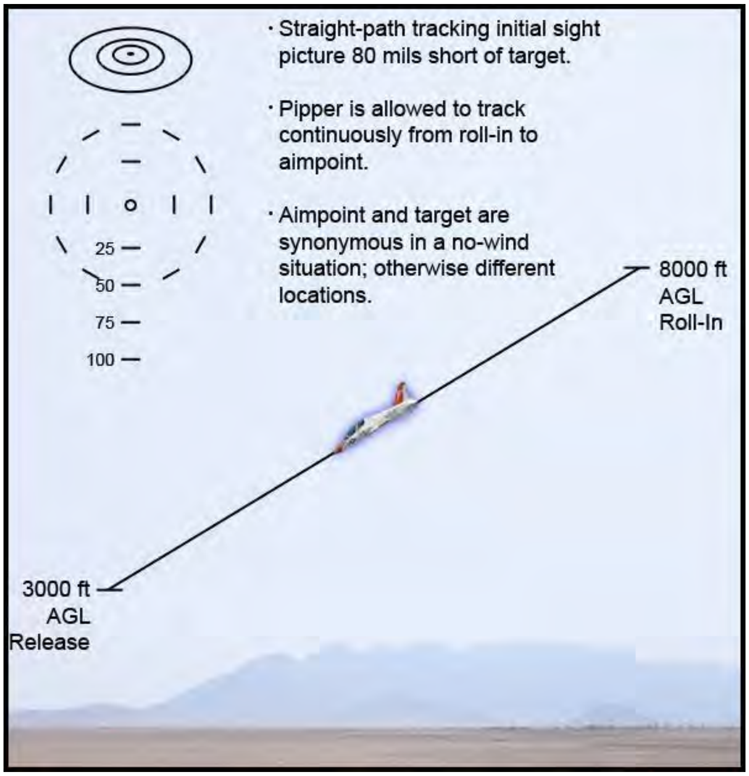


Figure 5-35 Straight-Path Tracking

Straight Path Guidelines are as follows:

a. 2/3 mil setting below aimpoint at 3-times the release altitude

b. 1/2 mil setting below aimpoint at 2-times the release altitude

c. 1/3 mil setting below aimpoint at 1.5-times the release altitude

2. Curvilinear Tracking

Curvilinear tracking occurs when the flight path becomes convex, with the dive angle continually increasing. This is accomplished by placing the pipper on a ground point and holding its position with forward stick pressure. G loading will gradually approach zero causing an attempted release to either hit long or become hung. For this reason, curvilinear tracking is not practiced. It is normally combined with straight-path tracking.

3. Curvilinear/Straight-Path Tracking

This combination starts with a curvilinear tracking run, and then transitions to a straight-path tracking run until release (Figure 5-37).

a. At roll-in, the pipper is held short of target (or offset aimpoint) by 1/3 of the mil setting until 1.5 times the release altitude.

b. At this point, straight-path tracking commences.

c. This method provides checkpoints that allow aircrew to determine required corrections prior to reaching release altitude.

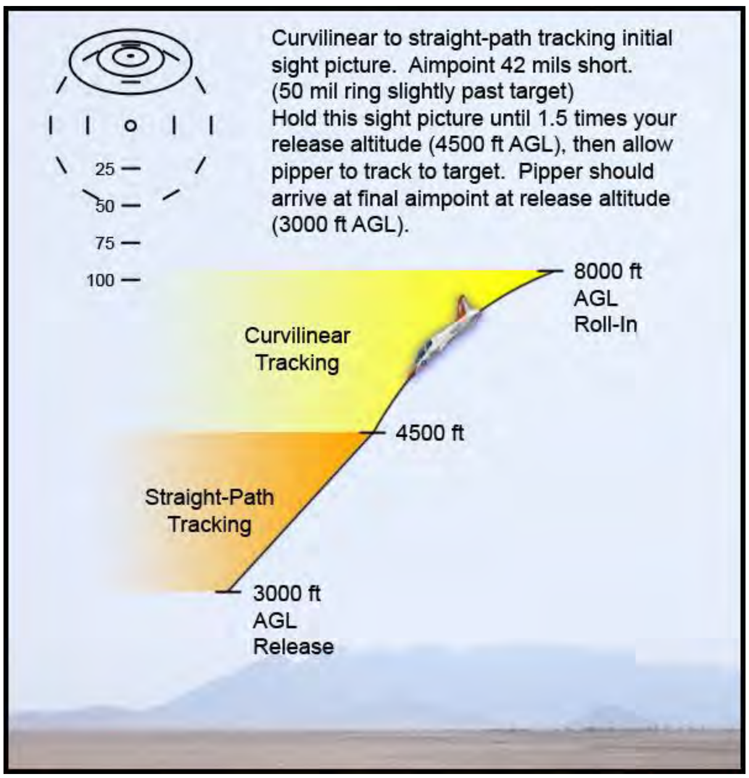


Figure 5-36 Curvilinear/Straight-Path Tracking Combination

4. Ordnance Release / Corrections

During a bomb or rocket run, the weapon is normally released (pickled) as the pipper reaches the final aimpoint at release altitude. During a strafing run, there is no single release altitude; instead, there are open-fire and cease-fire altitudes.

a. In a 10-degree strafing run, these altitudes are 1100 feet AGL and 800 feet AGL.

b. Ideally, the pipper should be at the top of the target at open-fire altitude and eased toward the bottom of the target throughout the burst. This compensates for decreasing slant range and subsequent decreased effect of gravity on the weapon.

Whether bombs or guns are used, aircrews always strive to arrive at the release point within parameters (airspeed, dive angle, altitude). During each run, corrections are constantly made. In order to make proper corrections, aircrews need to know the degree of error that will affect accuracy. The following table is a general guideline for evaluating error against accuracy (Figure 5-38).

Table of Error Sensitivities

	Dive Angle		Airspeed		Release Alt		Error
10° Bombs	+/- 1°	=	+/- 10 kt	=	-/+ 70 ft	=	+ 80 ft
10° Strafe	+/- 1°	=	+/- 10 kt	=	-/+ 100 ft	=	+ 30 ft
20° Bombs	+/- 1°	=	+/- 10 kt	=	-/+ 100 ft	=	+ 50 ft
20° Rockets	+/- 1°	=	+/- 10 kt	=	-/+ 100 ft	=	+ 20 ft
30° Bombs	+/- 1°	=	+/- 10 kt	=	-/+ 100 ft	=	+ 50 ft
30° Rockets	+/- 1°	=	+/- 10 kt	=	-/+ 100 ft	=	+ 20 ft

Figure 5-37 Release Error Sensitivities

To make dive angle corrections, perform the following procedures:

a. Read pitch angle on the ADI/HUD.

b. If dive angle is too steep, maintain dive angle and adjust release altitude accordingly

i. For example, on a 30 degree bomb run, if the HUD shows 32 degrees, you would compensate by releasing 200 feet high (refer to error sensitivities table).

c. If dive angle is too shallow, increase airspeed.

i. For example, on a 30-degree bomb run, if the HUD shows 28-degrees, you would accelerate to 470 kts and release at planned altitude.

d. Do not release with excessive G due to possible false sight picture.

e. Never press the run below normal release altitude to correct for a dive parameter or for any other reason.

To make airspeed corrections, perform the following:

a. Maintain awareness of airspeed during the final stage of the bomb run to ensure proper release airspeed.

b. Last second airspeed corrections are similar to those for dive angle errors

i. For example, on a 30-degree bomb run, airspeed indicates 20 kts fast nearing release. Aircrew can either pickle 200 feet high or release with pipper 100 feet short of the target.

ii. If 20 kts slow, allow the pipper to drift 100 feet past the target and release at planned altitude.

Pipper position at release is the single most important parameter in determining where the weapon will hit. Experience will help aircrews recognize ***early in the run*** that the pipper is not going to arrive at the final aimpoint by release altitude, thereby making the needed early corrections/adjustments. During a run, the pipper will arrive on the target early or late with regard to planned release altitude. The following will assist aircrew in making the proper correction:

a. Early Sight Picture – when the pipper arrives at the aimpoint before reaching the normal release altitude

i. If pickled at an early sight picture, the bomb will be short due to altitude error.

ii. If pickle is held until release altitude, the bomb will be long because the pipper will have traveled past the target.

iii. Holding the pipper on the target until release altitude will cause dive angle to increase and the bomb will be released with insufficient G.

iv. The proper correction is to notice the altitude at which the early sight picture occurs and split the difference between that altitude and the release altitude.

(a). For example, on a 30-degree bomb run (3000 feet planned release) with the pipper arriving at the aimpoint at 3400 feet AGL, compensate by continuing to hold the 30-degree dive and pickle at 3200 feet AGL.

(b). This assumes all other dive parameters are as planned.

(c). Improper pipper position can often be traced back to improper roll-in.

b. Late Sight Picture – when normal release altitude is reached with the pipper not yet on the aimpoint

i. Early recognition is key; this may have been caused by:

(a). Rolling in too far from target

(b). Not maintaining altitude during the initial roll-in

(c). Pulling the nose down during final portion of roll-in

ii. Correct by using very slight back stick pressure to change pipper placement and then resume proper G; this correction will shallow the dive angle necessitating additional corrections.

NOTE

Never release below normal release altitude to correct for late sight picture, or for any other reason.

For lateral pipper deflections such that the pipper is offset to one side of the aimpoint, perform the following:

a. Recognize early; use small bank angles to correct pipper placement and ensure wings level at release.

b. For forward-firing ordnance, aircrew can use rudder to correct for pipper deflections

i. Rockets: The correction factor is 4-times the deflection error (e.g., pipper 10 mils left, use rudder to correct 40 mils to the right).

ii. Guns: The correction factor is 1.25-times the deflection error (e.g., pipper 10 mils left, use rudder to correct 12.5 mils to the right).

For wind corrections, it is important to realize that wind primarily affects groundspeed and ground track (drift). All dive parameters may be correct, but if the wind is not considered, then the bomb will miss. For example, a 12-knot right crosswind causes the aircraft to drift left at 20 feet per second. A 7-second TOF will cause the bomb to be 140 feet left of target. Figure 5-39 illustrates the effects of wind versus pipper placement for different scenarios.

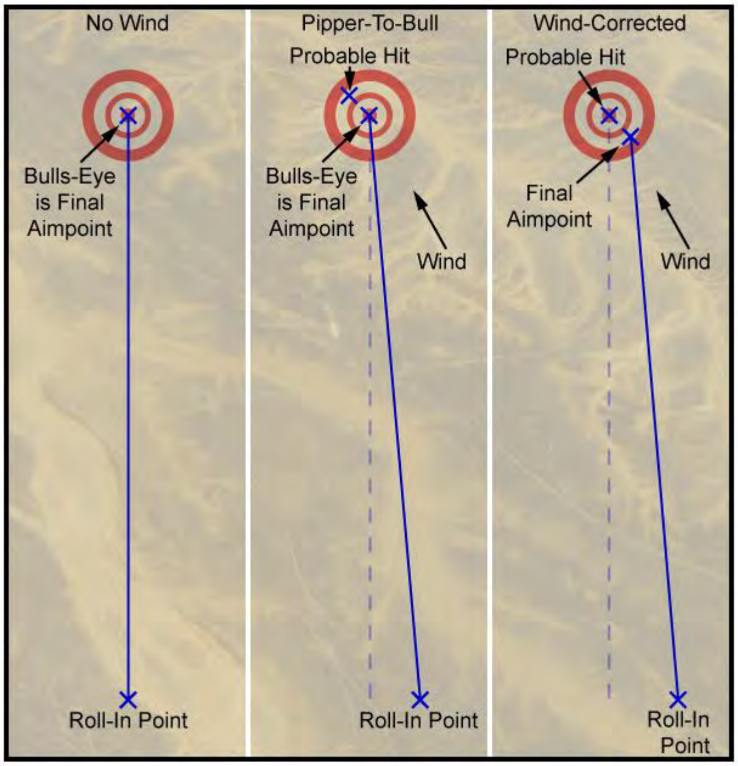


Figure 5-38 Pipper Placement with Crosswind

Most dive attacks are never perfect. In fact, multiple error corrections may be required on one run; these errors may be additive or they may cancel each other. It is important to have the error sensitivities/corrections table committed to memory. However, even knowing how to correct for all errors may not be enough; sometimes, the best option is to abort the run.

In order to better understand the diving run, we use the term "wire." Wire refers to the actual dive path versus the optimum dive path. A high wire refers to a dive path that is above the optimum, while a low wire would refer to a low run. The ultimate goal is to put a bomb on target, even when aircrew find themselves on the wrong wire. The effects of various wires are as follows:

a. Steep Wire – Aim-off distance is correct but dive angle is steep, resulting in a higher than planned weapon release solution (Figure 5-40).

b. Shallow Wire – Aim-off distance is correct but dive angle is shallow, resulting in a lower than planned weapon release solution (Figure 5-40).

c. High Wire – Aim-off distance is long, but dive angle is correct, resulting in a higher than planned weapon release solution (Figure 5-41).

d. Low Wire – Aim-off distance is short, but dive angle is correct, resulting in a lower than planned weapon release solution (Figure 5-41).

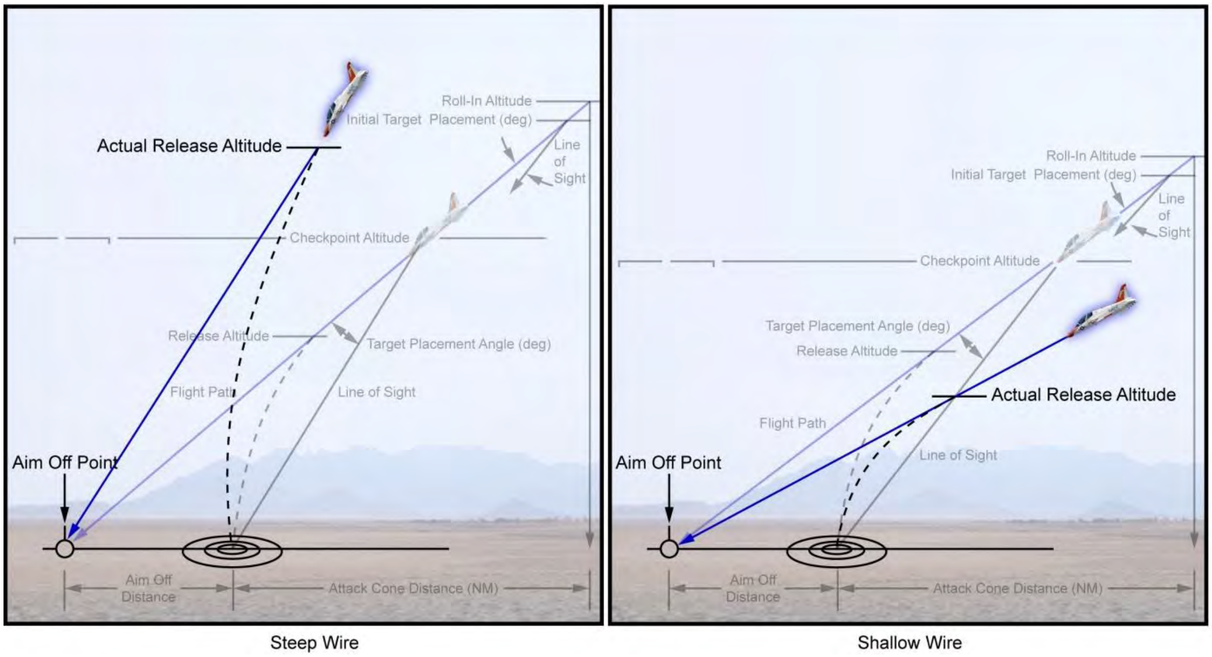


Figure 5-39 Steep Wire & Shallow Wire

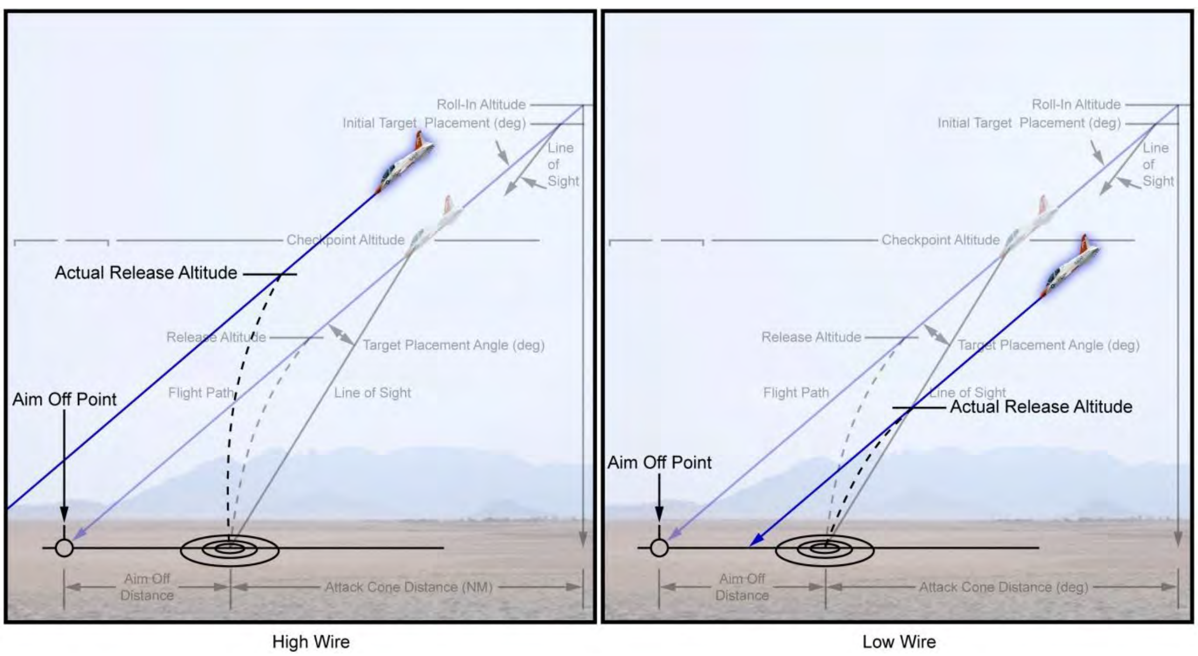


Figure 5-40 High Wire & Low Wire

5. The Z Diagram

"Z" Diagrams are graphic presentations of pattern and weaponeering information included on briefing boards and kneeboard cards. It is important to understand the concepts of weaponeering and the basic components of the Z diagram to apply those concepts to follow-on fleet aircraft training. In the fleet, Z diagrams must be created and tailored to the specifics of the mission. In the Training Command, these Z diagrams are already prepared.

The target type will drive the type of ordnance used. In Basic Conventional Weapons Delivery (BCWD), we want to pickle as close to the target as possible in order to increase accuracy. Also, the steeper the planned dive, the more accurate the hits will be due to error sensitivities. However, there are factors that dictate exactly how close bombing aircraft can get to the target:

a. Enemy Threat – Surface-to-Air systems designed to protect key ground targets

b. Weapon Fragmentation – The blast fragmentation of the weapon itself

c. Weapon Arming Time – The time required for the weapon to arm after leaving the aircraft

d. Terrain – Safe recovery from a dive attack must be incorporated into a Z Diagram

The most critical or the highest altitude of these four factors will be used to build the Z Diagram's minimum release altitude. Under no circumstances will aircrews release weapons below the minimum release altitude. Figure 5-42 shows the basic information required for all Z Diagrams.

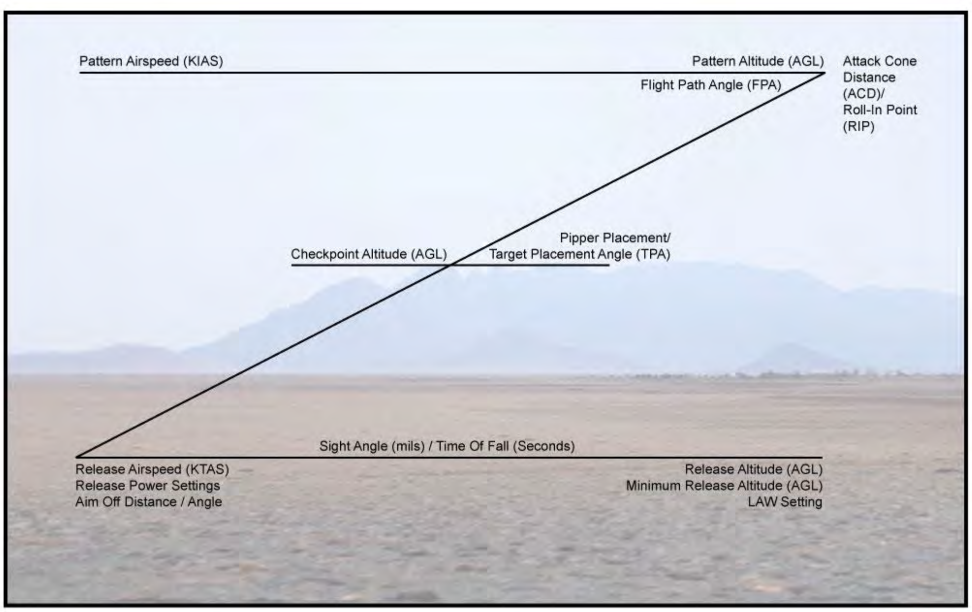


Figure 5-41 Z Diagram Components

Release Altitude is the planned release altitude, whereas the Minimum Release Altitude, or "Zmin" Altitude, is the "No Lower Than" release altitude. Strive to release with the pipper arriving at the aimpoint as close to the ***planned*** release altitude as possible. The minimum release altitude is just that – the absolute minimum.

Release Power Setting is the power setting prior to roll-in that will achieve the planned release airspeed. Aim-Off Distance (AOD) and Aim-Off Angle are shown below the Power Setting. These refer to the distance (linear or angular) past the target the Velocity Vector needs to be in order to compensate for the trajectory drop of the weapon.

All altitudes on the Z Diagram are shown in AGL. A space is allotted on the Z diagrams to add the MSL altitudes. MSL altitudes are calculated by adding the target elevation to the AGL altitudes on the Z-Diagrams. The Attack Cone Distance is the distance from the target at which the roll-in from pattern altitude begins. This is also referred to as the Roll-In Point or "RIP."

Figure 5-43 illustrates the three typical dive attacks that are flown in VT-86: 30-degrees, 20-degrees and 10-degrees. Again, these Z Diagram altitudes are AGL and require the SNFO to add the target elevation in order to have MSL altitudes that can be read in the aircraft.

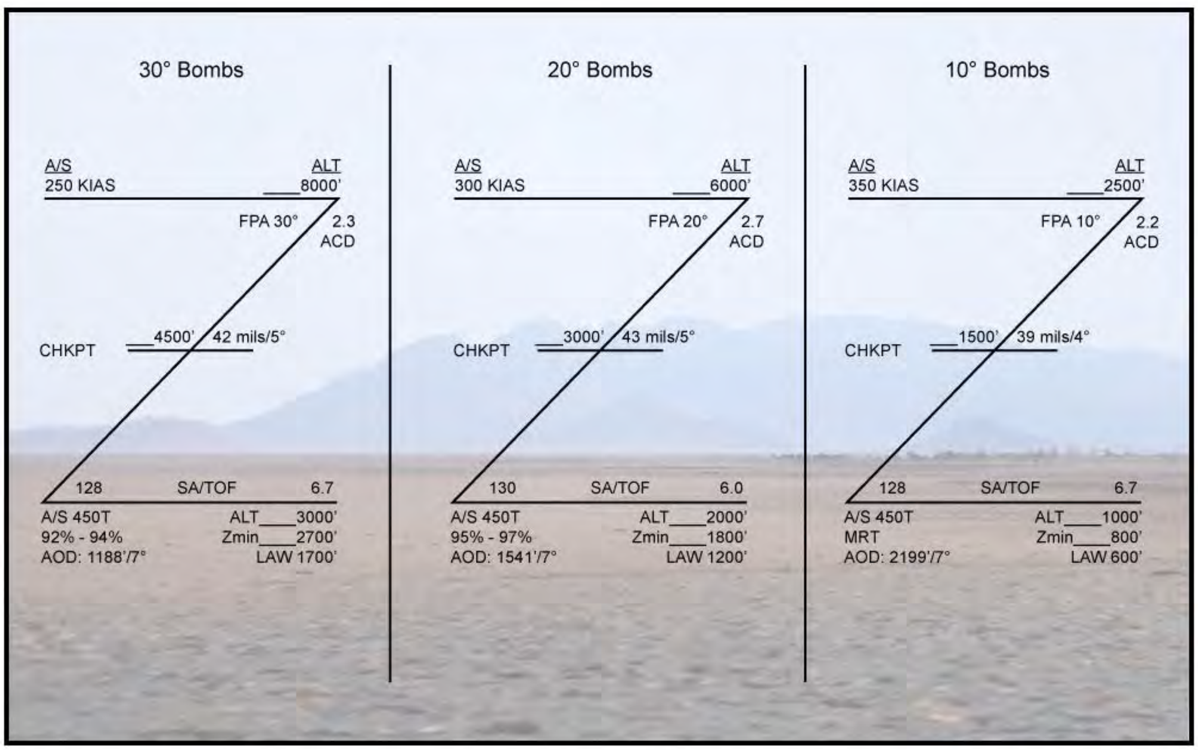


Figure 5-42 30-, 20,- and 10-Degree Z-Diagrams (AGL)

6. Circle the Wagons

"Circle the Wagons" is a race-track bombing pattern (left or right) that looks more like a pork chop than a circle or race track, used to practice bombing. The Z-Diagrams will be used for dive parameter practice during the pattern roll-ins. The pattern is initiated with a spacer pass; the lead aircraft flies the section or division down to the planned release altitude on the Run-In heading. The spacer pass verifies the range is "cold" and safe to conduct operations. LATOMS-T checks should be accomplished prior to commencing the spacer pass (and on every run):

L: LAW Set for Delivery

A: Air-to-Ground Delivery Mode (CCIP/MAN)

T: Target Elevation entered

O: Ordnance (Bombs/Guns/PGM)

M: Master Arm On

S: Symbology: No X's in the HUD

T: Target Designation/point

Once over the target on the spacer pass, the lead aircraft breaks away from the formation and proceeds up to Point 2 (abeam position) at pattern altitude (Figure 5-44). The wingmen break up into the pattern 5-7 seconds later in sequence. The pattern should be flown at or just outside the Roll-In-Point (RIP) distance. SNFOs are required to keep sight of wingmen throughout the pattern sequence. The pattern is not to exceed four total aircraft in the pattern at one time. As aircraft approach Point 3 (Roll-In-Point), aircrews should use extreme caution to avoid a SIMO run (two aircraft diving simultaneously).

The communication in the pattern is as follows:

a. Lead/Wing IP (Pri) - *"Hammer-11/-12, breaking."* (Spacer Pass)

b. Lead/Wing SNFO (Pri) - *"Hammer-11/-12, abeam."* (At Point 2)

c. Lead/Wing SNFO (ICS) - *"LATOMS-T complete."* (completed on every pass)

d. Lead/Wing IP (Pri) - *"Hammer-11/-12, in dry."*

e. SNFO should verify that the dive angle is +/- 5 degrees of planned and that the airspeed is climbing toward the desired release airspeed. If not call ABORT (ICS)

f. Lead/Wing SNFO (ICS) - *"Standby….Mark….Pull."* (at planned release altitude)

g. Lead/Wing IP (Pri) - *"Hammer-11/-12, off safe."* (after safe escape, master arm safe)

h. Lead/Wing SNFO (ICS) - "*Visual, 10 o'clock high."* (when visual of wingman, approaching abeam)

i. Lead/Wing SNFO (Pri) - *"Hammer-11/-12, 1.9."* (fuel check with no aircraft in dive)

j. Lead/Wing IP (Pri) - *"Hammer-11/-12, in dry, last pass."*

k. Lead IP (Pri) - *"Hammer-11, off safe, off target rendezvous."*

l. Wing IP (Pri) - *"Hammer-12, off safe, off target rendezvous, visual."*

This communication will continue throughout the pattern; LATOMS-T checks are required for every pass. For loss of SA in the pattern, request a "Posit" from the other aircraft. When requested, IPs will respond with "Hammer-11, approaching roll-in/abeam," as appropriate.

Aircraft climbing to the abeam position are required to stay below pattern altitude until visual of their interval. On the off target rendezvous, lead aircraft will orbit overhead at the pre-briefed altitude; wingmen are required to remain at 1000' increments below lead until visual of all aircraft in front of them. The figures below illustrate the pattern in various views.

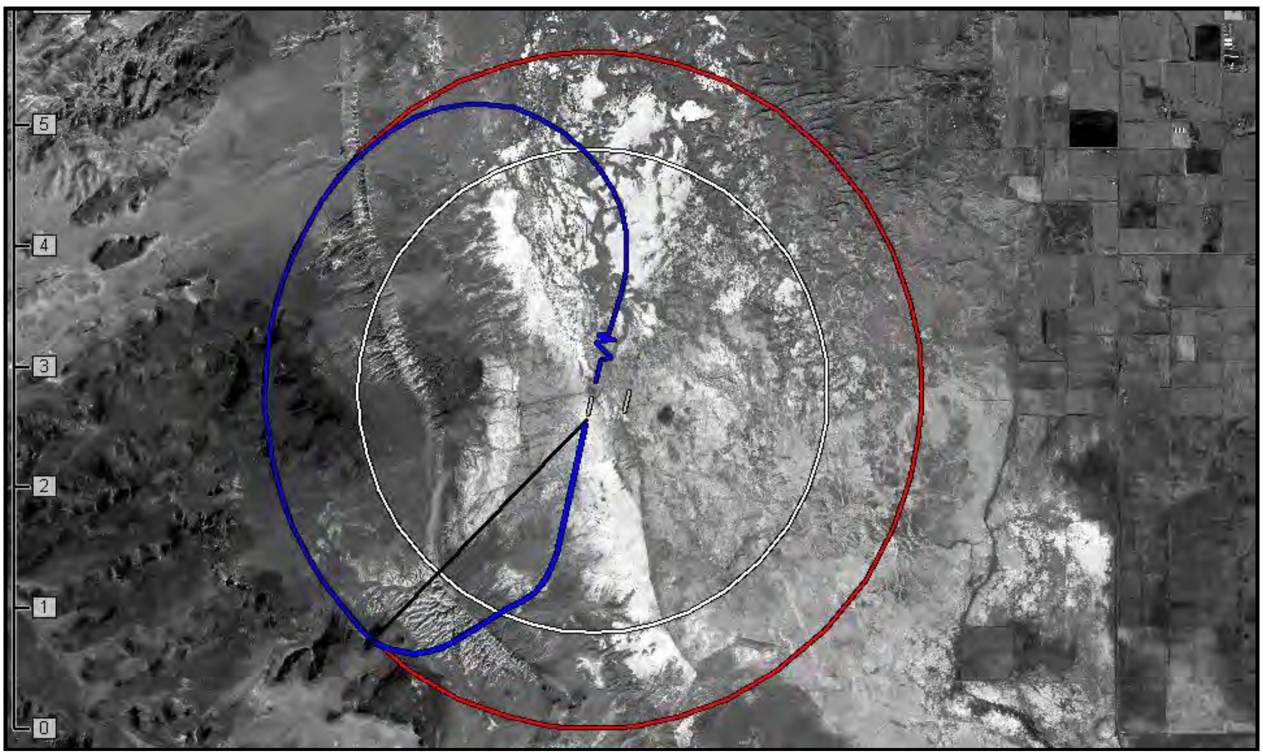


Figure 5-43 30-Degree Dive Circle with Pattern in blue

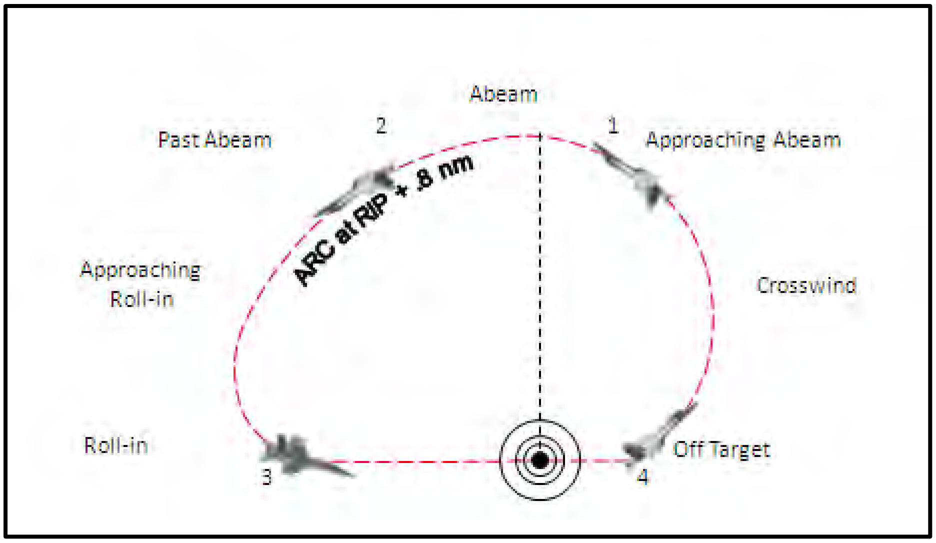


Figure 5-44 Pattern Positions

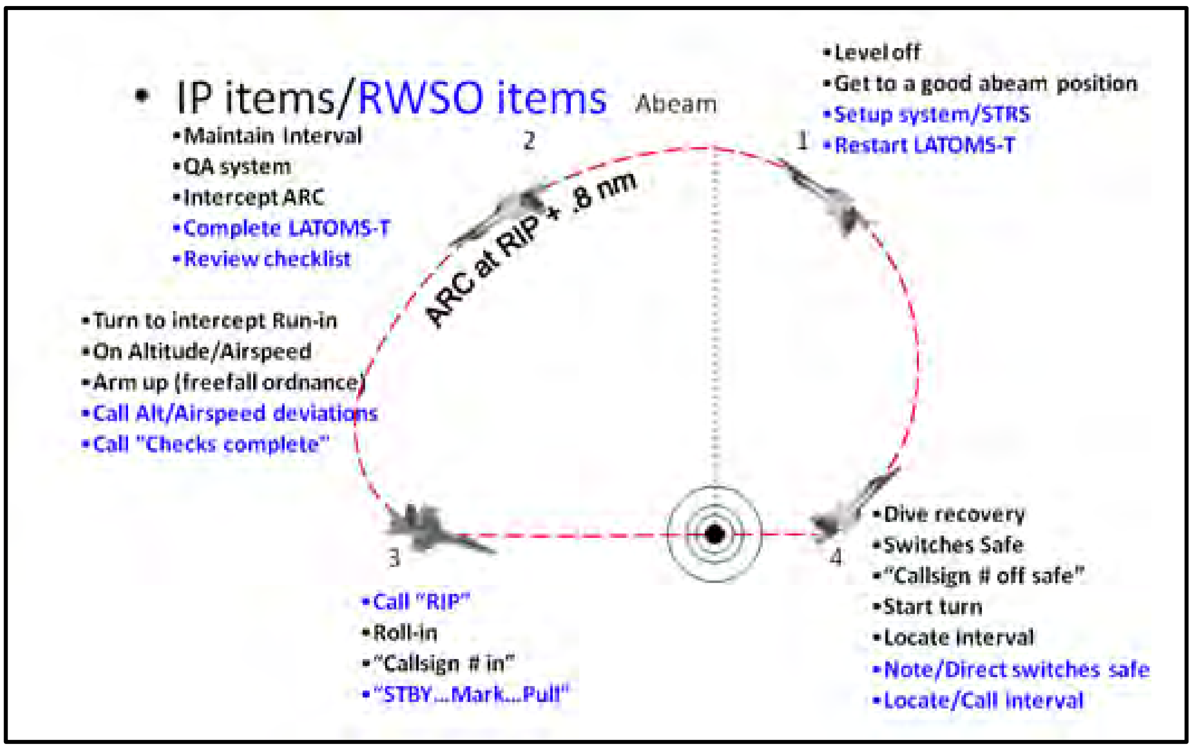


Figure 5-45 Pattern Procedure Overview

The other type of Dive Diagram utilized at VT-86 is the Low Altitude Pop Diagram. This is used when there is a high surface-to-air threat in a particular target area or region. Aircraft come in low, pop-up, and attack the targets. The Pop Diagrams for VT-86 use a 500 feet AGL run-in (Figure 5-47). SNFOs are responsible for writing in the MSL beside the AGL altitude; MSL altitudes are used in the jet during the attacks. As with the Z Diagrams, target height must be factored into the Pop Diagrams.

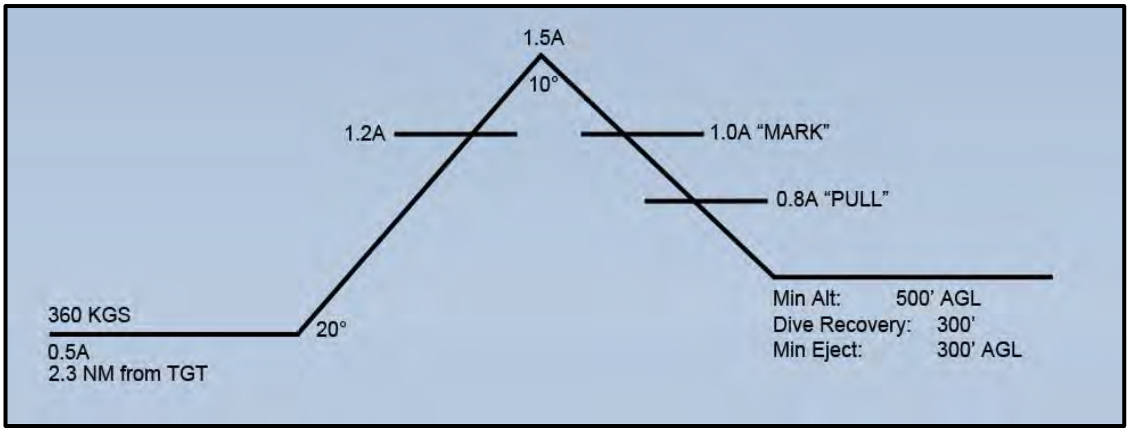


Figure 5-46 Pop Z Diagram

505. WEAPON DELIVERY VALIDATION

All dive deliveries in training and combat should be reviewed for validation. Validating deliveries involves much more than simply confirming the bomb hit its target. Aircrews train to meet specific dive parameters in order to build a "sight picture" for different altitude deliveries. The prescribed dive parameters are required to maximize the lethality of the weapon. There are five parameters that must be evaluated for every attack using the HUD video (Figure 5-48):

1. Dive Angle

    a. Velocity vector is within 5-degrees of planned dive angle for a 10-degree delivery.

    b. Within 7-degrees for a 20- or 30-degree delivery

2. Airspeed – True airspeed within 20 kts of planned release TAS (usually 450 KTAS)

3. Altitude – Aircraft altitude is no lower than the No Later Than (NLT) weapon release altitude.

4. Weapon Impact Point (WIP) Placement – The CCIP WIP is on the target at time of release.

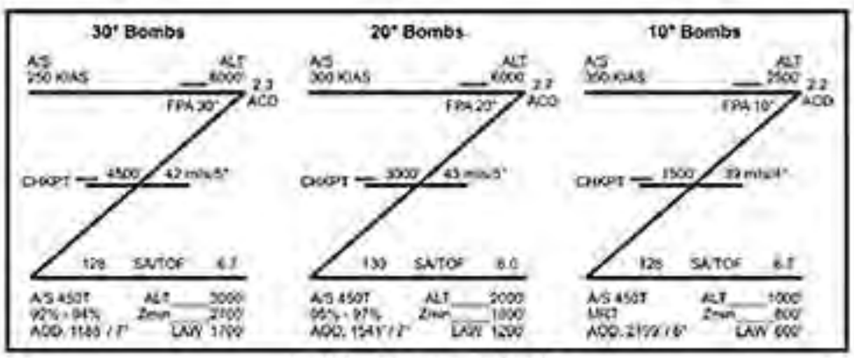
5. Safe Escape Maneuver – After release, the pilot executes a minimum of 4 Gs within 2 seconds, and sustains at least 4 Gs until the velocity vector is at or above the horizon.

Figure 5-47 A/G HUD Validation

The delivery will be assessed as "invalid" if any of the above parameters are not met. If unable to discern the validation criteria due to HUD or tape limitations, the delivery will be "not assessable for HUD or Tape." A tool that SNFOs will use for validating deliveries is the VT-86 A/G Validation Card (Figure 5-49). After landing, but before the debriefing, the SNFO will fill out this card by reviewing the tape.

VT-86 A/G Delivery Validation Card

Mark Time	TOF (+6"TOF)	Planned Dive Angle	Actual Dive Angle	KTAS	Mark ALT	Safe Escape Mnvr	Pipper On TGT?	Valid? V/UA/Ifor...



Valid Delivery Criteria

Freeze tape at Mark:

- Pipper on Target
- Dive angle within:
  - +/- 5° for 10° Dive
  - +/- 7° for 20° or 30 Dive
- Airspeed within +/- 20 KTAS
- Altitude ≥ NLT ALT

- "Safe Escape" Maneuver
  - Play tape
  - 4 G's within 2 sec
  - 4 G's until velocity vector above horizon

Figure 5-48 VT-86 A/G Validation Card

506. A/G TARGETING PROCEDURES - A/G TIMELINE

The procedures for target acquisition are slightly different in VMTS and the OFT; the OFT will have additional procedures due to its added capabilities. However, the overall concept and A/G timeline will remain constant.

Figure 5-50 provides the basic timeline for A/G target prosecution. The initial flights of the Strike stage will expose the SNFO to this timeline as well as introduce basic target acquisition procedures. The later strike flights will incorporate different ordnance delivery procedures and tactics in this timeline, including single-ship and section attacks.

Preparation is the key to successfully executing the timeline. Therefore, the cockpit must be properly set up prior to 25 nm from the intended target. The SNFO will have the cockpit set up as follows:

1. Nav Master Mode

2. MFCDs

    a. Left MFCD (LMFCD) – ADI/HUD

    b. Right MFCD (RMFCD) – HSI / SA / RDR

3. 360 kts Ground Speed (GS)

The Primary A/G Time line (Figure 5-50) will be executed for all flights and simulator events that do not utilize EXP modes.

The SNFO will continue to monitor the radar image around the stabilized cue until the target area can be identified. Once the target area is identified, the SNFO will:

1. RMFCD – Select FRZ

2. RMFCD – Full action trigger (Designating Cursor)

3. RMFCD – Slew designation cursor to new TGT

4. RMFCD – Release trigger (updated stabilized cue)

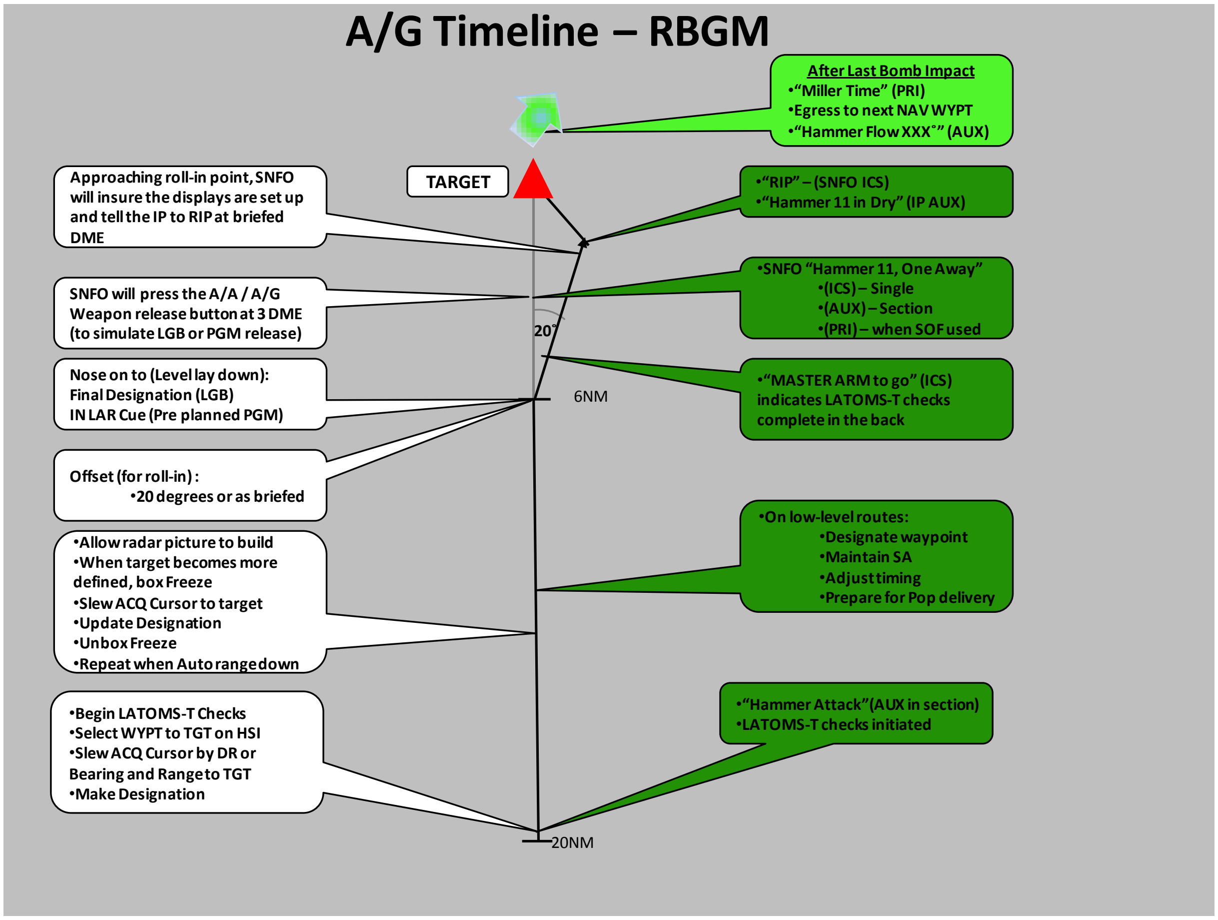


Figure 5-49 Basic A/G Timeline (No EXP Modes)

5. 25-20 nm (Figure 5-51)

   a. LMFCD -- Select STRS on Menu display.

   b. Select A/G, confirm A/G, SIM and BOMB is boxed.

   c. LMFCD – select Situational Awareness (SA/HSI) page and note target WYPT bearing and range info.

   d. RMFCD – select A/G radar attack display.

   e. "Hammer Attack" at 20 nm

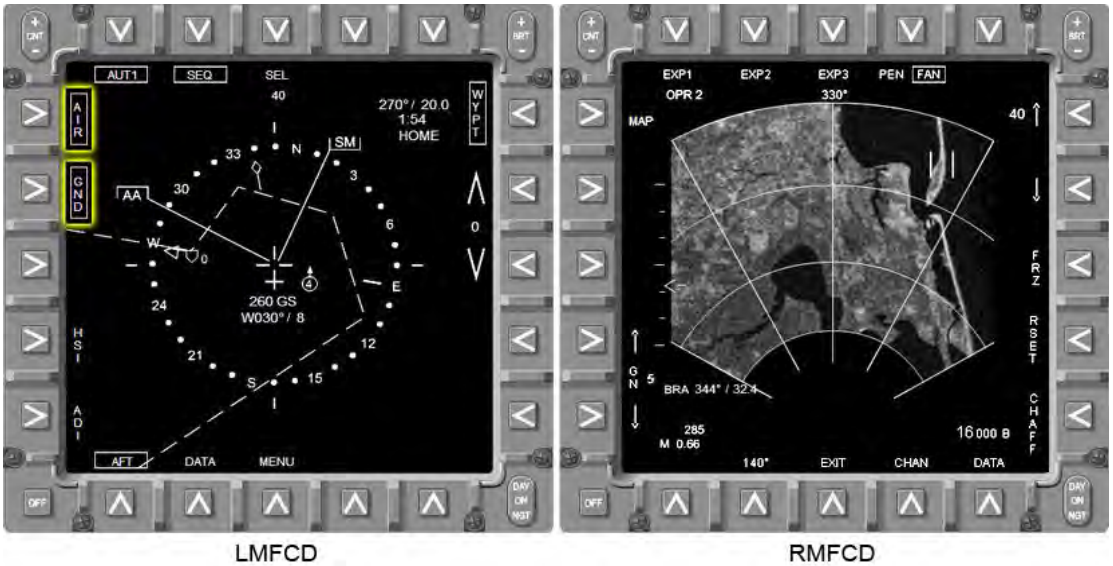


Figure 5-50 LMFCD and RMFCD Displays in VMTS at 25 NM

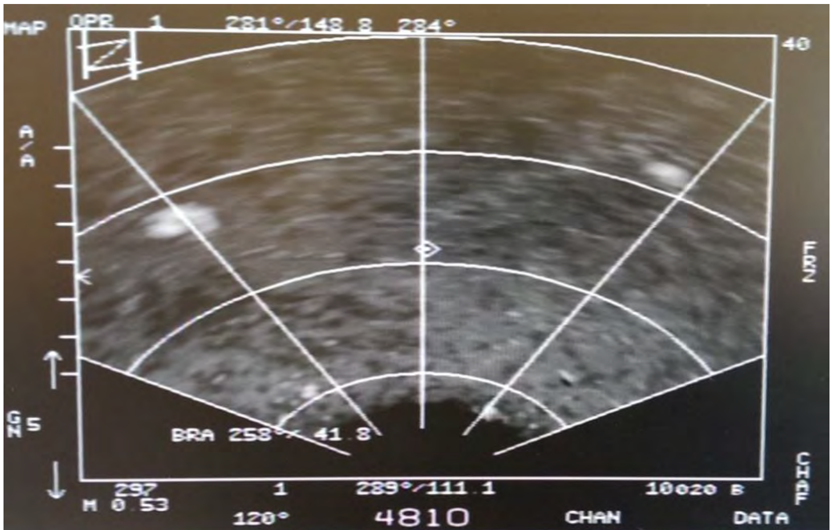
At this point, the SNFO will begin LATOMS-T checks to ensure system is set up for delivery:

1. L – LAW set for Delivery
2. A – A/G Delivery Mode: CCIP/MAN
3. T – Target Elevation entered
4. O – Ordnance: PGM/Bombs/GUN
5. M – Master Arm On
6. S – Symbology: No X's in the HUD
7. T – Target designation/point

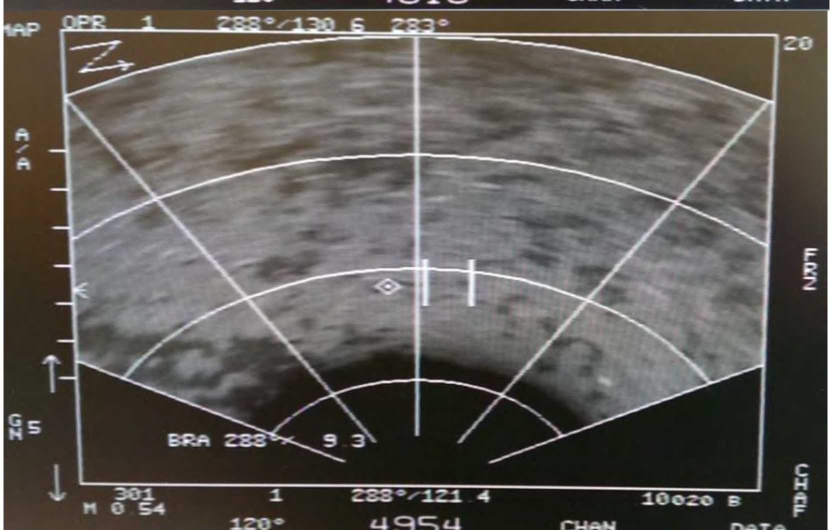
507. RADAR TO VISUAL HANDOFF DELIVERY

1. 20 - 6 nm (RADAR to VISUAL)

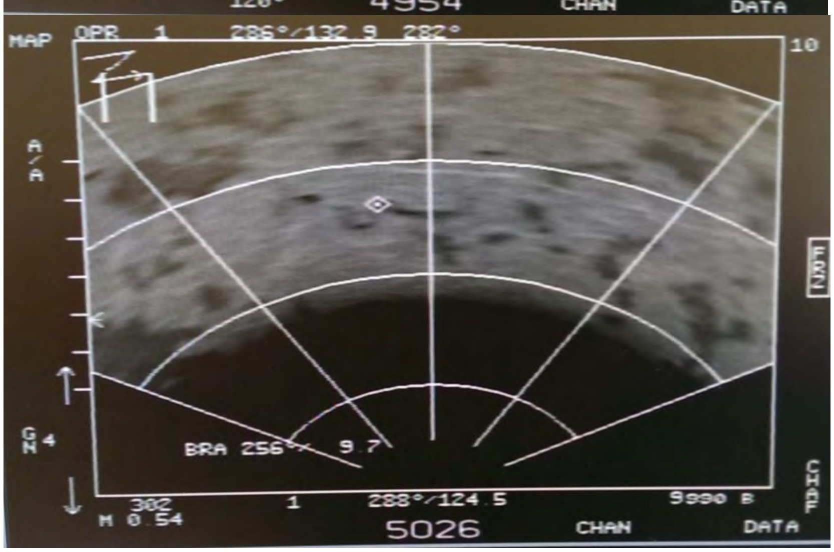
The Radar to Visual Handoff delivery utilizes the radar to tell the aircraft and aircrew about where the target is located. You can be very accurate, but not accurate enough to drop ordnance, but we want it to be accurate enough so that the aircrew can easily acquire the target visually. Because of the different type of ordnance and delivery, the procedures from 6 nm to the target are slightly different, but from 20-6 nm our goal is to ensure that we have a good designation and we are ready to deliver weapons. Once captured, the SNFO will direct the IP to execute a visual delivery. The snapshots in Figure 5-52 below show the A/G radar at various ranges along the attack.



Range to target = 21 NM



Range to target = 9 NM



Range to target = 6 NM

Figure 5-51 Approaching the Target

In the above series of Radar snapshots, the target is a dam at the south (left) end of a long skinny lake; you will not be able to see the dam on the radar and the lake does not break out until about 8 nm, but the two towns are visible on the 40 mile scope.

NLT 6 nm, complete your LATOMS-T checklist, set your displays and report to the IP:

a. SNFO (ICS) *"Master Arm to go."*

b. IP (ICS) "*Armed."*

c. SNFO (ICS) *"Flow XXX, [Target clock-code], low."* In this example, "*Flow 300, target one o'clock low.*"

d. IP (ICS) *"Tally Target."*

e. SNFO (ICS) *"Go Visual."*

At this point, IP will offset to intercept Roll-in-Point (RIP) and execute the dive delivery. SNFO is then responsible for standard dive delivery comms during the dive attack to include "RIP," "Mark," and "Pull" when required.

2. Level laydown

If conducting a level laydown, NLT 6 nm, complete your LATOMS-T checklist, set your displays and report to the IP:

a. SNFO (ICS) *"Master Arm to go."*

b. IP (ICS) "*Armed.*"

c. SNFO (ICS) *"Flow XXX, [Target clock-code], low."* In this example, "*Flow 275, target on the nose low.*"

d. SNFO (ICS) *"One away."* (at 3 nm.)

PGM level laydown is done in the OFT only. The A/G Expand modes, available in the OFT only, simulate a "zoomed in" picture of the target because they utilize Doppler shift to give a higher resolution or sharpened picture. Since the Doppler shift is negligible off the nose, there is a blind spot that is +/- 5 degrees off the nose where no expand mode picture can be created. Therefore, we execute an offset to allow for the higher resolution pictures to build. Figure 5-53 below shows the timeline.

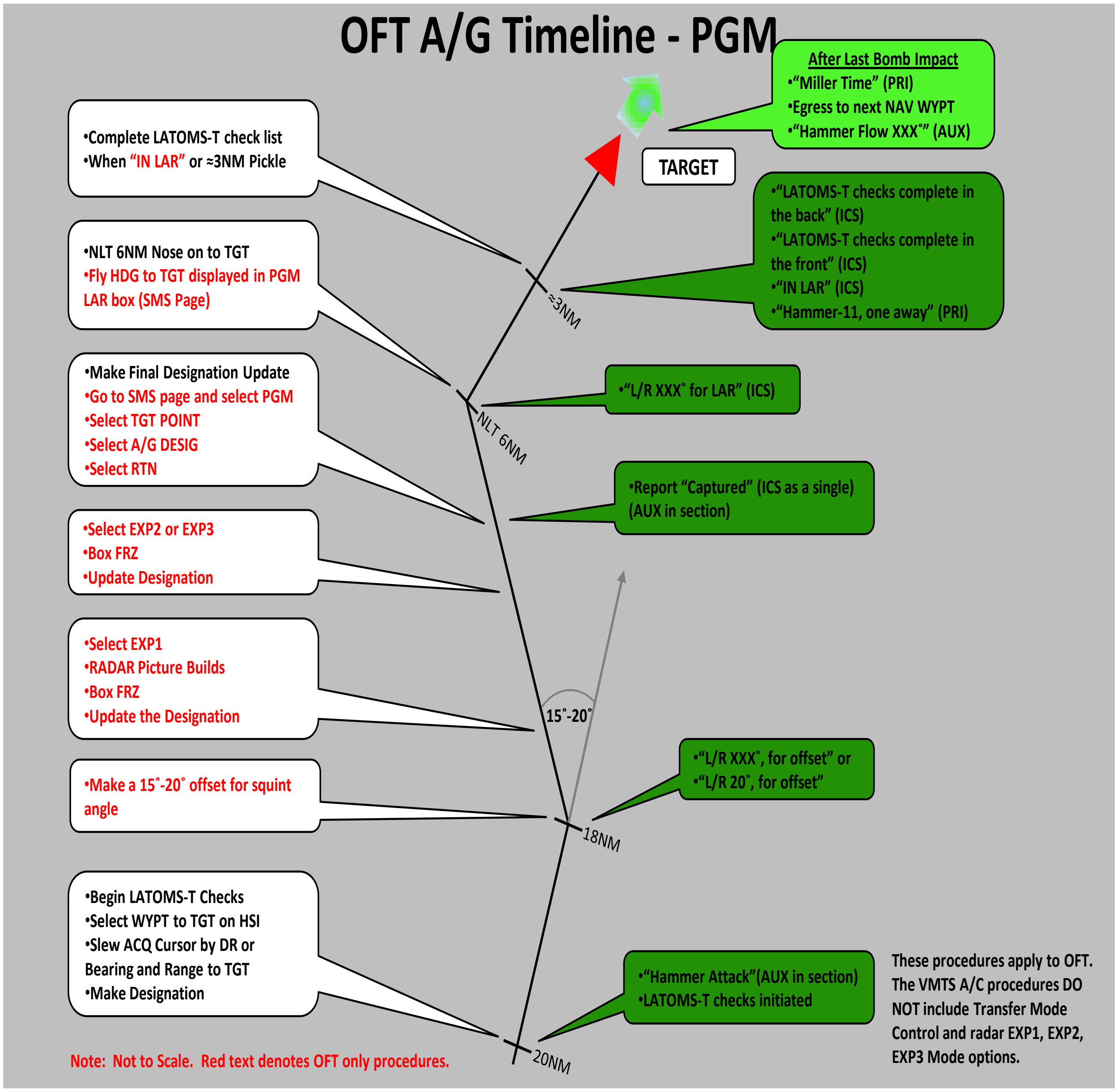


Figure 5-52 Basic PGM A/G Timeline (EXP Modes in OFT Only)

4. 25 - 20 nm

The SNFO will select the briefed target waypoint on the HSI and then perform the following:

a. In the OFT (Figure 5-54)

i. Transfer Mode Control (TMC) Switch - AFT

(a). Confirm LMFCD changes to SMS.

(b). Select A/G on SMS page, confirm A/G boxed (Figure 2-4 left).

(c). TMC Switch – AFT, confirm ADI/HUD on LMFCD.

(d). LMFCD – select HSI and note target WYPT bearing / range info (Figure 2-4 center).

ii. TMC Switch FWD

(a). Confirm RMFCD changes to A/G RDR (Figure 2-4 right).

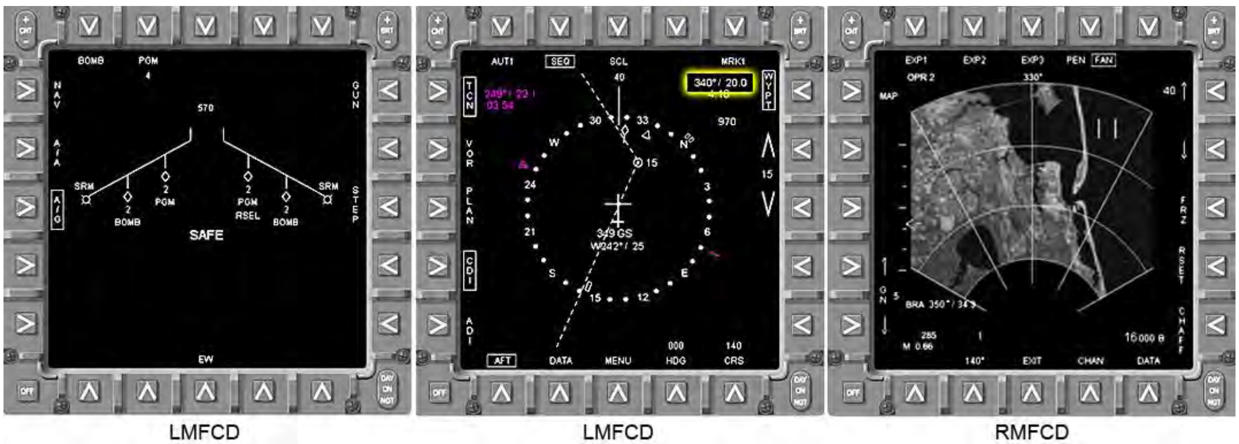


Figure 5-53 LMFCD and RMFCD Displays in OFT at 25-20 NM

5. 20 nm

SNFO will make attack call and perform the following on the RMFCD radar attack display (Figure 5-55):

a. Slew Acquisition (Acq) Cursor to BRA of waypoint based on HSI or SA page info

b. Full action trigger squeeze – Designating Cursor

c. Release trigger – Stabilized Cue (symbol is a cross in OFT, diamond in VMTS)

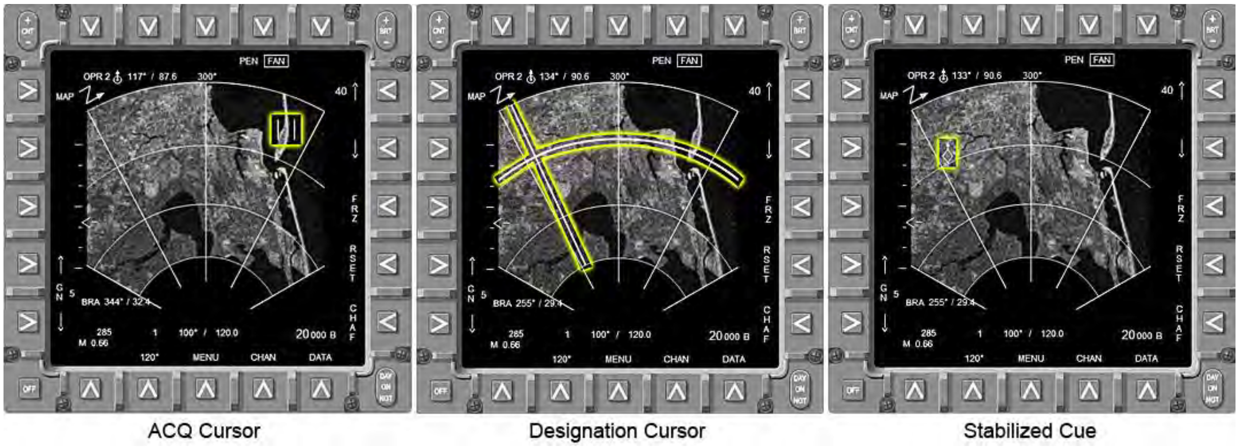


Figure 5-54 RMFCD Display in VMTS at 20 NM (OFT will show a cross)

6. 18 nm (OFT)

After the Stabilized Cue is designated at the appropriate BRA, the SNFO will select EXP 1 and do the following:

a. LMFCD – HSI or SA

b. SNFO call – *"L/R 10, for offset."* (By 18 nm)

i. This establishes an offset of 10 degrees.

ii. Offset used to take advantage of Doppler Beam Sharpening (increases fidelity of picture)

iii. If offset already established, no need for heading change.

c. RMFCD – A/G Attack Display, EXP 1 (Figure 5-56)

d. Let the Radar picture build (notice the runway in Figure 5-56, about one inch up and right of the designation).

The 18 nm procedures allow for 2 nm (20 seconds) to accomplish the aforementioned steps during an actual OFT event. As previously mentioned, the EXP modes are not available in the VMTS. For the VMTS, the SNFO will allow the picture to build while attempting to break out the target area.

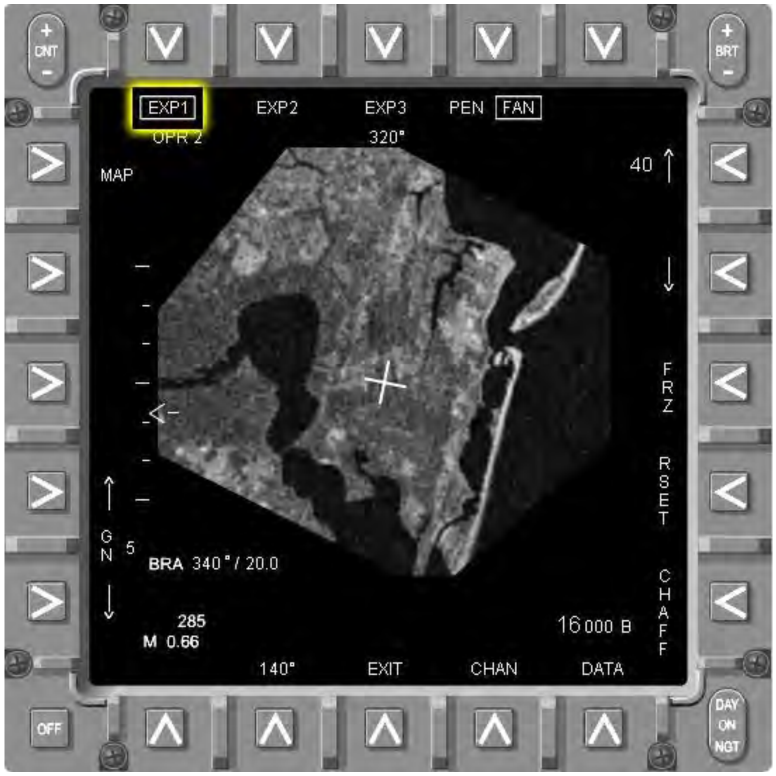


Figure 5-55 RMFCD Attack Display, EXP 1 After Offset

7. 18-12 nm

If the target location is positively identified in EXP 1, the SNFO can go directly to EXP 3. However, the following OFT (designation update) procedures are recommended for accuracy and procedural training (Figure 5-57):

a. RMFCD – Select FRZ in EXP 1 and ensure FRZ is boxed.

b. RMFCD – Full action trigger in frozen EXP 1 (Designation Cursor)

c. RMFCD – Slew designating cursor to refined TGT (EXP1 DC slews over frozen map)

d. RMFCD – Release Trigger (updated stabilized cue on frozen EXP 1 display)

e. RMFCD – Select EXP 2 and allow radar to build EXP 2 image.

f. LMFCD – Remains on HSI

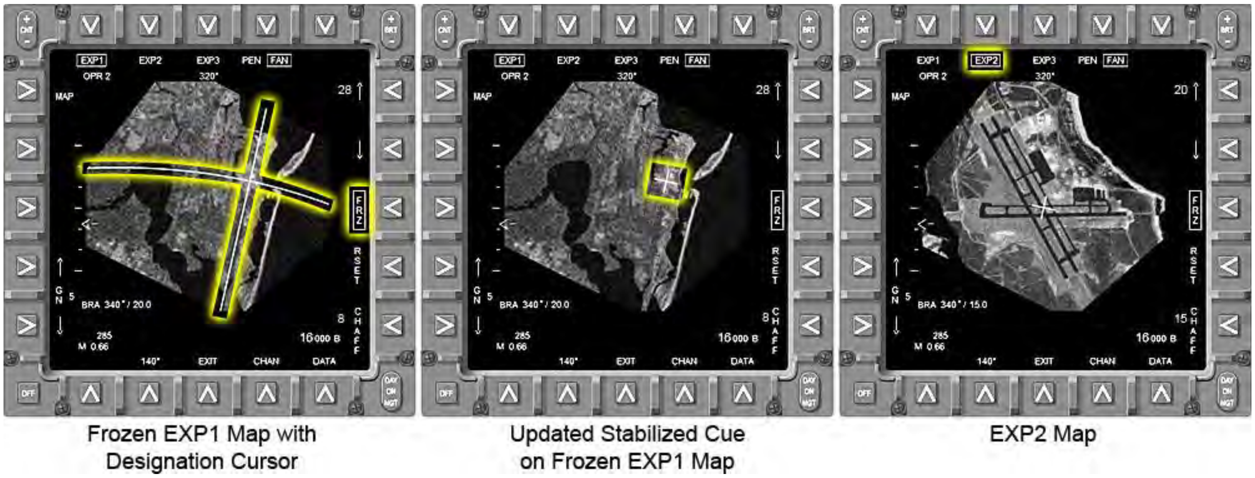


Figure 5-56 RMFCD Attack Display, FRZ EXP 2 18-12 NM

Once the EXP 2 picture is acceptable, the SNFO will accomplish the following designation update procedures in the OFT (Figure 5-57):

a. RMFCD – Select FRZ in EXP 2; ensure FRZ is boxed.

b. RMFCD – Full action trigger; and hold in frozen EXP 2 (RHC)

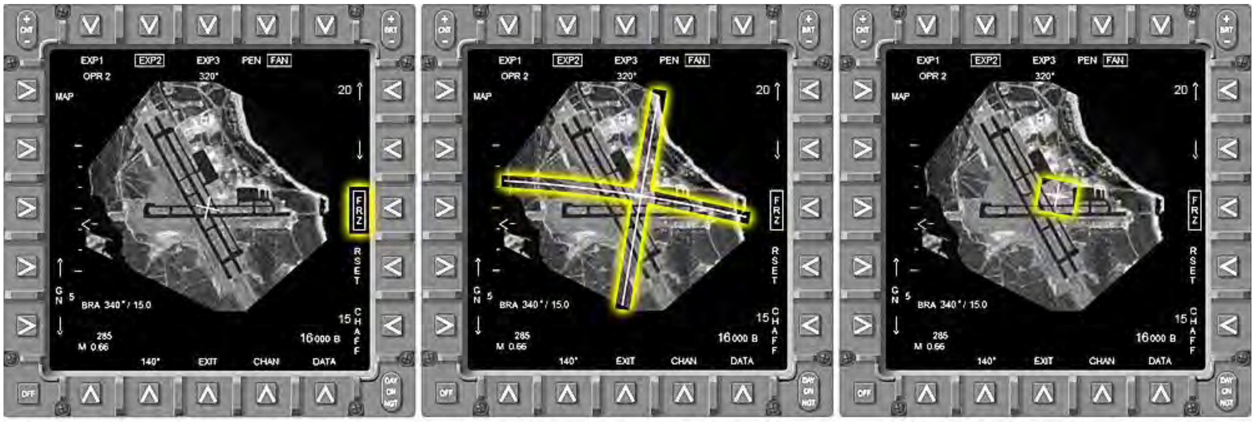
c. RMFCD – Slew designating cursor to refined TGT (DC)

d. RMFCD – Release Trigger (updated stabilized cue on frozen EXP 2 display)

   i. In Figure 5-58, note that the stabilized cue moved from the runway intersection to the refined TGT area.

e. RMFCD – Select EXP 3 and allow radar to build EXP 3 image which is now centered on new designation.

f. LMFCD – Remains on HSI



Frozen EXP2 Map with Stabilized Cue | Designation Cursor on Frozen EXP2 Map | Updated Stabilized Cue on Frozen EXP2 Map

Figure 5-57 RMFCD Attack Display, EXP 2 Slew 18-12 NM

8. NLT 6 nm

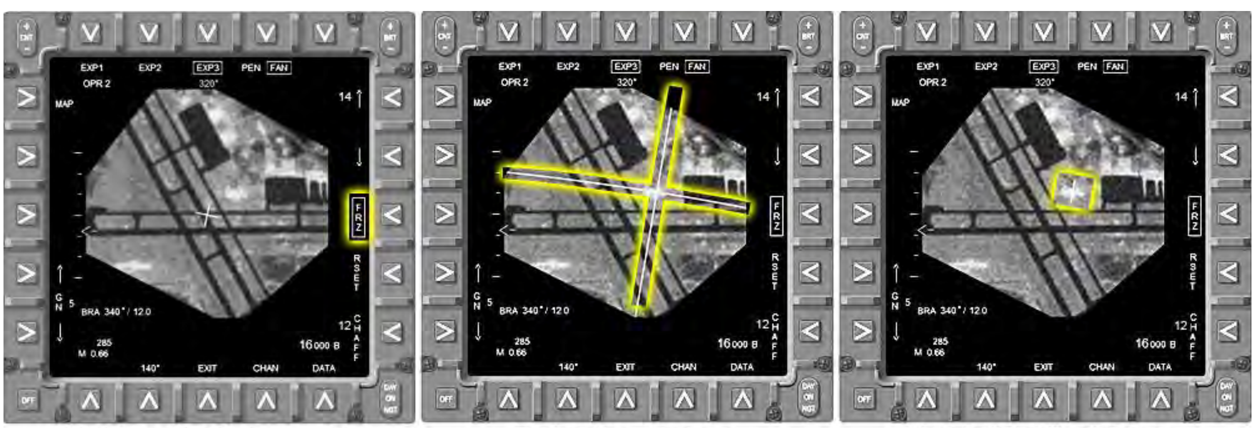
The final designation update will be made in the EXP 3 image. Once the EXP 3 radar image is satisfactory, the SNFO will perform the following (Figure 5-59):

a. RMFCD – Select FRZ in EXP 3; ensure FRZ is boxed.

b. RMFCD – Full action trigger in frozen EXP 3 (Designating Cursor)

c. RMFCD – Slew designating cursor to TGT (EXP3 DC slews over frozen map)

d. RMFCD – Release Trigger (updated stabilized cue on frozen EXP 3 display)



EXP3 Map with Stabilized Cue from EXP2 Update | Designation Cursor on Frozen EXP3 Map | Updated Stabilized Cue on Frozen EXP3 Map

Figure 5-58 RMFCD Attack Display, New EXP 3 Cue NLT 6 NM

Adhere to the timeline and repeat this radar designation procedure until the radar image is sufficiently refined to identify the TGT. This should be accomplished NLT 12 nm. Once the TGT is identified, Box FRZ and slew the Designating cursor to the TGT and proceed with the TGT attack.

NOTE

> In OFT or VMTS: If the Designation cursor is commanded and slewed to a new position before boxing FRZ, the radar will automatically rebuild the radar image when the trigger is released; the previous image will be lost.

Approaching 6 nm from the target, one of two delivery types will be executed: Level PGM or Radar to Visual Handoff.

508. LEVEL PGM TARGET OF OPPORTUNITY (TOO) DELIVERY

1. 12 - 10 nm (PGM)

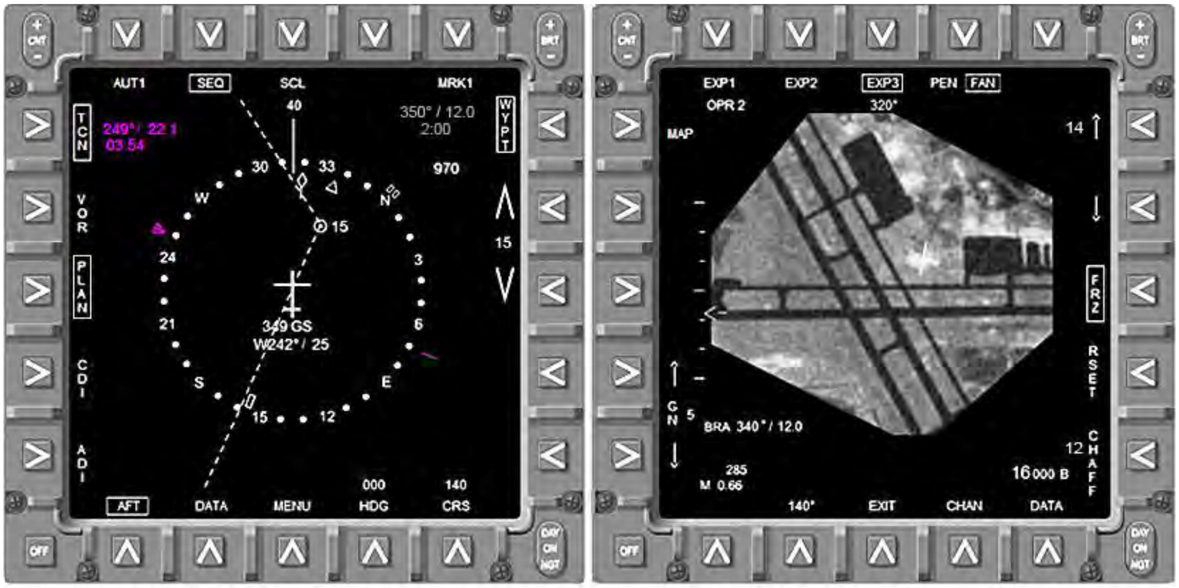
This is a Level PGM delivery with a Target of Opportunity (TOO) designation. In this case, a TOO designation refers to radar designation coordinates that are transferred into the system for PGM delivery. A Pre-Planned PGM delivery uses pre-flight target coordinates (waypoint) that are already loaded into the system.

At the 12 nm point, the final TGT designation should be complete with a frozen image on EXP 3 (Figure 5-60). The SNFO will make the following call and ensure proper MFCD selections:

a. SNFO (Aux/ICS) "*Captured.*"

i. LMFCD – HSI with steering to TGT WYPT

ii. RMFCD – Exp 3 Map with stabilized cue on TGT



HSI with Steering to TGT WYPT Stabilized Cue on Frozen EXP3 Map

Figure 5-59 HSI Steering to TGT WYPT/Stabilized Cue EXP 3

Once captured, the SNFO will then perform the Precision Guided Munitions (PGM) selection and TGT point display entry procedures (Figure 5-61):

a. Transfer Mode Control switch – AFT

   i. LMFCD –SMS page

   ii. RMFCD – Maintain EXP 3 with captured designation.

b. LMFCD – Select PGM on SMS page.

c. LMFCD – If applicable, use STEP to select preferred weapon station (STA 5 in this example).

d. LMFCD – Select TGT Point on SMS page.

e. LMFCD – SMS PGM TGT Display

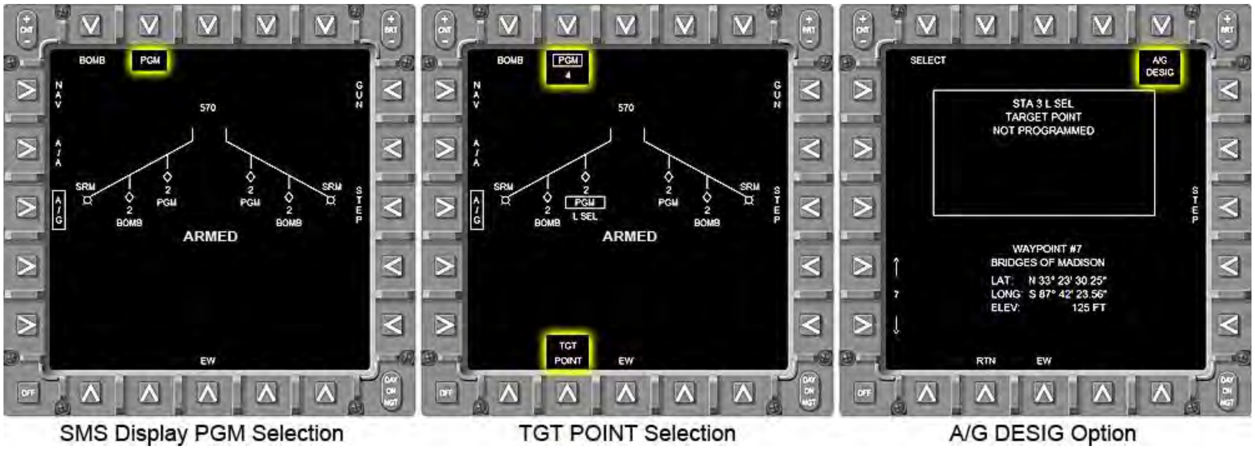


Figure 5-60 PGM, TGT Point, A/G DESIG Selection 12-10 NM

At this point, the SNFO will transfer the radar designation to the PGM utilizing the following procedures:

a. LMFCD – Select A/G DESIG; this transfers the radar designation location information to the selected PGM.

b. LMFCD – Select TGT Point again to return to SMS display.

c. LMFCD – Confirm PGM Launch and Release (LAR) info is displayed on the SMS page (Figure 5-62).

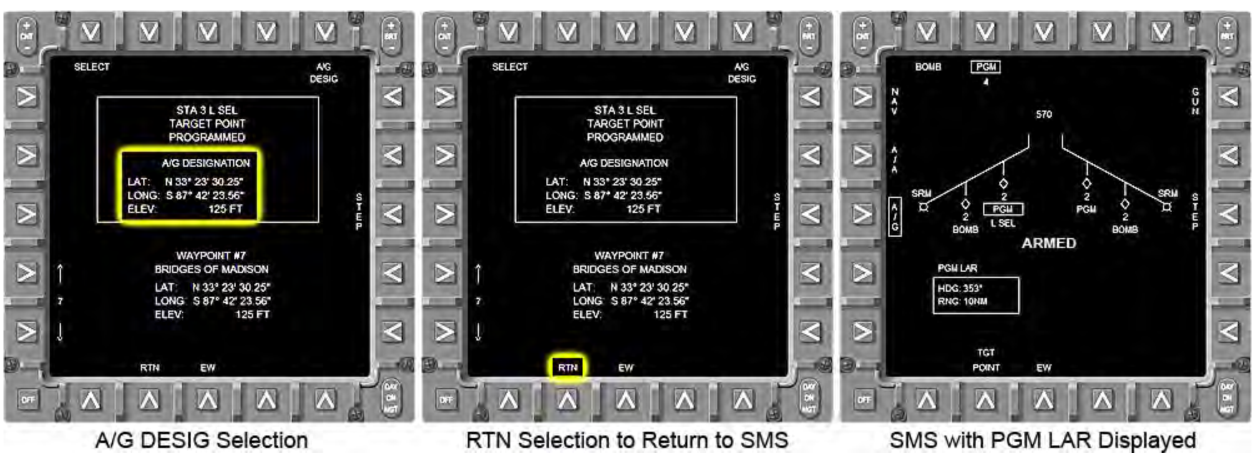


Figure 5-61 A/G DESIG selection, RTN to SMS, PGM LAR 12-10 NM

NOTE

For a Pre-Planned (PP) mission, use the arrows to choose the pre-planned waypoint target and then press SELECT. This will transfer the waypoint coordinates into the selected PGM.

When LAR is confirmed on the SMS page, execute the following:

a. RMFCD – Select MAP; attack display goes from EXP 3 with designation to A/G MAP display with designation (Figure 5-63).

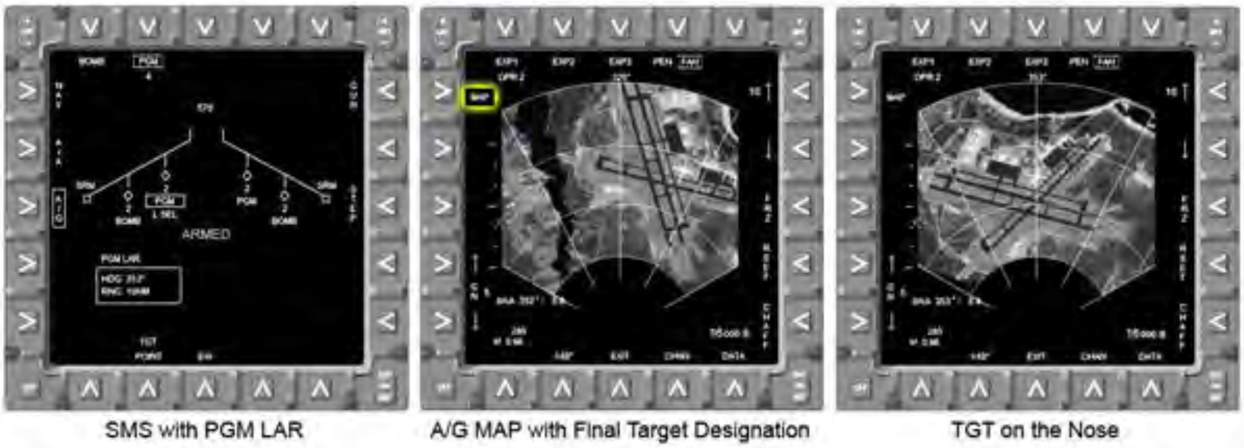


Figure 5-62 RMFCD Display MAP With Designation NLT 6 NM

2. NLT 6 nm - Delivery

Once the radar designation has been refined to the actual TGT and transferred to the PGM, the cockpit displays and aircraft must be properly set up for weapon delivery (Figure 5-64). NLT 6 nm, the aircraft must turn to put the target on the nose. The SNFO will make the call:

a. SNFO (Aux/ICS) *"Hammer flow XXX for LAR."* In this case, *"Hammer flow 353 for LAR."*

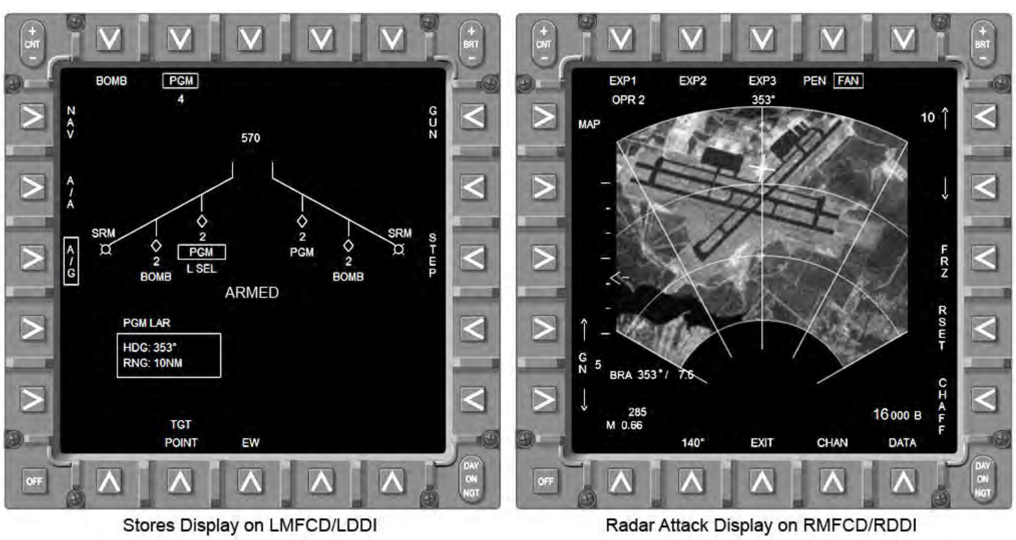


Figure 5-63 Displays set for TOO, PGM Delivery

The SNFO will confirm LATOMS-T checks complete, and confirm the following for the PGM delivery:

a. Target Designated

b. PGM selected

c. PGM LAR is displayed on LMFCD

d. Master Arm – ARMED

At 3 nm with the target in LAR (3 nm – 1.5 nm):

a. SNFO (Aux/ICS) *"In LAR."*

   i. Release (pickle) the Weapon via the A/G Weapon Release button NLT 1.5 nm

b. SNFO (Pri) *"Hammer-11, one away."*

Egress Actions:

a. TMC Aft once to command LMFCD to ADI/HUD

b. TMC Forward to command RMFCD to HSI

c. Select ADI/HUD page on the LMFCD

d. Egress from target area while scanning for Surface to Air threats

509. LOW ALTITUDE POP ATTACKS

During the low level attack flights, a minimum of two pre-planned target attacks will be executed on each low-level. The Lead SNFO will direct the section to commit to the A/G mode at a pre-planned ATTACK point through a directive "ATTACK" call on Tac Freq. This call will be acknowledged by the Wing SNFO with a "callsign" call. Students will then ensure that the A/G combat checks are completed, thus switching the section from a simulated A/A sanitization game plan to the A/G mindset for target prosecution.

The factors used to derive the Attack Commit Point are quite complex and well beyond the scope of this syllabus. Therefore, the Attack Commit Point in VT-86 will be 20 nm from the first target on the route (or as briefed). On the VR1021, this point is 20 nm prior to PT C (approximately at the town of Citronelle). After the first attack, the SNFO will change back to NAV mode. For the final "road recce" portion of the low-level, Lead SNFO will again call "Attack" as the wing aircraft joins into a TAC wing position.

1. Air-to-Ground Checks (LATOMS-T)

At the Attack Commit Point, when directed by Lead to "ATTACK," each SNFO will conduct the A/G checks utilizing the LATOMS-T checklist:

a. L - LAW set for Delivery

b. A - A/G Delivery Mode: CCIP/MAN

c. T - Target Elevation entered

d. O - Ordnance: Bombs/GUN

e. M - Master Arm On

f. S - Symbology: No X's in the HUD

g. T - Target designation/point

As part of LATOMS-T checks, the SNFO will select the desired number of released ordnance on the A/G Stores display after selecting "Bomb."

2. Pop Attacks

During the flights, pop attacks will be introduced and practiced. Pop attacks enable an attacker to ingress to a target at low altitude and "Pop" to a higher altitude for a dive run. Pop attacks allow a section of T-45Cs to fly a planned low-level, utilize Pop diagrams and conduct 10-degree dive runs while operating within the limits of the low-level route structure. The crew will have a choice of four types of pop attacks:

a. Shift Pop Attack (same target)

b. Crossing Pop Attack (same target) [not done at VT-86]

c. Section Pop Attack (same target)

d. Mirror Pop Attack (different targets)

Regardless of which attack is executed, each aircraft in the section will execute its own Pop in accordance with the Pop Diagram depicted in Figure 5-65. At the appropriate distance from the target, the IP will initiate a 2-3 G wings level climb to 20-degrees nose high until the roll altitude. At this point, the IP will over-bank the aircraft and intercept the Pop diagram dive angle and attack parameters. The apex of the pop will be the pattern altitude as depicted on the top of the Pop diagram. As a reminder, the Pop diagram utilizes AGL altitudes; target elevation must be added to get the MSL altitudes used during the attack.

After the "*Action*" call and acknowledgment by the IPs, the Pop mechanics require both the IP and the SNFO to make certain calls:

a. IP (Aux) - *"Hammer-11/-12, Popping."*

b. IP (Aux) - *"Hammer-11/-12, In Dry."*

c. SNFO (ICS) - *"___ degrees, ___ Knots."* (once wings level in dive)

d. SNFO (ICS) - *"STBY, Mark….Pull."* (at planned release altitude; "*Pull*" call if no pull initiated)

e. IP Lead (Aux) - *"Hammer-11, Off safe."* (after release, climbing, master arm safe)

f. IP Wing (Aux) - *"Hammer-12, Off safe, visual."*

g. Lead SNFO (Aux) - *"Hammer-11, 1.8."* (fuel check)

h. Wing SNFO (Aux) - *"Hammer-12, 1.7."*

While the mandatory route communications are made on Pri frequency, the tactical comms are made on Aux. One additional call SNFOs are required to make is the "*Abort*" call. "*Abort*" is called any time the dive angle limitations are exceeded, or if any unsafe situation develops during the attack.

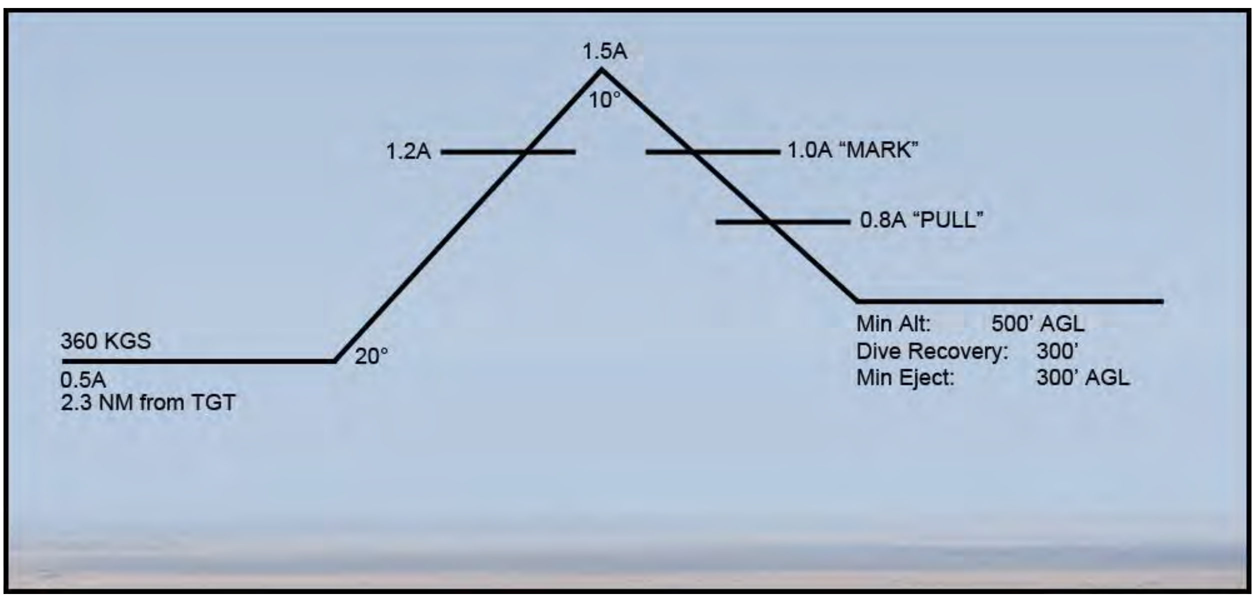


Figure 5-64 Pop Diagram, AGL Altitudes

3. Shift Attack

A Shift attack is a tactic that enables a section to create a distance and time separation between the two attacking aircraft in order to prosecute the same target. This has certain advantages and safety considerations that make it a viable and practiced tactic in the fleet. The separation between aircraft allows for fragmentation avoidance from the explosion of the first aircraft's attack. In the fleet, this separation is normally 30 seconds between aircraft due to fragmentation considerations for the wingman. This initial attack has the added benefit of identifying the target area for the second aircraft, and allowing for any corrections should the initial attack miss its intended target.

In VT-86, we will strive for 15-seconds of separation so the attack will begin at 7 nm from the pre-planned target. The attack will be initiated with an "*ACTION*" call from the Lead IP on Tac Freq . The Wing IP will acknowledge with "*Callsign*" and maneuver the aircraft to turn 90-degrees into the Lead's flight path. After rolling out of the turn, the wingman will wait 7 seconds before turning and pointing back in towards the intended target point.

Meanwhile, the lead aircraft will continue towards the target point and execute the pop attack at approximately 2.3 nm from the target (1.8 nm from VR-1021C waypoint) or as briefed. The Lead's attack shall be followed by the Wing's attack approximately 15 seconds (or 2-3 nm) behind the lead (Figure 5-66).

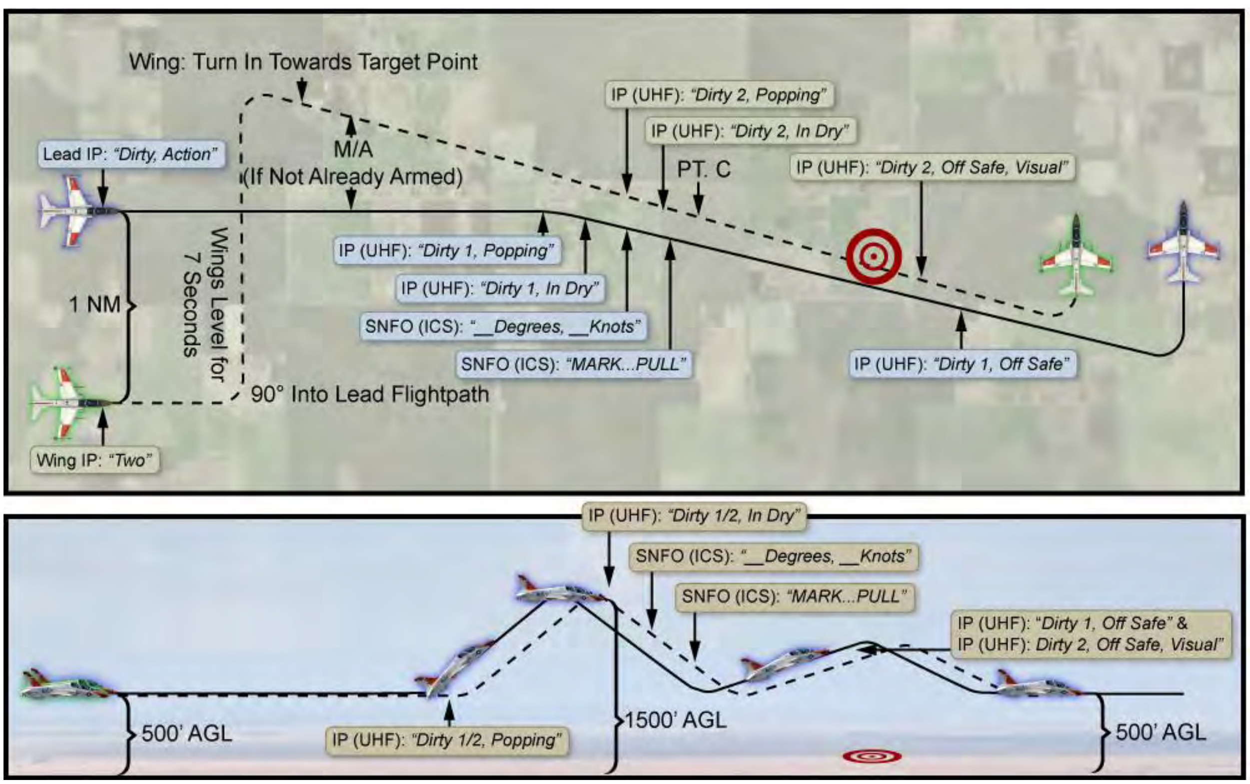


Figure 5-65 Shift Pop Attack Diagram

In the case of the VR1021, PT C represents the pre-planned target point. The target is a set of three blue water tanks located on a riverbed just south of PT C. At the "*Action*" call, the Lead will proceed to PT C while the Wing executes the shift maneuver. Since PT C is offset north of the targeted tanks, and the Lead is proceeding straight to PT C, the pop attack has a natural offset already built in.

Lead will execute the Pop by pulling straight up at 1.8 nm from PT C then executing a right hand roll-in towards the target. This will enable the crew to gain and maintain sight of the intended target as the pop is initiated and established in the attack dive angle. The Wingman will turn in and point back towards PT C in order to take advantage of the built in offset as well; Wing will also pop 1.8 nm from PT C. Once off target, Lead may extend upwind until the wingman calls "Off-Safe" in order to facilitate the wingman rejoin into combat spread. During the safe escape maneuver (pull off target) aircrew will experience approximately 4 G's.

4. Crossing Pop Attack

A crossing pop attack is a tactic that enables a section to conduct a coordinated two-plane attack on the same target (Figure 5-67). The section shall ingress at the planned low-level altitude in combat spread. Unlike the shift attack, the crossing attack does not have a delay or separation maneuver. Instead, the Lead SNFO will lead the section straight towards the target (bisecting the section to enable proper attack geometry) or the target reference point (referencing the relative position of the planned waypoint if not co-located with the target). At the appropriate distance (approximately 2.3 nm from the target), the Lead IP will initiate the maneuver with the "*Action*" call on Tac Freq .

Lead will then make a level turn away from the Wing for 30-degrees of heading change and initiate the Pop. Upon hearing the "*Action*" command, the wingman will acknowledge with a "*Callsign*" and mirror the lead's maneuvers in the opposite direction after a two-second delay. This delay is designed to keep the Lead forward of the wingman's wing-line and ensure section de-confliction.

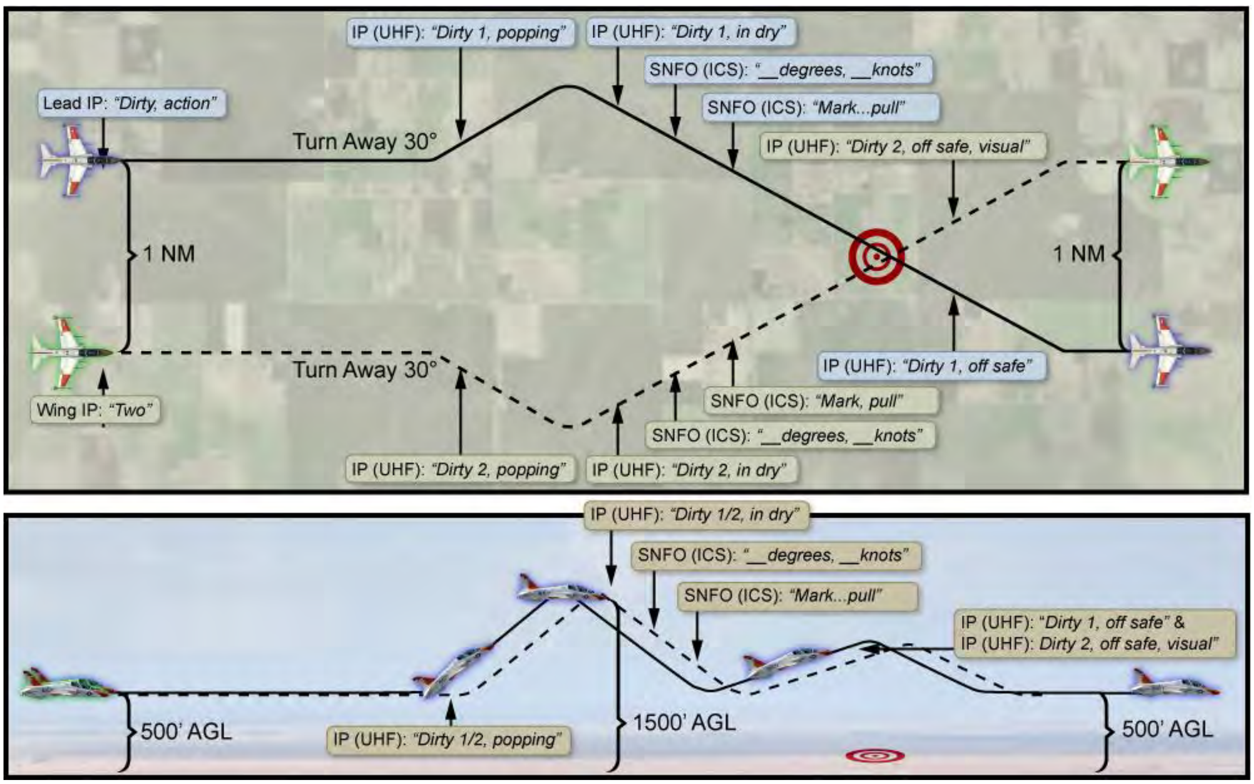


Figure 5-66 Crossing Pop Attack

5. Section Pop Attack

The section pop attack is a tactic that enables a section to conduct a coordinated two-plane attack on the same target from the same axis (Figure 5-68). The section pop attack will be executed from the TAC WING formation, with the wingman on the opposite side of Lead as the target.

Approaching the target, Lead SNFO will direct a heading toward an offset point, allowing for a straight ahead pop. This further allows the wingman to look through the Lead to acquire the target and maintain de-confliction. At a predetermined point, the Lead will execute the pop attack and the wingman, after a slight delay (for aircraft de-confliction), will execute an identical pop.

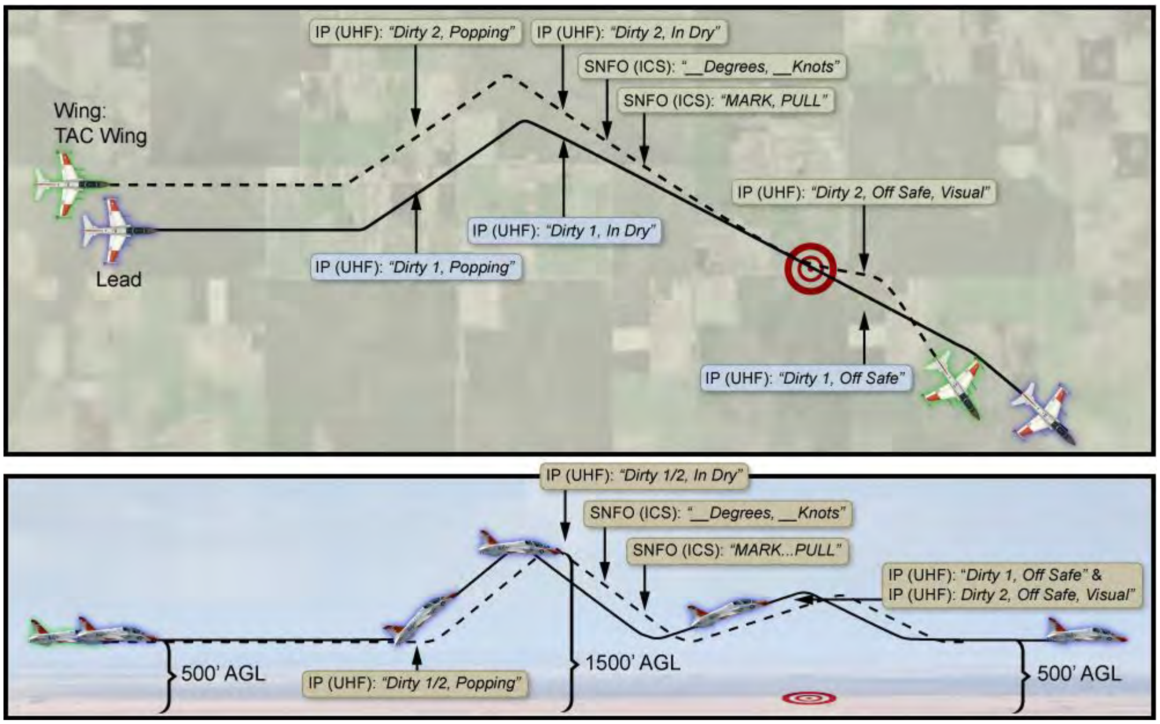


Figure 5-67 Section Same Side Pop Attack

The Pop diagram dive parameters and student attack comm procedures are identical to previously detailed pop attacks. The section pop attack will be utilized during the final target attack. At the completion of the final dive attacks, an off-target rendezvous will be executed. During the off-target rendezvous, the Wing SNFO is responsible for calling airspeeds; do not complete fence-out checks until the rendezvous is under control.

6. Mirror Pop Attacks

A mirror pop attack is a tactic that enables a section to conduct a simultaneous two-plane attack on two different targets in the same area, usually within 1-2 nm (Figure 5-69 and 5-70).

Figure 5-68 Mirror Attack; Two Targets, Same Area

The section will ingress at the planned low-level altitude, in combat spread, toward their assigned target. At the appropriate distance (approximately 2.3 nm from the target), the Lead IP will initiate the maneuver with the "Action" call on Tac Freq . The Lead and Wing will acknowledge and execute a turn away from each other for 30-degrees. The mirror pop attacks are then continued just like the crossing attacks, except that two distinct targets are prosecuted. Off the targets, the section will either be de-conflicted through target separation or may cross flight paths and continue on course. Aircraft de-confliction will be the responsibility of the Wingman.

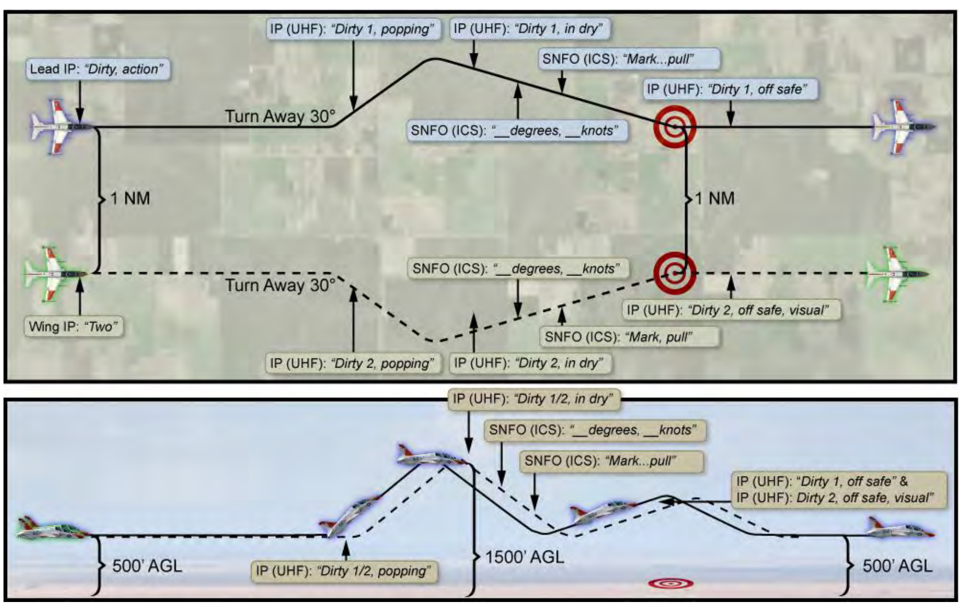


Figure 5-69 Mirror Pop Attack

THIS PAGE INTENTIONALLY LEFT BLANK

CHAPTER SIX
ELECTRONIC WARFARE

600. INTRODUCTION

Electronic Warfare (EW) refers to any military action involving the use of electromagnetic (EM) or directed energy (DE) to control the electromagnetic spectrum (EMS) or to attack the enemy. The purpose of EW is to deny the enemy the use or advantage of the EM spectrum while ensuring unimpeded access to the EM spectrum by friendly forces. EW can be applied from air, sea, land, and space by both manned and unmanned systems, and can target communications, radar, or other services dependent on the EMS.

With the advances in technologies, military operations are increasingly executed in an environment complicated by the EMS. The increasing portability and affordability of sophisticated EM equipment guarantees that the military's operational EM environment will become more complex in the future. The recognized need for military forces to have unimpeded access to, and use of, the EM environment creates both vulnerabilities and opportunities for EW. Naval Aviators must be well versed in all phases of EW if they are to be successful on today's battlefield.

601. ELECTROMAGNETIC SPECTRUM

Recall from Radar Theory that the term EMS refers to the range of frequencies of EM radiation from zero to infinity. The spectrum is divided into 26 bands ranging from radio frequencies at the low end to X-ray and gamma frequencies at the high end. Figure 6-1 graphically depicts the EMS.

In this figure, the top bar shows how the EM spectrum is divided into various regions and indicates the portion of the spectrum referred to as the Radio Spectrum. The lower bar illustrates the division of Federal, non-Federal, and shared bands for a critical part of the Radio Spectrum; the portion that is primarily used for communications. Also shown are selected military uses that would be impacted by reallocating the spectrum for competing uses. In other words, these are the bands that would directly impact or interfere with military operations. These are the bands that are of the most concern when discussing EW.

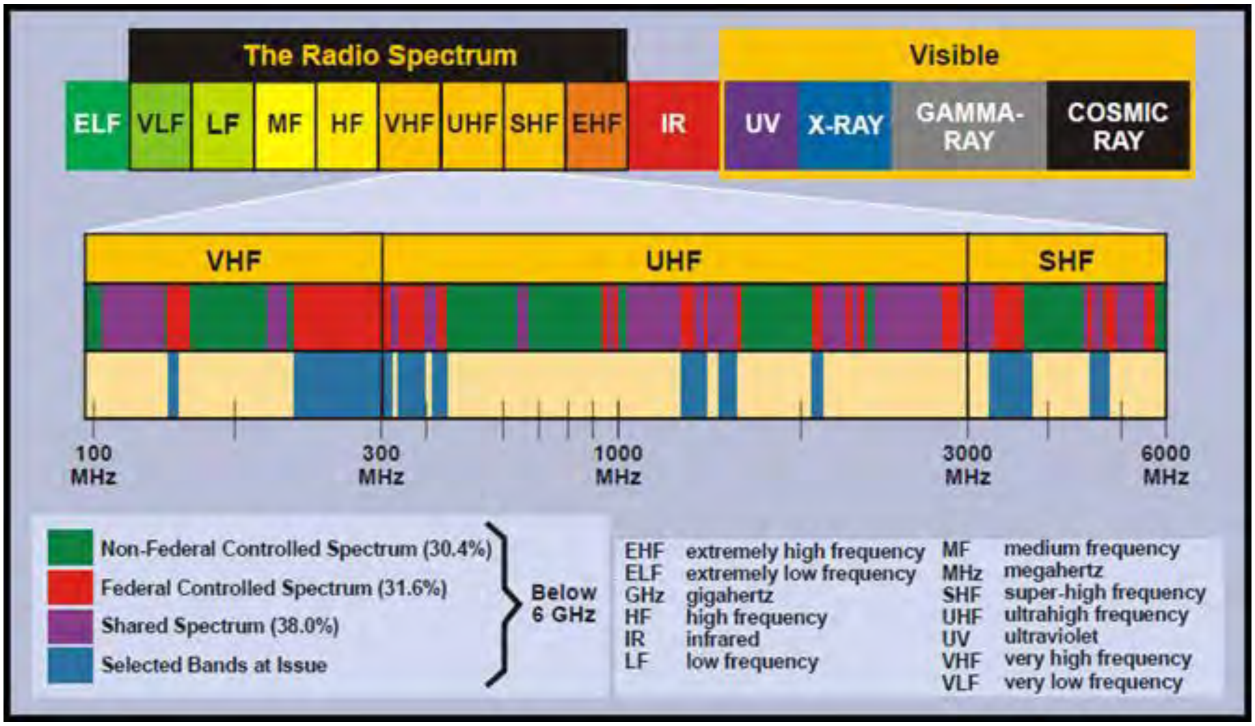


Figure 6-1 Electromagnetic Spectrum (EMS)

Because radar uses EM radiation to detect and track targets, it is important that we have control of that portion of the EM spectrum. Additionally, it would be quite advantageous to deny the enemy the use of the EM spectrum. The manner in which we ensure unimpeded access while denying our adversaries use of the EM spectrum is the focus of EW.

When discussing EW, it is important to have a working understanding of the terms associated with EM energy and the associated waveforms:

1. Wavelength

2. Frequency

3. Cycle

4. Amplitude

These terms have been defined in the Radar Theory FTI, but a review of their interrelationships is highlighted in Figure 6-2 and Figure 6-3. Recall that wavelength is directly proportional to cycle time and inversely proportional to frequency. A longer cycle time equates to a larger wavelength (Figure 6-2) but a lower frequency. As frequency increases, both wavelength and cycle decrease (Figure 6-3). One cycle per second is equal to one hertz.

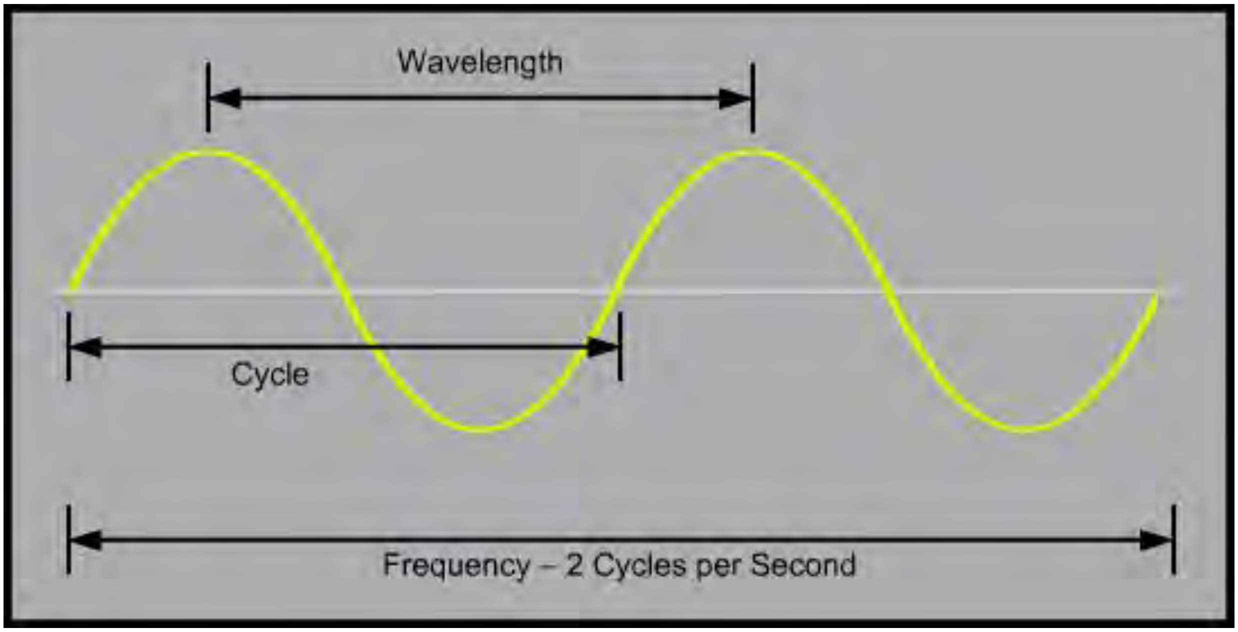


Figure 6-2 Waveform With Frequency of 2H

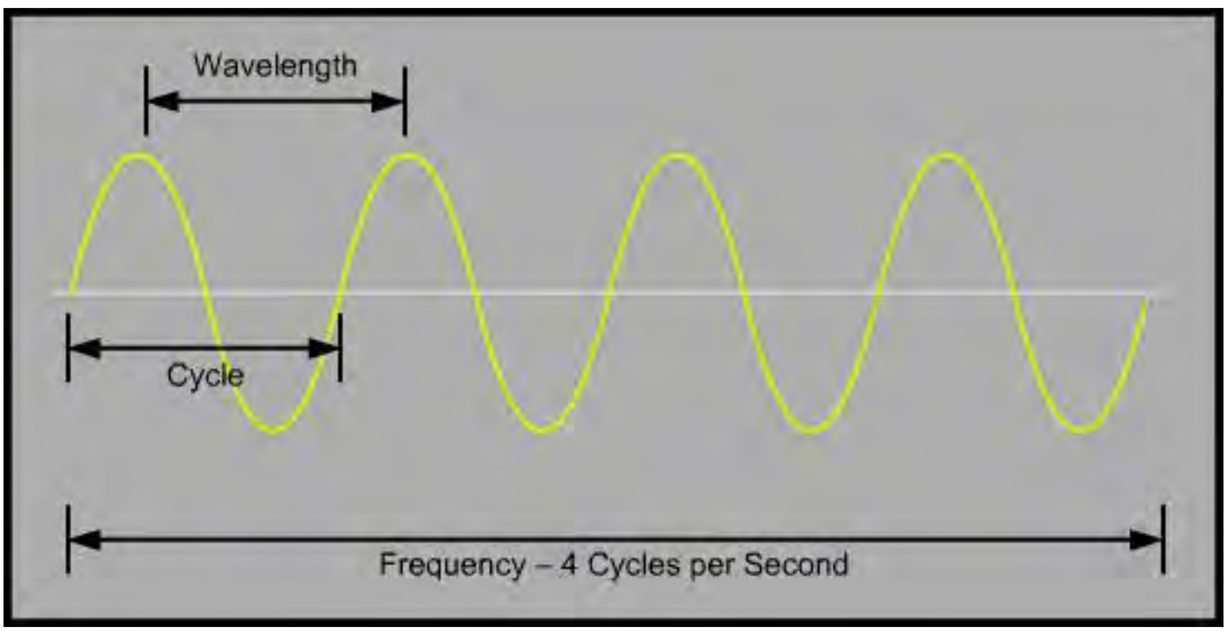


Figure 6-3 Waveform With Frequency of 4H

602. ELECTRONIC WARFARE COMPONENTS

EW is one of the five core capabilities of Information Operations (IO). It contributes to the success of military operations by using offensive and defensive tactics and techniques to shape, disrupt and exploit adversarial use of the EMS while at the same time protecting friendly freedom of action within the EMS. Military forces require unimpeded access to, and use of, the EM environment to properly execute the mission. This requirement creates vulnerabilities and opportunities for EW in support of military operations and objectives.

While control of the EMS through the application of EW is advantageous, when EW is not properly integrated and coordinated, it may adversely affect friendly forces. EW is employed to support military operations involving various levels of control, detection, denial, deception, disruption, degradation, protection and destruction. An overview of electronic warfare roles is depicted in Figure 6-4.

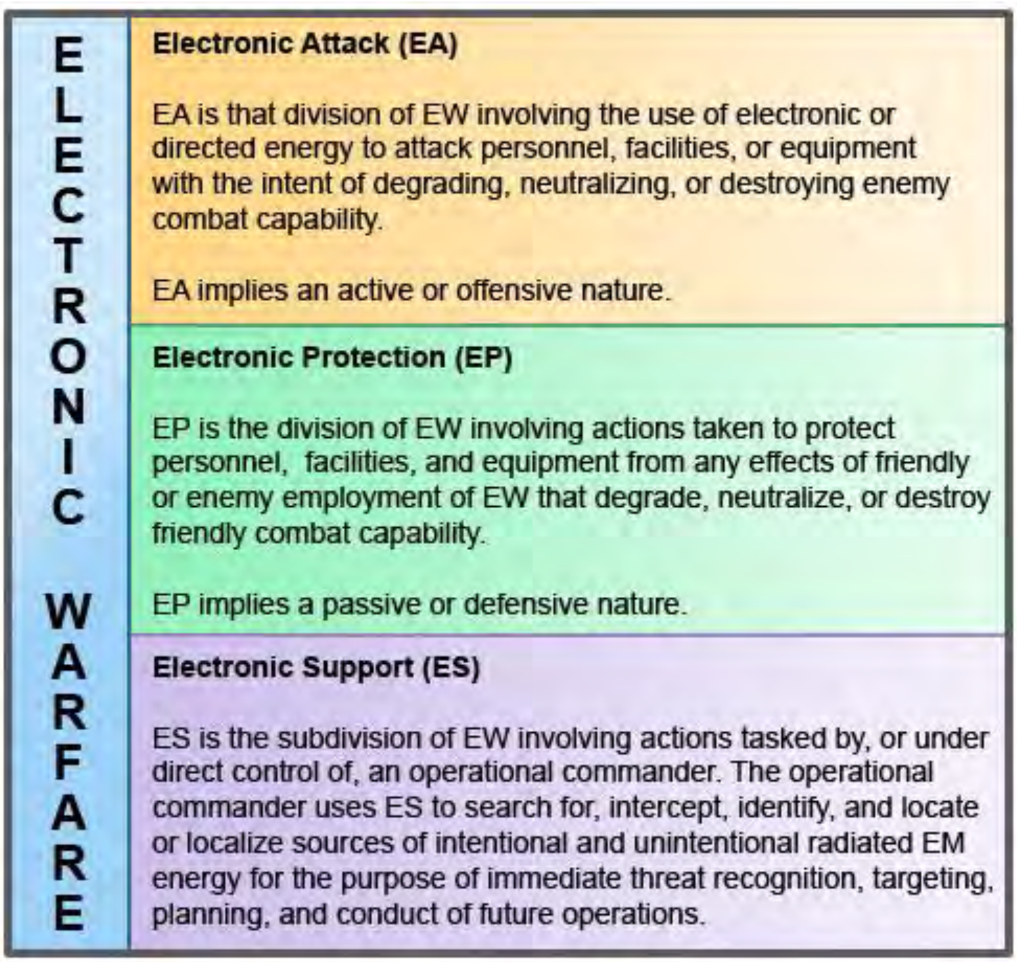


Figure 6-4 Electronic Warfare Roles

1. Subdivisions of EW

The principal EW activities have been developed over time to exploit the opportunities and vulnerabilities that are inherent in the physics of EM energy. Although new equipment and new tactics continue to be developed, the physics of EM energy remain constant. This physical constant is the reason basic activities of EW have remained effective despite changes in hardware and tactics. The principal activities used in EW include the following three major subdivisions:

a. Electronic Attack (EA)

b. Electronic Protection (EP)

c. EW Support (ES)

2. Electronic Attack (EA)

EA is the employment of EM energy, directed energy or anti-radiation weapons to attack personnel, facilities or equipment with the intent of degrading, neutralizing or destroying enemy combat capability. EA implies an active nature and is considered a form of fires in the joint theater. Various aspects of EA include:

a. Actions taken to prevent or reduce the enemy's effective use of the EMS, such as jamming and EM deception

b. The employment of weapons that use either EM or directed energy as their primary destructive mechanism:

i. Lasers

ii. RF weapons

iii. Particle beams

c. Both offensive and defensive activities to include countermeasures (CM)

i. Offensive EA activities are generally conducted at the initiative of friendly forces:

(a). Jamming an adversary's radar or command and control (C2) systems

(b). Using anti-radiation missiles to suppress an adversary's air defenses (c). Using electronic deception techniques to confuse an adversary's intelligence, surveillance, and reconnaissance (ISR) systems

(d) Using Directed Energy (DE) weapons to disable an adversary's equipment or capability

ii. Defensive EA activities use the EMS to protect personnel, facilities, capabilities and equipment. Defensive EA employs self-protection and force protection measures such as the use of:

(a). Expendables (e.g., flares, and active decoys)

(b). Jammers

(c). Towed decoys

(d). DE infrared (IR) CM systems

(e). Counter radio controlled improvised explosive device (RCIED) systems

d. Suppression of Enemy Air Defenses (SEAD)

SEAD is a specific type of mission intended to neutralize, destroy, or temporarily degrade surface-based opposition air defenses with destructive and/or disruptive means. These missions are of critical importance to the success of any operation when control of the air is contested by an adversary. SEAD relies on a variety of EW platforms to conduct ES and EA in its support. EW planners coordinate closely with joint and component air planners to ensure that EW support to SEAD missions is integrated into the overall battle plan.

SEAD missions have comprised nearly one-quarter of all combat sorties in recent conflicts. SEAD actions suppress enemy surface-based air defenses (surface-to-air missiles [SAMs] and anti-aircraft artillery [AAA]), primarily in the first hours of a large campaign, and also during follow-on attacks for specific targets. The weapons most often associated with this mission are anti-radiation missiles (ARMs), such as the American AGM-88 HARM and British ALARM. However, other weapons used for SEAD missions include anything that damages or destroys a component of an air defense system. A Paveway LGB, for example, is not a SEAD-specific munition, but when used to destroy a radar antenna, it achieves the objective of SEAD.

Possibly the most effective type of unguided ("dumb") weapons used during SEAD strikes are cluster bombs. Many SAM sites are dispersed over a fairly wide area in order to increase the difficulty of inflicting serious damage on the entire battery. Due to the dispersed fragmentation of cluster bombs and the relative "softness" of the targets (missile launchers, exposed radars, etc.), cluster munitions are very effective. The Mk-20 Rockeye II anti-armor cluster munition and the CBU-87 general-purpose cluster munition are often used against these fixed-location SAM sites. This is most often accomplished for "clean-up" of a site whose radar or command and control facilities are first destroyed by a longer-range ARM or AGM. The relatively new

American AGM-154 Joint Standoff Weapon (JSOW) is a valuable SEAD weapon due to its fairly long stand-off range. JSOW allows a launching aircraft to avoid being threatened by most SAMs, and it has a relatively large area of destruction against soft targets.

The primary USAF SEAD aircraft is the F-16 Fighting Falcon, which is a multi-role aircraft configurable for a variety of ground strike missions including SEAD. The Air Force and Navy's emphasis on multi-role strike aircraft has largely made specified SEAD variants obsolete; virtually any aircraft in the U.S. arsenal designed to carry air-to-ground ordnance can, if needed, be configured for SEAD. The F/A-18 Super Hornet, F-15E Strike Eagle, AV-8B Harrier and A-10 Thunderbolt II are common secondary choices for SEAD missions depending on availability and mission requirements.

e. Directed Energy (DE) Weapons

DE is an umbrella term covering technologies that produce a beam of highly concentrated EM energy or atomic/subatomic particles. DE weapons emits energy in an aimed direction without the means of a projectile. The weapon transfers energy to a target, the effects of which may be lethal or non-lethal depending on the intent. Military action involving the use of DE weapons, devices or countermeasures is known as DE warfare.

DE weapons fall into three categories:

i. Laser weapons

ii. RF weapons

iii. Particle beam weapons

iv. Laser Weapons

Laser weapons use EM radiation to deliver heat, mechanical or electrical energy to a target. The primary destructive force in laser weapons is the mechanical shear caused by the reaction when the target’s surface is explosively evaporated. A 1-megajoule laser pulse delivers approximately the same energy as 200-grams of high explosive and has essentially the same effect on the target. Recent advances in technology have resulted in lasers that are powerful enough to destroy targets at long ranges, including missiles and aircraft.

f. RF Weapons

RF weapons are primarily used against electronic equipment, but some variants can be used against personnel. These weapons use high-intensity radio waves on specific frequencies to affect the target. When used against equipment, RF weapons can operate similarly to omnidirectional EM pulse (EMP) devices by inducing destructive voltages within the electronic components and wiring. Unlike EMPs however, RF weapons can be focused on a specific target.

When used against personnel, RF weapons can cause a wide range of effects including confusion, anxiety and extreme drowsiness. Raytheon's Active Denial System (ADS) can cause dramatic effects such as an intense burning sensation. Pictured in Figure 6-7, this device can be mounted on a small armored vehicle such as a Humvee. At ranges of approximately 500 yards, it can make personnel feel as if their skin temperature is 130°F.

Figure 6-5 Active Denial System

g. Particle Beam Weapons

Unlike other DE weapons, particle beam weapons do not use EM energy. Rather, they use atomic or subatomic particles that have been accelerated to velocities approaching the speed of light. The particles are focused into a high energy beam resulting in significant destructive power. These subatomic particles can be either neutral or charged particles. Particle beams tend to travel much slower than EM weapon beams, because the particle beam has mass. Larger particles and denser beams produce more destructive power than smaller (subatomic) particle beams. However, the tradeoff is speed of propagation due to the larger mass and higher density.

h. Fleet Aircraft

Within the Navy and Marine Corps, offensive EA is primarily accomplished with the following aircraft using jammers and AGM-88 HARM (Anti-radiation missile):

i. EA-18G Growler

ii. EA-6B Prowler

3. Electronic Protection

Electronic protection encompasses actions taken to protect personnel, facilities and equipment from any effects of the EMS that degrade, neutralize or destroy friendly combat capabilities. This includes all actions taken to ensure friendly use of the EMS such as:

a. Spectrum Management

b. EM hardening

c. Emission control (EMCON)

d. Radar wartime reserve modes (WARM)

In theater, the two primary EP actions are:

a. Frequency Agility – This action involves continuous changing of radiated frequencies to counter jamming by retuning the signal to the transmitter between radiated pulses. Hostile jammers are unable to predict these frequency changes and are, therefore, unable to effectively restrict friendly use of the EMS.

b. Variable PRF – This technique is used to counter gate stealing CMs. By altering the PRF of transmitted pulses, the enemy's ability to employ gate stealing techniques is compromised. Hostile jammers cannot transmit a return (false) echo at a predetermined time if the PRF is randomized.

EP should not be confused with self-protection EA. While both protect personnel, facilities and equipment, EP protects from the effects of EA. Self-protection EA protects against lethal attacks by denying the enemy the use of the EMS. For example:

a. The use of flares is considered self-protection EA.

b. The use of flare rejection logic on an IR missile (to counter an adversary's use of flares) is EP.

The flare rejection technique ensures friendly use of the EMS to track the intended target despite adversary self-protection EA actions (the flare) to degrade friendly use of the EMS.

Again, EP protects from the effects of EA (friendly and/or adversary), while defensive EA is primarily used to deny adversaries the use of the EMS to guide and/or trigger weapons, thereby protecting friendly forces against lethal attacks.

4. Electronic Warfare Support (ES)

EW Support (ES) is the utilization of the EMS to search for, intercept, identify and/or locate sources of radiated EM energy. Electronic support measures (ESM) equipment searches the RF spectrum for emissions and analyze the results to exploit the weapons or sensors involved. ESM equipment receives and identifies emitters that are present in mission areas. Exploitation includes tactical early warning, identification for counter-weapon selection and recording to support future CM development.

ES is intended to respond to an immediate operational requirement. However, the same assets and resources that are tasked with ES can simultaneously collect intelligence that meets other collection requirements. Intelligence collected for ES purposes is normally also processed by the intelligence community for further exploitation after the operational commander's ES requirements are met. ES that is not part of the intelligence process is often referred to as combat information. The distinction between intelligence and ES is determined by who tasks the assets, what the assets are tasked to provide, and for what purpose the assets are tasked. From an operational standpoint, the purposes for ES tasking include:

a. Immediate threat recognition

b. Planning and conduct of future operations

c. Threat avoidance

d. Targeting

e. Homing

The two primary forms of intelligence that most commonly utilize ES are signals intelligence (SIGINT) and electronic intelligence (ELINT). SIGINT refers to the tracking of enemy emitters, while ELINT refers to the collection and cataloging of data on known emitters in theater.

Both SIGINT and ELINT employ ESM equipment to gather intelligence. The ESM equipment is used to:

a. Detect enemy RF emissions

b. Measure key parameters

c. Identify emission sources

ES assets tasked or controlled by an operational commander include:

a. EP-3E Aries, which is the Navy's only land-based aircraft primarily designed to collect SIGINT

b. P-3C Orion, which is capable of performing SIGINT as a secondary mission

c. P-8A Poseidon, which is also capable of performing SIGINT as a secondary mission

Enemy emitters are located through triangulation using multiple bearing lines, in much the same manner as position fixing. A single aircraft tracking an emitter would take separate readings at fixed intervals, thus allowing the intersection to be determined (Figure 6-5). Alternatively, multiple platforms could take simultaneous bearing readings thereby triangulating the position of the emitter (Figure 6-6). Once an enemy emitter is located, it can be deceived, destroyed or avoided.

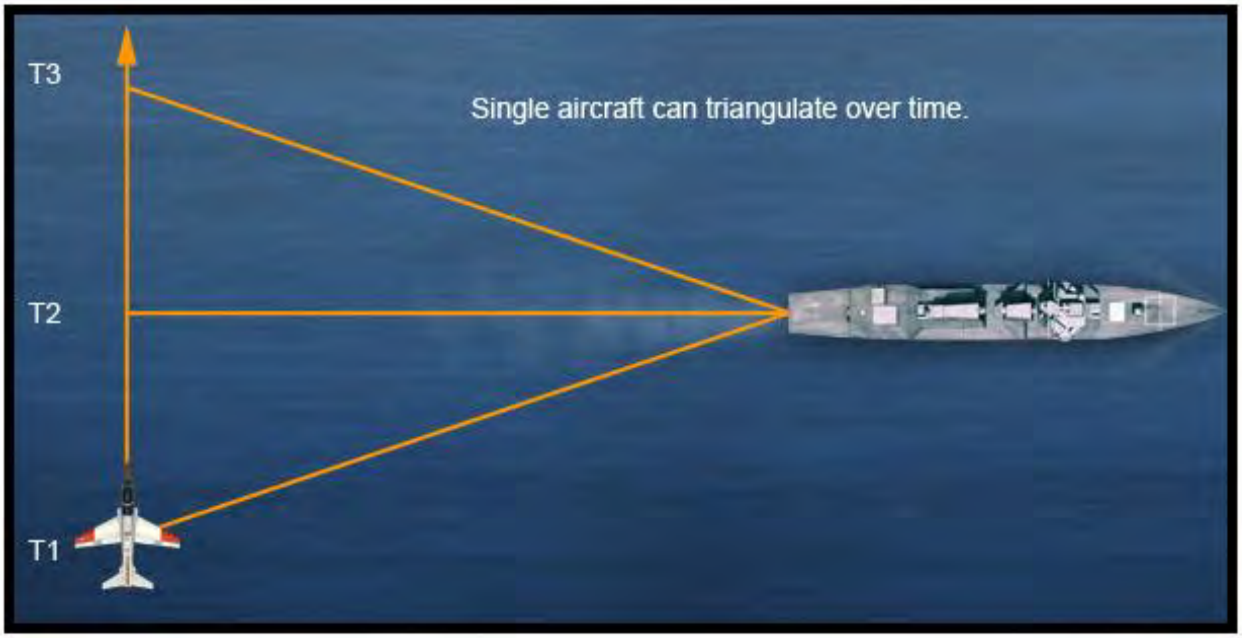


Figure 6-6 Single Platform Triangulation

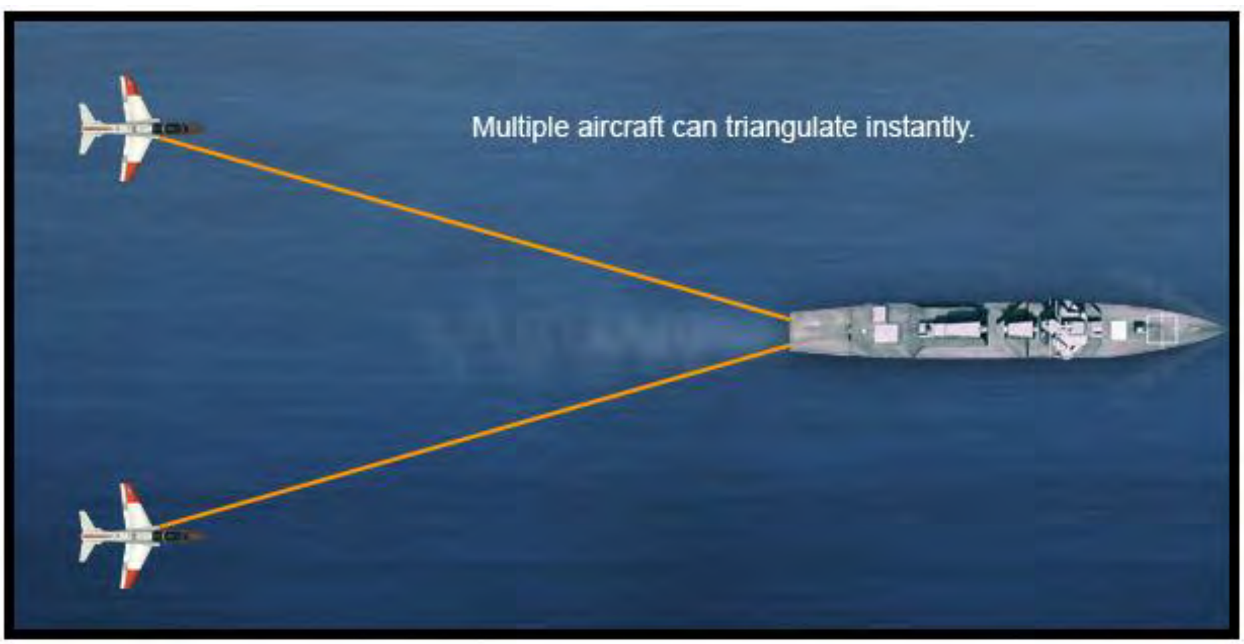


Figure 6-7 Multiple Platform Triangulation

603. DEFENSIVE COUNTERMEASURES

Defensive CM activities use the EMS to protect personnel, facilities, capabilities and equipment. Specifically, CM means the employment of devices and/or techniques to gain the objective of impairing the operational effectiveness of enemy activity. CMs can be active or passive, and can be deployed preemptively or reactively.

SAM avoidance CM activities include the use of expendables and jamming:

1. Expendable CMs

Expendable CMs are used to protect tactical aircraft during operational missions. These expendables include chaff, flares and decoys.

2. Chaff

Chaff is an expendable CM designed to confuse enemy radars. It consists of thin metallic fibers cut to various lengths, and is designed to resonate at the radar frequency. Thousands of these fibers are compressed into small packages (Figure 6-8). When dispensed into the aircraft slipstream, the chaff packages burst open and the fibers scatter to form a radar reflective cloud. This “cloud” creates a secondary target on radar screens.

Figure 6-8 Typical Chaff Canister

Each chaff package, dropped independently, can simulate an additional aircraft. A chaff curtain, consisting of thousands of false targets, can be dropped by a small number of aircraft. Such a curtain can confuse radars so that they are unable to locate the real targets within the chaff cloud. Chaff drops so slowly that it normally takes many hours to reach the ground.

Since the chaff particles have considerable aerodynamic drag, their forward velocity quickly drops to near zero. Because of its low velocity, chaff can be regarded as an airborne type of "clutter." Radars such as CW, pulse Doppler and MTI (Moving Target Indicator) that can reject clutter are not seriously affected by chaff. Thus, they can continue to track a target within a chaff cloud as long as the target has a radial component of velocity.

Nearly all tactical U.S. aircraft are outfitted with a chaff dispensing system. This system can deploy chaff at any altitude. The use of chaff is most effective when used in conjunction with aircraft maneuvering.

3. Flares

A flare is an infrared CM used to defeat an IR missile. The pyrotechnic composition of the flare is designed to lure the missile's IR seeker away from the targeted aircraft. The goal of the flare is to make the IR missile track the heat signature of the flare rather than the aircraft's engines. Several factors impact the effectiveness of flares:

a. The burning temperature of the flare must be equal to or greater than the engine exhaust temperature.

b. The flare must be launched on a trajectory that mimics the launch platform's path.

c. Multiple flares create the largest problem for the missile seeker.

A single, low temperature flare that was launched straight down would pose little problem for the flare rejection logic incorporated in modern missile seekers.

As with chaff dispensing systems, most modern tactical aircraft are equipped with flare dispensing systems. Some of these systems are automatic, while others require manual jettisoning of the flares. In addition to dispensing flares, aircrew must also take action to increase the likelihood of a successful decoy. When an IR missile is detected, flares should be jettisoned while the aircrew performs a hard turn away from the missile trajectory and simultaneously reduces engine power to reduce the exhaust temperature. Figure 6-9 shows an F/A-18C dispensing multiple flares.

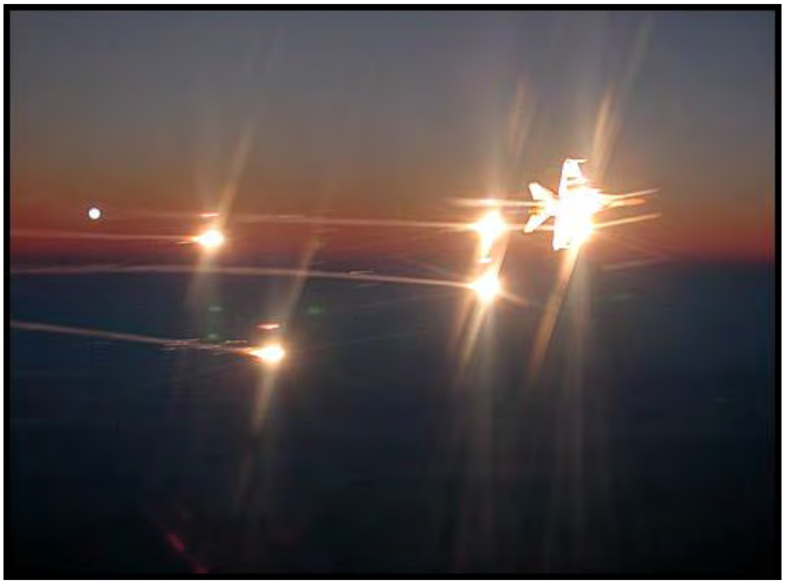


Figure 6-9 F/A-18C Dispensing Flares

4. Decoys

Decoys are used to lure a missile away from the targeted aircraft. These decoys can either be towed or launched. Typical decoys incorporate some form of radar enhancing technology that cover a range of frequencies and can, therefore, simulate any aircraft. To be most effective, decoys should be launched preemptively and in a direction away from friendly aircraft.

The Miniature Air-Launched Decoy (MALD) is a small, low-cost decoy missile used in the suppression of enemy air defenses. The MALD has several variants. The F/A-18 E/F will be fitted with the MALD-J. In addition to the active radar enhancers, the MALD-J incorporates a jamming capability.

5. Self-Protection Jammers

Radar jamming is the intentional emission of radio signals designed to impair the operation of radar by saturating the receiver with either noise or false information. Jamming can be offensive or defensive. The following are several generic types of jamming:

a. Noise jamming

b. False target generation

c. Gate stealing

d. Angle deception

The jammer detects the radar emissions of the hostile aircraft and compares the signal to a database. The jammer then transmits a return signal that jams the hostile radar.

6. Noise Jamming

Noise jamming is the simplest form of jamming and is highly effective. Noise jammers increase the background noise to a level that conceals all but the strongest radar returns. Figure 6-10 illustrates the relative signal return strength of a target versus jamming noise. In this example, the jamming signal exceeds the return signal strength by a magnitude of two, thus concealing the fighter.

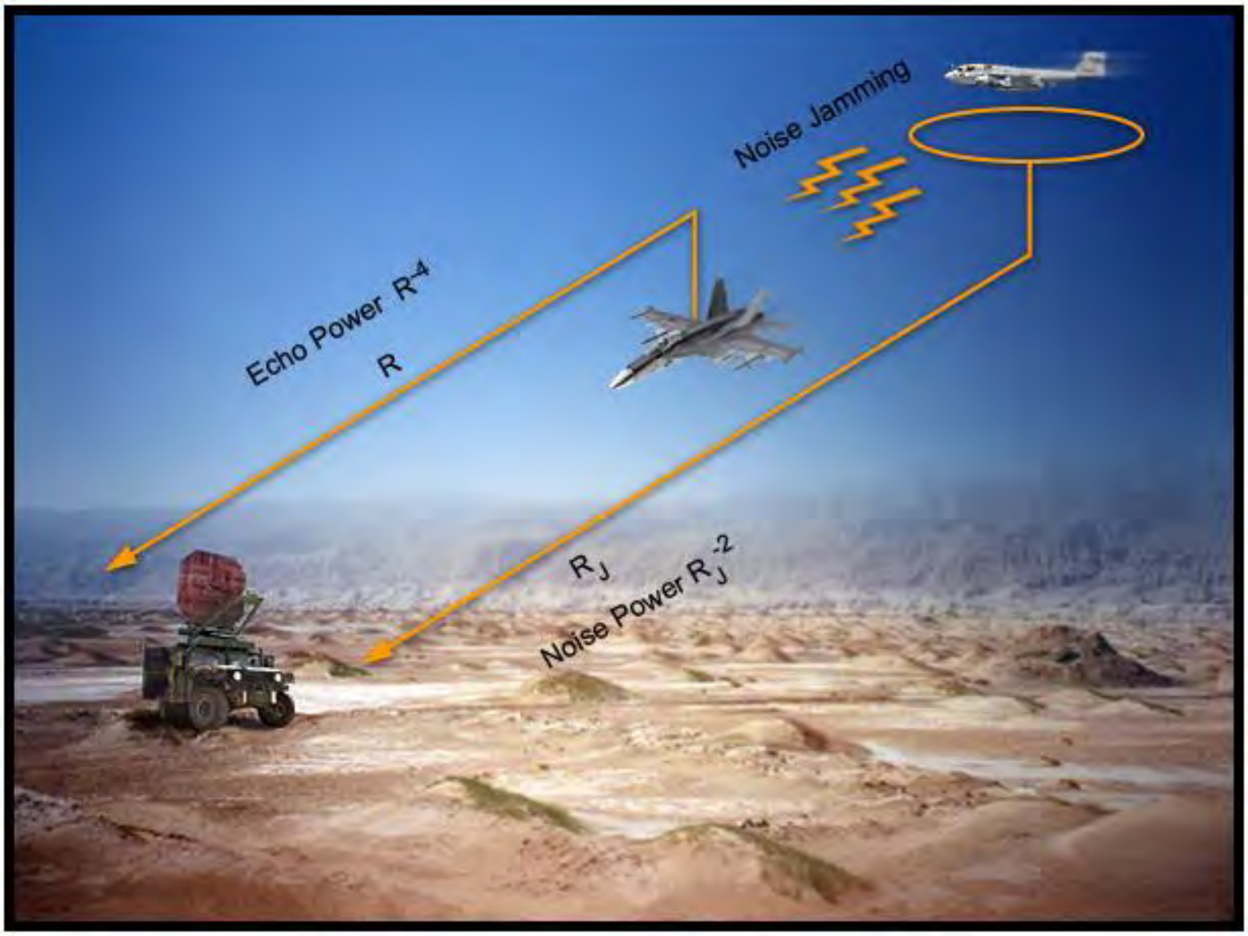


Figure 6-10 Noise Jamming

The two most common noise jammers are ***barrage jammers*,** which transmit high-power noise over a broad frequency spectrum, and ***spot jammers***, which transmit specific frequencies to target particular radar bands.

7. False Target Generation

As the name implies, false target generation entails the transmission of false targets to the hostile radar receiver, thereby deceiving the enemy radar. These deception jammers use transponders and repeaters to transmit several false targets with staggered Doppler frequencies. This form of jamming is very effective because the hostile radar will not necessarily recognize that it is being jammed. A simplified false target generator is shown in Figure 6-11. The transponder receives an RF pulse from a threat radar; the generator then inserts a delay that corresponds to the desired additional range of the false target. Following the delay, a false return is transmitted back to the enemy receiver, simulating additional targets. The end result is one or more false targets displayed on the enemy scope.

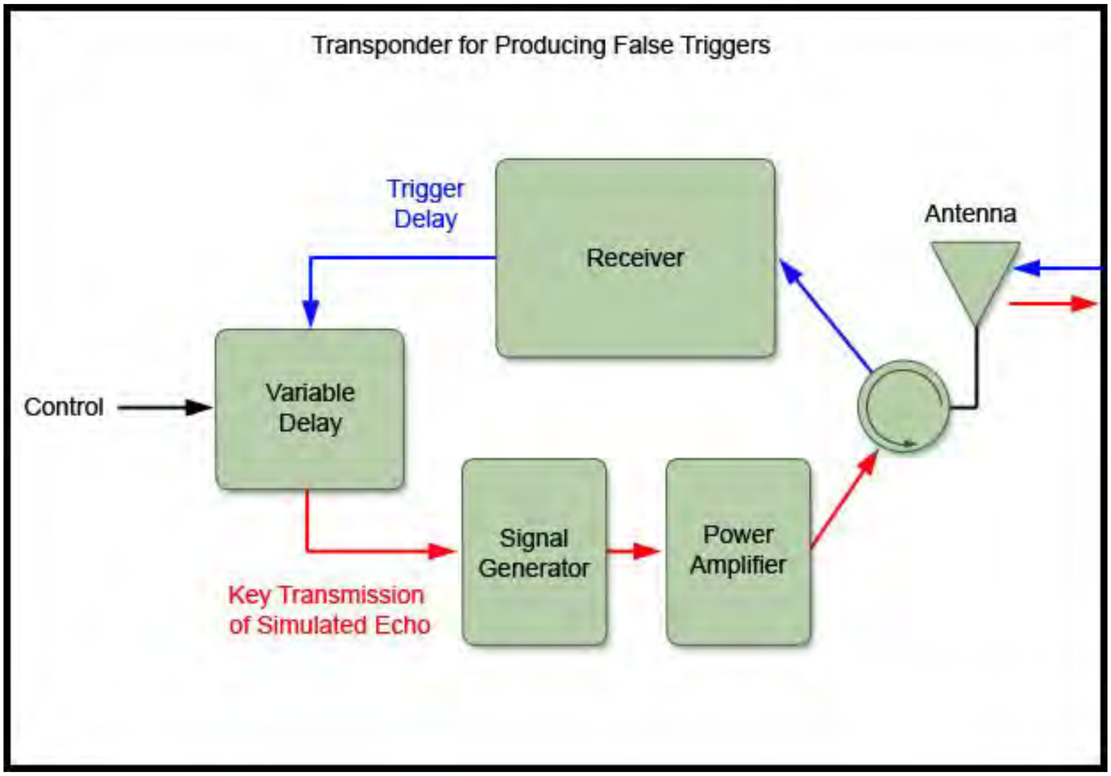


Figure 6-11 False Target Generator

By adding a repeater (Figure 6-12), a false target generation system can create more realistic false targets. The advantage of these types of jammers over noise jammers is the significantly lower power requirements since the repeater emits its energy in pulses similar to the radar pulses. The greatest disadvantage is the complex circuitry required for these systems.

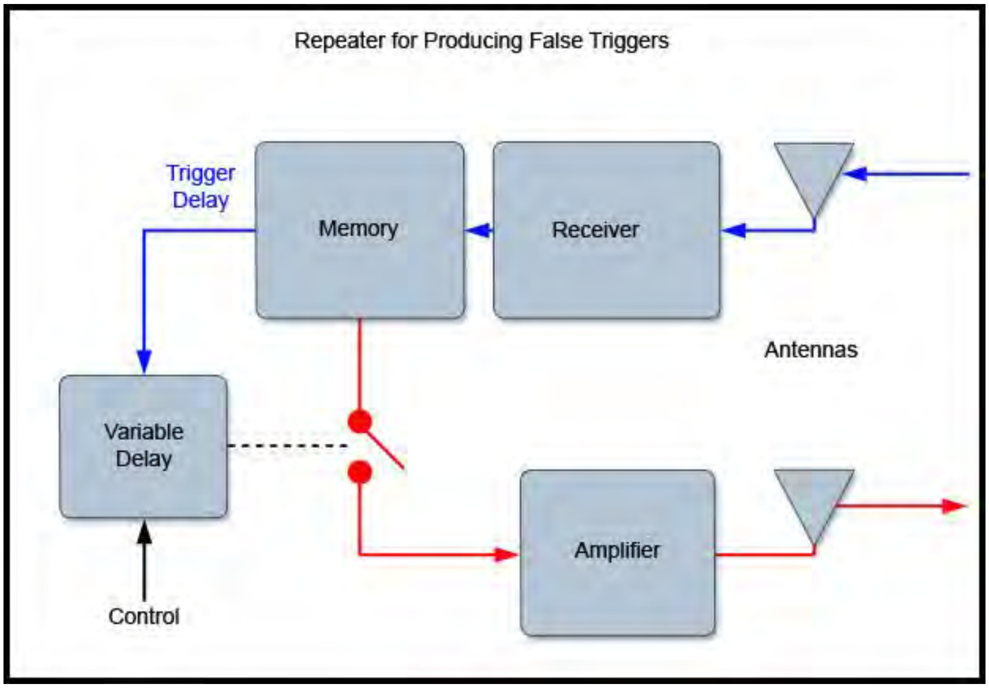


Figure 6-12 False Target Generator Repeater

8. Gate Stealing

As with false target generation, gate stealing is a form of jamming whereby false targets are created. However, in a gate stealing system, these false targets will have either changing ranges or changing velocities. Range gate stealing is typically used against automatic tracking radars operating at low and medium PRFs, while velocity gate stealing operates in the same manner as range gate stealing, but is typically used against high PRF or CW radars.

9. Angle Deception

While there are several forms of angle deception, one of the most common employs ***terrain bounce*** to defeat amplitude comparison monopulse tracking radars. These jammers are pulse repeaters that are carried by aircraft operating in the low altitude environment. The target jammer retransmits the received missile radar signal, directing it at the ground between the aircraft and the missile. Much like light reflecting off water, the retransmitted signal “bounces” off the terrain (Figure 6-14). The higher amplitude of this redirected return overpowers the actual return causing the inbound missile to home in on the false return.

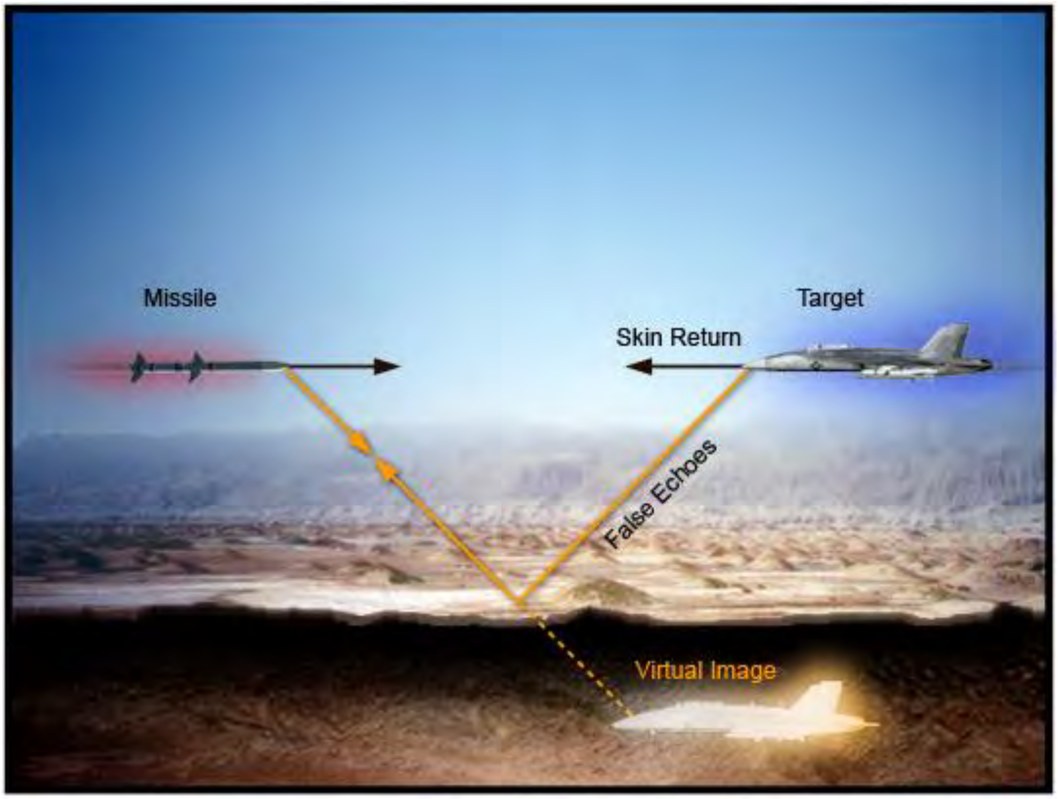


Figure 6-13 Terrain Bounce, Angle Deception Jamming

604. RADAR WARNING RECEIVERS

Radar Warning Receivers (RWRs) are used to warn aircrew of an attack. RWRs detect the RF emissions of radar systems and compare the signals to a database. A warning is issued when the RWR determines the detected signal to be a threat. Depending on the type of RWR system, appropriate responses to specific threats may be recommended. Nearly all modern military aircraft are equipped with RWR systems ("Raw Gear").

1. RWR Fundamentals

Generally speaking, RWR systems operate in similar fashion to ESM systems. Typical RWR equipment includes a receiver and a digital processor. The receiver detects the enemy emitter and the processor analyzes the signal and compares it to a database of known signatures. The RWR system then alerts the aircrew to the threat with visual and aural cues.

RWR indications consist of three components:

a. Direction of Arrival (DOA) strobe

b. Threat symbol

c. Aural cue

When a hostile emitter is detected, a DOA strobe appears on the display along the relative bearing of the emitter from ownship. A threat symbol identifying the type of emitter is placed along the DOA strobe indicating the range from ownship. Simultaneously, an aural warning informs the aircrew when a threat radar is illuminating the aircraft. This aural cue is modulated in accordance with the severity of the threat. If the emitter type is unknown, the RWR will still alert the aircrew, but the visual and aural cues will identify the threat as unknown.

2. Virtual Mission Training System (VMTS) and Operational Flight Trainer (OFT) RWR System

Both the VMTS and the OFT provide RWR indications, but each displays this information differently. Normally, RWR displays are selected on the left MFCD, and are configured during the fence checks. In the OFT, the EW page is only available on the LMFCD and the radar display on the RMFCD.

3. RWR Indications

RWR indications in both the OFT and VMTS include:

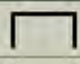
a. DOA strobe

b. Threat symbol identifying the type of emitter and range from ownship

c. Aural cue used in conjunction with display symbology to alert aircrew when a threat is tracking and when a threat has launched a missile

OFT and VMTS threat symbols are shown in Figure 6-15.

Both

Symbol	Meaning
	Air Threat
	Ground Threat

OFT

Symbol	Meaning
AL	Air (> 25 NM < 40 NM)
AM	Air Medium (> 10 NM < 25 NM)
AS	Air Short (< 10 NM)
SL	Surface Long (> 25 NM < 40 NM)
SM	Surface Medium (> 10 NM < 25 NM)
SS	Surface Short (< 10 NM)
U	Unknown Emitter

VMTS

Symbol	Meaning
AA	Air Threat (any range)
SL	Surface Long (> 25 NM < 40 NM)
SM	Surface Medium (> 10 NM < 25 NM)
SS	Surface Short (< 10 NM)
U	Unknown Emitter

Figure 6-14 RWR Threat Symbols

4. OFT EW Operation

In the OFT, the EW display provides an indication of the direction of arrival of detected threats, threat identification by type of emitter, and threat status. OFT RWR indications are displayed on the EW page with a DOA strobe and a threat symbol (Figure 6-16). No heading indication is given on this page which limits the usefulness of the display on its own.

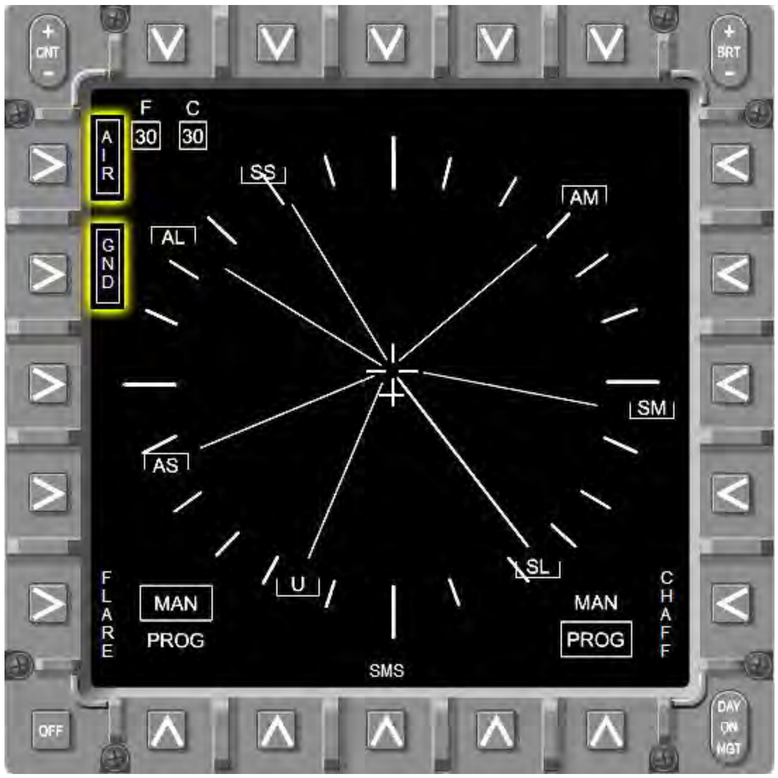


Figure 6-15 OFT MFCD EW Format

Depending on which threat type is boxed, the RWR will display the selected threats and enable the aural warning tones. Both AIR and GND may be selected to enable warnings for all emitters. However, unboxing threats may be useful when the display becomes cluttered.

The emitter bearing line (DOA) and threat symbol indicate that ownship is being tracked by that type of emitter along that relative bearing. The DOA strobe will flash when the RWR receives missile launch indications. A missile launch will also prompt a change in the aural warning cue. OFT EW threat symbols are shown in Figure 6-17.

Symbol	Meaning
⊓	Air Threat
⊔	Ground Threat

Symbol	Meaning
AL	Air (> 25 NM < 40 NM)
AM	Air Medium (> 10 NM < 25 NM)
AS	Air Short (< 10 NM)
SL	Surface Long (> 25 NM < 40 NM)
SM	Surface Medium (> 10 NM < 25 NM)
SS	Surface Short (< 10 NM)
U	Unknown Emitter

Figure 6-16 OFT EW Threat Symbols

5. OFT Expendables

The OFT has the capability to simulate both chaff and flares. The expendables are selected and dispensed on the radar page; chaff is selected in the bottom right and flares in the bottom left. Quantity remaining counters are also displayed on the radar page in the top left corner. As chaff and/or flares are dispensed, the associated counter decrements (starts with 30 chaff and 30 flares) to indicate the quantity of remaining expendables.

6. OFT Procedures

To select the stores page, momentarily move the Transfer Mode switch aft on the RHC. The Stores page will be displayed. From the Stores page, select the EW PB. The EW page will now be displayed on the LMFCD.

NOTE

In the OFT, the EW page can only be displayed on the LMFCD.

On the left side of the MFCD, the threat type can be selected (Figure 6-16):

a. ***AIR*** When boxed, the RWR will alert the aircrew to airborne threats.

i. When the hostile emitter is within 40 NM, the Air Long (AL) symbol is displayed in conjunction with an aural tone indicating an airborne threat is tracking ownship.

ii. When the hostile emitter is within 25 NM, the threat symbol automatically changes to Air Medium (AM).

iii. When the hostile emitter is within 10 NM, the threat symbol automatically changes to Air Short (AS).

iv. When an enemy missile is launched, the threat symbol (AA, AM or AS) flashes and the aural tone changes to indicate an incoming threat missile.

b. ***GND*** When boxed, the RWR will display surface threats.

i. When the ground emitter is within 40 NM, the Surface Long (SL) symbol is displayed in conjunction with an aural tone indicating a ground threat is tracking ownship.

ii. When the ground emitter is within 25 NM, the threat symbol automatically changes to Surface Medium (SM).

iii. When the ground emitter is within 10 NM, the threat symbol automatically changes to Surface Short (SM).

iv. When a Surface-to-air Missile is detected, the surface threat symbol (SL, SM or SS) flashes and the aural tone changes to indicate an airborne threat is tracking ownship.

NOTE

The EW page is initialized with both AIR and GND selected (boxed).

If the detected threat emitter is unknown, the threat symbol will be “U.” When a threat emitter has been detected, if the threat type (AIR or GND) is deselected then quickly reselected, the aural tone will be silenced but the threat symbol will remain on the display.

To return to the SMS page from the EW display, select SMS at the bottom of the MFCD.

7. VMTS EW Operation

VMTS RWR indications are displayed on the SA page with a DOA strobe and a threat symbol. The SA display combines the functionality of the EW display and the HSI into a common display. The VMTS SA display is very similar to those currently in use in the F/A-18 and is shown in Figure 6-18.

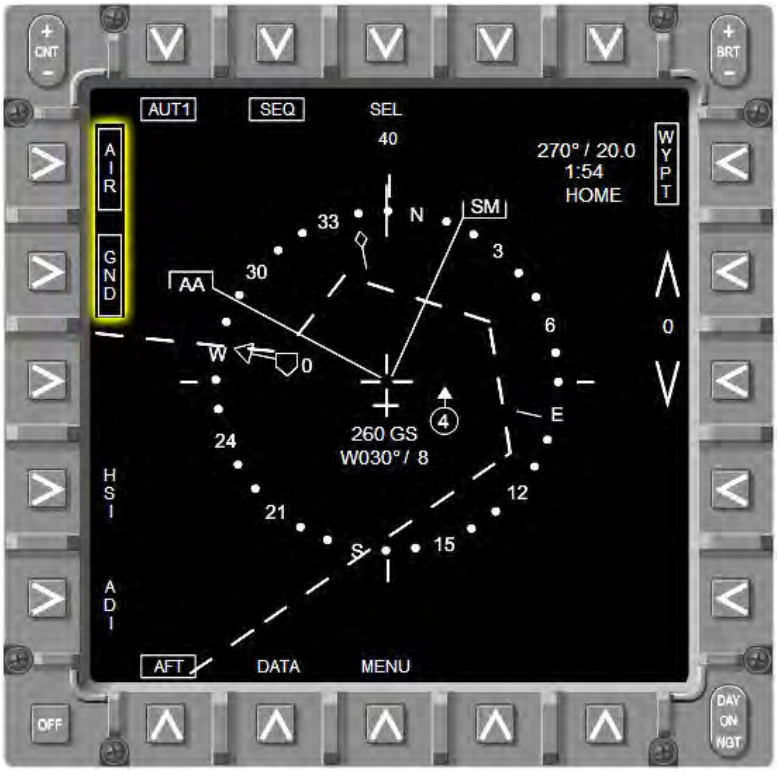


Figure 6-17 VMTS SA Display

As shown, the fighter has waypoint steering information, sequence information, auto sequence option and range selection options as in the HSI. As with the OFT, either AIR or GND can be boxed to select the desired threat warning type. VMTS EW symbols are simplified and shown below in Figure 6-19.

Symbol	Meaning
⊓	Air Threat
⊔	Ground Threat

Symbol	Meaning
AA	Air Threat (any range)
SL	Surface Long (>25NM <40NM)
SM	Surface Medium (>10NM <25NM)
SS	Surface Short (<10NM)
U	Unknown Emitter

Figure 6-18 VMTS EW Threat Symbols

The SA display allows the fighter to reference one display for route/area management, waypoint steering, GEOREF and EW information, making it a much better display than the HSI or EW display during an intercept. The only disadvantage of the SA page is that chaff cannot be dispensed from the SA page. This must be done from the attack display.

VMTS EW operation is very similar to that of the OFT, with a few minor differences:

a. Air threats:

   i. Top four priority air threats are displayed

   ii. Only lethal threats are displayed

   iii. Steady threat symbol and DOA strobe

   iv. The Air Long threat symbol is AA (vice AL as in the OFT)

b. Ground threats:

   i. Top five priority surface threats are displayed

   ii. Only critical threats are displayed (Missile Launch)

   iii. Flashing threat symbol and DOA strobe (SS, SM, SL)

In addition to the standard RWR visual cues, AIR threats will prompt a 555 Hz tone that alternates on/off every 0.08 seconds. The aural warning for GND threats is an alternating 455 Hz and 555 Hz tone. These tones will alternate at 0.166 second intervals.

605. SURFACE-TO-AIR WEAPON SYSTEMS

Despite the self-protection equipment previously described, the best defense against surface-to-air threats is preparation. As with any threat, mitigation begins with planning. Knowledge of the threat locations provides options like avoidance (either laterally or with altitude) and suppression (Jamming or HARM). In order for the planning to be effective, a thorough understanding of threat systems is required.

The five major categories of surface-to-air threats are:

a. Man Portable Air Defense Systems (MANPADS)

b. Command Guided Surface-to-Air Missiles (SAMs)

c. Semi Active SAMs

d. Anti-Aircraft Artillery (AAA)

e. Mobile and Composite Systems

1. MANPADS

Also known as shoulder launched SAMs, MANPADS provide hostile forces with a lightweight, highly effective, portable surface-to-air weapon. Additionally, flare rejection technology makes modern MANPADS a very credible threat. When there are hostile troops on the ground, it is safe to assume MANPADS are present.

MANPAD capabilities differ greatly from system to system. The higher NATO designation numbers (SA-7 versus SA-18) indicate more capable systems. General characteristics of MANPADS are as follows:

a. Range 0 to 6 NM

b. Speed 1.6 to 2.7 Mach

c. Maximum Altitude 10,000 to 20,000 feet

d. Users - Any threat nation/group

Some examples of combat proven systems (Figure 6-20) include:

a. FIM-92 Stinger

i. Shoulder fired, can be adapted to ground vehicle and helicopter mounting

ii. Short-range, low altitude

iii. Developed in U.S. but widely exported and exploited

iv. IR homing

v. Impact fuze

b. SA-7 Grail

i. Shoulder fired, low altitude MANPAD

ii. Passive IR homing guidance

iii. High explosive warhead

c. SA-14 Gremlin

i. Successor to the SA-7

ii. Improved seeker incorporates Nitrogen-cooled Lead Sulfide

iii. IR guidance homes in on jet exhaust plumes

d. SA-16 Gimlet

i. Shoulder fired, low altitude MANPAD

ii. Simple IR homing

iii. IFF system to prevent firing on friendly aircraft

iv. Delayed impact fusing

v. Aerodynamic spike on nose for improved range

e. SA-18 Grouse

i. Successor to SA-16

ii. Improved IR homing incorporates a more sensitive seeker for all aspect engagement

iii. Flare rejection technology

iv. Improved aerodynamic spike

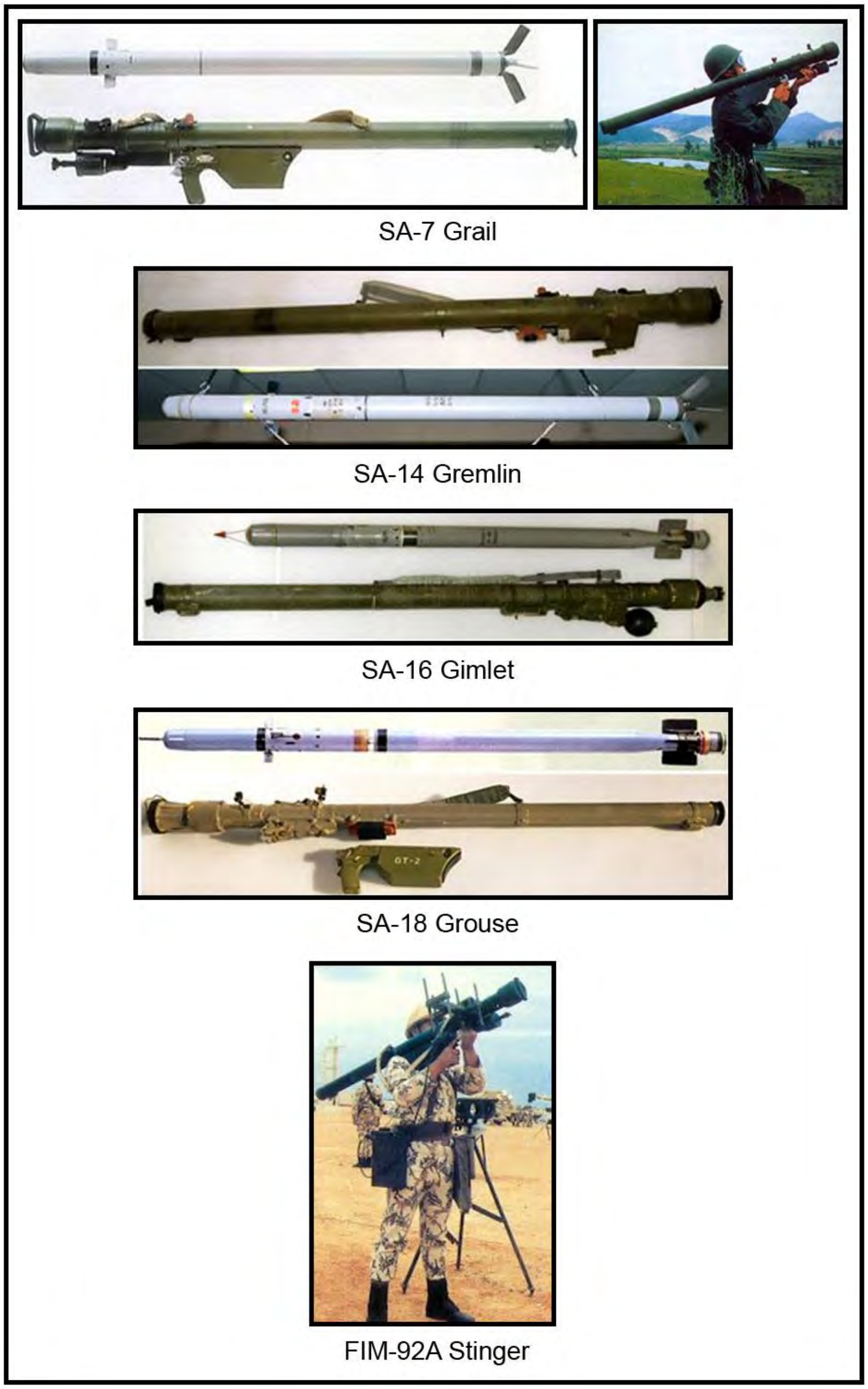


Figure 6-19 Common MANPADS

2. Command Guided Surface-to-Air Missiles (SAMs)

Command guidance operates on the same principal as radio control. The missile itself has no seeker and is guided by commands from the launching system. Although these systems are dated, they are widely deployed and are combat proven. Typical features of command guided SAMs are as follows:

a. Range 3 to 30 NM

b. Speed 2.0 to 4.0 Mach

c. Maximum Altitude 60,000+ feet

Characteristics of the most common command guided SAM systems include:

a. SA-2 Guideline (Figure 6-21)

i. A medium- to high-altitude SAM system with 360-degrees of coverage

ii. Extremely large missile with large solid propellant booster stage

iii. Four large delta fins on the booster

Figure 6-20 SA-2 Guideline

b. SA-3 Goa (Figure 6-22)

i. Low- and medium-altitude SAM system

ii. Short-range

iii. Designed to destroy aircraft, helicopters and low flying cruise missiles

Figure 6-21 SA-3 Goa

c. SA-8 Gecko

i. Highly mobile

ii. Low altitude

iii. Short-range

iv. First mobile SAM system to incorporate engagement radar on a single vehicle

v. Launch vehicle is fully amphibious and transportable by air

d. SA-15 Gauntlet

i. All weather, low- to medium-altitude

ii. Short-range

iii. Mobile launcher

iv. Phased array radar detection and tracking.

v. Highly accurate, very effective against small, fast, highly maneuverable targets.

vi. Can engage two targets simultaneously

3. Semi-Active SAMs

Semi-Active missiles use an internal seeker to detect and guide on the reflected energy from a tracking radar or target illuminator. Some systems combine illuminators and tracking radars on the same chassis, while other systems have tracking and illumination radars that are entirely separate. These systems are also widely deployed.

Typical features of SAM systems include:

a. Range 3 to 30 NM

b. Speed 2.0 to 4.0 Mach

c. Max Altitude 40,000+ feet

Characteristics of the most common command guided SAM systems include:

a. SA-6 Gainful (Figure 6-23)

    i. Low altitude SAM system

    ii. Highly mobile

    iii. Older design, but simplicity makes for a formidable threat

    iv. Proximity and impact fusing; direct hit not required for destruction of target

b. SA-11 Gadfly

    i. Successor to SA-6

    ii. Medium range

    iii. Four missiles per launch vehicle

    iv. Large warhead with proximity fusing

    v. Designed to destroy aircraft, helicopters and low flying cruise missiles

c. MIM-23 Hawk

i. Medium-range, low to medium altitude

ii. Developed in U.S., but widely exported and exploited

iii. Accurate and lethal

iv. Proximity and impact fusing

Figure 6-22 SA-6 Gainful

4. Anti-Aircraft Artillery

Anti-Aircraft Artillery (AAA) is any weapon system larger than 12.7 mm (.50 caliber) that is specifically designed to engage airborne targets. Generally, these systems fire explosive shells that have contact, time-delay or altitude fuzes. AAA systems are divided into three categories based on the caliber of the gun:

a. Light AAA - up to 30mm in caliber

b. Medium AAA - from 30mm to 80mm in caliber

c. Heavy AAA - above 80mm caliber

All countries deploy some type of AAA. Sample AAA systems are shown in (Figure 6-24):

a. ZSU-23 AAA

   i. Light AAA

   ii. 23mm caliber towed system

   iii. Twin barrels

   iv. Manually aimed and fired, relatively inaccurate

b. S-60 AAA

   i. Medium AAA

   ii. 57mm caliber

   iii. Short- to medium-range

   iv. Single barrel 57mm gun

   v. Relatively inaccurate, but highly lethal

   vi. Towed system is somewhat cumbersome

c. KS-19 AAA

   i. Heavy AAA

   ii. 100mm caliber

   iii. Relatively long-range AAA system

   iv. High explosive and fragmentation ammunition

Figure 6-23 Light, Medium and Heavy AAA Systems

5. Mobile and Combination Systems

Mobile AAA systems are designed to accompany troop formations and provide local air defense. These systems are fairly well deployed worldwide. Most incorporate fire-control radar to aim the guns, increasing their accuracy. The limiting factor in their deployment is the added complexity that comes with a motorized chassis as opposed to fixed or towed systems that rely on another vehicle to relocate them. Most mobile systems are in the light AAA category.

The most common mobile system is the ZSU-23-4 Shilka (Figure 6-25). The Shilka is a self-propelled, lightly-armored, 23mm light AAA system. Although it is a very short-range weapon, the four radar controlled auto-cannons make it highly lethal.

Figure 6-24 ZSU-23-4 Shilka

Combination systems incorporate short-range IR or laser guided SAMs with light AAA guns on one chassis. Coupled with a radar system for target detection and tracking, these systems are especially effective against attack helicopters, but are also effective against low flying aircraft.

Combination systems typically have gun ranges of up to 5 NM, although the missiles may have longer ranges. These systems are generally used against low altitude targets below 12,000 feet AGL. The most common combination system is the 2S6 Tunguska (Figure 6-26). The Tunguska is a highly mobile system that combines an SA-19 Grisom SAM with two 30mm cannons. This system is extremely accurate and highly lethal.

Figure 6-25 2S6 Tunguska

6. Missile Defense Procedures

When the aircrew receives a RWR indication, they communicate this by communicating "mud" or "singer." "Mud" notifies other members of the flight that the fighter has been illuminated by a ground threat with associated RWR display indications. Also, "Singer" notifies the flight that the fighter has RWR display indications of a SAM launch. Additionally, "Naked" indicates that the fighter is not illuminated. For both "mud" and "singer" threat type and direction are included in the call. Proper format for these calls is "*Callsign, Mud/Singer (S/A threat), bearing*." For example:

a. Hammer-11 - *"Hammer-11, singer 6, 270"*

b. Hammer-12 - *"Hammer-12, naked*"

In the above example, Hammer-11 has been illuminated by an SA-6 emitter bearing 270 from the flight. Additionally, this emitter is supporting a missile in flight, presumably directed at Hammer-11. Hammer-12 has no RWR indications.

If a missile launch is detected, a missile defense procedure must be executed:

a. Initiate a "Break" turn in the shortest direction that will place the missile in the beam; place the DOA strobe at the 3 O'clock or 9 O'clock position.

b. Dispense chaff.

c. Adjust heading to keep the strobe in the beam.

d. Continue to dispense chaff while established in the beam.

e. If still spiked after 8 seconds, turn in the shortest direction (Hard Turn) to place the DOA strobe at the 6 O'clock position and accelerate using maximum power. If no longer spiked, resume mission.

f. Deploy chaff in the turn.

CHAPTER SEVEN
STANDARD DIVISION PROCEDURES

700. INTRODUCTION

Division formations have three or four aircraft and are comprised of two sections. Dash One (Hammer-11) is the Lead of the first section and is also the overall division lead. Dash Two (Hammer-12) is Hammer-11's wingman. Dash Three (Hammer-13) is the Lead of the second section. Dash Four (Hammer-14) is Hammer-13's wingman. Division formations are commonly used in both administrative and tactical military flights. As a reminder, SNFOs may choose their tactical callsigns: Hammer, Viper, Tron, etc… If a division has only three aircraft, it is called a "light division."

701. DIVISION FORMATION BASICS

1. Division Formation Responsibilities

Responsibilities are very similar to two-plane formations, except now there are more wingmen to back up the Lead. In addition, it is common to detach the second section:

a. During severe weather

b. For tactical employment

c. In the event that an aircraft is having mechanical problems

For these reasons, Hammer-13 should always be ready to detach with Hammer-14 as a section to complete the mission. Additionally, Hammer-13 should be ready to assume the responsibilities of the division lead in the event Hammer-11 is unable to lead the flight.

2. Division Formation Communication

Passing hand signals in division is very similar to section work except the Lead cannot see all the wingmen all the time. Therefore, it is incumbent on each aircraft to pass hand signals up and down the formation.

Radio communication in division formation is slightly more difficult because of the number of aircraft. In VT-86, we will utilize positive check-ins as previously discussed in the *Section Formation Procedures* chapter. Due to the size of the formation, positive check-ins take longer to execute and are somewhat cumbersome on the radio. For that reason, each wingman must expeditiously check-in when prompted. Once the Lead has initiated a check-in, each wingman should wait for the aircraft ahead in the formation to check-in. However, if the preceding aircraft has not checked-in after a few moments, succeeding aircraft should continue to check in. This procedure enables the Lead to keep track of who is on the frequency and who is not. This makes tracking down the errant wingmen easier for the Lead.

The Lead should refer to the flight as a "flight of four" during initial communications with every new controller. On subsequent transmissions with the same controller, the standard call sign (i.e., ROKT 407) may be used. Identifying the formation as a flight of four will assist controllers and other aircraft to plan for the large formation. On the ground, this clarification should prevent other aircraft from taxiing between members of the formation.

3. Non-Tactical Formations

a. Echelon - Is a standard division formation that is normally utilized when the flight can be critically viewed from the ground (Figure 7-1). This is most common during the initial join-up after takeoff as well as division breaks. This formation is cumbersome, because turns into the echelon are difficult for the wingmen (especially Hammer-14). Echelon may be flown in either parade or cruise position, and the positioning of the wingmen is the same as for section parade (30-degree bearing) and section cruise (45-degree bearing). However, in echelon cruise, wingmen may fly slightly acute to facilitate the passing of visual signals.

Figure 7-1 Division Echelon Formation

b. Balanced Cruise or Fingertip - The balanced cruise position (commonly referred to as the fingertip formation) is a division formation that allows for more maneuverability and ease of flying as compared to echelon. As in Figure 7-2, fingertip is formed with Hammer-12 on one side of Lead and Hammer-13/14 on the other side. Fingertip is the most common formation used during the transit phase of the flight. It allows Hammer-11 to maneuver the division easily in any direction. Typically, Hammer-13 will pick the side of the formation desired while Hammer-12 will move to the opposite side to balance the formation; hence the name balanced cruise. In balanced cruise formation, Hammer-13 should leave enough room between his aircraft and Lead so that Hammer-12 can cross under into echelon formation if desired or required (Figure 7-2).

Figure 7-2 Balanced Cruise Formation (Fingertip)

The division can transition from echelon to fingertip in one of two ways (Figure 7-3):

a. Have Hammer-12 cross under

b. Have the Hammer-13/-14 section cross under

In the first case, the Lead will signal Hammer-12 to cross under. When the cross-under is complete, Hammer-13/14 will move up to cruise position.

In the second case, the Lead will signal for a section cross-under. Hammer-12 and Hammer-13 will pass the signal down the line, and the Hammer-13/-14 section will execute a section cross-under. For a section cross-under, Hammer-13 executes a cross under on Lead while Hammer-14 simultaneously executes a cross under on Hammer-13, controlling relative motion so that Hammer-13 is always between Hammer-14 and the Lead. Hammer-13 should not rush this maneuver because his wingman must travel a greater distance, causing the wingman to possibly lose proper position or to be spit out.

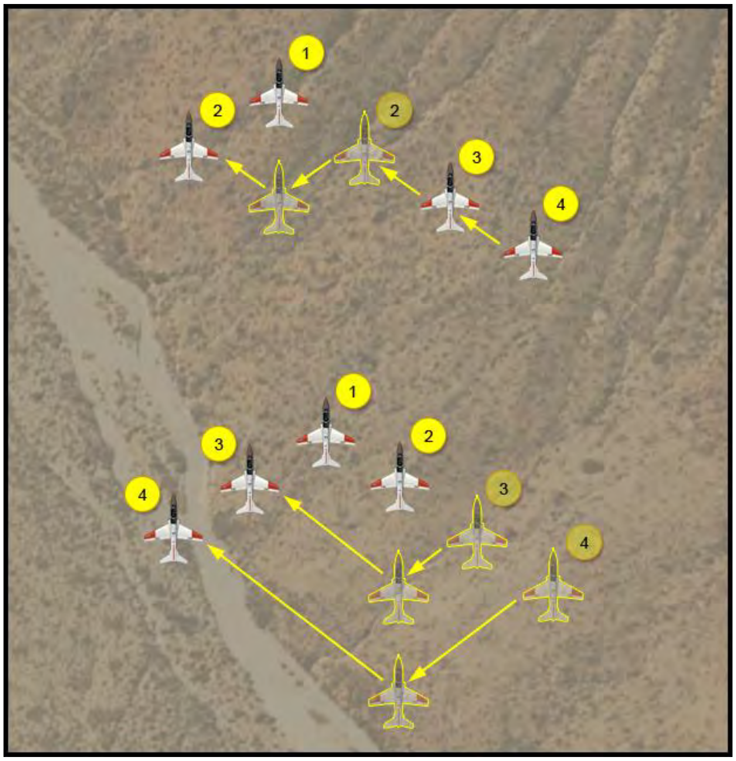


Figure 7-3 Echelon to Fingertip Transitions

If the division encounters inadvertent IMC weather, wingman will tighten into parade positions; Hammer-13 will match Hammer-12's spacing off the Lead (Figure 7-4). This formation is called balanced parade because each aircraft is flying a parade position on their respective interval. Divisions will not purposely fly into IMC, flight lead will establish two separate sections if Hammer-13 is a section lead. The key is to avoid IMC all together, if possible. This formation may also be used when the formation performs a flyover. The break is normally not performed from a balanced formation.

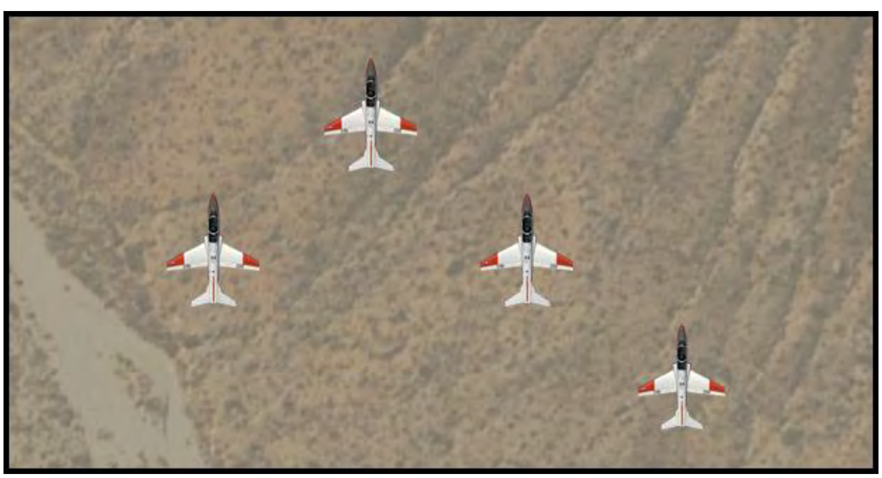


Figure 7-4 Division Balanced Parade or Fingertip Formation

4. Tactical Formations

Tactical formations generally offer mutual support to the formation and prevent compromise of the entire formation if one or two aircraft are spotted. There are many different formations used in tactical operations but it is not practical to list them all here. However, the two most common tactical division formations are briefly discussed below as one or both may be used while training at VT-86.

a. Battle Box - The Battle Box formation is normally used on division low-level ingress to the target area. As with all division formations, it is comprised of two sections. To form the Battle Box, the first section will push into Combat Spread. The second section will fall in trail of the lead section and push into Combat Spread as well. Spacing between aircraft within the sections is typically 1 NM, and separation between the sections is also 1 NM (Figure 7-5). These distances can be varied based on threat and posture (i.e., offensive or defensive). Additionally, the trail section can offset to the left or right as necessary for maneuvering, threat or other tactical considerations.

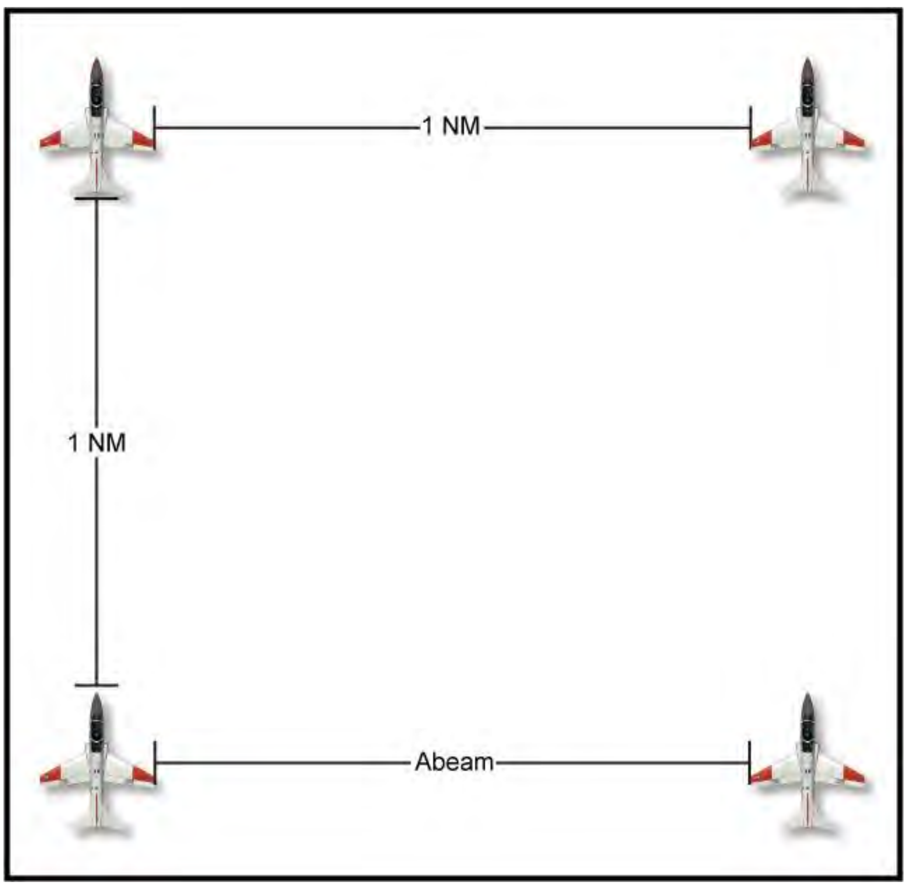


Figure 7-5 Battle Box Formation

b. Wall - The Wall formation (Figure 7-6) is a highly offensive tactical formation in which all four aircraft in the division fly abeam.

Figure 7-6 Wall Formation

To form the Wall, Hammer-13 will fly Combat Spread off the division lead. Hammer-12/-14 will fly combat spread off their respective lead. The distance between aircraft will be dependent on the enemy threat, as well as the friendly posture. Depending on the situation, the wall can be modified and the wingmen can close to a Tac Wing or even a Cruise position on their respective lead. Figure 7-7 illustrates a formation called "Fluid Four." Fluid Four is often used for admin transits to/from tactical areas.

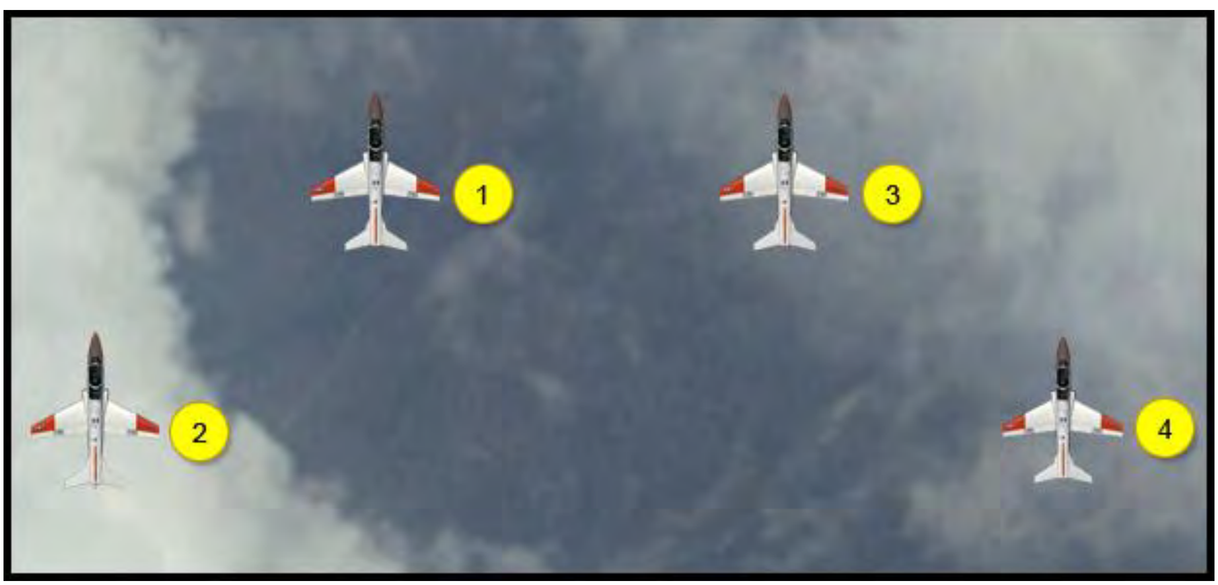


Figure 7-7 Fluid Four Formation

702. GROUND/DEPARTURE PROCEDURES

As with section procedures, each aircraft will conduct individual pre-flight inspections and engine starts. It is not until final checks that the individual aircraft become part of the division.

1. Division Line Procedures

Start up and line procedures are identical to those used in Contact and Section formation flights. The division lead will obtain clearance for the entire flight. If weather precludes a division takeoff, Lead will coordinate individual clearances for the sections or for individual aircraft as necessary.

Radios shall be set to the pre-briefed frequencies for each radio. On start-up, Pri will be set to ATIS, Clearance, and then Base to wait for a switch to Ground, while Aux will be set to TAC. This will ensure that aircrews can be contacted by Base, Lead, or wingmen as necessary while in the line. As always, take care of individual aircraft first and then attend to formation responsibilities.

Once all aircraft are complete with final checks, a thumbs-up will be passed from Dash Four up the line to the Lead (Hammer-14 to Hammer-13 to Hammer-12 to Hammer-11). It is important to note the side number and location of your wingmen on the ramp so that a thumbs-up can be passed to the correct jet at the appropriate time.

When all aircraft have passed the appropriate thumbs-up, Lead will initiate a positive check-in on Base, then push the flight to Ground frequency on Pri, just as in the section flights. Before switching off of Base, Lead will make the "taxi" call with side numbers for the flight. The flight will then check-in on Tac Freq in order. Once checked in, Lead will initiate the NAV Check:

a. Lead SNFO (Aux) - *"Hammer check TAC, Hammer-11"*

b. Hammer-12 (Aux) - *"Hammer-12"*

c. Hammer-13 (Aux) - *"Hammer-13"*

d. Hammer-14 (Aux) - *"Hammer-14"*

e. Hammer-11 (Aux) - "*Hammer, NAV check Rosie, 160, 28.5"*

f. Hammer-12 (Aux) - "*Two*"

g. Hammer-13 (Aux) - "*Three*"

h. Hammer-14 (Aux) - "*Four*"

2. Division Taxi

After the NAV Check is complete, Lead will call for taxi:

a. Lead SNFO (Pri) - *"Ground, ROKT 407, flight of four, taxi with Bravo"*

Division formations will taxi on alternate sides of the taxiway (staggered) to reduce the length of the formation and reduce the hazard of FOD. For a staggered taxi, the division Lead will take the downwind side of the taxiway, and the wingman will alternate sides in sequential order. If the division is unable to stagger the taxi and must remain on the centerline, then the interval between aircraft shall not be less than 500 feet. Figure 7-8 illustrates these division taxi procedures. Squadron SOP will define the minimum taxi distance for both staggered and centerline taxi profiles.

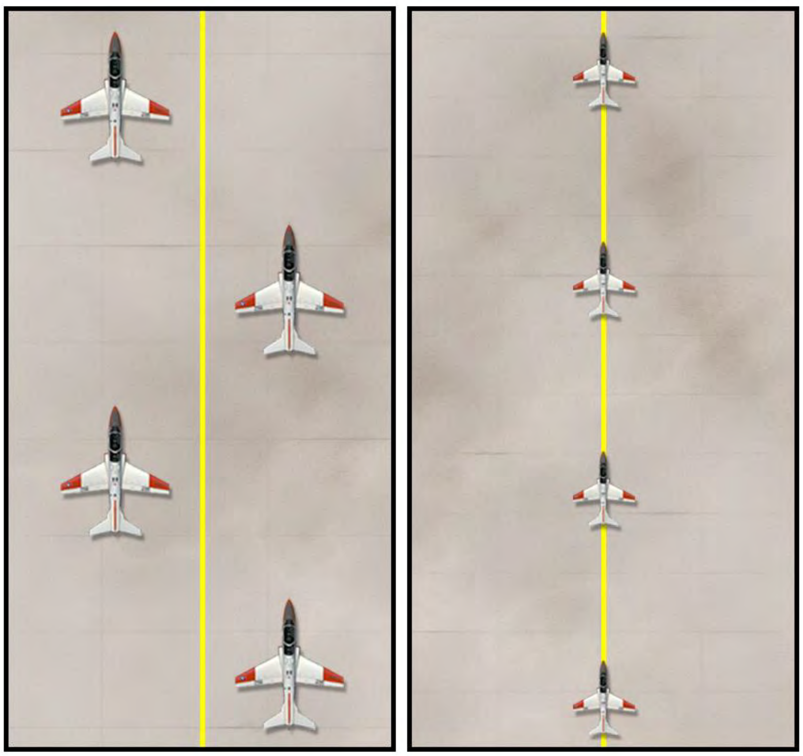


Figure 7-8 Division Taxi; Staggered and Centerline

3. Division Takeoff

Arriving in the hold short, each aircraft will pull up adjacent to the previous aircraft, and park in such a manner so as to facilitate the visual inspection (Figure 7-9). Once the last aircraft has arrived, and each aircraft has inspected adjacent aircraft, a thumbs-up will be passed up the line to Lead, who will then call for takeoff.

Figure 7-9 Division Hold Short Procedures

There are numerous division takeoff scenarios. The weather and runway available will determine the specific takeoff procedure utilized. The types listed below are the most common and those you can expect in the T-45C syllabus. Regardless of the type of takeoff, proper coordination is essential due to the formation size.

4. Section Go/Split the Duals

In this procedure, the division will split up into two sections and utilize both parallel runways (Figure 7-10). The Lead SNFO will advise Ground on the initial taxi call of the division's intention. This is normally accomplished by adding "Split the Duals" to the standard taxi call.

Once at the Hold-Short and after completing all hold-short checks, Lead will call for takeoff and add "Split the Duals" to the normal takeoff call.

Taxiing out of the line, on Ground:

a. Lead SNFO (Pri) - *"Ground, ROKT 407, flight of four, taxi with information Foxtrot, request to split the duals"*

b. GND: - *"ROKT 407, Taxi to runway 7R via Foxtrot, Delta, Alpha, altimeter 2992, split the duals on request"*

At the hold-short and ready for take-off on Tower:

a. Lead SNFO (Pri) - *"Tower, ROKT 407, flight of four, take-off, split the duals"*

b. TWR - *"ROKT 407, cleared for take-off runways 7L and 7R, wind 040/10, switch departure"*

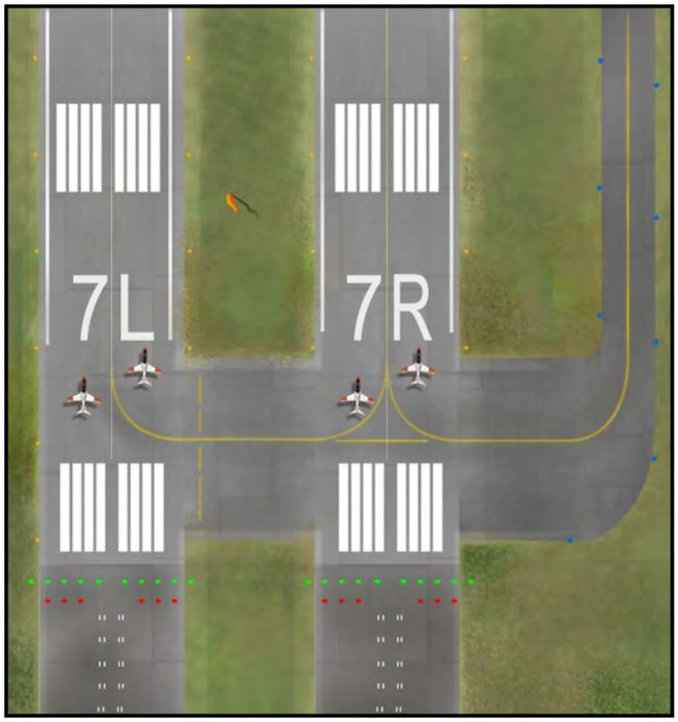


Figure 7-10 Division Takeoff (Section Go, Split the Duals)

Normally Hammer-11/-12 will utilize the outboard runway while Hammer-13/-14 will utilize the inboard runway. This convention expedites the rendezvous once airborne because the lead section will be turning into the trail section. After the two sections are on their respective runway, the Lead IP will signal to run-up. Dash Three IP will call "*3's set*" when the second section is ready for takeoff. Once set, both sections will do a standard section go with the second section delaying no more than a few seconds. As soon as both sections are airborne, they begin to rendezvous as a division. Hammer-13 SNFO will call "*4's Airborne*" on Tac Freq when the second section is clean.

5. Division Interval Go

This procedure is used when conditions do not permit splitting the duals. The runway width will determine if all four aircraft can take the single runway at once (200 feet or 50 feet per aircraft). If the runway is 150 feet wide, only three aircraft can be on the runway with Hammer-14 as a stinger waiting at the hold short. When space permits, Hammer-14 will take the runway and takeoff. In either case, the division will form up on the runway in an Echelon formation (Figure 7-11) that will permit an un-obstructed view between pilots. If Hammer-14 is a stinger, the IP will call "*4's set*" when the aircraft is in position and ready to take the runway.

When the Lead SNFO is directed to switch departure for takeoff, the flight will execute the run-up and conduct individual MRT checks. After MRT checks with a good thumbs-up from wingmen, the Lead will give the "kiss-off" signal and begin to roll. Wing aircraft will initiate their takeoff rolls in order and in accordance with the SOP mandated intervals. Once the last plane to launch is clean, the SNFO in that jet will call "*4's airborne*" (or "3" if a three plane) on Tac Freq . This will be the Lead SNFO's cue to contact Departure.

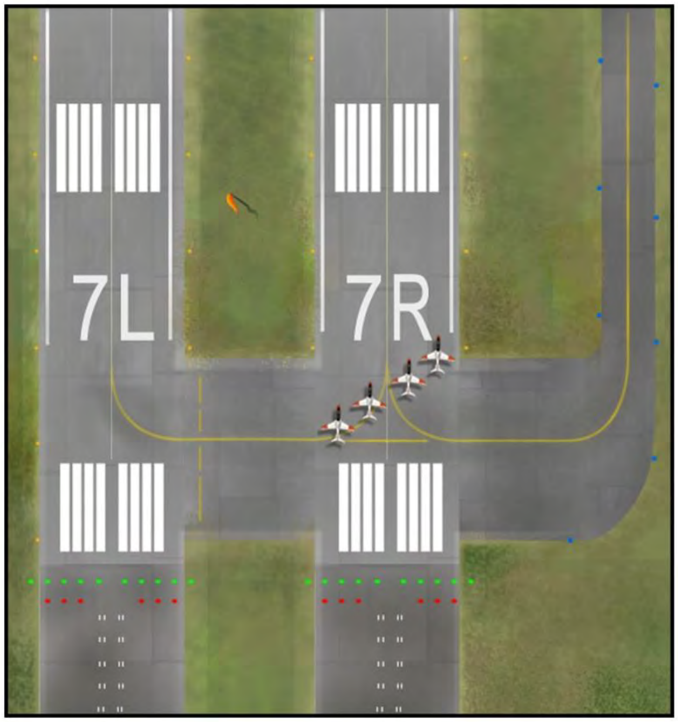


Figure 7-11 Division Take-off (Interval Go)

6. Division Departure

As in a two-plane running rendezvous, each SNFO will be expected to monitor closure and airspeeds during a division rendezvous. After takeoff, the flight will normally rendezvous in parade at 250 KIAS. Lead will then give the "take cruise" signal. Hammer-13 will then choose a side, Hammer-12 will automatically balance and the division will proceed on the departure.

703. ENROUTE PROCEDURES

The division will normally proceed enroute in the balanced cruise formation or as briefed. Each member of the division will maintain a position that allows Lead to keep sight and pass hand signals. If on an A/G mission, SNFOs are required to cycle into A/G mode and quickly set initial conditions for mission on STRS/SMS page, to include BOMB and quantity selection. When complete, they will cycle back into Nav mode for the transit.

Depending on the mission and working area, the Lead SNFO will be required to check in with range control and gain clearance into the MOA, Shelby Range or W-155. Entering the MOA and W-155 is similar to previous flights in the syllabus, except with more wingmen. However, entering the Shelby Range with a CAS division is somewhat different.

Passing TRADR enroute to Shelby Range, Lead SNFO will clear the FAC(A) off frequency to check in with Shelby Range. Once range entry clearance is obtained, the FAC(A) will report back on Tac Freq with the range clearance and restrictions. Each member of the flight is required to read back ***verbatim*** the range restrictions over Tac Freq .

After receiving clearance to enter Shelby range, and at the appropriate time (normally passing Mobile Regional), the Lead SNFO is required to cancel IFR, descend the flight, initiate the Fence-In checks, contact the range, execute the G-Warm and report Fenced-In. Aviate, navigate, communicate is key. Descending a division is more difficult than a section; staying ahead of the flight is required. Figure 7-12 illustrates a recommended timeline for descending the division.

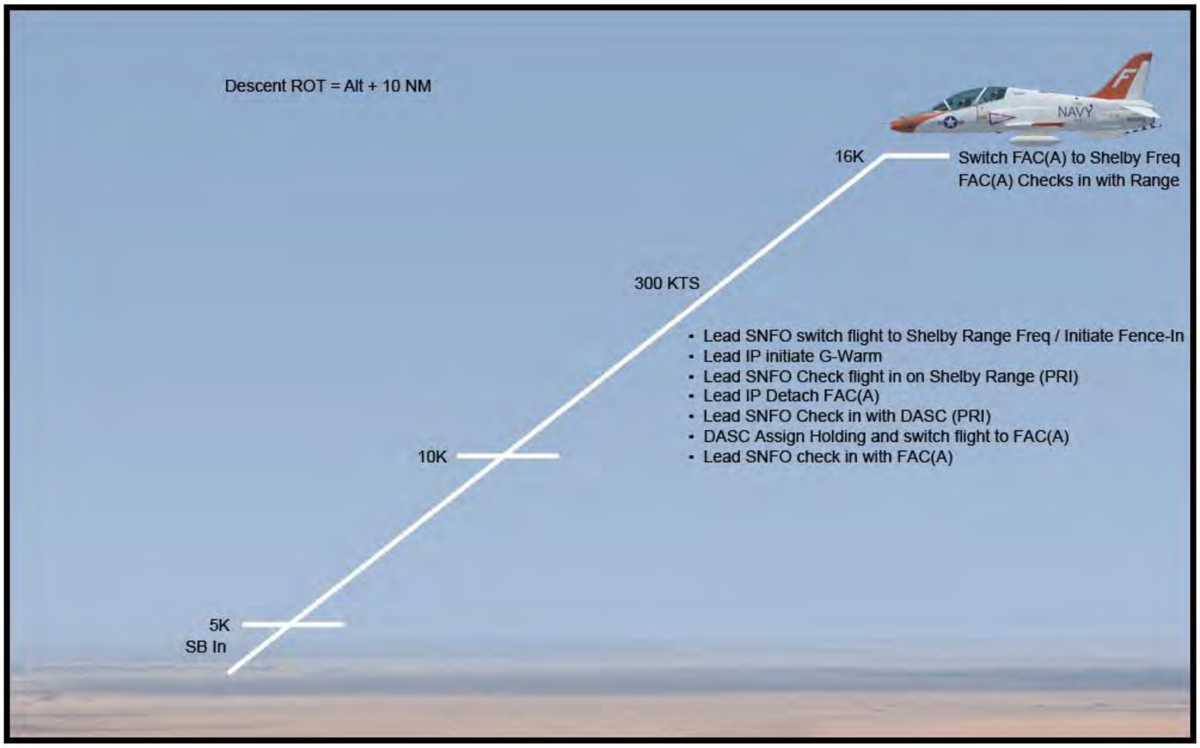


Figure 7-12 CAS Division Descent Timeline

704. COMBAT CHECKS – FENCE-IN/OUT

1. Fence-In

Approaching the working area, target area or range, the SNFOs shall complete the appropriate A/A or A/G combat checklist as required by the mission. This is accomplished by fencing in the flight with a "Fence-In" call over Tac Freq . As with section formations, this directs the flight to switch from an administrative mindset to a tactical mindset. The Fence-In checks will generally be directed after the flight has cancelled IFR, Lead has SA on the target area (or working area), and/or Lead has established communication and received entry clearance into the working area. Students shall endeavor to complete the Fence checks prior to entering the area or approaching the target. This will alleviate distractions in the working area and allow total focus on the task at hand once established in the range.

An example of the communication for cancelling the flight and proceeding into the Shelby Range (following range entry clearance) is as follows:

a. Hammer-11 (Pri) - *"Houston Center, ROKT 401, request a descent to Cancel IFR"*

b. Houston Center (Pri) - *"ROKT 401, descend and maintain 11,000, no observed traffic"*

c. Hammer-11 (Pri) - *"Houston Center, ROKT 401, Leaving FL 220 for 11,000"*

Passing FL 180:

a. Hammer-11 (Pri) - *"Houston Center, ROKT 401 Cancel IFR"*

b. Houston Center (Pri) - *"ROKT 401, IFR cancellation received, frequency change approved, squawk appropriate code and contact me on this frequency for RTB."*

c. Hammer-11 (Pri) - *"ROKT 401"*

d. Hammer-11 (Aux) - *"Hammer switch button 23, Fence In"*

e. Hammer-12-14 (Aux) - *"Two", "Three", "Four"*

f. Hammer-11 (Aux) - *"Hammer check Pri"*

g. Hammer-11-14 (Pri) – *"Hammer-11", "Hammer-12", "Hammer-13", Hammer-14"*

h. Lead IP (Aux) - *"Hammer, accel G-Warm…..90 right go…resume"*

After completion of the G-Warm and all other checks, the Lead SNFO will initiate the fenced-in call on Tac Freq :

a. Hammer-11 (Aux) - *"Hammer-11, Fenced In, 2.4"* (2.4 = fuel state)

b. Hammer-12 (Aux) - *"Hammer-12, Fenced In, 2.4"*

c. Hammer-13 (Aux) - *"Hammer-13, Fenced In, 2.3"*

d. Hammer-14 (Aux) - *"Hammer-14, Fenced In, 2.2"*

During CAS flights, the Division Fence-In checks will include:

a. A/A TACAN as briefed

b. G-Warm complete

c. All aircraft squawk 4000

d. LAW set/RADALT tested at 5K if High Threat CAS

2. Fence-Out

After the tactical conduct is complete and the division is safely joined up, the Lead SNFO will direct the flight to Fence-Out and switch back to Center (ATC). Ensure the Master Arm is safe, switch back to Nav Master mode, and reverse the Fence-In checks. This will transition the division from a tactical mindset back to an administrative one.

705. DIVISION RECOVERIES

Upon completion of the tactical portion of the flight, the division will rejoin and return to base. The type of recovery conducted will be dependent upon the weather and fuel states. As with sections, the lowest fuel state in the division becomes the fuel state of the flight. Weather may preclude the break. If that is the case, Lead will have to coordinate splitting the division into two sections for visual straight-ins or PARs. Individual PARs may be necessary if the ceiling is too low (below circling minimums or 1,000/3 in the absence of a circling approach) to allow safe separation of the aircraft after the landing environment is in sight.

Due to the size of a division, it is inherently less maneuverable than a section or single aircraft. Lead is limited in terms of maximum and minimum power allowed in flight, which means accelerations and decelerations take longer to affect. Angle of bank in turns is also more restricted when flying in a division. These considerations require Lead to anticipate climbs, descents, speed changes and turns to have the division properly configured for recovery. Effective and early communication with ATC is essential for a successful division recovery.

1. VFR Recovery

The overhead break is the most common recovery for a division. Normally a two-second interval break will be used from the echelon formation (Figure 7-13), although many variations may be briefed and flown.

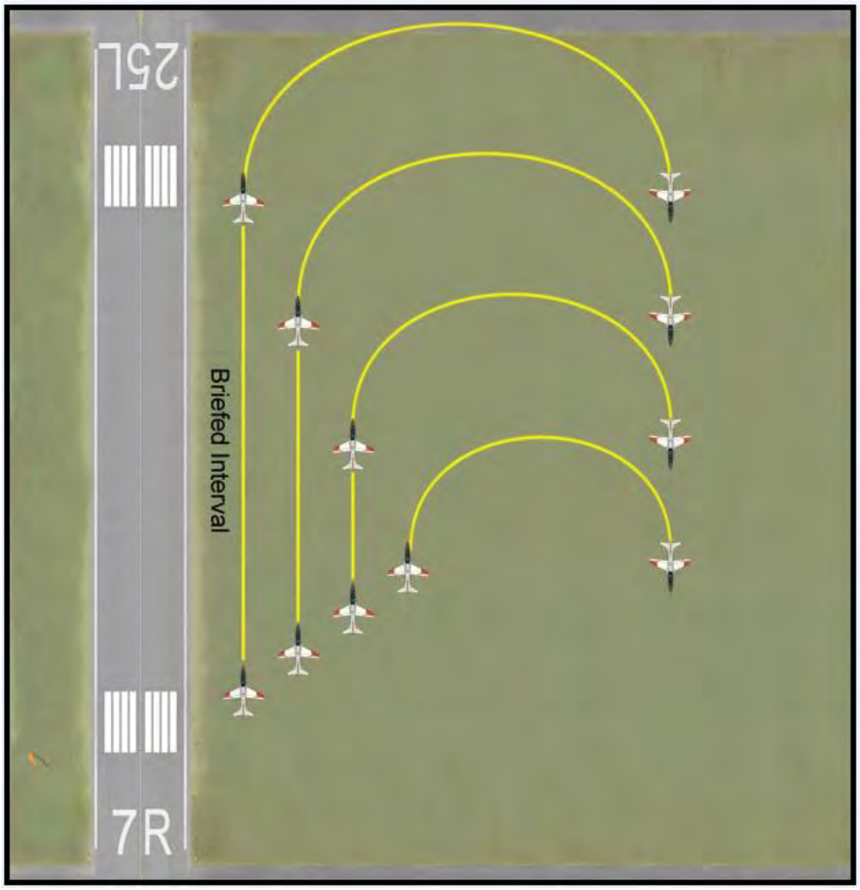


Figure 7-13 Echelon Break

Formation breaks such as finger-tip or diamond may be briefed and flown as well (Figure 7-14 and Figure 7-15).

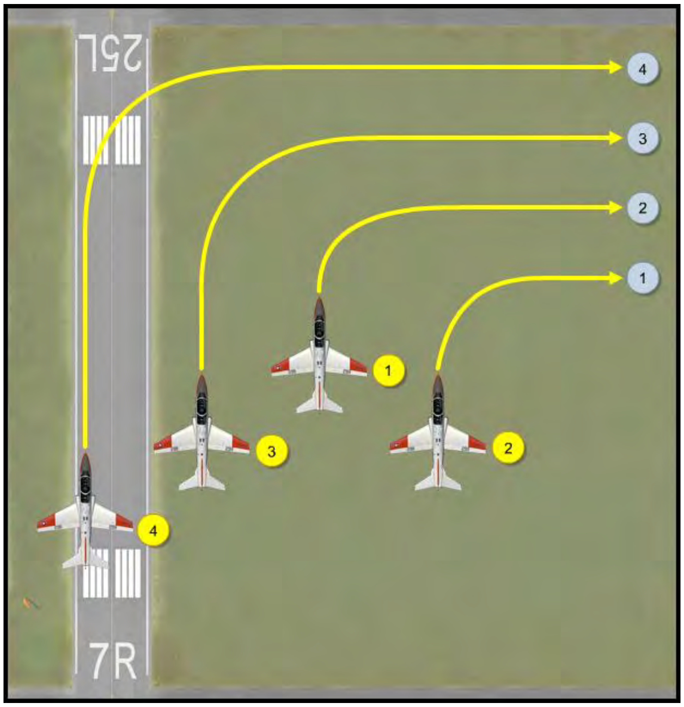


Figure 7-14 Fingertip Break

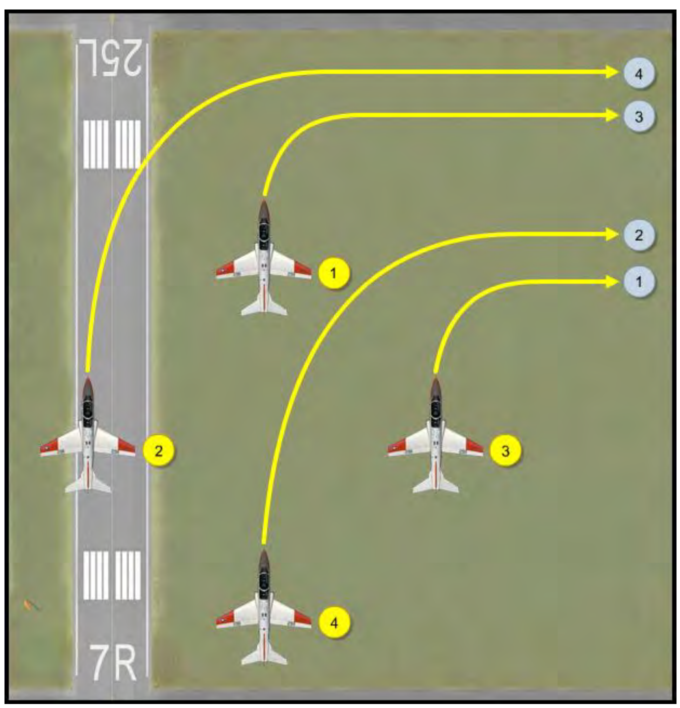


Figure 7-15 Diamond Break

Break interval and order is essential for safety of flight. In the finger-tip formation depicted in Figure 7-14, a right break would be executed in a 2-second interval (or as briefed) in the following aircraft order: Hammer-12, Hammer-11, Hammer-13 and then Hammer-14. A right break for the diamond formation in Figure 7-15 would be in the following order: Hammer-13, Hammer-14, Hammer-11 and then Hammer-12.

In any formation break other than Echelon, some, if not all, of the formation members will change roles. In the fingertip break illustrated above:

a. Hammer-12 becomes the lead

b. Hammer-11 becomes Hammer-12

In the Diamond break:

a. Hammer-13 becomes the lead

b. Hammer-14 becomes Hammer-12

c. Hammer-11 becomes Hammer-13

d. Hammer-12 becomes Hammer-14

It is incumbent upon the wingmen to be familiar with each of the above break procedures and know their respective roles following the break. The new role will depend not only on the break formation, but also the break direction. For example, if the Diamond formation executed a left break, the roles would be different than stated above.

Similar to section procedures, the division will be put in the proper break formation no later than 3-5 NM from the initial. For safety of flight considerations, every member of the division is responsible for proper position approaching the initial. Out of the break, the Lead will call abeam for the flight. The elements of the division will then complete landing checks individually and report "Dash-X three down and locked" in order.

NOTE

If a formation other than Echelon is flown to the break, the first aircraft out of the break to hit the abeam will become the lead. Each aircraft will be renumbered in order and make pattern calls appropriately (i.e., in ***Figure 7-15***, for a right hand break using the diamond formation, Hammer-13 will assume the role of lead at the abeam.)

2. IFR Recovery

Division IMC recoveries are prohibited because of the risks associated with configuring the flight and achieving flight separation in instrument conditions. Therefore, divisions are split into two sections prior to recovery. Each section will execute a section approach in accordance with normal procedures. If weather dictates, the flight lead may elect to breakup the flight and recover using single ship procedures.

The section leads (Hammer-11 and Hammer-13) may also elect to further split into individuals if the conditions at the destination warrant. Sequencing and obtaining individual squawks is normally coordinated with approach control. Headwork dictates that the aircraft be detached in order of fuel state.

706. DIVISION EMERGENCIES

1. Inadvertent IMC (Division)

If a formation flight inadvertently enters the clouds, and it is obvious that IFR conditions will prevail more than momentarily, the flight lead will transition to instrument flight and level his wings. When steady, the Lead may coordinate a new squawk and callsign with ATC, and detach the second section.

Another option for a division lead is to reverse his heading in a shallow, gentle turn to exit the IMC conditions. Turns should be made away from the second section in a division formation.

CHAPTER EIGHT
DIVISION CAS TACTICS AND PROCEDURES

800. INTRODUCTION

Close air support (CAS) can be conducted at any place and time friendly forces are in close proximity to enemy forces. The word "close" does not imply a specific distance; it is situational. Detailed integration due to proximity, fires, or movement is the determining factor. At times CAS may be required to exploit tactical opportunities; it provides firepower in offensive and defensive operations to destroy, disrupt, suppress, fix, harass, neutralize, or delay enemy forces.

Each service prepares to employ CAS within its roles as part of the joint force. As a result, a variety of aircraft are capable of performing CAS. The Joint Force Commander (JFC) and staff must be capable of integrating all CAS capabilities into the Operational Plan.

801. PRINCIPLES OF CLOSE AIR SUPPORT

CAS is used to attack the enemy in a variety of environmental conditions, during day or night, and to augment other supporting fires. The speed, range, and maneuverability of aircraft allow them to attack targets that other supporting arms may not be able to effectively engage. In order to accomplish this complicated mission, certain terms and ideas must be understood by ground forces and aircrews.

1. Definitions/Concepts

   a. CAS - Close air support (CAS) can be defined as air action by fixed and rotary wing aircraft against hostile targets in close proximity to friendly forces, requiring detailed integration of each air mission with the fire and movement of those forces.

   b. Controller - All references to "controller" in the rest of this FTI can refer to a Joint Terminal Attack Controller (JTAC), a Forward Air Controller (FAC), or a Forward Air Controller (Airborne) (FAC(A)). If a specific type of controller is required, it will be referenced directly.

   c. Types of CAS - Close Air Support missions are divided into two distinct mission categories, Preplanned and Immediate.

      i. Preplanned – CAS in accordance with a program planned in advance of ground operations.

      ii. Immediate – CAS to meet specific, real-time requests that arise during the course of battle and by nature cannot be planned in advance.

d. Preplanned - Preplanned CAS missions are further categorized into Scheduled and On-call missions.

i. A Preplanned Scheduled CAS mission is an air strike that has been requested by a supported ground unit sufficiently in advance to permit detailed mission planning and coordination prior to takeoff. These missions are flown against a predetermined target and executed at a precise Time-On-Target (TOT) specified by the supported unit.

ii. A Preplanned On-call mission is a mission where the aircraft are preloaded for a particular type of target and then placed in a standby ground or airborne alert status. On-call missions are then executed only when the requesting unit calls for them. Detailed mission planning and briefing of aircrews on all mission essential information is normally not possible prior to takeoff.

e. Immediate - An Immediate CAS mission is an air strike on a target that was not requested sufficiently in advance to permit any mission coordination or planning. These missions are executed in response to urgent requests by the supported ground unit to strike targets of opportunity. Urgency often requires that aircraft be diverted from a preplanned mission supporting one ground unit to an immediate mission for a different ground unit. Mission coordination is often accomplished while the flight is en route; the aircraft is usually briefed by the terminal controller. Most immediate CAS requests are filled with on-call missions.

f. Terminal Attack Control - There are three types of terminal attack control or weapons release authorization: Type 1, Type 2 and Type 3.

i. Type 1 Control: Type 1 control is used when the controller must visually acquire the attack aircraft and the target for each attack. This strict control is required to reduce the risk of affecting friendly forces and to reduce collateral damage.

NOTE

Attack aircraft are required to validate target locations by all means necessary: map plot, target designation on digital map, heads-up display symbology, FLIR, radar, visual recognition, etc.

(a). Type 1 is the most restrictive type of terminal control and is the default control for training. During Type 1 control you must hear "CLEARED HOT" from the controller prior to releasing any ordnance.

ii. Type 2 Control: Type 2 control will be used when the controller requires control of individual attacks and any or all of the following conditions exist:

(a). Controller is unable to visually acquire the attack aircraft at weapons release

(b). Controller is unable to visually acquire the target

(c). Attacking aircraft is unable to acquire the mark/target prior to weapons release.

This control is used in adverse weather, at night or with standoff weapons (JDAM, JSOW, LGB, etc.). During Type 2 control you must hear "CLEARED HOT" from the controller prior to releasing any ordnance.

iii. Type 3 Control: Type 3 control is used when the controller requires the ability to provide clearance for multiple attacks within a single engagement and any or all of the following conditions exist:

(a). Controller is unable to visually acquire the attack aircraft at weapons release

(b). Controller is unable to visually acquire the target

(c). Attack aircraft is unable to acquire the mark/target prior to weapons release.

Type 3 control does not require the controller to visually acquire the aircraft or the target; however, all the targeting data must be coordinated through the supported commander's battle staff. The controller will provide the CAS aircraft with targeting restrictions (e.g., time, geographic boundaries, final attack headings, specific target set).

Following the mandatory read-back by the CAS asset, the controller then grants a blanket weapons release clearance such as, "CLEARED TO ENGAGE" prior to initial weapons release. The attack aircraft will provide "COMMENCING ENGAGEMENT" to the controller. After completion of attack runs, the attack aircraft will provide "ENGAGEMENT COMPLETE."

g. Additional Considerations for All Types of Control - Controllers will provide the type of control as part of the CAS briefing. It is not unusual to have two types of control in effect at one time for different flights. For example, a controller may control helicopters working Type 2 control from a Battle Position (BP) outside the controller's field of view (FOV) while simultaneously controlling medium- or low-altitude attacks under Type 1 or Type 3 control.

Because there is no requirement for the controller to visually acquire the target or attack aircraft in Type 2 or 3 control, controllers are required to coordinate CAS attacks using targeting information from an observer. An observer may be a scout, COLT, FIST, UAS, JFO, SOF, CAS aircrew, or other asset with real-time targeting information.

The controller(s) maintain "ABORT" authority at all times.

h. Advantages of CAS:

i. Greater destructive power

ii. Ability to attack targets that are safe from other supporting arms (i.e., beyond the range of naval gunfire and artillery)

iii. Ability to employ a wide variety of ordnance and tactics

iv. Ability to engage moving targets

v. Ability to reattack if threat environment is permissive

vi. Ability to observe the battle area and engage targets unseen from the ground

i. Requirements for effective CAS - In addition to offering many advantages over other supporting arms, CAS also has some very strict requirements that must be satisfied in order to be effective:

i. Requires local air superiority to provide security for the strike aircraft

ii. Requires suppression of enemy air defenses

iii. Ground commanders must provide the FACs with a responsive and effective means of marking the targets for the CAS aircraft

iv. Generally requires favorable weather

v. Requires flexible control

vi. Requires effective two-way communication

vii. Requires a prompt response by the CAS aircraft to the ground commander's request

viii. Requires aircrew and terminal controller proficiency in order to successfully execute the complex CAS mission

802. MISSION PLANNING

As with all missions, pre-flight planning is critical for success in CAS. The factors involved are varied, complex, and dynamic. The overall main planning factors involved are:

a. Mission objective

b. Friendly situation

  i. Deep, close, or rear ops

  ii. Offensive/defensive ops

c. Ground Combat Element (GCE) scheme of maneuver

  i. Supported unit positions

  ii. Attack axis

  iii. Control measures

  iv. Timing

d. Enemy Situation

  i. Potential targets

  ii. Ground air capabilities

  iii. IADS (Integrated Air Defense System) locations/capabilities

  iv. Assessment of threat (discussed in detail later)

    (a). Low

    (b). Medium

    (c). High

1. Target Area Study/Chart Preparation

CAS missions require precision and coordination; being familiar with the target area is one of the keys for success. The first step in planning a CAS mission is to prepare a chart of the AOR or target area. Use a TPC (1:500,000) or preferably a JOGAIR (1:250,000). Plot all the CPs/IPs that are listed by Lat/Long or UTM grid in the Air Annex of the Air Tasking Order. Remember

CPs/IPs are easily identifiable geographical reference points from which the FAC can coordinate a CAS mission and deliver aircraft to the target.

Once in the aircraft, enter each CP/IP under a waypoint so that GPS/INS steering to each is available. Next, plot the Forward Line of Troops (FLOT) and the Fire Support Coordination Line (FSCL). These lines can change rapidly depending upon the speed of the advance so get the latest updates from the DASC. Any air-delivered ordnance between these two lines must be coordinated with the ground commander who owns the area.

Effective tools for the aircrews in CAS are the 1:50,000, 1:100,000, and gridded imagery charts. The target area minimum safe altitude, terrain funneling features, possible threat locations and avenues of approach (roads, trails, river washes, etc.) should be annotated. The correct datum should be briefed and used. In the absence of a 1:50,000 chart, for this syllabus we will use satellite imagery of the target complex to mark and identify targets passed by the FAC(A) via talk-on.

Fire Support Coordination Measures (FSCM) need to be confirmed and reviewed. On the maps, FSCMs are shown as black solid or dashed lines; they can be effective immediately, at a scheduled time or on-call. Figure 8-1 gives an example of a restrictive No Fire Area (NFA) and a permissive Free Fire Area (FFA). These FSCMs must be plotted on charts!

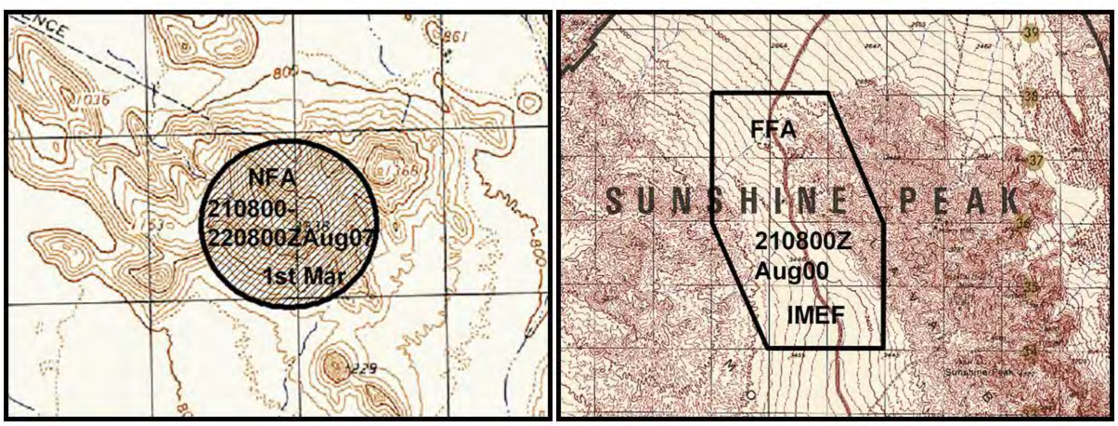


Figure 8-1 NFA and FFA Plotted on Chart

Due to the dynamic nature of CAS, not all missions will allow for extensive pre-flight target area or map study. However, if aircrews have the potential to be re-directed to CAS missions, being familiar with regional CAS procedures and potential target areas cannot be overemphasized.

It is essential for aircrews to have the information available to them in the cockpit while conducting CAS. "Smart Packs" are commonly used with CAS missions due to the complexity of the mission and the precision required for its execution. Smart Packs normally include a map with plotted FSCMs, friendly boundaries and targets if pre-planned. They also include target area imagery, 9-Line cards, CP/IP matrix, waypoint plans, frequency plans and weaponeering cards. Figure 8-2 is a map overview image with the VT-86 CP/IP matrix and FLOT/FEBA plotted for CAS missions in the R4401 Shelby Range. The CPs are green, the IPs are blue and the target is a red triangle.

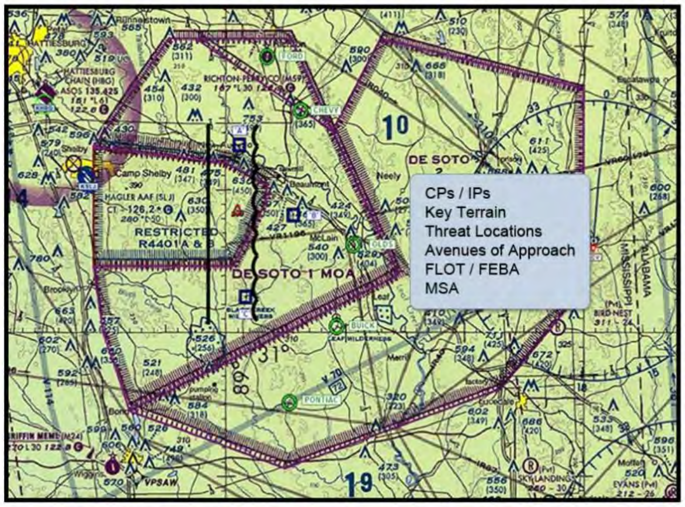


Figure 8-2 Shelby Range CAS Chart Overview

Figure 8-3 is an example of the Shelby Range target area imagery required for CAS missions in VT-86. Note that the FLOT, FSCL, Friendly Forces (blue) and potential enemy targets are plotted. Orienting the target area in terms of cardinal headings, funneling features and ground forces will aid in quick acquisition of the targets when inbound for an attack. This is especially true for high-threat scenarios where strikers come in low and then pop up to acquire and attack the targets. Pay particular attention to roads, runways, clearings etc., as these easily identifiable features will likely be used by the FAC(A) to talk aircrews onto the marks or targets.

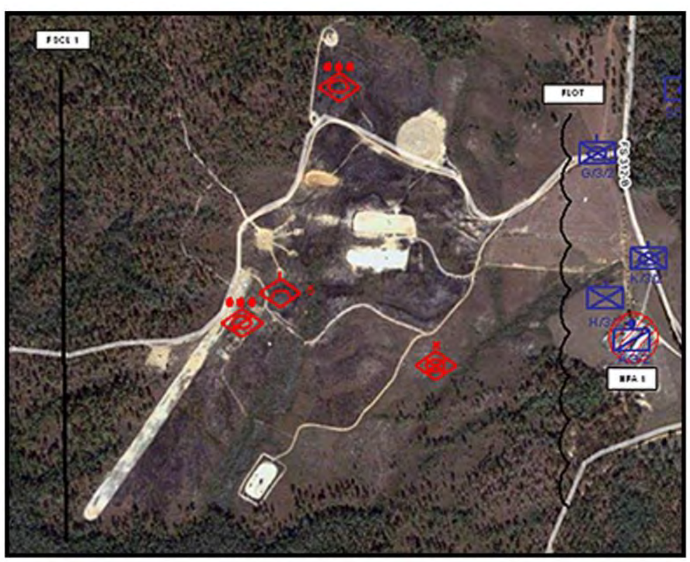


Figure 8-3 Target Area Imagery with Friendly Forces/Potential Targets

CAS missions in VT-86 will be conducted in Shelby Range or the Pensacola South MOA. Sequences 2 and 3 in the aircraft waypoint loads are reserved for these two areas and are not to be changed; the applicable sequence will be boxed throughout the mission. Sequence 1 is open for SNFO manipulation, and will be used for setting up the CP-IP-TGT-ECP sequence after receiving the JTAR or 9-Line.

2. CP-IP Matrix

Once each CP and IP is plotted, build a heading and distance matrix. Take a blank CAS Briefing Card and list all the CPs down the left side and all IPs across the top. Next, measure the heading and distance from each CP to each IP and enter it in the appropriate box. This matrix provides a quick reference for determining the distance from each CP to each IP. Simply add the IP to target distance to the CP to IP distance to determine the total distance to the target.

3. Distance/Groundspeed Matrix

The Distance/Groundspeed Matrix is a quick reference for computing the enroute time from the CP to the target, depicting Time-to-Go (TTG). TTG reflects the time required to fly a given distance, based on a groundspeed of 360 knots (6 NM/min). TOT is the time at which ordnance will impact the target, not the time the aircraft will be overhead the target. Because of this, the aircrew must take into account the effect that the delivery maneuver and bomb time of fall will have on timing to the target. For all T-45 tactics, use 15 seconds for maneuver and bomb time-of-fall. NFS will use TTG to overfly the target plus 15 seconds to figure push time to make the FAC(A) assigned TOT.

4. Briefing

The following items should be present or completed prior to the CAS briefings:

a. File a DD 175 flight plan or put appropriate stereo route on file

b. Set up the briefing board with Z diagrams (in MSL and AGL) and safety data

c. Prepare a kneeboard card for the instructor with Z diagrams in MSL and AGL

d. Ensure kneeboard packs include all charts and planning materials covered above

e. Have a briefing guide and T-45C models in briefing room

f. Have a tactical callsign for the flight

The Instructor aircrew will conduct a FAC-to-Fighter briefing outlining general CAS AOR procedures, deconfliction and safety. After the FAC-to-Fighter briefing, the Lead SNFO will conduct an admin briefing, covering Admin, TAC Admin, Emergencies and expected delivery tactics. Finally, Lead IP will finish with a more in-depth discussion of formation coordination and tactics.

803. COMMUNICATIONS

Due to the close proximity of enemy and friendly forces during CAS operations, open radio nets are vulnerable to compromise, endangering friendly forces both on the ground and in the air. Secure communications are facilitated by KY-58 (encrypted radio communications) usage and aircrews need to be completely familiar with its use as well as HAVEQUICK and SINCGARS (modes of the radio that provide anti-jam capabilities). Even the most sophisticated forms of communication can still be subject to jamming and intrusion. Always be prepared to conduct your mission through unsecure communications. To ensure general communications security (COMSEC) when using unsecure frequencies, the use of authentication procedures and code words are frequently used.

1. Authentication

Authentication tables appear as a square card containing scrambled letters with the numbers zero through nine across the top. There are up to 26 rows with the letters of the alphabet down the side. In each row, there are 26 letters (Figure 8-4). Authentication cards are only valid for six-hour periods based upon a Zulu time over a 24-hour period (i.e., 0000-0600, 0600-1200, etc.), so it is important to use the proper card for the correct Zulu Time of Day.

	0	1	2	3	4	5	6	7	8	9
A	FA	QLP	GBW	OI	DCX	VMU	EN	TYJ	SKZ	HR
B	LS	FVW	AQI	BX	JHT	PZG	OM	ERD	CNK	YU
C	IY	TVS	FOB	MQ	NAL	EJG	PK	DHU	RCX	ZW
D	UZ	CFN	JPQ	YD	MKG	HER	AT	SIV	OWL	XB
E	RY	KZL	PWJ	IE	DGX	BSQ	TA	UNF	CMV	OH
F	IT	XQW	SYD	ZH	FRB	PJN	VU	MOG	KLC	EA
G	FJ	SUT	WHI	PB	AKV	OZC	QN	MED	LXR	YG
H	ER	TWO	BXN	HC	LQF	VMS	PD	AZU	YGK	IJ
I	NV	YJM	DXG	ZC	IOE	FPT	WB	HLK	SAR	UQ
J	WS	PEC	IAL	TG	QYJ	DKM	HO	RFB	UVX	ZN
K	ZK	UWA	VXE	CI	LQF	HBY	RG	TMJ	NDO	SP
L	ZL	RXT	KHJ	OU	GSW	BFM	IN	QAD	EPC	VY
M	KQ	WBH	NFR	ML	OTY	UAD	GZ	VCJ	PIS	EX
N	QX	YAM	BSL	KH	ORN	ETC	PD	UIF	JGZ	WV
O	MZ	VNS	PIK	QW	CAO	TFU	EB	LHJ	RXG	YD
P	UJ	TDW	FVC	EX	HPA	GSK	IM	NBO	LRZ	QY
Q	PT	XZA	JFD	YO	WEH	RNV	GQ	UIL	SMK	BC
R	TM	APR	KXV	ZJ	WGN	IEU	YO	QDH	BSL	CF
S	WS	PNA	ZMI	YX	FKD	HCE	OR	LVT	JQU	GB
T	XD	LOF	WUT	KV	QGE	HNM	ZC	IBP	SJR	YA
U	RG	HTZ	ICF	DL	WAU	VKB	NM	PQX	JSY	EO
V	GD	ABF	WQX	RM	PKU	VCL	TE	IOY	JSH	NZ
W	JI	ETV	DLX	SN	RZY	GUB	FP	WAH	KQM	OC
X	VX	BZG	NSD	LU	EFT	YHW	MP	CQO	JKI	RA
Y	AP	MEB	KTQ	ZU	FSH	WXY	LG	RJC	NDO	VI
Z	NC	PVF	ZWU	OX	JKI	RMS	LH	DBY	QGE	AT

Figure 8-4 Authentication Table

2. Authentication Procedure

There are two procedures for authenticating: the two-letter and three-letter methods. In VT-86, the two-letter method is used, often remembered with the "down, across, down" nmemonic.

a. The challenger states, "authenticate" and provides two letters.

b. The receiver reads ***down*** the left side of the table until the first letter is located, then right, ***across*** the table until the second letter is found, then ***down*** one row to the answer. Perform the following example using the provided authentication table:

i. FAC (A) (Pri) - *"Hammer-11, authenticate Alpha Foxtrot."*

ii. Lead SNFO (Pri) - *"Grunt, Hammer-11 authenticates Lima"*

Fighters will often "come back" with a counter authentication to ensure the controller is authenticated.

3. Code Words

Code words are frequently used to refer to enemy threats and capabilities as well as friendly compositions and capabilities. Locations and altitudes are also encoded using a "base" number as a reference to keep from compromising friendly positions, i.e., "altitude base plus four." The following are examples of code words that might be used in a CAS environment:

a. SPEAR = SA-6 GAINFUL LAUNCHER

b. SPYGLASS = STRAIGHT FLUSH RADAR

c. CHAINSAW = AAA

d. SLINGSHOT = MANPAD

e. CUTLASS = SMALL ARMS

f. BASE = 0 (VT-86 will use Base=0 for training)

4. Check-In Briefing

VT-86 CAS aircraft will check-in on-deck with either the TAOC, the DASC, or both, as well as the JTAC or FAC(A) airborne. Figure 8-5 illustrates the check-in using the MNPOTTA format:

a. M Mission Number

b. N Number/Type Aircraft

c. P Position and Altitude

d. O Ordnance

e. T Time on Station

f. T Type Sensor/Capabilities

g. A Abort Code

Close Air Support Check-In Briefing

(Aircraft Transmits to Controller)

Aircraft: ______________________, this is ______________________
(controller call sign) (aircraft call sign)

1. Identification/Mission Number: ______________________

Note: Authentication and an appropriate response are suggested here.
The brief may be abbreviated for brevity or security("as fragged" or "with exception").

2. Number and Type of Aircraft: ______________________

3. Position and Altitude: ______________________

4. Ordnance: ______________________

5. Time on Station: ______________________

6. Type Sensor and Capabilities: (FAC(A), Sensors, Link-16)

____

7. Abort Code: ______________________

Figure 8-5 CAS Check-in (MNPOTTA)

Check-In ***on-deck*** (after clearance and alpha check complete). Example:

a. Hammer-11 - Lead SNFO, T-45 Strike Aircraft

b. Spartan - DASC

c. Hammer-11 (Aux) - *"Spartan, Hammer-11 ready to check-in"*

d. Spartan (Aux) - *"Hammer-11, Spartan, authenticate Alpha Foxtrot."*

e. Hammer-11 (Aux) - *"Spartan, Hammer-11 authenticates Lima"*

f. Hammer-11 (Aux) - *"Spartan, Hammer-11 counter-authenticate Sierra Hotel"*

g. Spartan (Aux) - *"Hammer-11, Spartan, authenticates Hotel."*

h. Spartan (Aux) - *"Hammer-11, proceed with your check-in"*

i. Hammer-11 (Aux) - *"Hammer-11 mission #210, 2 T-45s, on-deck NAS Pensacola, 4 Simulated Mk-82s on-board, 0+45 minutes of playtime, WGS-84, good GPS hack, we have JTAR 21-001 and 003, and SITREP G, Abort code Abort"*

j. Spartan (Aux) - *"Hammer, proceed to Olds, Hammer-11 base plus 7, Hammer-12 base plus 8. Contact me 10 miles east of Olds"*

Airborne check-in (after fence-in, range check-in and another authentication):

a. Hammer-11 (Pri) - *"Snake 11, Hammer-11 mission #210, 2 T-45s, 10 miles east of Olds base plus 7 and 8, 4 Simulated Mk-82s, TOS 0+30 , WGS-84, good GPS hack, JTAR 21-001 and 003 on-board, SITREP G"*

b. Spartan (Pri) - *"Hammer-11, copy all, proceed to Olds as briefed, contact Falcon 51 on Brown for tasking"*

c. Hammer-11 (Pri) - *"Falcon 51, Hammer-11/-12, established Olds, base Plus 7, base plus 8"*

After receiving the check-in, the controlling agency (TAOC, DASC, JTAC, FAC(A)) will update the SITREP and pass amendment to holding instructions if required. The JTAC or FAC(A) will also confirm charts on-board, get a time hack and pass the abort code if in question.

5. Situation Reports (SITREPS)

SITREPS give strikers the current information dealing with friendly and enemy positions, threats, ordnance required or restricted, and restrictions. SITREPS are usually identified by a letter (managed similarly to ATIS information). Example: The current SITREP is SITREP G. SITREPs will be passed by the TAOC, DASC, JTAC or FAC(A) in the TTFACOR format as follows:

a. T – Targets

b. T – Threats

c. F – Friendlies

d. A – Artillery

e. C – Clearance

f. O – Ordnance

g. R – Restrictions

h. L – Localized SEAD efforts

i. H – Hazards

Example of FAC(A), Falcon 51, passing a SITREP:

Falcon 51 (Pri)	*"SITREP G is current"*
T –	*"Targets in the vicinity of the Shelby Airfield"*
T –	*"Cutlass, Slingshot, and an un-located Spear in the area"*
F –	*"The FLOT runs from MV090802 through MV890654, FSCL runs from MV789093 through 838729"*
A –	*"B5S is at Gun Position 3"*
C –	*"Falcon has Type 1 Control"*
O –	*"1 bomb per pass, no CBUs"*
R –	*"All fixed wing aircraft stay above 10k AGL for threats"*
L –	*"B5S providing interrupted suppression 1 km north of your target area"*
H –	*"No other hazards of flight"*

Updates to recent information are often passed as changes-only, instead of restating the entire SITREP. Regardless, TTFACOR is a nmemonic used to remember all the pieces of information that need to be passed/considered; the order used to convey all the information is largely a matter of technique.

6. 9-Line Briefing

The 9-Line briefing is the standard JCAS format to transmit target and mission information to strike aircraft. The 9-Line format is as follows:

a. LINE #1 IP - Initial Point, often an easily identifiable geographical reference point used to orient the aircraft with the target.

b. LINE #2 HDG - Heading, given in degrees magnetic from the IP to the target. Also may include the offset direction (left or right) for weapons delivery tactics, airspace management, threat deconfliction and supporting fires coordination.

c. LINE #3 DIST - The distance from the IP to the target given in nautical miles, measured to tenths.

d. LINE #4 ELEV - Target elevation given in feet/MSL.

e. LINE #5 DESC - Brief description of the target to assist aircrew in visual target acquisition (i.e., six tanks in column east to west).

f. LINE #6 COOR - Target coordinates, given in either UTM grid coordinates or LAT/LONG.

g. LINE #7 MARK - The type of mark used to designate the target. (This can be ordnance, artillery, white phosphorous, smoke, illumination rounds, laser, IR marker, etc.)

h. LINE #8 FRDS - Location of the closest friendly position to the target. Referenced from the target and expressed in cardinal/subcardinal heading and distance in meters (i.e., south 800 meters).

i. LINE #9 EGRS - These are the instructions the aircrew use to exit the target area. Egress instructions can be given as a cardinal/subcardinal direction or by using control points (CP). The word "egress" is used before delivering the egress instructions.

j. REMARKS - Additional information, including threat location, active gun-to-target line, hazards to aviation, additional target information and other time considerations.

k. RESTRICTIONS - Instructions/procedures that will affect the aircraft's tactics and weapons delivery. Examples: final attack heading, altitude restriction, ACAs, danger close (DC) (if applicable and with commander's initials), and TOT.

The 9- Line briefing is transmitted to the aircrew by the controller who reads only the information necessary to fill in the 9-line briefing. The full 9-line briefing will be given in groups of 3 lines with a pause between each group of 3-lines. After the 9-lines are given, the controller will pass remarks (if any) and restrictions, including TOT. After typing in or verifying target coordinates, aircrews are required to read back lines 4 and 6 ***(from the aircraft system's waypoint page)*** as well as restrictions.

The first priority for SNFOs is to ensure the target coordinates are entered correctly. When this is accomplished, the timing from the CP – IP – TGT must be calculated quickly; if this timing is not known, SNFOs cannot accept or reject the given TOT. A great time to calculate this is when wingmen are reading back Lines 4, 6 and restrictions.

Aircrews should use as a kneeboard card to copy the 9-Line as the FAC(A) reads it (Figure 8-6). During and following the 9-line Briefing, the aircrew has the following options:

a. During the briefing, if the aircrew missed 1 or more lines of information, respond at the PAUSE between each 3-Line group of information with "*Say again line 1*" or "*Say again lines 4 and 5*." Never use the word "REPEAT" (it is a term used exclusively for artillery, meaning to fire another salvo on the same target location).

b. If the aircrew is unable to make the given TOT, then respond with *"unable."* If you are unable to make the TOT, then pass a TOT you ***can*** comply with in order to keep the situation efficient and get you to the target as quickly as possible. Example: "unable time 22, but can make time 24."

c. If you are able to comply with the given TOT, then respond by repeating the TOT, "*TOT 22*." This is now the contract between the aircrew and the FAC that your ordnance will hit the target at this agreed upon time.

Example:

Hammer-11/-12 = T-45 Strike Aircraft

Falcon 51 = FAC(A) Aircraft

Falcon 51 (Pri) - "*Hammers, advise when ready to copy 9-Line.*"

Hammer-11 (Pri) - "*Hammer-11, ready to copy.*"

Falcon 51 (Pri) - *"A, 180 Left, 4.5"* (Pause)

Falcon 51 (Pri) - "*300 feet, SPEAR, N3108.4 W08859.0"* (Pause)

Falcon 51 (Pri) - *"None, E 800M, egress east to OLDS. Advise when ready for restrictions."*

Hammer-11 (Pri) - *"Hammer-11, ready for restrictions."*

Falcon 51 (Pri) - *"One bomb per pass, remain east of Highway 29. Hammers read back lines 4, 6, 9, and restrictions when ready."*

Hammer-11 (Pri) - *"Hammer-11, line 4, 300 feet, line 6 N3108.4 W08859.0, one bomb per pass, remain east of Highway 29."*

Hammer-12(Pri) - *"Hammer-12, line 4, 300 feet, line 6 N3108.4 W08859.0, one bomb per pass, remain east of Highway 29."*

Falcon 51 (Pri) - *"Readback correct. HAMMER 11 TOT 53. HAMMER 12 TOT 54."*

Hammer-11 (Pri) - *"Hammer-11, TOT 53."*

Hammer-12 (Pri) - *"Hammer-12, TOT 54."*

Falcon 51 (Pri) - *"Hammers, advise when ready for chart talk-on"*

Hammer-11 (Pri) - *"Hammer-11"*

CLOSE AIR SUPPORT BRIEFING FORM (9-LINE)

Do not transmit line numbers. Units of measure are standard unless otherwise specified. Lines 4, 6 and any restrictions and mandatory read-back items. JTAC may request read-back of additional items as required.

Terminal controller: ______________, this is ______________
(aircraft call sign) (terminal controller)

1. IP/BP: ____________________

2. Heading: ________________ Offset ________ (left/right)

3. Distance: ___________________

4. Target elevation: _________________ (in feet above MSL)

5. Target description: _________________________________

6. Target location: ____________________________________
(latitude/longitude, grid coordinates, offsets or visual)

7. Type mask: ________________ Code: ____________
(WP/laser/IR/beacon) (actual code)

Laser-to-target line:______________ degrees

8. Location of friendlies: __________________________

Position marked by: ________________________

9. Egress ______________________________________

- -

Remarks (as appropriate): ______________________________________
(Threats, hazards, weather, restrictions, ordnance delivery, attack heading, danger close, or SEAD)

Time on target: TOT_________________

— or —

Time to target: standby________ plus ________ ...Hack

Figure 8-6 Standard 9-Line Kneeboard

7. Joint Tactical Air Request (JTAR)

JTARs (Figure 8-7) are preplanned CAS missions utilized by DASCs and FACs to expedite the passing of target information for preplanned targets in the CAS environment. JTARs incorporate mission information utilizing the same 9-line format. If strikers have a specific JTAR onboard, FACs will have strikers execute the appropriate JTAR, changing any of the information as necessary. As with a 9-line briefing, strikers have the same obligation to read back lines 4 and 6 ***(from the aircraft system's waypoint page)*** as well as restrictions.

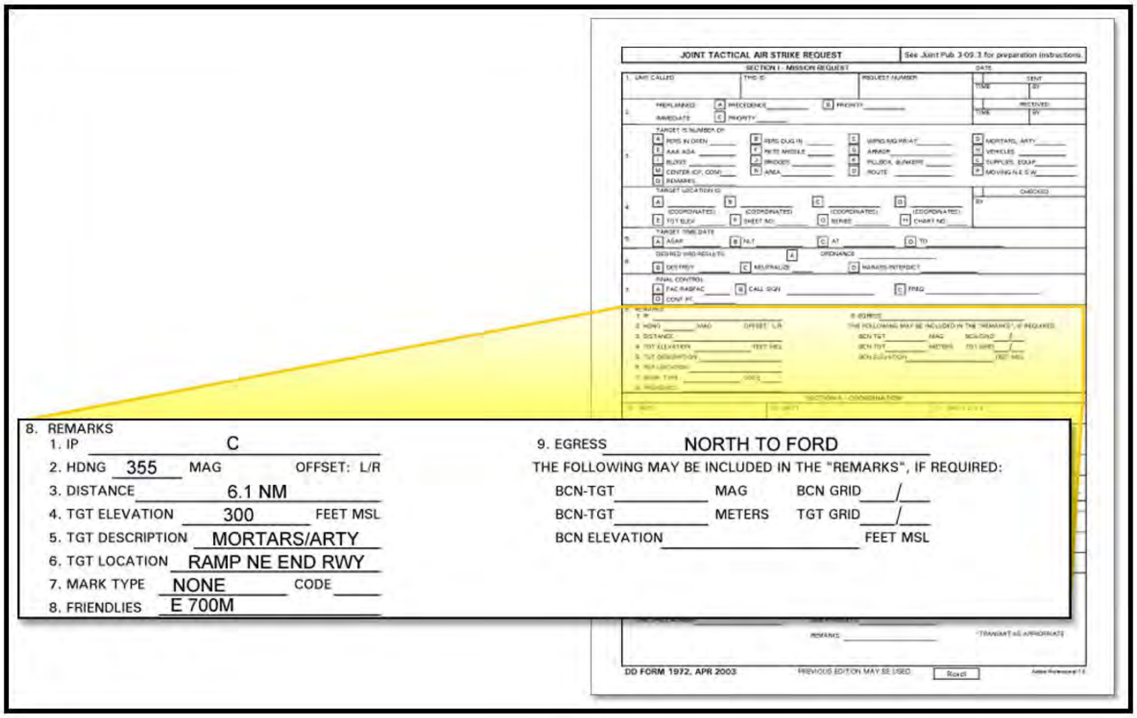


Figure 8-7 Joint Tactical Air Request Form (JTAR)

Example:

Hammer-11, 12 = T-45 Strike Aircraft

Falcon 51 = FAC(A) Aircraft

Falcon 51 (Pri) - "*Hammer-11, understand you have JTAR 06-001 on board?"*

Hammer-11 (Pri) - *"Hammer-11, affirmative."*

Falcon 51 (Pri) - *"Hammers, standby to execute JTAR 06-001. Change line 4 to read N3108.3, W08859.0. Advise when ready for restrictions."*

Hammer-11 (Pri) - *"Hammer-11, ready for restrictions."*

Falcon 51 (Pri) - *"One bomb per pass, remain east of Highway 29. Hammers read back lines 4, 6 and restrictions when ready."*

Hammer-11 (Pri) - *"Hammer-11, line 4 300 feet, line 6 N3108.3 W08859.0, one bomb per pass, remain east of Highway 29."*

Hammer-12 (Pri) - "*Hammer-12, line 4 300 feet, line 6 N3108.3 W08859.0, one bomb per pass, remain east of Highway 29."*

Falcon 51 (Pri) - *"Readback correct. Hammer-11 TOT 48. Hammer-12 TOT 49."*

Hammer-11 (Pri) - *"Hammer-11, TOT 48."*

Hammer-12 (Pri) - *"Hammer-12, TOT 49."*

8. DASC Checkout Briefing (In-flight Report)

Following the attack the FAC(A) will provide the flight with a Bomb Damage Assessment (BDA). This data must be relayed to the DASC and TACC during the checkout (DASC checkout brief/In-flight Report). The BDA is extremely important as CAS agencies must decide whether more aircraft are necessary to attack the target. A sample of the information contained in a DASC checkout briefing is shown in Figure 8-8.

INFLIGHT REPORT (INFLTREP)

Aircrew transmits:

" ______________ , this is ______________ , INFLTREP, over."
(addressee) (aircraft call sign)

(authentication requested here, as required)

"This is ______________ , INFLTREP."

Line One/Call Sign ______________

Line Two/Mission Number ______________

Line Three/Location ______________
(latitude/longitude, UTM grid, place name)

Line Four/Time-on-Target ______________

Line Five/Results ______________

Remarks ______________
(Target area weather, significant sightings, essential elements of information)

Figure 8-8 In-flight Report

Example:

Hammer-11 = T-45 Strike Aircraft

Chieftain 97 = DASC

Hammer-11 (Pri) - *"Chieftain 97, Hammer-11, In-flight Report."*

Chieftain 97 (Pri) - *"Ready to copy."*

Hammer-11 (Pri) - *"Hammer-11 and 12, Mission #06-401, executed JTAR 06-001, TOTs 48, 48+30, 6 arty pieces disabled; next target, target coordinates N3108.3, W08859.0 TOTs 53 and 53+30, 1 Spyglass disabled, 1 Spear destroyed; next target, target coordinates N3108.4 W08859.0, TOTs 01 and 01+30, 3 tanks destroyed, 1 disabled, 1 company mechanized infantry killed or wounded. Worked with FALCON and GRUNT on BROWN; weather, clear; Spear launch, time 53+30. How copy?"*

Chieftain 97 (Pri) - *"Hammer-11, say again target coordinates."*

Hammer-11 (Pri) - *"Target coordinates N3108.3 W08859.0 and N3108.4 W08859.0."*

Chieftain 97 (Pri) - *"CHIEFTAIN 97 copies all. Frequency change approved."*

9. Laser Terminology

Use the following standard J-LASER calls when simulating laser guided weapons:

a. *"10 seconds"* – prepare to start laser designation in 10 seconds

b. *"Laser On"* – Call from the CAS aircraft to the designator to designate the target with laser energy

c. *"Spot"* – aircraft has acquired laser energy

d. "*Negative Laser"* – aircraft has not acquired the laser energy

e. *"Shift*" – call from the CAS aircraft to shift the laser spot from the offset point onto the target

f. *"Terminate"* – call from the CAS aircraft to stop lasing

804. FLIGHT CONDUCT/FLOW

The conduct of each CAS flight in VT-86 will be highly standardized so as to maximize training in the range area.

1. On Deck/Enroute/Range Check-in

Lead SNFO will check-in with the DASC on Tac Freq prior to taxi and will be passed current SITREP, holding instructions and FAC frequency. The flight will adhere to the IFR clearance and division flight procedures outlined in Chapter 7. Approaching the target area, the flight will obtain a lower altitude from ATC to cancel IFR, weather permitting, for entry into the MOA/Restricted area.

Clearance into the range will be obtained from Range Control. A restricted area may not be entered without clearance from the appropriate controllers. Clearance to enter the Range will be requested from the FAC(A) aircrew after TRADR; however, the SNFO shall be prepared to make the range check-in if necessary. The following flight information will be passed to Range Control on check-in:

a. Flight call sign

b. Number and type of aircraft in the flight

c. Position (relative to the target)

d. Ordnance onboard

The FAC(A) aircraft will proceed overhead the target for check-in while the remaining aircraft in the division proceed to the holding CP as assigned by the DASC. Once established in holding, the flight will check in utilizing the previously outlined communication procedures.

2. Fence-In/Range Procedures

Lead SNFO will ensure the division is fenced-in in accordance with the procedures outlined in Chapter 7. Once in the range, the FAC(A) will run the CAS scenario and will be the overall coordinator for safety and deconfliction. All dive clearances in the target area will be given by either Shelby Range Control or by the FAC(A). All instructions given by the FAC(A) and/or Shelby are mandatory, including assigned altitudes or directive communications.

3. Final Rendezvous/BDC/RTB

At the end of the scenario, all aircraft will be directed to an egress CP to rendezvous for the RTB. All aircraft will maintain their assigned altitude until they have all aircraft in sight. The FAC(A) aircraft will join as Hammer-13 or 14 as appropriate. In the division flights, battle damage checks are conducted as each aircraft joins the flight on the final rendezvous. Each aircraft will inspect the others as it crosses under into position. Once the flight is rejoined, the

FAC(A) aircrew will check out with Range Control. After the check-out, Lead SNFO will direct the flight to fence-out and switch to ATC. Lead SNFO will coordinate the division RTB as outlined in Chapter 7.

805. CAS TACTICS

CAS missions in VT-86 are designed to teach SNFOs basic CAS flow and procedures. The scenarios will be either Low-, Medium- or High-Threat scenarios with associated tactics. Keyhole CAS (low threat) is used to facilitate use of airspace in a low threat environment as shown in figure 8-16. All runs will be planned to be flown at 360 kts groundspeed. The overall flow for the VT-86 CAS missions is as follows:

a. Check in with DASC/check in with FAC(A)

b. Report Established in holding stack at CP

c. Execute a fuel check

d. FAC(A) passes mission JTAR/9-Line

e. SNFOs enter target coordinates into waypoint 1 and read back lines 4,6 and restrictions

    i. Read back coordinates off of waypoint page in jet

    ii. Calculate time from CP to TGT

f. FAC(A) passes TOTs

g. SNFOs read back TOTs

    i. If unable to accept a TOT, offer a new TOT

    ii. Calculate Push Time

    iii. ***If time permits***, enter CP-IP-TGT-ECP sequence

h. FAC(A) initiates chart talk-ons

i. SNFOs direct IP to ***push on time!!!***

j. Aircraft will push in 1 minute intervals

k. After pushing, SNFOs will complete Air-to-Ground checks (LATOMS-T) prior to IP

l. Execute Target attack and egress to ECP

m. FAC(A) passes BDA/BHA

n. Repeat the second attack in the reverse flight order (i.e., Hammer-13 now goes first, followed by Hammer-12/11…)

o. Proceed overhead for low threat talk-on (if time/fuel permits)

NOTE

SNFOs are reminded to push on time. Although using the entire system with the CP-IP-TGT-ECP sequence is desired, do not forget the priority. A common mistake is to be heads down typing in the sequence and missing the push time.

1. Holding

Upon check in with the DASC or FAC(A), the strikers will be assigned a specific altitude and given a CP for holding. For the purposes of safety at VT-86:

a. Each striker will be assigned an individual altitude for deconfliction.

b. Strikers will push to the target as singles.

Once all strikers are established in the holding stack (Figure 8-9) at the CP, the controller will pass mission data via the pre-assigned JTAR or an immediate 9-Line. Strikers will determine the time to push to make their assigned TOT and will hold appropriately. Typically, there are two types of holding techniques used in order to be at the CP at push time: perpendicular and parallel.

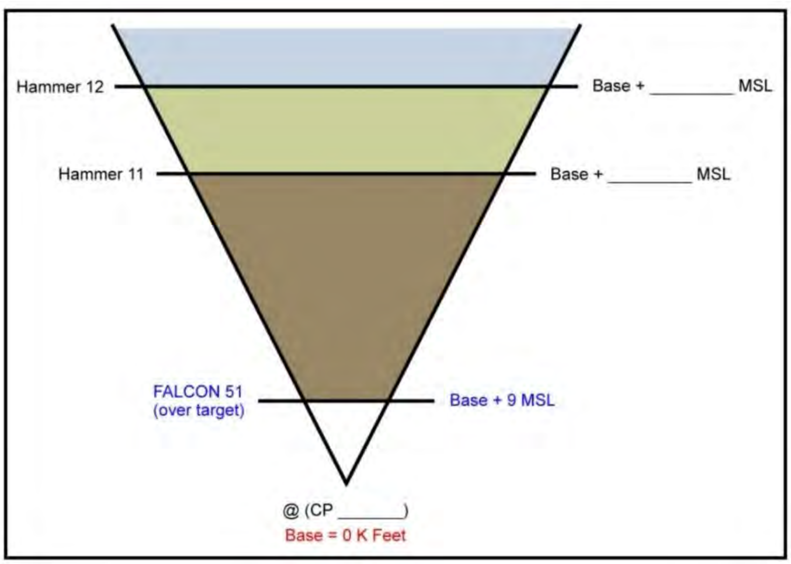


Figure 8-9 CAS Stack at CP

2. Perpendicular Holding

Perpendicular holding orients the flight in an oval or "figure 8" pattern over the CP and perpendicular to the CP/IP run-in line. Eight to ten nautical mile legs are flown centered on the holding CP, adjusted as required for airspeed, push time, threat, and airspace constraints. Turns of 180-degrees are standard, but the tactical situation, number of aircraft and formation must be considered. Advantages are that the aircraft are kept closer to the CP and it allows for larger timing corrections; if the FAC(A) needs an immediate push, a perpendicular pattern will allow for it. Disadvantages are that it may require aircraft to turn hard prior to push, resulting in slower initial airspeeds. Also, aircraft are not oriented toward the target or threat area to aid in pre-push visual lookout or sensor employment. ***Figure 8-10*** illustrates a perpendicular holding pattern.

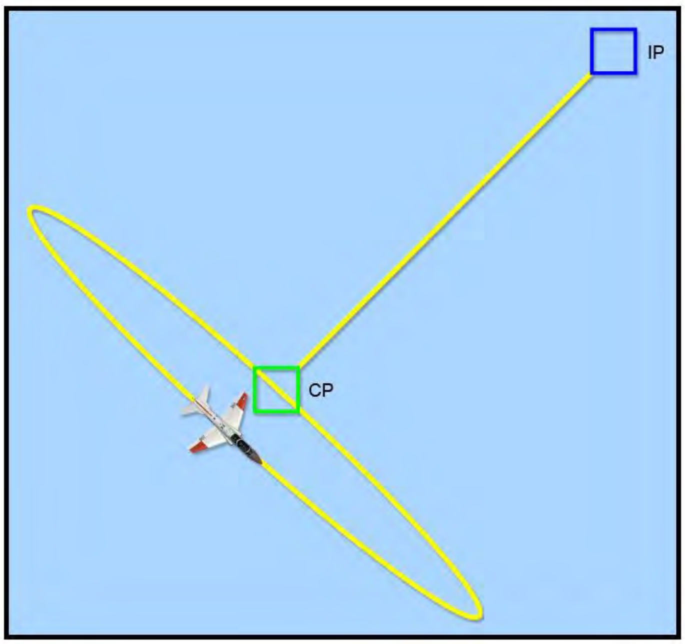


Figure 8-10 Perpendicular Holding at CP

3. Parallel Holding

Parallel holding orients the flight in a racetrack pattern over the CP, parallel to the CP/IP run-in line (Figure 8-11). Six to eight nautical mile legs are flown with 180-degree turns as the standard. An advantage of parallel holding is that it enables aircraft to approach the CP on the correct CP/IP heading. Additionally, it allows for sensor usage and visual lookout oriented toward the threat while flying inbound to the CP. Disadvantages are that it can place aircraft a minute or more away from the CP, and if, for some reason, the time hack is shortened, it may present a serious timing difficulty.

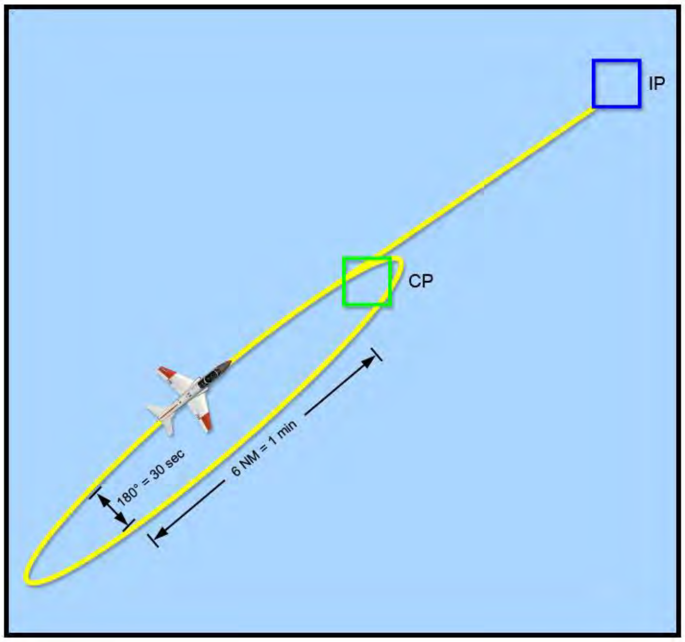


Figure 8-11 Parallel Holding at CP

4. Air-to-Ground Checks (LATOMS-T)

Prior to each target attack, SNFOs will conduct Air-to-Ground checks utilizing the LATOMS-T checklist:

a. L: LAW Set for Delivery

b. A : Air-to-Ground Delivery Mode (CCIP/MAN)

c. T: Target Elevation entered

d. O: Ordnance (Bombs/Guns/PGM)

e. M: Master Arm On

f. S: Symbology: No X's in the HUD

g. T: Target Designation/point

The LATOMS-T checklist will typically be executed NLT the IP in the Medium/High Threat ingresses, or NLT than the RIP in the Low Threat scenario. A normal sequence will have the SNFOs completing the LATOMS-T checks after the "Pushing" call.

5. Ingress/Target Area Tactics

The tactics used on the ingress and in the target area depend entirely on the expected threat in the target area. In general, there are three distinct threat levels that dictate our target area tactics: low, medium and high threat.

6. Low Threat CAS

A permissive, low-threat environment is always the preferred scenario when supporting our troops on the ground. It exists only after air supremacy is established, eliminating all air-to-air and surface-to-air threats. In a low-threat environment, aircraft loiter overhead the target with impunity, observing the battlefield and reacting to targets we receive via talk-on from the FAC or FAC(A). Low Threat CAS is conducive to dive deliveries, level LGBs and gun attacks (15-60 degrees).

Generally, CAS assets operate at higher altitudes in the target area to aid in target acquisition and to provide a sanctuary from enemy small arms fire and possible MANPADS. In the VT-86 syllabus, SNFOs will employ a 30-degree circular dive pattern overhead the target in a low threat scenario. Multiple aircraft will fly across the circle from each other in the overhead pattern and will be deconflicted in altitude by the FAC(A) (Figure 8-12).

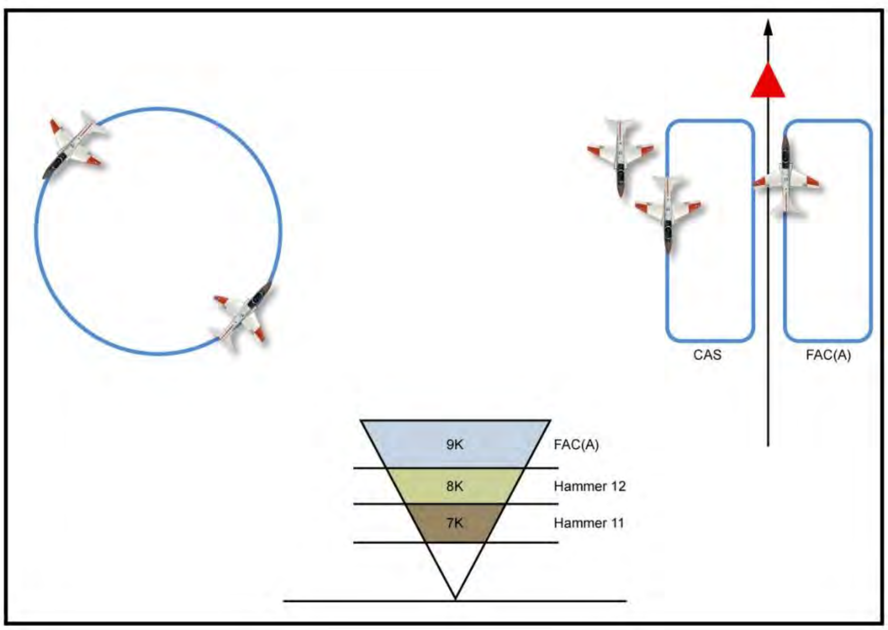


Figure 8-12 Dive Pattern Overhead Target, Low Threat

The CAS overhead pattern is similar but slightly different than a practice circle the wagons pattern. A practice pattern, with defined pattern points, is normally oriented about one target, whereas the CAS overhead pattern is centered over the target area. This allows for an immediate roll-in from any point on the circle to any target, as long as the attack heading is in compliance with FAC(A) attack axis restrictions. CAS aircraft should attempt to be across the circle from one another to provide mutual support for surface-to-air launches.

7. Visual Talk-Ons

Once established overhead, visual talk-ons will be executed by the FAC(A). Low Threat talk-ons will be performed as a FAC(A) to IP demo. SNFOs will annotate the assigned target on chart imagery for debriefing purposes. Some standard calls during visual talk-ons are:

a. *"Contact*" – Geo-Ref is in sight

b. *"Visual"* – Friendly aircraft/troops in sight

c. *"Tally"* – Target in sight

d. "*Not in sight, but I see…"*

Airborne mark/Arty mark:

a. *"FAC's in for the mark"* – FAC(A) is in dive for mark delivery

b. *"Mark's in the air*" – 10 to 20 seconds prior

c. *"Mark's on deck"* – Look for the mark at grid coordinates, geo ref, etc.

Example:

Hammer-11/-12 = T-45 Strike Aircraft

Falcon 51 = FAC(A) Aircraft

Falcon 51 (Pri) - *"Hammer-11, Falcon 51, are you contact the mark?"*

Hammer-11 (Pri) - *"Hammer-11, negative mark, but I see a north / south runway, with a road extending east from the north end of the runway."*

Falcon 51 (Pri) - *"Copy, using the north/south runway as a unit of measure, the target is half a unit from the north end of runway along that east running road, target is a tank pointed east."*

Hammer-11 (Pri) - *"Hammer-11, tally target."*

Falcon 51 (Pri) - *"Hammer-11, cleared for attack heading 160 to 210"*

Or:

Falcon 51 (Pri) *"Hammer-12, are you contact lead's hits?"*

Hammer-11 (Pri) *"Hammer-12, contact lead's hits"*

Falcon 51 (Pri) *"Hammer-12, from lead's hits, south 40 meters, target is a truck with a white tarp on the back"*

Hammer-12 (Pri) *"Hammer-12, tally target"*

Falcon 51 (Pri) *"Hammer-12, cleared for immediate attack, any heading"*

8. Medium Threat CAS

There may be certain scenarios where the threat level in the target area prohibits the loitering of friendly aircraft overhead the battlefield. Those threats could consist of heavy AAA or unsophisticated mobile SAM batteries. In those cases, strikers will generally hold outside the target area at an assigned CP/IP and ingress into the target area at high altitude to provide an altitude buffer above those threats, allowing sufficient time and airspace to defend against such a threat as required, as well as good overview of the target area for target acquisition. After completing their attack, strikers are directed to egress back to a CP/IP outside the threat ring for follow-on tasking or RTB. For the VT-86 syllabus, strikers will ingress into the target area at 8,000 feet AGL, utilizing a 30-degree dive attack.

After receiving the JTAR or 9-Line, typing the information into the system and reading back lines 4, 6 and restrictions, SNFOs are responsible for setting up the system for the attack. Once the push time is calculated and passed to the IP over ICS, SNFOs should build the attack sequence in SEQ 1 with the CP-IP-TGT-ECP matrix (time permitting). ***Always use waypoint 1 as the TGT waypoint for consistency***. If unable to build the sequence, push from the CP on time and use the waypoint load and overview chart for a heading to the IP. Then use the heading, distance, and offset from the 9-Line for the IP-TGT leg. CAS aircraft should push with SEQ 1 boxed, AUTO boxed, 10 NM scale and plan form on the HSI.

The FAC(A) will give the CAS aircraft a chart talk-on as they are waiting for the push time. If at any point the chart talk-on is too distracting, tell the FAC(A) to "Standby" and complete the required tasks. The chart talk-on can occur after the push if needed. SNFOs should plot the target on their chart based off of grid information and the chart talk-on.

As the push time approaches, SNFOs should keep their IP informed about the timing. A "1 minute to push" or "30 seconds to push" call is a great technique for ensuring both IP and SNFO are aware of the timing and are able to position the jet accordingly. Figure 8-13 gives a flow from the CP to the TGT with all the associated calls. Notice the Pri communications switch from SFNO to IP after the IP inbound call. The SNFO will assume the tactical communications again when enroute to the ECP. Figure 8-13 shows a Medium Threat CAS attack. The left side of the figure also summarizes the general flow to be expected while holding and copying the 9-Line.

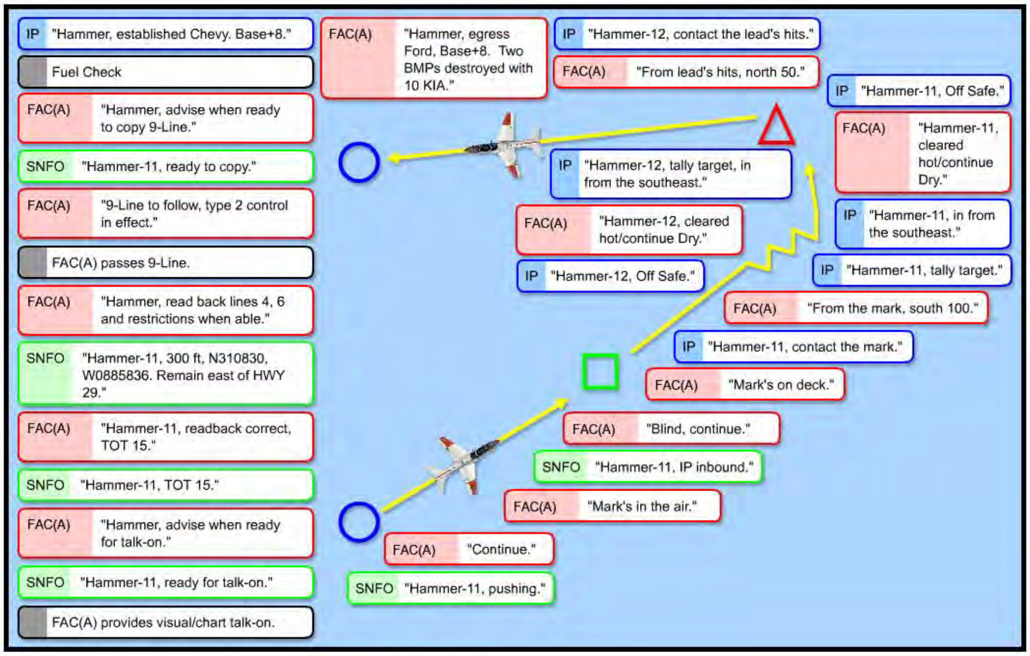


Figure 8-13 Medium Threat CAS Attack

Normally, the 30-degree Z-Diagram is used for Low- and Medium-Threat scenarios. Should weather preclude the use of the 30-degree dive pattern for the Low- or Medium-Threat scenarios, the 10-degree and 20-degree patterns will be briefed as an administrative contingency. Figure 8-14 illustrates the Z-Diagrams to be used for a 10-, 20-, or 30-degree dive attacks.

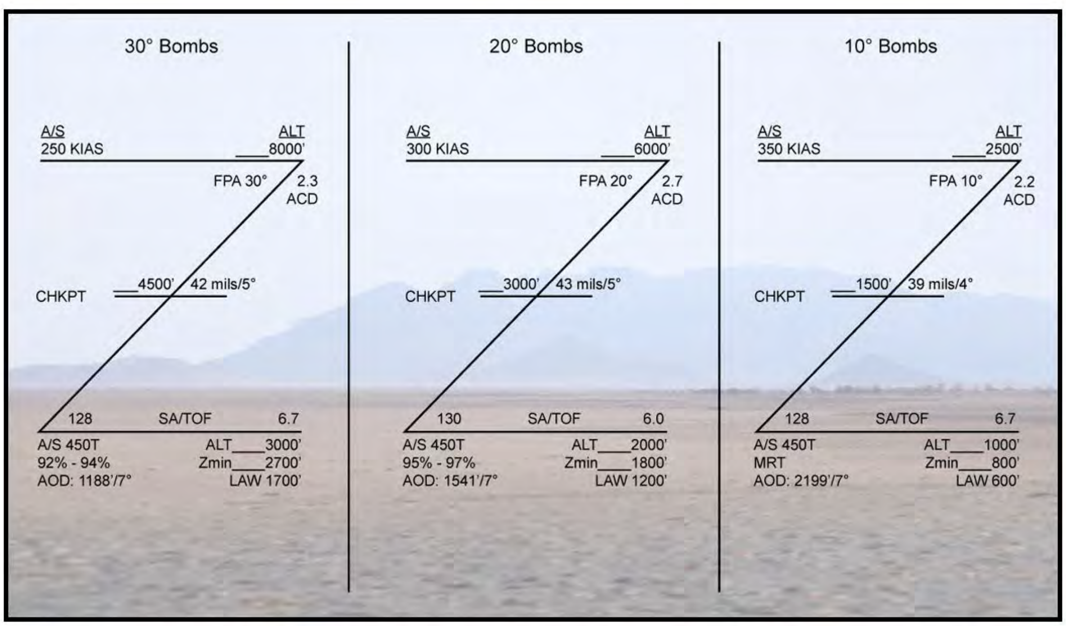


Figure 8-14 Z-Diagrams For CAS (Add Target Height For MSL)

9. High Threat CAS

When there is a significant surface-to-air threat in and around the target area, comprised usually of sophisticated SAM systems (or a low ceiling combined with small arms and/or MANPAD threats), the use of high-threat tactics becomes necessary. High-threat tactics usually consist of a low level ingress to utilize terrain masking, as well as SEAD support, while providing limited exposure to the threat.

Utilizing low pop tactics, strike aircraft are only vulnerable for a short period of time but at the expense of target acquisition time. For that reason, chart talk-on is generally a FAC technique to provide SA of the target area prior to striker ingress. Strikers are generally directed to egress at low altitude back to a CP outside the threat ring for follow-on tasking or RTB. VT-86 aircraft will utilize the same low level pop tactic previously introduced in section attacks (Figure 8-15), either as singles with one-minute separation or as a same-side section attack.

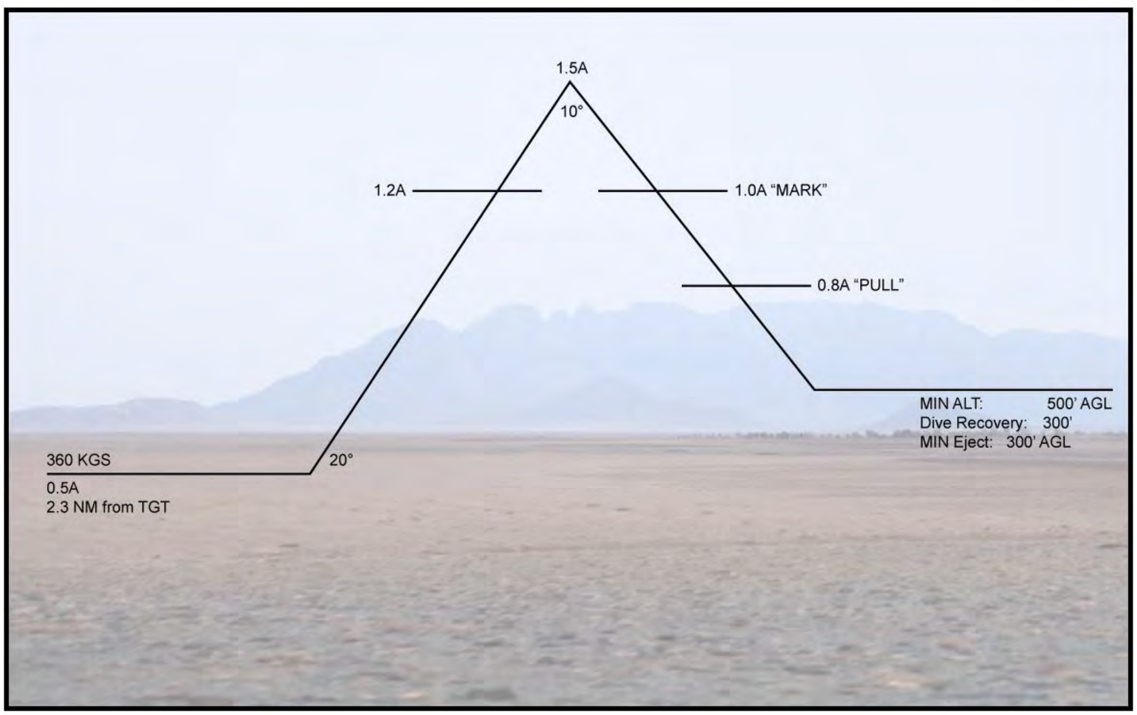


Figure 8-15 Pop Z-Diagram (Add Target Height For MSL)

The communication calls, timing and procedures are basically the same in a High-Threat scenario as those outlined in the Medium-Threat CP-TGT attack. The general procedural flow and communications illustrated in Figure 8-13 also apply to a High-Threat scenario. The difference is that the aircraft will ingress at low altitude and the IP will make the "Popping" call at the appropriate time. As in the Medium-Threat scenario, the SNFO is required to complete LATOMS-T checks after the "Pushing" call, prior to "IP inbound." Aircrews are reminded about Mission Crosscheck Times down at low altitude, especially in a high task environment like CAS.

10. Keyhole CAS / Precision Guided Munitions (PGM) CAS

Keyhole CAS works well in a low-threat environment; it allows the FAC to stack numerous aircraft near the target in different directions, giving a more expeditious flow from stack to TGT (Figure 8-16). This method was used quite effectively in the town of Fallujah. The FAC first reads the target location, and then gives a bearing and distance from the target to hold or from which to commence the attack. Keyhole allows CAS air assets to monitor the target area for an expedited response.

For the VT-86 syllabus, when CAS aircraft have simulated laser-guided or GPS-guided weapons on board, and the surface-to-air threat in the target area is permissible, plan on using the "Keyhole" Method for assigning IPs. The CAS aircraft will simply hold at the IP assigned by the FAC(A) at high altitude. Type II control will normally be used by the FAC(A) since the attacking aircraft most likely will not see the target prior to simulated release of ordnance. The CAS aircraft will remain at their assigned altitude throughout the attack and egress. Attacks will be made as singles with 1-minute separation between aircraft. VT-86 aircraft will simulate having one GBU-38 (GPS guided 500 lb. bomb) and one GBU-12 (laser guided 500 lb. bomb).

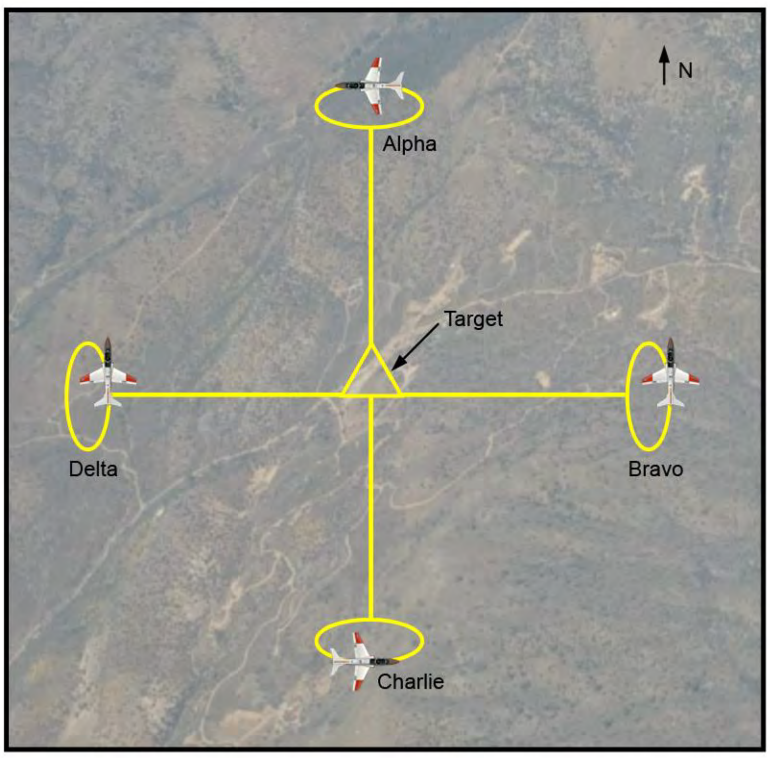


Figure 8-16 Keyhole CAS

Figure 8-17 illustrates the flow and procedures used for a Keyhole CAS with a level JDAM delivery. In this case, the target coordinates are critical. In other Keyhole CAS deliveries, laser target designators, IR pointers, FLIR/FLIR talk-ons or visual talk-ons may be used to acquire the target, but the basic flow and procedures remain the same. During Keyhole PGM deliveries at VT-86, SNFOs will provide all tactical communications.

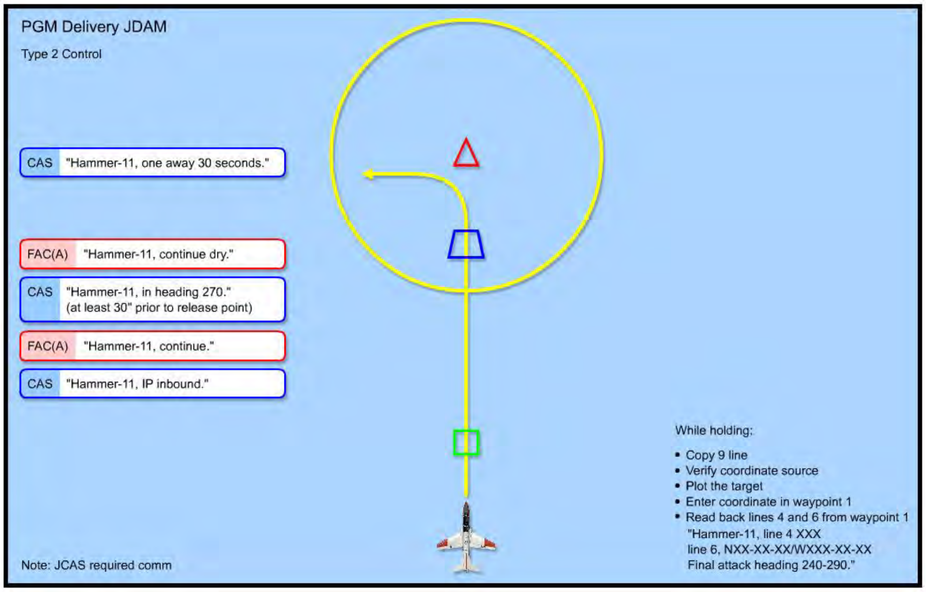


Figure 8-17 Keyhole CAS With A Level JDAM Delivery

806. CAS SAFETY

The dynamics of CAS and the weapons pattern require additional attention. The FAC(A) aircraft is the overall safety observer in the range complex, and will provide for deconfliction of aircraft.

1. Lost Sight/Lost Comm

Any time an aircraft loses sight of his proper interval, the potential for a mid-air exists. An aircraft with lost communications will remain at their assigned holding point and altitude where the FAC(A) or flight lead will conduct a rendezvous. If an aircraft goes NORDO while prosecuting ingress, the NORDO aircraft will climb to enter the lame duck pattern overhead the target.

If an aircraft experiences a serious problem while NORDO, the aircrew has the option to squawk the appropriate code and return to base or divert to an emergency airfield as required. The Lead may dispatch a wingman to assist.

2. Target Fixation

Every crew would like to get a bullseye on every run, but unfortunately, some have become so engrossed in achieving hits that they have flown into the ground by fixating on the target and disregarding the release altitude. This is especially a problem with forward firing ordnance where it is easy to "follow" the projectile's flight path. Last-second corrections usually result in both a false sight picture and a loss of altitude. SNFOs have traditionally played a large part in preventing mishaps due to pilot target fixation. Safety requires a continual scan of the altimeter in the low-altitude environment. Aborting a dangerous dive run is the responsibility of each member of an attack aircrew.

3. Lame Duck Pattern

The "lame duck" pattern is an administrative holding pattern for aircraft with problems that do not require an emergency divert, but prevent the aircraft from continuing with the weapons pattern.

The lame duck pattern will be overhead the target at an altitude briefed by the Lead and is normally 1,000 feet above the FAC(A)'s assigned altitude. Aircraft in the "lame duck" pattern will orbit in left-hand turns to indicate NORDO, or right-hand turns to indicate another or additional system problem. The aircraft will maintain assigned altitude. The FAC(A) aircraft will join on the lame aircraft after the scenario has been terminated and lead it to the off-target rendezvous. The NORDO or Lame aircraft will then be shuffled to the Dash Two position for division or section recovery.

The Lame Duck Pattern will be used for any minor emergency (i.e., immediate divert not required), overstress, airsickness, NORDO, etc.

4. Exceeding "G" Limits

Overstressing the aircraft in the weapons pattern is usually the result of snapping on G, instead of applying it smoothly when beginning the pullout after release. An overstress is determined by the G pulled relative to the aircraft weight. See the NATOPS manual for limitations. If an overstress occurs, the aircrew will notify the flight lead and proceed to the "lame duck" pattern.

APPENDIX A
GLOSSARY

A100. GLOSSARY OF CLOSE AIR SUPPORT TERMINOLOGY

Airspace Coordination Area (ACA) - The three-dimensional block of airspace in a target area, established by the appropriate ground commander, in which friendly aircraft are reasonably safe from friendly surface fires. The airspace coordination area may be formal or informal. Informal ACAs may be assigned real-time by the DASC, TAC(A), or controller and include phrases such as "remain east of the river," "remain at or above 7000," or "remain north of N 32° 18.0 feet."

Air Tasking Order (ATO) - Normally a joint publication, the ATO provides mission air tasking, assignments, and related coordination information for all air assets operating in the campaign, also known as the mission frag.

Contact Point (CP) - A CP is a point normally outside the range of enemy surface-to-air weapons where CAS aircraft contact the terminal controller. Marked by coordinates (latitude, longitude), conspicuous terrain feature or other identifiable object which is given a name or number, it is used as an aid to navigation or control of aircraft. It also serves as a place for aircraft to hold so they can receive the target briefing and coordinate an attack plan.

Coordinating Altitude - A procedural airspace control method to separate fixed-wing (FW) and rotary wing (RW) aircraft by determining an altitude below which FW aircraft normally will not fly and above which RW aircraft normally will not fly. The coordinating altitude is normally specified in the airspace control plan and may include a buffer zone for small altitude deviations.

Direct Air Support Center (DASC) - The principal air control agency of the US Marine Air Command and Control System (MACCS) responsible for the direction and control of air operations directly supporting the ground combat element. It processes and coordinates requests for immediate air support and coordinates air missions requiring integration with ground forces and other supporting arms. It normally co-locates with the senior fire support coordination center (FSCC) within the ground combat element, and is subordinate to the tactical air command center. (Non-radar capable)

Egress Control Point - A point located just outside the enemy air defense area that is used to control aircraft egress from the target area.

Fire Support Coordination Center (FSCC) - A single location for centralized communications facilities and personnel incident to the coordination of all forms of fire. Each FSCC is staffed with representatives of the various supporting arms such as artillery, air, and naval gunfire.

Fire Support Coordination Line (FSCL) - A line drawn on easily identifiable terrain and established by the senior ground commander. It serves as a limit to all supporting fire not directly under the ground commander's control and prevents ordnance from being delivered into that area of responsibility without authority. Targets may not be attacked between the FSCL and FLOT without first obtaining approval of the local ground commander.

Fire Support Coordination Measures (FSCM) - Measures employed by land or amphibious commanders to facilitate the rapid engagement of targets and simultaneously provide safeguards for friendly forces. Examples are forward line of own troops (FLOT), fire support coordination line (FSCL), restrictive fire areas (RFA), free fire areas (FFA) and no fire areas (NFA).

Forward Air Controller (FAC) - A member of the tactical air control party (TACP) who, from a forward ground or airborne position, controls aircraft in close air support of ground troops. (Commonly, but incorrectly used interchangeably with JTAC.)

Forward Air Controller (Airborne) (FAC(A)) - A specifically trained and qualified aviation officer who exercises control from the air of aircraft engaged in close air support of ground troops. The FAC(A) is normally an airborne extension of the tactical air control party (TACP).

Forward Edge of the Battle Area (FEBA) - The foremost limits of a series of areas in which ground combat units are deployed, excluding the areas in which the covering or screening forces are operating. FEBA is designated to coordinate fire support, the positioning of forces, or the maneuver of units.

Forward Line of Own Troops (FLOT) - A line that indicates the most forward positions of friendly forces in any kind of military operation at a specific time. The forward line of own troops normally identifies the forward location of covering and screening forces.

Fratricide - Fratricide is the killing of friendly forces, often referred to as "Blue on Blue." All CAS tactics, procedures, and techniques are designed to avoid fratricide while maximizing CAS effectiveness. Uncertainty, loss of SA, misidentification of targets, incorrect target coordinates and weapons malfunctions can cause fratricide. It is the responsibility of all participants to mitigate this threat. Training and proficiency are the keys.

Free Fire Area (FFA) - A specific area into which any weapon system may fire without additional coordination with the establishing headquarters.

Ground Combat Element (GCE) - Combat troops engaged on the ground; GCE stands to benefit the most from CAS missions.

High Density Airspace Control Zone (HIDACZ) - Airspace overlaying a tactical area and subject to high density use. A ground commander may activate a HIDACZ to restrict a volume of airspace from those not involved in the operation; effective only for the time needed to fulfill the tactical requirement.

Initial Point (IP) - An IP is a point designed to direct and control the flight path of attack aircraft. IPs are often visually significant and used to funnel aircraft toward the target from a specific bearing. It can also be used to avoid a surface threat for inbound attack aircraft. FAC(A)s can use the "IP inbound" call from attacking aircraft as a means of visually acquiring the attackers by scanning the area around the IP. Timing and coordination are paramount.

Joint Terminal Attack Controller (JTAC) - A qualified Service member who, from a forward position, directs the action of combat aircraft engaged in CAS and other offensive operations. A qualified and current JTAC will be recognized across the Department of Defense as capable and authorized to perform terminal attack control.

Marine Air Command and Control System (MACCS) - A functional duplicate of NTACS, but operates ashore supporting the landing force through control of air operations. The MACCS maintains two centers: TAOC and DASC.

Minimum Risk Route (MRR) - A route established that poses minimum hazard to transiting friendly aircraft in the vicinity of a specified tactical area. This route provides safe passage of aircraft through Missile Engagement Zones and Fighter Engagement Zones.

Navy Tactical Air Control System (NTACS) - Maintains command and control of all air operations during the initial phase of the assault until MACCS is established ashore.

No Fire Area (NFA) - An area designated by the appropriate commander into which fires or their effects are prohibited. NFAs usually exist around areas of strategic importance or around churches, hospitals, and schools, or any other area with a high percentage of noncombatants.

Permissive Threat - Threat exists at a predominantly low level; which permits CAS operations and support to continue along traditional lines with little interference from enemy EW, SAMs, AAA, fighters, etc.

Restrictive Fire Area (RFA) - An area in which specific restrictions are imposed, and into which fires that exceed those restrictions will not be delivered without coordination with the establishing headquarters.

Restricted Operations Area/Restricted Operations Zone (ROA/ROZ) - Specified airspace within which air operations are limited, established in response to specific situations and requirements such as CSAR or aerial refueling.

Restrictive Threat - A threat environment in which specific aircraft performance and weapons systems capabilities are allow for acceptable exposure time to enemy air defenses.

Sophisticated Threat - Integrated massing of heavy combat power to include EW, SAMs, AAA, and fighters. Sophisticated threats can seriously degrade CAS capability.

Standard Use Army Aircraft Flight Routes (SAFFRs) - Normally a route established below the coordinating altitude. These allow the Army commander to safely route the movement of aviation assets performing combat support. These routes do not cross the FLOT and normally do not restrict target area tactics.

Suppression of Enemy Air Defenses (SEAD) - Measures taken to neutralize or reduce enemy air defense effectiveness prior to or during CAS execution. This may be accomplished using HARM, EW, artillery, attack helicopters, infantry, or any combination thereof.

Tactical Air Control Party (TACP) - Headed by an air officer who is responsible for employment and coordination of all assigned supporting aircraft. Accompanies frontline rifle companies and provides terminal control of CAS aircraft with two Forward Air Control (FAC) parties.

Tactical Air Coordinator (Airborne) (TAC(A)) - The TAC(A) is an airborne extension of the DASC. The TAC(A)'s authority and responsibility can range from simple radio relay to having launch (takeoff), delay, and divert authority over other assets. In order to be effective, TAC(A)s must conduct detailed planning and integration with all supported units, including aviation, ground, and C2 units.

Tactical Air Operations Center (TAOC) - Detects, identifies, and directs the destruction of hostile aircraft and missiles (possesses radar capability). Also provides navigational aid and control of friendly aircraft to ensure their safety while in the AOA.