NAVAL AIR TRAINING COMMAND

NAS CORPUS CHRISTI, TEXAS **CNATRA P-819 (03-18)**

FLIGHT TRAINING INSTRUCTION

ADVANCED NFO STRIKE PROCEDURES T–45C

2018

DEPARTMENT OF THE NAVY
CHIEF OF NAVAL AIR TRAINING
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Subj: FLIGHT TRAINING INSTRUCTION, ADVANCED NFO STRIKE PROCEDURES, T-45C

1. CNATRA P-819 (Rev. 03-18) PAT, "Flight Training Instruction, Advanced NFO 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 NFOTS 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 the electronic TCR form located on the CNATRA website.

4. CNATRA P-819A (Rev. 01-14) PAT is hereby cancelled and superseded.

S. E. HNATT
By direction

Distribution:
CNATRA Website

FLIGHT TRAINING INSTRUCTION

FOR

ADVANCED NFO STRIKE PROCEDURES

T-45C

P-819

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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

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100. 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 VT-86 Advanced Strike syllabus will build upon these skills by introducing T-45C section procedures and coordinated tactical target attacks with simulated ordnance delivery. Emphasis during the Strike stage will be on Admin and Tac-Admin procedures, strike route procedures, target acquisition, situational awareness, air-to-surface (A/S) timeline awareness, and aircrew coordination. As with any syllabus flight, basic FAM flight procedures will be the bedrock of every successful event, and student 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, and tactical requirements such as “close air support” (CAS), and enemy Integrated Air Defense Systems (IADS). The VT-86 Advanced Strike syllabus is designed to expose the SNFO to both high and low altitude tactics and procedures.

Simply stated, before executing either high or low altitude deliveries, the target must be acquired. Additionally, 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 1-1):

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.

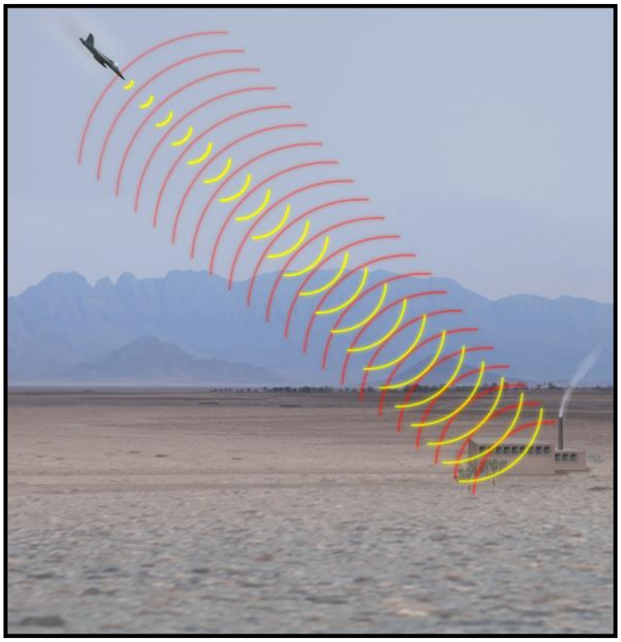


Figure 1-1 Echo Potential for a Target

Man-made metal objects with a vertical development 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, a 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 1-2 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.

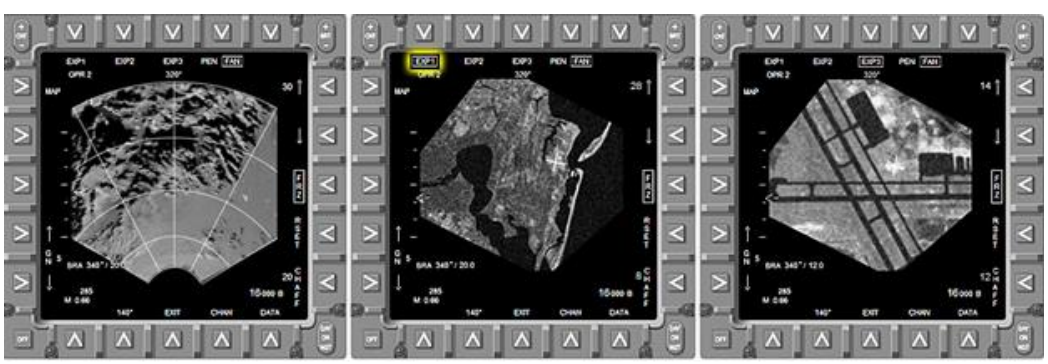


Figure 1-2 Radar Return Examples

101. CHART PLANNING

As with all facets of military aviation, pre-flight planning is paramount. SNFOs will be required to plan a flight from start to shutdown, including all administrative and tactical procedural requirements; contingency planning must be incorporated into each flight. It is rare for a flight or simulator sortie to go exactly according to plan, therefore "what if" scenarios must be considered. Weather, Air Traffic Control (ATC), enemy forces, aircraft emergencies, and weapon failures are a few of the issues that may be encountered on any given event. Thorough contingency planning will provide the aircrew 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 1-3):

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

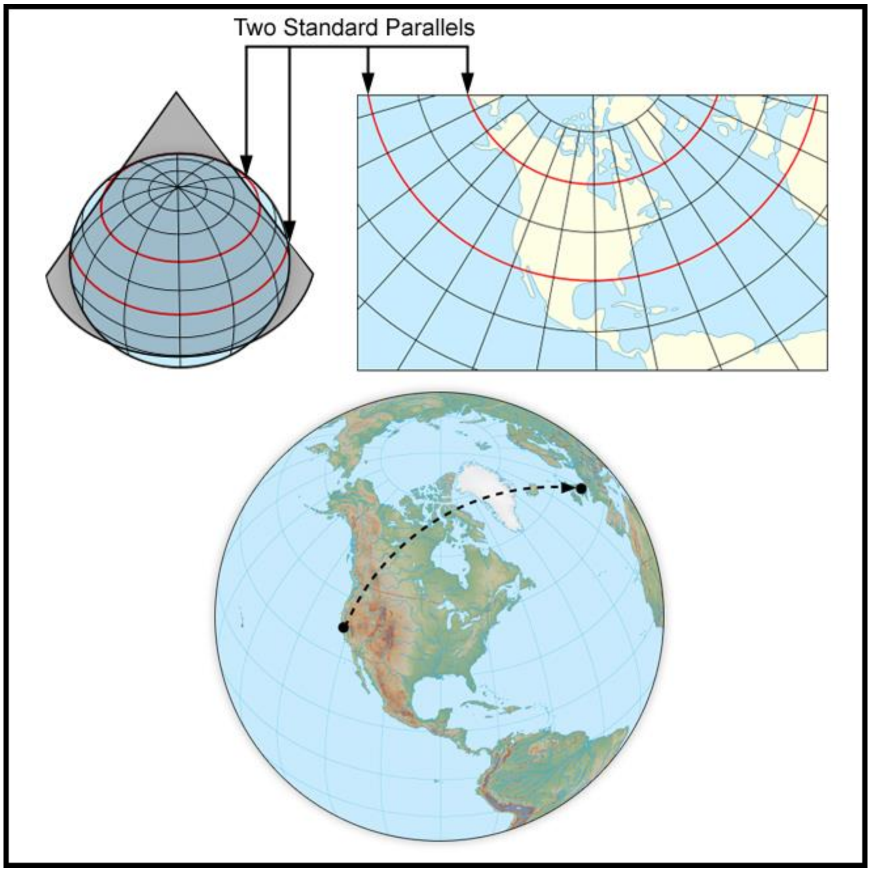


Figure 1-3 Lambert Conformal Chart

To tactically operate in an airspace, different charts will be used to provide detail and fidelity. The following charts are the most commonly used for military aviation (Figure 1-4).

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; used for 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; used for 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; used for 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 the tactical perspective at VT-86, the ONC and the TPC are the charts most applicable to the NFOTS syllabus; therefore, they are the most commonly utilized.

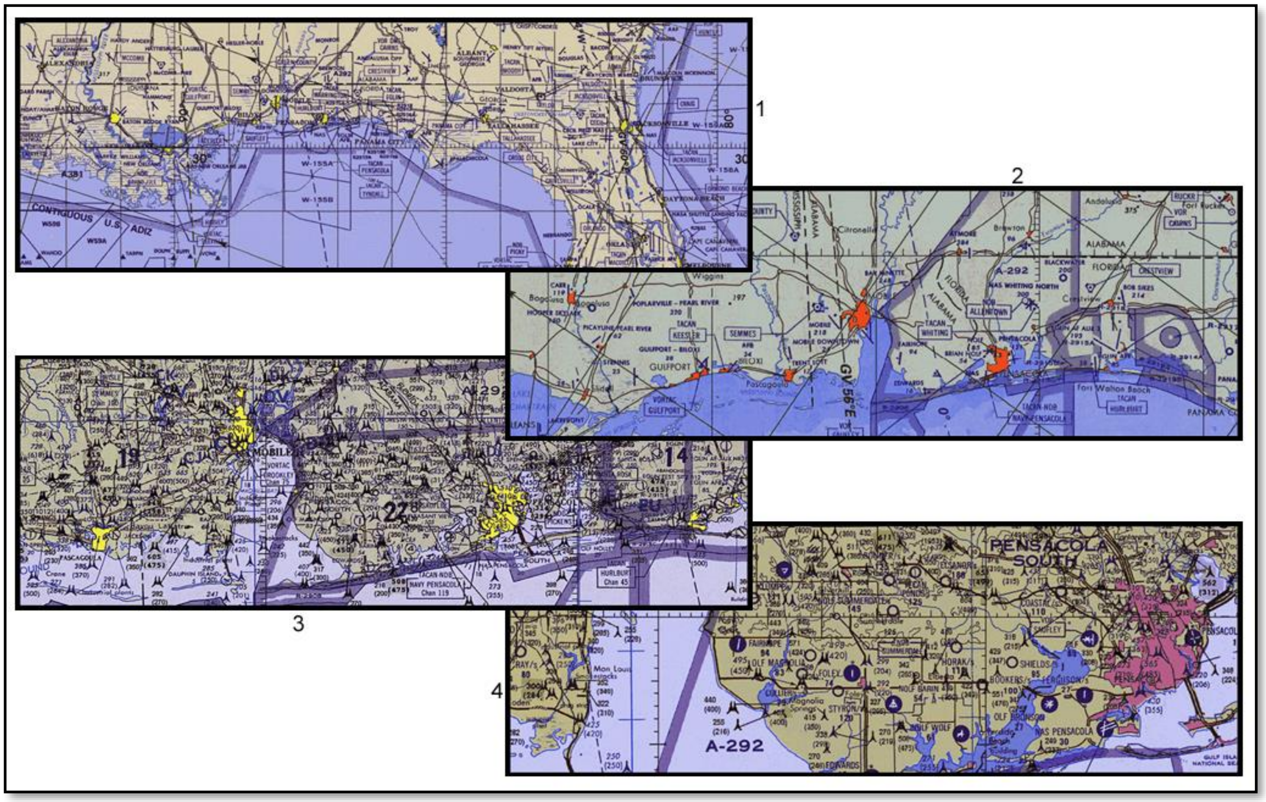


Figure 1-4 Chart Types

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 chart detail.

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 1-5)

   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 1-5)

   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 1-5)

   i. Dual-lane highways

   ii. Primary roads

   iii. Bridges

   iv. Power transmission lines

   v. Railroad tracks

   vi. Funneling features into towns/cities

Figure 1-5 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 1-6):

a. Chart scale

b. Intended use of the chart

c. Area covered

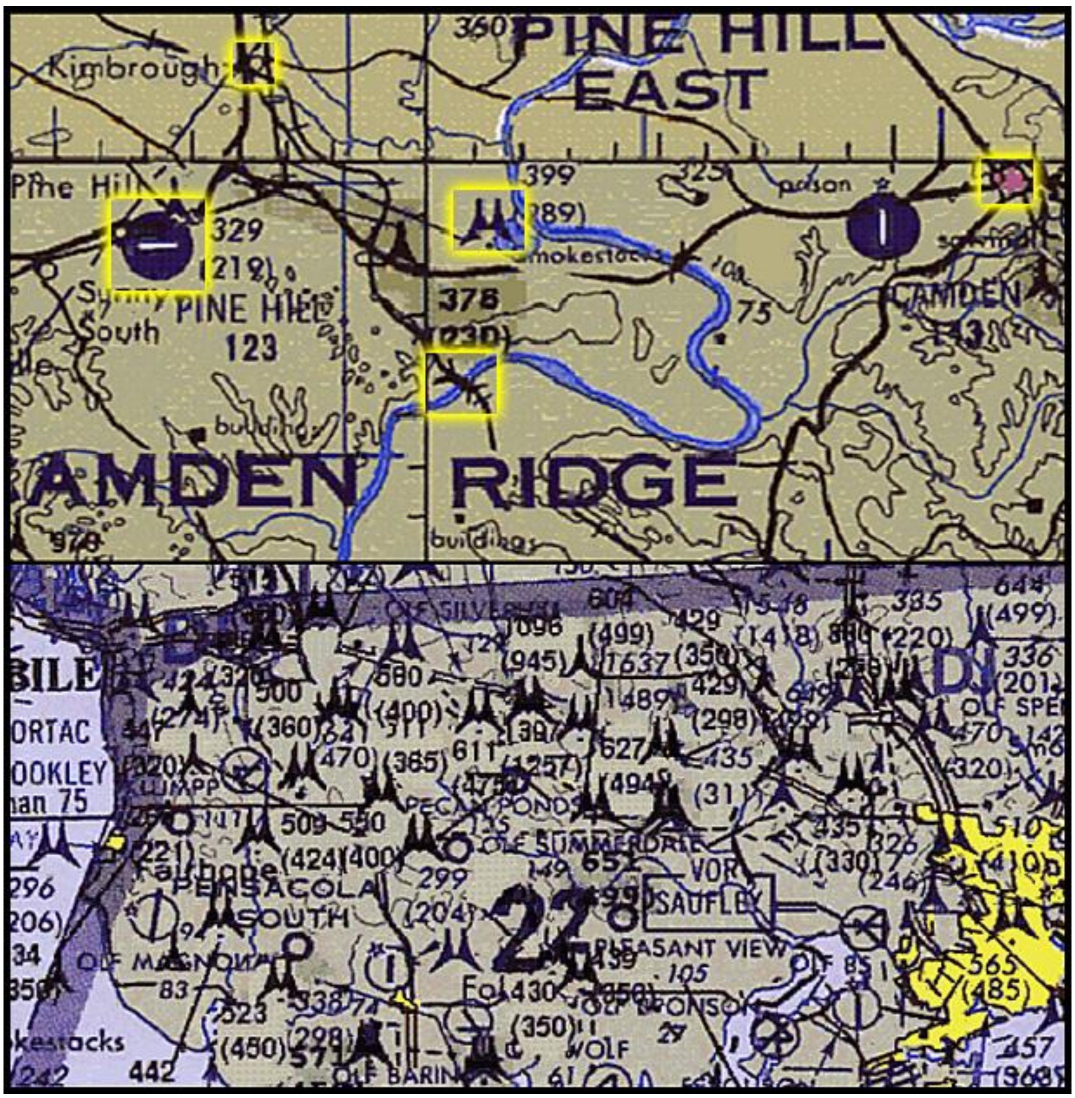


Figure 1-6 Cultural Features on a Chart

102. MILITARY TRAINING ROUTES (MTR)

The missions in the Advanced Strike phase will utilize 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 MTRs, 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 accordingly. The SNFO is responsible for scheduling and checking the web-based Route Manager to confirm the time and route deconfliction.

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 radio frequencies and general operating procedures.

1. IR Route Planning

The IR routes will be used during the early strike stage events and will focus on basic radar acquisition skills. The SNFO may also expect the same flights to be accomplished in a MOA. The A/S timeline will be referenced but not as heavily emphasized, as it will be 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, plan on using a 360 kt groundspeed during these target acquisition events. See the Strike Stage Planning Guide for a list of all high altitude and low level routes.

The strip chart planning for IR routes will be the same as the VR route chart procedures, with the exception of using ECHUM, which will be discussed later in this FTI. Additionally, if there are VR crossing routes with altitudes that exceed 1500' AGL, the SNFO will be responsible for knowing if that route is a factor. Since the routes will be flown at higher altitudes, the ground obstructions associated with ECHUM are not needed since they 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 Pensacola South or Desoto MOA, could also be utilized for these events. In these events, SNFOs will be provided ample time and materials to prepare for the flight. Refer to the Strike Stage Planning Guide for the VT-86 specific turn points and targets for these routes. If operating away from the local area, turn points and targets may be at your discretion, however ensure they fall within the route structure outlined in the AP-1B.

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

The following procedures are to be followed for all low-level flights at VT-86. Be sure to reference the CNATRA P-912 Low Altitude Awareness Training manual prior to execution:

a. Aircrew shall enter the low-level route +/- 4 minutes from the scheduled entry times and no earlier than (NET) 30 minutes after sunrise, and shall exit no later than (NLT) 30 minutes prior to sunset.

b. Brief and abide by Low Altitude Training Rules, which are published in the TW-6 In-Flight Guide (IFG).

c. The G-Warm shall be conducted at a safe altitude with maximum G approaching amount anticipated on that flight..

   i. The spacer pass on a strike flight, to include Pop Attacks, shall satisfy the requirement for a G-Warm. Do not descend in the spacer pass.

   ii. If planned G is less than 4 G's, a G-Warm is not required but recommended.

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/) via http://www.baseops.net, or the Naval Safety Center links.

Figure 1-7 Bird Strike; Check the BASH!

e. Weather and Turbulence

i. Minimum acceptable weather conditions for conducting low altitude training is 3,000 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 aircraft shall not be flown in areas where greater than moderate turbulence is experienced or forecast.

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 even if planning to use a stereo route

i. Final copy needs to be complete with no mistakes and ready to file by brief time.

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

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

(a). Primary method is via Naval Weather Briefer (https://fwb.metoc.navy.mil/).

(b). Can be via phone (call and fax from Weather Shop)

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

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

103. LOW-LEVEL PLANNING

Do not print routes until completion of Joint Mission Planning System (JMPS) class, and be familiar with the Strike Stage Planning Guide. Bring all applicable charts (this includes all sectionals and IFR low/high charts necessary to fly the planned route) to each event along with completed jet cards). JMPS shall be utilized and charts are to be constructed using card stock in flip-style format. Students are required to prepare original high altitude target acquisition (HATA) and low-level strip charts IAW the Strike Stage Planning Guide. Additionally, the following guidelines apply:

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

2. No scripted information is permitted on low-level charts. This is all-inclusive for "comm script" and flight admin script. Any scripted information found will need to be removed prior to event execution and repeat offenses will not be tolerated.

Students are responsible for preparing briefing boards for each event; portable briefing boards are not authorized. Briefing boards will be prepared according to the current Briefing Board example located on VT-86 E-Brief.

Mission Completion Fuel (MCF) will initially be set in the Bingo bug for all Strike events with the exception of the Circle the Wagons flight where Joker/Bingo will be used. Wingman will advise Lead when MCF 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 your fuel state.

Several routes cross the MTRs you will fly. The routes TRAWING SIX schedules will be de-conflicted from other TRAWING SIX managed routes that intersect each other; however, there are additional non TRAWING SIX MTRs that cross which are not deconflicted. SNFOs should contact the scheduling authority to deconflict these to the max extent practical. As an additional safeguard, it is required per the AP-1B and VT-86 Strike Stage Planning Guide that when approaching route intersections the SNFO will make an advisory call on the FSS frequency. SNFOs shall follow all directives in the AP-1/B, and Strike Stage Planning Guide.

Low-levels will be planned at 360 kts ground speed and 500 feet AGL, or per AP-1B and VT-86 Strike Stage Planning Guide restrictions.

To summarize, overall SNFO low-level expectations are:

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

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

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

d. Visually identify and arrive on target during low-level flight in accordance with course training standards (CTS).

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

f. Execute standard turn point procedures during flight execution.

g. Recognize wind corrections and groundspeed adjustments required to maintain SA and time.

104. STRIP CHART LAYOUT AND PREPARATION

1. Divert Chart

You will be required to create two types of charts at VT-86; the strip chart or flip chart, which will be discussed next, and the divert chart, which is an overview chart, that will be on a single page kept within your strip chart.

Divert charts will be created with an ONC chart (Figure 1-8) and will contain an overview of the route with divert data. They are 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

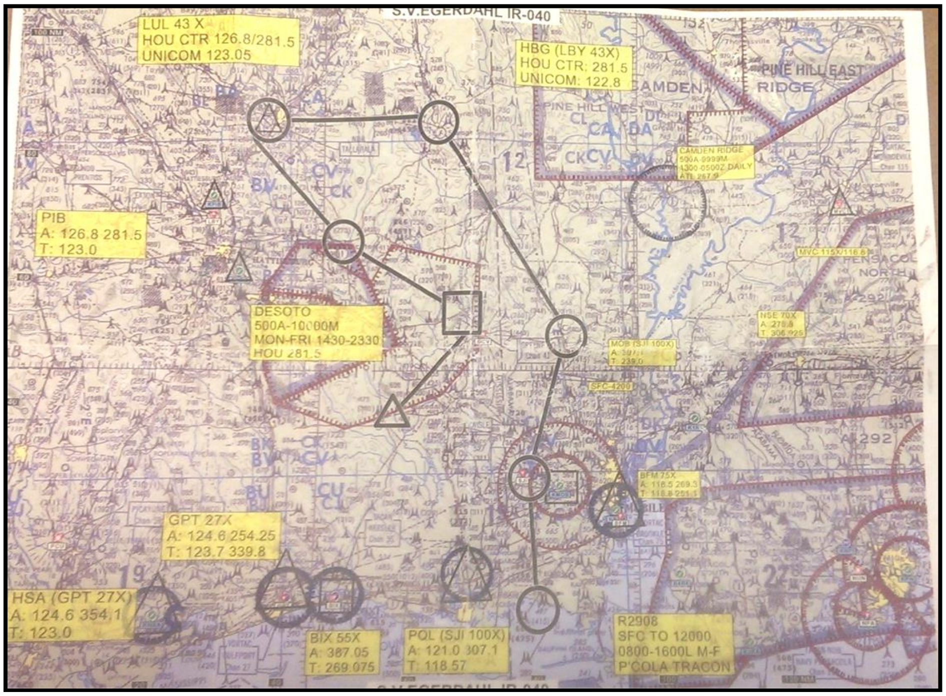


Figure 1-8 ONC Used for Divert Charts

2. Strip Chart

Each SNFO will be required to make a strip chart for each IR and VR route required by the Strike Stage Planning Guide. At your instructor's discretion, this requirement may be modified if you are going on detachment or a cross country. Detailed procedures on how to make strip charts are located in Appendix A of this FTI.

105. FUEL PLANNING

Fuel requirements are the primary concern in mission planning. Whether carrying 2,900 or 29,000 pounds of fuel, you should always be conserving fuel in order to maximize your range, or provide more options if the weather deteriorates or you experience unexpected delays in the terminal area. In addition to having enough fuel for the engine start, taxi, transit to the target area, RTB, and approach, the tactical portion of the strike must be taken into consideration. Tactical strikes require higher burn rates due to tactical airspeeds. Some definitions that you will use during your fuel planning include:

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

2. EFR – (Estimated Fuel Remaining); calculated during mission planning.

3. MCF – (Mission Completion Fuel) 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 amount:

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

When planning MCF with a divert, your EFR minus your spare fuel will not always equal 500 lbs at your destination, but it should always equal 400 lbs at your divert. Do not plan a MCF greater than EFR! That is ***unsatisfactory***.

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

a. VMC: SOP minimum fuel (500 lbs) on deck, or enough 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 enough 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 information box described below 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 and arrive with the published NATOPS reserve fuel (300 lbs).

– The information provided in the information box described below 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.

The SNFO will be required to set the Bingo bug to a fuel state that they determine during planning. Those fuel states will be MCF and Divert fuel states. MCF at route entry point will be set into the Bingo bug before takeoff. During the fence in, when it is determined the flight will enter the route at or above MCF, MCF at the target will be set in the Bingo bug. Off the route, Divert fuel state will be set in the Bingo bug. Ensure you have a thorough understanding of all fuel terms and concepts.

Strike routes will be planned for 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 1-9 is similar to the one you will find in the TW-6 In-Flight Guide (IFG). In addition to NATOPS, the IFG chart should be used as the T-45C fuel planning guide for NLT and NET fuels. JMPS also calculates fuel, and JMPS may be used for that purpose, but use the JMPS plan cautiously because garbage in equals garbage out. Do not blindly trust the prior inputs in JMPS; doing so could be the difference between mission success or failure.

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 contain all of the fuel information. 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_

COMTRAWINGSIXINST 3710.17H
19 Mar 15

CTW-6 STANDARD T-45 FUEL PLANNING DATA

For initial planning only.

Actual performance will vary with prevailing temperature, winds, drag index and varying gross weight.

Total usable fuel (JP-8/JET A+) ....2,861 lbs
Start/Taxi/Take off 200
Penetration 200
GCA 250
Reserve (20 min @ 10,000 ft MSL) 300

Low level (12,000 GW)....360 KGS = 6.6 LB/NM = 2,375 PPH
300 KGS = 5.0 LB/NM = 1,500 PPH

JP-4=6.5 LB/GAL JP-5=6.8 LB/GAL JP-8(JET A+)=6.7 LB/GAL

Climb Out (13K GW, 250 KIAS to 10K, 300 KIAS to .75 IMN)

Altitude	KIAS	NM	Time	Fuel Used (lbs)
5,000	250	04	0+01	60
10,000	250	08	0+02	110
15,000	300	14	0+03	180
20,000	300	22	0+04	240
25,000	300	32	0+05	320
30,000	283/.75	44	0+07	380
35,000	253/.75	60	0+09	460
40,000	225/.75	91	0+13	570

En route (Optimum Cruise @ 12K GW, Drag Index 0)

Altitude	#/NM	IMN	CAS	#/HR	TAS
5,000	4.76	.38	230	1,195	250
10,000	4.35	.42	230	1,138	262
15,000	3.88	.46	230	1,102	282
20,000	3.42	.51	230	1,073	310
25,000	3.09	.56	230	1,055	340
30,000	2.82	.61	230	1,047	370
35,000	2.58	.68	230	997	380

Normal descent (12K GW IDLE W/SPD BRAKES IN)

Altitude	IAS	NM	Time	Fuel Used (lbs)
5,000	250	10	2+30	19
10,000	250	20	4+30	36
15,000	250	31	6+30	57
20,000	250	41	8+30	66
25,000	250	52	10+30	79
30,000	250	64	12+15	90
35,000	235	74	14+00	100
40,000	209	84	15+30	108

18 Enclosure (3)

Figure 1-9 T-45C Fuel Planning Chart

Appendix B of this FTI discusses specifics on fuel planning further.

106. 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 the best 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 1-10 depicts various features that could be selected for checkpoints. You must have ***at least one*** intermediate check point per leg and it is recommended that these checkpoints be ***highlighted***. Information about that checkpoint should be provided in the margin of the strip chart adjacent to the checkpoint.

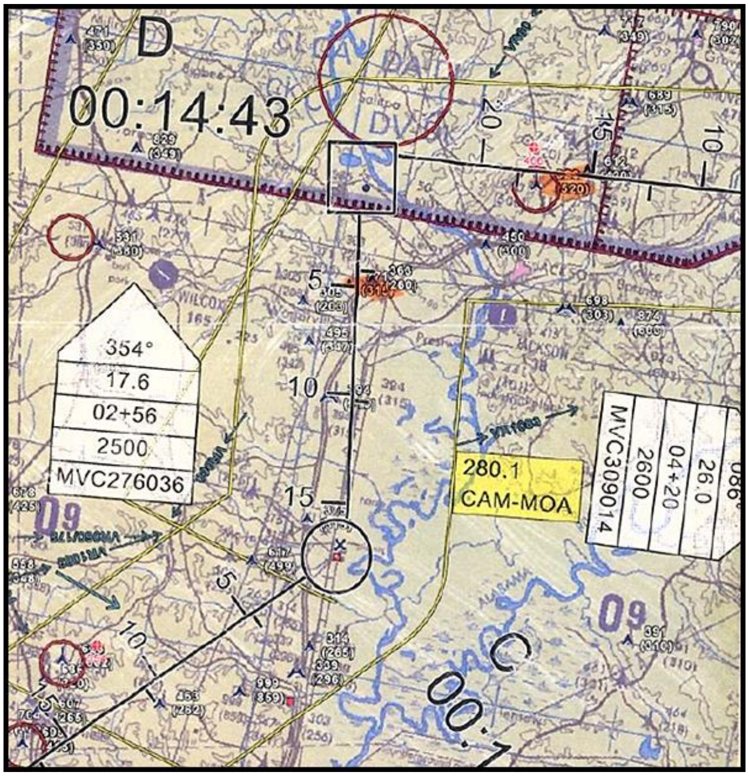


Figure 1-10 Checkpoint Selection

When designating checkpoints, adhere to the following:

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

b. Do not select anything inside the turn point circle, as this would be redundant.

c. While no minimum number of checkpoints is prescribed, one every 2-3 minutes is a good rule of thumb.

d. Look for funneling features and “get-well” checkpoints.

e. Be prepared to defend your checkpoint selection.

There is no requirement to find a certain percentage of checkpoints once airborne and on the route; but you should use all available information to maintain course and time.

107. JMPS PLANNING

The Joint Mission Planning Software (JMPS) will be the standard planning tool used for Advanced Strike missions at VT-86 as well as in the fleet. The most current JMPS operating instructions can found in Appendix A of this FTI. Reference E-Brief for updates to Appendix A.

108. TACTICAL CALL SIGN

Students shall choose and brief an appropriate tactical call sign for each event. Tactical call signs should generally be one or two syllables and easily understood over the radio. Reference the VT-86 TACSOP for current Tac call sign usage.

109. A/A TACAN DECONFLICTION

Each section event will utilize air-to-air (A/A) TACAN for de-confliction purposes. SNFOs will brief an A/A TACAN channel for each aircraft and will print out the channels on the kneeboard card. Typically, SNFOs will switch from using TACAN for navigation to A/A TACAN during Fence In and will switch back to navigation mode during Fence Out, although other administrative uses for A/A TACAN may be used and briefed. An A/A TACAN frequency will provide ranging only (in DME) when paired with another A/A TACAN frequency 63 channels apart. For example, 11 X A/A will provide ranging from 74 X A/A. When both aircraft have the appropriate A/A channel selected, you will see the TACAN on the HSI provides DME but not bearing. By boxing TACAN, you can provide DME information to the HUD; however, the TACAN needle will spin on the HSI and you will be unable to use WYPT steering for navigation. SNFOs should brief the appropriate A/A TACAN channels and plan based on the current TACSOP.

110. BRIEF

The briefing board template can be found on the VT-86 E-Brief. Keep in mind this is a template and it should be appropriately missionized for your specific event, e.g., section items should not be on a single ship briefing board. The appearance and accuracy of the briefing board sets the tone for the entire event. All pertinent information should be on the briefing board. The SNFO should use the abbreviated briefing guide to ensure all items are covered. There is an expanded briefing guide available, however this should be used when practicing for the brief, not during the actual event.

The SNFO should be familiar enough with the route to be able to brief it from the board without the use of the chart; however, it will be at instructor discretion to brief from the chart. The SNFO shall brief the target(s) in detail to include big to small funneling features and limiting features. A radar acquisition game plan is required for radar routes.

Turn-point and Target imagery is ***required*** for all turn-points and targets for the brief. Target imagery ***shall*** be provided to all members of the flight.

111. PRODUCTS

All materials required for FAM events are still required for Advanced Strike events. The additional requirements are a JMPS Chart and a High Level Timing Plan. If flying a VR, a VFR sectional chart is required.

The SNFO is also responsible for providing an RMM to each aircraft and a kneeboard card to each member of the flight including the IOS operator or Contract Instructor for simulator events.

112. KNEEBOARD CARD

The kneeboard card is a very important part of preflight planning and is used to relay mission information to all crew members**.** The kneeboard card shall be completed accurately and in a standard format**.** Figure 1-11 shows an example of the VT-86 Strike kneeboard card**.** This will be filled out and provided to each crew member during the brief**.** Information can be added as required for the mission, but the overall format should not be changed**.** The kneeboard card is one of the first products seen by the instructor and is a reflection of your attention to detail, so it should be neat and free from formatting errors to the max extent possible**.** Disagreements between the card and the briefing board should be avoided because they show a lack of attention to detail**.**

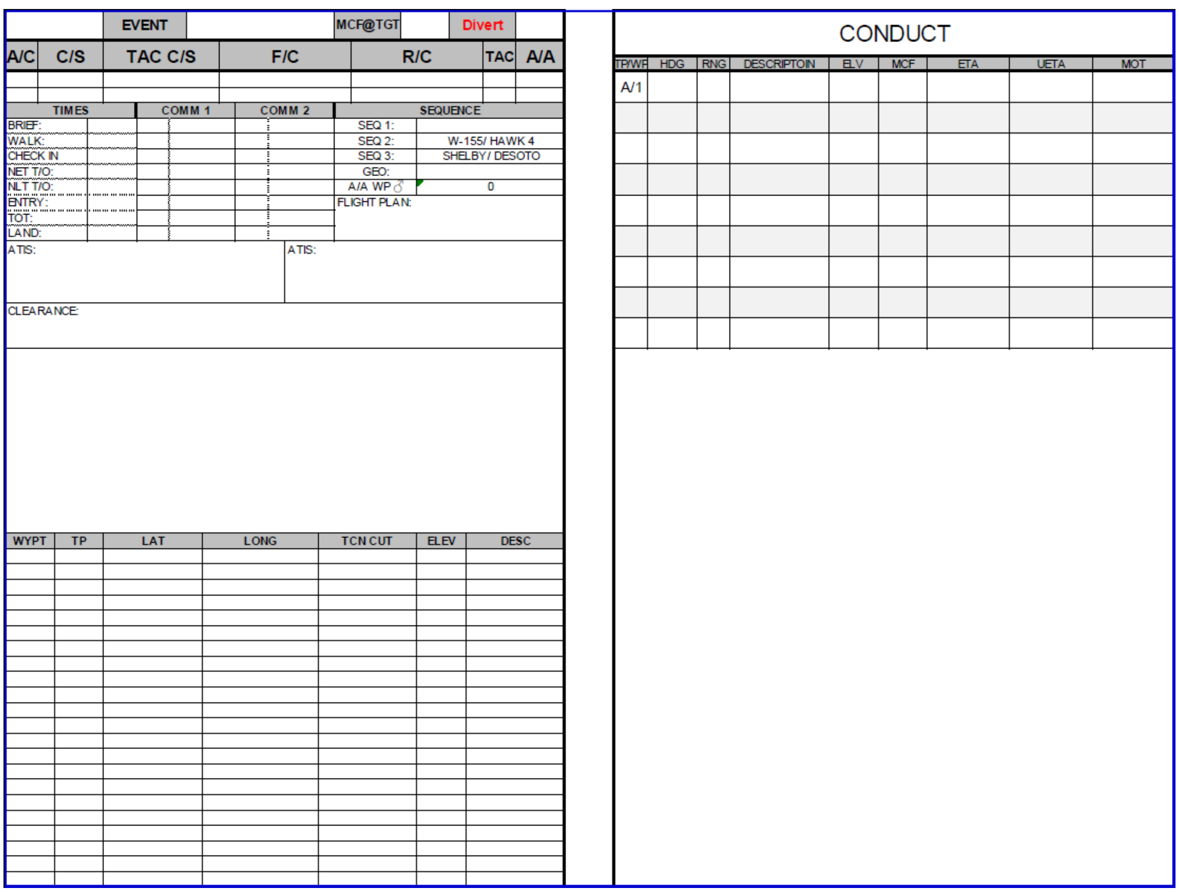


Figure 1-11 Strike Kneeboard Card

1. Comm Plan

The comm plan on your card should be well thought out and include all expected frequencies. This includes any enroute frequencies that can be anticipated, such as Mobile App 307.1 BTN 19 for the IR-37, 40, and VR-1021, 1023, 1024, and the frequencies you can expect to use when you exit the route. This is especially important for VR routes. Also, if the event is an out and in, be sure to include expected frequencies for your destination. While these can be found on the approach plates, having the frequencies readily accessible can aid in flight management and will ensure you are on the same frequency as your wingman. Section flights should include a tactical frequency and a backup tactical frequency (known as a chattermark). These shall be de-conflicted from other events on the flight schedule.

NOTE

VHF frequencies will be used when operating at civilian airfields. This will allow you to gain SA as to civilian traffic operating both in the approach environment and on the ground.

2. Waypoint Plan

The waypoint plan also needs to have detailed consideration. A plan well laid out on your kneeboard card is key to limiting data entry time in the line. It is the place to list the location of all the waypoints you expect to need during the flight whether they are in the standard load or they need to be manually entered. LAT / LONG data on your card must be must verified. It is paramount that the information is correct or serious navigation errors can occur. This is also the source all crew members will use to verify the waypoints are accurately entered into the aircraft. The waypoints for the IR / VR routes will be loaded from the aircraft database, if available. Expect that the database points for VRs is the SSPG turnpoint, and for IRs is the AP/1B turnpoint.

You must have a waypoint for each of your diverts; they shall be entered in as a GEOREFs. The sequence section should be filled out with the waypoints for SEQ1, and a general description of what is in SEQ2 and SEQ3.

The back of the card is used during the conduct portion of the event. It should be filled out with route, fuel, and timing from your preflight planning and chart. It also provides space to take note of timing and space for any other specific mission information you may need to record. ***Do not*** use the knee board card as a script for your flight. Use it to record notes for the debrief, such as mark on top times, environmental factors, fuel states, and any other noteworthy item you want to remember.

3. Student Pairing

Students will be paired for all section events to the maximum extent practical. Students will be held equally responsible for the mission planning and products. For flight events only, the SNFO in the lead aircraft will brief. The Lead SNFO may delegate items such as weather/NOTAMS, Questions of the Day, ORM, and Training Rules to the Wing SNFO. However, if circumstances dictate, it may benefit the Lead SNFO to brief the entire event. For example, if weather will greatly impact the flight, or requires contingency plans, it would be wise for the Lead to brief the weather. For simulator events, both students should expect to share the brief equally.

CHAPTER TWO
GENERAL STRIKE ROUTE PROCEDURES

200. INTRODUCTION

WEAPONS ON TARGET, ON TIME, FIRST TIME

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

In VT-86, SNFOs will fly as single aircraft, or in a section of two aircraft, on a strike route over simulated enemy territory. They will be responsible for avoiding enemy surface-to-air threats by minimizing radar detection. The goal is to successfully attack the assigned target and then return home safely. The basic skills and tasks required to accomplish this mission are the same whether flying as a single aircraft or in a section.

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 be used for the majority of your training in the Strike stage. These missions will require extensive preparation and preflight planning, to include the completion of strip charts, which were discussed in the previous chapter.

201. HIGH LEVEL TIMING

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

A control time is a pre-determined, real world time that does not change. For the Strike stage, the Time on Target (TOT) is the control time. Timing is planned ***backwards*** from the TOT to determine the takeoff time. It is not difficult to achieve +/- 10 sec timing, if planning is done correctly. During the brief, cover the timing game plan thoroughly, to include a takeoff window that consists of a No Earlier Than (NET), an On Time (O/T), and No Later Than (NLT), takeoff times. Although this time window should guarantee getting to your TOT on time if executed correctly, they do not ensure getting to the entry point on time, which is not the primary goal. When performing high level timing in the jet, it is important to remember that TOT is the objective of timing, not getting to the entry point exactly on time. You should also have a good idea for what kind of time window you can hit the entry point with and still make your TOT.

For NET / NLT times, students shall plan to enter all TW-6 scheduled low level routes +/- 4 minutes from the route scheduler entry times. If two or more entry times are scheduled, the entry window is - 4 minutes from the earliest and + 4 minutes from the latest entry time, however do not preflight plan to enter outside of +/- 4 minutes of each entry time.

The SNFO must be able to explain each of the factors considered when calculating the timing game plans. Including altitude selection, airspeed conversion from IAS-TAS-GS, high-level navigation distances, and fuel associated with NET and NLT times.

1. Planning

a. High level timing plans will be constructed at the same time 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 route of flight may be provided in the VT-86 Strike Stage Planning Guide or you may need to determine it yourself.

ii. Plan to fly the most reasonably direct route to the entry point or the route provided by the applicable stereo route. Do not draw a straight line from take-off to entry. To use a cutoff, you need to have it built into the plan. Be sure that the cut-off airspace will be usable; trying to use a restricted area on the inside of your route may cause ATC to deny your request to go direct.

c. Use a cruising altitude based on the distance from the IFG, or consider the distance you are going. A general rule of thumb is your altitude should be your distance with two additional zeros added to the end and rounded up, then adjusted for direction of travel. For example, if you will be flying west for 157 NM, 16,000 FT MSL is a good start.

– Adjust altitudes based on direction of travel (north, south, east, or west).

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

– 250 KIAS is the standard descent airspeed, and for planning purposes, use the Idle SB-In profile; however, if the situation dictates, the following are other decent profiles you can use. The first column is throttle setting/AOA, the second column is distance traveled downrange, and the third column is altitude lost:

12 units	3-4 miles	1000ft
75%	2.5 miles	1000ft
Idle SB-Out	1 mile	1000ft

e. Take the total distance from takeoff to entry and subtract the distance for the climb and descent. The remaining distance is what you will use to determine time at altitude.

f. For an on time takeoff, plan to fly at Max Range airspeeds. Divide the cruise range (NM) by Max R speed (adjusted for wind) to determine time at altitude. Significant increases or decreases from Max Range will increase your fuel consumption. These fuel consumptions can be found in NATOPS Chapter 28.

g. Add the times to get total time from takeoff to route entry. This is your planned time enroute to the entry point. This same formula can be used to calculate your No Earlier Than (NET) and No Later Than (NLT) times. Reference NATOPS for fuel calculations.

h. Consider cases where a ROLEX may apply but avoid using it as a going in game plan.

i. If a student determines that the TOT is not achievable at any point in the mission they may request to change the TOT or "ROLEX" from the instructor. The instructor may deny the request. ROLEX is not intended for use as a safety net for poor awareness to timing, rather as a tool to ensure an achievable TOT when real world circumstances delay or accelerate the event. ROLEX may be requested in increments of 5 minutes.

   i. If a planned TOT of time 30 is noted as unachievable due to troubleshooting in the line a ROLEX of 5 minutes would set the new TOT at time 35.

   ii. Anticipated ROLEX should be noted and discussed on deck prior to takeoff, and a reasonable ROLEX requested after level-off at enroute cruising altitude.

   iii. If the requested ROLEX will result in a route entry time in excess of 5 minutes, coordination with the route controlling agency is required to reschedule.

2. NET Takeoff Time

a. Compute the minimum airspeed.

   i. **IAS:** 200 KIAS is the minimum airspeed for high level timing. This equates to roughly 14 units AOA. Airspeeds less than 200 KIAS make it difficult for the wingman to maintain formation and therefore should not be flown.

   ii. **TAS:** Reference NATOPS Chapter 31 for IAS to TAS calculations. As a rule of thumb, take your altitude in thousands of feet and multiply it by 5, then add the IAS to get TAS. For example: 10k x 5 = 50 kts + 250 KIAS = 300 KTAS.

iii. **GS:** Determine the average winds at altitude using available weather forecasts and apply them to your TAS to get the minimum GS for high level timing, e.g., 300 KTAS – 20 KT Headwind = 280 KGS.

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

3. NLT Takeoff Time

a. Compute the maximum airspeed.

i. ***TAS:*** A maximum of .70 IMN will be used for planning at VT-86 due to fuel consumption; .75 IMN may be allowed during flight at instructor discretion. Other IMNs can be found in NATOPS Chapter 29.

ii ***GS:*** Same calculation as NET.

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. Calculate how much additional fuel will be consumed with this new airspeed. Confirm this still meets Mission Completion Fuel requirements.

d. Use the IFG and NATOPS/PCL 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. Always be aware of fuel considerations when inputting speed corrections. Flying .70 IMN may get you back on time, but there is also the possibility it may push you below MCF. The times derived from planning should be considered a reference, not a guarantee ensuring mission completion.

e. Once enroute time and fuel have been calculated, add the climb and descent times and fuels respectively to determine total time and total fuel. Now that total distance, time, and fuel have been calculated, an exact entry time and takeoff window can be determined.

NOTE

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

4. Preflight

a. The first step in the planning process is to get the takeoff time from the VT-86 flight schedule

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

c. Using your takeoff time from the flight schedule as a base, add the enroute time, plus the route time and then round up to the next 10 minute time. This is your preflight Time on Target (TOT).

   i. Ensure you are scheduled for the route and the time is appropriate given your takeoff time and transit time. (See Chapter 1 MTR).

   ii. Contact the phone number listed in the AP-1B or the instructor immediately if the route is in question or not scheduled correctly.

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

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

   ii. Chair-fly the event; focus on communications and procedures.

   iii. Study route imagery and your strip chart.

Preflight Timing Example

Example on how to set TOT

Scheduled takeoff	ENROUTE	ENTRY	ROUTE	TOT
1500	~10+00	1510	~40+00	1550

Based on a 1500 scheduled takeoff, it takes about 10 minutes to get to the entry point and the route is about 40 minutes giving you a TOT of 1550. Set the above time in the TOT and work backwards to find your entry and takeoff windows:

	TAKEOFF	***ENROUTE***	***ENTRY***	***ROUTE***	***TOT***
NET	1455+46	11+20	1507+06	42+54	1550
ON TIME	1503+36	07+52	1511+28	38+32	1550
NLT	1508+04	05+16	1513+20	34+40	1550

The TOT of 1550 is the same for all three profiles. The route can take as much as 42+54 minutes going slow and as little as 34+40 minutes going fast giving you three different route entry times. Similarly, enroute times vary from 5+16 to 11+20 giving you your NET, On Time and NLT takeoff times.

e. Walk time to takeoff

– Allow at least 30 minutes prior to takeoff for walking, preflight, and startup. 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 some type of delay is expected. If this is the case, walk earlier. Reasons for a delay may include:

i. Excessive on deck time due to a large number of waypoints or data to enter following startup. ***Do not plan to enter waypoints after taxi.*** The IP or INFO may allow this depending on SNFO proficiency.

ii. A large number of aircraft are expected to launch at your takeoff time.

iii. Inexperienced aircrew.

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

5. Execution

a. During or before taxi, QA current time compared to planned takeoff.

– Inform the IP of timing status 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 early or late you are based on takeoff time, runway, and departure routing. Taking off between "On time" and "NLT" will require a speed correction somewhere between 12 units and .75 IMN. Intermediate speeds are acceptable to avoid large throttle movements, however do not "Zen" an airspeed. If you cannot determine an accurate airspeed prior to level off, start with a known point to deviate from. For example, if you are late, upon level off set .70 IMN. Once you gain SA on the situation set an airspeed that makes sense. Use time gates, which will be explained later, to aid in your decision, especially for long transit times.

Airborne Timing Example

You depart NPA 2 minutes late, flying toward TEEZY for the VR-1024. You took off on Runway 25L and were vectored around for traffic, and then cleared to TRADR. If you cannot determine if you are early, late or on time, note that you took off late, and at level off set .70 IMN.

a. Upon reaching transit altitude and at requested airspeed, verify system groundspeed on the HSI. Convert to NM per minute.

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

c. 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 a longer period of time. "Time out" corrections will be at entry so you don't have to remember to take it out.

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

d. 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 minutes 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. This can be applied to any fraction of an hour.

  ii. Gate Method to the Entry Point Examples

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

NOTE

This method does not factor in a descent; however, you will be within ~1min of your desired entry time.

e. Mach Number Method:

i. Use the rule of thumb that .5 IMN = 5 NM/minute, .7 IMN = 7 NM/min and so fourth at any given altitude.

ii. Mach Number Method Examples:

(a). With 60 NM left to the entry point and 10 minutes left to entry realize that you must travel 6 NM per minute to enter on time, commanding .6 IMN would be appropriate.

(b). With 160 NM left to the entry point and 20 minutes left to entry realize that you must travel 7.5 NM per minute to enter on time, commanding .8 IMN would be required, but not legal at VT-86.

(c). With 150 NM left to entry point and 30 minutes left to entry realize that you must travel 5 NM per minute to enter on time, setting .5 IMN would result in an on time entry.

202. ROUTE ENTRY PROCEDURES

Workload increases for aircrew prior to route entry. Prior to route entry aircrew must ensure clearance onto the MTR with the appropriate local controlling entity. In addition, aircrew must conduct fence checks, acquire the entry point, make a one minute prior call, and verify timing. These procedures should be well rehearsed so that they are accomplished quickly and accurately. A well-rehearsed flight enables flexibility and adaptability for aircrew so that they are better prepared to handle any unplanned situation.

1. Route Entry Considerations

a. Single/Section

b. ATC workload/Personal Prioritization Ability – “Am I cleared to enter the route?”

c. SA – “Am I aware of all my surroundings? My wingman is currently in what position?”

d. “Are we in the right place?” (altitude, airspeed, position)

e. “Are low level checks complete?” (low levels only)

f. “Are we Fenced in?” (i.e., Are we ready to fight with this jet?)

2. Fence-in

This call is made to tell the flight that it is time to set up all systems for the tactical portion of the flight. Reference the VT-86 TACSOP for the fence checklist, with these Strike stage specifics:

a. MSTR ARM – SAFE

b. A/A TACAN – Set as required (divert for single flights, A/A for section)

c. Displays – In accordance with the standard setup (discussed later)

d. BINGO – Set to MCF at TGT (verify MCF at entry point prior to resetting)

e. Recorders – Set VREC in accordance with the standard setup (discussed later)

f. SMS/MSTR Mode – Set as required

g. Squawk/Strobes – Direct IP to set as required (All aircraft shall squawk 4000 with strobes ON for low level routes unless ATC assigns a different squawk)

203. ROUTE ENTRY POINT ACQUISITION

Locating the route entry point is vital and sometimes doing so 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 your eyes, the HSI, radial/DME cuts, and the VMTS A/G radar. 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.

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 2-1 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 checklists, required communications, and timing.

Figure 2-1 First Leg on Strip Chart

204. 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 comply with the standard setup.

1. Setup

    a. HATA routes

i. Left MFCD – SA or HSI (scale 20)

ii. Right MFCD – A/G Radar

iii. VREC – A/G Radar

b. Low-level routes

i. Left MFCD – HUD

ii. Right MFCD – SA or HSI (scale 10)

iii. VREC – HUD

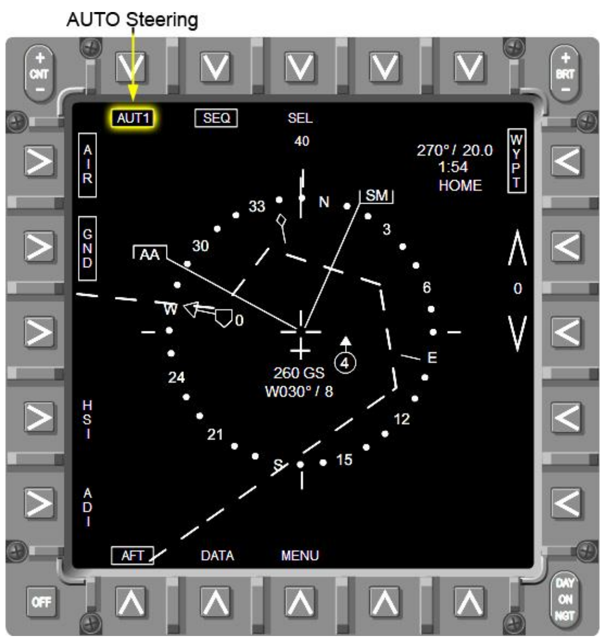


Figure 2-2 10 NM Scale, SEQ Boxed with AUT1 Boxed

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. Automatic sequential steering may be 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 route points in your tactical sequence.

205. 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 an efficient scan pattern. Basic turn point procedures are utilized during all flight and simulator events in the Strike stage. For planning purposes, anytime a navigation point on a route or a target acquisition point is approached, the SFNO will make the following calls over the ICS: ***one minute prior, mark on top, and wings level***.

These calls will vary slightly depending on the type of flight and route flown. For example, IR routes 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 and SA page also display the wind-corrected ground track at the top of the display.

Turn point procedures begin approximately one minute before the route entry or turn point. These calls should be well rehearsed so that the SNFO is able to conduct other flight requirements in addition to verbalizing these calls on the 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 routes at VT-86. While flying the strike routes, you will only need to verbalize fuel and timing analysis for the wings level call, but you may need to verbalize flight parameters as well, if they need to be modified.

1. Required Calls

   a. One Minute Prior – Based on 360 kts ground speed (6 NM/minute), call should be made 6 NM prior to the turn point, or 1 minute (6 NM) prior to the expected turn if utilizing geometry. Call will include:

      i. 6 NM prior to the turn point – *"One Minute 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."* (update HDG bug.)

      iv. Outbound airspeed – *"360 Ground."* (verbalized if a speed change is necessary)

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

      vi. Recommend turn (section only) – *"Recommend Tac right"* (Before you recommend a turn, have SA to where your wingman is, not where you expect him to be. You can't execute a Tac turn if your wingman is in cruise for example).

b. Mark on Top – Once over turn point.

i. Command turn – *"Right 045."* (Recognize there will be a minor delay in the pilot calling the turn when in section.)

ii. Lead IP (AUX) – "*Hammer Tac right.*"

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

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

v. Direct new altitude/airspeed if appropriate.

vi. Update navigation – Select waypoint steering to next point, *"TACAN changes to Monroeville."* (only change TACAN as a single)

vii. Reset radar (URG) – Un-designate, Range to 40 NM, Gain to 5 (IR ONLY)

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

i. Verify heading (verbalized by exception) – *"045."*

ii. Verify altitude (verbalized by exception) – *"500 feet."*

iii. Verify airspeed (verbalized by exception) – *"360 knots."*

iv. Fuel analysis – *"Fuel is 2.1, 100 pounds above MCF, steady trend, continue."* Recognize the trend in fuel burn; it is either negative, steady or positive. A negative trend is not always a bad thing, e.g., you had a speed up correction in for a long time, or you have been constantly overflying turn-points to bleed off time. However, you should be ready to make a decision if you cannot explain a negative trend, or if fuel drops below MCF.

v. Wingman location (only if wingman is out of expected position) – *"Wingman is at 3 o'clock low, they should be above us on the left."*

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

vii. DR designation (IR routes)

(a). Method of using the radar attack display to aid in your navigation

(b). Place the cursor close to the next turn point/target. Slew the cursor the length of the current leg downrange. If it is a 35 mile leg, move the cursor 35 miles away on preplanned bearing.

(c). Calculate the distance traveled along the course since your last turn (30 seconds = 3 NM), then move the cursor toward you that many miles.

(d). When wings level on planned course, designate at the distance remaining on the leg. (Using the example above, for a 35 NM leg, designate on the nose for 32 NM). Cross reference the sequence on the HSI with your designation to make sure your radar cursor is in the appropriate position. If the distance differential seems excessive, either your waypoint in the system is off, or your radar designation is off.

(e). Always analyze how position, heading, and airspeed affect timing.

d. Fuel and timing analysis 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.

206. 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 A/S timeline, and practicing good crew coordination are all things that must be managed 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 his or her position at all times; do not be afraid to explore the space. ***Route study is paramount to your success and overall SA.***

iv. Expect the unexpected; remain calm and do not hesitate to make a decision due to the fear of being wrong. Part of being a good Mission Commander is using CRM. When things change, come up with a plan, and brief your pilot/wingman as necessary. If they have a better idea, then you will have time to talk about it. You won't get points for hiding your plan and springing it on the flight last minute, even if it's the right course of action.

b. Funneling navigation.

i. This refers to a method of scanning. Work "big to small" when trying to locate a point; strive to use vertical features at distance. For example, when looking for an intersection near a tall tower, find the 400' tower 1 mile left of the intersection on the highway first, then find the highway. Focus your scan to the right of the tower to find the smaller road perpendicular to course, then find the intersection.

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 you are 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 abbreviated, or delayed. Never forget the basics; ***aviate***, ***navigate***, ***communicate checklists***.

iii. If you become overwhelmed, tasks can be given to the pilot. For example, you could ask the pilot to take over radio communications or navigation for a time. Remember to take back any tasks you assigned to your pilot when you are no longer task saturated.

iv. Items that can be abbreviated or delayed include turn point procedures, and updating ETA to the next point. Prioritize what is most important at any specific time. For example, if ATC gives you a frequency switch 5 seconds prior to your MOT, you must answer ATC; however, you may decide to delay the actual radio switch until you are wings level, outbound from the turn point.

207. 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 TOT and the time to the entry point or turn point will be communicated in the brief in local time.

1. Timing Corrections

   a. Course Correction

      – If you find yourself deviating away from course, use visual references to the max extent to correct back to centerline, however if visual references are not able to be utilized, the following corrections at 360KGS will work:

1 mile off course:	10 degree cut for 48 seconds
2 miles off course:	10 degree cut for 1 minute 36 seconds 20 degree cut for 48 seconds
3 miles off course:	10 degree cut for 2 minutes 24 seconds 20 degree cut for 1 minute 12 seconds 30 degree cut for 48 seconds

   b. Geometry Correction

      – This is the preferred method of timing correction if you are late (saves you fuel and time). Simply increase or decrease the distance to travel. Without getting into trigonometry, when traveling at 6 NM/min (360 KGS), if you turn 6 NM prior to a 90º turn you will reduce your distance by roughly 6 NM and therefore 1 min. So, to correct for 30 sec you would need to turn 3 NM early. Unfortunately, for turns other than 90º the time saved is not linear. For example, early turning a 45º route change at 6 NM will only save you about 10 seconds. It is best to study route geometry during preflight planning and make mental notes of how much time you can save using only early turns.

   c. Speed Correction.

      i. This is the preferred method of timing correction if you are early (saves you fuel by slowing down). All strike routes will be planned for a base airspeed of 360 KGS. From a mathematical sense we are just manipulating the Speed=Distance/Time equation. When deciding whether to adjust the speed or distance we must keep in mind that an increase in speed will also increase fuel flow and a decrease in speed will decrease fuel flow. In general if we are late it makes more sense to reduce the distance via an early turn, conversely if we are early we will save fuel by slowing down

(a). Early - Slow down. Calculate the amount of time you will need to use with simple math (discussed later).

(b). Late - Speed up. Consider the effects on fuel consumption. Calculate the amount of time you will save using simple math (discussed later). Remember to prioritize geo-cuts to shorten the distance if able.

(c). 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 predictable results.

ii. An increase/decrease of 1 KGS over 6 minutes will increase/decrease 1 second of route time. The standard correction you can use will be in 30 KGS increments. This will increase/decrease 30 seconds of mission time over 6 minutes, or more simply, 5 seconds for every minute. At any point, you may go as slow as 330 KGS or as fast as 390 KGS (fuel permitting). On the final target leg you can increase your speed up to 420 KGS (this will give you a correction of 10 seconds for every minute flown). Airspeeds slower than 330 will not be permitted in order to maintain maneuvering airspeed.

iii. 30 KGS is the standard speed correction; however with high SA and at instructor discretion you may request something other than the standard correction. If you choose an intermediate speed, i.e. 23 KGS, ensure you are not doing complex calculations in your head. For example, if you have 6 minutes of time left on the route and you are 23 seconds off, set a 23 KGS speed correction for 6 minutes. Do not try to figure out what 23 KGS will do for the next 1+30. Most importantly, ***do not guess a speed correction!*** If this is not an option, default to a standard 30 KGS correction and continue to assess your timing.

iv. For example, if you note a time of 15+15 on top of point Alpha, when the planned MOT time was 15+30 an appropriate seed correction is “Set 330 ground, time in 15+30, time out 18+30.”

For planning purposes, use 330, 360, and 390 KGS to get your NET, OT, and NLT route times. Do not plan geometry corrections or 420 KGS on the final target leg. This will give you some room for error once you are on the actual route. Some general rules for when and how to apply speed corrections are:

a. Only apply a speed correction if 15 sec or more off preflight, unless on target leg.

b. Only apply a single up speed correction if geometry alone will not fix timing.

c. It is acceptable to round.

d. Fix timing as early as possible.

e. Get to the target on time.

208. SPECIAL USE AIRSPACE DECONFLICTION

Many of the MTRs you will fly, such as the IR-037 transiting the Desoto MOA, transit some form of special use airspace. A deconfliction plan needs to be briefed and executed to ensure safe passage through airspace where we are MARSA (Military Assumes Responsibility for Separation of Aircraft) since the controller cannot guarantee IFR separation while we are in active military airspace.

As a single aircraft on an IR or VR, one technique is to make an advisory call on and then monitor the de-confliction frequency for the Special Use Airspace (SUA) you are transiting. As a section, the lead SNFO should positively switch the flight to the SUA common frequency in the AUX radio and conduct a positive check-in, then make an advisory call and de-conflict as required. If another element is in the area and using the frequency for tactical communications, expect to advise them of your frequency (not the channelized button) then positively switch the flight back to Tac in the AUX radio once you have coordinated a de-confliction gameplan with the other element in the area.

There are three basic forms of de-confliction: time, lateral, and vertical. If we check-in to the Desoto MOA at 5,000’ on the IR-037 and a section of F-16s replies they will be exiting to the south in 3 minutes, we can likely de-conflict with time as we will not be in the same piece of sky at the same time. If that same section replies that they are strafing in the R-4401 only, with sound knowledge of the MOA and our route, we know that the IR-037 does not penetrate the R-4401, and we are therefore laterally clear of the F-16s. If they reply that they are working target acquisition between five and 15 thousand feet, we would need to come up with a vertical de-confliction plan. This would involve our flight coordinating an altitude that affords at least 1,000’ of clear air between us and the F-16s. This can be done by modifying our altitude with ATC to 4,000’ or greater than 16,000’, or we could ask the F-16s to work 6,000’ and above while we transit at 5,000’.

At VT-86, expect to commonly share the Desoto MOA with other VT-86 CAS players while you transit through on an IR route; note this on the flight schedule and make every effort to deconflict before the brief, and then brief your deconfliction gameplan during the brief

209. 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 help 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 2-3, 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 break out late, meaning they will not be positively identified until at close range, this is usually less than 10 NM. Correlation points are required for such points. The procedures for finding a point are the same for each leg.

Initial setup of the VMTS should occur on deck, time permitting. This is done from the menu page selecting BIT at push button 8, then push button 19 (VMTP). After powering on the VMTS processor, proceed back to the menu page and select pushbutton 17 (RDR) and turn the radar to OPR. After a warm-up period, box A/G and verify proper operation. For Strike events, the data link should not be turned on.

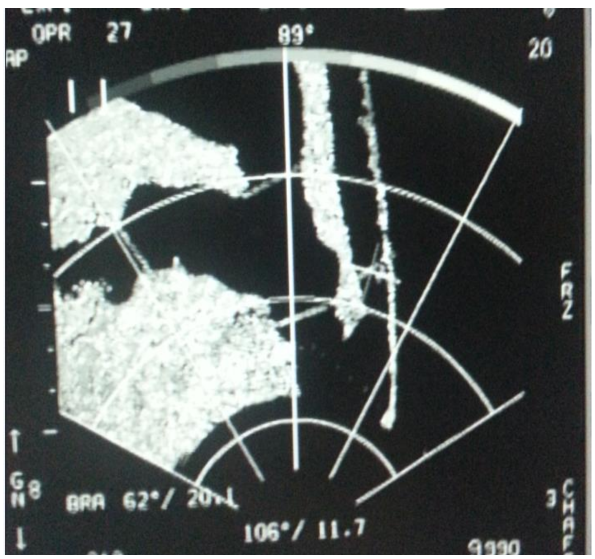


Figure 2-3 Bridge

1. A/S Designation Procedures:

   a. As a default the radar should be in Scale 40, Gain 5. Use funneling features to place your initial designation. If unable to break out features at range, use the INS/GPS for navigation. Consider radar correlation points to help guide the designation.

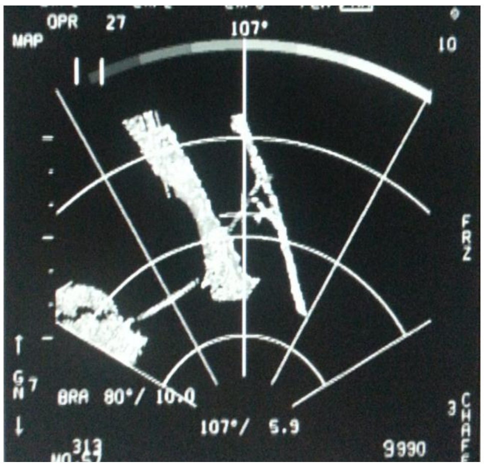
   b. Allow the radar picture to build. Adjust gain to see contrast (bright and dark returns). Use the entire radar picture to find the target area. Coast lines, cities, lakes, etc., should yield prominent returns. Correlate those returns to the strip chart.

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

i. Perform a full action trigger squeeze to drop a designation if you are confident in its position. If further refinement is necessary, pull the trigger to the first detent and hold.

ii. Move the acquisition cursor with the designator controller (DC) to the desired location and perform a full action trigger squeeze.

iii. Unbox FRZ if necessary.



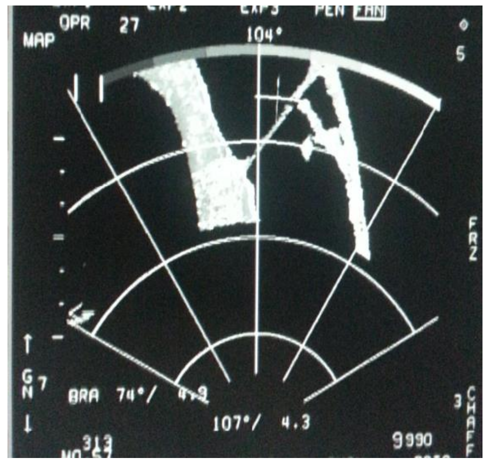


Figure 2-4 Bridge on the 10 Mile Scale **Figure 2-5 Bridge on the 5 Mile Scale**

iv. Hard to find points will break late (5-10 NM). The radar will automatically decrement range once you have commanded a designation.

v. Once you are confident your designation is on the intended point, report "Captured" on ICS. If you are still unsure about your designation, you can report "Designated," but do not report "Captured."

Figure 2-4 (10 NM scale) and 2-5 (5 NM scale) shows the bridge break out as range decreases.

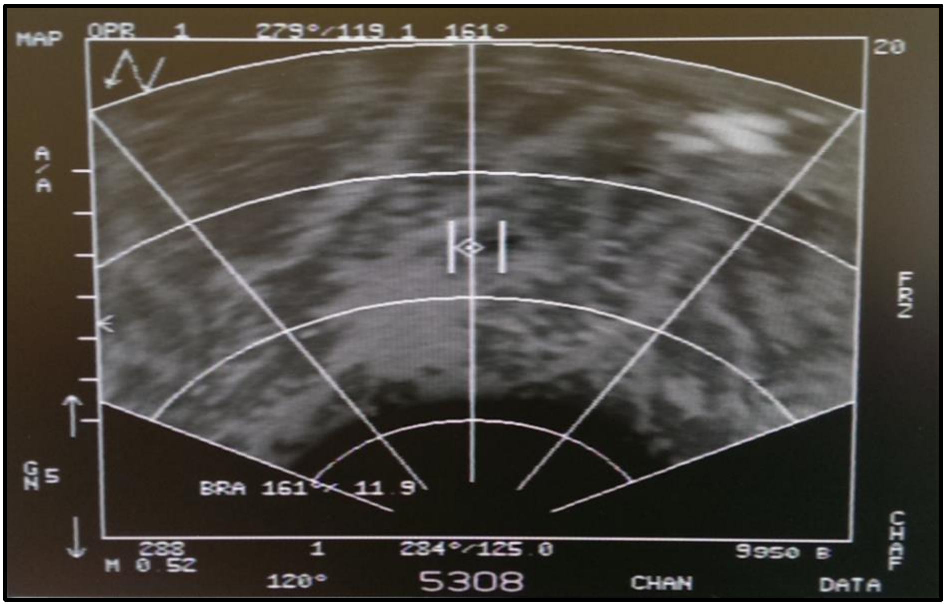


Figure 2-6 Initial Stabilized Designation

Figure 2-6 shows an example of a HATA leg. The turn point is the center of a small lake that is about 10 NM northeast of a small 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 2-6.

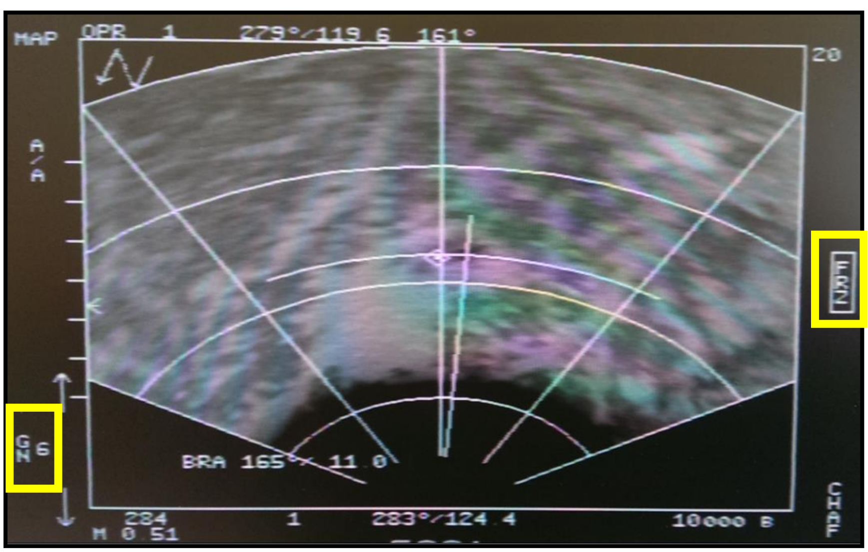


Figure 2-7 Updating Designation

Adjusting the gain will help break out the lake (Figure 2-7). 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 2-8 shows the lake as it would appear using the 10 mile scale.

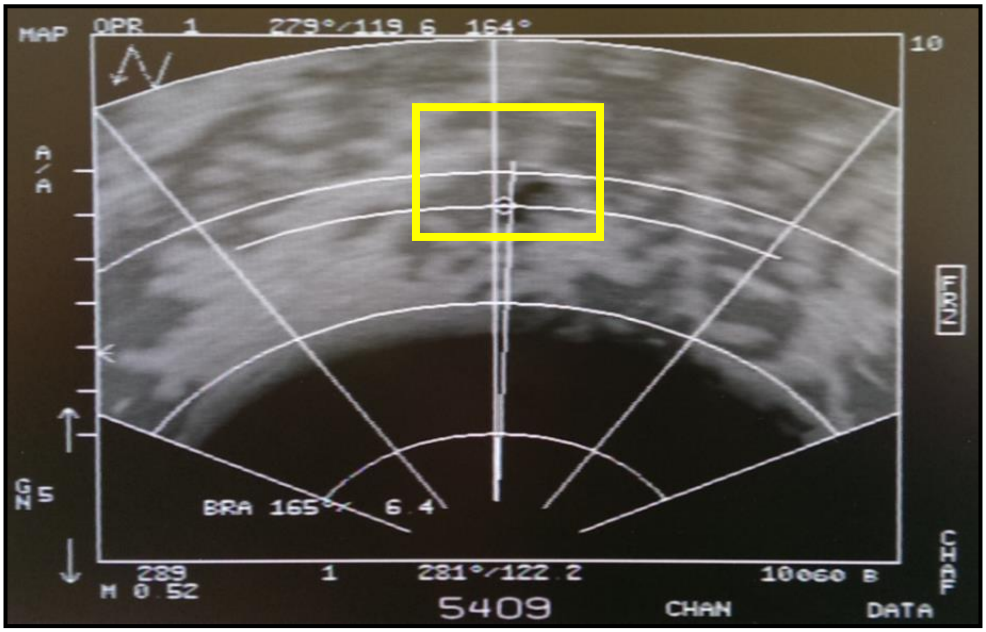


Figure 2-8 Update on the 10 Mile Scale

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 range decrements. The radar will not automatically range down until distance to the designation is approximately 80% (e.g., ~8 NM in scale 10). It may be beneficial to un-designate and manually scale down if you are having trouble breaking out the target in a larger scale.

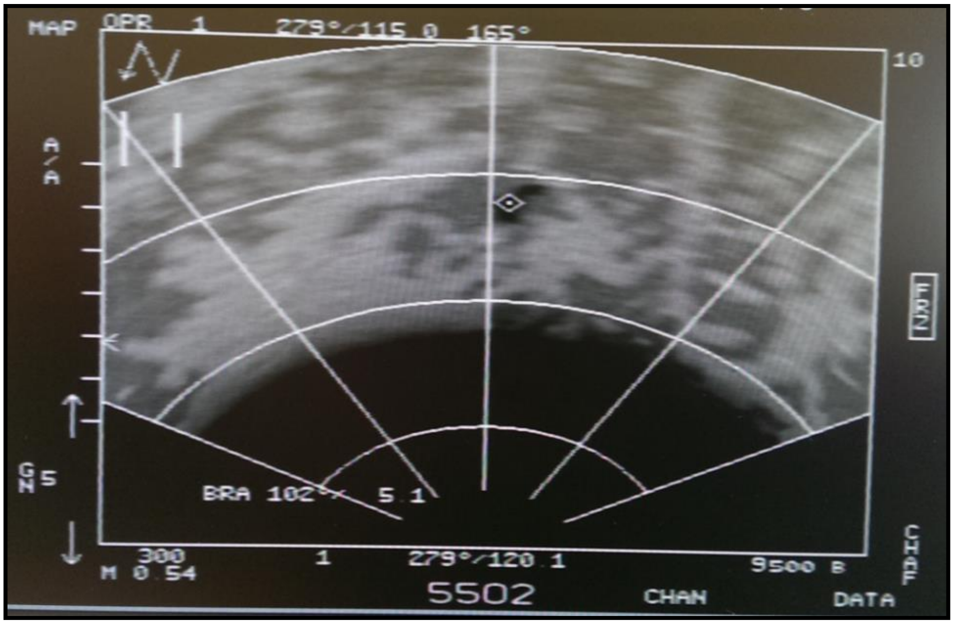


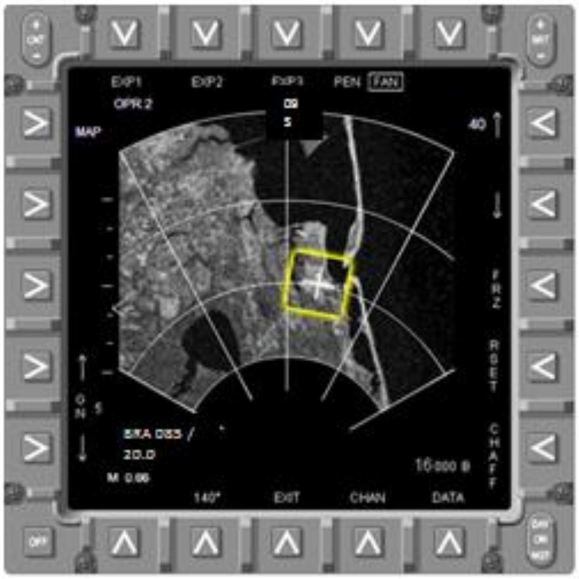
Figure 2-9 Refined Designation

Figure 2-9 shows the final designation, approximately one minute from the turn point. Note the lack of displayed radar returns located at the bottom of the tactical display. The turn point will no longer be displayed at approximately 3 NM; however, the system will continue to hold the designation coordinates.

The key to success for finding each turn point stems from solid preflight planning. The more you know about what to expect to see on the radar the more successful you will be in finding each turn point. Once you are able to determine that the correct turn point/target is under the designation, state "captured" over the ICS. This may occur at 40 NM or inside of 5 NM depending on the radar significance of the turn point. If the turn point is a late breakout, keep your pilot informed of your intentions while you work to capture the turn point/target.

2. Air-to-Surface 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.



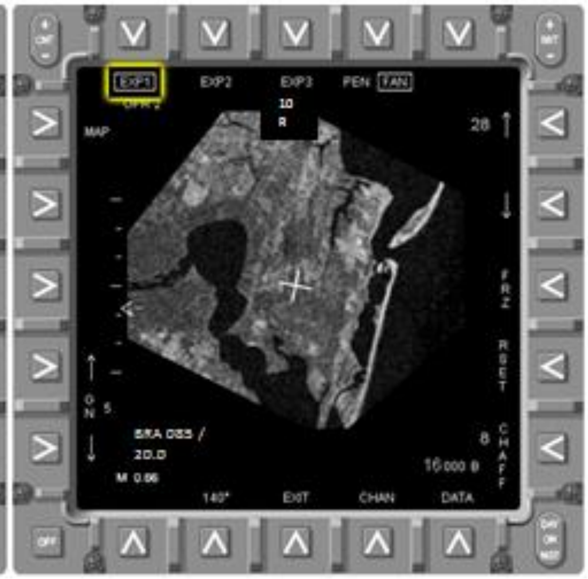


Figure 2-10 Stabilized Cue on Target Area **Figure 2-11 EXP 1 Picture of Target Area**

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 2-10 shows a designation in RBGM. Notice the correlating features that can be used to find the general vicinity of the airfield. Figure 2-11 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.

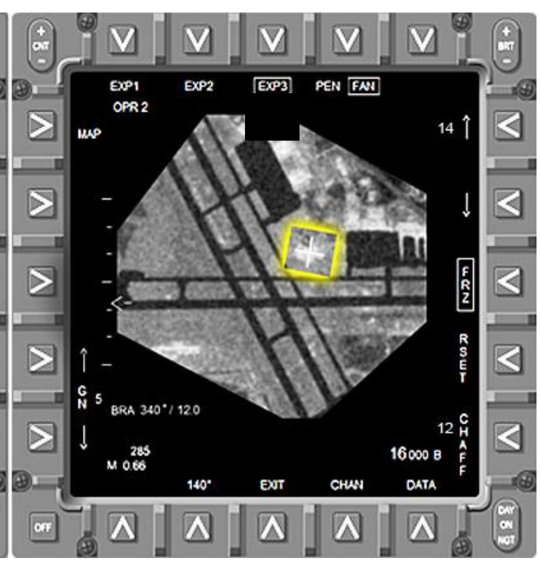


Figure 2-12 EXP 2 Updated Designation Cue **Figure 2-13 EXP 3 Stab. Cue on Target**

Figure 2-12 shows further refinement in EXP 2. Here we can break out runways, taxi ways, roads, and buildings. Further enhancement to EXP 3 in Figure 2-13 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.

EXP modes may be demonstrated at instructor discretion, but SNFOs should not expect to use EXP modes during simulator events to capture the target.

210. ROUTE EXIT AND RETURN TO BASE (RTB)

The mission is not complete until engine shutdown. Hitting your TOT perfectly will mean nothing to your instructor if you can't exit the route and return home safely. Exiting any route will be one of the busiest portions of the flight and should be well rehearsed. The exact order of procedures is not set in stone and will vary based on which route you are flying, the airspace you are in or near when exiting, and many other factors. Think about your priorities and remember to aviate, navigate, communicate. If you are in a section, part of "aviating" is the rejoin. It is critical that you monitor the rejoin; administrative tasks can be performed simultaneously but are secondary to a safe rendezvous.

– RTB Considerations

a. If exiting an IR route, slow to 250 KIAS and turn towards your next waypoint. Request a climb or descent from ATC if desired, and update steering.

b. If exiting a VR route, 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.

c. Initiate the FENCE-out checks. This call is made to tell the flight that it is time to reset all systems back to the administrative portion of the flight. ***These checks don't necessarily need to be done in order or right away after calling fence out***. For example, it may be wise to leave A/A TACAN in A/A mode if Wing is still joining. Reference the VT-86 TACSOP for the fence checklist, with these Strike stage specifics:

i. MSTR ARM – SAFE

ii. A/A TACAN – Set for navigation (leave in A/A until wingman joined)

iii. Displays – Set as required for navigation

iv. BINGO – Set to Divert fuel

v. Recorders – Set VREC to HUD or HUD repeater if HUD camera is inoperative

vi. SMS/MSTR mode – Set to Nav mode

vii. Squawk/Strobes – Direct IP to set as required

d. Check off the route with FSS (if applicable)

e. Obtain IFR clearance or remain VFR/IFR as briefed.

f. Complete Battle Damage checks (if applicable)

g. Confirm FENCE-out complete

h. Get ATIS for the briefed destination

CHAPTER THREE
STANDARD SECTION FORMATION PROCEDURES

300. INTRODUCTION

Formation flying is an essential part of tactical military flying. It serves many purposes including aiding in the expeditious recovery of aircraft at the carrier and tactical mutual support in a high-threat environment. It provides aircrew 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 hallmark of a superior aviator. An NFO'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 at VT-86, it is important for them 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

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 Strike 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 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.

a. 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:

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

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

iii. Lead's tailpipe slightly visible from the front seat (lateral positioning)

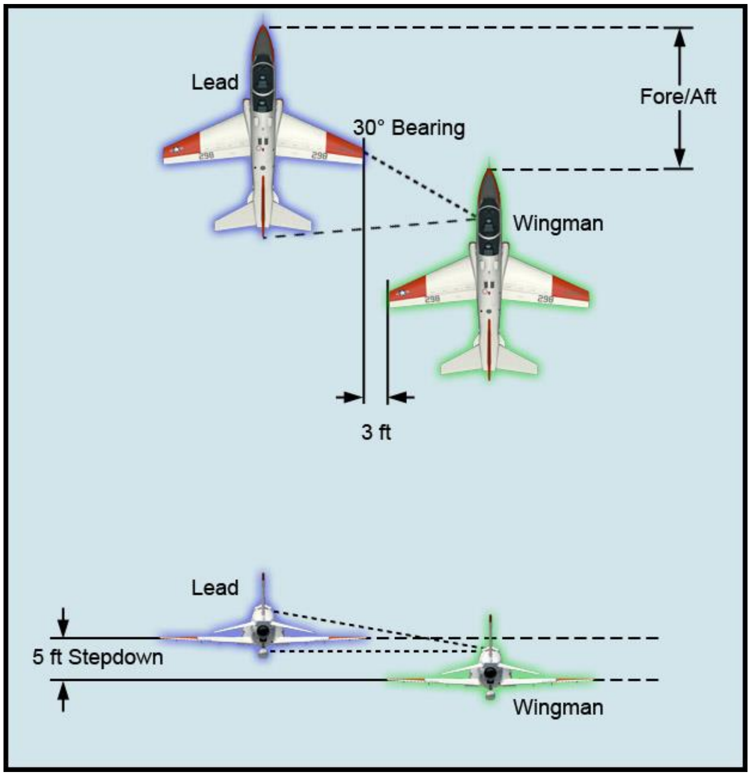


Figure 3-1 Proper Parade Positioning and Sight Picture

Figure 3-2 Proper Parade Position

Figure 3-3 Acute Parade Position

Figure 3-4 Sucked Parade Position

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 flying. 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.

b. 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 3-5). Wing pilot maintains proper positioning by:

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

ii. Sighting along the leading edge of lead’s horizontal stabilizer

iii. Approximately 1-3 plane-widths laterally spaced

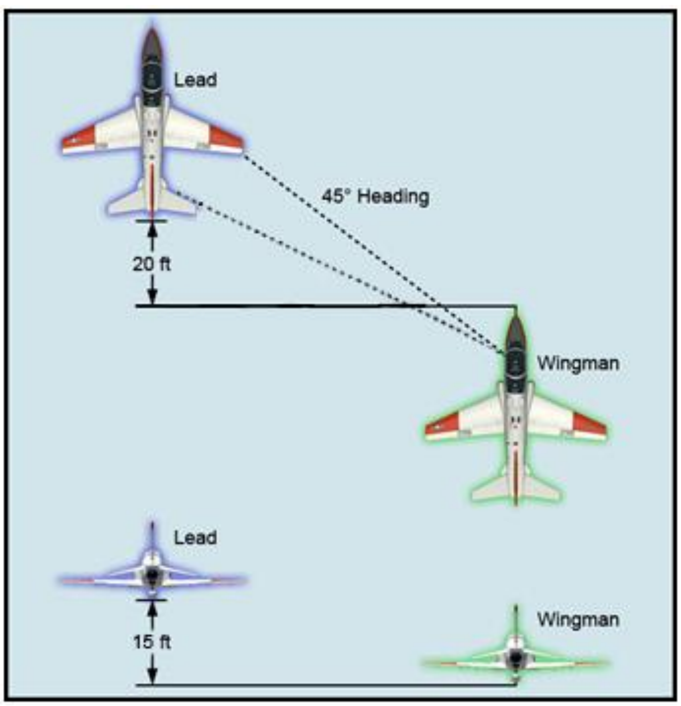


Figure 3-5 Proper Cruise Positioning and Sight Picture

The cruise formation is less fatiguing, and provides greater fuel efficiency for the wingman by eliminating the excessive power corrections required to maintain a tighter 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.

2. 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. You will use two Tactical Formations in the Advanced Strike syllabus; Combat Spread and Tac Wing.

a. Combat Spread

Combat spread is a highly effective section formation that offers both maneuverability and mutual support. In the tactical 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 3-6). 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.

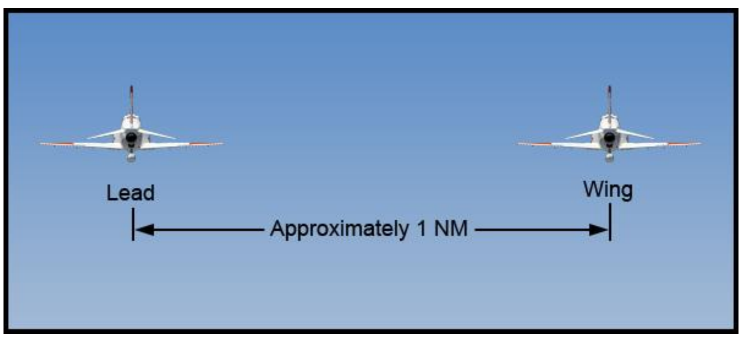


Figure 3-6 Combat Spread

Combat spread provides the following advantages:

i. Excellent lookout capability

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

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

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

v. Visual acquisition problems of both aircraft by an enemy

From a tactical perspective, combat spread offers the most mutual support. Figure 3-7 depicts the lookout responsibilities for each crewmember.

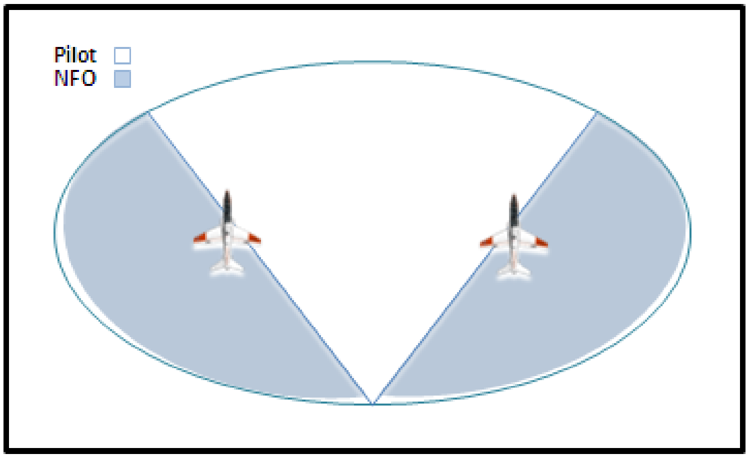


Figure 3-7 Lookout Responsibilities

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.

b. Tac Wing

Tac Wing (Figure 3-8) is an extremely fluid formation designed to provide:

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

ii. Ease in maneuvering a section through rough terrain

iii. Aircraft in close formation can amass firepower while at the same time avoid the fragmentation ("frag") pattern of the other aircraft (e.g., during A/S 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.

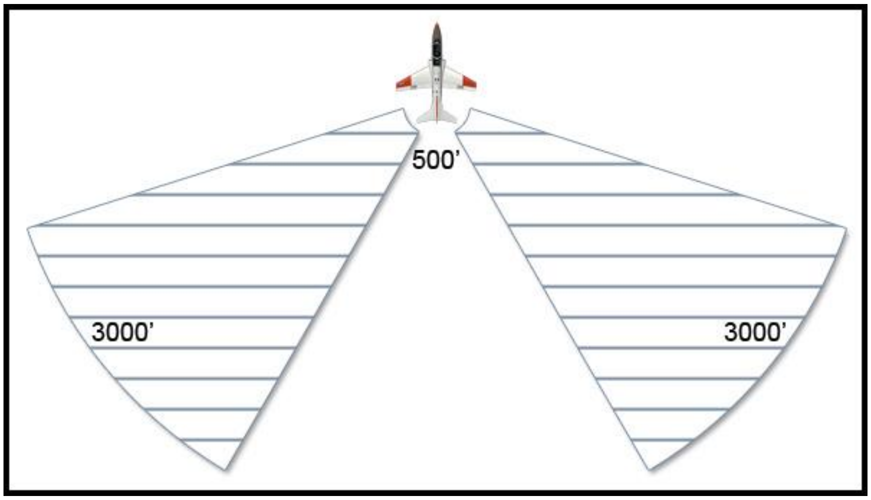


Figure 3-8 Tac Wing

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 well 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 (block altitudes may be used on section IR routes to aid with this).

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.

e. Back up Lead's navigation and maintain situational awareness.

f. 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 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 are essential for mission accomplishment. Formation communications include both verbal and nonverbal (hand signals) communications. The VT-86 TACSOP provides section communication specifics regarding verbal communication, PRI/AUX usage, frequency pushes, and positive radio check-ins. Thorough knowledge of the communication procedures in the VT-86 TACSOP will greatly aid in the flow of the admin and Tac-Admin portions of your flights and avoid confusion on the radios.

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 it will be used whenever talking to base, maintenance, or ATC.

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

2. PRI/AUX Usage

Comm 1 is referred to as the primary radio (PRI) and Comm 2 is referred to as the auxiliary radio (AUX). Typically, ATC communications are conducted on PRI and section admin communications are conducted on AUX. When operating in an airspace utilizing a discrete PRI frequency, e.g., W-155A, R4401, all tactical communications are typically performed on PRI. When monitoring a common frequency on PRI, e.g., PNSS MOA or on Low Levels, all tactical communications will typically be made on AUX. It is important when briefing your communication plan to brief which radio section communication will take place on and when/if this will change during the flight.

3. Frequency Pushes

The Lead SNFO will positively "push" wingman to frequencies when ATC does not assign a specific frequency:

a. On PRI:

i. ATC - *"ROKT 11, switch tower."*

ii. Lead SNFO - *"ROKT 11, switching tower."*

b. On AUX:

– Lead SNFO - *"Hammer, 118.3 PRI.*"

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 11, switch approach 357.0."*

ii. Lead SNFO - *"ROKT 11, switching 357.0."*

There are a few automatic frequency changes. On deck ATIS, Clearance Delivery, and Base in PRI are all automatic and should be briefed as such.

4. Positive Check-ins

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

a. On deck, once both aircraft have completed final checks and are ready for check in, Lead SNFO will initiate a check-in on Tac Freq (AUX):

i. Lead SNFO (AUX) - *"Hammer check Aux, 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. Special Use Airspaces (MOAs, Warning Areas, Restricted Areas)

(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 Aux, Viper 11."*

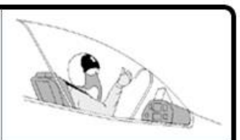
iv. Wing SNFO (AUXx) - *"Viper 12."*

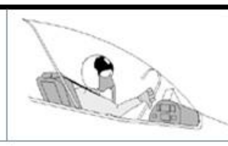
5. Hand Signals

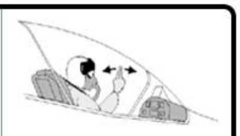
Good formation discipline depends upon the proper use and execution of visual signals. Formation hand signals cover most maneuvers encountered and lessen the need for airborne radio transmissions. Lead must give the signal in such a manner as to be easily seen and understood. A wingman must fly in a 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. Although not always used, hand signals are sometimes easier than making a radio call, and they are the only means of communication if you are NORDO. The following table (Figure 3-9) and images (Figure 3-10 and 3-11) describe and illustrate the typical hand signals utilized in formation.

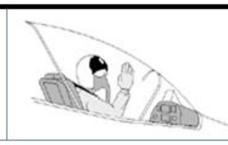
SIGNAL	MEANING
Thumbs-up/down	Self-explanatory
Forearm vertical, 1 through 5 fingers extended	Numbers 1 through 5
Forearm horizontal, 1 through 5 fingers extended	Numbers 6 through 9
Clenched fist	Zero
Arm raised in circular cranking motion	Preparatory gear signal
Exaggerated head nod	Execute signal
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

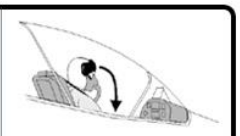
Figure 3-9 Formation Visual Signals

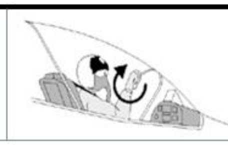
Signal	Thumbs-up or head nod	
Meaning	Affirmative	
Response	As appropriate	

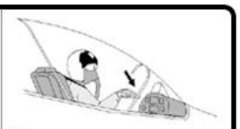
Signal	Thumbs-down or head shake	
Meaning	Negative/do not understand	
Response	As appropriate	

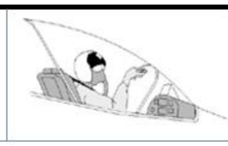
Signal	Raises two fingers in back/forth motion	
Meaning	Perform normal engine run-up	
Response	Wingman repeats signal and executes run-up and responds with a thumbs-up	

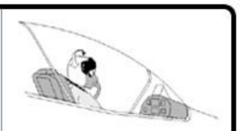
Signal	Section leader raises arm vertically	
Meaning	Preparatory: take-off path clear	
Response	N/A	

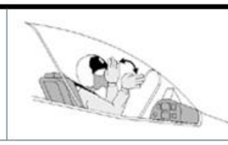
Signal	Section leader drops arm smartly below canopy rail	
Meaning	I am commencing section take-off	
Response	Wingman executes section take-off	

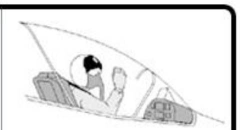
Signal	Rotary movement of clenched fist as if cranking wheels, followed by nod	
Meaning	Raise/lower gear and flaps	
Response	Execute at nod	

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	

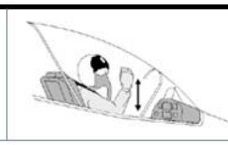
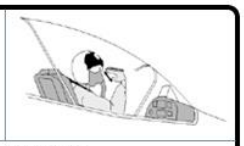
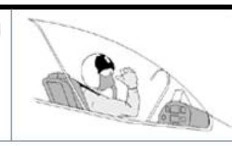
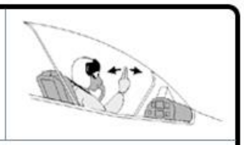
Signal	Leader holds up right/left fore-arm vertically with clenched fist and double pump	
Meaning	Section crossunder to right/left echelon	
Response	Dash-3 relays to Dash-4, then execute	

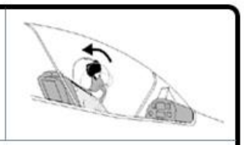
Figure 3-10 Hand Signals

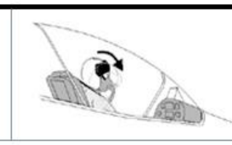
Signal	Open and close four fingers and thumb	
Meaning	Extend/retract speed brakes, as appropriate	
Response	Repeat signal. Execute when Lead nods head or fans speed brakes in or out	

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

Figure 3-11 Hand Signals (continued)

Additionally, in the event of an aircraft malfunction, HEFOE signals can be used (Figure 3-12). 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 3-12 HEFOE Signals

304. GROUND/DEPARTURE PROCEDURES

From the moment the aircrew 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, throughout the flight until landing, and in the debrief. Coordination begins in the line with engine starts and sets the tone for the remainder of the flight.

1. Section Line Procedures

Start up and line procedures are nearly identical to those used in the FAM stage. Radios shall be set to the pre-briefed frequencies for each radio. Typically, both aircraft will cycle through ATIS, Clearance Delivery, then Base on PRI; AUX will be set to the Tac frequency after engine start. This procedure will ensure that aircrew can be contacted by Base, Lead, or Wing. As always, take care of the aircraft first and then attend to formation responsibilities while on 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. Once both aircraft are ready to taxi, Lead will initiate a positive check-in on AUX as explained above. If Wing SNFO did not copy the clearance, he should let the Lead SNFO know during the initial check-in so Lead can provide the clearance details.

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 will typically be to the target 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 3 NM or per the VT-86 TACSOP. If the tolerance is exceeded, Wing should respond with the bearing and range shown on their HSI. 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, and checked in on AUX, Lead will call for taxi clearance with Ground Control.

Taxiing in close interval increases the risk of "Foreign Object Damage" (FOD) in jet aircraft. To minimize this risk, VT-86 Standard Operating Procedure (SOP) will define the approved taxi interval. Additionally, when adequate taxiway width is available, it is customary to taxi formations on opposite sides of the taxiway centerline. All checklists and taxi reports will be conducted in accordance with FAM flight procedures.

Both aircraft should switch to tower as briefed or when directed by Lead. If holding short, the crewmembers of each aircraft should check the other aircraft for integrity and configuration.

Once cleared by Tower to take the duty runway (line up and wait or cleared for takeoff), SNFOs will clear the groove and complete the hold short checklist. Lead should have the strobes off while the Wing will have the strobes on; Lead should squawk normal; Wing squawks standby. The Lead SNFO will direct the Lead IP to take the downwind side of the runway while Wing SNFO will anticipate the opposite side. The flight will switch to departure control on PRI after takeoff clearance has been issued or as directed by Tower.

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, crosswind component limitation, like-aircraft configurations e.g., flap settings and fuel states, and long-field gear are several of the deciding factors. Refer to the VT-86 SOP for current section takeoff requirements and limitations. To takeoff as a section, the weather must be above circling minimums, or in the absence of an approach with circling minimums, 1000/3. If the weather is below circling minimums, the flight cannot take off as a section and must get individual clearances to launch as single ships. A rendezvous plan should be covered in the brief in the event the section has to launch as singles and join up airborne.

Takeoffs may be accomplished in one of two ways:

a. Section Go

i. Both aircraft will begin their takeoff roll at the same time and rotate in formation. A section go is best utilized when ceilings are lower than desired, limiting the ability to join prior to encountering IMC.

ii. 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, then the Lead IP will reduce power to 98% to give Wing a slight power advantage. As in FAM Flight Procedures, each SNFO will ensure their aircraft is ready for takeoff and make the appropriate report on ICS. Additionally, each SNFO and IP will give one last check to the other aircraft and look for any obvious damage, un-secure panels, leaks, etc. Once the thumbs-ups have been appropriately passed, the Lead IP will initiate the takeoff with a hand signal: The Lead IP will raise their arm with an open hand noticeably above the canopy rail and slowly lower their hand. Once completely below the canopy rail (out of sight) both IPs will release brakes.

iii. During the takeoff roll, it is important that SNFOs keep their head out of the cockpit to the max extent possible. The wing pilot will essentially “fly form” on the runway and maintain the proper bearing line.

iv. The Lead and Wing SNFOs 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, no call is necessary. No more than two position calls should be necessary during the takeoff roll.

v. The Wing SNFO will monitor aircraft position, as well as airspeeds, and will make the same standard ICS calls as described in FAM Flight Procedures. Approaching rotation speed (approximately 120 KIAS), the Lead IP will give the “Go fly” signal.

vi. At approximately 140 KIAS, an exaggerated head nod from the Lead IP will prompt both aircraft to raise gear and flaps simultaneously. SNFOs should first ensure their aircraft is clean prior to gear speed and then 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.

b. Interval Go

i. The initial position on the runway is the same as 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 VT-86 SOP-mandated interval (approximately 7 seconds) and initiate the takeoff roll. SNFO procedures during the Lead and Wing takeoff rolls are the same as for a FAM takeoff.

ii. The Lead SNFO should wait sufficient time for Wing to get airborne before contacting Departure. For example, at NPA wait to call departure until established in the turn at 1 DME. The join up from an interval go will either be made by a "running" rendezvous or a "CV" rendezvous; more typically by a combination of both. Both SNFOs should remember to aviate, navigate, communicate. First make sure your own aircraft is clean, climbing, and turning as required then shift your attention outside of the jet to the other aircraft. Lead will set 250 KIAS on the departure unless briefed otherwise.

iii. Lead SNFO should execute the departure procedures while simultaneously monitoring the rendezvous. As time allows, Lead SNFO should give the wingman's status to the pilot over ICS. For example, "Wing coming in at our 4 o'clock, level, good closure" or "Wing coming in low to high, high rate of closure."

iv. 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 and stabilized in position, or the IP reports "I got it" over the ICS. Wing SNFO should initiate the airspeed calls once a speed advantage is gained over Lead. As Wing you should work to develop a familiarity for what airspeed advantage is too much and what is within an acceptable range. This will naturally vary greatly with distance remaining in the join, pilot experience level, and other factors. Over time, you will become better at judging closure rates; a calibrated eyeball. Be the NFO that saves the day by helping your pilot out with a timely, heads up call, instead of the NFO that is heads down completing checklists when a mid-air collision occurs. Remember, if safety is in question, any member of the flight can call for an "under run."

5. Individual Take-off

If weather precludes both a section go and an interval go (e.g., the weather at the departure field is less than circling minimums), a third option is to split the section and perform individual take-offs. Each SNFO will get their respective clearances and upon successful check-in, will taxi and takeoff as singles. Both aircraft will follow ATC directions until able to proceed to a predetermined TACAN position or waypoint to join the flight.

ATC permitting, the flight may be able to join enroute. This is best done on a specific radial from a fix or NAVAID which can be briefed on deck or verbalized once airborne. Plan to request different altitudes with Wing stepped down 1,000' from Lead, then communicate your intentions to ATC. Wing will utilize the A/A TACAN for ranging and report to ATC and Lead once the Lead aircraft is in sight. Once ATC clears you to join, Wing will secure squawk and join as briefed.

305. ENROUTE/SECTION RECOVERIES

1. Enroute

During the enroute portion of the flight, the section will fly the formation directed by the Lead. 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 approach. Individual approaches 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. Lead SNFO should ensure that Wing is on the appropriate side NLT the initial and if not, inform their IP to direct a cross under. An obvious prerequisite for this is that you must know the proper break direction. Lead SNFO should strive to gain this information from Tower as early as possible.

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 FAM 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 preferably prior to, the numbers. When cleared to break, and with proper interval in sight, the Lead IP will initiate the break as briefed with the appropriate hand signal.

There are several different types of section breaks (e.g., fan break and 2 or 4-second interval break). To execute a fan break, Lead will pass the "fan" signal and then 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 and extend speed brakes. 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 shall be covered in the brief.

Following the break, and when established on downwind, the Lead SNFO will report the abeam position and obtain clearance for the flight to land. Upon completion of the landing checklists, the SNFOs will report “gear" in flight order to the tower. The Wing SNFO will wait until the Lead has made his “gear” call before making the “Dash-2 gear” call. Each aircraft will land on centerline and drift inboard to provide a clear lane for the aircraft behind to go around if required. If either aircraft desires a touch and go, then separate clearances must be issued. Lead should request their individual clearance at the abeam, then Wing will make their own abeam call with the appropriate ROKT call sign to obtain clearance to touch and go or land.

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 approach. If the weather is below circling minimums, individual instrument approaches must be performed. The LAW should be set 10 percent below HAA ***(for circling minimums)*** in accordance with FAM flight procedures.

Procedures are basically the same for all possible types of section approaches; PAR, ASR, ILS, TACAN, and Visual Straight-in. The primary consideration is to comply with the controller's directions or the printed approach plate. All FAM 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 PAR or ASR, the Lead SNFO should call “slow for gear” over ICS within 10 NM and 30-degree heading of the final approach course. On a TACAN, VOR, or ILS 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 FAM FTI, special emphasis must be made on the above ranges due to the limited maneuverability inherent in a formation. Considerations must also be made for weather, and where and how the controller is turning you onto final (i.e., strive not to dirty up in the clouds or in a turn). Fuel permitting, dirtying up above clouds might be wise in order to make a stable approach.

Upon the “slow for gear” call, the Lead IP will slow the formation to configure. Speed brakes may be required to slow the section below 200 KIAS. After passing the preparatory gear and flap signal to the wingman, and 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)

When the Wing aircraft has three down and locked, the Wing SNFO will pass a thumbs-up to the Lead SNFO. The Lead SNFO will ensure the pilot stabilizes the approach speed at 150 KIAS to allow ample airspeed for the wingman to maintain parade position without sacrificing maneuverability or safety of flight.

With the Landing Checklist complete, and a thumb's up from the wingman, 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 automatically be extended at the final approach fix, or glide path intercept. 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. Typically this occurs around three miles or about 900' on a three degree glideslope. Once detached, the wingman will immediately slow to on-speed by lowering flaps to FULL and decelerate accordingly. The Lead will maintain airspeed until acceptable separation has occurred, then lower flaps to FULL and slow to on-speed for touchdown. On a PAR/ASR, the Lead SNFO should advise the controller "proceeding visually" as the flight break up. This implies you are VMC, have the runway environment in sight, and intend to proceed with no further assistance from the controller. After landing rollout, you will be directed to "switch tower on landing rollout." As Lead SNFO, ensure Wing is safely on deck before switching the flight to tower.

At fields where parallel runways are available, the Lead SNFO may request to "split the duals," if doing so was briefed. A request to split the duals should be made as early as possible with approach to ensure you will get clearance from tower in a timely manner. 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 25R, the Wing should be on the right side). This allows an easy transition from formation flying to landing for the Wing pilot.

In the event of a missed approach, Lead IP will give the "go fly" signal and will automatically retract the speed brakes. Once a positive climb is established, the Lead IP will then raise the gear and flaps via hand signals while ensuring airspeed stays below 200 KIAS until both aircraft are clean. Each aircrew will ensure their aircraft is clean with a good handle check, then Wing IP will give a thumbs up to Lead. Lead SNFO will wait for this thumbs up prior to advising the Lead IP "flight's clean" and contacting Departure.

5. Post Landing

As in FAM flights, during landing rollout, each SNFO will make the appropriate "board and speed" ICS calls. After clearing the runway, Lead SNFO will switch the section to ground and base and request clearance to taxi (Wing may still be on the runway).

Unlike a FAM flight, "clear the active" will not be part of the call to ground since the wingman may not have cleared the runway at this point. Simply leave this part of the transmission out as "clearing the active" can easily be misinterpreted. The section will proceed to the line area and complete the required cockpit checklists.

306. TACTICAL FORMATIONS/MANEUVERING

On the route, Combat Spread will be the preferred formation. For terrain considerations and target attacks, Tac Wing may be utilized.

1. Combat Spread

Combat spread formation in the tactical environment is defined as follows (Figure 3-13):

a. 90 (270) degree bearing line

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

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

Five distinct section turns are used while flying in combat spread. These turns are:

a. Check turns: 0-30 degrees

b. Tac turns: 31-120 degrees

c. Shackle

d. In-place turns

e. Cross turns (not discussed in this FTI)

Cross turns 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) unless "un-called" turns are specifically briefed.

All turns during low-level 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 and the ground. The main priorities during the turns are to track the turn and avoid the ground. Crewmembers should not exceed more than one second mission crosscheck time (MCT). MCT will be explained in the next chapter.

2. 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 3-13). The Wing SNFO should recommend a sucked or acute position prior to the anticipated turn to avoid the IP using power to maintain proper formation. No communication is required for this turn, although the Lead may make a courtesy call on Tac Freq.

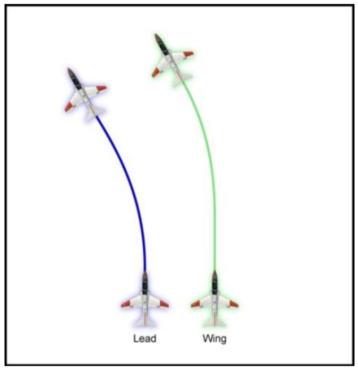


Figure 3-13 Check Turn

3. 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 3-14)

a. Lead will initiate with a call on AUX.

b. Wingman initiates a 14 unit AOA 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), Lead will execute a 14 unit AOA turn to the new heading and roll out. Wing should visually clear the Lead's 6 o'clock as they make the turn.

d. The wingman may need to execute a small repositioning turn or adjust AOA 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 (Wing will always pass above the Lead).

g. Example communications flow is as follows:

i. Lead IP (AUX) - *"Hammer, Tac Left."*

ii. Lead IP (AUX) - *"Hammer flow 270."* (Made only if rolling out on heading other than 90 degrees of original heading)

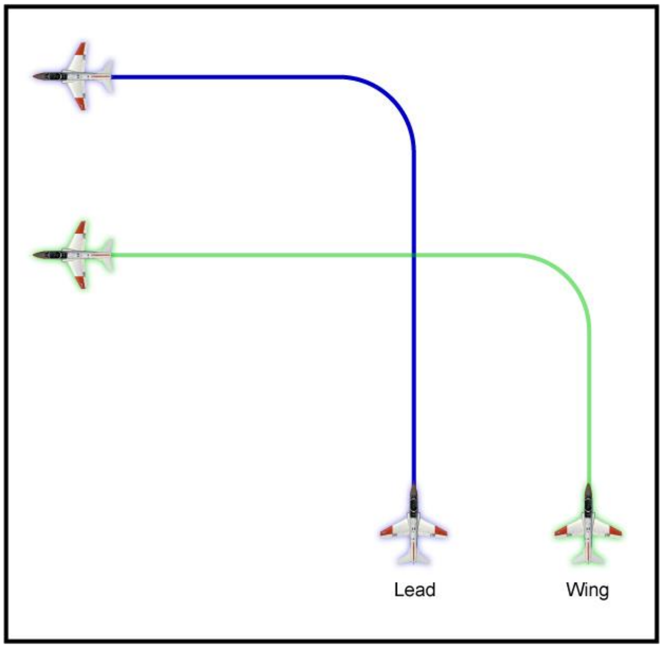


Figure 3-14 Tac Turn Away

Tac Turn Into (Figure 3-15)

a. Lead will initiate the appropriate call on AUX, executing a 14 unit AOA turn 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 14 unit AOA turn to the new heading.

c. The wingman may need to execute a repositioning turn or adjust AOA 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. Lead ensures deconfliction (Wing will always pass above the Lead).

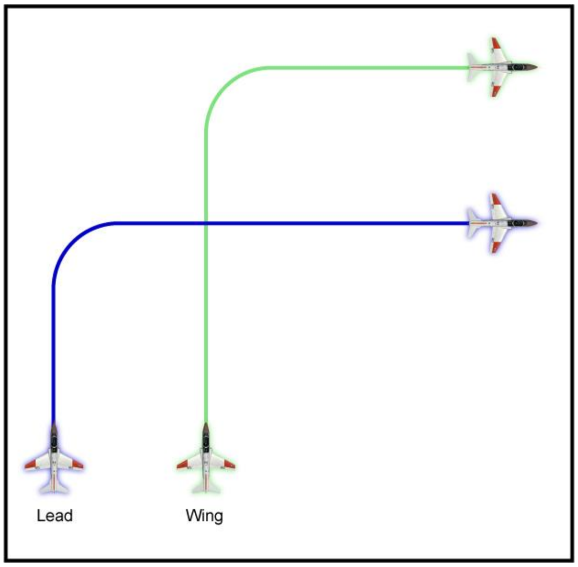


Figure 3-15 Tac Turn Into

4. Shackle

A Shackle (Figure 3-16) is normally used to correct for timing, or to redress the section following a turn or attack. An "Off-heading" shackle can also be used to turn the section less than 90 degrees, typically around 30-60 degrees.

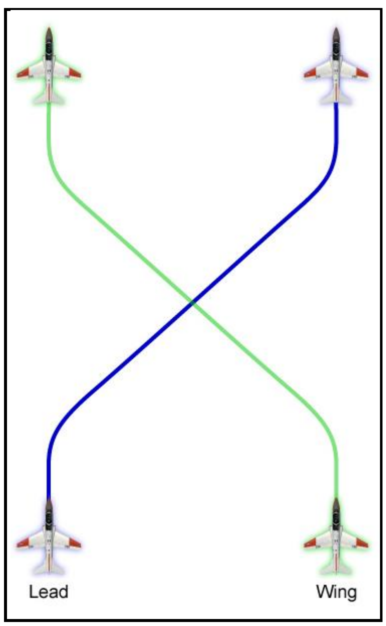


Figure 3-16 Shackles

Shackles will be executed as follows:

a. Lead will initiate a shackle with a call on AUX.

b. The wingman will respond by starting a 14 unit AOA turn into Lead.

c. As Lead sees the wingman start his turn, Lead will then commence a 14 unit AOA turn into Wing 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 (approximately 2 seconds after crossing paths). 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 communication is as follows:

– Lead IP (AUX) - *"Hammer, Shackle."*

In cases where a shackle is used to redress a section, the aircraft will be maneuvered so that the sucked aircraft will be able to regain proper bearing (Figure 3-17).

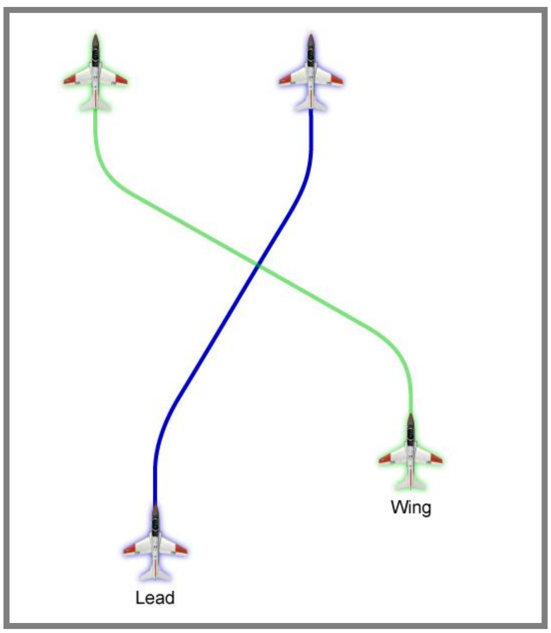


Figure 3-17 Shackle Turn to Redress Section

Primary lookout doctrine should be tracking 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.

In cases where a shackle is used to turn or change the heading of the section, both aircraft will adjust their turns so that they roll out on the proper heading and in combat spread. Example communication is as follows:

– Lead IP (AUX) – "*Hammer, Shackle, 270.*"

5. In-Place turns

The In-Place Turn is an engaging turn that changes flow heading by 180 degrees, and causes the aircraft to swap sides of the formation. Both aircraft will begin and finish their turn at the same time. Normally, an In-Place Turn is used to engage a bandit that is in the section's rear quarter, in the direction of the turn. During Strike, an In-Place turn will typically only be used entering or exiting a route if geometry dictates a 180 degree turn. Lead will specify left or right for the direction of turn. Example communications is as follows:

– Lead IP (AUX) – "*Hammer, In-Place, Right.*"

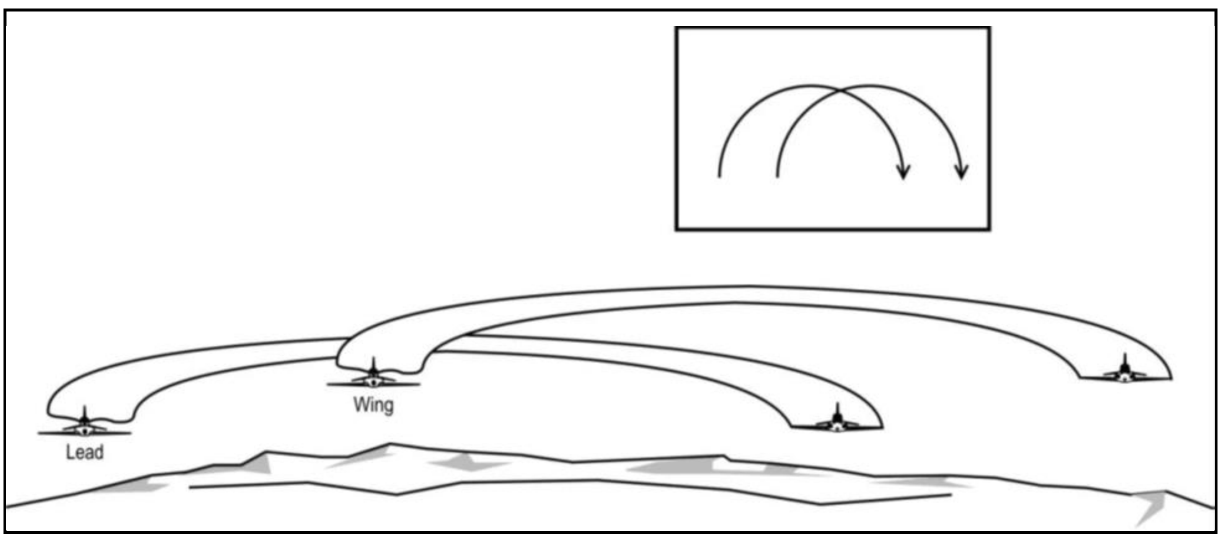


Figure 3-18 In Place Turn

6. Tactical Maneuvering Summary

It is imperative that all aircrew master the concept of task management: First and foremost, avoid hitting the ground, ensure flight deconfliction, and then execute the mission. The workload on a mission is extremely high. It is critical that the basics discussed are learned correctly and proper habit patterns are practiced from the beginning of your training. If safety is ever in doubt, do not be afraid to speak up!

307. FUEL MANAGEMENT

– 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 constant need for adjusting the throttles to maintain position in formation, Wing will typically be at a lower fuel state than Lead. The Lead SNFO will be responsible for initiating all fuel checks on the Tac Freq.

At a minimum, fuel checks should be performed:

a. After every lead change

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

c. As part of the Fenced in/out comm

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.

308. FENCE IN/OUT

1. G-warm

CNATRA Low Altitude Training Rules require the performance of a G Awareness Maneuver prior to low altitude training. The G-warm is conducted from combat spread and consists of two 90 degree turns for at least 4 Gs. These turns can flow back to the original heading or reverse the heading of the section 180 degrees. IPs will execute the communication and conduct of the G-warm; however the Lead SNFO is expected to direct the IP to begin the G-warm and to recommend the manner in which it is performed. During preflight planning, give consideration to where and when to perform the G-Warm and in which direction would be optimal for route entry, traffic, etc. Brief your plan but be prepared to flex real time.

2. Fence In/Fence Out

A strike fighter aircraft's role is to be employed tactically in order to execute an Air-to-Air (A/A) or an Air-to-Surface (A/S) mission. 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 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 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. During your training, these checks are covered by the FENCE checks located in the VT-86 TACSOP. During the Advanced 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. Some items of the checklist will be executed by the IP; however it is the SNFO's responsibility to ensure they are completed.

Fence in/out specifics for the Advanced Strike stage are delineated in the previous chapter.

3. Battle Damage Check (BDX)

After all tactical flights, the potential exists for aircraft damage. Upon conclusion of the tactical conduct, the section shall conduct a battle damage check by visually inspecting each aircraft for damage such as loose panels, leaks, or any other discrepancy that may affect the RTB.

Although this is a check that is coordinated and executed by the IPs, it is the SNFOs' responsibility to ensure that BDXs are monitored and executed in a timely fashion. This will ensure ample time for coordination if damage occurs.

309. EMERGENCIES

1. Aborts

"Sympathetic" aborts are used during interval takeoffs, as the wingman should be able to safely stop behind the lead. If Lead aborts, Wing aborts. The seven-second delay on an interval takeoff will normally ensure Wing is below line speed to prevent a dual high speed abort situation. If Lead aborts, Lead IP will transmit "*call sign, aborting*" over AUX. Wing IP will transmit "*Clear*" over the radio which informs the lead aircraft that it is safe to use the long field arresting gear.

NOTE

> The front aircraft will be cleared for the long field arrestment by the trailing aircraft making any radio transmission. That is why it is extremely important for the trailing aircraft to only transmit when the lead is clear for the gear (also known as "only good news" over the radio).

When a Section go is executed, there are no sympathetic aborts. Instead, both aircraft shall maintain their side of the runway or takeoff lane. The non-aborting aircraft will continue the takeoff roll and clear the runway by becoming airborne. 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 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 has an emergency 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. SNFOs in the non-emergency aircraft should have the PCL open to the appropriate page and be ready to be a book reader. 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 “*call sign, 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)

This is a minor emergency when flying in formation. When operating beyond the range of hand signals, if Lead becomes NORDO, they will porpoise their aircraft to signal Wing to join into parade. If Wing becomes NORDO they will automatically join into parade and pass the appropriate hand signals. The aircraft with the communication failure will become the Wingman, if not already.

If another emergency is experienced while NORDO, Wing should relay this information to Lead using HEFOE signals. Wing should also drop their hook if a straight in or arrested landing is required. Raising the hook will indicate a straight in is requested, leaving the hook down indicates an arrested landing is required. Lead will acknowledge this by dropping and raising their hook.

The aircraft with the good radio will be given the Lead via hand signals and perform a recovery in accordance with the weather conditions. If in VMC, and no other emergencies exist, the flight should maintain VMC 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 or a straight in is requested, Lead will have to recover the NORDO aircraft with a 150 KIAS, half-flap section instrument approach. Section approach procedures will be utilized. At approximately 500 feet AGL and in a position for a safe landing, Lead will pat the dash (meaning 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 executes a touch-and-go, bolters or goes missed approach, Wing should visually acquire the Lead at the 10 o’clock or 2 o’clock position at pattern altitude (or below the ceiling). 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 or LCLS), 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. For low levels, the LCLS point will typically be the next point being flown to with separate altitudes briefed. If on an IFR flight plan (such as on an IR route), a LCLS point cannot be used, and both aircraft must continue per the FIH. De-confliction should be assured through altitude separation as briefed.

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 appropriate local 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 maintain or regain control of the aircraft if it can be flown or eject if the aircraft is out of control. If the mid-air was internal to the flight, the elements of the formation will separate and not rejoin.

Each aircrew will execute controllability checks of the damaged aircraft above 10,000 feet AGL while proceeding to the landing field; remain over water or unpopulated areas, if possible. The PCL shall be followed but aircrew should be familiar with the basic flow of the controllability check. These are:

a. Slow the aircraft in increments of 10 kts

b. Lower the gear at 200 kts or below

c. Evaluate the slow flight characteristics

Flaps may be lowered at pilot discretion, if wing damage is not suspected. Continue to slow the aircraft in 5 kt increments to on-speed or until the aircraft control becomes marginal. Increase airspeed 10 kts and use this speed as a minimum airspeed. 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. NATOPS recommends a field arrested landing if available.

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CHAPTER FOUR
LOW ALTITUDE TACTICS AND PROCEDURES

400. INTRODUCTION

Low altitude tactical flight training is designed to teach visual navigation using prominent terrain features, increase aircraft survivability, and minimize the increased risk associated with low altitude tactical flight. 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.

All LAAT at VT-86 will be accomplished in accordance with the CNATRA LAAT FTI (P-912) and reference 500' AGL as the absolute minimum altitude for training.

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 members 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 Fighter Wing. 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 requires all aircrew to read Low Altitude Training Rules prior to each low-level flight. These can be found in the CNATRA LAAT FTI and published in the TW-6 IFG.

2. The "Bucket" Concept

Task saturation in a high speed, low altitude environment happens quickly. High workload combined with high risk is potentially dangerous. Aircrew 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 individual 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).

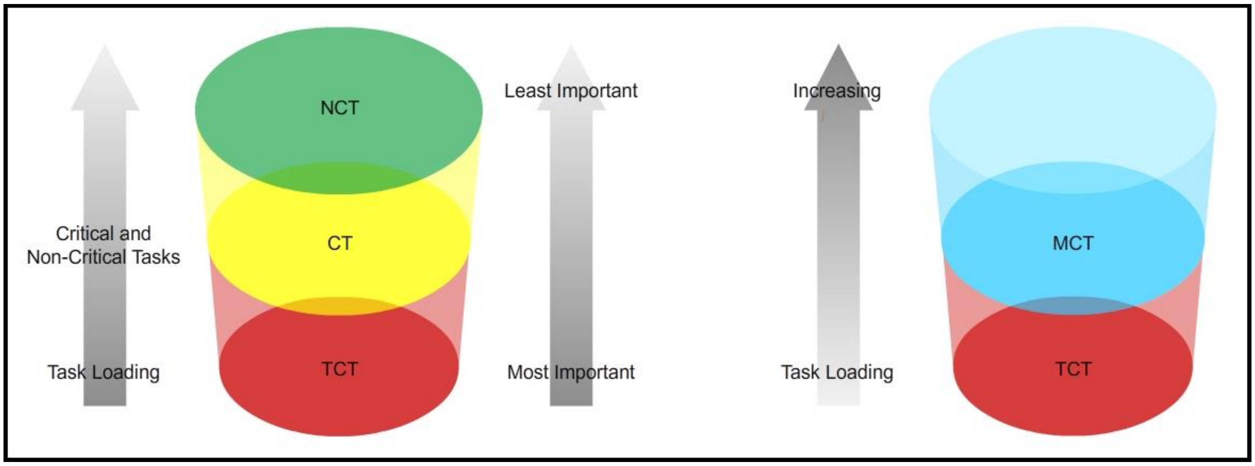


Figure 4-1 The Bucket/MCT Applied to Bucket

Certain tasks can be critical at one point during the mission and non-critical at another. MCT dictates how much time aircrew is 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 in a turn at low altitude

Task Management timelines can be applied to low altitude as a means of methodically forcing aircrew 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 and TCTs 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.

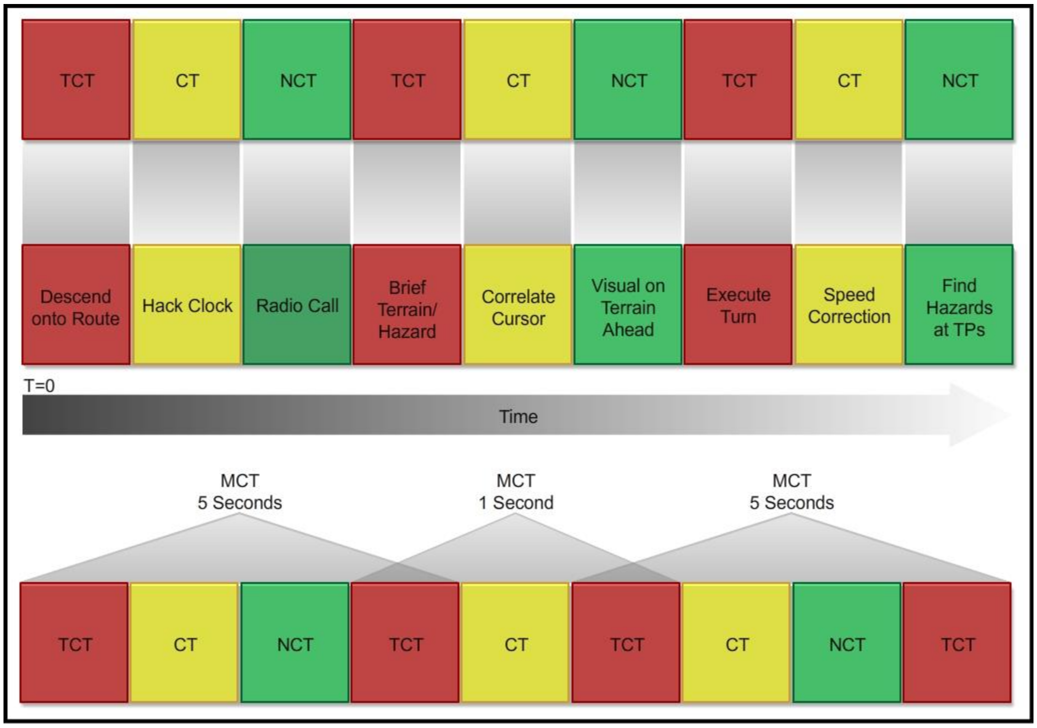


Figure 4-2 Task Management Timeline with MCT

In addition to time and task management, aircrews must learn their limits and be able to immediately recognize when their buckets are 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; this 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.

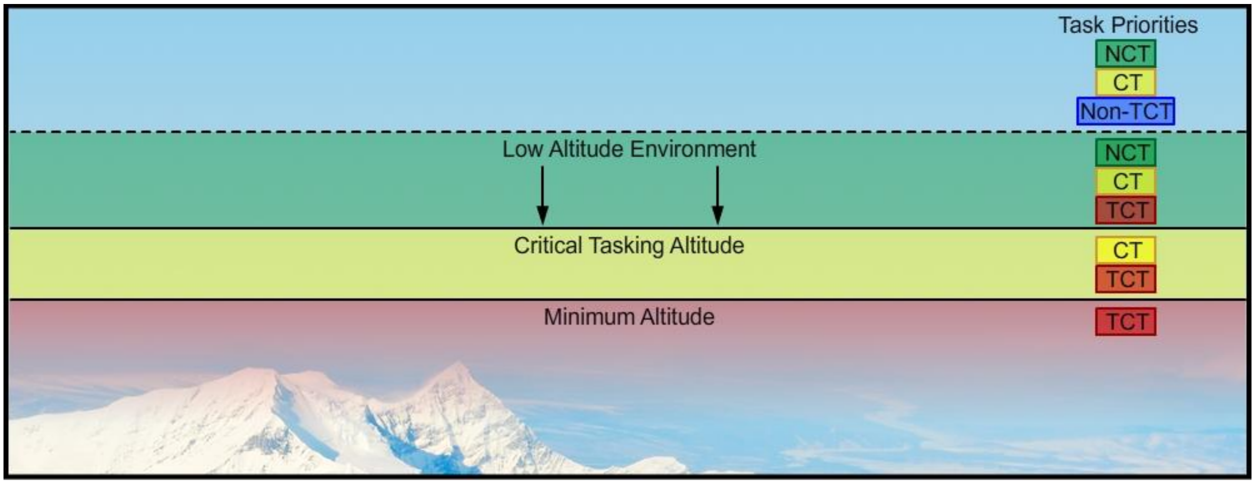


Figure 4-3 Reference Altitudes

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, un-acquired 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 gray out 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).

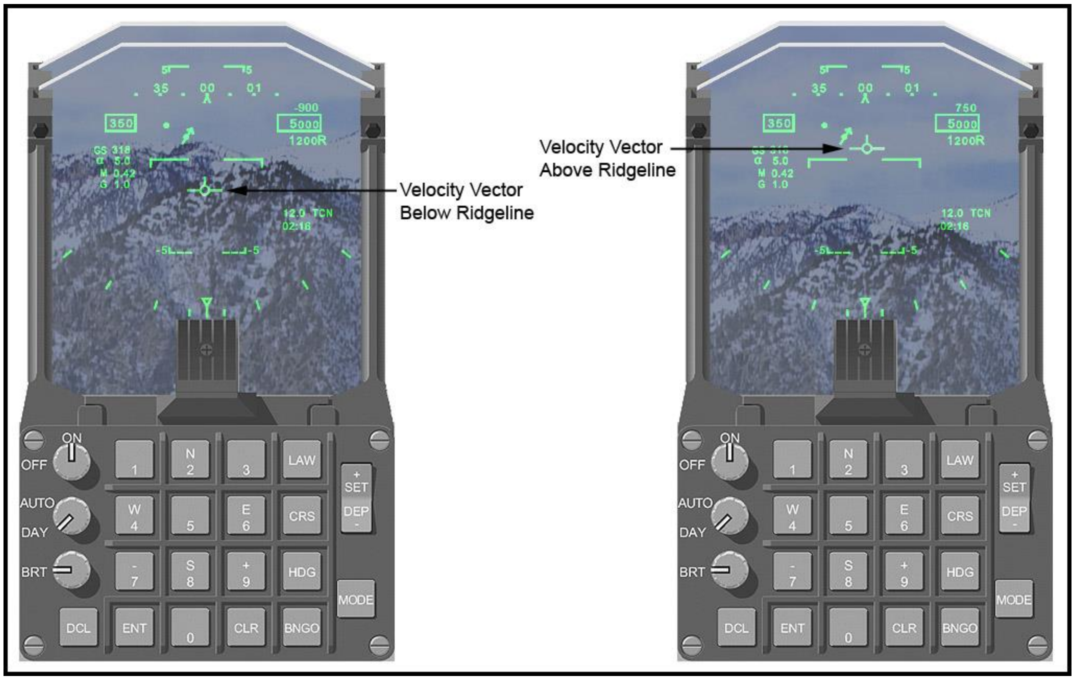


Figure 4-4 Velocity Vector Placement Relative to Ridgeline

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.

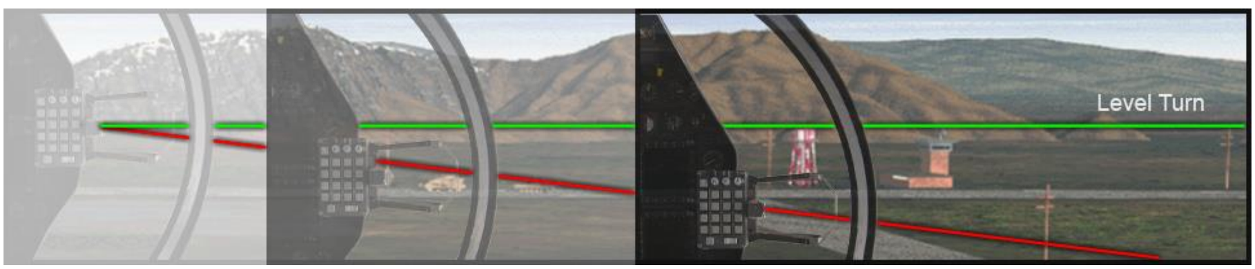


Figure 4-6 Nose Slice in a Turn

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 must 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 Low Altitude training rules, SOPs, LAAT procedures, and NATOPS. ***Detailed route preparation and study are required***. Recall from the Chapter Two planning discussion, that SNFOs must prepare a briefing board. Figure 4-7 is an example, but reference E-Brief for most up to date briefing board examples. SNFOs must bring the following items to the low-level briefing:

a. SNFO Junk Jacket

b. Applicable publications

c. Jet Log

d. All applicable charts

e. Pocket Checklist (PCL)

f. Briefing Guide

g. Target and turn point imagery

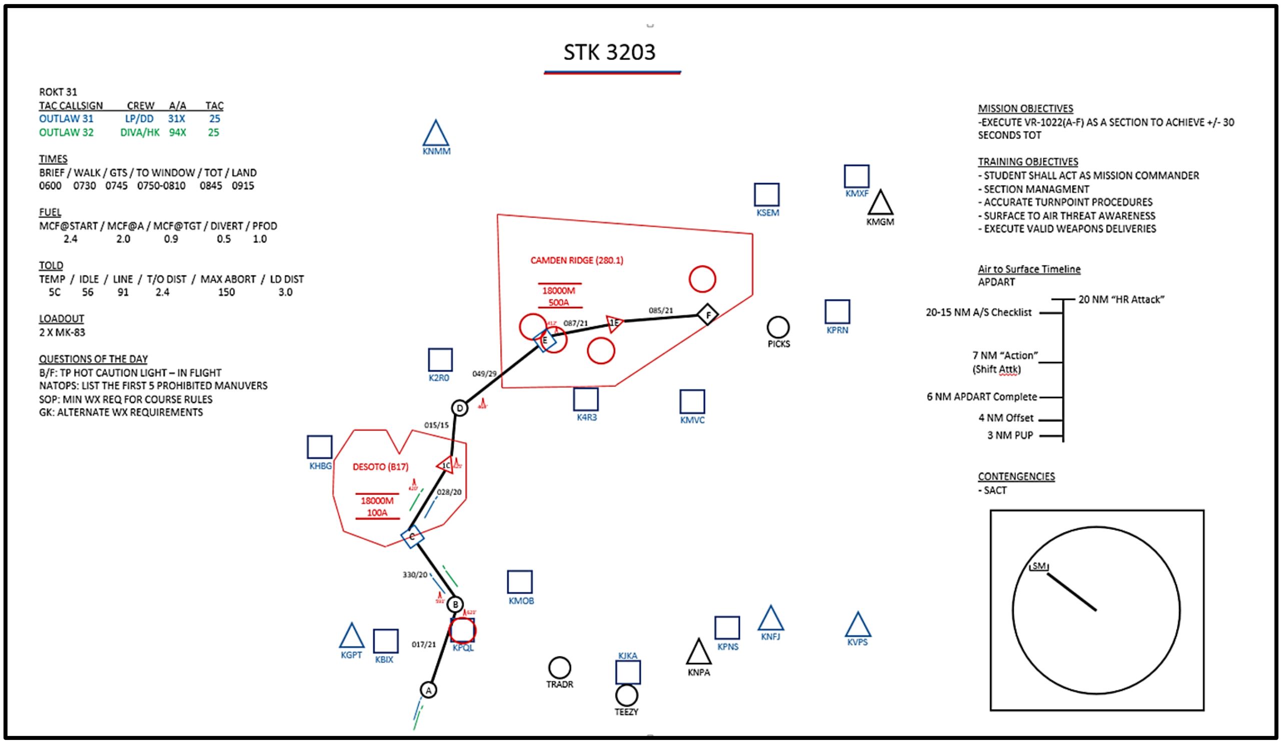


Figure 4-7 Section STRIKE Briefing Board

2. Enroute Procedures and Route Entry

Low-level flights begin with the standard section administrative procedures detailed in the previous chapters. 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 you near the entry point a descent to low level will be required. One technique is to multiply the altitude to lose in thousands of feet by two, then add 10 NM. For example, on the way to the entry point of the VR at FL250 it would be appropriate to coordinate a descent about 60 NM from the entry. (24,500' feet to lose X 2 = 50 NM, + 10 = 60 NM.) As the flight approaches the route, Lead SNFO will take charge and:

a. Cancel IFR

i. Below FL180 and clear of traffic. SNFOs can request either a descent to minimum vectoring altitude or VFR flight following. With a short amount of time to the entry point, flight following may be problematic as ATC may give you a new squawk and will require you to cancel the flight following as well. ***Do not*** say "request traffic off my nose for the next XX miles" as this sounds like you are asking for ATC to place traffic in front of you and is unprofessional. ***Do not*** say, "request traffic advisories" as this is often misinterpreted as requesting flight following.

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

iii. About 20 miles prior to entering route, or as briefed.

Lead SNFO (PRI) - "*Houston Center, ROKT 11, cancel IFR.*"

Houston Center - *"ROKT11, Houston Center, cancellation received, frequency change approved, squawk the appropriate code."*

Lead SNFO (PRI) - *"ROKT 11, switching."*

iv. Once cancelled, direct IP to squawk 1200 or as assigned. Lead IP will push Wing to the appropriate formation. All aircraft shall squawk 4000 or as assigned with strobes ON once on the route.

b. Low level checks - Low level checks shall be accomplished and reported complete by each crew member prior to entering the low level environment. Low level checks include:

i. Mask – On

ii. Visor – Down

iii. Loose items – Stowed

iv. Good LAW tone upon passing platform

v. LAW – set 10% below MINALT for each segment per training rules

vi. The first three steps are for verification purposes only. Low level checks are easily completed as soon as you hear a good tone and reset the LAW.

c. FENCE-in: As previously discussed this call is made to tell the flight that it is time to set up all systems for the tactical portion of the flight.

– Conduct G-Awareness Maneuver (G-warm) as part of the fence-in.

d. FSS Radio Call

i. The Lead SNFO will inform the FSS 2-3 minutes prior to route entry

ii. Lead SNFO (PRI BTN29) - "*99, ROKT11, 2 T-45s, entering VR-1031 point A, 1800Z, 500 feet, 360 knots.*"

Just prior to entering the route, ensure fence checks and low level checks are complete. One minute prior to the entry point, the SNFO will give the IP an outbound airspeed and heading using standard turn point procedures.

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. A useful technique is to hold your strip chart in one hand above the dash to keep your head out of the cockpit. 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 below 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 intermediate 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.

Students shall be familiar enough with the route to maintain course and timing without reference to waypoints or sequence. All SNFOs shall input all turn-points into SEQ1 and check the HSI with SEQ1 displayed for accuracy. To facilitate outside scan for ICPs, TPs, and hazards, expect instructors to remove the sequence at some point during the VR forcing purely visual navigation. Once there has been concurrence between both cockpits that the route sequence is correct, SEQ will be unboxed and the route flown by visual navigation only. The instructor will have the option of directing SEQ1 displayed any time adherence to AP/1B route restrictions is in question.

403. ROUTE CORRECTIONS/DISORIENTATION

While established on the low-level route, Lead and Wing students will be mutually responsible for navigating the route. As previously stated, Lead will navigate as close to the route center as possible while Wing 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

Use the HSI/SA course line to make course corrections; Lead must make course corrections with Wing's position in mind. Make small corrections for longer periods of time in order to allow Wing to maintain position. Additionally, ensure Wing remains within the route structure at all times. Make the appropriate corrections to keep the flight inside of the route corridor, while maintaining SA of your surroundings and time.

2. Timing Corrections

Timing corrections follow the same overall procedures described in Chapter Two. As Wing, you will monitor timing and make recommendations to your IP. 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.

If at any point on the route you become lost, check the clock immediately. Look outside for unexpected hazards. Check the fuel state and compare with MCF and Bingo fuel states. The disorientation may have caused more problems than just navigation. If unable to determine your location, remember the “Five Cs” of Strike:

a. Confess: Do not complicate matters. Once you acknowledge you are lost, talk to your pilot. Decide upon a temporary plan and avoid wandering aimlessly around at low altitude while deciding what to do.

b. Climb: 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 towards a known landmark. If practical, climb to conserve fuel, or if holding, slow to maximum endurance speed.

c. Communicate: Advise wingman of situation. If you must exit the route structure, start communicating with the appropriate controlling agency.

d. Conform: 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.

e. Correct: In order to reorient yourself, the crew must find landmarks and identify them on the chart. Reference the clock to determine estimated location on the chart and compare with what is seen outside. Care must be taken to avoid following a hunch or making a decision based on uncertain information. A water tower with the town’s name painted on the side has reoriented more than one naval aviator in the past.

Once reoriented, make a correction to get back on course. These procedures will not be possible unless the aircrew’s charts include sufficient area coverage to account for disorientation.

404. 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 fence checklist will be used to transition back to the admin mindset.

1. Route Exit

After completion of the final target attack, Lead will initiate a VFR climb on course and commence the RTB. Wing will complete his target attack and commence an off-target rendezvous. During the off-target rendezvous, 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.

ii. Ensure Wing calls *"Hammer-12 off safe, visual"*

iii. Update navigation

iv. Initiate the Fence-out checks.

v. Direct IP to squawk 1200/STBY.

vi. Monitor the rendezvous

vii. Check off the route with FSS

viii. Switch flight to appropriate ATC frequency/obtain IFR clearance

ix. Complete Battle Damage Checks

x. Conduct Fence-out report

xi. Complete 10k checks

b. Wing SNFO

i. Monitor rendezvous (provide airspeed calls to IP over ICS)

ii. Follow Lead's frequency changes

iii. Fence-out on Lead's direction

iv. Direct IP to secure squawk

v. Ensure Battle Damage Checks are completed

vi. Complete 10k checks

vii. Back up Lead with navigation

After the final target attack, an example comm flow is as follows:

a. Lead IP (AUX) - *"Hammer-11, off safe."*

b. Lead SNFO (ICS) - *"Right 210, climb VFR to 7,500."*

c. Wing IP (AUX) - *"Hammer-12, off safe visual."*

d. Lead IP (AUX) - *"Knock it off, knock it off, Hammer 11 Knock it off."*

e. Wing IP (AUX) - *"Hammer 12 Knock it off."*

f. Lead SNFO (AUX) - *"Hammer, Fence-out."*

g. Lead/Wing SNFO (ICS) - "*Squawk 1200/stby."*

h. Wing SNFO (ICS) - *"380....350....320."* (call airspeeds until safely joined)

i. Lead SNFO (PRI) - *"Anniston Radio, ROKT 11 exiting VR1021, PT E."*

j. Lead SNFO (AUX) - "*Hammer, Button 20 PRI.*"

k. Lead SNFO (PRI) - *"Houston Center, ROKT 11."*

l. ATC - *"ROKT 11, Houston Center, go ahead."*

m. Lead SNFO (PRI) - *"Houston Center, ROKT 11, flight of 2 T-45s VFR 10 miles northeast of Monroeville VORTAC, request IFR as filed to Navy Pensacola."*

n. Lead SNFO (AUX) - *"Hammer-11, fenced-out, 1.1, good G."* (after wingman joined and BDX complete)

o. Wing SNFO (AUX) - *"Hammer-12, fenced-out, 1.1, good G."*

NOTE

The above order is one example only and will need to be modified based on the particular situation.

2. Approach and Recovery

The section will recover in accordance with the section procedures detailed in the previous chapter. SNFOs should brief and plan to execute section approaches until MCG requirements have been met. After that, the order of precedence for recovery is:

a. Course Rules

b. Section Visual Straight-in

c. Section approach

d. Individual approaches

405. 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 bird strike for example), eject immediately as 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). Never troubleshoot at low altitude. You should have an emergency safe altitude calculated for each leg of the route. Flying at this altitude will ensure safe clearance from all obstructions so that you can devote your attention to the immediate problem of weather, aircraft malfunction, or navigation error.

For an engine failure, trade airspeed for altitude and execute NATOPS immediate action items. Consider that the best airspeed for ejection is below 250 knots. SNFOs shall 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 do not delay your decision to eject.

For Lost Comm/Lost Sight (LCLS) on the route, slow to 250 KIAS, climb, proceed to the next point or a pre-briefed LCLS point and orbit; Lead at 2000 feet, Wing at 3000 feet (or as appropriate ***outside*** of the route structure) and squawk 1200. Determine a bingo fuel state from this point to a suitable airfield. Execute one turn in holding; left hand turns inbound to the point. If after one turn sight is not regained or Bingo fuel is reached, Wing will immediately proceed to a suitable airfield and Lead will fly 5 miles towards the next turn-point then proceed to a suitable airfield. The NORDO aircraft (potentially both) will change squawk to 7600 and proceed to a suitable airfield utilizing normal lost communication procedures.

CHAPTER FIVE
AIR TO SURFACE ATTACKS

500. INTRODUCTION

Air-to-surface (A/S) 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 target, on time, while minimizing 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 number and type of weapon(s), 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 aircraft and OFT provide excellent training for the F/A-18 Hornet and Super Hornet and EA-18G Growler. The following section will provide descriptions, details, and differences of the T-45C and OFT VMTS 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/S 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; however, at VT-86 we will only simulate the carrying of ordinance. General Purpose (GP) bombs or “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.

– 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 5-1 Mk-76 or BDU-33D/B Practice Bomb

Although the T-45C does not carry precision-guided practice bombs, the VMTS/OFT system provides an 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. Dual Laser/GPS guided

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 5-2 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. Control stick weapons release button and gun trigger

f RHC – A/A and A/G weapon release button

g. A/A weapon select switch

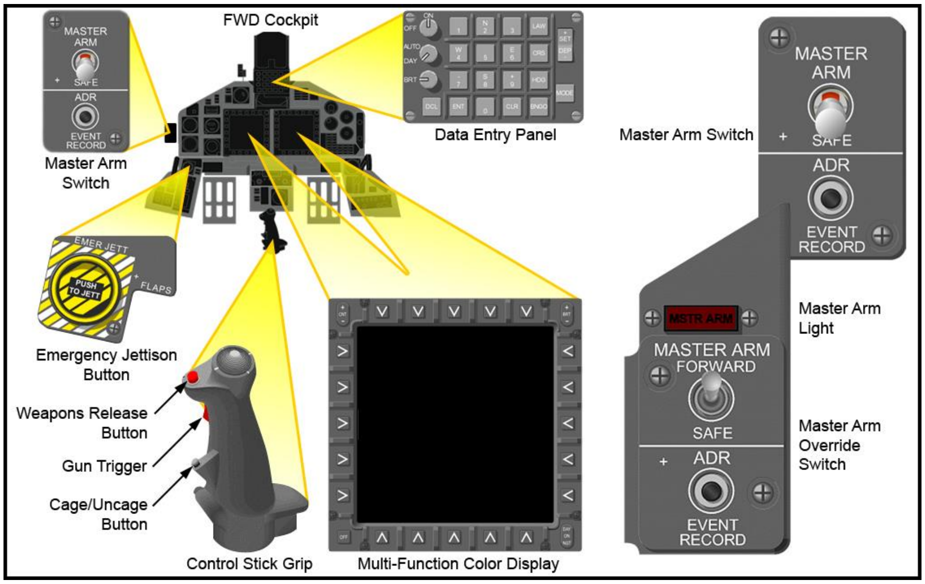


Figure 5-2 Mstr. Arm Switch/Fwd Cockpit Armament Controls/Master Arm Override

The emergency jettison button is powered by the 28 VDC essential bus and is placarded PUSH TO JETT (Figure 5-3). 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.

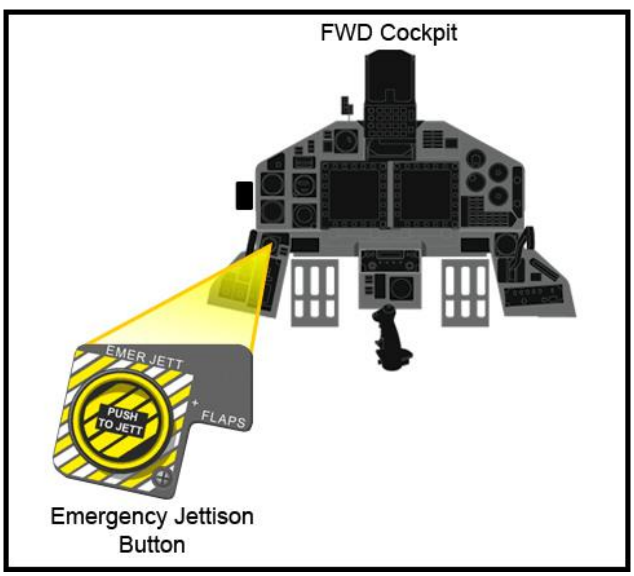


Figure 5-3 Emergency Jettison Button location

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 5-4 shows the control stick A/G and A/A release, and the RHC A/A and A/G release.

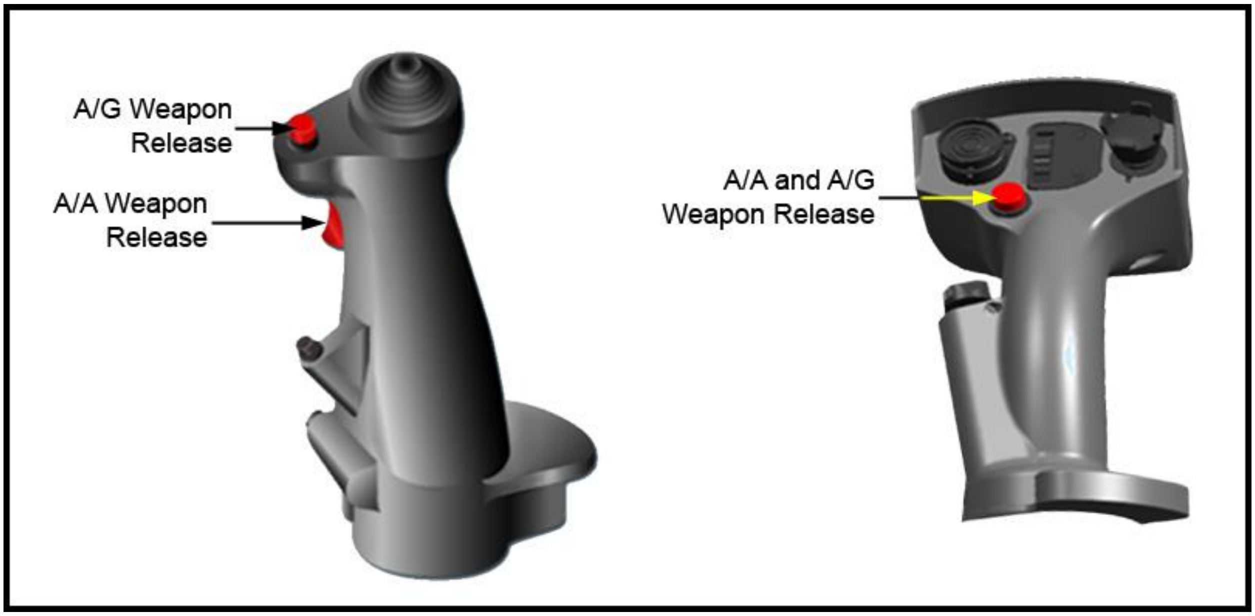


Figure 5-4 Control Stick Weapon Releases/RHC Weapon Release

3. VMTS Stores (STRS) Display Procedures

The VMTS stores display is selected by actuating STRS on the MENU display (Figure 5-5).

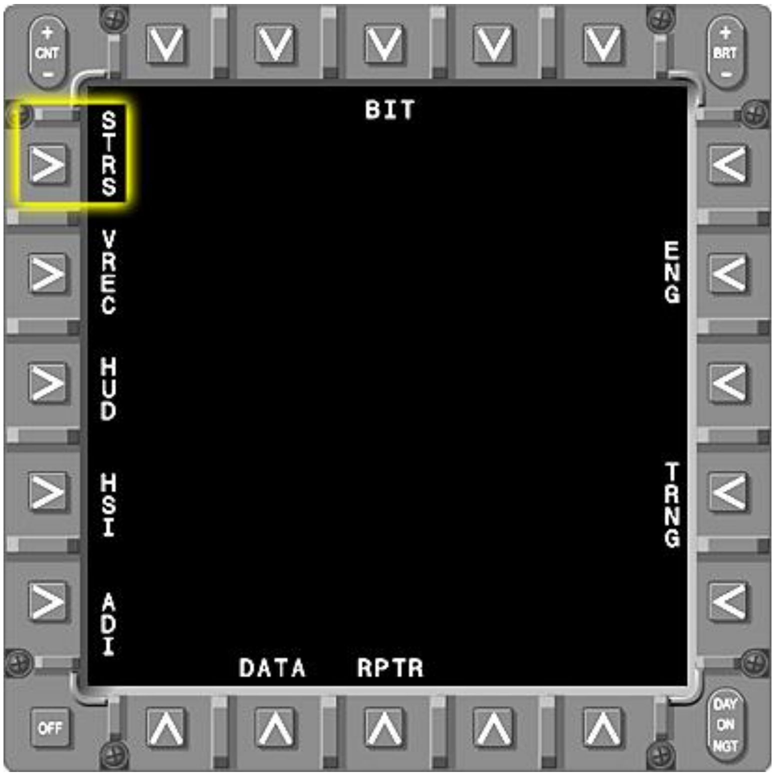


Figure 5-5 STRS Option On The MENU Display

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 5-6). A/S weapons capability and modes are the same as the basic non-VMTS T-45C 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/S inventory management and employment via the Stores display and the aircraft audio system.

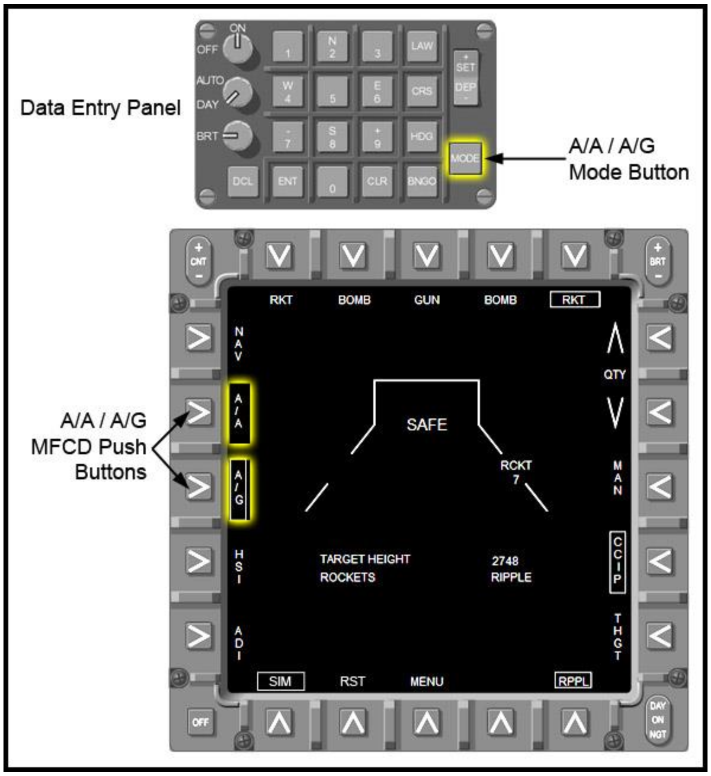


Figure 5-6 Data Entry Panel (DEP)/A/G Selection VMTS

The selection logic for simulated A/S 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 5-7):

a. SIM – Enables/disables SIM mode and RHC/HOTAS control of simulated A/S 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/S stores and initializes the A/S 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.

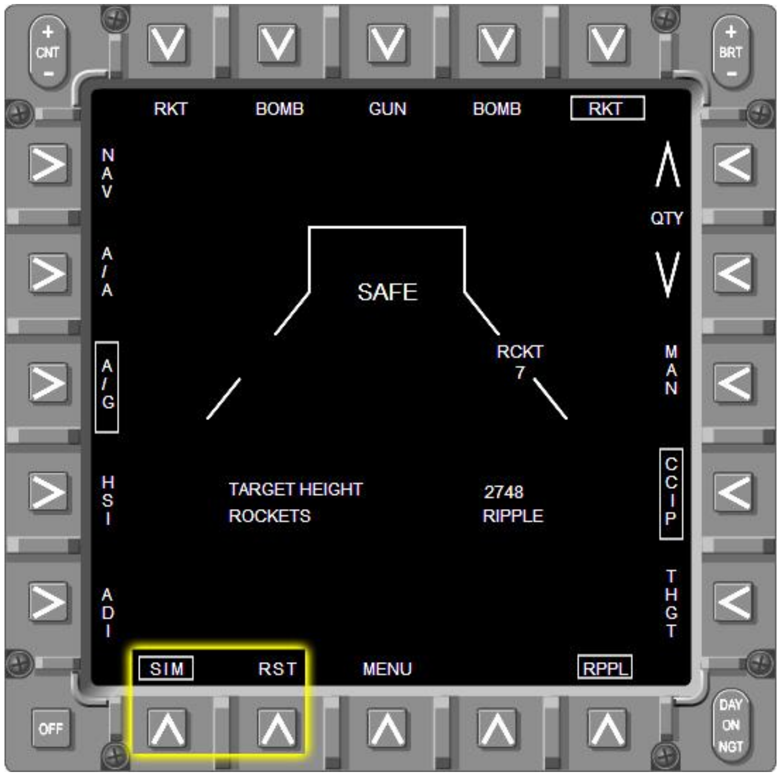


Figure 5-7 VMTS SIM Mode and RST Options

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 5-7). 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. Bombs are the normal weapons utilized in the Advanced Strike stage. Rockets will only be used at Instructor discretion.

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 5-8). The aircraft weapon stations interface with the stores page, so if actual bombs are released or the pickle button is pressed, the stores quantity will decrement after release. The MAN (manual) option unboxes CCIP and displays mil dep setting on the Stores Display and HUD.

The VMTS in both the aircraft and OFT have the A/G stores display page which function identically. Additionally, the OFT has the SMS page which the aircraft VMTS system does not have. This page in the OFT is not utilized as part of any graded evolution and should only be demonstrated at Instructor discretion.

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.

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 5-8):

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.

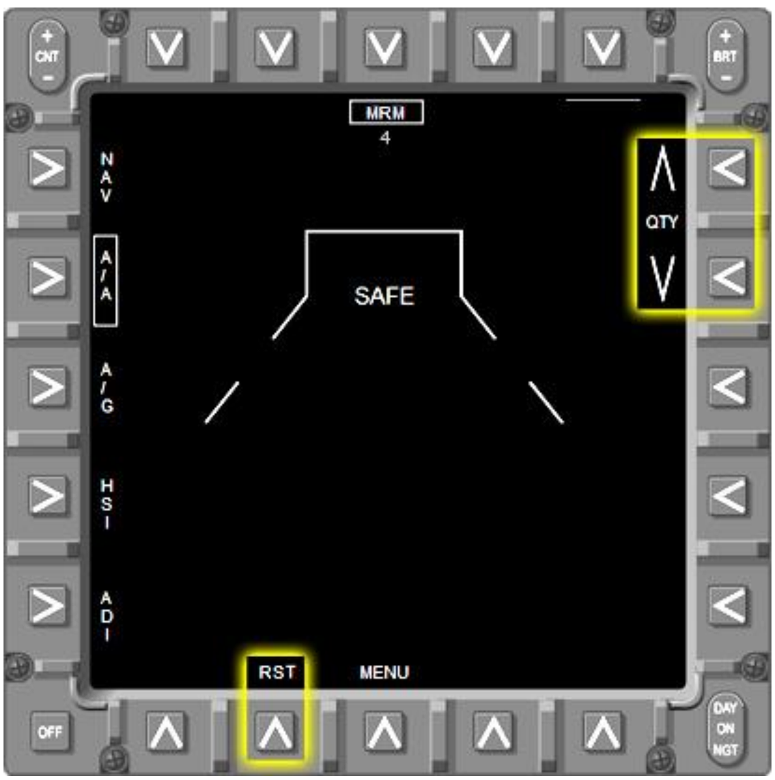


Figure 5-8 A/A STRs Display Options, QTY and RST

502. AIR TO SURFACE WEAPONS

Accurate A/S delivery of ordnance on surface targets is one of the primary missions of Navy and Marine aviation. Mastery of A/S concepts, procedures, and skills is critical to A/S mission success and to the ground forces that depend on aircrew to put bombs on target (Figure 5-9).

The SNFO's knowledge of weapons concepts and procedures provides the foundation for developing accuracy and consistency in the skills introduced at VT-86.

Figure 5-9 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

2. 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 5-10):

a. Mk 82 – 500 lbs

b. Mk 83 – 1000 lbs

c. Mk 84 – 2000 lbs

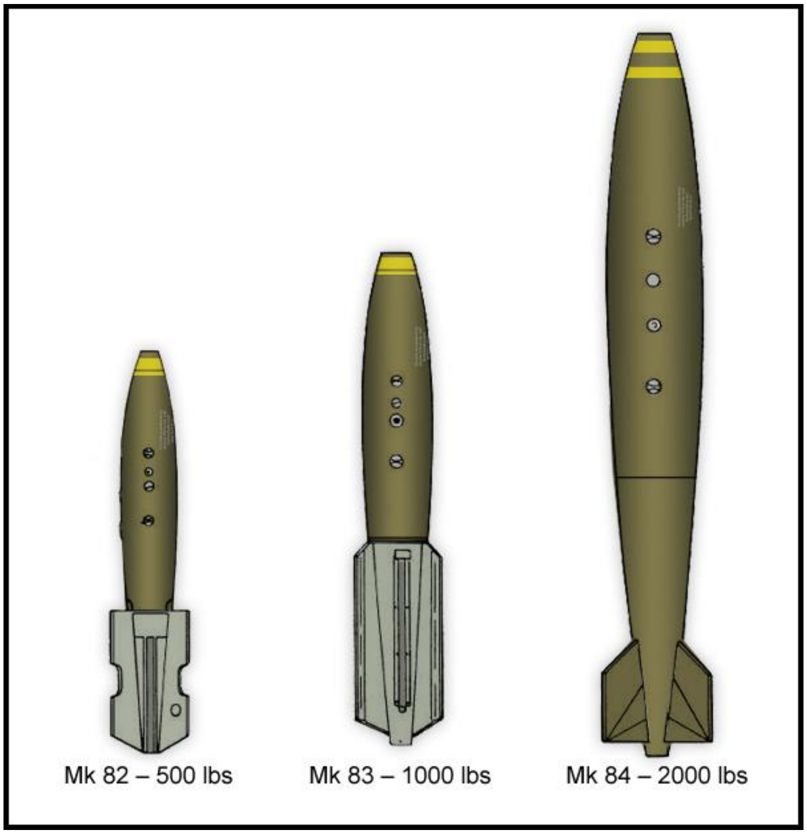


Figure 5-10 Mk 80 Series Bombs

NOTE

All GP Air-to-Surface attacks at VT-86 will simulate utilizing the Mk 82 – 500 lb bomb.

3. Laser-Guided Bombs (LGBs)

LGBs are "smart" weapons made by attaching a laser guidance package to a GP bomb body. The guidance package is called the Paveway system. Laser guidance systems allow bombs to be steered to their targets. The guidance system seeker head detects coded laser energy reflected off the designated target. It then commands steering fins on the weapon to guide on the laser reflection.

Forward Looking Infra-Red (FLIR) systems are typically used to acquire the target and fire the laser. Laser PRF codes are programmed into the FLIR (or other designator) and programmed into the seeker head of the LGB.

The guidance kit of a Paveway system includes (Figure 5-11):

a. Nose laser seeker

b. Airfoil group

c. Tail fuze

d. Wing assembly

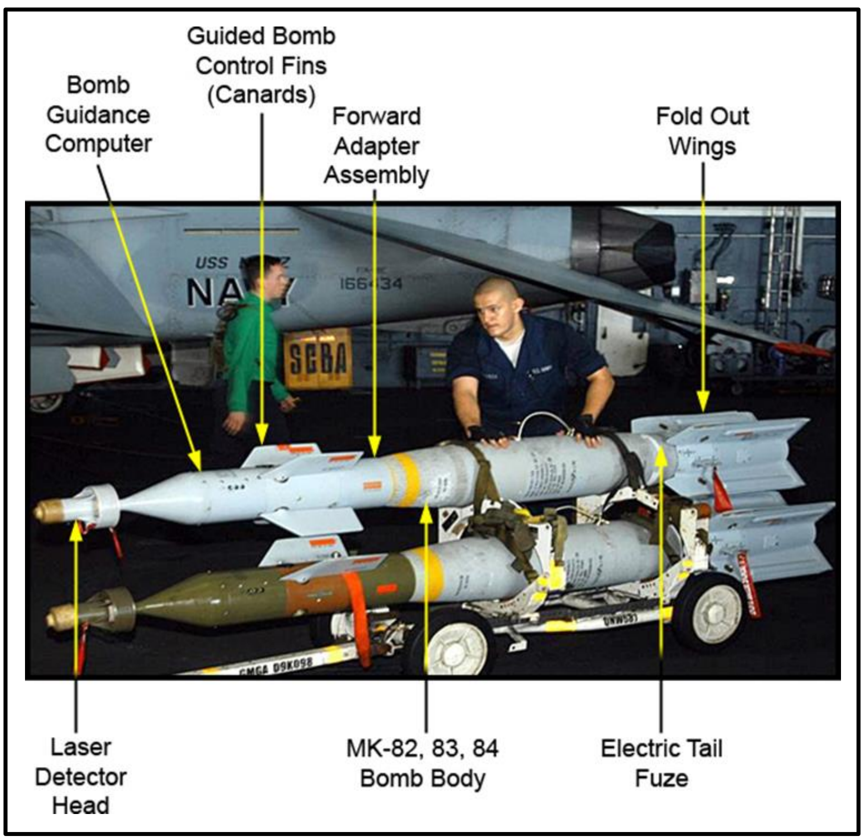


Figure 5-11 LGB Kit Components

LGB types include (Figure 5-12):

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)

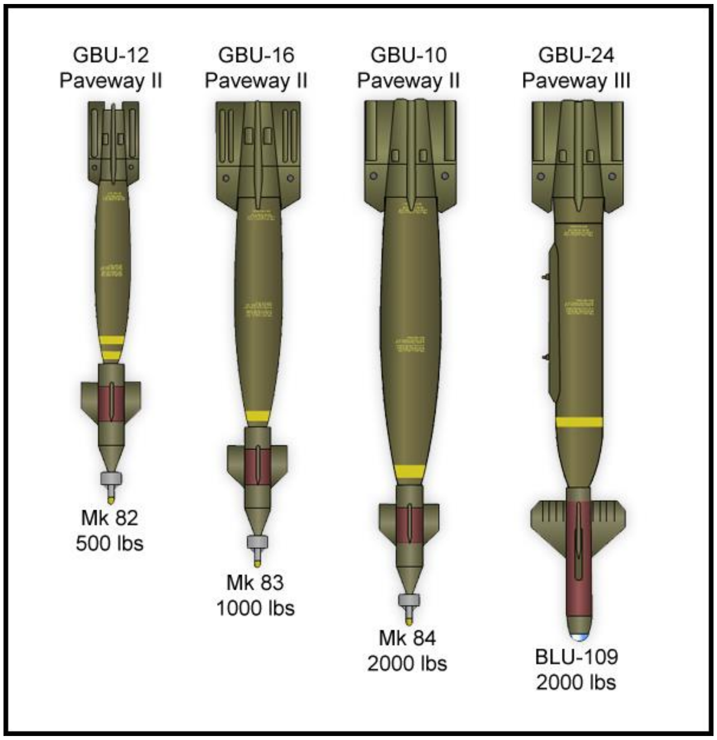


Figure 5-12 LGB Types

Figure 5-13 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 5-13 BLU-109 with LGB Kit

NOTE

LGBs will be simulated later in the syllabus. All LGB deliveries at VT-86 will be with a GBU-12 – 500 lb bomb and a notional, off-board laser platform.

4. 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.

A JDAM kit consists of the following components (Figure 5-14):

a. Bomb Body

b. Nose and/or tail fuzes

c. Body strakes for aerodynamic flight

d. Tail assembly with guide fins

e. GPS Antenna

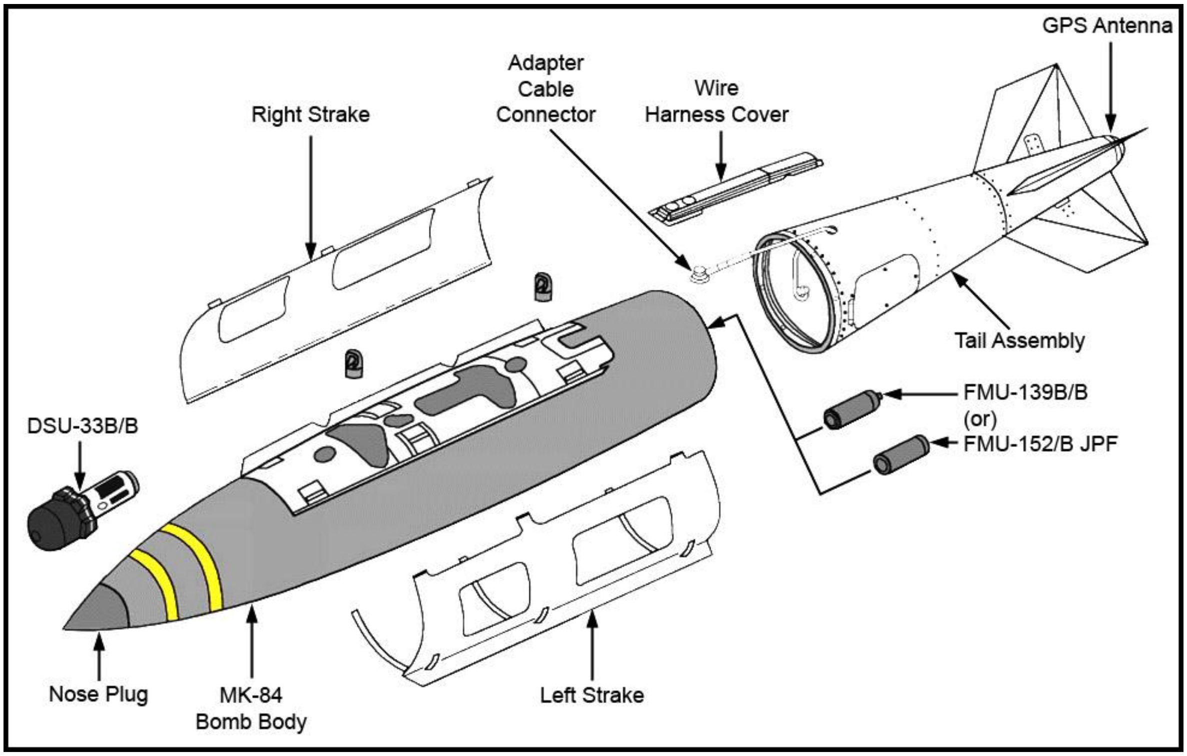


Figure 5-14 JDAM Kit Components

JDAM GPS/INS guided bombs consist of Mk 80 series bomb bodies with a JDAM kit attached. The JDAM uses GPS information to guide on the target coordinates.

The different types of JDAM are (Figure 5-15):

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. EBU-24 – BLU-109 (2000 lbs) with JDAM kit

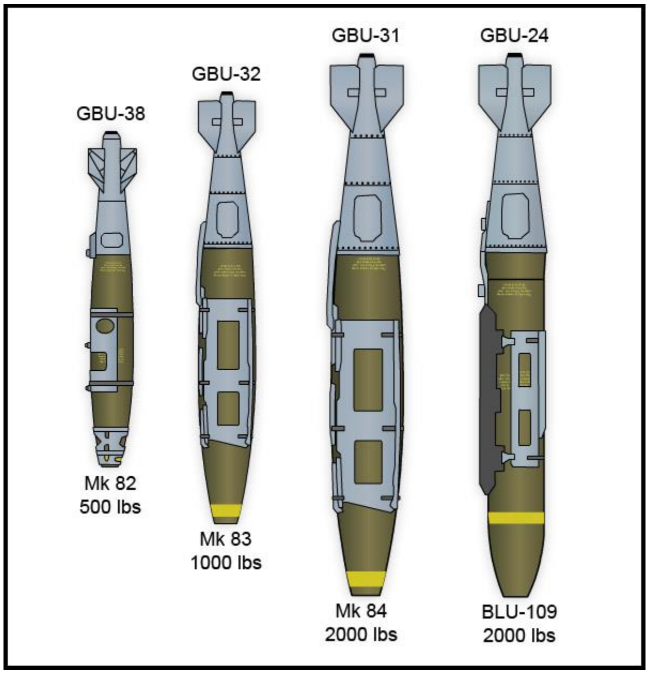


Figure 5-15 JDAM Inventory

5. M61A2 Gatling Gun

The gun is the most widely used and simplest A/A or A/S 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-18 E/F nose, so weight is a big concern. The A/A gun envelope will be discussed in later FTIs. Figure 5-16 is a diagram of the M61A2.

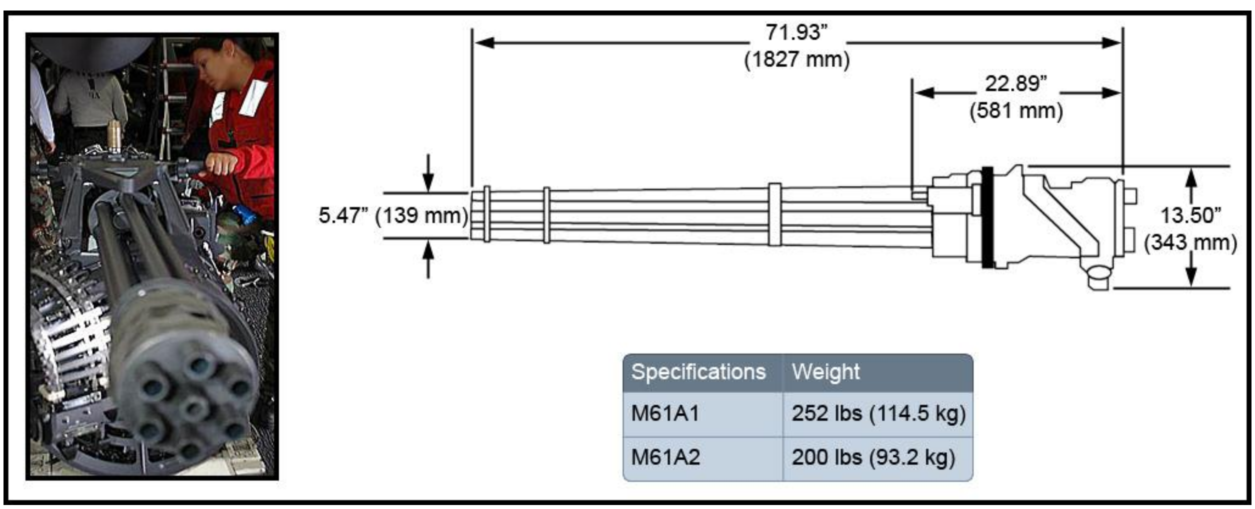


Figure 5-16 M61A2 Vulcan Cannon

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 and will NOT be used in SNFO training at VT-86.

CCIP mode computes 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 5-17). 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, RKT, or GUN indicates that the Master Arm switch on the Armament Control Panel is in the SAFE position. The "X" is removed when ARM is selected.

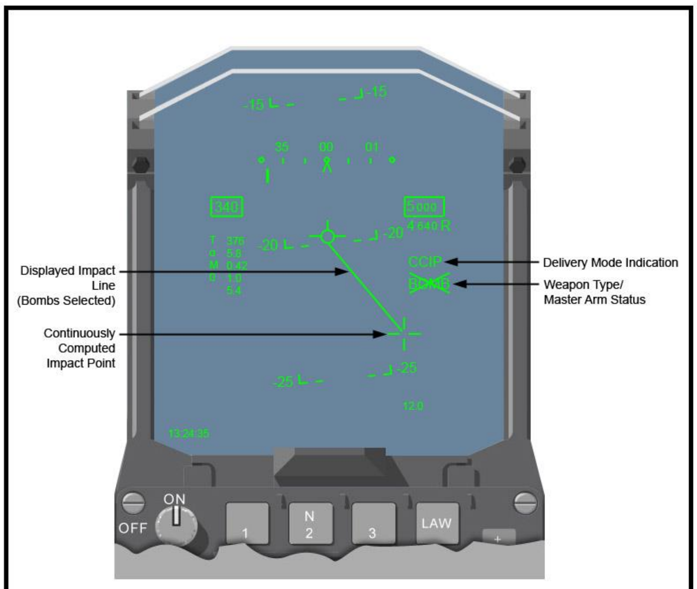


Figure 5-17 CCIP Mode HUD Symbology

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/S 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 or GPS/INS. 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.

3. Bombing Triangle/Delivery Basics

The bombing triangle (Figure 5-18) 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.

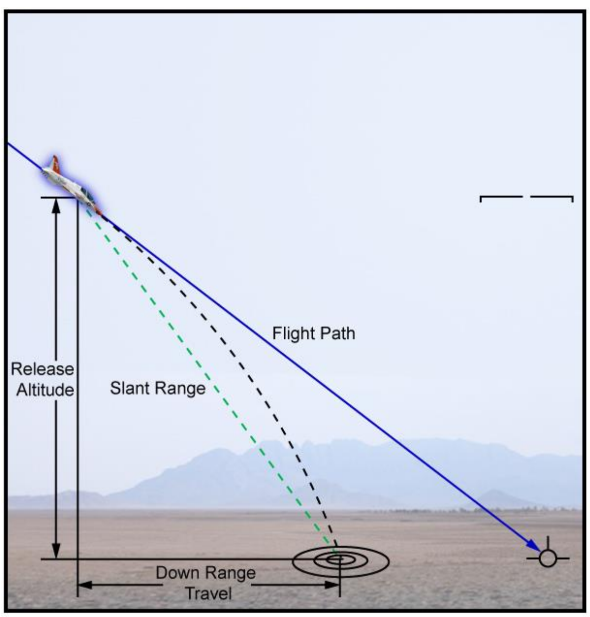


Figure 5-18 Bombing Triangle Components

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/S targets, SNFOs need to be familiar with the following definitions (Figure 5-19):

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 - The 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.

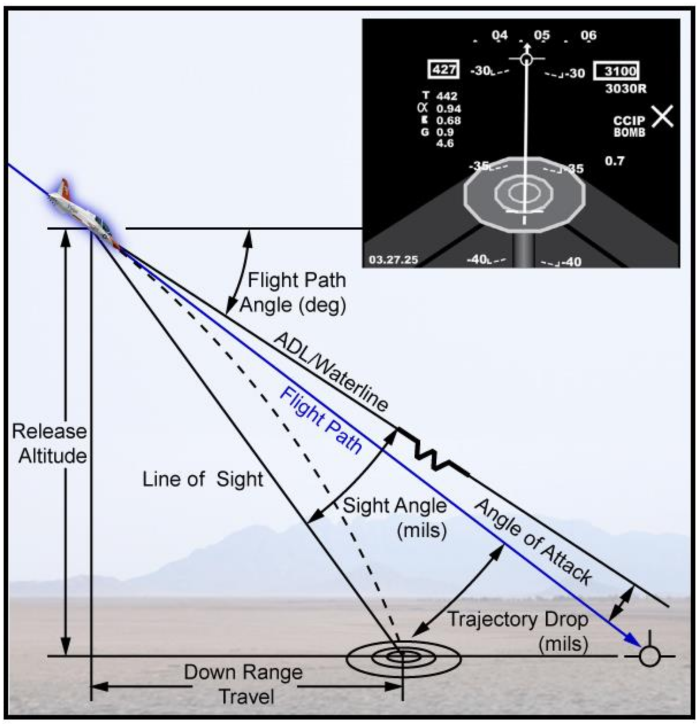


Figure 5-19 Bombing Triangle Definitions

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 5-20).

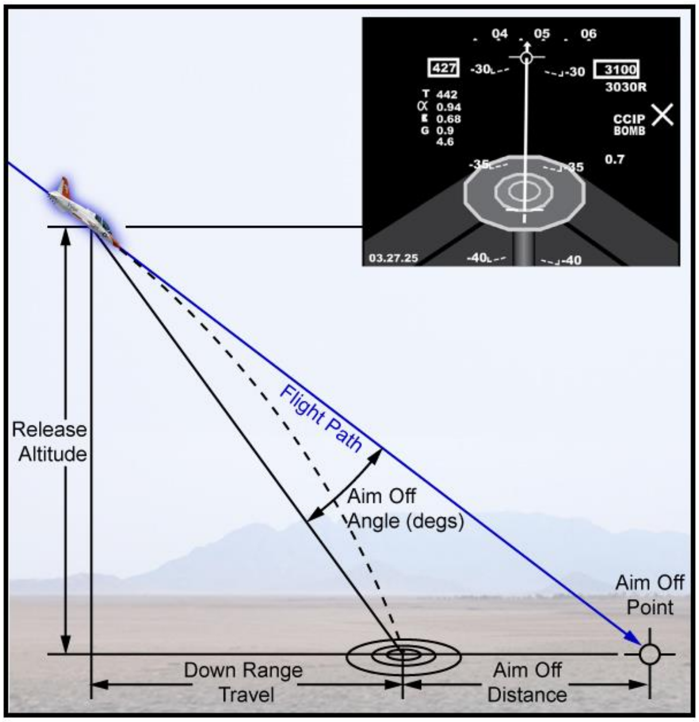


Figure 5-20 Aim-Off Distance

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 5-21).

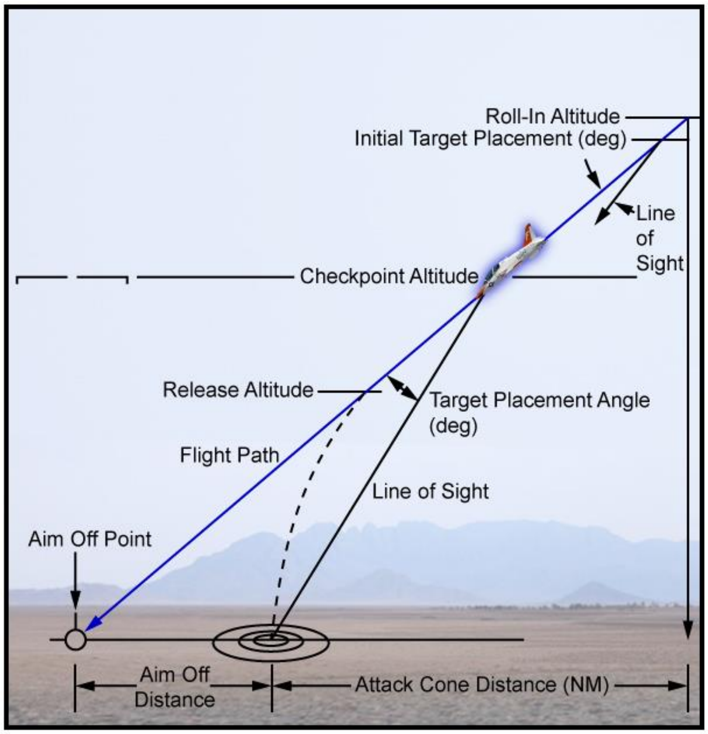


Figure 5-21 Attack Cone Distance and Target Placement Angle

504. DELIVERY PROCEDURES

1. Factors Affecting Trajectory (CCIP Mode)

CCIP allows us to utilize the aim-off angle method of bombing and is the primary method of dive-bombing used in fleet aircraft. Aim-off angle bombing focuses on setting the proper aim-off angle immediately once established in the dive while making smooth corrections in order for the armament system to generate a valid release solution.

Wires

The term "wire" represents specific combinations of dive angle and aim-off angle that deviate from planned release parameters. Deviations from these parameters will result in four possible dive wires:

Steep Wire**:** Aircraft rolled in high, fast, or late but set the correct aim-off angle. The dive angle is steep, and will result in a higher than planned weapon release solution.

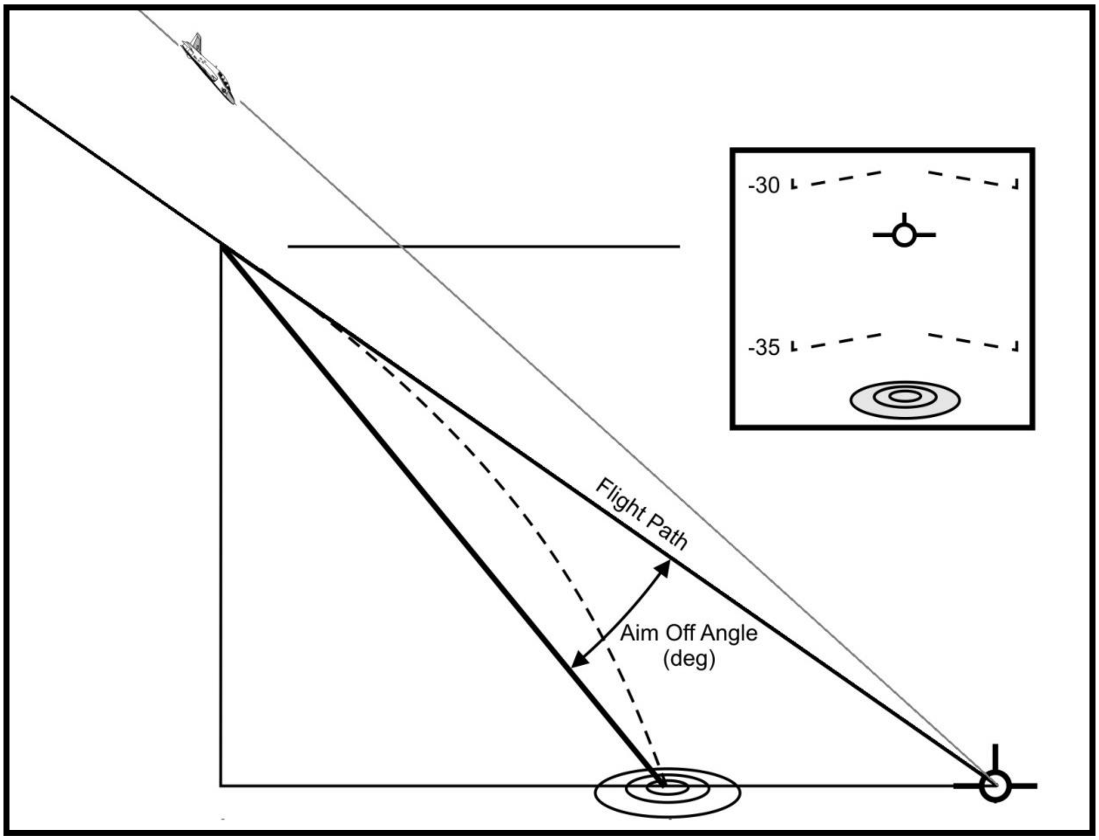


Figure 5-22 Steep Wire

Shallow Wire**:** Aircraft rolled in low, slow or early but set the correct aim-off angle. The dive angle is shallow, and will result in a lower than planned weapon release solution.

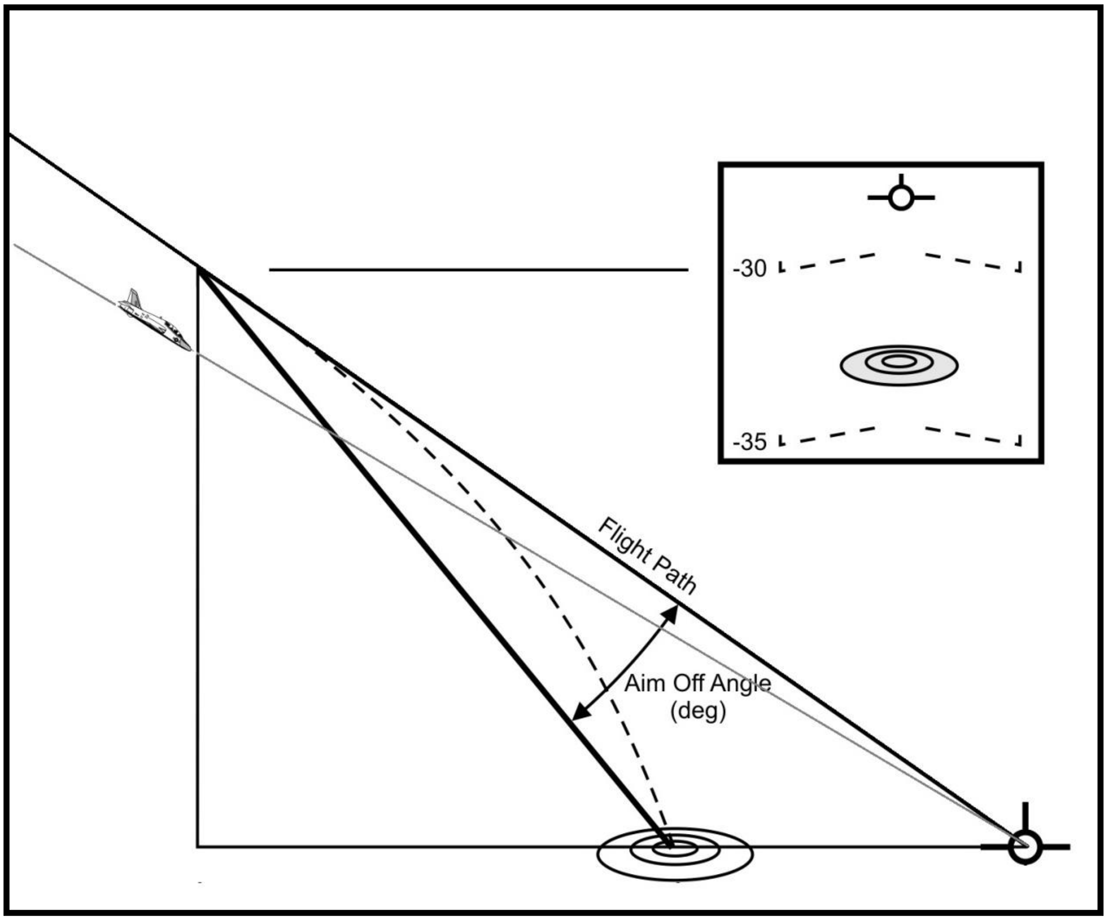


Figure 5-23 Shallow Wire

High Wire**:** Aircraft rolled in high, fast, or late and set too large of an aim-off angle. The dive angle is correct, but the aircraft is high, resulting in a significantly higher than planned weapon release solution.

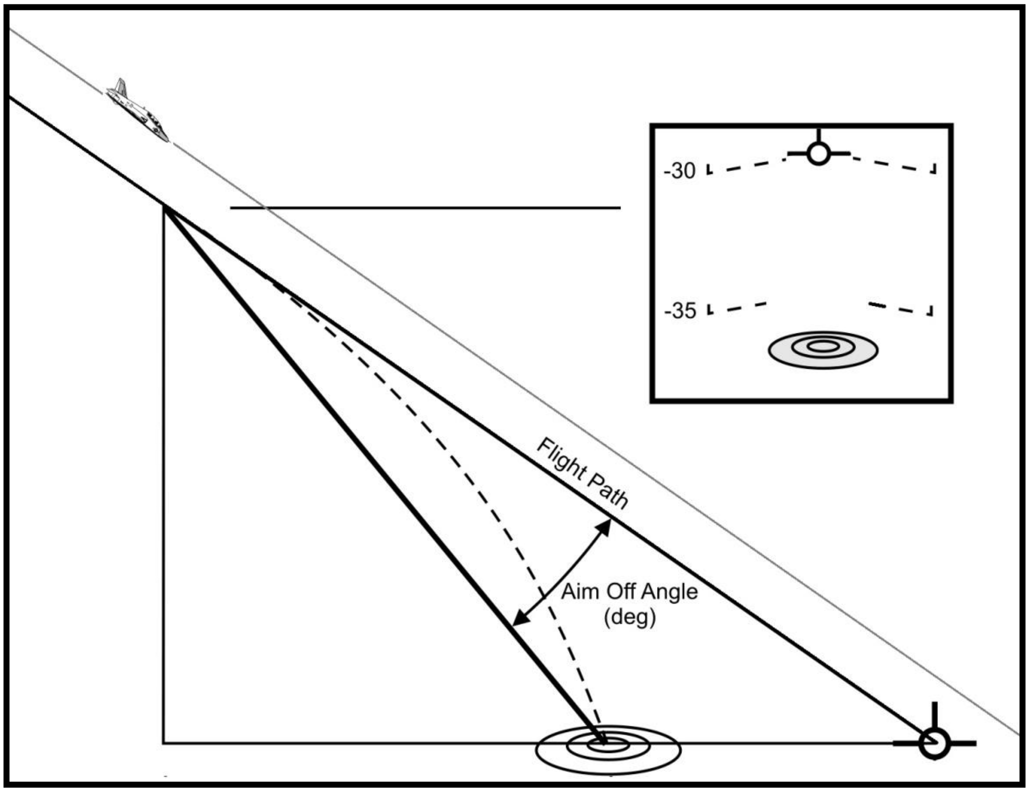


Figure 5-24 High Wire

Low Wire**:** Aircraft rolled in low, slow, or early and set too little of an aim-off angle. The dive angle is correct, but the aircraft is low, resulting in a *significantly* lower than planned weapons release solution. The low wire can result in aircrew pressing the target, causing an unsafe situation. If passing through no lower than release altitude, ***abort!***

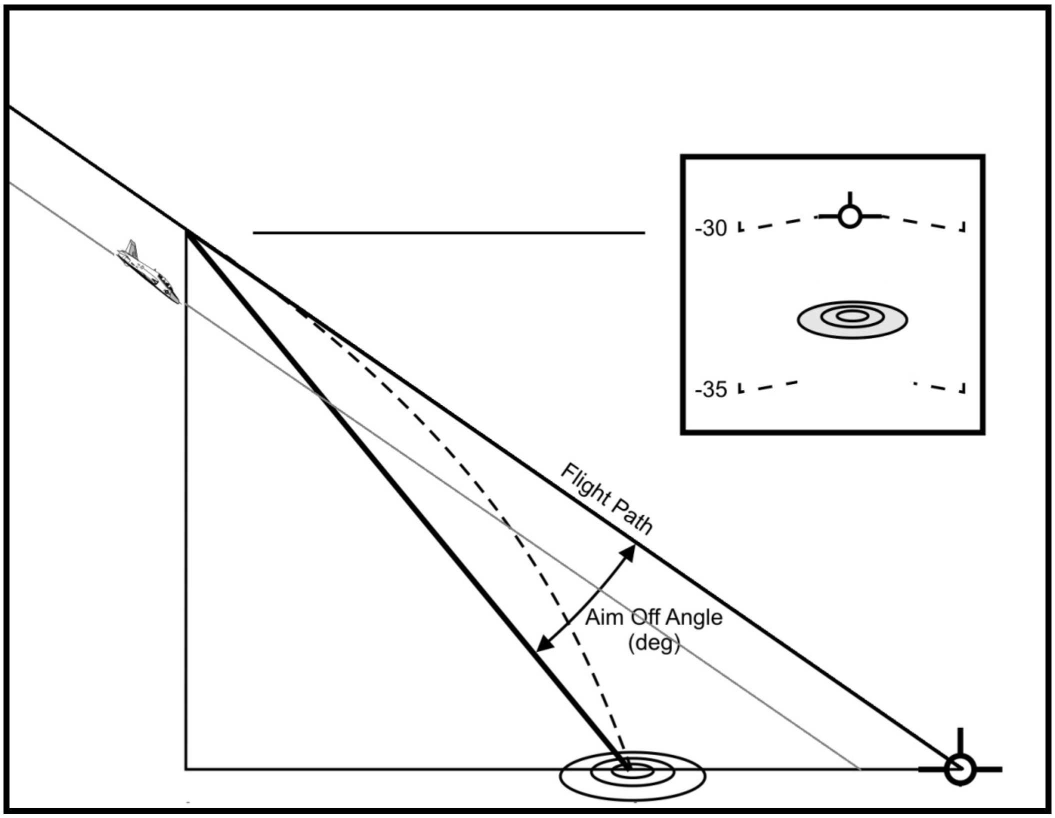


Figure 5-25 Low Wire

High or low wires result in large deviations in release altitude. Winds will also affect ability to adhere to planned Z-Diagrams. To correct for a headwind or tailwind, adjust the RIP according to the following rule-of-thumb; add/subtract. 1 NM from planned RIP distance for every 20 kts of tailwind/headwind. (ex., for a 30º CCIP dive delivery with a RIP of 2.2 NM, compensate for a 20 kt headwind by adjusting the RIP to 2.1 NM, or for a tailwind by adjusting RIP to 2.3 NM).

2. The Z-Diagram

Z-Diagrams are presentations of weaponeering information included on briefing boards and kneeboard cards. In the fleet, aircrew are responsible for developing their own Z-Diagrams tailored to the specifics of their mission. In the Training Command, these Z-Diagrams are prepared for you. It is critical to understand the concepts of weaponeering and the basic components of the Z-Diagram so you can apply those concepts to follow-on training in fleet aircraft.

The first step in building a Z-Diagram is to determine the MINALT or Minimum Altitude. There are four factors that determine how low we can go and why we ***do not*** want to continue below the MINALT. They are:

1. Enemy Threat

2. Weapon Fragmentation

3. Weapon Arming Time (fusing time)

4. Terrain

The most critical of these will drive our tactics and be the determining factor of calculating MINALT. In CNATRA, MINALT will never be lower than 500' AGL.

Enemy Threat. Target attack planning should craft a solution to avoid or minimize time spent in the simulated enemy threat envelope, thereby increasing chances of survivability while decreasing enemy survivability.

Weapon fragmentation. Fragmentation from the weapon's explosion ascends and has the potential to impact our aircraft if we find ourselves below the apex of the weapon's fragmentation pattern. It is critical we calculate our MINALT and release altitudes as to recover the aircraft above this "frag pattern."

Weapon Arming Time (fusing). If release occurs too low, the time of fall of the weapon decreases and the fuse may not have time to arm causing the weapon to "dud."

Terrain. In the training command, since enemy threat on a VR route or in a MOA is highly unlikely and fusing is not a factor, hitting the ground with our aircraft becomes our number one threat and consideration.

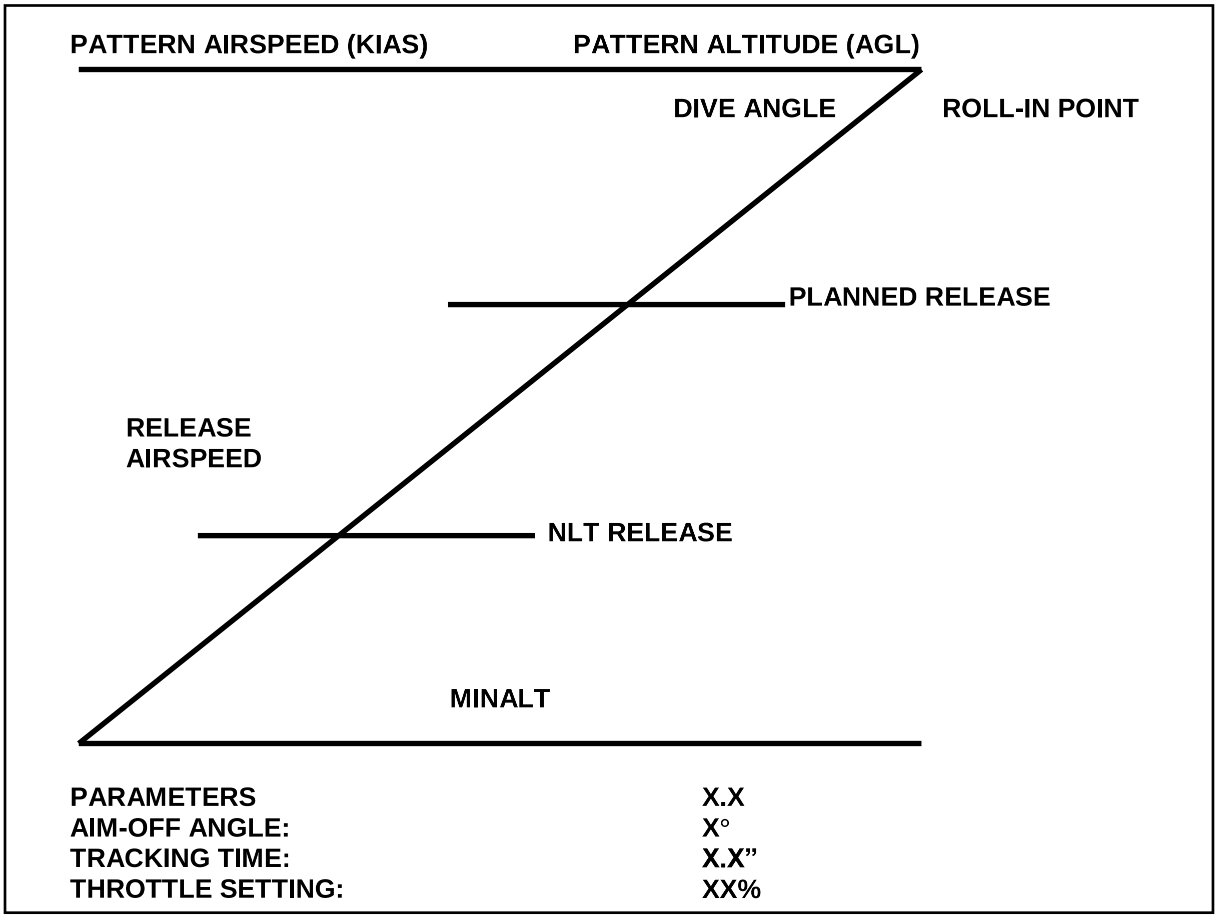


Figure 5-26 CCIP Z- Diagram Components

Planned Release altitude, or PR, is the altitude at which the release solution will occur given the aircraft is on planned dive angle and airspeed with the correct aim-off angle set. Releasing at PR also guarantees that the aircraft can be steep (up to 10º steep for high-angle, or 5º steep for low-angle bombing) and up to 20 knots fast and still recover above MINALT when a 4G pull is initiated within 2.5 seconds. No Lower Than release altitude, or NLT release, is the lowest calculated safe release altitude. Release at this altitude guarantees the ability to recover above MINALT when on planned dive angle, and up to 20 knots fast. ***Releasing below the NLT Altitude is not tolerated.*** If upon reaching NLT release a valid solution has not been reached, ABORT.

Aim Off Angle is shown below the Z-Diagram. This is how far 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 depicted in AGL. A space is allotted on the Z diagrams to add target elevation to the AGL altitudes thereby deriving the MSL altitudes flown in the aircraft. Throttle Setting is the power setting prior to roll-in that achieves planned release airspeed. Realize that these throttle settings are approximate and do not substitute for an effective airspeed scan.

Definitions Related to Z-Diagrams

Aim-Off Angle: The angle created at the planned release point between the aircraft's flight path and line of sight to the target.

Dive Angle: The angle between the flight path and the ground.

LAW Setting: Set to the appropriate Z-Diagram dictated MINALT.

Minimum Altitude (MINALT): The lowest altitude on a Z-Diagram. An aircraft executing an air-to-surface attack shall not go below this altitude.

No Lower Than Release Altitude (NLT): The lowest acceptable altitude at which ordnance may be released for a given Z-Diagram without posing a safety of flight or training rule violation.

Pattern Airspeed: The indicated airspeed that each aircraft in the pattern flies in order to maintain proper spacing/interval.

Pattern Altitude: The altitude from which an aircraft executes its target attack. This altitude is depicted as an AGL altitude on the Z- Diagram.

Planned Release Altitude: The altitude at which, given planned parameters, a release solution is expected.

Release Airspeed: The airspeed an aircraft must attain for the weapons trajectory to match the Z-Diagram.

Roll-In Point (RIP): The DME from the target at which the attacking aircraft should roll in.

Time Of Fall (TOF): The elapsed time from weapon release until impact.

The standardized Z-Diagrams for CCIP deliveries can be found in APPENDIX C.

3. The Pop Diagram

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 can also be found in Appendix C. SNFOs are responsible for writing in the MSL altitude 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. More information on the pop diagram will be discusses in a later section.

4. CCIP Deliveries

The Roll-in Point (RIP)

The Roll-In Point (RIP) is the distance at which a smooth 15-17 unit AOA pull with the lift vector placed on the target will result in the aircraft reaching the planned dive wire.

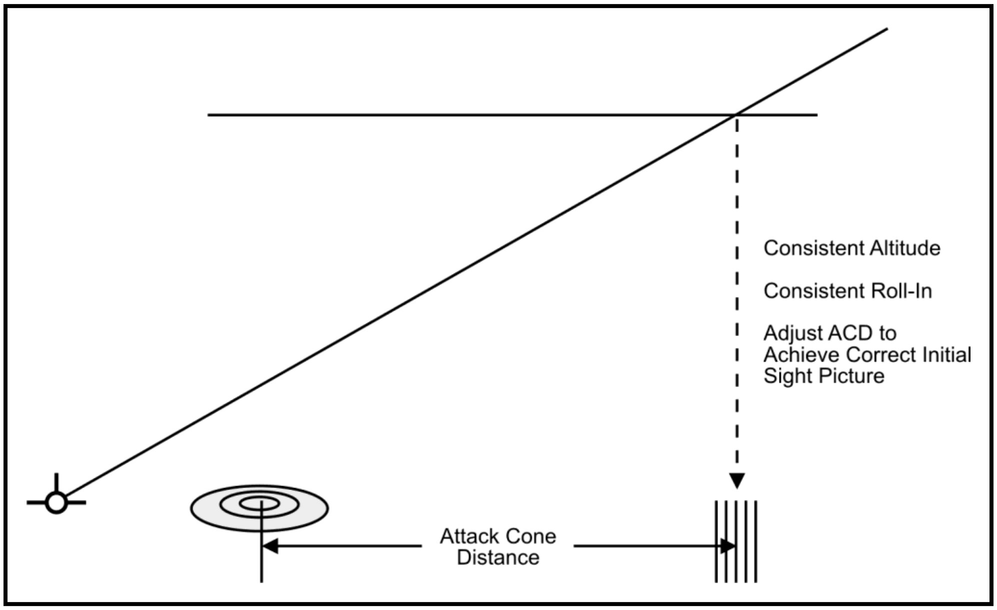


Figure 5-27 Roll-In Components

Aim-Off Angle on the Tracking Run

The *Aim-Off Angle* is the angle between the velocity vector and the Line of Sight to the target. Notice in Figure 5-28, the Velocity Vector is initially placed 4 degrees above the target immediately upon rolling wings-level at the beginning of the tracking run. The ***resultant*** flight path angle created is subsequently maintained for the rest of the tracking run until release. The target will gradually become more depressed below the Velocity Vector as the aircraft proceed towards Planned Release altitude.

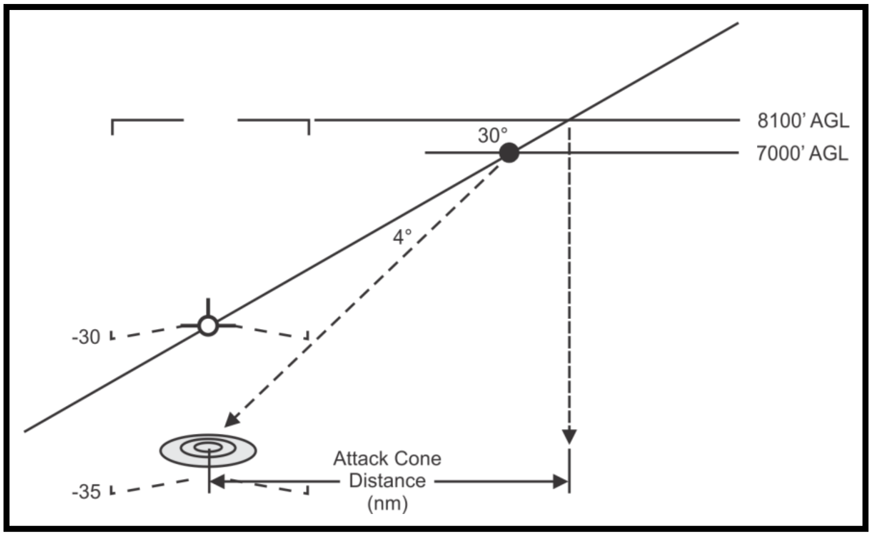


Figure 5-28 Initial Sight Picture

Initial Sight Pictures

Figure 5-29 displays what a good initial sight picture should look like. Placing the Velocity Vector 4 degrees above the target at the roll out (approximately 7,000' AGL) should result in the planned flight path angle of 30 degrees. Notice the target is 35 degrees depressed in the HUD.

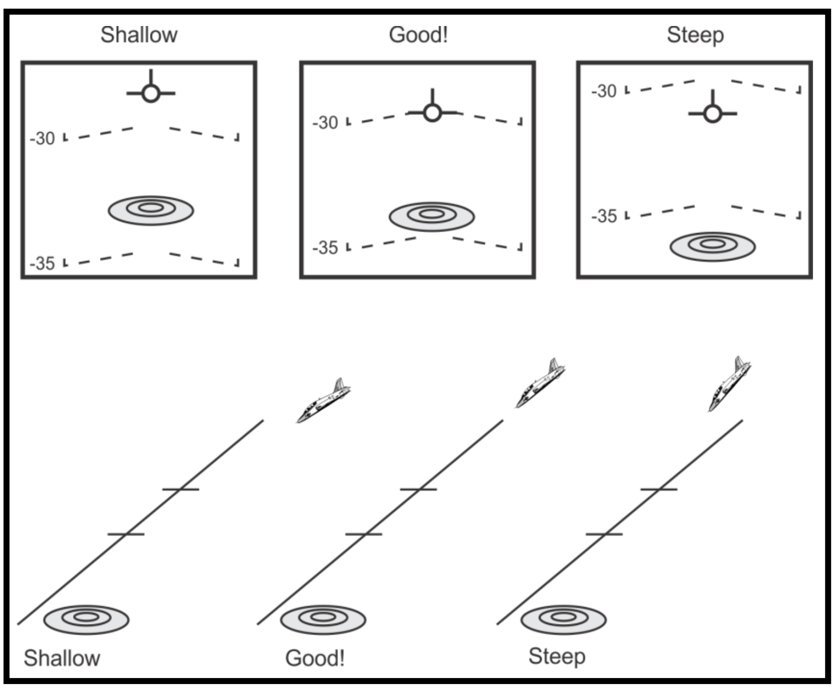


Figure 5-29 Shallow/Good/Steep Initial Sight Pictures

Causes of a Steep or Shallow ISP

As shown in the next graphic, if the aircraft rolls in at planned pattern altitude, executes proper roll-in mechanics, and rolls in at the planned distance from the target, the aircraft should be on the planned Flight Path Angle. This is also referred to as being on the planned wire.

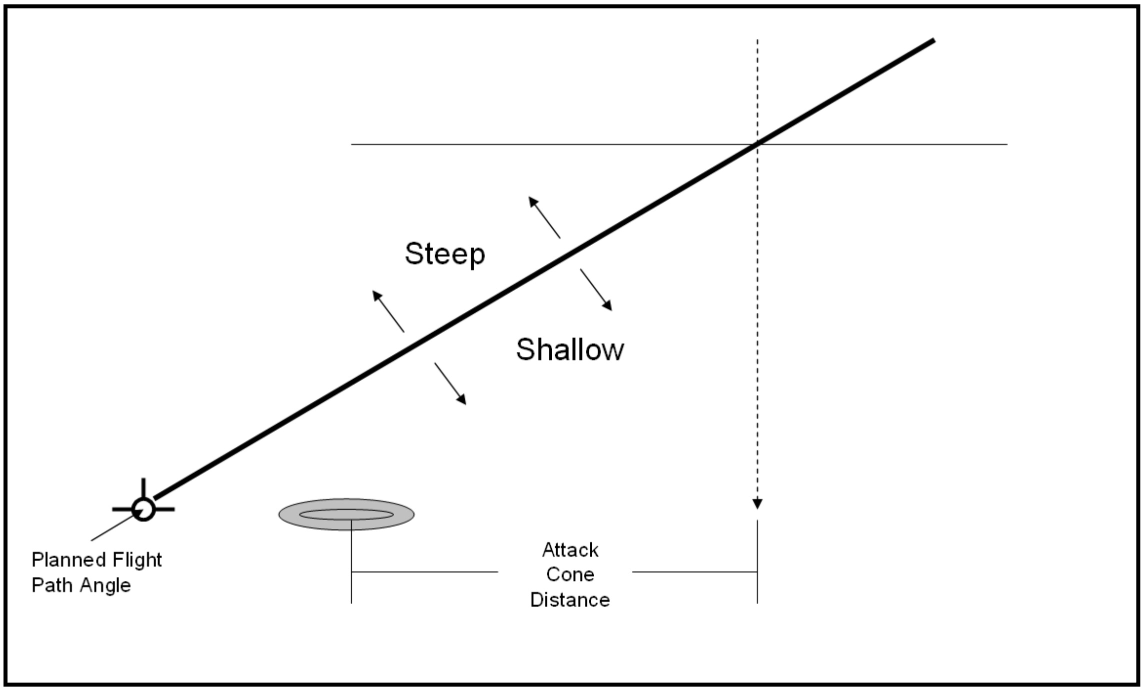


Figure 5-30 Causes of a Steep or Shallow

Any deviations from these variables that cause the aircraft to be **above** the planned wire will result in a STEEP Initial Sight Picture. Any deviations that cause the aircraft to be ***below*** the "wire" will result in a SHALLOW Initial Sight Picture.

Causes of a Shallow Initial Sight Picture

Altitude. Beginning the roll-in at the appropriate RIP distance but below pattern altitude will result in the aircraft arriving below the "wire" on the tracking run. For example, instead of rolling in at 8,100' AGL, the roll-in occurs at 7,700' AGL. This is one cause of a SHALLOW ISP.

Roll-in Mechanics. If the aircraft is over-banked too far, placing the lift vector well below the target and/or if the pull is too aggressive, the aircraft will arrive below the "wire" on the tracking run.

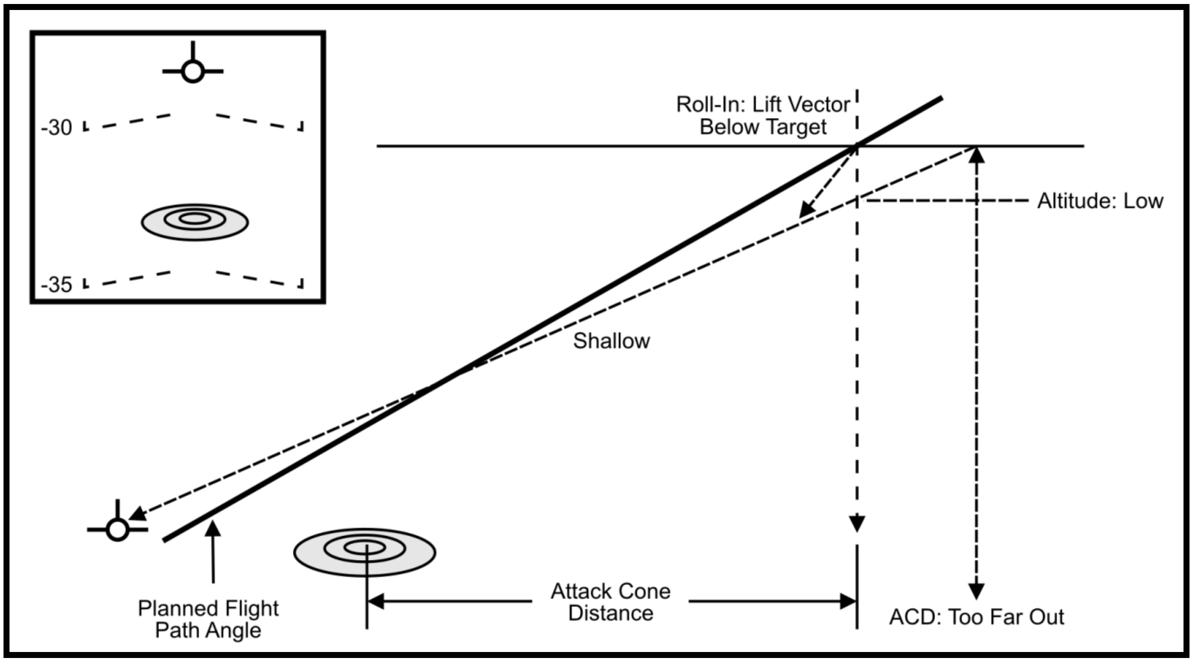


Figure 5-31 Causes of a Shallow ISP

<u>RIP distance</u>. Rolling in at greater distance than planned RIP will result in a shallow ISP.

Effects & Corrections for a Shallow

A shallow dive wire will result in a release solution below Planned Release altitude. Provided the appropriate aim-off angle is held, this solution should still occur above Now Lower Than Release altitude. The pilot will correct by adding power (if able). The increase in speed will result in a release solution closer to PR altitude. ***Be careful*** not to target fixate while on a shallow dive wire, and continue to scan altitude. ***Do not*** press the target below NLT release altitude!

Causes of a Steep Initial Sight Picture

Referencing the three variables of altitude, roll-in mechanics and RIP distance, a steep Initial Sight Picture is caused by the inverse of what caused a shallow Initial Sight Picture.

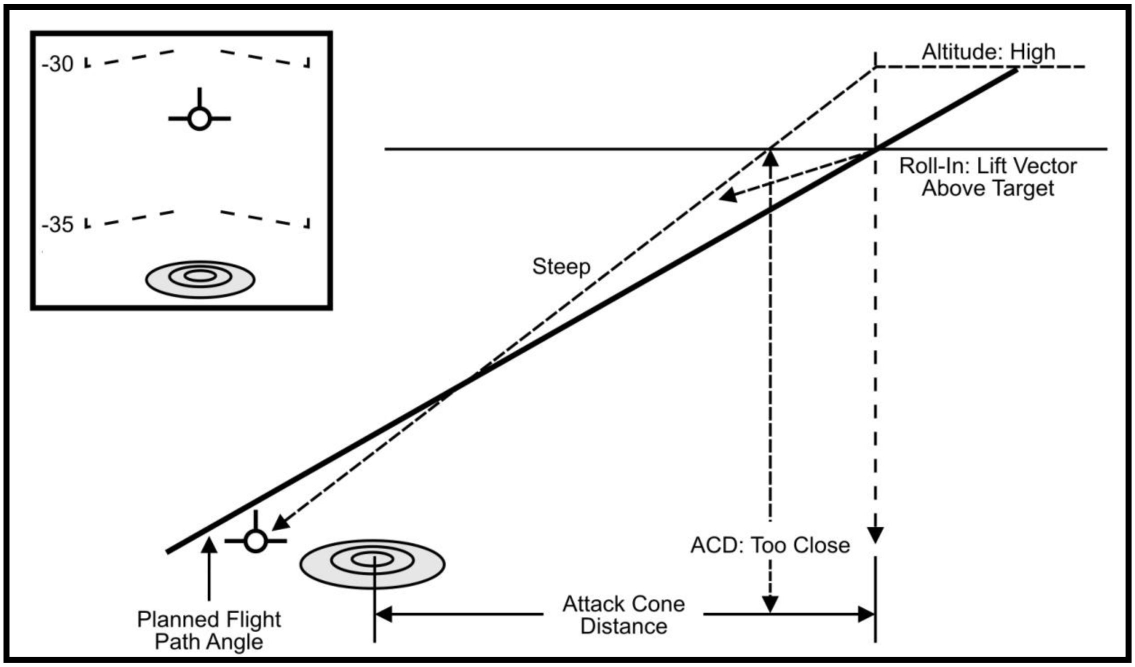


Figure 5-32 Causes of a Steep ISP

Altitude. Beginning the roll-in at the appropriate RIP distance but above pattern altitude will result in the aircraft arriving above the "wire" on the tracking run. For example, instead of rolling in at 8,100' AGL, the roll-in occurs at 8,500' AGL resulting in a steep ISP.

Roll-in Mechanics. If the aircraft is not over-banked enough, placing the lift vector well above the target and/or if the pull is too weak, the aircraft will arrive above the "wire" on the tracking run.

RIP distance. Rolling-in at a closer distance to the target than planned RIP will result in a steep ISP.

Effects/Corrections Regarding a Steep

A steep dive will result in an early weapons release solution that may be above Planned Release altitude. The pilot may throttle back to control airspeed in order to arrive at a solution close to PR altitude and accept a slightly high release. As long as the release solution comes no higher than 500' above PR altitude, the release will still be considered valid.

Effects of Wind on RIP Distance

The Z-diagrams are based upon no wind conditions. Winds at altitude and at release can induce error in deliveries. A tailwind at altitude will cause the aircraft to be blown towards the target requiring a roll-in slightly farther out than planned. The opposite is true for a headwind. Adjust the RIP distance 0.1 NM for a headwind/tailwind component of 20 knots.

Initial Sight Picture, Velocity Vector Placement, and Line-Up Guidance

In order to adjust for line-up, the pilot will correct laterally in order to superimpose the DIL through the center of the target. This will ensure that the CCIP cue tracks directly over the target at release.

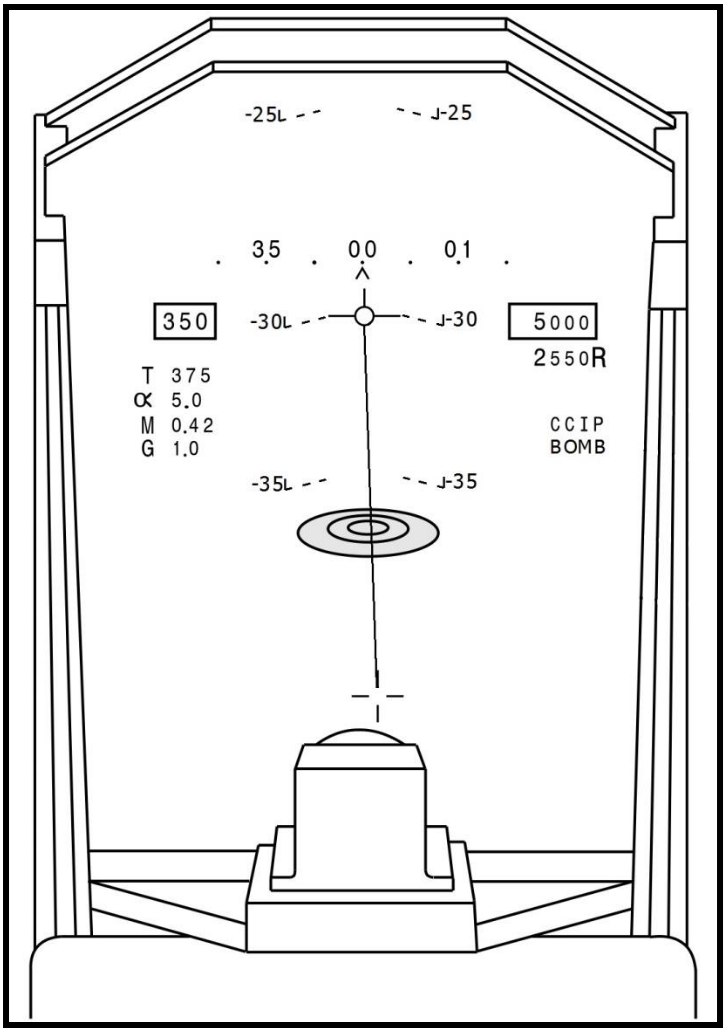


Figure 5-33 Displayed Impact Line and CCIP Cue

Figure 5-33 shows that Velocity Vector is placed close to the 12:00 position, ***relative to the target***.

Tracking Time and References

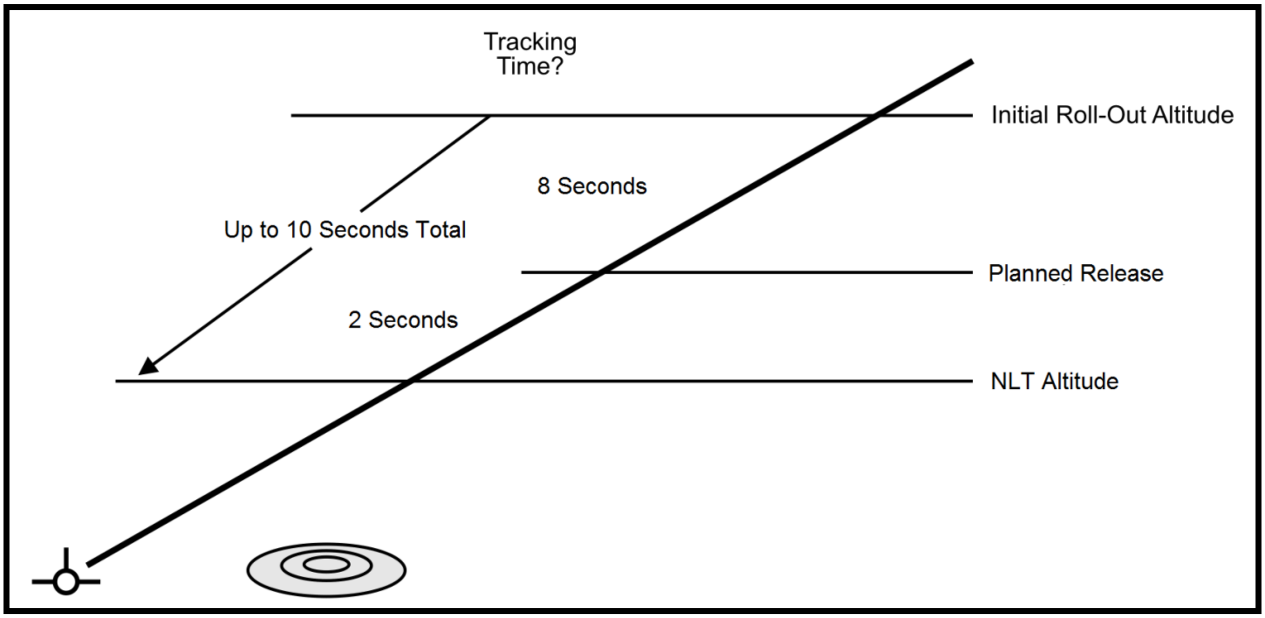


Figure 5-34 Tracking Time / References (CCIP Deliveries)

Normal tracking time is usually between 8 to 10 seconds, depending on airspeed and dive angle. Knowing what to scan and when to scan it is crucial. As time and experience progresses, tracking time will become more manageable.

Immediately after rolling upright in the dive, determine the dive angle and altitude. ***Always*** keep altitude in your scan and ***never*** stare at the target. This is known as *target fixation*. If your aircraft is out of parameters for a valid delivery approaching release, it is your job to call the Abort!

CCIP Error Sensitivities

In CCIP mode, the weapons computer calculates a release solution based on current aircraft parameters. In essence, a release solution will occur high or low due to deviations from planned parameters. The computer cannot control dive angle or airspeed. It can only provide a release solution altitude based on the other variables.

Therefore, if the aircraft is ***STEEPER or FASTER than planned***, the CCIP cue will display a ***HIGH*** release solution to compensate. If the aircraft is ***SHALLOW or SLOW,*** the CCIP cue will display a ***LOW*** release solution relative to planned parameters.

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 5-35):

1. Dive Angle – Velocity vector is within 5 degrees of planned dive angle.

2. Airspeed – True airspeed is within 50 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 4 G pull within 2.5 seconds, and sustains at least 4 Gs until the velocity vector is at or above the horizon.

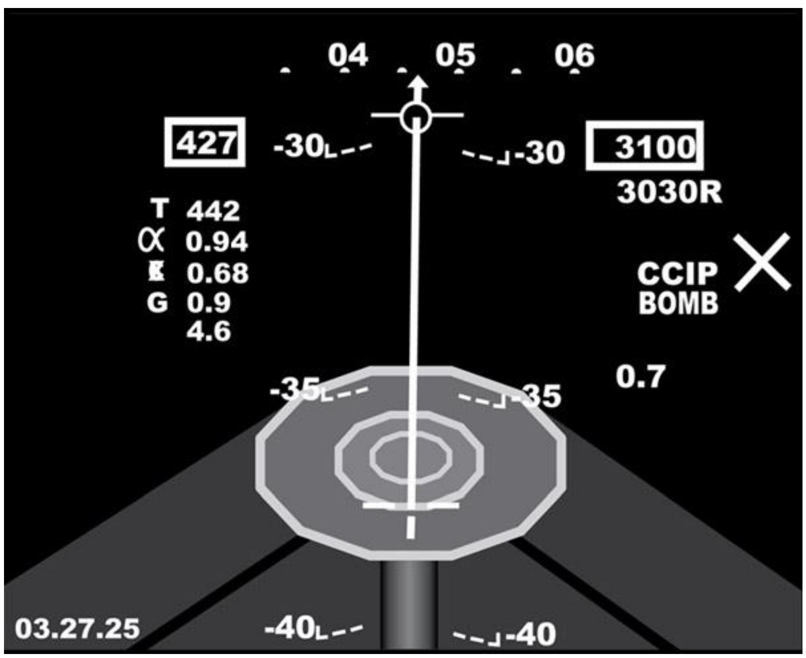
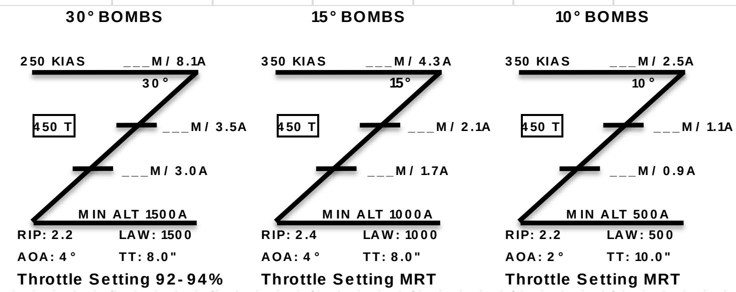


Figure 5-35 A/S HUD Validation

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.”

VT-86 A/S DELIVERY VALIDATION CARD

MARK TIME	PLANNED DIVE ANGLE	ACTUAL DIVE ANGLE	KTAS	MARK ALT	SAFE ESCAPE	VALID? V/UA/I FOR...



VALID DELIVERY CRITERIA

STOP TAPE

DIVE ANGLE WITHIN:

+/- 5 DEGREES FOR DIVE ANGLE

AIRSPEED < 500 KTAS

ALTITUDE > NLT ALT.

PLAY TAPE

4 Gs WITH IN 2.5 SECONDS?

4 Gs UNTIL VV 10 DEGREES ABOVE THE HORIZON?

Figure 5-36 VT-86 A/S Delivery Validation Card

506. A/S TARGETING PROCEDURES – HIGH ALTITUDE A/S 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/S timeline will remain constant.

Appendix C provides the basic timeline for A/S target prosecution. The initial flights of the Strike stage will focus on basic admin and section procedures. Later flights expose the SNFO to this timeline as well as introduce basic target acquisition procedures. These later 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 and configured to release ordnance according to the timeline. The SNFO will have the cockpit set up as follows:

1. A/G Master Mode – As Req

2. MFCDs

    a. Left MFCD (LMFCD) – HSI / SA (Jet only)

    b. Right MFCD (RMFCD) – RDR

The Primary A/S time line (Appendix C) will be executed for all flights and simulator events. The SNFO will continue to monitor the radar image until the target area can be identified. At the appropriate distance, the Lead SNFO will call "*Hammer, attack.*"

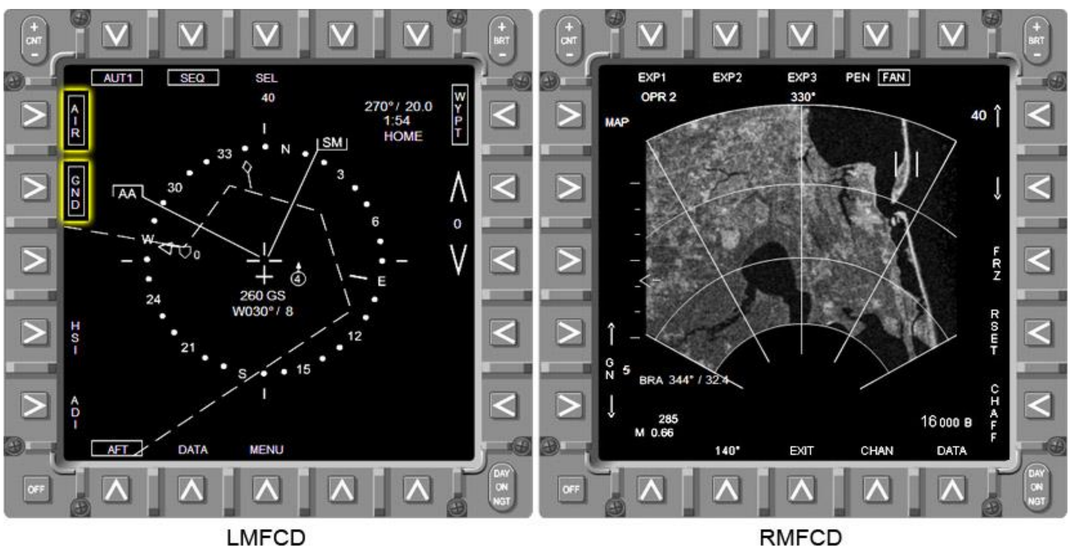


Figure 5-37 LMFCD and RMFCD Displays in VMTS at 20 NM

At this point, each SNFO will begin A/S checks (found in Appendix C) to ensure system is set up for delivery. NLT weapons release, complete your A/S checklist and report to the IP:

a. SNFO (ICS) *"APDART complete, Master Arm to go."* (If the target has not been designated yet, do not report APDART complete. Advise your IP you are holding on the designation instead and report once you are captured).

b. IP (ICS) "*Armed.*" (NLT weapons release)

c. SNFO (ICS) *"Master Arm On, good symbology ."* (with good symbology in the HUD).

Weapons release should occur 3±0.2 NM from the designation. If you have not pickled by 2.8 NM, abort the attack. There is no NLT distance for “capturing” the target on the radar other than NLT weapons release. Some targets may be “late breakers” and can’t be captured until 5 NM scale on the radar. When this is the case, brief to it, and the use of good CRM with your pilot is paramount to keeping them informed of your status. Brief the Air to Surface timeline and the associated tactics (POP / Roll-In / PGM) during the mission conduct portion of the brief for each TGT leg.

Precision Guided Munition (PGM) Level Lay Deliveries require CRM between the front and aft cockpit of both aircraft, as an example, the following radio and ICS comm should be referenced:

a. SNFO (AUX) - *“Hammer-11/-12, In Dry, (heading).”* (4-6 NM and established WL inbound)

b. SNFO (ICS) - *“Pickle.”* (at planned release distance)

c. SNFO Lead (AUX) - *“Hammer-11, Off safe, sim one away.”* (after release, master arm safe)

d. SNFO Wing (AUX) - *“Hammer-12, Off safe, sim one away, visual.”*

e. Lead SNFO (AUX) - *“Hammer-11, 1.8, good G.”* (OPS/G check)

f. Wing SNFO (AUX) - *“Hammer-12, 1.7, good G.”*

While working a MOA or Flight common frequency in PRI it would be appropriate to call all weapons release or shot comm there; however, on an IR this will take place on the AUX radio due to ATC/SOF in PRI.

Always remember the basics of Aviate, Navigate, Communicate. It may very well be a priority to maneuver the aircraft immediately after weapons release, in that case a modification to the comm, directing a turn on ICS, may take priority over the “Off Safe” comm.

507. LOW ALTITUDE ATTACKS

During the later stage low level flights, one or two pre-planned target attacks will be executed. 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. Students will then ensure that the A/S combat checks are completed, thus switching the section from a simulated A/A sanitization game plan to the A/S 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). After the attack, the SNFO will change back to NAV mode.

At the Attack Commit Point, when directed by Lead to "ATTACK," each SNFO will conduct the A/S checks found in Appendix C.

As part of A/S checks, the SNFO will select the pre-briefed (usually one) number of released ordnance on the A/G Stores display after selecting "Bomb."

1. Section Attacks

During the flights, section attacks will be introduced and practiced. Section attacks allow multiple aircraft to attack a single target or multiple targets within close proximity to on another. They provide de-confliction and vary the attack axis. The crew will have a choice of four types of section attacks:

a. Shift Attack (same target)

b. Section Attack (same target)

The delivery method used during a Section Attack may be level lay down, roll-in, or a pop attack. For each target along your route, you should brief what type of attack you intend on executing and with what type of delivery. As Lead you should give consideration to what side you want your wingman on to start the attack and if executing a pop or roll-in, in which direction you want to offset. ***These considerations include environmentals, terrain, and hazards on the route and off target geometry.*** Regardless of which attack is executed, each aircraft in the section will execute its own weapons delivery in accordance with the appropriate Z-diagram.

The examples below are for Section Pop-attacks, as these are the most complex. For other delivery methods, the communications will be similar but must be modified accordingly.

Low level POP attacks will be performed on STK42XX block events when the approved POP attack profile remains contained within the MTR structure, reference the most current Z-Diagrams to determine planned apex altitudes. On MTRs where POPs are not possible students shall brief and execute the A/S transition to include Comm and section maneuvering for a particular attack profile. The IP will make an "in dry from the north" call where the PUP would be. Weapons employment and "pickle" call will be level laydown at route altitude, 1 NM from the target.

– Low level POP attacks will be performed in the STK32XX block regardless of route structure. Acknowledge the MTR exceedance if applicable and execute the delivery per STAN.

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, (heading)."*

c. SNFO (ICS) - *"STBY, Mark….Pull."* (("Mark" if no release at planned release ALT; "Pull" if no pull initiated at NLT release ALT)

d. IP Lead (AUX) - *"Hammer-11, Off safe, sim one away."* (after release, safe escape, master arm safe)

e. IP Wing (AUX) - *"Hammer-12, Off safe, sim one away, visual."*

f. Lead SNFO (AUX) - *"Hammer-11, 1.8, good G."* (fuel check)

g. Wing SNFO (AUX) - *"Hammer-12, 1.7, good G."*

Strive to have a sterile cockpit while "in the chute" established in the dive. ICS comm should only happen if the attack is not going as planned. For example, if the aircraft is established at 37 degrees nose low on a 30-degree roll in (2 degrees past the acceptable range) then an emphatic "37 FOR 30" or "CHECK DIVE ANGLE" would be appropriate. If a correction is not immediately made it would be appropriate to call the "ABORT" on ICS.

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.

2. 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 maneuver the aircraft to turn 90-degrees into the Lead's flight path. After rolling out of the turn, the wingman will wait approximately 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 attack. The Lead's attack shall be followed by the Wing's attack approximately 15 seconds (or 2-3 NM) behind the lead (Figure 5-38).

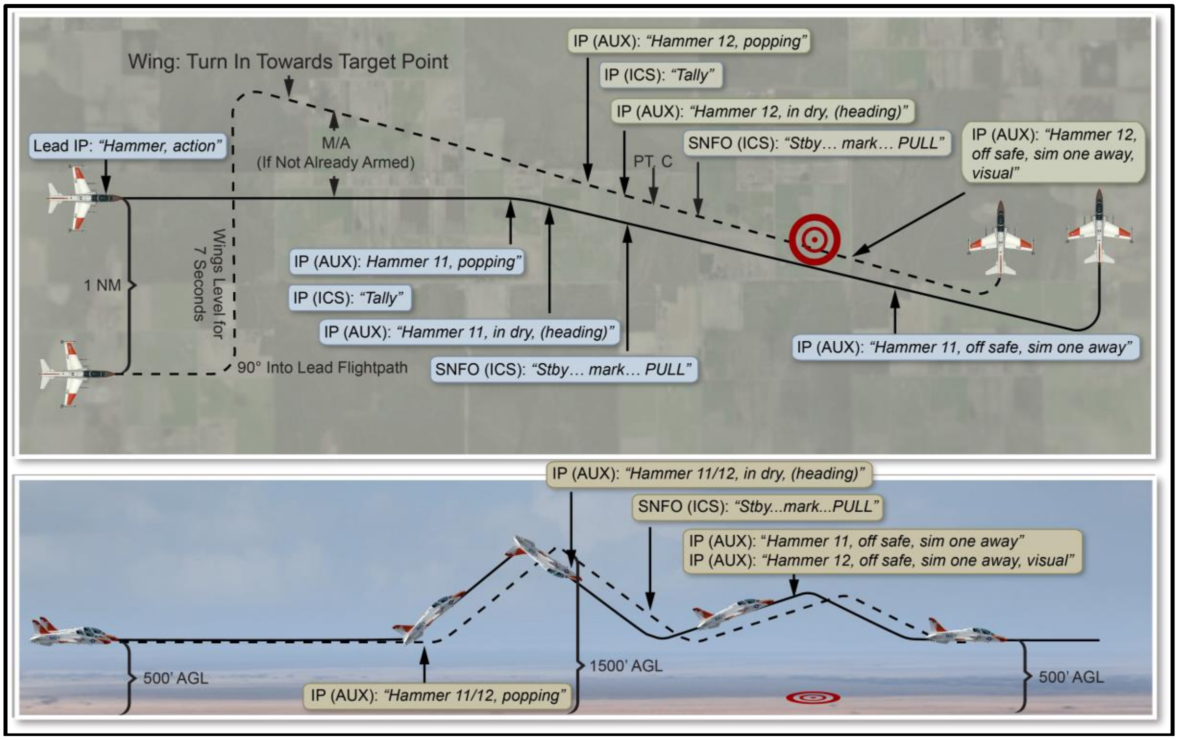


Figure 5-38 Shift Pop Attack Diagram

3. Section Attack

The section attack is a tactic that enables a section to conduct a coordinated two-plane attack on the same target from the same axis (Figure 5-39). 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 attack. 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 attack, and the wingman, after a slight delay (for aircraft de-confliction), will execute an identical attack.

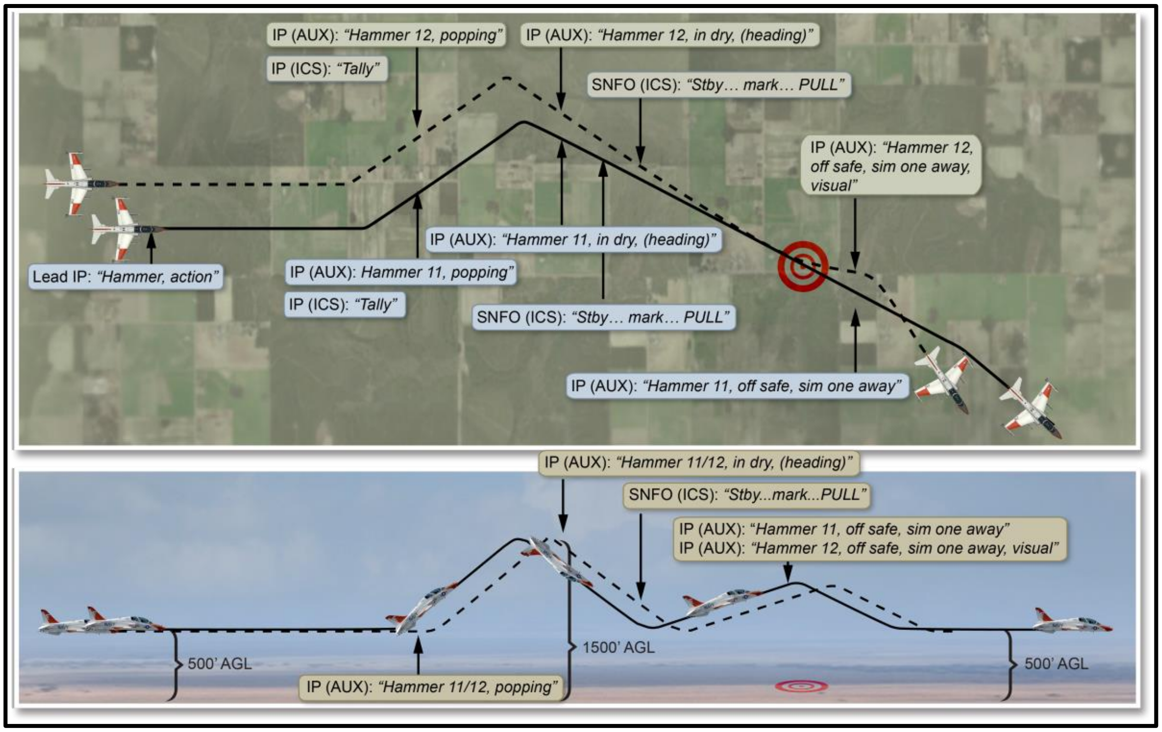


Figure 5-39 Section Same Side Pop Attack

508. 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. It is used to practice bombing, and in VT-86, it is used to introduce the SNFO to dive deliveries and Weapons pattern communications. The Z-Diagrams located in Appendix C will be used for dive parameter practice during the pattern roll-ins.

Circle the wagons will be introduced and practiced on one of the later stage strike flights. This flight will require the use of a Military Operating Area (MOA). Thorough preflight preparation of controlling agencies, entry/exit procedures, and target selection is paramount. This event will also utilize a Joker and Bingo fuel in place of an MCF.

Approaching the MOA, Lead SNFO will switch the flight to the target or MOA frequency. The flight lead will then check-in with the target/MOA after ensuring a positive check-in by Wing. Lead SNFO will make the area check in call on PRI.

Upon MOA entry, complete the fence in if not already accomplished. Fence in/out specifics are similar to low level flights, but unlike other Advanced Strike flights, A/G mode will be selected at Fence in and remain on until Fence out.

After descending through platform and confirming a good tone, the LAW shall be set to the prescribed altitude for the first dive delivery you will be executing.

1. The Spacer Pass

The primary objective of the Spacer Pass is to over-fly the target at release altitude and airspeed ensuring that the aircraft is properly trimmed. The secondary objective is to note the winds at release parameters and take note of how the environmentals will affect the trajectory of the bombs.

Approaching the target area, the flight lead will call tally on the target and set up for the spacer pass. Wing should be set on parade bearing line with double the normal cruise interval.

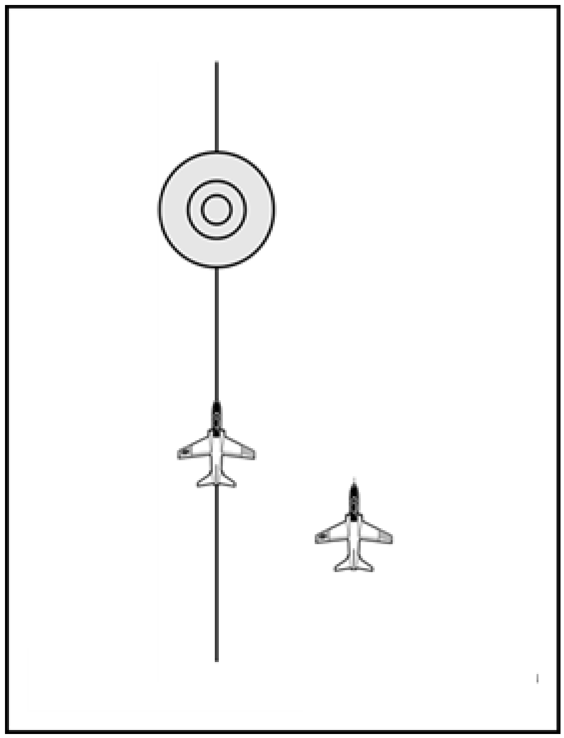


Figure 5-40 The Spacer Pass

Passing over the target, everyone should take a moment and visually clear the target. ***Everyone is a Range Safety Officer***. If you see something that does not look right, speak up.

2. The Break into the Pattern

Slightly before the target, the Lead IP will call "*Hammer 11, breaking, (hi/mid/low) pattern*." Pattern break interval will be 10 seconds. Once Wing has broken into the pattern, Lead SNFO will make their position call with fuel state.

After the IPs make their "breaking" call into the pattern, they will roll the aircraft roughly 45 degrees AOB and 30 degrees nose high (for a 30 degree pattern) and smoothly apply approximately 3-4 G, set MRT and fly the jet to the Abeam position.

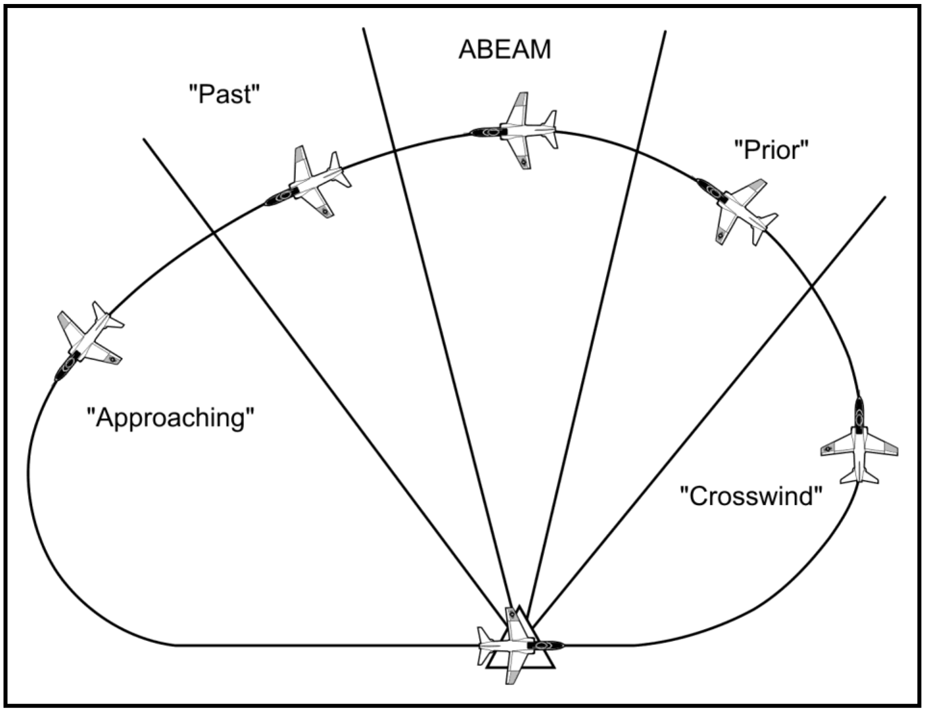


Figure 5-41 Circle the Wagons Pattern Positions

3. Pattern Action Points

Pattern action points are:

a. Abeam

b. Approach Turn Arc

c. Approaching or Power-up Point

d. Roll-In Point (RIP)

e. Target Tracking

f. Safe Escape

g. Pull to the Abeam

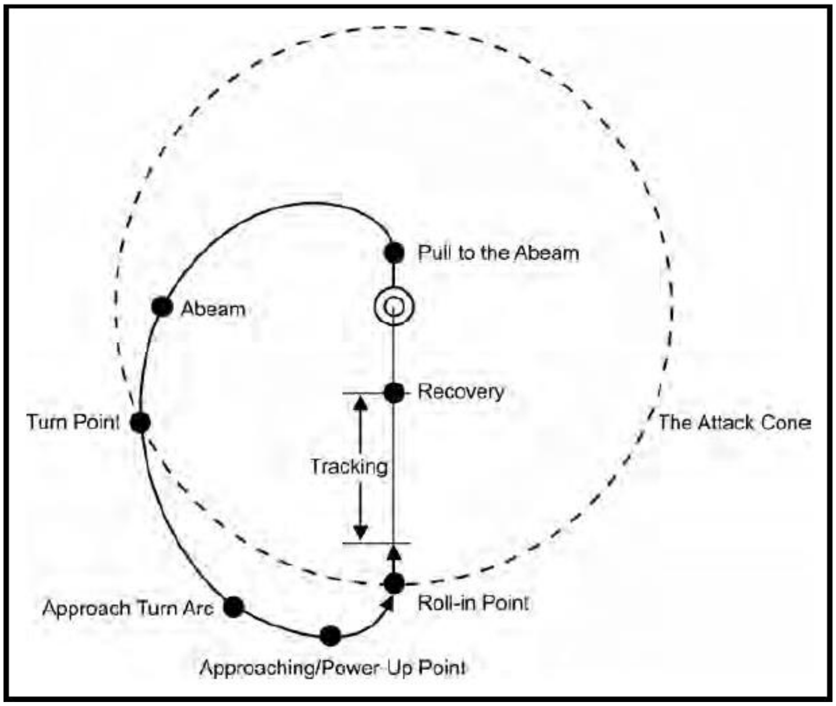


Figure 5-42 Circle the Wagons Pattern

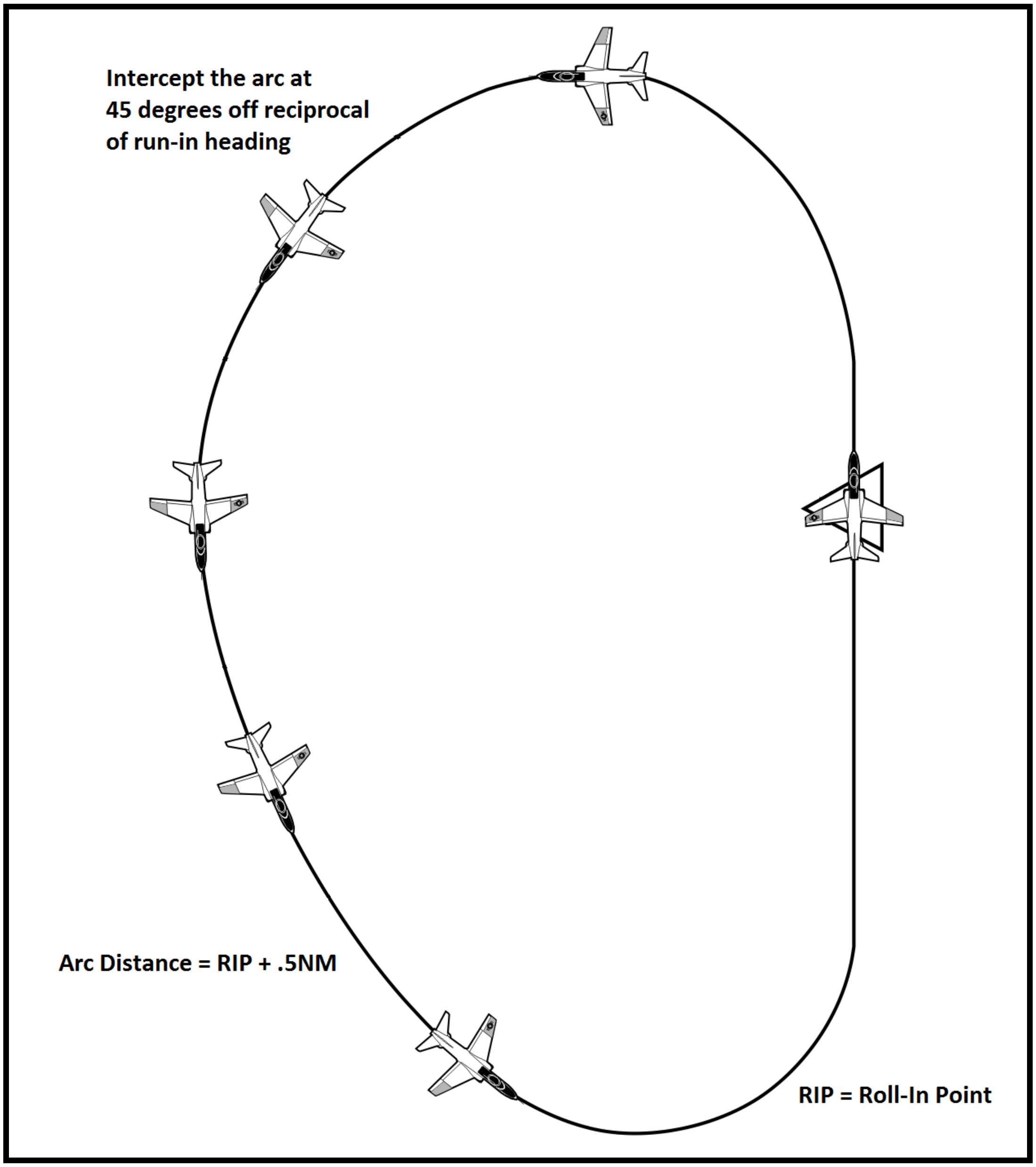


Figure 5-43 Pattern Procedures

4. The Abeam Position

Upon reaching the abeam (approximately 1.7 NM), the target should appear just above the canopy rail. The pilot will roll out on an outbound heading 45 degrees off the reciprocal of the run-in. (ex. if the run in heading is 180, the reciprocal is 360, and the outbound heading should be 360+45 or 045 degrees). Hold this heading until intercepting arc distance of RIP + .5 NM. The only time a 45° turn away at the Abeam would be required would be following the initial break into the pattern or following an off-target extension. After that a 30° offset is typical.

Figure 5-44 The Abeam Position

5. The Abeam to the Arc

Just prior to reaching the appropriate arc distance, the pilot will begin a smooth pull in order to arrive on the arc with the target directly at the 9 o'clock position for a left-hand pattern (3 o'clock position for a right-hand pattern). If the target is directly abeam the aircraft, it will be just slightly uncomfortable to turn your neck to look directly at the target.

6. The Arc

The Arc is 0.5 nautical miles outside of the planned Roll-in distance. The pilot will vary the angle of bank in order to stay on the arc.

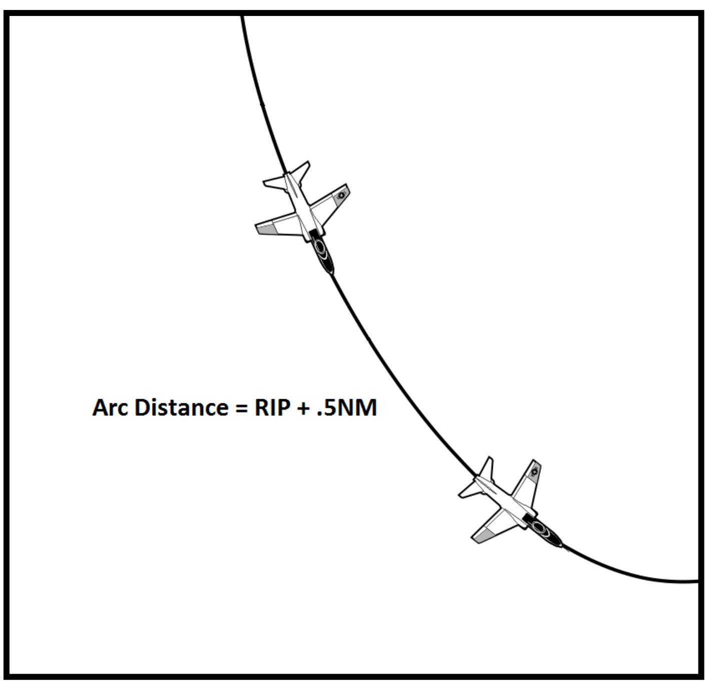


Figure 5-45 The Arc

7. The Approaching Turn – Adjustment for Strong Winds

Winds at altitude will affect the pattern. In order to correct for a headwind or tailwind, the RIP can be adjusted according to the following rule-of-thumb: add/subtract .1 NM from the RIP distance for every 20 kts of tailwind/headwind.

8. The Approaching/Power-up Point

When flying a good pattern in the simulator, the target should remain in the field of view while on the Approach Turn Arc. In the aircraft, the target should always be visible. In both cases, the target will move slightly forward of your inboard shoulder as the nose of the aircraft approaches perpendicular to the run-in line.

Figure 5-46 Target from the Approaching/Power-Up Point

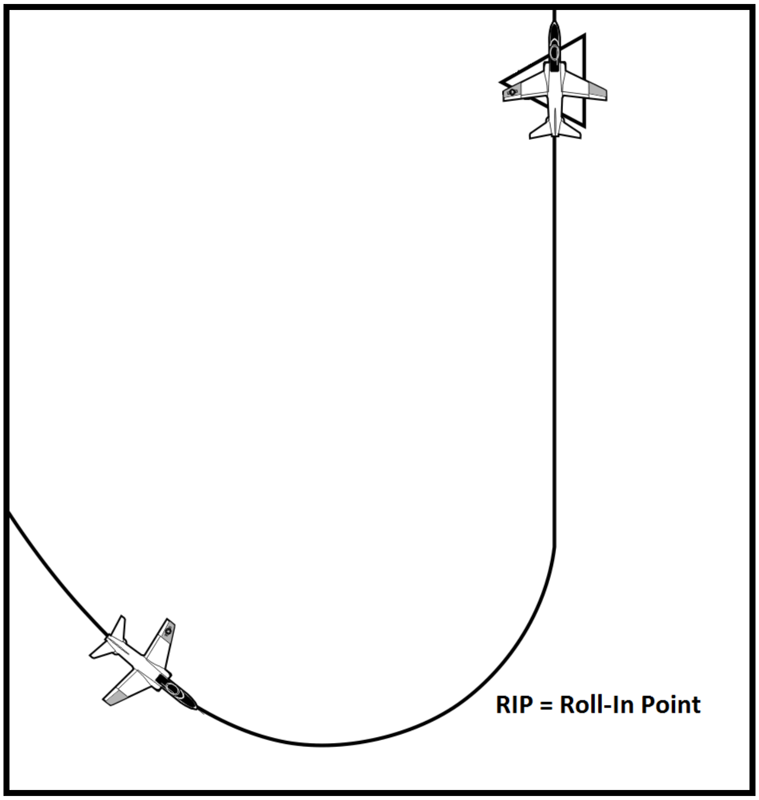


Figure 5-47 Pull to RIP

The pilot will set planned release power setting when the nose of the aircraft is perpendicular to the run-in line, (i.e. 90° off planned run-in heading).

9. The Approaching to the Roll-in Point

After setting the power, the pilot will set MASTER ARM to ARM and start a hard pull (15-17 units AOA) and adjust the pull to arrive at the roll-in point 30-45° off planned run-in heading. It is critical to maintain a good inside/outside scan approaching the roll-in. The pilot will strive to arrive at the RIP with the target 30-45° off the nose. If the pilot has not armed up and is starting the pull to the RIP, it's a good idea for the SNFO to verbalize "check Master Arm."

10 The Roll-In Point (RIP)

The *Roll-In Point* (RIP) is defined by the sight picture described above and where the aircraft starts down from pattern altitude to begin the tracking run established on the bombing triangle/ planned dive wire. Figures 5-48 and 5-49 show the visual and HSI sight pictures at the RIP for a high angle delivery. Take note of where the target appears in relation to the dash and the canopy bow. Provided DME to the target is available, plan on executing the RIP once reaching the appropriate DME.

Figure 5-48 The Target from the RIP

Figure 5-49 HSI at the RIP

11. The Roll-In

Upon reaching the Roll-In Point, the pilot will overbank, place the lift vector on to slightly above the target, smoothly pulling 15 to 17 units AOA, and stop the aircraft upon reaching the appropriate aim-off angle.

12. The Rollout

As the aircraft waterline (airspeed and altitude boxes in the HUD) approach the appropriate Aim-off Point/Distance, the pilot will smoothly neutralize the stick, roll the aircraft upright, and immediately set the planned Aim-off Angle. The target should be lined up beneath the standby compass and the center of the uncaged HUD pitch ladders.

13. The Safe Escape

After the Pickle the pilot will pause a half a second to allow the bomb to clear the aircraft, then start a 4 G pull within 2.5 seconds to 10° Flight Path Angle. Once completing the safe escape, the pilot will place the MASTER ARM Switch to SAFE and make the *"(c/s), OFF SAFE"* call.

Pattern Communications

1. Position Calls

The position call references the location of your aircraft in the pattern at the time the call is made. The positions in order are Crosswind, Prior, Abeam, Past, and Approaching. Prior or Past are referenced from the Abeam position. Position calls will be made by the SNFO after each "Off Safe" call and serves the purpose of letting the aircrew that is calling off safe know where to look for their interval.

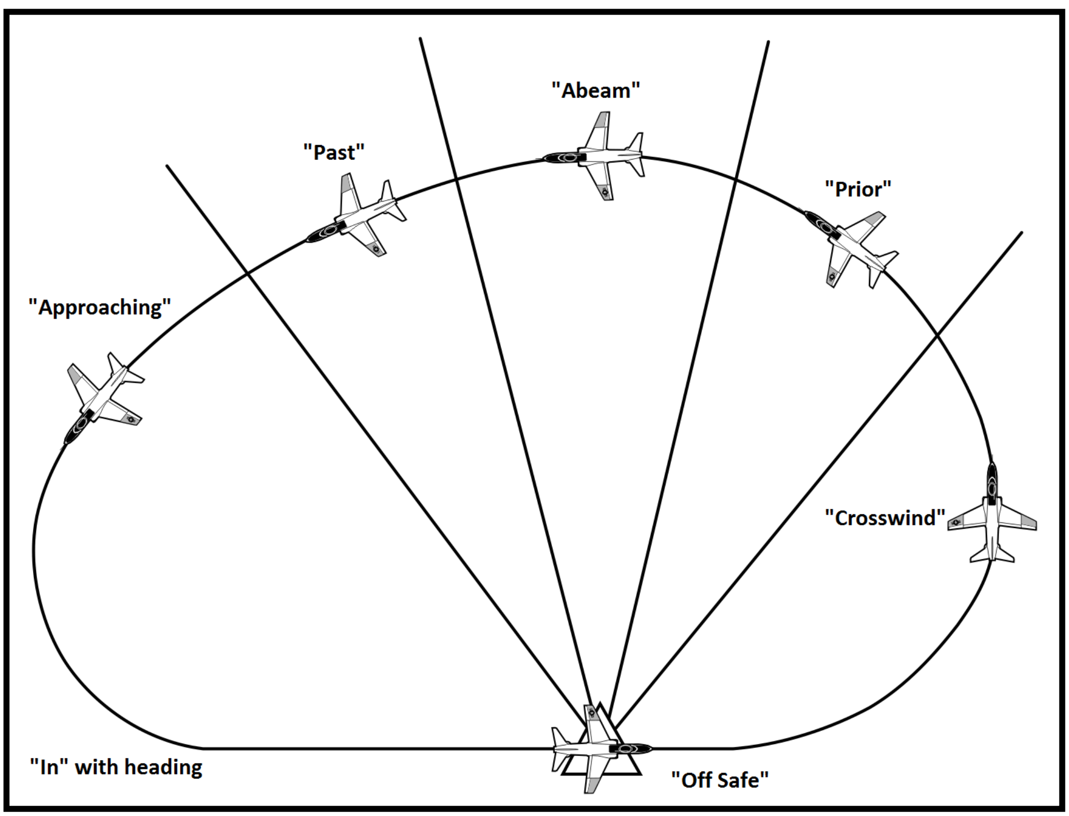


Figure 5-50 Position Calls

Some of the A/S checks may be accomplished prior to entering the pattern and will not change; however, all items should be reviewed every pass once established in the pattern prior to the RIP.

The pattern is designed not to exceed four total aircraft in the pattern at one time, however at VT-86 it will normally be conducted with only two. SNFOs are required to keep sight of wingmen throughout the pattern sequence. Listen to your interval's position report after coming off the target and this should tell you where to look. Keep in mind they will probably be significantly higher than you are if they are at pattern altitude and you are at or just above release altitude. As aircraft approach the Roll-In-Point, aircrews should use extreme caution to avoid a SIMO run (two aircraft diving simultaneously). Solid communications and understanding of the pattern will help to alleviate this risk.

Aircraft climbing to the abeam position are required to stay 1,000' below pattern altitude until visual of their interval.

Pop Up Attack Pattern

Attacks from medium/high altitude are only one method of delivering ordnance on a target. Higher threat environments might necessitate a strike from a pop-up attack following a low altitude ingress. Aircraft will "pop" from low altitude and climb to the RIP altitude. A pop attack is designed to quickly elevate the aircraft from ingress altitude to roll-in altitude. The methods and techniques for getting to the roll-in point after the pop include offset and oblique pops (also referred to "Navy" and "Marine" methods). Oblique pops may be demonstrated but will not be discussed in this FTI. Different pop attack diagrams are available for use and are located in Appendix C. The objectives and procedures remain the same for all pop attacks.

1. Pop Attack Pattern

After completing the dive deliveries, the section will transition to the pop pattern. Unlike the standard weapons pattern, the pop-up pattern is a long racetrack pattern. The pattern is flown at 1,000' AGL and 360 KGS unless terrain or other restrictions dictate otherwise. The abeam position will be slightly wider at 2 miles. At the abeam, track outbound on the reciprocal of the run-in heading for approximately 5-6 NM. Once reaching the appropriate turn point, the pilot will perform a level 90-degree turn and roll out perpendicular to the run-in line. Once the aircraft starts the turn-in, the SNFO should make the "*turning in at (DME)" call* unless there is an aircraft in the dive. Approaching the run-in line, the pilot will add power to MRT and execute a 3-4G level turn inbound to arrive over the run-in line with the target off the nose. The pilot will descend once inbound towards the target to 500' AGL.

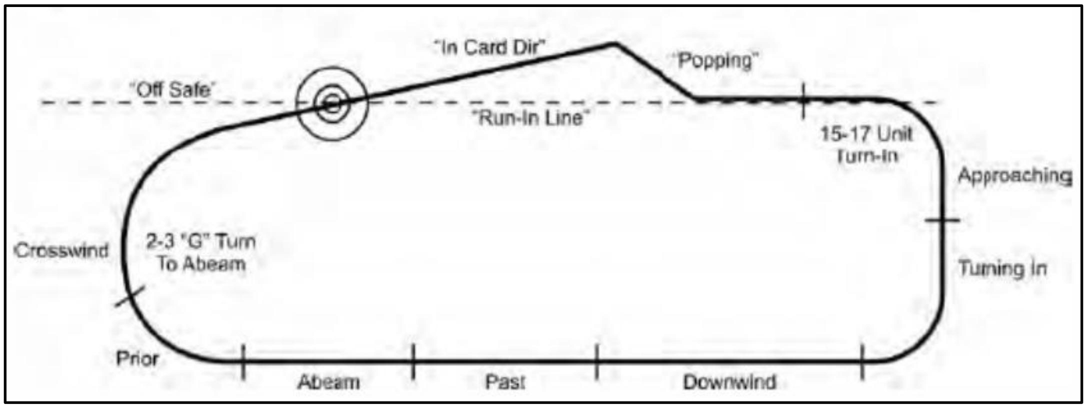


Figure 5-51 Low Pop Pattern Overview

2. Offset Pop Mechanics

The advantage of an offset pop is the ability to keep the target area in sight throughout the entire maneuver. Once established on the ingress to the target level at 500’ AGL, the pilot will continue accelerate to 400 KIAS. At the appropriate action point, he will set the power to MRT (if not already set), perform a level 20° turn away from the pattern and roll wings level. Once reaching the appropriate pull up point distance, he will pull the nose wings-level up to the appropriate nose high attitude based on the pop diagram using a smooth ***4 G*** pull. The amount of wings level time in the climb is only a few seconds. Passing reversal altitude, he will roll to put the lift vector on the target and execute a smooth pull to set the appropriate aim-off angle. If performed correctly, the aircraft should be established on the planned dive angle towards the target.

Off-Target

After release, the pilot will execute the safe escape (smooth 4G pull within 2.5 seconds up to 10 degrees FPA). Once recovered, the pilot will set the MASTER ARM to SAFE, call “off safe,” and begin a LEVEL pull to the abeam. Descend back to pattern altitude once established on the downwind with high SA or preceding interval in sight. ***Do not*** make descending turns below 2,000’ AGL.

Following the last pass, a pre-briefed off-target rendezvous will be performed. SNFOs should brief to rendezvous overhead the target or at a specified point and altitude with Wing 1,000’ stepped down until visual of Lead, left turns, 250 KIAS. Lead SNFO should initiate the fence out but the priority is a safe rejoin. Once Wing is in sight of Lead, the Lead IP may elect to continue the rendezvous as a running rendezvous while proceeding to exit the MOA. Once rejoined, conduct BDXs, complete the Fence out, exit the MOA, and RTB.

Communication Procedures

An example of the communication in the weapons pattern is as follows:

a. Lead/Wing IP (UHF) - *"Hammer-11/-12, breaking (high/med/low) pattern."* (Spacer Pass)

b. Lead SNFO (UHF) - *"Hammer-11, (position)."* (After wing calls *"breaking"*)

c. Lead/Wing SNFO (ICS) - *"APDART complete."* (completed on every pass)

d. Lead/Wing IP (UHF) - *"Hammer-11/-12, In dry, (heading)."*

e. Once an aircraft calls "IN," no UHF calls except for SOF should made from the non-executing aircraft until after the "Off safe" call is made.

f. Over ICS, once established in the dive, the SNFO will ***verbalize*** airspeed and dive angle during the dive. If any of these are out of parameters approaching the "Mark" altitude, call "ABORT" over the ICS.

g. Lead/Wing SNFO (ICS) - *"Mark."* (at planned release altitude) "*Pull."* Only if reaching NLT release altitude and not seeing climb indications.

h. Lead/Wing IP (UHF) - *"Hammer-11/-12, off safe, sim one away."* (after safe escape, and master arm safe)

i. Lead/Wing SNFO (UHF) - *"Hammer-11/-12 (position)."* In the event an aircraft reaches the RIP prior to the other aircraft calling "*Off safe,"* the position call will be made by the pilot in the dive.

j. Lead/Wing SNFO (ICS) - "*Visual, (clock code)."* (when visual of wingman)

k. Lead SNFO (UHF) - *"Hammer-11, 1.9, Good G"* (fuel check with no aircraft in dive), Wing SNFO (UHF) - *Hammer-12, 1.9, Good G."*

l. Approaching final dive pattern run, Lead/Wing IP (UHF) - *"Hammer-11/-12, in dry, (heading), transition pop pattern."*

m. Lead/Wing IP (UHF) - *"Hammer-11/-12 off safe, sim one away, transition pop pattern."*

n. Off target Lead will turn to downwind for the low altitude pop pattern. APDART completion timeline will remain the same as for the dive pattern. LAW should be set in a timely fashion to avoid getting a LAW tone when descending to pattern altitude.

o. After Wing reports - *"Off safe,"* Lead SNFO (UHF) - *"Hammer-11, (position)."*p. Lead/Wing SNFO (ICS) - *"Visual, (clock code)"* (when visual of wingman)

q. At Turn In, Lead/Wing SNFO (UHF) - *"Hammer-11/-12 Turning in at (___)"* (Round to the nearest half NM).

r. Lead/Wing SNFO (ICS) - *"Approaching offset."*

s. Lead/Wing IP (UHF) - *"Hammer-11/-12 popping."*

t. Once an aircraft reports *"Popping,"* no UHF calls except for SOF should made until aircraft calls "Off safe"

u. Lead/Wing IP (UHF) - *"Hammer-11/-12, In dry (heading)."*

u. Lead/Wing SNFO (ICS) - *"Mark"* (at planned release altitude) "*Pull"* Only if reaching NLT release altitude and not seeing climb indications.

v. Lead/Wing IP (UHF) - *"Hammer-11/-12, off safe, sim one away"* (after safe escape, master arm safe)

w. Lead/Wing SNFO (UHF) - *"Hammer-12, (position)."*

x. On the final target run in, the IP will report on UHF, - *"Hammer-11/-12, In dry, last pass, last pass."*

y. Lead IP (UHF) - *"Hammer-11, off safe, sim one away, off target rendezvous."*

z. Wing IP (UHF) - *"Hammer-12, off safe, sim one away, off target rendezvous, visual/blind."*

509. PRECISION GUIDED MUNITION (PGM) LEVEL LAY DELIVERIES:

PGM mechanics shift much of the comm to the aft cockpit, on an IR this will take place on the AUX radio due to ATC/SOF in PRI.

a. SNFO (AUX) - "Hammer, In Dry, (heading)." (4-6 NM established WL inbound)

b. SNFO (ICS) - "Pickle." (at planned release distance)

c. SNFO Lead (AUX) - "Hammer-11, Off safe, sim one away." (after release, master arm safe)

d. SNFO Wing (AUX) - "Hammer-12, Off safe, sim one away, visual."

e. Lead SNFO (AUX) - “Hammer-11, 1.8, good G.” (OPS/G check)

f. Wing SNFO (AUX) - “Hammer-12, 1.7, good G.”

CHAPTER SIX
ELECTRONIC WARFARE

600. INTRODUCTION

Electronic Warfare (EW) refers to any military action involving the use of electromagnetic energy to control the electromagnetic spectrum (EMS). 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 a small portion of the EMS.

The electronic warrior will mostly be concerned with frequencies ranging from Very High Frequency (VHF), starting at 30 MHz to Extremely High Frequency (EFH), ending at 30 GHz. Contained within this band are frequencies commonly used for communications, navigation, and multiple types of radar. You can see from Figure 6-1 that much of this range is controlled by the federal government and shared between military and civilian use.

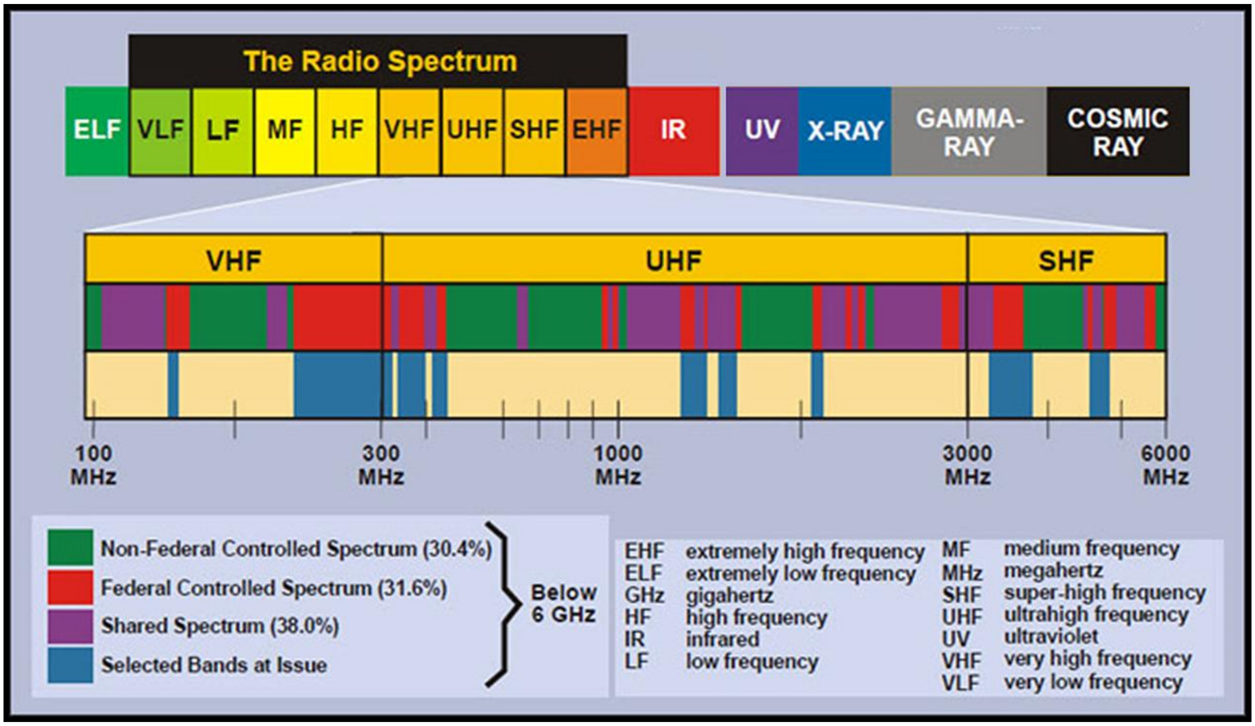


Figure 6-1 Electromagnetic Spectrum (EMS)

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.

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.

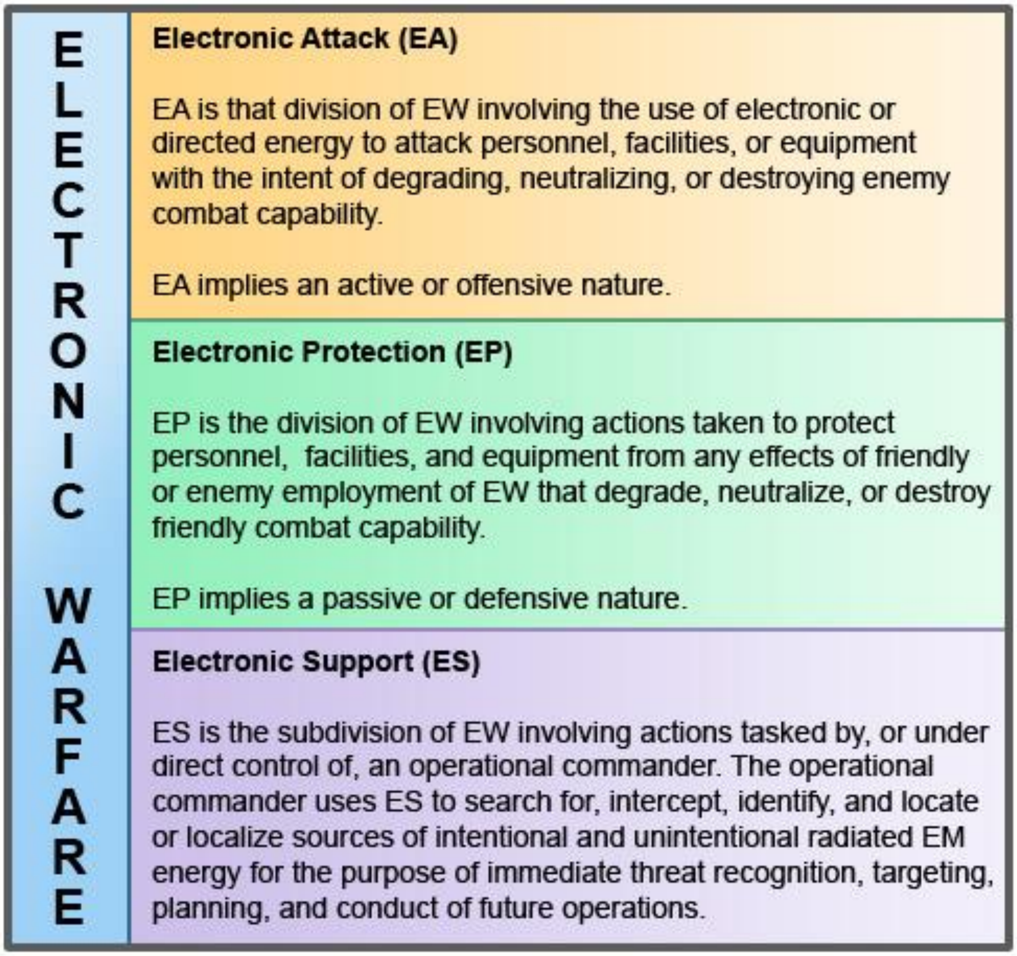


Figure 6-2 Electronic Warfare Roles

1. Electronic Attack (EA)

EA is the employment of EM 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, deception, and kinetic weapons.

b. 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

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). Counter radio controlled improvised explosive device (RCIED) systems

c. Suppression of Enemy Air Defenses (SEAD)

SEAD is a mission devoted to neutralizing or reducing enemy air defense effectiveness prior to or during mission execution. This may be accomplished using both non-kinetic and kinetic means.

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 AGM-88C HARM and AGM-88D AARGM. 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.

The primary USAF SEAD aircraft is the F-16D/J Fighting Falcon, which is a multi-role aircraft with modified targeting systems to perform SEAD. The Air Force's emphasis on multi-role strike aircraft has largely made specified SEAD variants obsolete and Navy "Expeditionary" EA-18G squadrons execute the SEAD mission in direct support of USAF assets.

d. Fleet Aircraft

Within the Navy, Marine Corps, and Air Force, offensive EA is primarily accomplished by the EA-18G Growler using a variety of systems.

i. The ALQ-218 receiver set is a pattern of antennas on the exterior of the aircraft coupled with data processing computers that can analyze and localize the EM environment. This data can be processed real-time by the Growler crew and tactical decisions made.

ii. The ALQ-227 Communications Countermeasures Set is optimized to intercept radio transmissions and if desired disrupt them. This system can also be used to broadcast FM /AM radio for use in psychological warfare.

iii. The ALQ-99 Tactical Jamming System is a set of under wing pods that can actively jam multiple frequencies simultaneously and disrupt enemy communication and navigation systems as well as degrade their use of radar tracking systems.

iv. The AGM-88 HARM / AARGM is a radiation homing missile that can be launched at range to temporarily physically destroy a radar emitter.

2. Electronic Protection (EP)

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)

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.

3. 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.

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. EA-18G Growler, which is designed to be “in the fight” and able to provide real-time information and support to a strike package, as well as perform SIGINT and ELINT missions from an aircraft carrier.

b. EP-3E Aries, which is the Navy’s only land-based aircraft primarily designed to collect SIGINT

c. P-8A Poseidon and P-3C Orion, which are capable of performing SIGINT and ELINT for extended time far from their launch location.

d. MH-60R Seahawk, which is a ship-based helicopter, has a primary mission of anti-submarine warfare, but will perform ELINT and SIGINT as a secondary mission in concert with Surface Search and Control (SSC).

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 6-3). Alternatively, multiple platforms could take simultaneous bearing readings thereby triangulating the position of the emitter (Figure 6-4). Once an enemy emitter is located, it can be avoided, deceived, or destroyed.

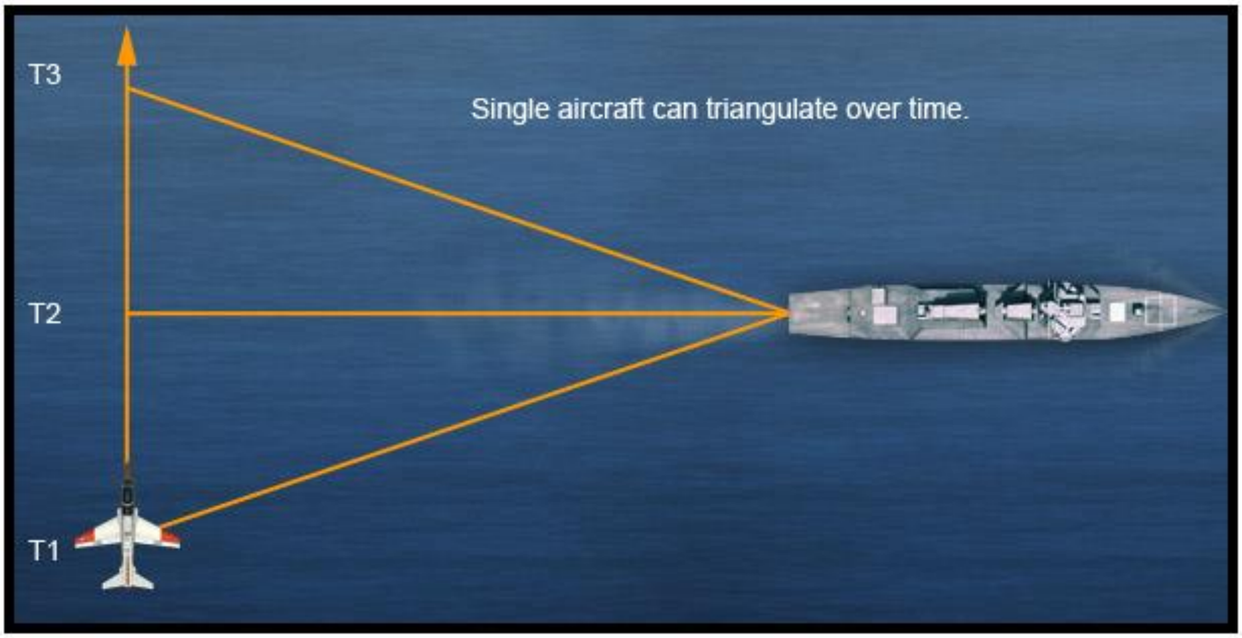


Figure 6-3 Single Platform Triangulation

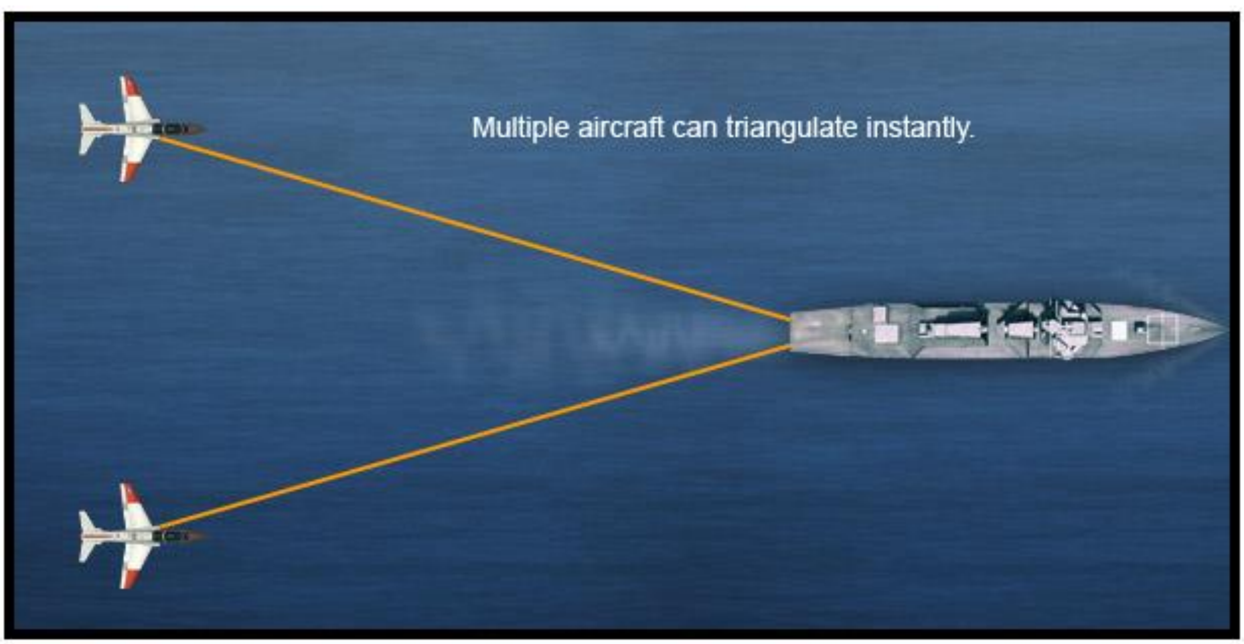


Figure 6-4 Multiple Platform Triangulation

603. 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.

604. 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 6-5). 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 6-5 Typical Chaff Canister

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."

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.

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 maneuvering.

Figure 6-6 EA-18G 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.

5. Self-Protection Jammers

Most modern aircraft are equipped with an on-board EA suite that can spoof acquisition and tracking radars once detected by on-board sensors. These systems are very effective as the alignment piece of the equation is instantly solved.

605. DETECTION SYSTEMS

In order to shoot down an aircraft, it must first be detected by some means. Aircraft can be detected with visual based instrumentation as simple as a sight on a rifle, or as complicated as an automated infrared tracking camera. Longer range systems will often use an integrated network of early warning, target acquisition, and target tracking radars to complete an intercept. Airborne electronic attack focuses its effort into disrupting this network and breaking the SAM operators kill chain.

1. Visual Tracking Systems

Visual detection and engagement is primarily used by shorter range man portable systems and often used as a secondary means of engagement on medium range systems in cases where emitting radar energy is not desirable. Visual cameras are subject to atmospheric obscurations such as smoke, haze, and darkness, just as our eyeballs are; however, visual instruments are much simpler and are immune to the effects of radar jamming.

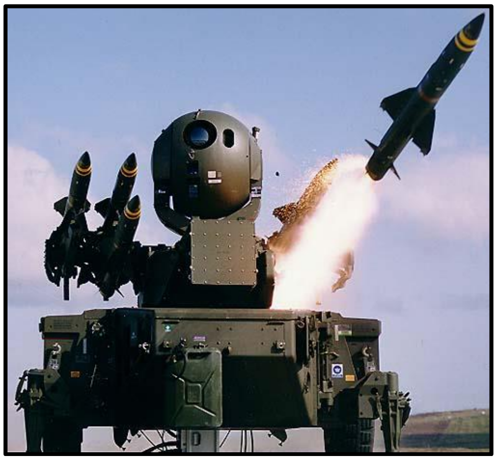


Figure 6-7 Combination Visual Tracking Ball on Rapier Surface to Air Missile System

2. Early Warning Radars

EW radars will typically use low frequency, high power emitters, at slow scan rates to detect targets at very long ranges. This information can be passed to follow on acquisition radars. They are typically very large and difficult to move.

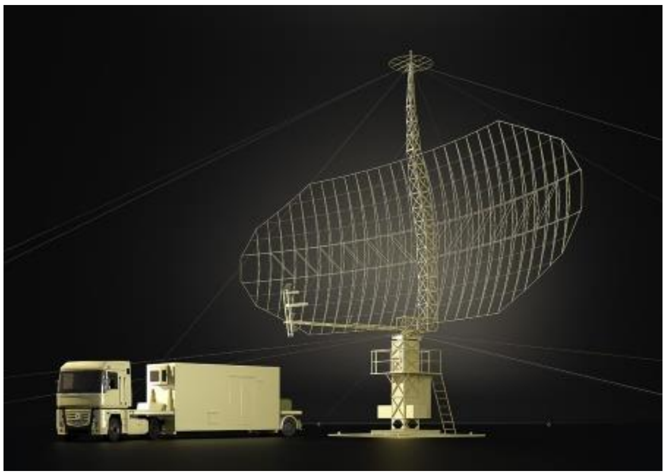


Figure 6-8 Tall King Early Warning Radar

3. Target Acquisition Radars

These radars are best thought of as smaller, shorter range versions of EW radars and are often paired with an engagement system and are highly mobile. Acquisition radars typically use a higher frequency and are therefore able to process higher fidelity information more quickly than EW radars. Modern EW radars can be capable of generating targeting solutions without the aid of tracking radar.

Figure 6-9 Tin Shield TA Radar Mounted On Mobile Chassis

4. Target Tracking Radars

Typically the final radar used in an engagement will be some form of tracking radar. They are usually very high frequency and non-scanning, meaning that they are effectively “staring” at a target through a soda straw and continually providing updated precise information regarding a targets position and velocity. These radars are usually in very close proximity to the engagement site and are highly mobile.

Figure 6-10 Low Blow Tracking Radar

606. 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.

Two types of surface-to-air threats are:

- Man Portable Air Defense Systems (MANPADS)
- SAMs

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.

Some examples of combat proven systems (Figure 6-11) include:

a. SA-7 Grail

   i. Shoulder fired, low altitude MANPAD

   ii. Passive IR homing guidance

   iii. High explosive warhead

b. 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

c. 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

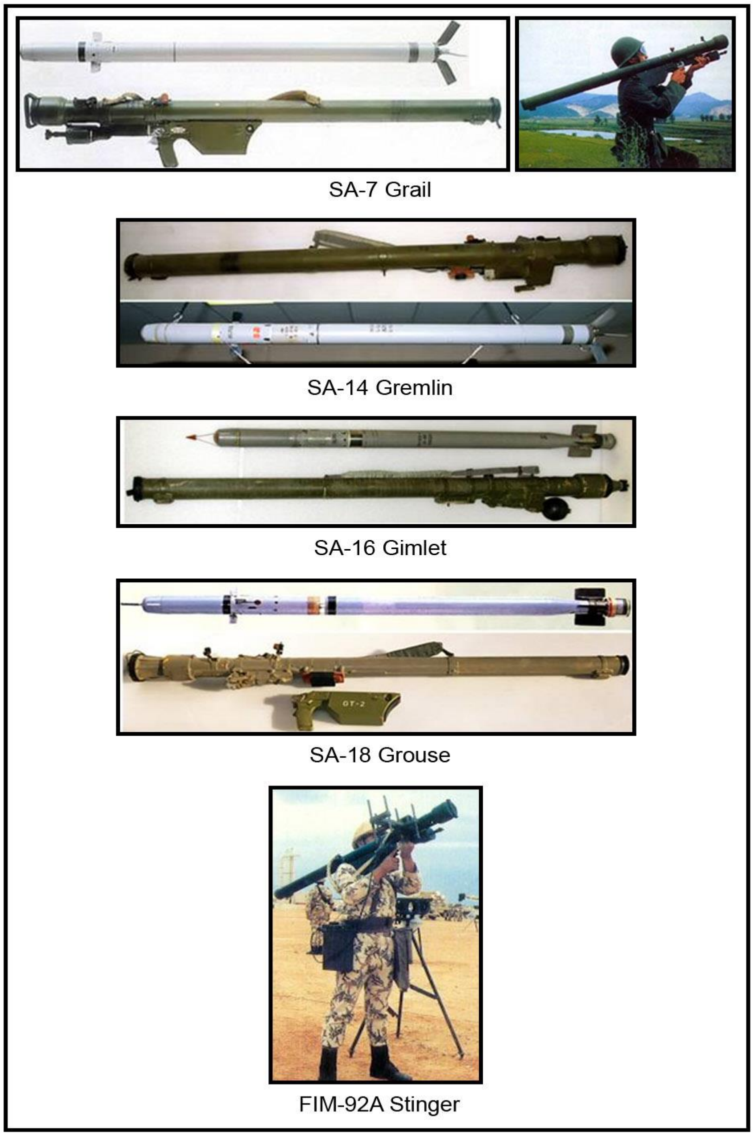


Figure 6-11 Common MANPADS

2. Surface-to-Air Missiles (SAMs)

SAMs are commonly divided into three groups based on how they engage at target. Command guided, semi-active radar homing, and active guidance.

a. Command guided missiles require a system to actively track both the target and the missile, and through a data-link an operator will typically provide manual guidance to the missile all the way to intercept. These systems are usually older, less technologically advanced, and are less efficient due to the pure pursuit curve required by the missile. Nonetheless, they are very lethal if not avoided or countered. A USAF F-117 stealth bomber was lost in 1999 and an SA-3 credited with its shoot down.

i. SA-2 Guideline (Figure 6-12)

(a). A medium- to high-altitude SAM system with 360-degrees of coverage

(b). Medium range

(c). Four large delta fins on the booster

Figure 6-12 SA-2 Guideline

ii. SA-3 Goa (Figure 6-13)

(a). Low- and medium-altitude SAM system

(b). Short-range

(c). Designed to destroy aircraft, helicopters and low flying cruise missiles

Figure 6-13 SA-3 Goa

iii. SA-5 Gammon

(a). Medium and high altitude SAM system

(b). Long range

(c). Designed to destroy bomber and support aircraft at longer ranges greater than 100 NM

Figure 6-14 SA-5 Gammon

iv. SA-15 Gauntlet

(a). All weather, low- to medium-altitude

(b). Short-range

(c). Combined radars and launcher

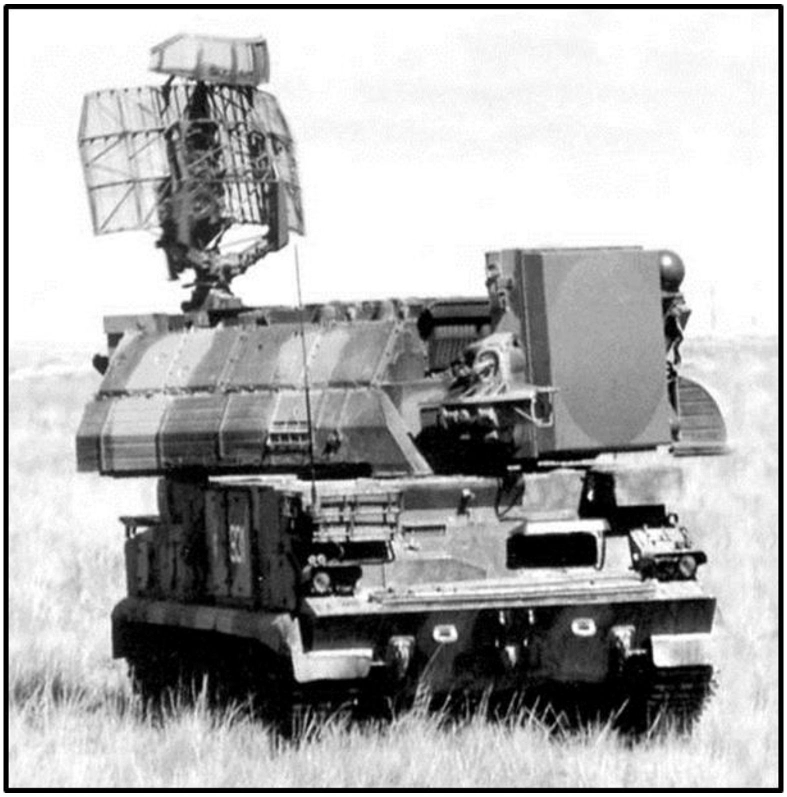


Figure 6-15 SA-15 Gauntlet

b. Semi-active radar homing SAMs add a radar receiver to the missile itself, alleviating the necessity of tracking the missile in addition to the target. In these systems the target is continually "illuminated" by a ground based transmitter and the signal is received by a missile in flight. Most systems incorporate logic onboard the missile that will make necessary course corrections and guide the missile to impact.

i. SA-6 Gainful (Figure 6-16)

(a). Low to medium altitude SAM system

(b). Highly mobile

(c). Medium range


Figure 6-16 SA-6 Gainful and Straight Flush Radar

ii. SA-N-7 Gadfly

(a). Ship based

(b). Medium range

(c). Designed to destroy aircraft, helicopters and low flying cruise missiles

Figure 6-17 SA-N-7 Gadfly

c. Active guided SAMs are the most technologically advanced and incorporate radars based both on the ground and in the missile itself. A combination of both these signals is used to consummate intercept of a target.

i. HQ-9 Red Banner

(a). Highly mobile, canister launched

(b). Medium to long range

(c). Designed to be paired with multiple radars, including passive sensors

Figure 6-18 Chinese HQ-9 With Associated Planar Array Tracking Radar

607. T-45C VIRTUAL MISSION TRAINING SYSTEM (VMTS) AND T-45C 2F205A OPERATIONAL FLIGHT TRAINER (OFT)

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.

1. 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 is 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 6-19.

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 6-19 RWR Threat Symbols

2. 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 6-20). No heading indication is given on this page, which limits the usefulness of the display on its own.

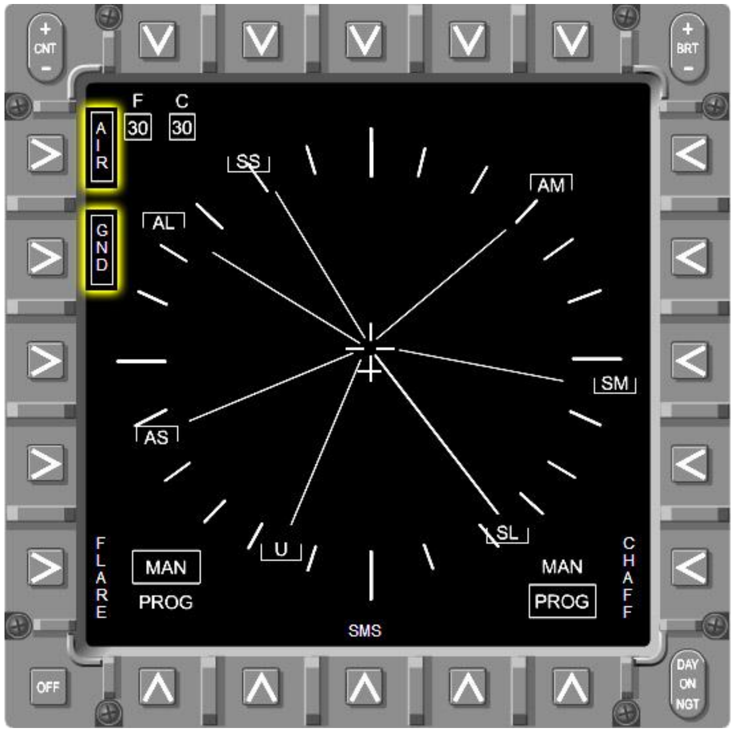


Figure 6-20 OFT MFCD EW Format

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 6-21.

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 6-21 OFT EW Threat Symbols

3. 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.

4. 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 LMFCD, the threat type can be selected (Figure 6-20):

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 (SS).

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 LMFCD.

5. 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.

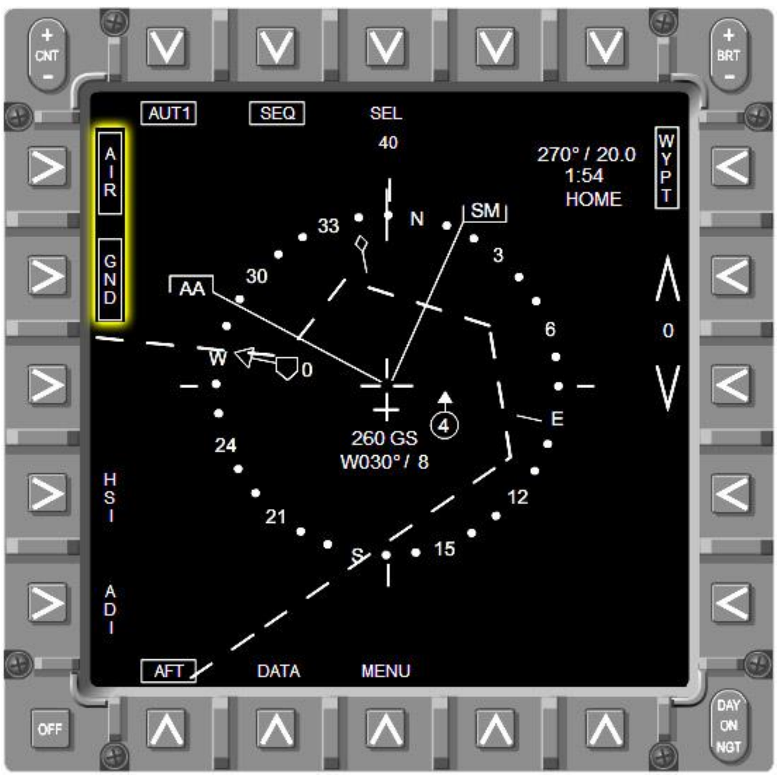


Figure 6-22 VMTS SA Display

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 6-23.

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 6-23 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 disadvantages of the SA page are that chaff cannot be dispensed from the SA page and TACAN information is not available. Chaff must instead be dispensed 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,) 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.

608. SURFACE TO AIR COUNTER-TACTICS (SACT)

If a missile launch is detected, a missile defense procedure must be executed:

Hammer 11 SNFO (AUX) - "*Hammer defend north, singer short 090.*"

Since Hammer 11 is being targeted, Hammer 12 will respond with their status:

Hammer 12 SNFO (AUX) - *"Hammer 12, naked."*

While maneuvering, both students direct the release of chaff over ICS.

SNFO (ICS) - *"Chaff."*

The pilot will initiate a break turn to the cardinal or sub-cardinal direction; over ICS the SNFO will provide a refined heading to put the strobe in the beam:

Hammer 11 SNFO (ICS) - *"Steady 015."*

Adjust heading to keep the strobe in the beam. Directing small check turns is acceptable and encouraged over recalculating a defense heading. If still spiked after 10 seconds, turn in the shortest direction (Hard Turn) to place the DOA strobe at the 6 O'clock position and accelerate using MRT, and over UHF, direct the section with another defend call and direction to defend. Once no longer spiked, resume mission:

Hammer 11 SNFO (AUX) - *"Hammer flow 348." Or "Hammer flow direct IP."*

There is no need for Hammer 11 to report "*naked.*" Unless otherwise stated, it is understood Hammer 12 is not being targeted and will comply with leads directives.

1. Wingman Considerations

Anytime a member of the section changes its targeted status, the other aircraft will reply with their status:

Hammer 12 SNFO (AUX) - "*Hammer defend north, singer short 090.*"

Hammer 11 SNFO (AUX) - "*Hammer 11, naked.*"

In VT-86 when one aircraft begins a missile defense he assumes the Tac lead and the untargeted aircraft will turn to put the threat in the beam. The untargeted aircraft is responsible for deconfliction. SACT should be briefed after the conclusion of mission conduct as a tactical contingency.

When the targeted fighter subsequently goes naked, the lead SNFO will recommend a flow.

Hammer 12 SNFO (AUX) - *"Hammer 12, naked."*

Hammer 11 SNFO (AUX) - *"Hammer flow 348."*

Students should be aware of the potential of a wing aircraft being spiked while lead is naked. In this scenario -2 now has the Tac Lead until subsequently naked, at which point lead should seamlessly resume the Tac Lead. Example:

Hammer 12 SNFO (AUX) - "*Hammer defend northwest, singer medium 030*."

Hammer 12 SNFO (ICS) - "*Chaff, steady 300*."

Hammer 11 SNFO (AUX) - "*Hammer 11 naked.*"

Hammer 12 SNFO (AUX) - "*Hammer 12 naked.*" (when no longer spiked)

Hammer 11 SNFO (AUX) - "*Hammer flow direct point Charlie*."

APPENDIX A
MISSION SOFTWARE PLANNING GUIDE

A100.JOINT MISSION PLANNING SOFTWARE (JMPS)

This section is designed as a quick reference and supplement to the JMPS lecture. The SNFO is responsible for making sure JMPS products adhere 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 junior 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 (if after 1900).

d. Store your personal planning files on the designated student drive in your own student folder.

Prior to building charts, verify the following initial conditions in JMPS, utilizing the top tool bars, Options/Preferences/Chart Tools:

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 – 6000, Width – 100

(b). Active Civil with Maj Facilities, Active Joint, Active Military – ON

(c). Hide airports above – 1:1M.

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

(e). SIDC/SMRS/IAP-SHOW LABELS

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 1:500 K.

iii. Hide labels above 1:250 K.

iv. Display route options – display route corridor – ON

v. Corridor color – yellow

vi. Display route points – OFF

vii. VR and IR Routes – ON

viii. Remove all "Routes Displayed."

e. NAVAIDs

i. VOR, VORTAC and TACAN – ON (a). NAVAID Uses – RNAV OFF

ii. Hide Nav above 1:2 M.

iii. Hide labels above 1:2 M.

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 1:2 M.

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

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 sync items – OFF.

v. Highlight New ECHUM – 2 months.

vi. Hide CHUM labels above – 1:500 K

h. Manual CHUM

i. Blue-based icons and power lines

ii. Line width: thin

iii. Hide manual CHUM above 1:500 K.

iv. Hide chum labels above 1:500 K.

i. Route

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

ii. Calculate point displays.

(a). Forms – clear all.

(b). Graphical editor – clear all.

(c). Tabular editor – clear all.

iii. Default vehicle – Change to T-45A/C

iv. Departure point – Change Point ID to KNPA/A Airport Center of Mass.

v. Graphical editor – Corridor: deselected ON.

j. Doghouses

i. Hide doghouses above 1:500 K.

ii. Doghouse, dividing line, bind to leg ON

iii. Side of route – right

iv. Initial distance up route leg – 1⁄2

v. Color – white

vi. Shading – 69.9%

vii. Font – Arial, regular, 20, outline, background: white, foreground: black

k. General

i. Deselect all under route point labels.

ii. Line thickness – 3

iii. Leg style – solid

iv. Symbol size – 40

v. Route color – black

vi. Deselect hide route legs and points.

l. Rehearsal – OFF

i. Tick Marks

(a). Display Threshold – 1:500 K

(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 – ARIAL, 22, outline, background: white, foreground: black

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

iii. Time Hacks

(a). Display threshold – 1:500 K

(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

m. Vehicle Preferences – T-45A/C

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). ALTITUDE – 28,000M

(d). Bank angle – 60 for low levels

(e). Airspeed – 360 GS (ground speed)

iii. STTO Preferences – Fuel per STAN

n. Scale Bar

i. DISPLAY SCALES – BOTH

ii. Font size – large

iii. Units – nautical miles/yards

iv. Background: white, foreground: black

o. Session Preferences – coordinate options.

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

ii. General – Select save session layout automatically on exit, apply close, and reopen JMPS.

iii. Open session preferences and deselect save session and apply.

p. 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 your personal folder; 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).

(a). ONC 1:1M

(b). 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, uncheck Banner Print Override

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.

g. JMPS Overlays and Doghouses (Figure A-1)

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

(a). Set MTRs to show Route Corridor. (Display 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 A-1)

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.

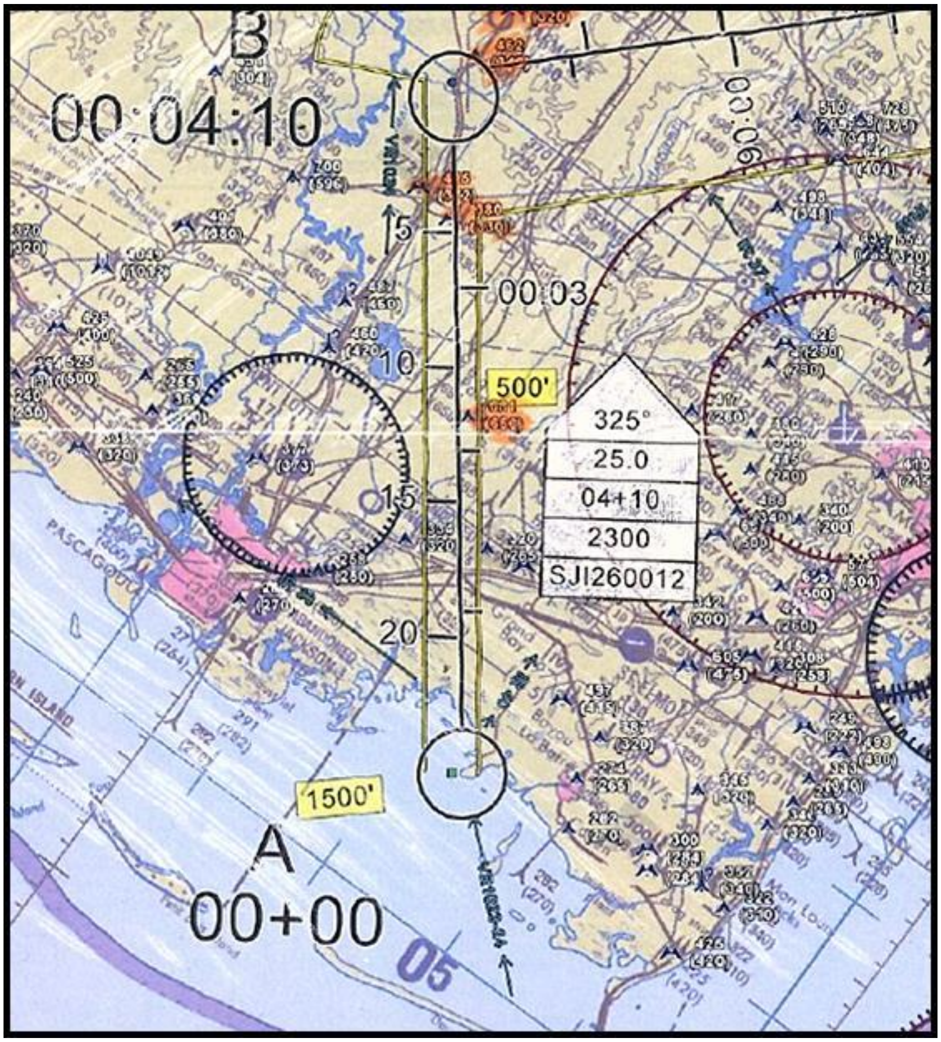


Figure A-1 Doghouse, Turn Point Labels and Times

i. JMPS Informational text boxes (Figure A-2) – Build for MOA calls, altitude changes, FSS calls, and other Strike Segment Planning Guide info. To build a text box:

   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.

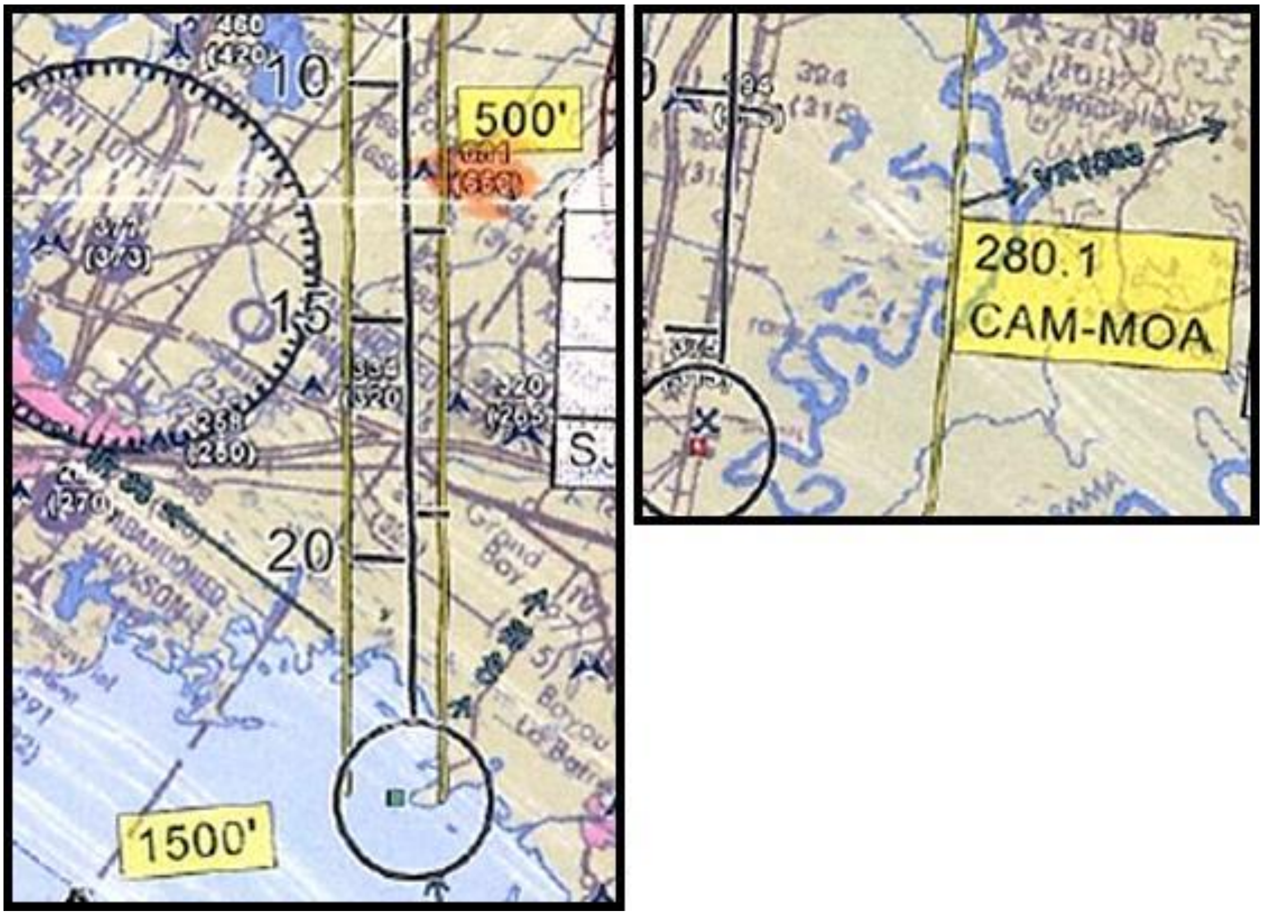


Figure A-2 Info Text Boxes

j. JMPS Ellipses – Build for NSAs, Airfields, No Fly Areas, and other AP/1B info (Figure A-3). To build an ellipse:

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.

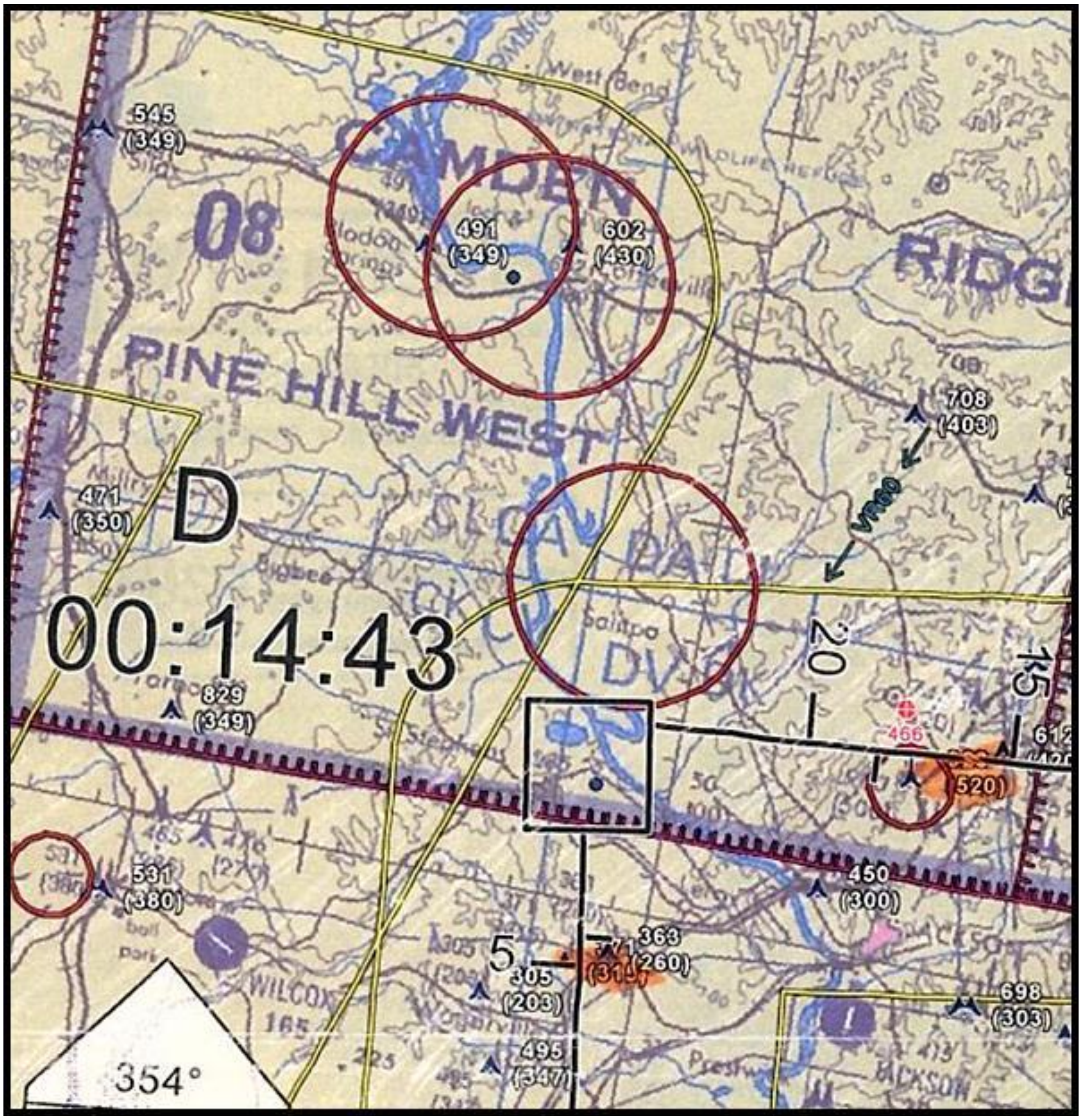


Figure A-3 Ellipses

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. Crossing routes may be found in the AP/1B under Conflicts and Cautions. To draw a crossing route:

i. Center the Graphical editor on the applicable leg

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

iii. Displayed Route Options/All Route

(a). Centerline: blue

(b). Route Corridor: yellow

iv. Displayed Point Options/All Available Routes

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

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

vii. 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.

viii. 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.

ix. 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.

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

xi. 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. Setup Labeling Options – Select Chart Tool/Chart Tool Generation Preferences (right side).

(a). Select Labeling Options.

(b). Uncheck everything.

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

n. JMPS Strip Chart Printing Prep

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

ii. 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.

iii. 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 personal folder/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.

– 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 A-4).

ii. Paste the strip chart on the left side to leave room on the right for notes, fuel stamps, times (Figure A-5).

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

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

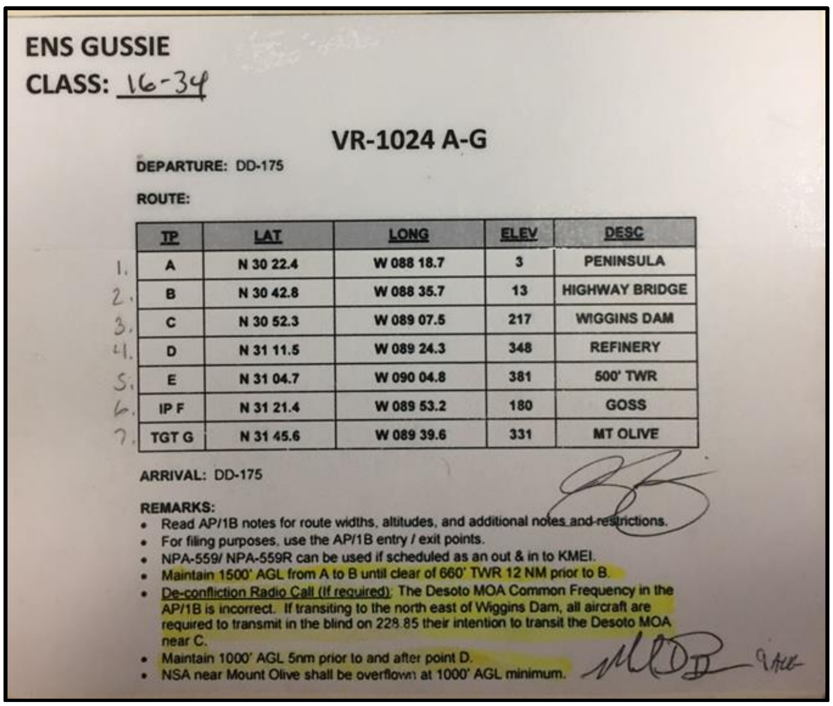
(a). Rubber cement and other wet glues will cause chart to bleed and become unusable.

(b). Stick glues may work.

(c). ***Do not use spray glue inside the jmps room!!!!***

v. Notes, e.g., turn-point description, outbound heading, ATC freqs, tacans etc, are authorized for your benefit on your chart; however, do not write so much on your chart that the focus is taken off the actual chart itself. Less is more.

vi. You may need to print off each strip chart one by one to avoid having route lines through your turn points and targets.



ENS GUSSIE
CLASS: 16-34

VR-1024 A-G

DEPARTURE: DD-175

ROUTE:

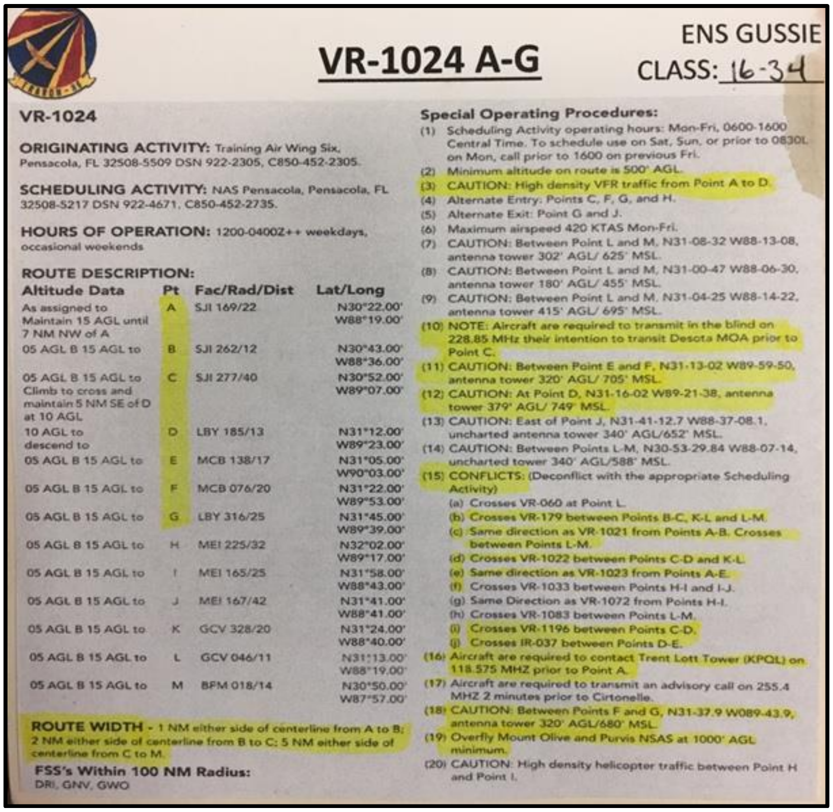
	TP	LAT	LONG	ELEV	DESC
1.	A	N 30 22.4	W 088 18.7	3	PENINSULA
2.	B	N 30 42.8	W 088 35.7	13	HIGHWAY BRIDGE
3.	C	N 30 52.3	W 089 07.5	217	WIGGINS DAM
4.	D	N 31 11.5	W 089 24.3	348	REFINERY
5.	E	N 31 04.7	W 090 04.8	381	500' TWR
6.	IP F	N 31 21.4	W 089 53.2	180	GOSS
7.	TGT G	N 31 45.6	W 089 39.6	331	MT OLIVE

ARRIVAL: DD-175

REMARKS:

- Read AP/1B notes for route widths, altitudes, and additional notes and restrictions.
- For filing purposes, use the AP/1B entry / exit points.
- NPA-559/ NPA-559R can be used if scheduled as an out & in to KMEI.
- Maintain 1500' AGL from A to B until clear of 660' TWR 12 NM prior to B.
- De-confliction Radio Call (If required): The Desoto MOA Common Frequency in the AP/1B is incorrect. If transiting to the north east of Wiggins Dam, all aircraft are required to transmit in the blind on 228.85 their intention to transit the Desoto MOA near C.
- Maintain 1000' AGL 5nm prior to and after point D.
- NSA near Mount Olive shall be overflown at 1000' AGL minimum.

Figure A-4 Strip Chart - Cover - Final Product



VR-1024 A-G

ENS GUSSIE

CLASS: 16-34

VR-1024

ORIGINATING ACTIVITY: Training Air Wing Six, Pensacola, FL 32508-5509 DSN 922-2305, C850-452-2305.

SCHEDULING ACTIVITY: NAS Pensacola, Pensacola, FL 32508-5217 DSN 922-4671, C850-452-2735.

HOURS OF OPERATION: 1200-0400Z++ weekdays, occasional weekends

ROUTE DESCRIPTION:

Altitude Data	Pt	Fac/Rad/Dist	Lat/Long
As assigned to Maintain 15 AGL until 7 NM NW of A	A	SJI 169/22	N30°22.00' W88°19.00'
05 AGL B 15 AGL to	B	SJI 262/12	N30°43.00' W88°36.00'
05 AGL B 15 AGL to Climb to cross and maintain 5 NM SE of D at 10 AGL	C	SJI 277/40	N30°52.00' W89°07.00'
10 AGL to descend to	D	LBY 185/13	N31°12.00' W89°23.00'
05 AGL B 15 AGL to	E	MCB 138/17	N31°05.00' W90°03.00'
05 AGL B 15 AGL to	F	MCB 076/20	N31°22.00' W89°53.00'
05 AGL B 15 AGL to	G	LBY 316/25	N31°45.00' W89°39.00'
05 AGL B 15 AGL to	H	MEI 225/32	N32°02.00' W89°17.00'
05 AGL B 15 AGL to	I	MEI 165/25	N31°58.00' W88°43.00'
05 AGL B 15 AGL to	J	MEI 167/42	N31°41.00' W88°41.00'
05 AGL B 15 AGL to	K	GCV 328/20	N31°24.00' W88°40.00'
05 AGL B 15 AGL to	L	GCV 046/11	N31°13.00' W88°19.00'
05 AGL B 15 AGL to	M	BFM 018/14	N30°50.00' W87°57.00'

ROUTE WIDTH - 1 NM either side of centerline from A to B; 2 NM either side of centerline from B to C; 5 NM either side of centerline from C to M.

FSS's Within 100 NM Radius:
DRI, GNV, GWO

Special Operating Procedures:

(1) Scheduling Activity operating hours: Mon-Fri, 0600-1600 Central Time. To schedule use on Sat, Sun, or prior to 0830L on Mon, call prior to 1600 on previous Fri.
(2) Minimum altitude on route is 500' AGL.
(3) CAUTION: High density VFR traffic from Point A to D.
(4) Alternate Entry: Points C, F, G, and H.
(5) Alternate Exit: Point G and J.
(6) Maximum airspeed 420 KTAS Mon-Fri.
(7) CAUTION: Between Point L and M, N31-08-32 W88-13-08, antenna tower 302' AGL/ 625' MSL.
(8) CAUTION: Between Point L and M, N31-00-47 W88-06-30, antenna tower 180' AGL/ 455' MSL.
(9) CAUTION: Between Point L and M, N31-04-25 W88-14-22, antenna tower 415' AGL/ 695' MSL.
(10) NOTE: Aircraft are required to transmit in the blind on 228.85 MHz their intention to transit Desota MOA prior to Point C.
(11) CAUTION: Between Point E and F, N31-13-02 W89-59-50, antenna tower 320' AGL/ 705' MSL.
(12) CAUTION: At Point D, N31-16-02 W89-21-38, antenna tower 379' AGL/ 749' MSL.
(13) CAUTION: East of Point J, N31-41-12.7 W88-37-08.1, uncharted antenna tower 340' AGL/652' MSL.
(14) CAUTION: Between Points L-M, N30-53-29.84 W88-07-14, uncharted tower 340' AGL/588' MSL.
(15) CONFLICTS: (Deconflict with the appropriate Scheduling Activity)
  (a) Crosses VR-060 at Point L.
  (b) Crosses VR-179 between Points B-C, K-L and L-M.
  (c) Same direction as VR-1021 from Points A-B. Crosses between Points L-M.
  (d) Crosses VR-1022 between Points C-D and K-L.
  (e) Same direction as VR-1023 from Points A-E.
  (f) Crosses VR-1033 between Points H-I and I-J.
  (g) Same Direction as VR-1072 from Points H-I.
  (h) Crosses VR-1083 between Points L-M.
  (i) Crosses VR-1196 between Points C-D.
  (j) Crosses IR-037 between Points D-E.
(16) Aircraft are required to contact Trent Lott Tower (KPQL) on 118.575 MHZ prior to Point A.
(17) Aircraft are required to transmit an advisory call on 255.4 MHZ 2 minutes prior to Cirtonelle.
(18) CAUTION: Between Points F and G, N31-37.9 W089-43.9, antenna tower 320' AGL/680' MSL.
(19) Overfly Mount Olive and Purvis NSAS at 1000' AGL minimum.
(20) CAUTION: High density helicopter traffic between Point H and Point I.

Figure A-5 Strip Chart - Inside Cover - Final Product

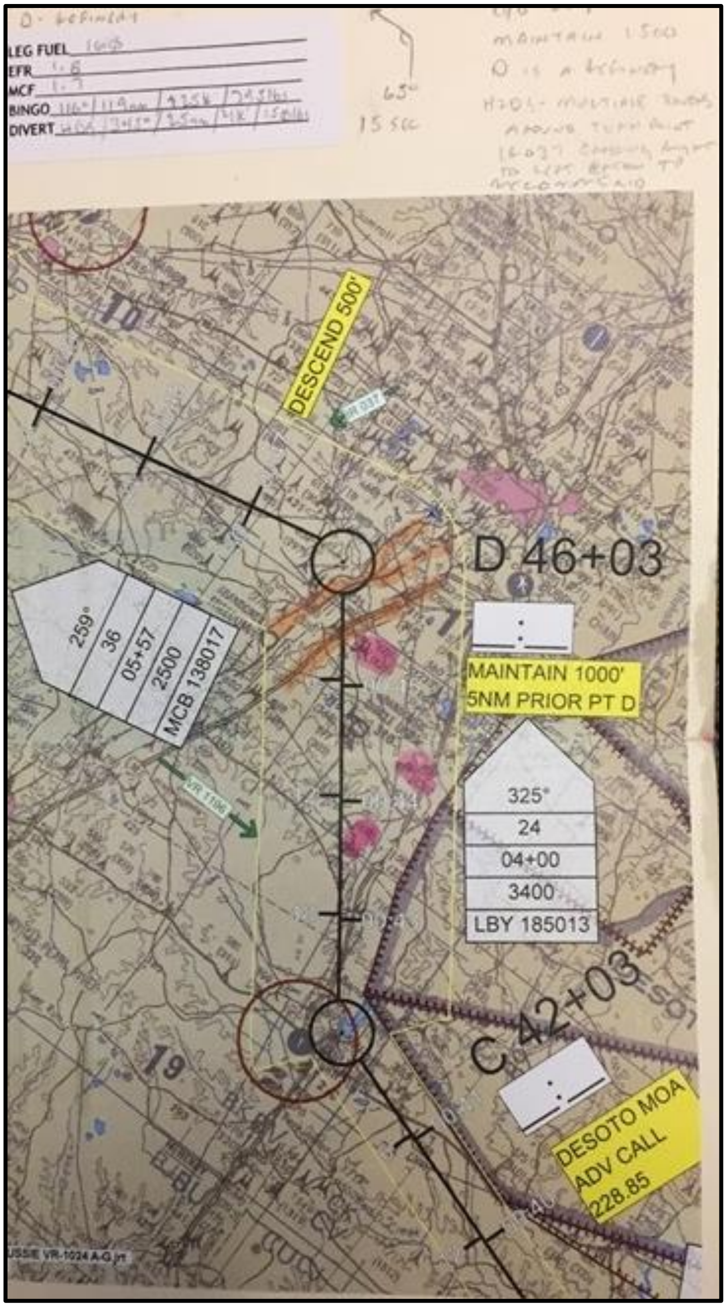


Figure A-6 Strip Chart Final Product

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 chum manual is the final word*** when updating charts. The use of such items as E-CHUM is not adequate for route planning purposes. Students shall CHUM all low- level charts within 10 NM of course.

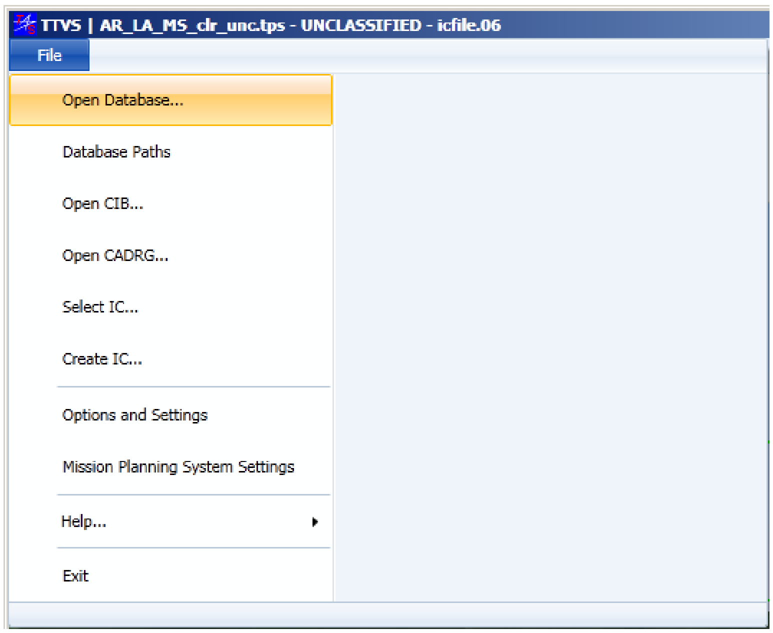
TopScene Configuration and Usage Guide

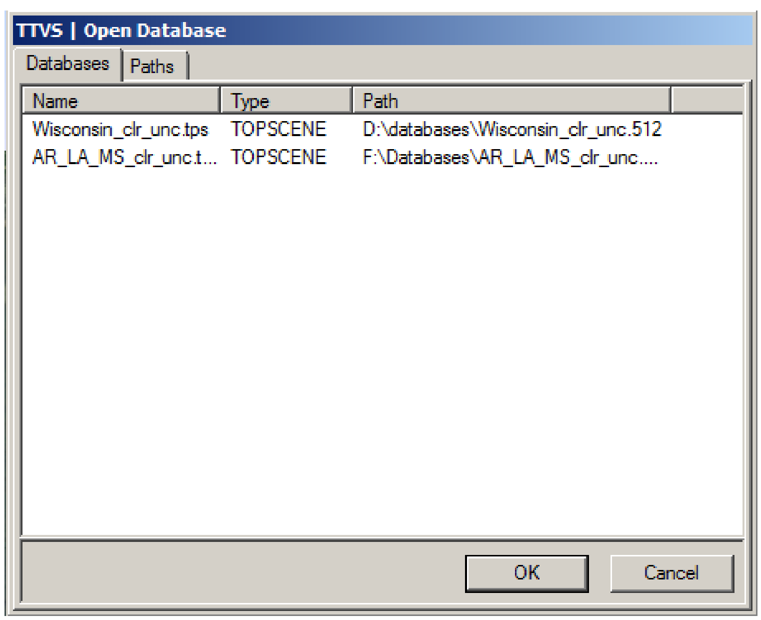
Basic Setup:

1. Open TopScene (TTVS) (JMPS will automatically open as well).

2. Open a Database (corresponds to the area for the route you want to fly).

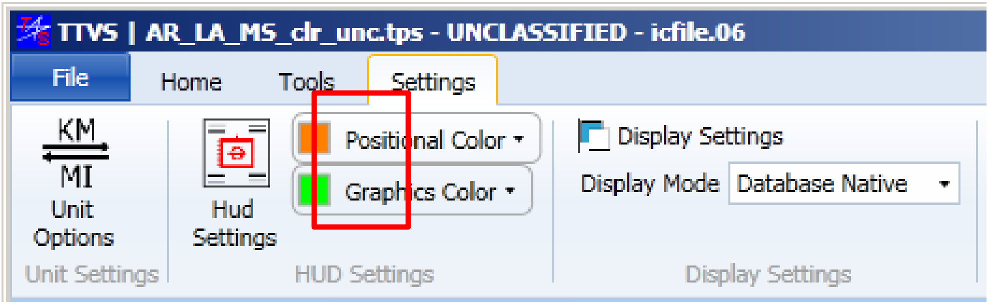
   – File→ Open Database.



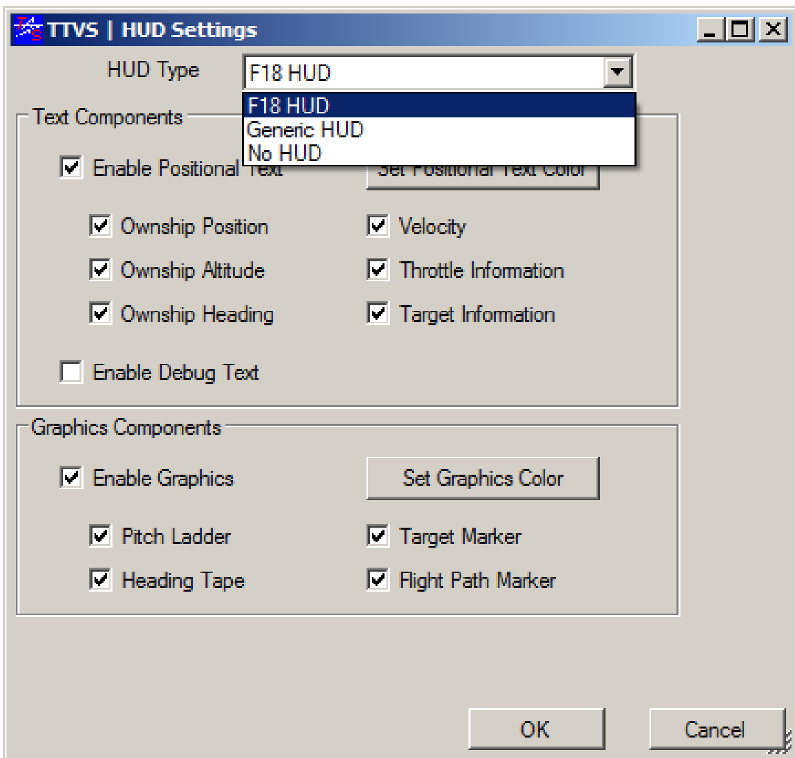


3. Setup the proper HUD.

   a. Select settings→Hud Settings.



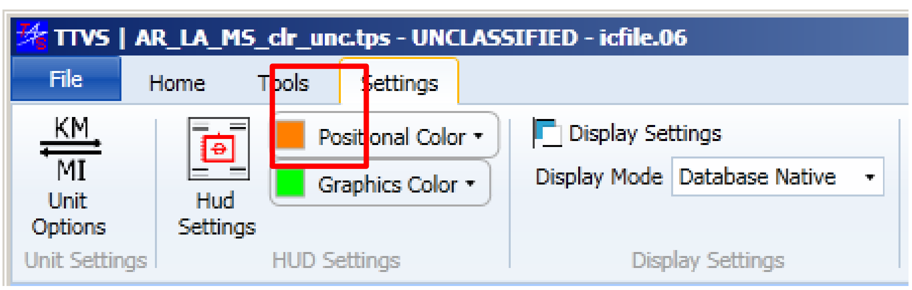
   b. Select F18 HUD.



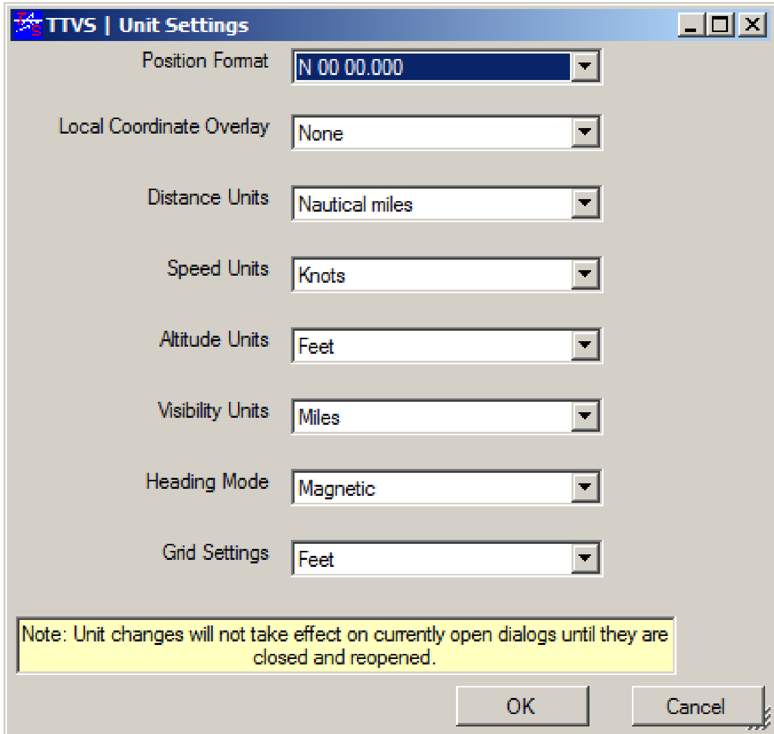
c. Select Graphics Color→ More colors.

– Change the color to bright green.

4. Set Unit Options.



– Select HH MM.MMM for your position format.



<u>How to Fly Through a Route</u>

1. Select Route Display to turn your route overlay on.

2. Select MPS Overlays to import your Route from JMPS.

3. Select route playback and hit play.

4. Adjust speed 1.0→20.0. Pause and play as necessary.

<u>How to Create an IC</u>

1. Fly along your route until you get to where you want to present your imagery (e.g., 2 NM away from your turnpoint, level flight, on route heading)

2. Select file→Create IC.

3. QA the position data (if you've flown your route to this point, it should be correct).

4. Give your IC a description that makes sense (YOURNAME_VR1021_PTA).

5. Hit Save. You must save in the default directory presented to you.

How to Open an IC

1. Select File→Open IC or select the Open IC icon at the top left.

2. You should see your user-created file at the bottom. Select the one you want to open and hit OK.

APPENDIX B
FUEL PLANNING SUPPLEMENT

1. Fuel Planning Requirements

Referencing CNAF M 3710.7, we have specific guidance for fuel requirements:

4.8.5.1 Fuel Planning

All aircraft shall carry sufficient usable fuel, considering all meteorological factors and mission requirements as computed below:

1. If alternate is not required, fuel to fly from takeoff to destination airfield, plus a reserve of 10 percent of planned fuel requirements.
2. If alternate is required, fuel to fly from takeoff to the approach fix serving destination and thence to an alternate airfield, plus a reserve of 10 percent of planned fuel requirements.
3. In no case shall the planned fuel reserve after final landing at destination or alternate airfield, if one is required, be less than that needed for 20 minutes of flight, computed as follows:
   a. Reciprocating engine-driven aircraft. Compute fuel consumption based on maximum endurance operation at normal cruise altitudes.
   b. Turbine-powered fixed-wing/tiltrotor aircraft. Compute fuel consumption based on maximum endurance operation at 10,000 feet.
   c. Turbine-powered helicopters. Compute fuel consumption based on operation at planned flight altitude.
4. Minimum fuel reserve requirements for specific model aircraft shall be contained in the appropriate NATOPS manual.

Figure B-1 Fuel Planning Requirements

Alternate planning is a topic that requires some thoughtful consideration and sound judgment. We need to understand when and why an alternate divert is required. Generally speaking, there are two scenarios that require alternate diverts. One is weather; the other is a problem at the destination airfield. Reference the following table, taken from the CNAF 3710.7, for weather divert requirements.

4.8.4.3 Alternate Airfield

An alternate airfield is required when the weather at the destination is forecast to be less than 3,000-foot ceiling and 3-statute-mile visibility during the period 1 hour before ETA until 1 hour after ETA.

Figure B-2 Alternate Airfield Requirements (1)

DESTINATION WEATHER ETA plus and minus 1 hour	ALTERNATE WEATHER ETA plus and minus 1 hour	
0 — 0 up to but not including Published minimums	3,000 — 3 or better	
Published minimums up to but not including 3,000 — 3 (single-piloted absolute minimums 200 — 1/2) (single-piloted helicopter/tiltrotor absolute minimums 200-1/4)	NON-PRECISION	PRECISION
	* Published minimums plus 300-1	* Published minimums plus 200-1/2
3,000 — 3 or better	No alternate required	
* In the case of single-piloted or other aircraft with only one operable UHF/VHF transceiver, radar approach (PAR/ASR) minimums shall not be used as the basis for selection of an alternate airfield.		

Figure B-3 Alternate Airfield Requirements (2)

This table is an excellent place to start, but we also need to consult any additional CNATRA, TRAWING, or Squadron SOP for requirements that might be more restrictive. For example, the CNATRAINSTR 3710.2V states all fixed wing flights shall have sufficient fuel to proceed to a suitable alternate regardless of destination weather if the flight does not remain in the local flying area.

Regardless of official instructions, good headwork dictates having an alternate/divert in the event an unforeseen problem arises at your planned destination. A problem at the destination airfield can be just about anything; an emergency aircraft inbound to the field delaying other arrivals, a crash on deck, arresting gear issues, unplanned runway closures, etc. Notice CNAF M 3710.7 does not provide guidance in this case; however, experience and sound judgment tell us that a variety of situations could arise that might prevent us from landing at our destination, or at least delaying landing beyond remaining fuel. Therefore, at VT-86, even if the weather is 3,000-3 or better, we are going to plan for an alternate/divert. For a VFR divert, planning from the destination airfield to the divert airfield is sufficient.

To complete the discussion on CNAF M 3710.7 Fuel Planning, we need to discuss the requirements in bullets 3 and 4. Fuel reserve requirements, as indicated by 3710.7, are 20 min at 10,000 feet MSL or 10% of required fuel, whichever is higher. This equates to between 300-400 lbs based on a fuel flow of 1100 PPH to 1200 PPH for max endurance at 10,000. The VT-86 SOP tells us what our min fuel on deck shall be in the following, (reference (a) is CNAF 3710):

a. All T-45 flights shall be planned to land with a minimum of 500 lbs of fuel remaining at the destination and within reference (a) alternate fuel requirements.

b. Minimum fuel shall be declared whenever the estimated usable fuel at the point of landing will be less than 500 lbs but equal to or greater than 400 lbs.

c. Emergency fuel shall be declared, with fuel remaining in minutes, whenever the estimated usable fuel remaining at the point of landing will be less than 400 lbs.

Figure B-4 VT-86 Sop Fuel Requirements

2. Fuel Planning Considerations

Now that we understand the requirements for fuel planning, it is time to turn those requirements into plans of action. The overall goal of fuel planning is know how much fuel you should have at any given time, how much is required to complete the mission as planned, and that you are able to adjust the mission based on fuel analysis in flight. What this conceptual understanding of fuel planning drives towards is called Mission Completion Fuel (MCF). Mission Completion Fuel is defined as the fuel required to complete the planned flight profile from start to finish and land with no less than the minimum required fuel on deck. As stated previously, all TW-6 T-45 flights shall plan to land at our alternate with no less than 400 lbs. It is your responsibility as the mission planner to develop a fuel plan that allows for completion of the mission, complies with all directives, and accounts for the weather.

3. Fuel Planning Tools and Calculations

Now that we are armed with governing instruction and guidance, and understand our role as fuel planners, we can look at the planning process and discuss the products we need to produce. To use as a reference, below you will see a generic flight profile that encompasses most flights. While not all-inclusive, it serves as a framework for the following discussion.

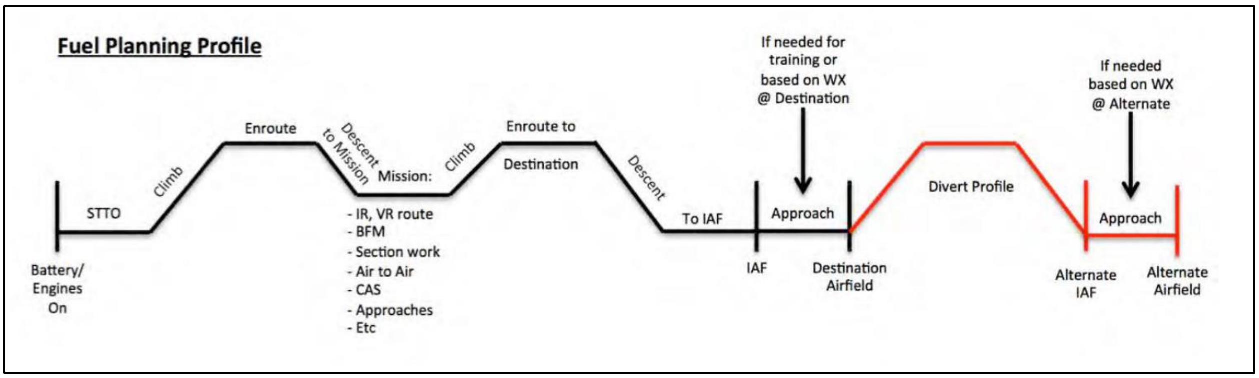


Figure B-5 Fuel Planning Profile

Jet Card - The Flight Log or jet card (Figure B-6) is the primary document used while fuel planning in the training command. While in VT-86, you are required to have a jet card completed for every Advanced Strike Stage event. It should take into account the forecasted weather for the scheduled time of flight.

FLIGHT LOG

DEP ELEV	CLNC DELIV	GND CONT	TOWER
ATIS	WIND AT ALT	TAS	LBS/HR, LBS/MIN
CLEARANCE			
DEPARTURE	TIME OFF		
DEST ELEV	APC CONT	TOWER	GND CONT

ROUTE TO	IDENT / CHAN	CUS	DIST	ETE	ETA / ATA	LEG FUEL	EFR / AFR	+/-	IAF	CRAB GS	MISC

ALTERNATE	ROUTE	ALTITUDE	FUEL	TIME
ALT ELEV	APC CONT	TOWER	GND CONT	

CNATRA-GEN 3760/14 (Rev 2-03) S/N 0197LLCF23761 (OVER)

FLIGHT LOG

FUEL PLAN

1. CLIMB/ROUTE DEST IAF ________
2. ROUTE ALT IAF (If required) ________
3. APPROACHES ________
4. TOTAL (1, 2, & 3) ________
5. RES 10% OF 4 (Min 20 mins) ________
6. START/TAXI ________
7. TOTAL REQUIRED (4, 5, & 6) ________
8. TOTAL ABOARD ________
9. SPARE FUEL (8-7) ________

EMERGENCY "BINGO" TO ALTERNATE

	REQUIRED		APPROACH		RES		TOTAL
LAST CRUISING ALT	____	+	____	+	____	=	____ (MCF)
INITIAL APP ALT	____	+	____	+	____	=	____
BINGO	↗ ____	→	____	↘	____	=	____

CHECK LIST	DESTINATION	ALTERNATE	EMER FIELDS
RWY LENGTH			
LIGHTING			ID
FUEL/JASU/LOX			CH
ATIS			PAGE NO.
METRO			
RAPCON			
PAR MINS			
TAC MINS			
ARR GEAR			
PUBS			
NOTAMS			
FUEL PACKET			
FLASHLIGHT WALLET, ETC.			

CNATRA-GEN 3760/14 (Rev 2-03) S/N 0197LLCF23761 (BACK)

Figure B-6 CNATRA Jet Card

Front of the jet card - Plan from takeoff to planned destination airfield to determine fuel required. Do not include start, taxi, or approaches, as they will be accounted for on the back of the card. Do include the fuel required to fly your VR or IR route as a single line with total time and fuel required.

Your primary resource for fuel planning while at VT-86 will be JMPS. Inherent in the JMPS software is a feature to print out your jet log with the JMPS calculated fuel burn and fuel remaining at each point along your route, both to the destination and alternate. If JMPS fuel planning is used, as is expected at VT-86, then the appropriate form shall be printed and brought to the brief in place of the manually calculated jet log.

To print this form from a JMPS machine do the following:

a. In the "File" dropdown menu select "Forms."

b. Select the appropriate form from the ones displayed and ensure the correct route is checked in the box on the right.

   – If the appropriate form is not an option, click "Add" and select from the root folder.

c. Click "Downgrade" and ensure that "Suppress Classification on Printouts" is selected.

d. Click "Display Form."

– This process will take a few seconds and will result in a JMPS generated Excel file in the format of a knee board card (KBC).

e. Highlight only the left side of the KBC

Select print and ensure that "Print Selection" is boxed, otherwise the blank right half of the KBC will be printed, thereby wasting note taking space.

Back of the jet card - Determine your spare fuel by filling out the top section of the fuel plan 1-9:

4. Fuel Plan

a. Total plan from front of jet card

b. Fuel required traveling from the MAP at the destination to either the furthest IAF at the alternate if an approach is required at the alternate or to the alternate airfield if an approach at the alternate is not required. Planned routing should avoid MOAs, Restricted Areas, etc.

c. 250 lbs per approach if an approach is required for weather*

d. Total of 1 + 2 + 3

e. Plan for 400 lbs per TW-6 SOP of minimum fuel on deck at alternate

f. 200 lbs for STTO

g. Total of 4 + 5 + 6

h. Total fuel on board per NATOPS. 2,900 lbs.

i. Subtract 8 – 7 to determine spare fuel

Practice approaches can be conducted at the instructor's discretion if sufficient fuel remains.
****Practice approaches should not be accounted for in MCF.***

The Emergency 'Bingo' to Alternate section of the card is not required to be completed. If an Emergency "Bingo" scenario is encountered airborne, refer to the T-45 PCL, pg. E.89, "blue pages."

NOTE

VT-86 does not use the "LAST CRUISING ALT" equation to determine MCF. MCF calculations are covered in the next section.

5. Spare Fuel & MCF

If you have planned your fuels correctly, line 9 is your spare fuel. If line 9 is less than 0, then the fuel required to fly the mission is more than the aircraft can carry and therefore not possible as planned. MCF can be determined at any point along the entire route of flight by simply subtracting spare fuel from the estimated fuel remaining. If you have done this correctly the following will be true:

1. MCF at engine start should be total fuel on board, 2,900 lbs, minus spare fuel.

2. MCF at the entry point will be EFR at the entry point minus spare fuel.

3. The MCF at the exit point will be the same as the EFR from the jet card after completing the route minus spare fuel.

4. Divert fuel plus spare fuel should equal Planned Fuel on Deck (PFOD).

Actual performance will vary with prevailing temperature, winds, drag index and varying gross weight.

For initial planning only.

Total usable fuel (JP-8/JET A+)	2,861 lbs
Start/Taxi/Take off	200
Penetration	200
GCA	250
Reserve (20 min @ 10,000 ft MSL)	300

Low level (360 KGS @ 12K GW=6.6 LB/NM=2,375 PPH//300 KGS=5.0 LB/NM=1,500 PPH)

JP-4 = 6.5 LB/GAL JP-5 = 6.8 LB/GAL JP-8 (JET A+) = 6.7 LB/GAL

Climb Out (13K GW, 250 KIAS to 10K, 300 KIAS to .75 IMN)

Altitude	KIAS	NM	Time	Fuel Used (lbs)
5,000	250	04	0+01	60
10,000	250	08	0+02	110
15,000	300	14	0+03	180
20,000	300	22	0+04	240
25,000	300	32	0+05	320
30,000	283/.75	44	0+07	380
35,000	253/.75	60	0+09	460
40,000	225/.75	91	0+13	570

En route (Optimum Cruise @ 12K GW)

Altitude	#/NM	IMN	CAS	#/HR	TAS
5,000	4.76	.38	230	1,195	250
10,000	4.35	.42	230	1,138	262
15,000	3.88	.46	230	1,102	282
20,000	3.42	.51	230	1,073	310
25,000	3.09	.56	230	1,055	340
30,000	2.82	.61	230	1,047	370
35,000	2.58	.68	230	997	380

Normal descent (12K GW IDLE W/SPD BRAKES IN)

Altitude	IAS	NM	Time	Fuel Used (lbs)
5,000	250	10	2+30	19
10,000	250	20	4+30	36
15,000	250	31	6+30	57
20,000	250	41	8+30	66
25,000	250	52	10+30	79
30,000	250	64	12+15	90
35,000	235	74	14+00	100
40,000	209	84	15+30	108

Figure B-7 T-45C General Fuel Burn Rates

All of these statements should be true for your fuel plan.

If they are not, you have made a mistake somewhere. A typical mistake is planning everything out the night before, but then checking the weather in the morning and including an approach at your alternate because forecast weather at the alternate is now IMC not VMC, and not including that 250 lbs in the MCF calculation. If done correctly, your fuel plan on all your products should work. In other words, both sides of the jet card, fuels on the briefing board, and the fuels in your chart should match.

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APPENDIX C
ATTACK DIAGRAMS AND CHECKLIST

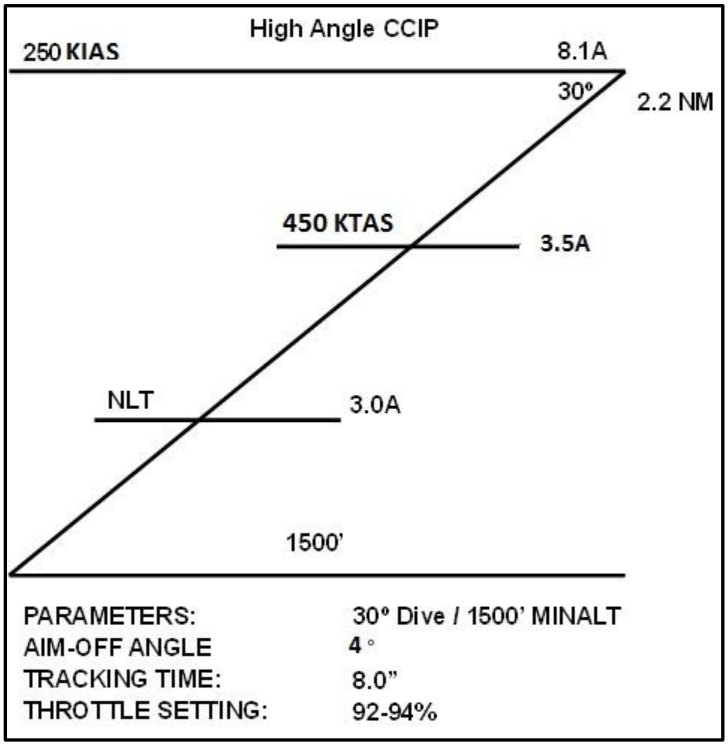

Figure C-1 High Angle (30°) CCIP Z-Diagram

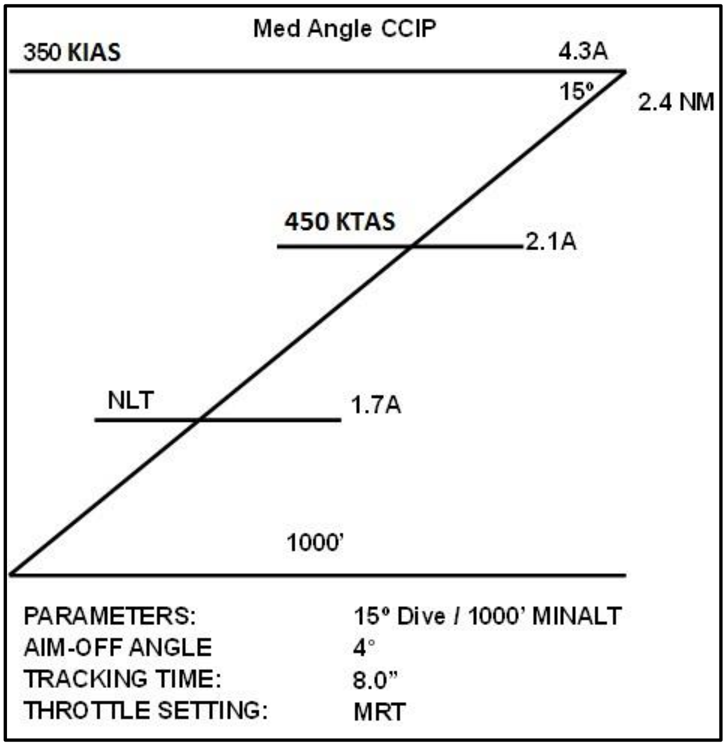

Figure C-2 Medium Angle (15°) CCIP Z-Diagram

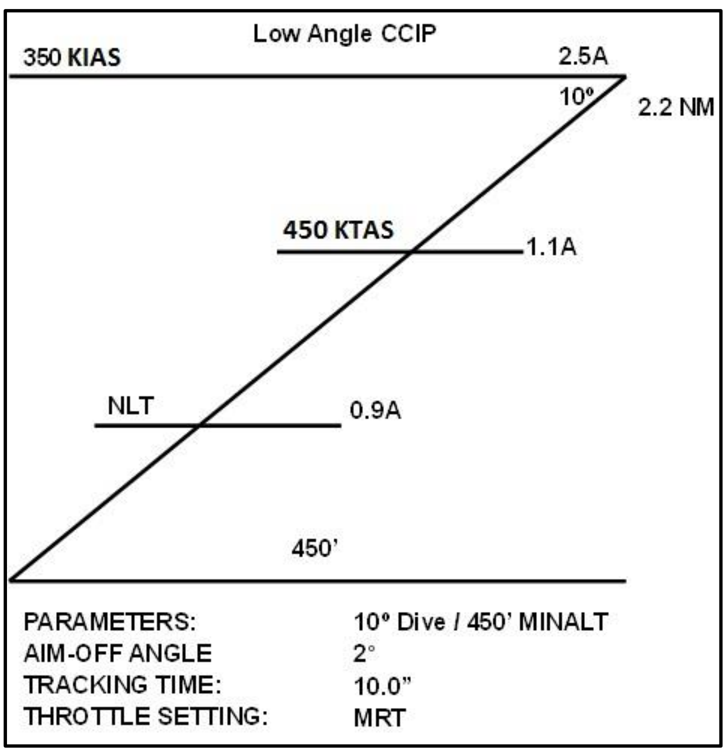

Figure C-3 Low Angle (10°) CCIP Z-Diagram

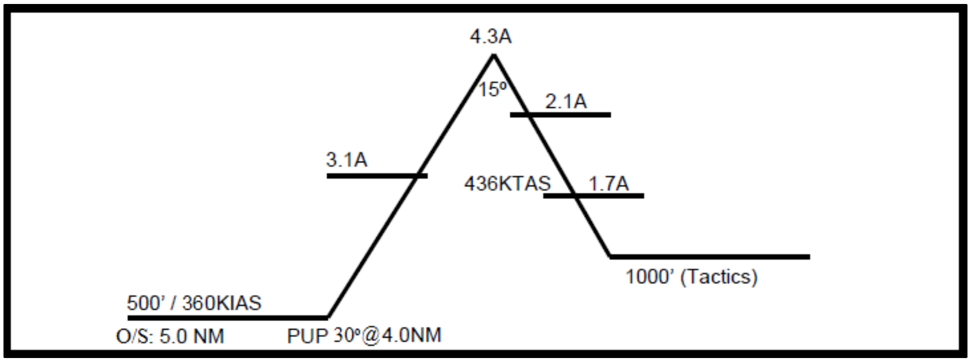

Figure C-4 Medium Angle Pop Z-Diagram

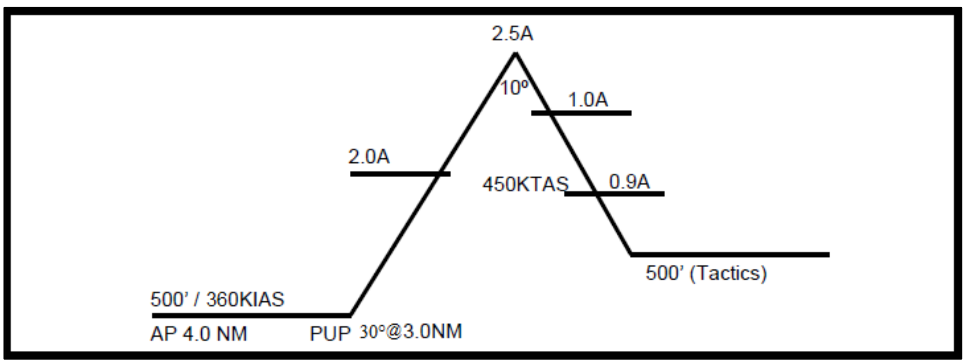

Figure C-5 Low Angle Pop Z-Diagram

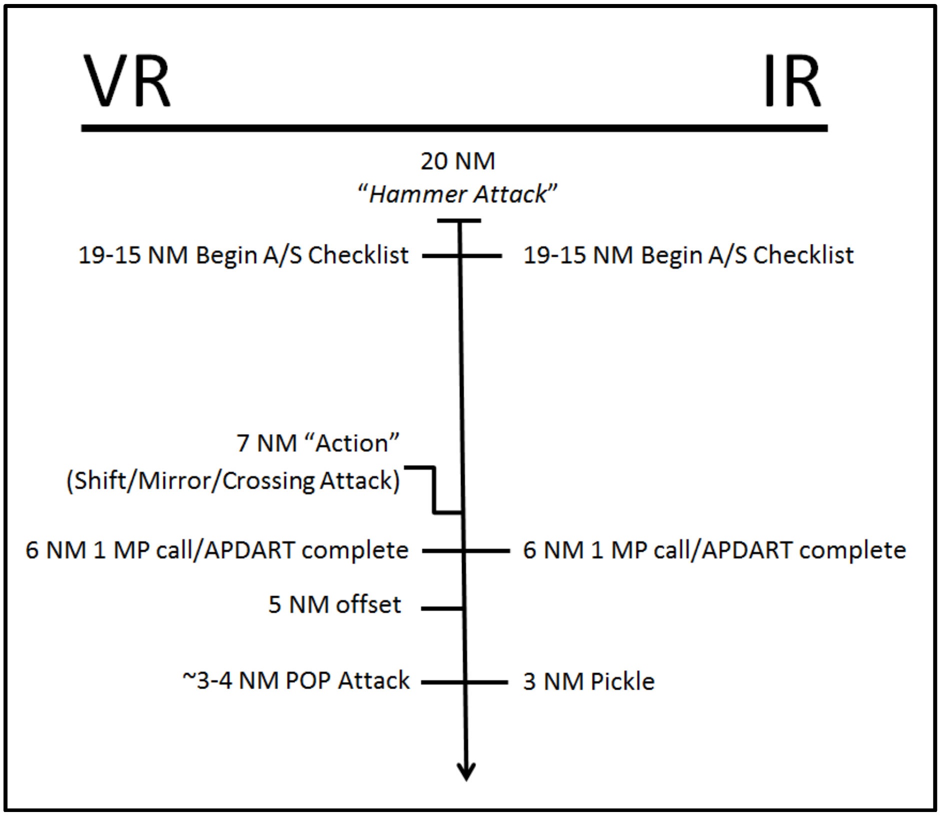

Figure C-6 A/S Timeline

6. APDART (A/S Checklist)

A A/G Mode – Selected

P Program Selected

- CCIP Delivery Mode
- Target height entered
- Ordnance selected

D Designate/Select – Target Waypoint

A Master Arm – ARM

R RADALT – SET for the planned delivery

T Tapes – ON