FLIGHT TRAINING INSTRUCTION

TACTICAL FORMATION T-45 STRIKE

2023

DEPARTMENT OF THE NAVY
CHIEF OF NAVAL AIR TRAINING
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Subj: FLIGHT TRAINING INSTRUCTION, TACTICAL FORMATION T-45 STRIKE

1. CNATRA P-1288 (Rev. 01-23) PAT, "Flight Training Instruction, Tactical Formation T-45 STRIKE" is issued for information, standardization of instruction, and guidance to all flight instructors and student military aviators in the Naval Air Training Command.

2. This publication is an explanatory aid to the T-45 STRIKE curriculum and shall be the authority for the execution of all flight procedures and maneuvers herein contained.

3. Recommendations for changes should be submitted via the electronic TCR form on the CNATRA Web site.

4. CNATRA P-1288 (Rev. 05-20) PAT is hereby cancelled and superseded.

A. P. RYBAR
By direction

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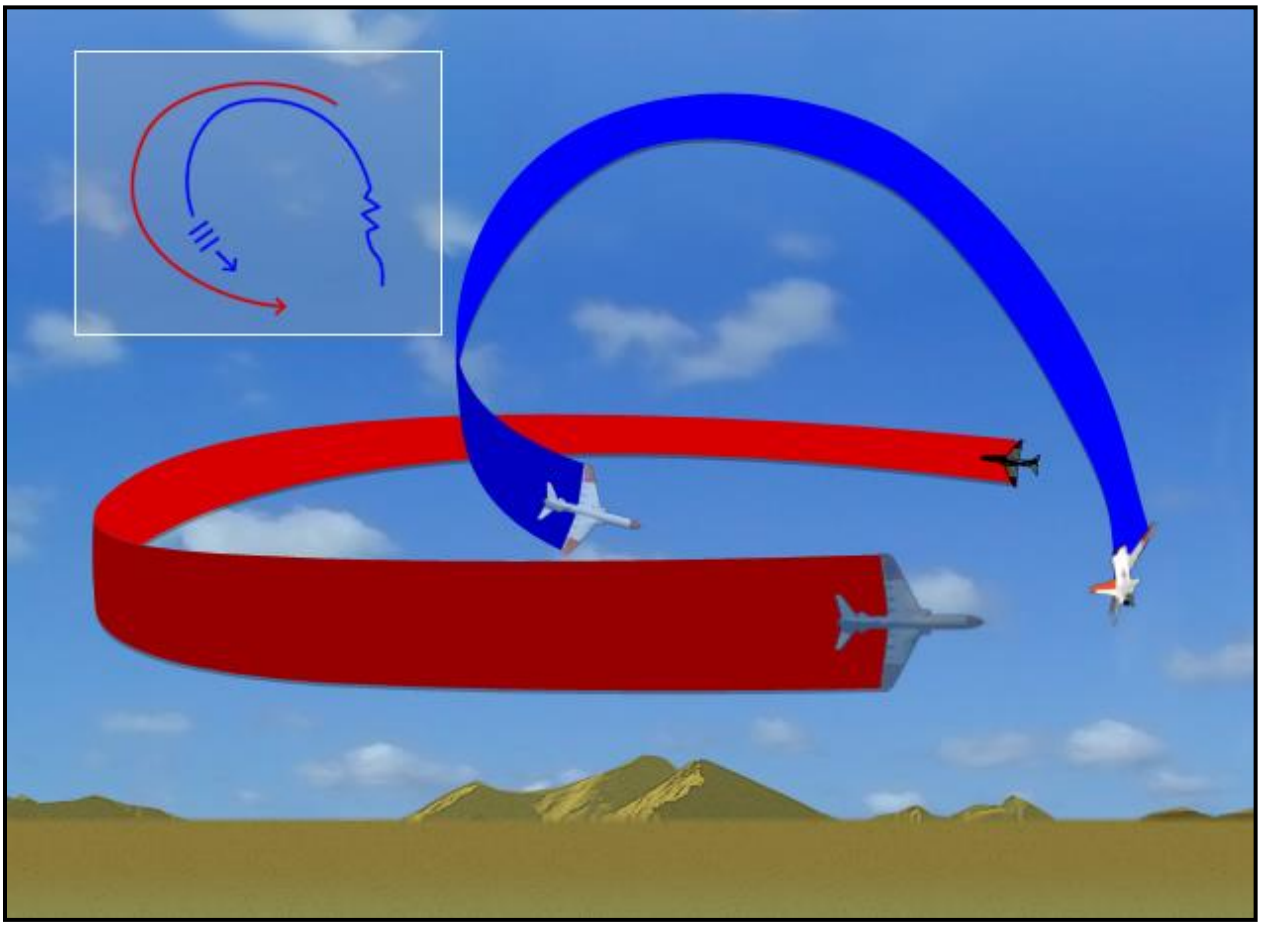
FLIGHT TRAINING INSTRUCTION

FOR

TACTICAL FORMATION

T-45



HOW TO USE THIS FTI

This Flight Training Instruction (FTI) is your textbook for the Tactical Formation (TAC FORM) stage of your Jet Pilot Training and is the source document for all procedures related to TAC FORM. It includes suggested techniques for performing each maneuver and making corrections.

This FTI focuses on three major areas relating to your TAC FORM flights: background knowledge, specific briefing items, and flight procedures. Read and understand your NATOPS and the CONCEPTS & DEFINITIONS (C&D) portion of this FTI prior to studying the follow-on sections related to flight procedures. In general this FTI is laid out in a manner that will roughly outline a TAC FORM flight brief in a building block approach. ***It is imperative that you reference the current TACSOP for additional guidance while studying this FTI.***

Use your FTI to prepare for and to review following the Lecture and CAI lessons, as well as syllabus flights. Know all of the procedures ahead of time so you will be prepared to ask questions of your instructors in the brief. This will allow you to focus on where the real learning will take place: in the jet!

Note that this FTI also contains information on emergencies related to this stage. This section of the FTI amplifies but does not replace NATOPS. The end of stage exam will be based on course objectives. Complete the required reading prior to each lesson or lecture.

LIST OF EFFECTIVE PAGES

Dates of issue for original and changed pages are:
Original. . . . 10 Oct 08 (this will be the date issued)
Revision 1…10 Aug 09
Revision 2…09 Nov 12
Change 1…03 Aug 17
Revision 3…11 May 20
Revision 4…23 Jan 23

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 74 CONSISTING OF THE FOLLOWING:

Page No.	**Change No.**	**Page No.**	**Change No**
COVER	0		
LETTER	0		
iii – x	0		
1-1 – 1-17	0		
1-18 (blank)	0		
2-1	0		
2-2 (blank)	0		
3-1 – 3-6	0		
4-1 – 4-4	0		
5-1 – 5-11	0		
5-12 (blank)	0		
6-1 – 6-9	0		
6-10 (blank)	0		
7-1 – 7-8	0		
8-1 – 8-2	0		
A-1 – A-2	0		

INTERIM CHANGE SUMMARY

The following Changes have been previously incorporated in this manual:

CHANGE NUMBER	REMARKS/PURPOSE

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

INTERIM CHANGE NUMBER	REMARKS/PURPOSE	ENTERED BY	DATE

TABLE OF CONTENTS

TABLE OF FIGURES

CHAPTER ONE
TACTICAL FORMATION

100. INTRODUCTION

The Navy's tactical doctrine for aerial combat has at its heart a section of fighters operating in Combat Spread. This FTI will attempt to teach you the basics of TAC FORM flying, which is fundamentally how sections maneuver while in Combat Spread. The procedures in these pages will give you fundamentals of how to maneuver the aircraft. Each TAC FORM instructor might have slightly different techniques for keeping position or making corrections. You should draw from their experience and techniques to find what works for you. The FTI is a starting point and you should strive to know it to the maximum extent possible. You will gain more knowledge about TAC FORM from the instructors you fly with than can be written in any FTI.

101. CONCEPTS AND DEFINITIONS

Communications

As in basic formation flights, an ATC call sign will be used for ATC purposes. As a reminder, use Lead's call sign if talking with ATC regardless of who is in the lead. Use your actual call sign (side number) when talking with Tower. Intra flight communications become a little more 'fleet style' at this stage of training, and Wing will be expected to keep up. To start with, all acknowledgements of Lead's comm will reference your full tactical call sign (e.g., "Hammer 12"). In close formation, Lead may back up frequency switches with hand signals or simply look to Wing for a head nod affirming that he/she heard Lead transmitting on the new frequency.

Environmentals

All flight members shall assess and record the environmentals (sun azimuth and elevation, cloud decks in operating area, and winds at altitude in operating area). These should be drawn on the white board post flight by the student in preparation for debrief.

Fighter

The term "Fighter" in this FTI refers to either aircraft that is a member of the friendly section.

Flight Lead, Wingman and their Responsibilities

The Flight Lead (or simply "Lead") is the Fighter responsible for all navigation, external comm, and mission/training objectives, and is the default for all tactical decisions. The Wingman ("Wing") is responsible for ***maintaining sight*** and ***staying in position***. Both Fighters are responsible for good lookout doctrine, internal communications, and flight safety.

Bandit

The term Bandit refers to a threat that may or may not be employing maneuvers and/or weapons in a hostile manner.

Bogey

A Bogey is an unidentified aircraft, or an aircraft of known type but unknown origin.

Shorthand Symbology

The figures in this FTI use shorthand symbology which is common to all air-to-air engagements, and will be utilized in your follow-on Basic Fighter Maneuvering (BFM) training. The horizontal tick marks represent a descent, and the zig-zag "peaks" represent a climb. The number of marks represent the magnitude of descent or climb. Each line or peak represents approximately 20 degrees of nose position.

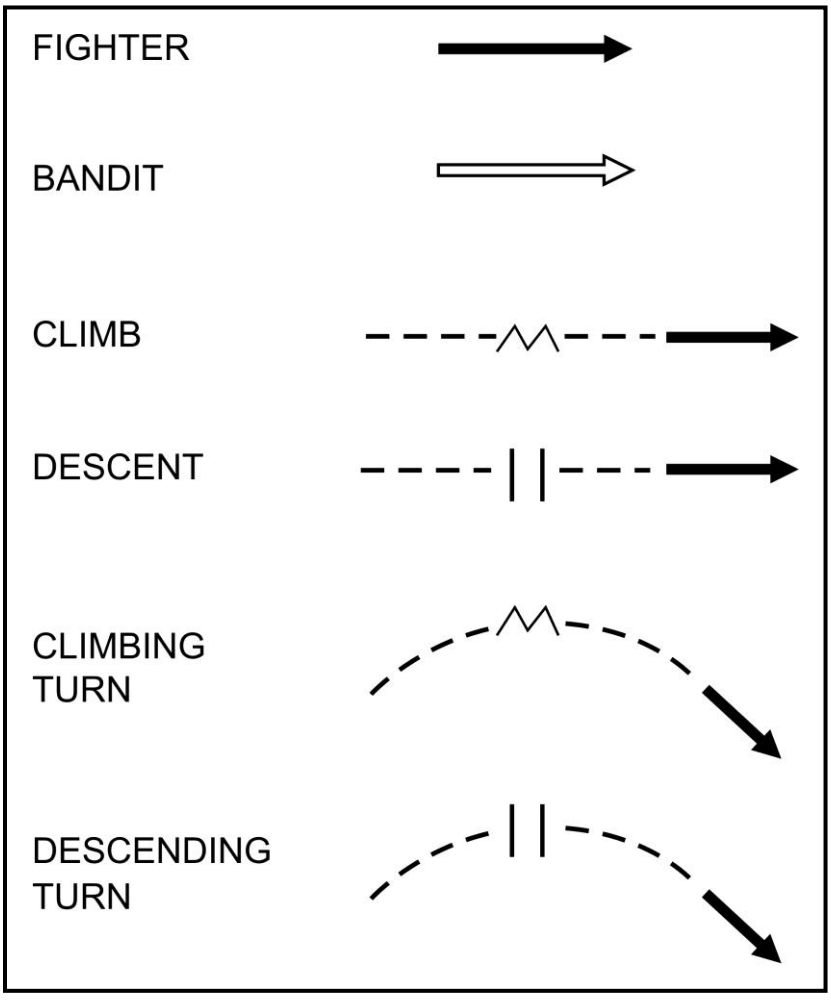


Figure 1-1 Shorthand Symbology

Combat Spread

Combat Spread enables a section to maintain a high degree of maneuverability while also preserving a high degree of visual mutual support. Wing will fly on Lead's 90-degree bearing line (abeam or 3/9 line) at a distance of .8 to 1.0 nm, and 1,000 ft above or below Lead's altitude at 300 KIAS. Lead will typically brief 15,000 ft for Lead, and 16,000 ft for Wing during your syllabus TAC FORM flights. The two Fighters are spaced far enough abeam to still be maneuverable, but allowing aircrew the ability to devote more time to cockpit tasks and visual lookout. Realize that although Wing may fly a stepped-up position in training here, the option to fly stepped down may be used due to environmentals and various other reasons.

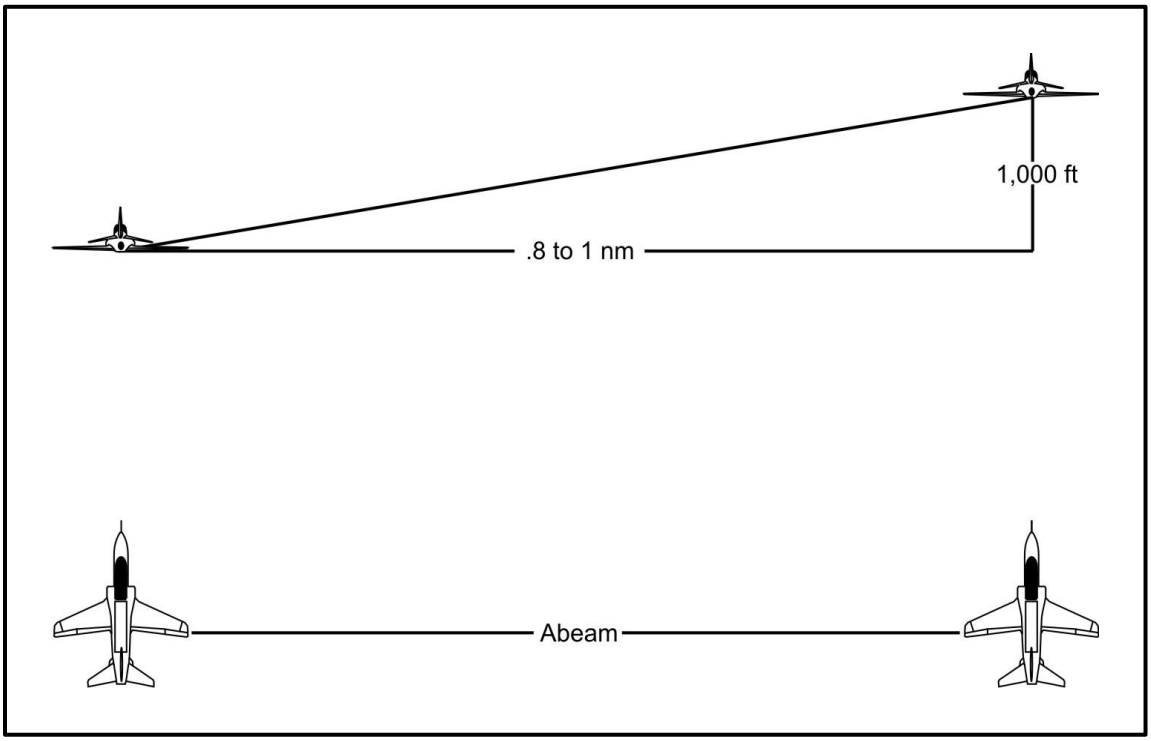


Figure 1-2 Combat Spread

"Visual/Tally" and "Blind/No Joy"

'Visual' and 'Blind' refer to whether or not you can see a friendly aircraft. 'Tally' and 'No Joy' mean the same thing respectively, but are applied to bandits or bogeys.

Lookout Doctrine

An effective lookout doctrine is the cornerstone of mutual support, requiring each pilot to develop and employ a thorough visual scan pattern inside and outside of the cockpit. Coordinated scan patterns between Lead and Wing in Combat Spread ensure maximum visual coverage, while allowing sufficient reaction time to engage a threat. The threshold of visual detection depends on numerous factors such as aspect, environmental conditions, etc. Starting with your eyeball as your primary sensor (in the T-45 anyway), focus on a distant point (cloud

formation, terrain feature, etc.) to give your eyes a depth of vision from one mile out to infinity. This technique greatly aids in detection of potential threats at distance before they get close enough to become a factor.

Lead and Wing's primary scan region starts 30 degrees outside of the formation, sweeping through the formation to the aft visual limit for roughly 75% of the time. Visual search beyond 30 degrees outside the formation is a secondary responsibility for both Lead and Wing, and requires the pilot's attention roughly 25% of the time. Don't limit this scan to just the horizon, but include scans both above and below the horizon such that the combined scan of both Fighters covers as much of the 3-dimensional airspace surrounding the section as possible. Finally, be disciplined with your scan pattern because searching random points in the sky tends to result in poor detection rates.

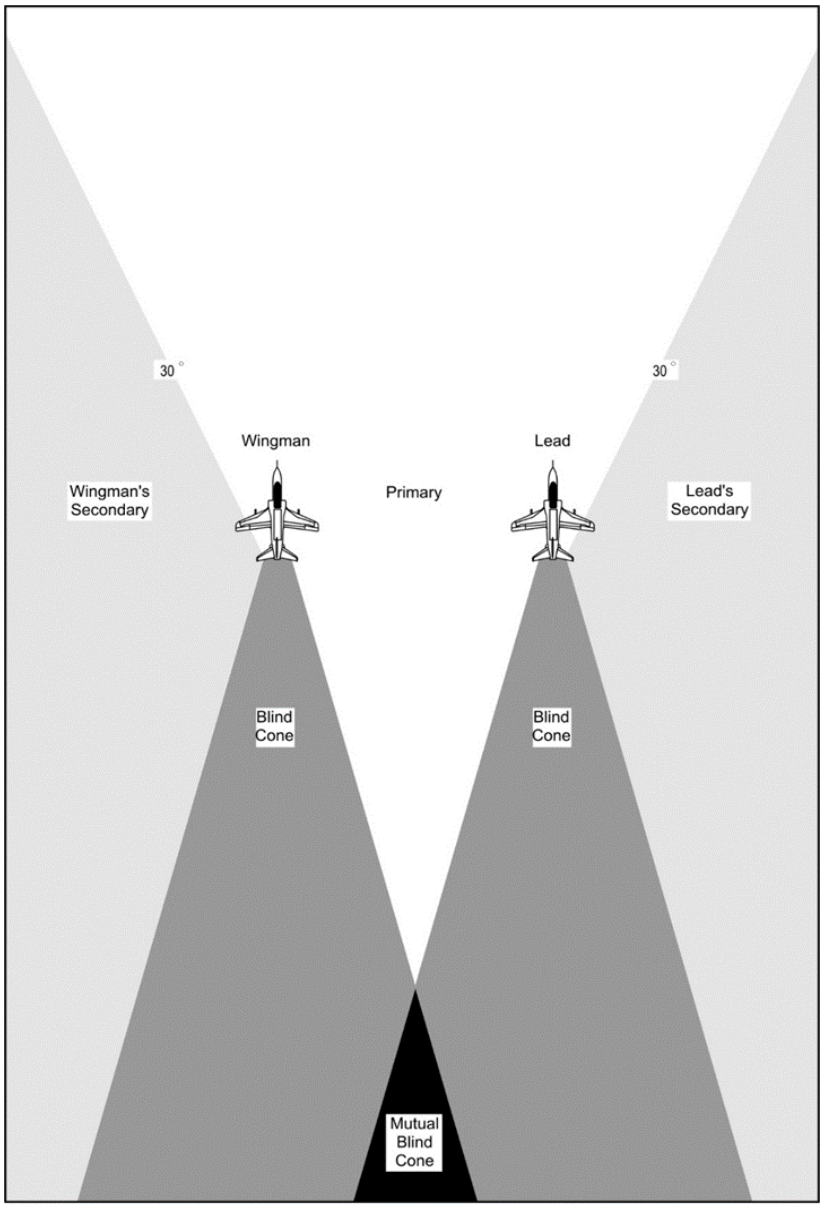


Figure 1-3 Lookout Responsibilities

Directly behind each Fighter is a small unseen area (to that specific pilot) referred to as the 'blind cone'; we are in section so that each Fighter's scan includes the other Fighter's blind cone, so as to cover each other's 'six-o'clock.' This scan pattern does however, result in a mutual blind area formed at the intersection of each aircraft's visual limit, between 1.5 and 2 nm astern, in between the section, depending on lateral separation between Fighter aircraft.

As the above discussion goes to mutual support via your eyeballs, good lookout doctrine doesn't do any good if members of the flight are not ***communicating*** what they see or do not see. You will use clock codes and degrees above or below the horizon when referencing other aircraft. By practicing making these calls, it will come easier in the jet when your brain is task saturated.

Engaging Turns

An Engaging Turn is an energy-sustaining turn performed at 14 units AOA, 300 KIAS, and is the most common turn you will use during TAC FORM. It allows the section to be maneuvered quickly without a large energy penalty so as to maintain airspeed while conserving fuel.

Hard Turns

A Hard Turn is a compromise between turn performance and energy depletion. Hard turns are flown at 17 units AOA (nibble of buffet), and 300 KIAS, and are used when the section is not defensive, but desires to expeditiously orient itself to a threat.

Break Turns

A Break Turn is a maximum performance turn executed at 19-21 units AOA (roughly the maximum lift a T-45 can generate), but not to exceed 7.33 Gs (T-45 G-limit above 5,000 ft). A break turn gives the best instantaneous turn performance, but at a large energy penalty. A break turn may be used offensively to gain a shot opportunity, or defensively to defeat an incoming missile or a Bandit's firing solution. It is important to note: max-performing the aircraft does NOT mean to use erratic or jerky aircraft control inputs. You will probably encounter pitch buck in the T-45; if so, ease off the G a little bit, and then smoothly reapply G as required until within the rate airspeed band.

Significant Airspeeds

The T-45's Best Sustained Turn Rate Airspeed Band is 240-330 KIAS. At the lower end of the rate band the aircraft yields a small advantage in turn rate (0.5° higher at 240 KIAS, compared to 330 KIAS). The T-45's ability to trade airspeed for angles (energy excursion) is however reduced below 300 KIAS; at slower airspeeds the aircraft becomes more difficult to handle as it is more prone to stall/pitch buck. ***Initially, targeting the upper portion of the rate band (300-330 KIAS), until an energy excursion is necessary, is prudent in most cases.***

Corner Airspeed is 410 KIAS. This airspeed yields the aircraft's best instantaneous turn performance, but also sustains the highest airspeed bleed rates.

Engaged Fighter

The Engaged Fighter is either the ***most defensive*** or the ***most offensive*** Fighter, in that order. If you are about to get shot, you are, by default, engaged defensively. If you find yourself within visual range with a valid shot on a Bandit, or are maneuvering for a shot and no other Fighter is engaged defensively with that Bandit, you are engaged offensively. Anyone in the flight can designate the engaged role (including the Bandit) based upon who is attempting to be engaged.

Free Fighter

The Free Fighter is the Fighter that is not engaged and, having achieved separation from the Engaged Fighter, is responsible for flight de-confliction.

Lift Vector

The Lift Vector is an imaginary line that extends upward (relative to your body), and perpendicular to the plane of your wings, regardless of pitch or roll angle. In the T-45, the lift vector is visualized by looking straight up between the canopy MDC cords. If you roll inverted your lift vector would be pointing toward the ground. In a pure vertical climb, your lift vector would be on the horizon.

Angle-Off-Tail (AOT)

Angle-Off-Tail is a descriptive position relative to an aircraft's longitudinal axis, with 0 degrees being directly behind the aircraft's tail, and 180 degrees being directly ahead of the aircraft's nose. Intermediate angles between 0 and 180 degrees are not specific to just the top, bottom, or sides of an aircraft; any AOT can be described at any one point around an aircraft that lies on a cone of that angle.

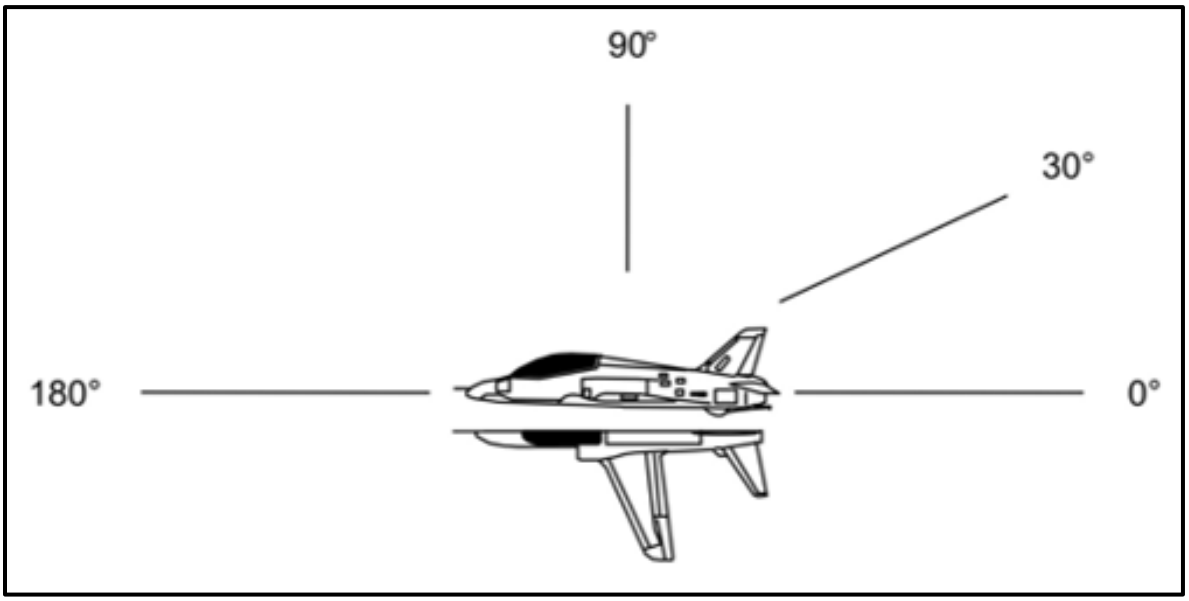


Figure 1-4 Angle-Off-Tail (AOT)

Aspect

Aspect quantifies (in general terms) where your aircraft is positioned relative to another aircraft, such as the Bandit, and is generally defined by three separate ranges of AOT with respect to the other aircraft. Low aspect arises when you are looking, more or less, at another aircraft's tail (0-45 deg AOT); medium aspect as we approach the other aircraft's planform or wing line (45-90 deg AOT); and high aspect is forward of the other aircraft's planform or wing line (90-180 deg AOT). Aspect change describes how an object appears to pivot in our canopy.

Line of Sight (LOS)

Line of sight is just what it sounds like. It's the line from a pilot's eyeball to something that he/she may be looking at. 'LOS rate' describes how an object appears to move across your canopy.

Closure

Closure is the rate at which separation between two aircraft is decreasing. A negative closure would describe a separation that is increasing, or opening.

Pursuit Geometry

The concept of pursuit geometry between attacker and defender is basic to every tactical maneuver. The type of pursuit can be determined by the attacker's nose position when in the same plane of motion as the defender, and lift vector placement when not in the same plane of motion. There are three basic types of pursuit:

1. Lead pursuit: used to decrease nose-to-tail separation, or solve for a gun solution, often at the cost of generating high AOT and closure.

2. Pure pursuit: used primarily to gain an IR missile lock. Pure pursuit is achieved by putting your nose (velocity vector) right on the bandit. While not as rapid as lead pursuit, pure pursuit can be used to close nose-to-tail distance if the pursuing fighter is at least co-airspeed with the bandit.

3. Lag pursuit: used to maintain or increase nose-to-tail separation. Lag pursuit allows the Fighter to maintain his/her energy while keeping AOT and closure under control.

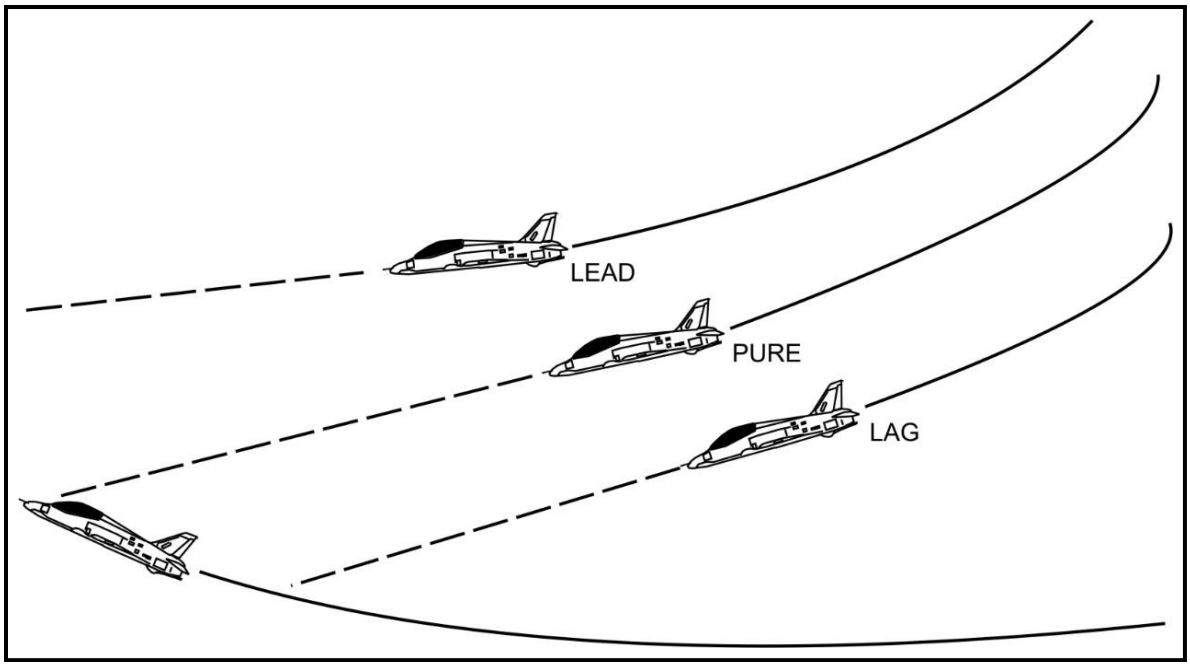


Figure 1-5 Pursuit Curves In-Plane

We can expand the concept of pursuit geometry from the two-dimensional discussion above, to three dimensions. For example, an attacker that is flying in a different plane of motion can orient the ***lift vector*** ahead of, on, or behind a defender to achieve many of the same goals as would be achieved with nose position if flying in the same plane of motion.

Turn Circle

A Turn Circle is an imaginary two-dimensional circle that an aircraft is scribing through the sky, defined by the aircraft's performance parameters at any instance in time. In a horizontal turn, the turn circle is, more or less, just a circle. In the vertical plane, such as an aircraft in a constant-G loop, gravity will shrink an aircraft's turn radius at the top and widen its turn radius at the bottom.

Bubble

The Bubble is a three-dimensional representation of an aircraft's turn circle in a max performance turn. The Bubble should not be confused with the 500 ft bubble that Wing needs to maintain from Lead at all times during dynamic maneuvering. The average Bubble of the T-45 is represented by a circle with a radius of 3,000 ft. You will draw it on the white board prior to your brief along with the Attack Window (AW), Control Zone, Post, and the Bandit.

Post

The Post is the center point of a turn circle. This is the same post we encounter during a TACAN rendezvous, but is not restricted to turn circles in the horizontal plane. The Post does

not define pursuit curves, but is used in the discussion of the Bubble, Attack Window Entry (AWE), etc.

Control Zone (CZ)

The Control Zone is a truncated cone extending from 2000 ft to 4000 ft behind the defending aircraft, and along its flight path. The volume is defined along this length expanding from 20 degrees wide at the front, to 40 degrees wide at the back. The practical application of the Control Zone is such that should an attacking aircraft arrive within a defending aircraft's Control Zone, ***with range, angles and closure under control***, the defending aircraft has little chance of forcing the attacking aircraft out of the Control Zone.

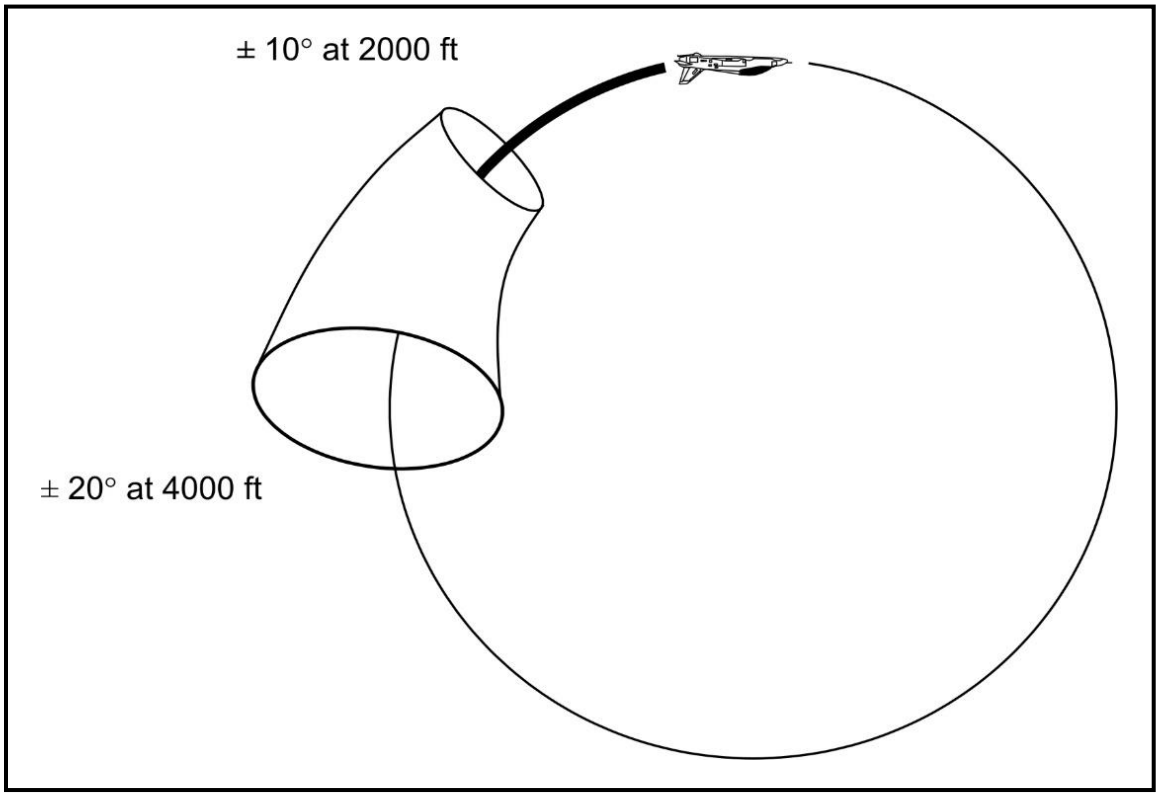


Figure 1-6 Control Zone

Attack Window

The Attack Window is the point in the sky where, if an attacking aircraft executes a max performance turn, it will arrive in the defensive aircraft's Control Zone (with the aforementioned range, angles, and closure under control). ***The most useful cue for the Attack Window Entry is a sudden decrease in the Bandit's aspect change, accompanied by a sudden increase in the Bandit's LOS rate.*** In practical terms, the Bandit's aircraft appears to stop pivoting and begins to rapidly move aft in your canopy.

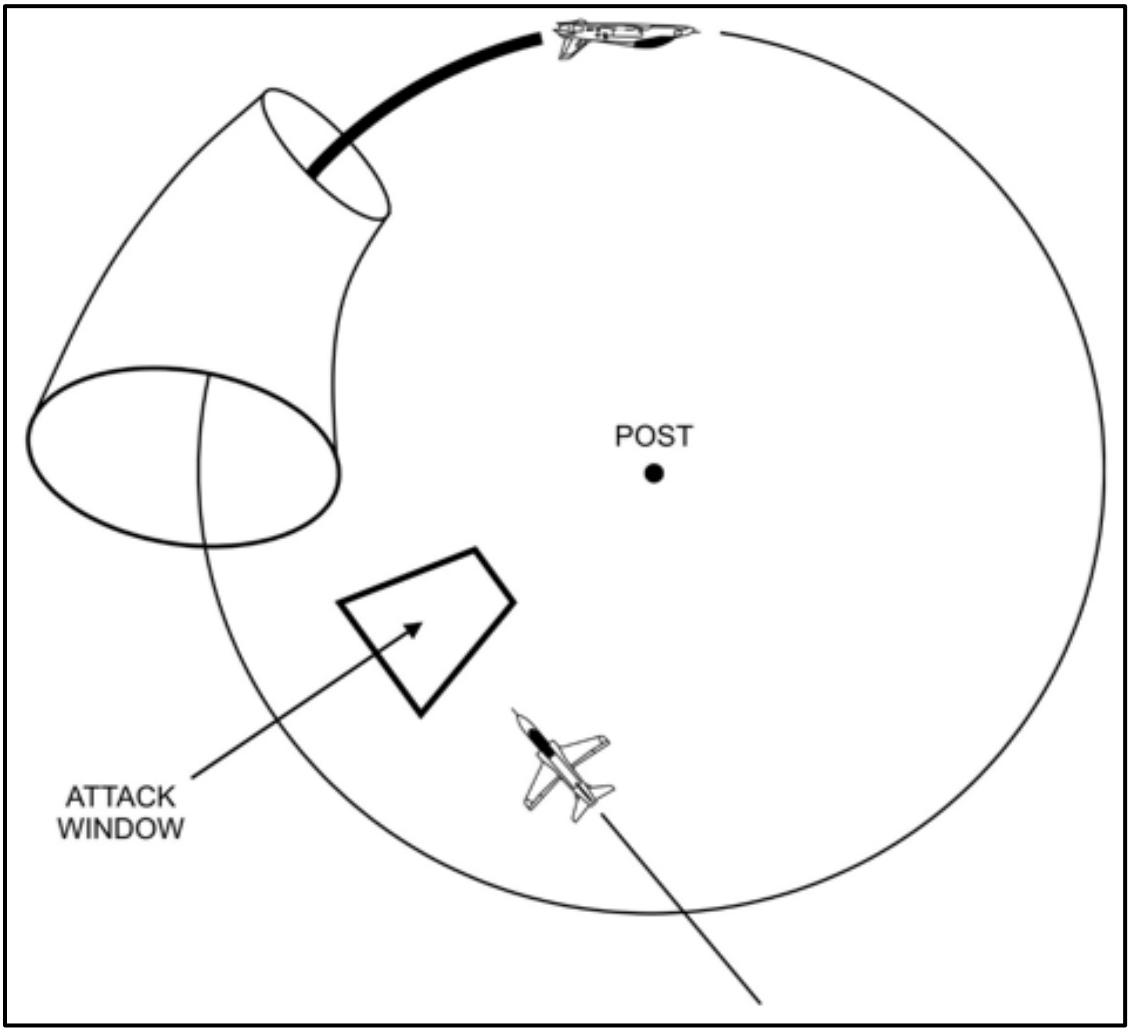


Figure 1-7 Attack Window

Misaligned Turn Circles (MATC)

MATCs are created due to the fact that each aircraft's bubble is displaced over a different geographic point in space. Given the same exact turn performance, the geometry of MATCs will enable an attacker's nose to eventually come to bear on the defender through pure geometry without having to perform an energy excursion.

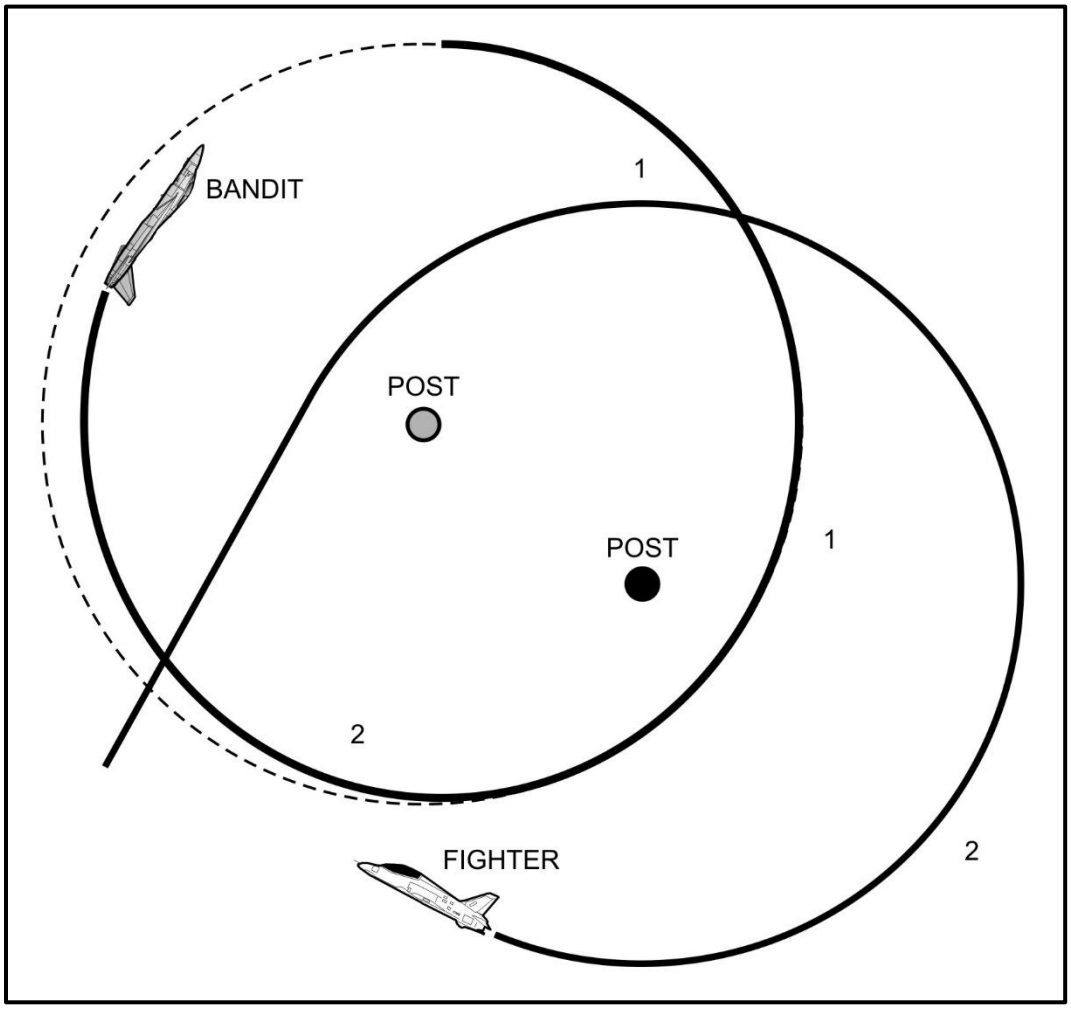


Figure 1-8 Misaligned Turn Circles

Low Yo-Yo

The Low Yo-Yo is a nose-low (and possibly out-of-plane) maneuver used to decrease nose-to-tail separation.

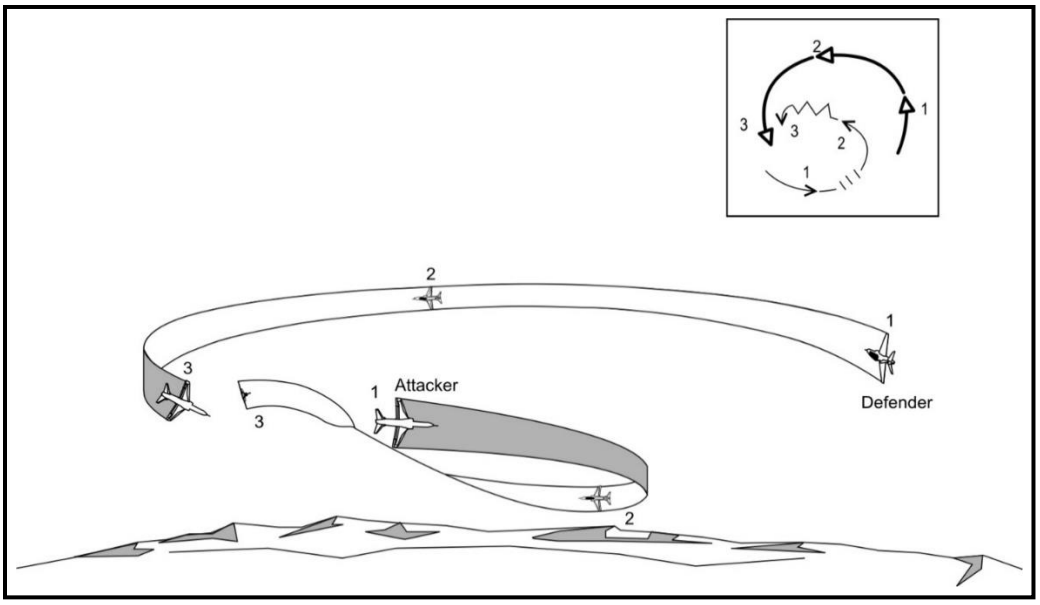


Figure 1-9 Low Yo-Yo

High Yo-Yo

The High Yo-Yo is a nose-high (and again, possibly out-of-plane) maneuver to slow or stop closure and/or increase nose-to-tail separation.

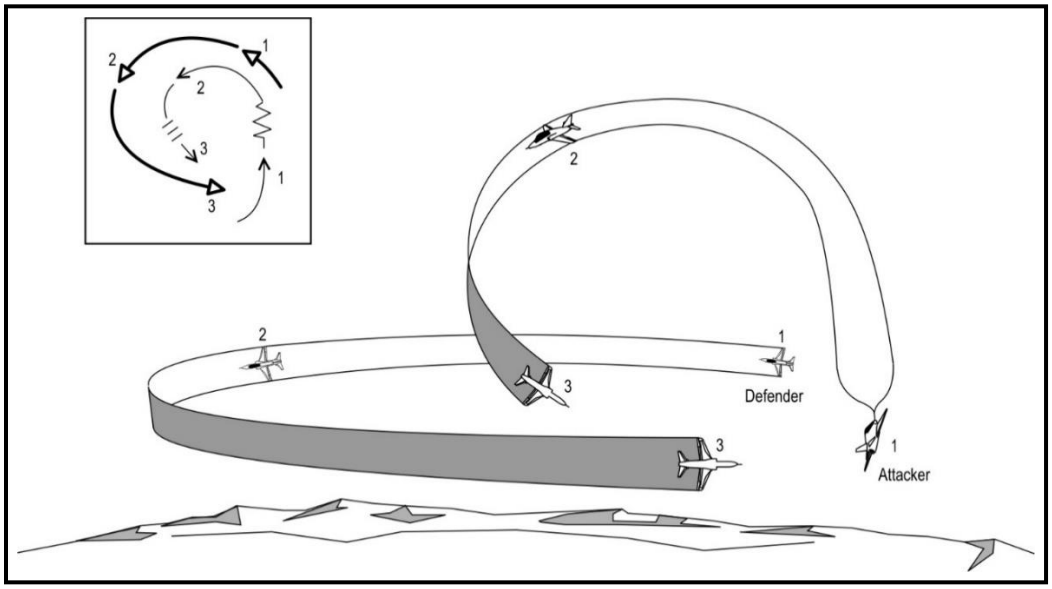


Figure 1-10 High Yo-Yo

Three Overshoots:

1. Flight path overshoot – flying through the adversary's flight path. Ensure the flight path overshoot occurs within or aft of the confines of the CZ. This will deny a reversal opportunity.

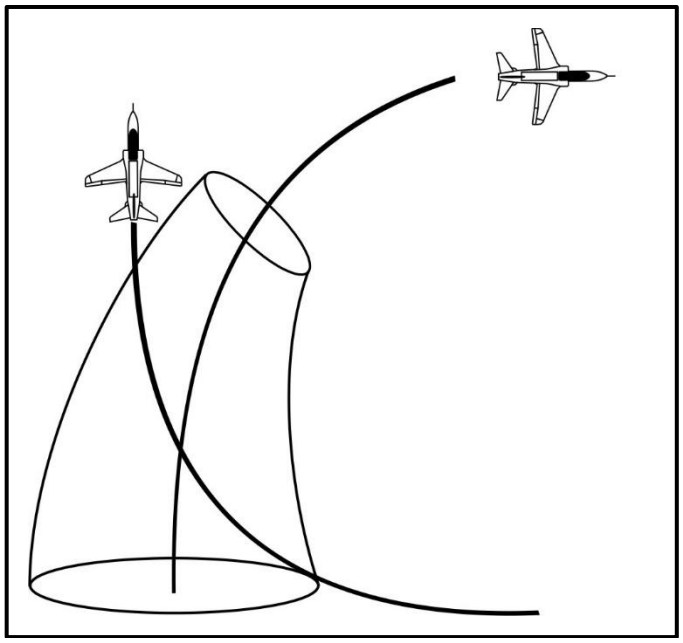


Figure 1-11 Flight Path Overshoot

2. In-close overshoot – a flight path overshoot that occurs inside the near portion of the defender's CZ, within 2,000 ft aft of the defender.

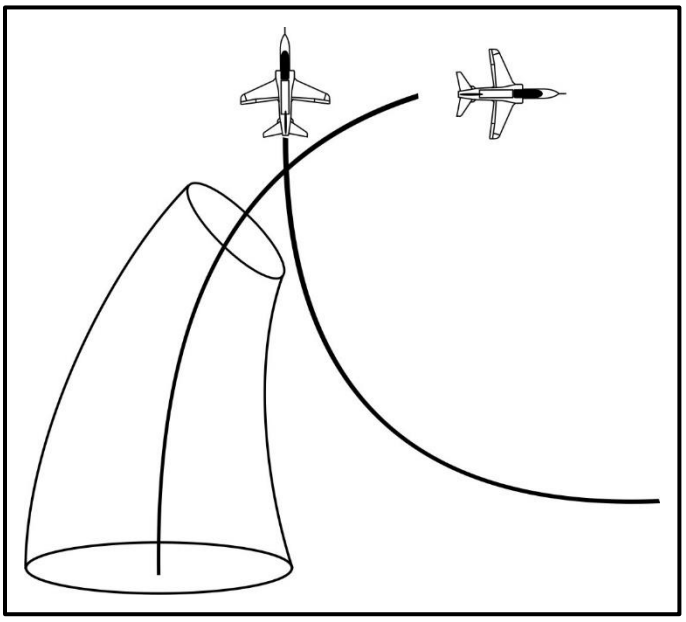


Figure 1-12 In-Close Overshoot

3. 3/9-line overshoot – an overshoot of the defender's 3/9-line that results in a positional role reversal (i.e., passing from behind the adversary to in front of him/her).

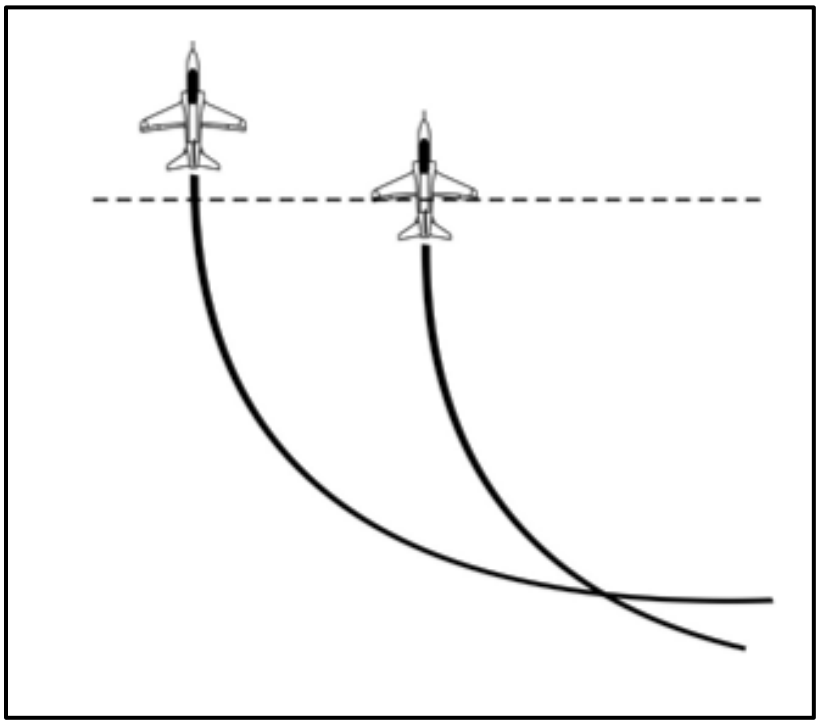


Figure 1-13 3/9-Line Overshoot

CNATRA Weapons Envelope

A weapons envelope is a graphical depiction of the limits of a particular weapon, centered on the target. A weapons envelope is at best a rule of thumb taking into account shooter and target airspeed, altitude, G, and weapon capability. Firing from within the envelope greatly increases the Probability of Kill (P_k). The CNATRA Weapons Envelope approximates both an infrared (IR) seeking (Fox-2) AIM-9 Sidewinder missile, and the 20 mm Vulcan cannon. Valid shots will require meeting appropriate wickets. For an IR Missile shot to be valid, it has to be taken with the defender in the HUD FOV, and the Shooter within the CNATRA Sidewinder Envelope. For a Tracking Gun Shot to be valid, it has to occur with the shooter in the Tracking Gun Envelope, and the trigger pulled with the pipper on the target. For a Snap Gun Shot to be valid, it has to occur with the shooter in the Snap Gun Envelope, trigger pulled early (>1 sec. prior) to establish bullets downrange at target distance, and the target must pass through the pipper.

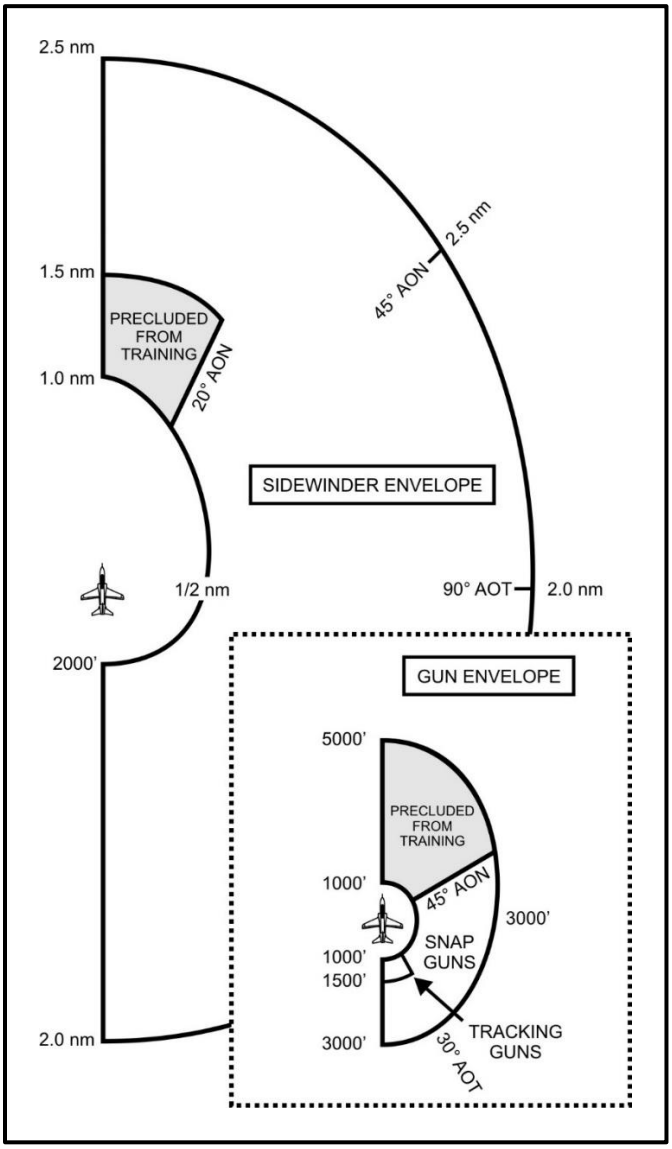


Figure 1-14 CNATRA Weapons Envelope

"FENCE(d) In/Out"

FENCE is an acronym for ***F***ire control, ***E***lectronic Countermeasures (ECM), ***N***avigation, ***C***ommunication, ***E***mitters. To FENCE(d) In means that administrative functions (to include G-warm) and proper setting of cockpit switchology have been completed prior to entering the combat area, and/or tactical portion of the flight. FENCE(d) Out means just the opposite, weapons switchology has been returned to a non-employment mode, and you are ready to return to a non-tactical portion of the flight.

Yardstick

Yardstick is the term for air-to-air (A/A) TACAN ranging. Yardstick gives DME ranging to the nearest aircraft transmitting 63 channels apart from the TACAN channel you have in your system. For example, 29X A/A gives ranging for an aircraft with 92X A/A. This is usually assigned in the brief, but may be modified as required in flight. You will only have it displayed in the HUD if TACAN is boxed.

PADS

PADS is an acronym for the starting parameters of an engagement or maneuver: ***P***osition, ***A***ltitude, ***D***istance, ***S***peed.

OPS CHECKS (Fuel and G)

This is a call initiated by Lead and echoed by Wing after the 'Fenced In/Out' call and after every KIO stating the current fuel state and "good G" if within limits (fuel state in thousands of pounds, alibis by exception). If G is not within limits, say the actual max G. Do not delay ***aviating*** and ***navigating*** your jet back to Spread just to ***communicate*** your 'fuel and G' call.

"Speed and Angels"

This is a call initiated by Lead and echoed by Wing when in position (that is, on your PADS) for the next maneuver set and it ***implies that you are visual***. Lead should initiate this call when he/she feels you are in a good position. If Lead calls it and you are not in position yet, call "standby." Being in position is being within +/- 200 ft, +/- 10 kts, and +/- .1 nm. Reference the TACSOP for execution. The maneuver will not begin until all aircraft have called Speed and Angels.

"Pipper On, Tracking"/"Pipper Off"

Due to the low AOT of Tracking shots, closure is much easier to control, and you may find yourself able to hold the 'pipper' (HUD gun reticle) on the target for long periods of time. Keep in mind that you will only have between 6 and 9 seconds worth of ammunition in the gun. A two second burst at most is recommended for each shot. With the pipper on and the trigger depressed call *"pipper on, tracking...."* As you pull the pipper off for whatever reason, call *"pipper off."*

"Trigger Down"

"Trigger down" is used in conjunction with an attempted Snap Gun shot where you are unable to hold the pipper on the target due to high track crossing rates. Pull the trigger as the target reaches the canopy bow and call *"Trigger down."*

"Snap"

The "snap" call is made when the shooter assesses the bullets are at target range (e.g., as the target passes through the reticle), and is followed by the assessment of where the pipper actually was as it passed the target. If you assess that the bullet would have impacted the target, a *"looks good"* call would be appropriate following the "snap" call. It also implies that you are off the trigger. If you assess your shot did not hit your target, again make an assessment to follow the "snap" call. Examples of the full call could include *"Trigger down…Snap…looks good"* or *"Trigger down…Snap…miss low."*

"Knock It Off" (KIO)

This is a call made by anyone in the flight to end an engaged maneuvering set (e.g., Gunsight Tracking). The KIO call is acknowledged by Lead, then by Wing. The KIO procedures are described in detail in the TACTICAL ADMINISTRATION section. ***Disciplined KIO comm and procedures are paramount for safety as the post-KIO portions of flights have historically been where most incidents occur.***

"Joker/Bingo" Fuel

Joker fuel is a pre-briefed fuel state above Bingo intended to advise Lead of the flight's fuel status.

Bingo fuel is the fuel state at which maneuvers must be terminated to rejoin the flight and comply with local course rules to the destination airfield in order to preserve sufficient fuel for approach(es) and landing(s). Be aware that this term also represents an emergency fuel state when briefed as such. Refer to local SOP regarding fuel management.

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CHAPTER TWO
ADMIN

200. INTRODUCTION

ADMIN encompasses the non-tactical portions of the brief and flight. The following paragraphs describe the major portions of ADMIN.

201. PREFLIGHT/START/MARSHAL/TAXI/TAKEOFF

These procedures are identical to two-plane formation operations. Reference the SOP/TACSOP for further guidance.

202. INITIAL RENDEZVOUS

Join all the way to Parade position utilizing whatever rendezvous method Lead briefs. Work hard and be precise on your join-up remembering all the basics. Lead may clear you to Cruise position right away; however, you as the Wingman are responsible for being in Parade as appropriate for weather.

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CHAPTER THREE
TACTICAL ADMINISTRATION (TAC ADMIN)

300. INTRODUCTION

TAC ADMIN encompasses anything concerned with tactical employment (brief items, flight maneuvers, etc.), and starts with the push to Spread, and ends after all have fenced out.

301. CALL SIGNS

A tactical call sign (tac call sign) will be used for all intra-flight communications. For your tac call signs, pick a word (not a personal call sign) of no more than two syllables that you can say five times very fast. This may sound silly, but you'll get the point later in the jet if you don't. All comm will reference your ***full*** tactical call sign (i.e., 'Hammer 12') and not just '2'. You will maintain your tactical call sign regardless of if you changed positions from Wing to Lead.

302. WEAPONS SYSTEMS

Review "NATOPS, PART VIII: WEAPONS SYSTEM, A/A MASTER MODE" for information regarding A/A modes and HUD symbology.

The most notable difference between the Navigation and Air-to-Air master modes is the lack of bank angle display. (When maneuvering in relation to other aircraft, specific bank angle is less important.) The selected sub-mode of Air-to-Air is indicated by Lead Angle Computing (LAC), or Real Time Gun Sight (RTGS), displayed just above GUN on the right center of the HUD. An "X" over GUN indicates that the Master Armament switch on the Weapons Selector Panel is set to SAFE. The "X" is removed when the Master Armament switch is set to ARMED.

The wingspan setting entered (31 ft default for T-45) sets the diameter of the reticle in both LAC and RTGS. With the Bandit's wingspan set, the reticle can be used to estimate range. At 1,000 ft, the Bandit's wings fill the inside diameter of the reticle. The center of the A/A aiming reticle (The 'pipper') indicates the computed impact point. The reticle flashes if it reaches the edge of the HUD field of view, and any shots are invalid until the reticle is brought back into the field of view (steady, not flashing).

1. LAC. In LAC, the pipper indicates the impact point of the round at 1,000 ft, but you need to track the target for at least one second to get a valid aiming solution. LAC is used for a non-maneuvering or mildly maneuvering target.

2. RTGS. In RTGS, the pipper indicates the instantaneous impact point of the round at 1,000 ft. Since it will take 1/3 of a second for the round to travel 1,000 ft, you need to place the pipper ahead of your target's flight path with an offset distance that accounts for this 1/3 of a second time of flight. RTGS is used for a hard-maneuvering target and will be the mode you use during your TACF and BFM flights. The technique for using the HUD is basically a matter of experience. As you maneuver your aircraft, the reticle will move in the HUD as it compensates

for G and yaw. For this reason, the more smoothly you maneuver your aircraft while tracking, the more accurate the aiming solution will be.

303. COMBAT CHECKLIST

All combat checks should be accomplished either on deck or en route to the area, short of selecting MASTER ARM switch to ARMED. This way you have only one action to accomplish following the G-warm. Combat checks for the T-45 are as follows:

Cockpit – Secure.

STORES page – A/A, GUN, RTGS all boxed.

VCR Switch – ON.

Environmentals – Note.

MASTER ARM switch – ARMED (Post G-Warm).

Personal technique or local SOP will dictate when you turn your VCR tape on. You could turn your tape on while on deck, and leave it on until taxiing back at the end of the flight. At a minimum, it should be on before calling "fenced-in*"* and stay on until you are 'fenced-out' on the RTB.

304. PUSHING TO SPREAD

Lead will brief you on when to expect the 'push-out' signal to Spread from Cruise. Lead will give this signal by pushing his/her palm out and away towards the canopy. Give Lead a head nod and add a sufficient amount of power. As you drive forward to the bearing line, take a cut away from Lead to establish a 10 to 20 degree heading differential, setting attitude (if in a climb), and resetting power as necessary to maintain 10 kts of excess airspeed for every 10 degrees of heading differential. Hold this heading differential until achieving a lateral separation of 0.8 to 1.0 nm, then turn to parallel Lead. Anticipate bleeding the excess airspeed as you turn to parallel Lead's heading. Your primary position-keeping reference is your eyeball. As a visual cross-check, if you can read the white or black letter on the tail of Lead, you are 7 nm or closer. If you see a character on the orange tail but cannot tell exactly what it is, you are about .8 nm. If you see only an orange tail with no white/black character, you are outside 9 nm. These distances are environmentally dependent, so get used to looking at the size of Lead as well as cross-checking what you see outside with what the A/A TACAN reads if you are using it.

NOTE

The sight picture from a good Combat Spread position will force you to turn your head somewhat uncomfortably while you look down your shoulder.

3-2 TACTICAL ADMINISTRATION (TAC ADMIN)

Common errors:

1. Taking too aggressive a cut away, resulting in a sucked position.

2. Taking too little of a cut away for the excess airspeed, and either going acute or never getting out to the appropriate abeam distance.

305. G-WARM

A G-Warm shall be executed prior to beginning any TAC FORM maneuvering. A G-Warm requires a minimum of 180 degrees of turn. Normally, the flight will conduct two 90-degree turns in opposite directions such that the flight ends up on the original heading. The turn will be executed to achieve 4 Gs for the first 90 degrees, and then a peak to 6 Gs, easing to 4 Gs, for the second 90 degrees of turn. This allows for the flight to efficiently complete a G-Warm while transiting to the working area. The G-Warm will be initiated with the wingman in Combat Spread or as close to it as local course rule altitudes allow. Reference the TACSOP for specific instructions on how the G-Warm will be executed.

You will lose sight of Lead in a G-Warm if it is initiated into you, so don't call *"*blind*"* when Lead goes into trail. If the G-Warm is initiated away from you and you lose sight of Lead, call *"*blind*"* ***immediately*** and ***execute all of the turns as directed!*** The trailing aircraft should strive to be at the leading aircraft's dead 6 o'clock after the first turn.

It is essential that both aircraft strictly adhere to the airspeed and G requirements outlined in the TACSOP, as there is a potential for a mid-air if the trail Fighter floats the second turn.

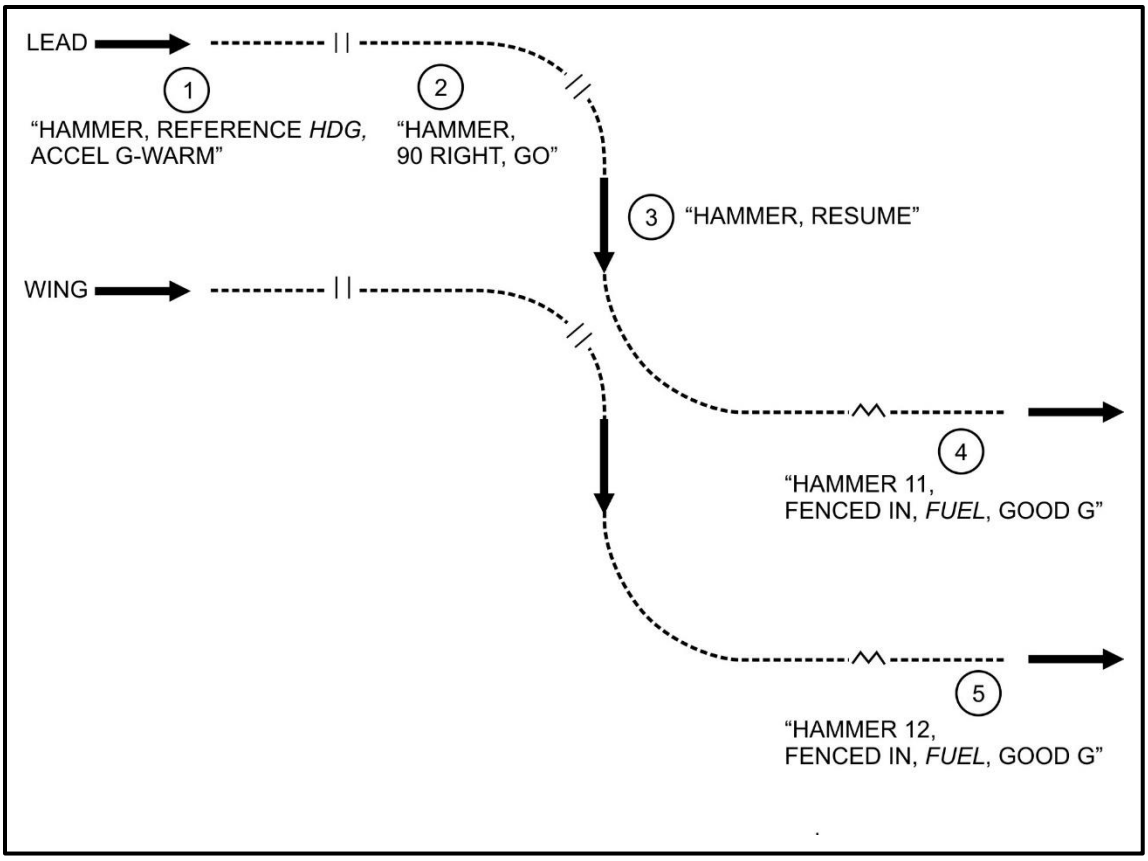

Figure 3-1 G-Warm (Into Wing)

Common errors:

1. Pulling for greater or less than 90 degrees on the first turn, resulting in skewed geometry. This is more readily apparent when Wing does not end up at Lead's six o'clock during initial G-Warms away from Wing.

2. Poor Lift Vector and/or nose placement during the first turn and getting too fast (>400 KIAS) or too slow (<380 KIAS) prior to the second turn.

3. Not pulling right to 6 Gs in the second turn, or not maintaining at least 4 Gs thereafter.

4. Not getting the nose up quickly enough for the climb back to Spread, resulting in getting fast and going acute.

5. Post G-Warm – not intercepting Lead's bearing line and 300 KIAS.

306. FENCE IN

Most of the items in the Combat Checklist may be done at any time prior to fencing-in; however, the ***MASTER ARM switch may only be moved to ARM after the G-Warm***. During the climb post G-Warm, set the MASTER ARM switch to ARM and double check that your VCR tape is

3-4 TACTICAL ADMINISTRATION (TAC ADMIN)

on. The "fenced in" call indicates that all members are ready for the combat phase and have completed an assessment of themselves, the environment, their aircraft, weapons, and systems. Reference the TACSOP for execution.

307. "KNOCK-IT-OFF" (KIO)

The last training objective during your TAC FORM flights will typically be the Gunsight Tracking Exercise. We will terminate these engaged maneuvering sets with a "Knock-It-Off." It is very important to respect and understand the KIO, as it is a tool to ensure safety-of-flight. Thus, anyone in the flight (even the Flight Surgeon in Lead's trunk) can call a KIO. Upon the KIO call, regardless of who called it, cease maneuvering, listen, and wait for Lead to initiate the follow-on comm sequence. Wing is responsible for flight path de-confliction unless blind, and makes a 'blind' call. In this case, Lead, if visual, will have primary flight path de-confliction. If Lead is also blind, he/she will call blind with altitude; for example, *"Hammer 11 blind*, ***altitude.***" Wing will echo this call*, "Hammer 12*, ***altitude***." Lead will dictate an altitude separation plan as applicable. The priorities following the KIO are:

Stand up the throttle (if applicable), stop fighting, and maintain sight and/or SA throughout the maneuver. Post KIO cadence, use pull and power as required to the called flow heading to arrive in Combat Spread; sometimes this will be a 17-unit AOA pull at MRT, other times it will be different. During this process, avoid going belly up inside of a ½ mile from Lead. If you find yourself in this scenario, maintain sight of Lead and flow to the outside of the turn. Lead determined the heading such that you should end up in Combat Spread, so you'll have a good idea where to look. Then, get back to bearing line while capturing 300 KIAS. Once you've gotten back to bearing, you can start fixing abeam distance and altitude. Lead will then initiate a '(Fuel) and (G)' call. Again, the initial 'Knock-It-Off, Knock-It-Off' call can be made by anyone. Reference the TACSOP for execution.

Common Errors:

1. Delaying the turn to the called heading.

2. Not adjusting pull and/or power to arrive in Combat Spread in a timely manner.

3. Being well below assigned Combat Spread altitude, and out of position following the KIO, yet pulling power prior to initiating corrections back to Spread.

4. Going 'belly up' to Lead inside ½ mile.

308. FENCE OUT

Post KIO, your contract is still to maneuver back to Combat Spread. At some point, Lead will initiate the fence out. Set the MASTER ARM switch to SAFE, VCR tapes – as required, TACAN – mode as briefed, and select HUD – NAV master mode. Reference the TACSOP for execution.

309. TACTICAL REJOIN

The Tactical Rejoin gets the Fighters back into Parade formation prior to returning to base. It will be executed from Combat Spread and initiated at the "fence out" call from Lead. If in a position other than Combat Spread at the "fence out" call, utilize Tac Form corrections to establish Combat Spread position (sucked positions do not require corrections as join up may be executed from this sight picture). If beginning a tactical rejoin from an acute position, avoid closure into Lead until you are on or aft of Lead's 3/9 line. Expect Lead to be at 80% N2 as you execute the rejoin, conditions permitting. It is critical to maintain sight of Lead at all times during the join. ***Within a half mile, never go 'belly up' for safety of flight.***

The ultimate goal of the Tactical Rejoin is to safely maneuver your aircraft to a position in which you can execute a join you have been taught previously. To execute the rejoin from Combat Spread, turn to establish a cut into Lead and descend. Modulate throttle position as appropriate for the unknown airspeed rendezvous. As nose to tail separation is established, maneuver the aircraft to a position in which a running rendezvous or CV rendezvous can be executed. Tactical rejoins from sucked positions require a small cut into Lead due to nose to tail separation already established. During these maneuvers, be co-altitude to slightly below Lead to avoid going 'belly up' inside of a half mile and losing sight of Lead as you turn to parallel Lead's heading. ***Sight of Lead must be maintained.***

If you fail to execute the basics during the running rendezvous, you may find yourself in an 'overrun.' An overrun occurs when the wingman flies past bearing line, ending up acute. If you find yourself driving to bearing line too fast, you may have to use the speed brakes to try and capture bearing line. If you are unable to stop on bearing line, maintain approximately 250-300 ft abeam Lead while you decelerate, work back to bearing line and once airspeed control is established, continue the join up. If you find yourself in a CV rendezvous situation, execute the fundamentals (Altitude, Bearing and Closure), and use your speed brakes if necessary to avoid an underrun.

Once Parade is established, the Tactical Rejoin is complete.

CHAPTER FOUR
BASIC POSITION-KEEPING AND CORRECTIONS

400. INTRODUCTION

The following section gives basic procedures for maintaining and regaining position. These are not specific maneuvers to perform, but rather tools to reference while performing various maneuvers or correcting for deviations that arise while flying TAC FORM.

401. MAINTAINING POSITION

The laws of physics that affect your position-keeping when flying in Combat Spread are the same laws that affect your position-keeping while flying in Parade. The only major difference is your ability to discern deviations due to the relatively large separation between you and your Flight Lead. A disciplined inside/outside scan is crucial to seeing deviations, but ***the real key to staying in position is basic air work***; how long do you think you could stay in Parade position with five more knots than Lead, or two degrees difference in heading? While Spread is much farther from Lead than is Parade, the same principles of position-keeping apply.

Scanning your fuel flow as much as your airspeed will pay dividends in keeping airspeed under control while attempting to maintain proper TAC FORM positioning. 1,800 to 1,900 PPH is a good reference point for maintaining 300 KIAS in level flight. For heading control in your early TAC FORM flights, try setting the course line/CDI or heading bug to the section's downrange heading, as early flights typically involve turns that occur in 90 or 180 degree increments. In later TAC FORM flights, you will not have the benefit of using the course line or even knowing what exact heading Lead is on or turning to, so you must develop the ability to look at Lead's jet and determine what will be a parallel heading. Finally, altitude and changes in altitude are fairly easy to see, either with the altimeter or by comparing Lead's jet to the horizon.

402. POSITION CORRECTIONS

There are three variables you must solve to correct and maintain position in Spread. TAC FORM positioning order of priorities is:

1. Bearing line.

2. Abeam distance.

3. Altitude.

A rapid inside-outside scan will be required to maintain the proper bearing, abeam distance, and altitude. The right combination of airspeed, heading, and power will control the proper Combat Spread position, so remember what each of these controls: airspeed controls bearing, heading controls distance, and power controls altitude. Any deviation in just one of these parameters will cause a deviation to the accepted Combat Spread position. It is possible, and preferred, to apply multiple corrections simultaneously to control your Combat Spread position.

We are going to apply a few rules to our corrections while trying to fix the above variables:

1. ***Always lead acute or altitude corrections***. Be accelerating back to 300 KIAS before you hit bearing line while fixing an acute, and/or starting level-offs before you blow through altitudes.

2. ***Never lead sucked or abeam distance corrections***. Wait until you drive all the way up to the bearing line from a sucked position before you climb to decelerate, and don't turn to parallel Lead before you've driven in or out to the abeam distance that you need.

Now is a good time to introduce the concept of ***energy conversion***. Getting proficient at trading altitude for airspeed, and vice versa, will pay dividends in making smooth, expeditious, and efficient corrections while attempting to maintain Combat Spread.

Maneuvers and corrections need to be timely and smooth. It is important to note that erratic and/or abrupt control inputs will just aggravate all involved. Learn to make smooth and controlled, yet aggressive corrections; sometimes a 7 unit AOA pushover will be required. Other times, rolling upside down and pulling will achieve the same result. Going up on a wing might also be used if applicable. Whichever technique is used, be aware of what you are trying to achieve with the jet, and do it smoothly.

403. CORRECTING FOR A SUCKED POSITION

Correcting for a sucked position is simply a matter of trading altitude (potential energy) for airspeed (kinetic energy) to start the correction, and reversing the trade to stop the correction. If you find yourself sucked, simply push the nose over (up to 7 units AOA) to gather airspeed as you come downhill. Take your extra airspeed 'along the bottom' and drive forward to the bearing line. When you hit bearing line (never lead a sucked), smoothly and aggressively pull 2 to 3 Gs until the nose is up, and climb back to your desired altitude. This significant pull up and nose-high attitude will rapidly get you climbing, while concurrently decelerating. As a useful rule of thumb, every 1,000 ft of altitude that you climb or descend will lose or gain about 30 knots respectively. This correction can be accomplished with little to no throttle modulation, but for a large deviation you may need to add power to further expedite the correction. Adjust the climb attitude to arrive back on bearing, at altitude, and 300 KIAS with about 1,800 PPH fuel flow. This is simplified, but the premise works for all variations of sucked corrections as long as you tailor your application of the above method for the magnitude of correction to be made.

404. CORRECTING FOR AN ACUTE POSITION

There are many ways to decrease downrange travel with respect to Lead, and work off an acute. Listen to your instructors to develop techniques to get the desired result. Remember, you must spend a majority of your time looking outside, referencing Lead, to build the sight pictures necessary to become skilled at fixing geometry problems. Use the following procedures to help build your own techniques.

For ***slightly acute*** positions, you can simply make level turns, or climb and slow down. Making level turns can correct bearing line, but may bleed energy, so power may be needed to maintain

airspeed (which uses more fuel). Climbing and slowing down is more fuel efficient. Simply climb to trade airspeed for altitude and start a drift aft towards bearing line. Before arriving on bearing (always lead an acute) push the nose over and descend back to altitude. You will continue to drift aft to the bearing line as you accelerate in the descent. Adjust power as necessary to arrive on bearing as you reach 300 KIAS. As in the sucked correction, this method can be utilized with little to no throttle modulation.

For ***full acute*** positions, the above methods will work but you can get back to bearing line more expeditiously by coupling turns with an altitude excursion and power adjustment. ***It is very important to make your corrections smooth and precise. Abrupt and erratic turns will only result in a loss of SA, and potential for RADAR gimbal in fleet aircraft.*** Use nose position and power as required to arrest downrange travel. This might involve greater pure level deviations or by combining turns with power and altitude adjustments. There are many techniques your instructors will talk through that you can use. Regardless of the techniques used, accelerate and correct back to capture bearing line, abeam distance, altitude, and airspeed prior to going sucked.

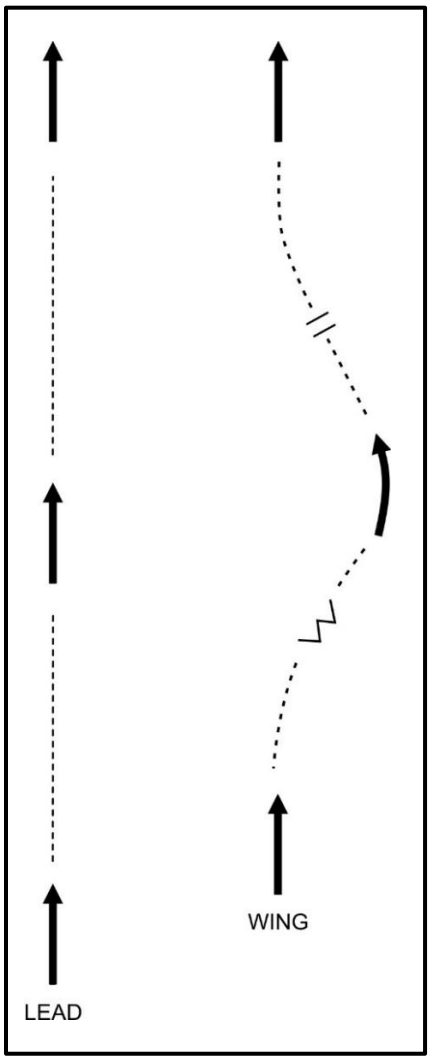

Figure 4-1 Acute Correction

405. ABEAM DISTANCE CORRECTIONS

Abeam distance corrections are simple, add a few knots of airspeed and take a cut into or away from Lead. As a rule of thumb, add as many knots as you add degrees of heading change.

406. ALTITUDE CORRECTIONS

With all other variables solved, add power and set nose attitude to maintain 300 KIAS for a climb. For a descent, you can pull power and/or partially extend the speed brakes so as not to accelerate too much. For an even more rapid descent, you can add a turn to help control your downrange travel (DRT).

CHAPTER FIVE
TAC FORM PROCEDURES

500. INTRODUCTION

The following information is presented in the general order of flow for each of your TAC FORM flights, along with procedures for each portion. Your Advanced Tactical Formation flights will include maneuvers that you will read about in the Chapter titled "Advanced Tactical Formation Procedures and Maneuvering." Refer to your Master Curriculum Guide for specific flight block requirements.

501. CHECK TURNS

A Check Turn is used to turn the section 30 degrees or less. Lead will roll into a 30-degree AOB turn for 30 degrees or less of heading change at 300 KIAS. Think of these turns as putting you ***instantly*** acute or sucked, requiring smooth and aggressive bearing line corrections. As will be the case for all the turns in your TAC FORM flights, Lead will not start maneuvering until Wing acknowledges the Lead's comm:

Lead: *"Hammer, Check left, 2-5-0"*

Wing: *"Hammer 12, 2-5-0"*

502. CHECK TURNS INTO WING

You will see Check Turns used to get Wing back into position in order to expedite setting up for the next maneuver in your training. This will happen when applying cooperative maneuvering. While in the TAC FORM stage of training we will use them to create an acute situation so you gain an understanding of the geometry and fixes required. Check Turns into the wingman require corrections that basically mirror what you would use for an acute position described earlier in this text. We will reference three options that you can pull from to build your own technique for fixing an acute, although there are many to choose from. Some of these steps are deliberately vague, so the focus is on looking outside and assessing vice concentrating inside on rigidly achieving specific parameters. TAC FORM is an art that you will continue to perfect throughout your career.

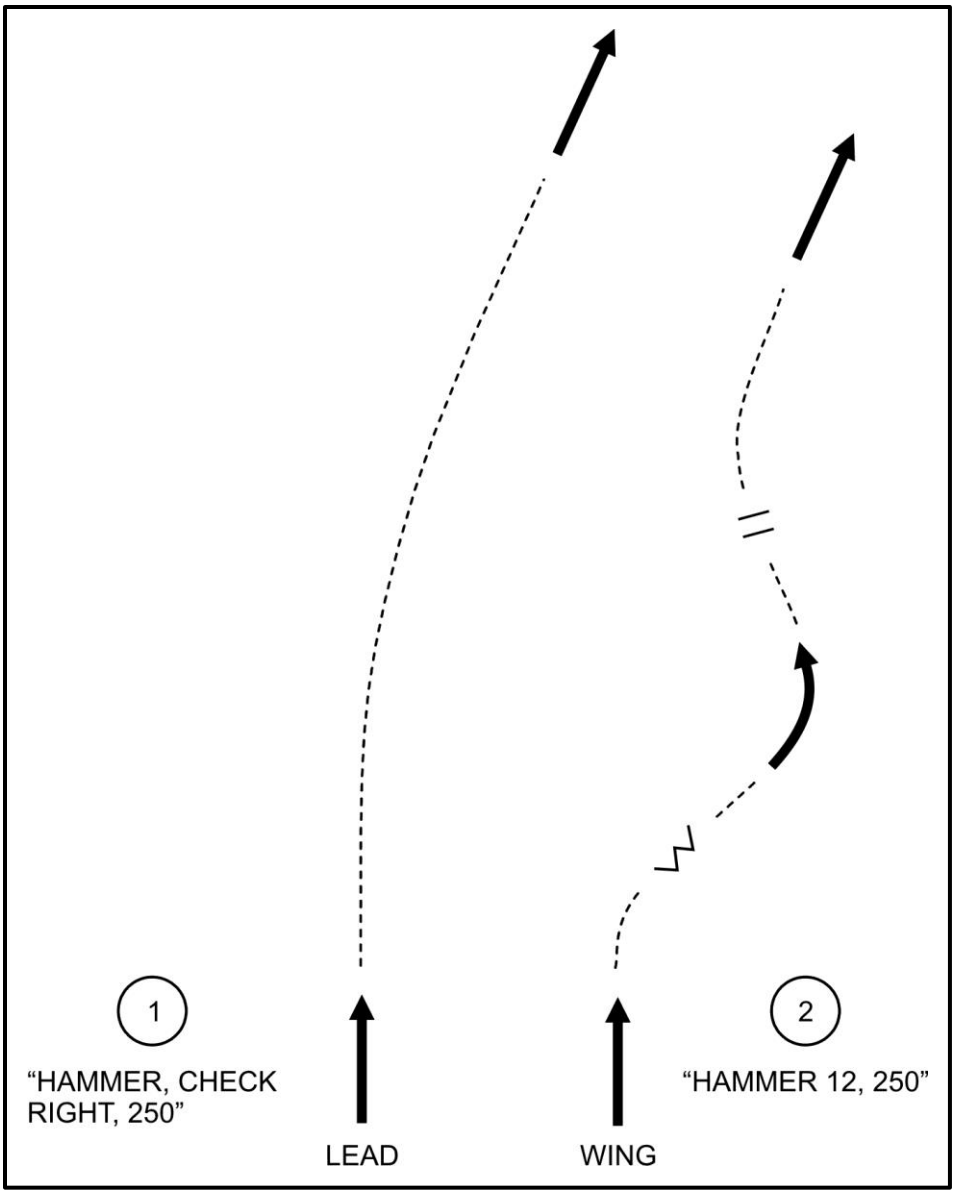

Figure 5-1 Check Turn Into Wing

- Option 1, ***Turn with a climb***. Turn to the new heading, referencing Lead in the turn. Manage your nose position and power to decrease downrange travel (increase nose attitude, reduce power). Watch bearing line as it approaches from behind and be in a correction to capture bearing line, abeam distance and altitude. Continue to assess and manage power to capture and maintain airspeed (300 KIAS) out of the maneuver. Your IPs will have many techniques to include gouge power settings, nose attitudes, and timing for success. Bottom line, look outside and continue to assess for corrections and re-corrections to be in position expeditiously.

- Option 2, ***Pure level maneuvering***. Use a series of hard level turns away-from and into Lead to slow your downrange travel using pure geometry. Be aware of excessive abeam distance errors, as this makes judging position more challenging; allow your jet to displace for a while to decrease down range travel, then re-assess. A good rule of thumb is to take a mental snapshot of how much correction is required, and reverse your turn back towards Lead when 50% of that correction has been made.

- Option 3, ***Oblique maneuvering with S-turns***. A climbing turn past the flow heading, then turning down and into Lead is another way to quickly slow downrange travel. The power should remain constant during this maneuver to eliminate variables unless needed due to resultant geometry. Large vertical and lateral errors should be avoided, as this makes it harder to judge where you are in relation to Lead. As a technique, avoid maneuvering further away than 2.0 nm, climbing more than 2,000 feet, and decelerating more than 50 knots.

Check turns into Wing can be one of the most difficult corrections to master.

Common Errors:

1. Floating (less than 2 Gs) the cuts away and into Lead.

2. Not looking back at Lead, and not continuing to quickly adjust for desired results.

503. CHECK TURNS AWAY FROM WING

A Check Turn away from Wing will induce a sucked position. The goal is to accelerate quickly so that you reduce your positional error as expeditiously as possible. For a Check Turn away, make a turn to the new heading while aggressively lowering the nose to gain airspeed (descending below Lead is acceptable). This is one situation where you can justify bringing the throttle up to expedite acceleration. Once you have a healthy excess of airspeed reset your fuel flow, and keep the extra airspeed gained to drive forward to the bearing line. Abeam distance errors can be fixed as you approach bearing line. Once you hit the bearing line, aggressively climb back to altitude, and recapture 300 KIAS.

504. SHACKLE TURNS

Shackles allow Lead to re-dress the section (get Wing back into position), or to have the jets maneuver to opposite sides of the formation. If Lead desires to keep the section on the current heading, both aircraft begin a level 14 AOA turn toward each other for approximately 45 degrees of heading change, adjusting power as necessary to maintain 300 KIAS. Both aircraft will roll out with a new heading on appropriately a 45-degree benchmark and wait for flight path passage. The wingman is responsible for altitude de-confliction, and should keep Lead in sight throughout the maneuver. If both aircraft cross over each other and reverse back to the flow (original) heading ***at the same time*** (roughly 2 sec after the pass), both should come out of the turn on bearing line at the appropriate abeam distance.

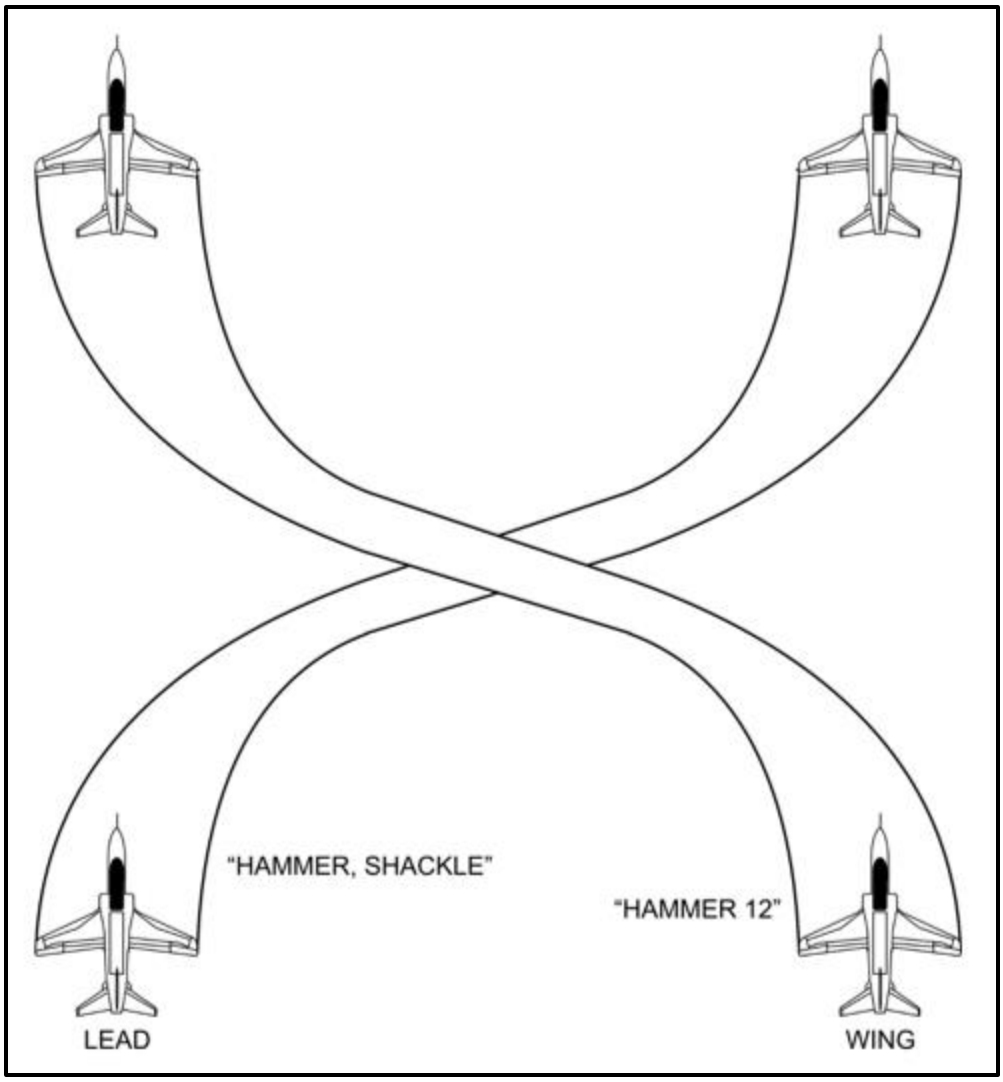

Figure 5-2 Shackle

A Shackle can be used to help the wingman regain bearing line from either a sucked or an acute position. If the wingman starts out slightly sucked, he/she may elect to turn 45 degrees, and reverse earlier after the pass back to the flow heading. If the wingman is excessively sucked, he/she may turn less than 45 degrees, or not at all in the worst instances. If Wing starts out slightly acute, he/she may turn 45 degrees and wait longer after the pass to reverse back to the flow heading. If the wingman is excessively acute, he/she can turn greater than 45 degrees initially before turning back to the flow heading. Any of these techniques may be used, and are situation-dependent, so adjust accordingly.

Since a Shackle is a somewhat cooperative maneuver, don't blindly initiate a correction without assessing what Lead may be trying to accomplish with the Shackle. Mentally note whether you are in position or out of position to begin with, and tailor your correction according to what Lead is trying to accomplish.

Common Errors:

1. When in position and Shackling straight ahead, Wing turns all the way to the pass (greater than 45 degrees), instead of rolling out on the 45-degree benchmark.

2. Not pulling 14 units AOA in either turn.

3. Not scanning airspeed and getting either too fast or too slow.

505. OFF-HEADING SHACKLES

Lead will call an Off-Heading Shackle to a new heading of 30 degrees or less from the original flow heading. Each jet will turn towards the other at 14 units AOA and 300 KIAS until the new flow heading reaches the first 45-degree benchmark on the HSI. One jet will turn ***a lot*** (~75 degrees of turn), while the other jet will turn only ***a little*** (~15 degrees of turn), to put the new flow heading on the appropriate benchmark.

Unlike straight-ahead Shackles, the section will not pass directly over or under each other; the jet turning ***a little*** will tend to pass slightly in front of the jet that turned ***a lot***. After the pass, look over your shoulder at Lead's jet. When Lead gets to an angle behind your wing line that roughly equals how many degrees you have left to turn to the new flow heading (usually 45 degrees), start your turn. This should put Lead on your bearing line, which equates to you being on Lead's bearing line. A good rule of thumb is that the jet turning ***a lot*** normally dictates the reversal timing. As long as Wing passes close to Lead with approximately 90 degrees of heading differential AND reverses at the same time as Lead, Wing will come out of the turn on bearing (first priority), and can make a simple correction for abeam distance as necessary.

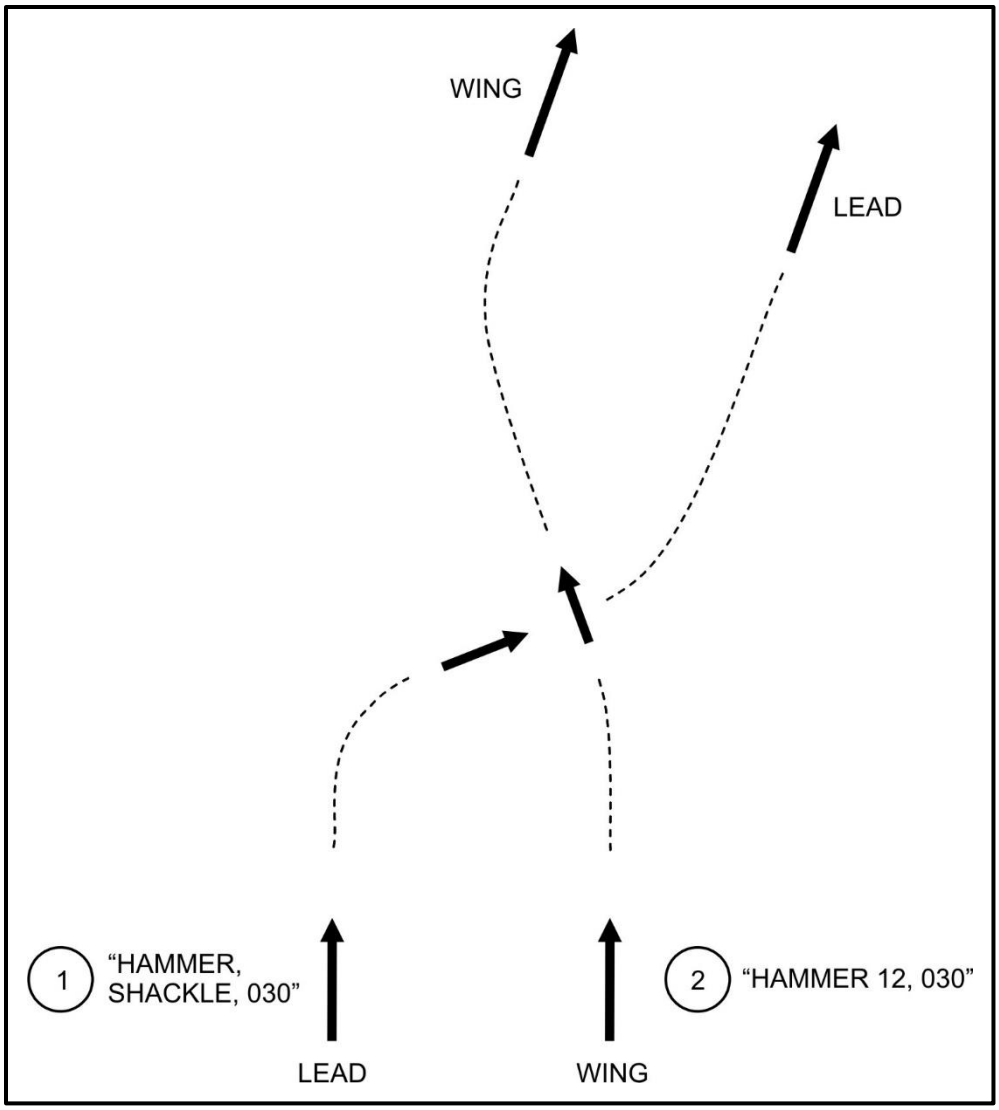

Figure 5-3 Off-Heading Shackle

Common errors in Off-Heading Shackles include those of the straight-ahead Shackle, plus the addition of potentially turning too far by putting the new flow heading past the HSI 45-degree benchmark.

506. TAC TURNS

The Tac Turn is an engaging turn in which flow heading changes by 90 degrees, and the Fighters swap sides of the formation. A Tac Turn allows the section to maneuver rapidly to engage a threat in the beam. Tac Turns will be performed at 14 units AOA, using power as required to maintain 300 KIAS. At the completion of the turn, you should be back in Spread on the opposite side at 300 KIAS. The turn begins immediately following Wing's acknowledgement of Lead's comm:

Lead: *"Hammer, Tac left"*

Wing: *"Hammer 12"*

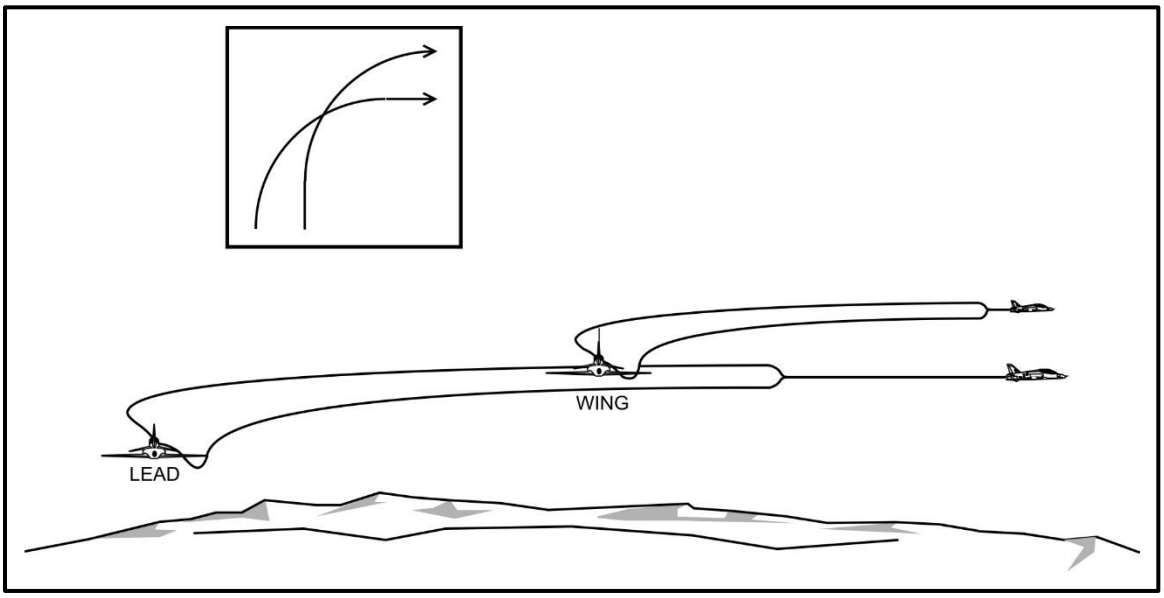

Figure 5-4 Tac Turn into Wing

507. TAC TURNS INTO WING

Initially you will drive straight and do nothing as Lead starts the turn into you. Begin your turn in the called direction just prior to being able to look down Lead's intakes. About halfway through your turn you should pick up Lead over your shoulder as he/she rolls wings level, with you on bearing line. Expect most of Lead's turns to be into Wing as this allows you to get the most training on timing and corrections. Realize that if you are out of position to start the maneuver you can adjust your timing to come out of the turn in position. If you start out acute, you will come out acute if using the same sight picture to begin your turn. Wait slightly longer to begin your turn; this will help fix bearing line (first priority) out of the turn, but will induce some abeam distance errors. To fix abeam distance errors, simply put in a correction to fix being wide coming out of the turn. If you start out sucked, you will come out sucked if no adjustment is made. Starting from a sucked position, you will need to turn slightly sooner in order to arrive

on bearing line at the completion of the maneuver. This will induce an abeam distance errors as well (close abeam), and a correction can be made out of the turn.

508. TAC TURNS AWAY FROM WING

Immediately begin your turn into Lead with a smooth pull to and maintaining 14 units AOA and 300 KIAS through the turn. Lead will maintain heading waiting for your jet to approach nose-on. At the appropriate time, Lead will start his/her turn. You should arrive at the new heading, on bearing, as Lead is about halfway through his/her turn.

509. IN-PLACE TURNS

The In-Place Turn is an engaging turn that changes flow heading by 180 degrees, and causes the Fighters to swap sides of the formation. Both Fighters should begin and finish their turn at the same time. Realize that if you are out of position at the start it will require adjustments to your AOA and nose position in order to arrive in position out of the turn. An In-Place Turn is used to engage a bandit that is in the section's rear quarter, in the direction of the turn. The turn begins immediately following Wing's acknowledgement of Lead's comm:

Lead: *"Hammer, In-Place right"*

Wing: *"Hammer 12"*

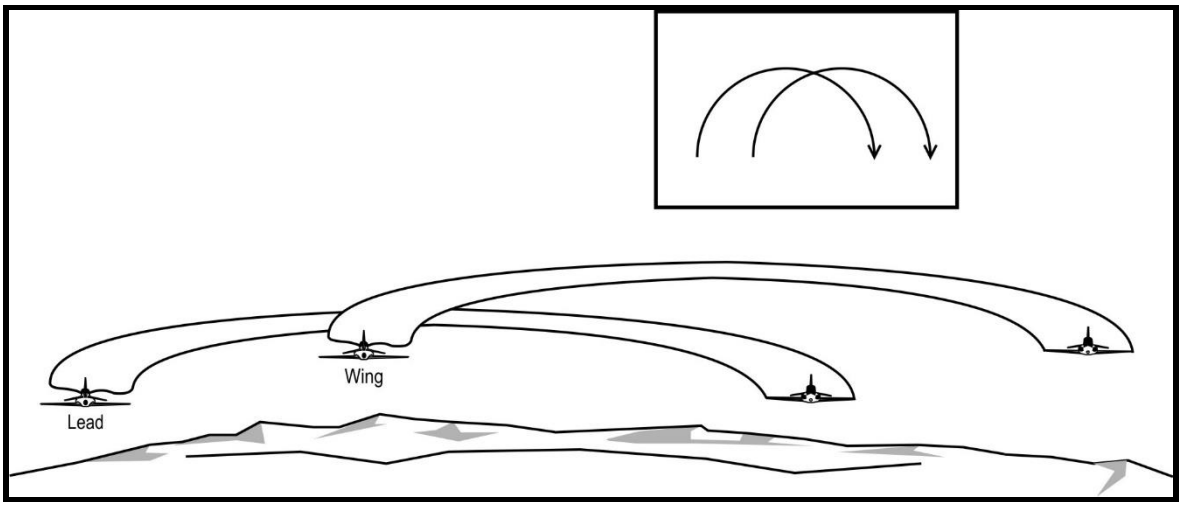

Figure 5-5 In-Place Turn into Wing

Common Errors:

1. Not maintaining 14 units AOA and 300 KIAS during the turn.

2. Not assessing corrections needed during the turn.

3. Not maintaining altitude while blind in the turn.

5-8 TAC FORM PROCEDURES

510. IN-PLACE TURNS INTO WING

Upon responding to the initiating comm, immediately begin your turn away from Lead adding power as required to maintain 14 units AOA and 300 KIAS. After roughly 135 degrees of turn look for Lead to appear over your shoulder, and assess bearing line. Since In-Place Turns take twice as long to accomplish as Tac Turns, bad air-work from Wing will result in amplified deviations after the turn is complete. Think ahead as the maneuver is progressing and assess your air-work. Adjust AOA as soon as you recognize deviations. Think ahead, and make early or mid-maneuver corrections to save you from having to make bigger corrections at the end of the maneuver.

511. IN-PLACE TURNS AWAY FROM WING

Upon responding to the initiating comm, immediately begin your turn into Lead adding power as required to maintain 14 units AOA and 300 KIAS. Your first check point in the turn will be after 90 degrees of heading change. You need to assess if you are leading or lagging Lead's turn rate, and if you are offset to what appears to be outside or inside of Lead's turn. If you are lagging Lead's turn rate, or appear to be outside of the turn, you need to "wrap up" the turn using an extra unit or two of AOA to catch up. If you are leading Lead's turn rate, or appear to be inside of the turn, then you need to "float" the turn an appropriate amount. Be mindful that when you wrap up or float the turn, you are going to induce abeam distance errors. Anticipate abeam distance errors, and start planning a correction out of the turn to correct geometry deviations. ***As a safety note, descending out of altitude during an In-Place Turn away from Wing should only be done with situational awareness to Lead's position.***

512. CROSS TURNS

The Cross Turn is a 17 unit AOA, 300 KIAS hard turn into each other at MRT. The Fighters cross each other's flight path and change flow heading by 180 degrees. Out of Cross Turns the Fighters are on the same relative side of the formation (if you start on the left, you finish on the left); additional comm is needed for safety of flight de-confliction because Fighters are going to make a relatively close pass.

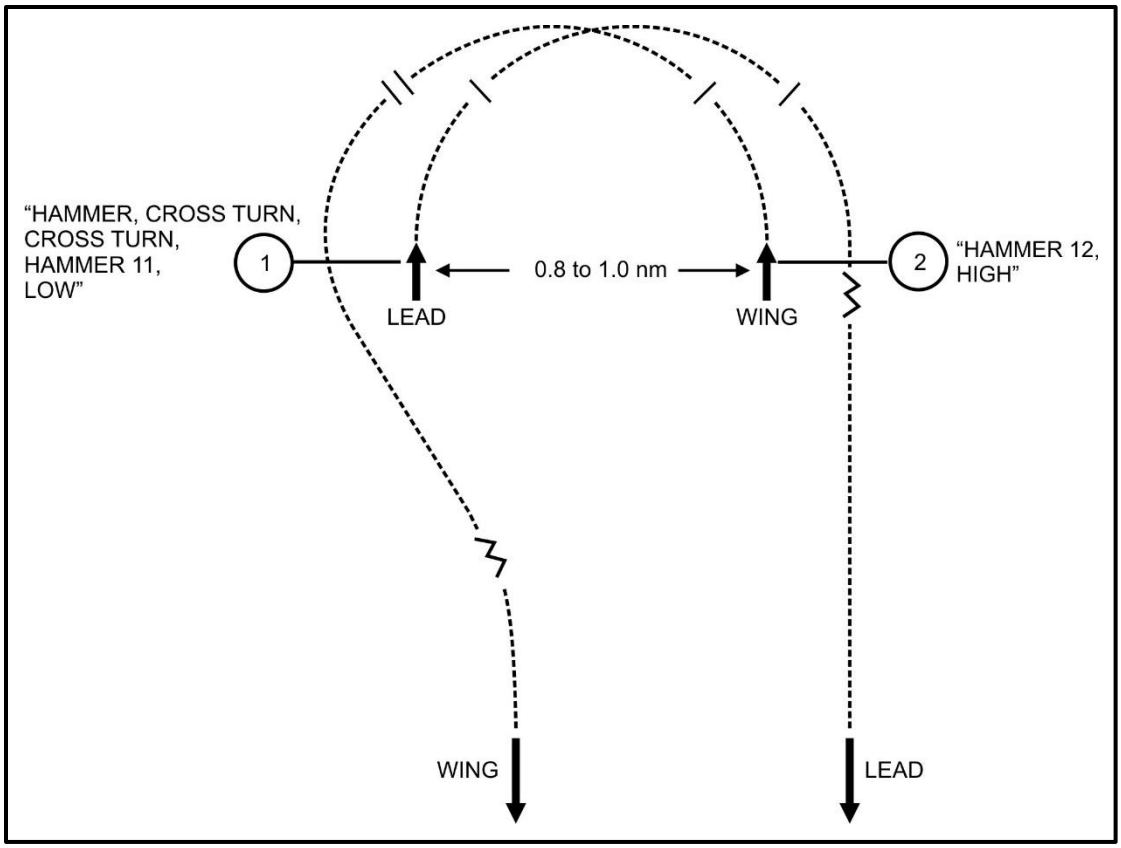

Figure 5-6 Cross Turn

Lead will initiate the Cross Turn, "Hammer, Cross Turn, Hammer 11 low." In early TAC FORM flights, Wing will be the high Fighter, so he/she will respond, "Hammer 12 high." As Wing begins to transmit, he/she should select MRT and begin rolling to execute a 17 unit AOA, slightly nose-low (just like the min radius turn in FAMs), hard turn into Lead. Lead will execute an identical turn into the Wing. Both Fighters will end up turning 180 degrees to the new flow heading. The pass will occur just prior to either jet achieving 90 degrees of turn. Wing should be right above and slightly inside of Lead's turn radius. The degree to which Wing goes nose-low is predicated on being ***no closer than 500 ft*** above Lead at the pass.

Once the pass is safely assured, Wing should overbank briefly, maintaining 17 units AOA, allowing the jet to accelerate past 300 KIAS in the nose-low slicing turn. The section started out at 0.8 to 1.0 nm abeam prior to the Cross Turn, but the wingman will likely end up on bearing wider than usual due to turn radius at 17 units AOA, >=300 KIAS. Because of this, Wing should continue the turn 30 degrees or so past the new flow heading into Lead, using excess airspeed to collapse and achieve the correct abeam distance. Wing can then parallel the new flow heading while simultaneously correcting back to altitude and 300 KIAS.

If Wing is blind out of the Cross Turn, only turn 180 degrees to parallel the new flow heading ***but do not climb***. Once visual, proceed with correcting back to the proper abeam distance and altitude. This assumes that Wing is on bearing after 180 degrees of turn. Typically, Wing ends up slightly sucked, and will also have to drive to bearing line after correcting for abeam distance.

Once Wing hits the bearing line with proper abeam distance, climb back up to altitude. Should Wing show up acute after 180 degrees of turn, assuming visual, Wing will need to incorporate an acute fix while collapsing the abeam distance.

Common Errors:

1. Not talking while turning at the start, resulting in Wing being outside Lead's turn.

2. Not selecting MRT early enough or maintaining 17 units AOA throughout the turn.

3. Overbanking too much and/or too early, resulting in a close pass with Lead.

4. Overbanking late, resulting in a lack of excess airspeed to correct for bearing line and abeam distance deviations.

5. Going belly-up to Lead to correct heading/abeam distance, while climbing through Lead's altitude.

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CHAPTER SIX
ADVANCED TAC FORM PROCEDURES AND MANEUVERING

600. INTRODUCTION

In your later TAC FORM flights you will be given a chance to practice position-keeping and to hone eyeball calibration in a more realistic setting. During these flights, free-flowing maneuvers will force you to maintain proper Combat Spread in spite of non-standard turns or other internal and external factors.

If it sounds like this advanced TAC FORM maneuvering is set up to challenge you as a wingman, that's correct. You will find these flights challenging and enjoyable, and they will give you a good look at what to expect during your follow-on Advanced Strike stages in the Training Command and in the Fleet.

601. ADVANCED TAC FORM MANEUVERING

As mentioned previously, some turns that Lead calls will not be for 30, 90, or 180 degrees of heading change. Even when called turns conform to these benchmarks, Lead may vary airspeed and/or AOA to create a higher degree of difficulty for the Wing. In short, this 'non-cooperative' maneuvering will create the need to evaluate and make continuous corrections from one turn to the next, while taking care of other Admin or Tac Admin related items. For any of the turns Lead may elect to maneuver within +/- 30 degrees of standard parameter heading changes. The corrections during random maneuvering can be confusing if some significant preparation isn't made. Spend time thinking about the geometry and the corrections required to maintain appropriate positioning.

In-Place Turns to 150 degrees from the original heading. You have to think about In-Place Turns with respect to which side of the formation you start from. Look at the HSI and determine the outcome (will I be ahead or behind Lead out of the In-Place Turn if I turn at the same time as Lead), and this will help you understand if you need to start your turn early or late.

- ***In-Place Turns < 180 degrees away from Wing*** will result in Wing being well-sucked out of the turn if no adjustment is made. In this case, Wing must begin the turn right away **while** responding with the comm. Use increased power as required, and increase the AOA slightly, so as to come out of the turn as close to in position (bearing line first priority) as possible, and make fine-tuned corrections as soon as bearing line deviations are noted. With this In-Place geometry setup, expect to have to make a correction for being sucked, and begin this correction while coming out of the turn.

- ***In-Place turns executed < 180 degrees into Wing*** will result in Wing being well-acute out of the turn if no adjustment is made. In this case, Wing must begin the turn later than normal. With this setup, expect to have to make a correction for being acute, so work your geometry coming out of the turn to achieve appropriate positioning.

Tac Turns to 60 or 120 degrees from the original heading. A Tac Turn into Wing will force Wing to do all the work (expect most Tac Turns to be into Wing). Again, look at your HSI and determine the outcome (will I be ahead or behind Lead out of the Tac Turn if I turn with Lead's intakes on), and this will help you understand if you need to start your turn early or late.

- ***Tac Turns into Wing <90*** will result in Wing being well-acute out of the turn if no adjustment is made. Wing must begin the turn later than normal. Judge your timing throughout the turn, and be making corrections as you are coming out of the turn (bearing line is the priority).

- ***Tac Turns into Wing >90*** will result in Wing being well-sucked out of the turn if no adjustment is made. Wing must begin the turn earlier than normal. Judge your timing throughout the turn, and be making corrections as you are coming out of the turn.

602. CO-ALTITUDE TACTICAL FORMATION MANEUVERING

During the TAC stage, the concept of co-altitude Tac Form Maneuvering will be introduced. This will require different eyeball calibration and timing to execute turns effectively. This exposure leads into the fact that you will be required to set specific PADS prior to maneuver sets in this stage as well as future stages of training such as BFM and FTX. It is important to note that mechanics and timing must be adjusted when executing turns at different airspeeds and abeam distances. For example, when executing Tac Form at 350 KIAS, turns will be conducted at MRT utilizing G to maintain airspeed, and while executing Tac Form at 200 KIAS, turn mechanics will target 17 units AOA with power modulated to maintain airspeed.

During the TAC stage, co-altitude maneuvering will be executed at 1.5 nm abeam Lead at 300 KIAS and will consist of both on- and off-heading turns. Some differences you will see while maneuvering in this position are as follows:

1. ***Check Turns***. Check Turns initiated with Wing in position are executed the same, but the magnitude of correction will be greater, as you have more downrange travel in order to get back to bearing line. Check turns initiated with Wing out of position (either acute or sucked) are executed with the intent to put Wing back in to position and are cooperative in nature. Simply turn to the called heading.

2. ***Shackles***. Co-altitude shackles will require a pass to be called ("high" or "low" and are typically initiated by Lead) in order to preserve a 500 ft bubble around both aircraft. This will require one fighter to climb slightly and the other to descend. Shackles will require longer timing after the pass before reversing to the flow heading. Methods for making corrections remain the same.

3. ***In-Place Turns***. There is no difference for the In-Place Turns.

4. ***Tac Turns***. Tac Turns into Wing require slightly different timing. Instead of waiting to look down Lead's intakes, Wing should wait slightly longer (until Lead reaches the 5 or

7 o'clock position) before starting a 14-unit AOA turn. A Tac Turn initiated with the wingman significantly out of position may require a pass to be called ("high" or "low" typically initiated by Lead) and will require both aircraft to maneuver cooperatively to preserve a 500 ft bubble around both aircraft.

603. UNCALLED TURNS

Uncalled turns are used to simulate maneuvering in a comm-out environment. They will be either Tac or In-Place Turns. Lead will give an exaggerated wing flash in the direction the turn is to be executed, then roll back to wings level. Only after Lead is wings level will either jet maneuver. If you are unable to discern which way Lead gave the wing flash, assume a Tac Turn away from you. If you are wrong, it will be readily apparent when Lead begins a Tac Turn into you, and you can quickly reverse to where you need to be. If you incorrectly assume that the uncalled turn is into you, you stand the chance of losing sight.

An uncalled In-Place Turn will only be performed away from Wing. Tac Turns may be performed either into or away from Wing. Since an uncalled turn away from Wing could mean either a Tac Turn or an In-Place Turn, again, always assume an uncalled Tac Turn away. The realization that it's an In-Place Turn occurs when Wing rolls into what is assumed to be a Tac Turn away, but observes Lead also turning in the same direction.

604. GUNSIGHT TRACKING EXERCISE

The Gunsight Tracking (GST) exercise introduces the basic concepts of the Bubble, Attack Window, and Control Zone. You must understand both the Training Command Sidewinder Missile and Gun envelopes (CNATRA weapon envelopes) completely prior to your first TAC FORM flight. We will explore the process by which a pilot can control range, angles, and closure to effectively employ a particular weapon system against a target. This exercise is not BFM, but a part-task trainer used only to explore the concepts above. In keeping with traditional air-to-air training terms, we will refer to the terms 'Fighter' and 'Bandit' in the following discussion. Lead will be representing the 'Bandit' and Wing will be representing the 'Fighter.' Lead will be maneuvering to allow you to achieve a tracking solution fairly quickly (180 to 270 degrees of turn), yet hard enough to simulate a realistic scenario.

The goal of the GST is to recognize the Attack Window, execute Attack Window Entry Mechanics to arrive in the Control Zone with range, angles, and closure under control, and to employ follow-on tracking gun shots on the Bandit. You will need to use lead to employ shots, and lag to stay offensive and manage the forward portion of the Control Zone. You will be just forward of the Control Zone for a tracking gun shot at the Bandit's 0-30 deg AOT cone, at a distance of 1,000 to 1,500 ft. ***During the GST maneuver, the throttle should be advanced to MRT at the "Fox-2" call and kept there through the break turn execution***. After the break turn, with stabilized AOA, the throttle may be modulated as required by the Fighter as to maintain closure in the Control Zone, and to manage pipper placement for a tracking gun shot. You may also use a High Yo-Yo maneuver to slow or stop closure, and/or increase nose-to-tail separation, or a Low Yo-Yo maneuver to decrease nose-to-tail separation, as applicable.

605. GST ENTRY AND EXECUTION

The set up for entry into the GST exercise will involve some three-dimensional geometry and communication to get both Lead and Wing at 16,000 ft, 350 KIAS, and 1.5 nm abeam. This procedure is listed below:

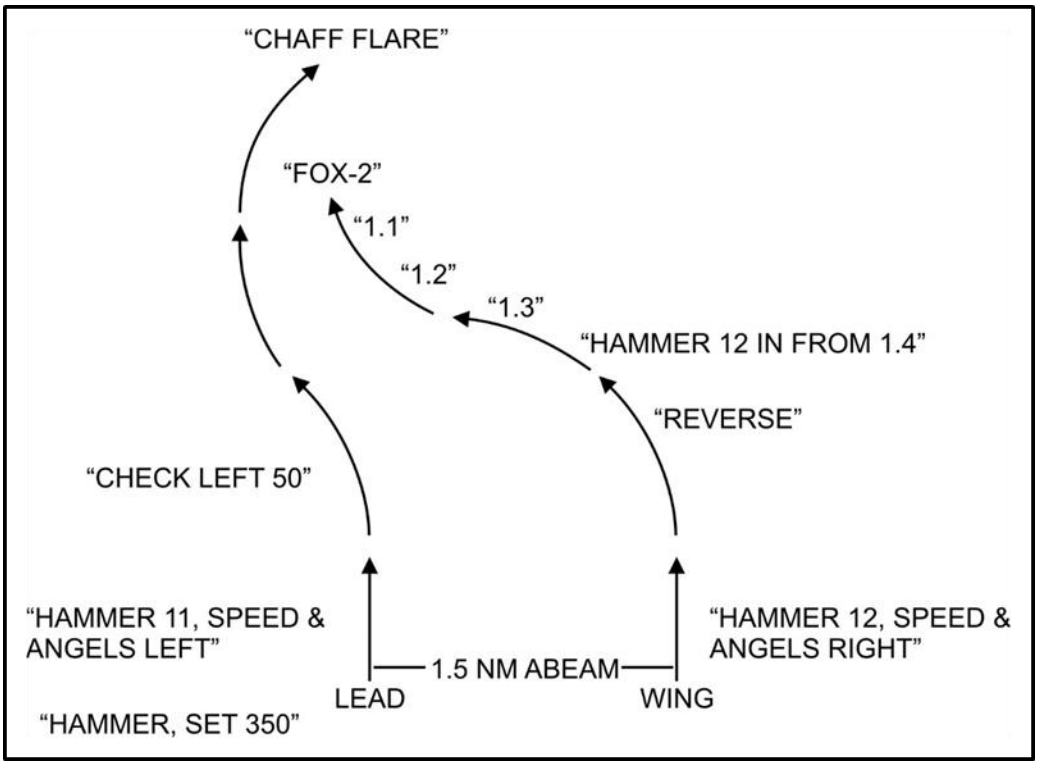

Figure 6-1 Set-up for GST

The set-up will be initiated by Lead:

Lead: *"Hammer, setting up for GST"*

Both Lead and Wing maneuver to achieve 16,000 ft, 300 KIAS, and 1.5 nm abeam. Once both aircraft are established there:

Lead: *"Hammer, set 350"*

Both aircraft will select MRT and execute a level acceleration, resetting power as required to establish 350 KIAS. Lead will initiate the Speed and Angels call, echoed by Wing:

Lead: *"Hammer 11, Speed and Angels left"*

Wing: *"Hammer 12, Speed and Angels right"*

Lead will then Check the flight 50 degrees away from Wing:

Lead: *"Check left/right 50"*

Wing will continue to turn toward Lead and direct a "reverse" when Lead is at Wing's canopy bow. Wing will reverse the turn and fly a pure pursuit curve, maintaining airspeed and altitude, and putting Lead between the airspeed and altitude boxes in the HUD. Wing will then call:

Wing: *"Hammer 12 in from X.X (A/A TACAN DME)"*

Wing will count down the range to Lead in tenths of miles, while directing Lead to either tighten or ease the turn to maintain 40° AOT. At 1.0 DME, Wing will call:

Wing: *"Fox-2"*

At the Fox-2 call, both aircraft will select MRT. Lead will then attempt to defeat the Sidewinder shot by calling:

Lead: *"Chaff Flare"*

At the Chaff Flare call, Lead will execute a defensive break turn, placing his/her lift vector on to slightly below the attacker for approximately 180 degrees of turn, bleeding down to 300 KIAS. Lead will then set power to 94–96%. At the Fox-2 call, Wing will drive to the Lead's point of departure. A good technique is to use a geo-reference point to drive to Lead's departure point (e.g. a cloud, ground ref, etc.). When aspect stops changing and the line of sight (LOS) rate rapidly increases, you are inside the Bubble, and have arrived at the Attack Window; realize that you might be able to notice the aspect change stabilizing more than a large LOS rate increase when flying the T-45.

Upon Bubble entry, you need to execute Attack Window Entry Mechanics. Roll to place your lift vector on to slightly below Lead, and max perform to stabilize Lead in your canopy (about 1 fist above the canopy bow). Analyze the Attack Window Entry (AWE) timing and subsequent defender maneuvering. Wing will then use lead, lag, and pure pursuit to arrive in the Control Zone while managing range, angles and closure. The student should look to initially take a tracking gunshot (1000 – 1500 ft) on a non-maneuvering, cooperative target. After several successful tracking gunshots, Lead should be cleared to maneuver by the Wing trunk IP calling "cleared to maneuver." Lead will leave the throttle set and use no more than 17 units AOA while maneuvering. Wing should look to employ tracking gun shots by squeezing the trigger with the pipper 1 – 2 plane lengths in front of Lead, then lagging to the Control Zone.

This is not BFM, so Leads should not be trying to create overshoots or closure problems. Lead may flash a wing into the Wing to indicate poorly managed range, angle, or closure problems to simulate where a reversal would normally have neutralized the fight, but Lead will not maneuver to create BFM merge mechanics. A KIO call may be initiated by any member of the flight when any aircraft is Bingo fuel, but is normally initiated by the Wing IP when learning objectives are met, per the TACSOP.

For amplifying information regarding follow-on BFM training refer to Appendix B and your BFM/SEM FTI.

606. GETTING TO THE CONTROL ZONE AND ATTACK WINDOW ENTRY

After the shot, roll wings-level and watch the Bandit go across the horizon for approximately 2 to 3 seconds. About this time you should be near the point where the Bandit began his/her break turn (Attack Window Entry). With the Bandit at approximately the 11 or 1 o'clock position (roughly the canopy bow), execute Attack Window Entry Mechanics to arrive in the Bandit's Control Zone with range, angles, and closure under control. Getting to the Control Zone with angles and closure under control comes from executing a max performance break turn toward the right piece of sky at just the right time.

607. MISSING THE CONTROL ZONE

There are a few reasons why the Engaged Fighter may ultimately arrive outside the Bandit's Control Zone after executing Attack Window Entry Mechanics. If the Fighter does not max perform the jet, the Bandit will initially establish a greater turn rate, such that the Fighter will have to work longer and harder to make up the angles to achieve Control Zone management.

If the break turn was late (after passing beyond the Attack Window), the flight path created may result in passing aft of or outside of the Bandit's Control Zone (or both). If early (before the Attack Window), the chance of turning in front of the Post, resulting in an in-close overshoot with the Bandit and high AOT, may exist. This subsequent in-close overshoot often gives the Bandit an opportunity to reverse and possibly neutralize the fight.

It should be noted again that your TAC FORM flights are not BFM, so the Bandit will only acknowledge a recognized overshoot or missed Control Zone/Attack Window Entry with a wing flash. After the wing flash, the Bandit will cooperatively roll back to the original direction of turn for continued training.

608. STAYING OFFENSIVE

The objective is to maneuver inside the Bandit's 0–30 deg AOT cone at a distance of 1,000 to 1,500 ft for a tracking gun shot. Proper Attack Window Entry is the first key to getting to a gun solution, however, management of the pipper can also be difficult to achieve. Control of the jet and steady pipper placement is dependent on smooth and precise control inputs required for valid shots.

609. MISALIGNED TURN CIRCLES (MATC)

When we discussed the Attack Window, the notion of 'near the point where the Bandit began his/her break turn' was used to mean just that – 'near' where the Bandit broke, not 'exactly' where the Bandit broke. Assuming similarly performing aircraft, if the Fighter executes Attack Window Entry Mechanics at exactly the point in space as where the Bandit executed, theoretically the Fighter will end up on the same turn circle as the Bandit, but with the nose stuck

in lag. Breaking 'near' where the Bandit broke (or in the Attack Window), will establish what's needed for 'misaligned turn circles.'

Misaligning your turn circle ever so slightly with respect to the Bandit's is essential in being able to get your nose on the Bandit, given there aren't too many angles to make up. When turn circles are misaligned appropriately, you will initially notice your flight path drift slightly to the outside with the feeling you are going further into lag. However, as the fight continues, the Engaged Fighter will eventually observe his/her flight path crossing back inside the Bandit's turn circle, with the nose inching towards pure or lead pursuit. When misaligned properly, the Engaged Fighter will achieve the desired effect while remaining inside the Control Zone the entire time. Excessively misaligning turn circles will lead to flying too far outside the Bandit's turn circle and eventually, out of the Control Zone. Excessively misaligned turn circles are most commonly attributed to late Attack Window Entries.

610. EXCESSIVE RANGE OR STUCK IN LAG

After poorly performed Attack Window Entry Mechanics, the Fighter may become stuck in lag and/or stuck outside of gun range. Executing some form of a Low Yo-Yo, as previously described, will probably be the solution to overcome excessive range or lag problems. With the Low Yo-Yo, if the Bandit has not maneuvered all the way down to the deck, then you may be able to trade altitude below you for airspeed, enabling more G (and turn rate) available to make up the remaining angles and closure on the Bandit. If getting stuck in lag was the result of aligned turn circles, then a Low Yo-Yo will tend to force some misalignment and allow for future shot opportunities.

611. EXCESSIVE CLOSURE OR TOO LITTLE RANGE

If the Fighter is able to get the nose on the Bandit and take a shot, some amount of closure on the Bandit may have been generated. A little closure can be manageable if the Fighter is still within the Control Zone; too much closure can be a problem if it results in the Fighter flushing out in front of the Control Zone. Some form of a High Yo-Yo should at least allow the Fighter to slow closure, or if aggressive enough, even allow for some range opening.

Pulling power and decelerating isn't a solution to excessive closure, or too little range. Pulling power and reducing the Fighter's overall energy state may work, if the Bandit is not in a position or energy state to capitalize on the Fighter's reduced energy. An obvious advantage to pulling power is that it saves gas, however, the disadvantage of pulling power is a depleted energy state. The Fighter may later need to utilize or call upon lost energy if the Bandit decides to do something different than simply continuing current flow, and the self-induced energy loss from the Fighter may later show itself as a lethal error in the air-to-air arena. Energy = Options.

612. METHODS FOR TAKING GUNSHOTS

Taking the shot is not difficult in theory. Put the pipper on the Bandit and pull the trigger. Sounds easy enough, but you will probably find that getting the pipper to settle down on the target takes much finer control inputs than you think. Below are a couple methods for getting bullets to hit your target:

- ***Saddling In***. By adjusting power, you may be able to settle comfortably 'in the saddle' (1000-1500 ft) with the pipper stationary on your target. It can be difficult to get the pipper on the target, and equally difficult to hold it there. A disadvantage to this method may occur if the Fighter excessively decreases power to maintain ranging during pure pursuit, and ends up at an energy deficit with respect to the Bandit.

- ***Pilot Controlled Error Technique***. In essence the pilot controlled error technique is accomplished by placing the pipper slightly in front of the Bandit (e.g., a half pipper's width), and pulling the trigger while letting the pipper drift back through the target. The spread of bullets from this technique forces the target to fly through a string of bullets, increasing the probability of a successful engagement. If the Bandit survives, the Fighter should be able to execute a Low Yo-Yo, placing the nose back out in front of the Bandit for another quick shot. This method has a couple of advantages: first, pipper control is easier since the Engaging Fighter is not trying to steadily hold the pipper on a target. Second, allowing the pipper to drift aft to the target briefly puts the Fighter's nose into a slight lag, allowing for a higher energy state throughout the maneuver.

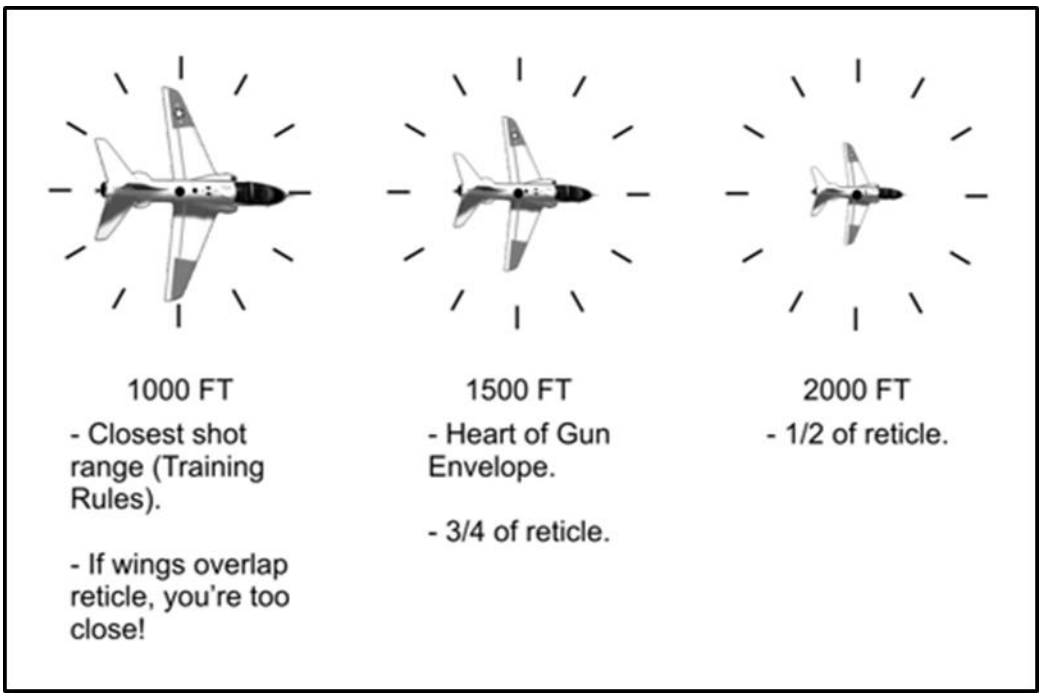

Figure 6-2 The Gun Reticle and Associated Ranges

Common Errors:

1. Poor timing on the Fighter's Attack Window Entry.

2. Inadequate/floated Attack Window Entry Mechanics.

3. Leaving the pipper on the target for too long and generating excessive closure, leading to an in-close overshoot.

4. Bleeding past turn rate numbers accidentally, and not allowing MATC geometry to work for you.

613. TACTICAL WING POSITION AND MANEUVERING

Tac Wing position is used during the Tac Admin portion of the flight to allow Lead flexibility to maneuver the section as required to a briefed location, execute a join, or to facilitate pushing Wing to a briefed tactical formation. Increased distance between Wing and Lead (greater than Admin Cruise) allows Lead to maneuver more dynamically but also allows Wing increased mission cross-check time to complete cockpit tasks. Tac Wing is defined as Lead's cruise bearing line or aft, 0.2-0.6 nm, and no lower than 1,000 ft below Lead's altitude. Attempt to avoid large throttle movements and capitalize on the fluidity of the position to utilize geometry to flow to the outside and inside of the turn as required to maintain position. On later block TAC FORM flights, expect Lead to direct Wing to take Tac Wing after the G-warm to practice Tac Wing maneuvering. Tac Wing positon and maneuvering will be utilized in follow on stages of training and in the fleet.

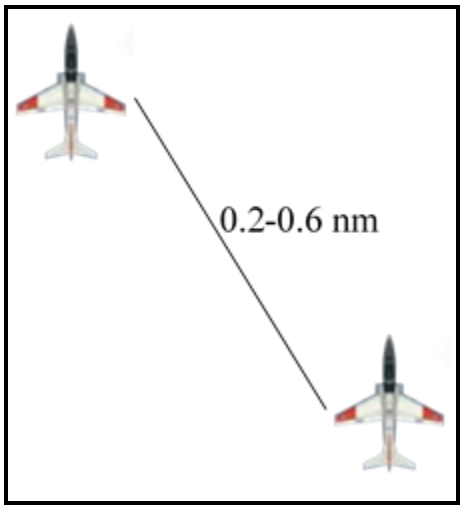

Figure 6-3 Tac Wing Position

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CHAPTER SEVEN
DIVISION TACTICAL FORMATION

700. INTRODUCTION

The Navy/Marine Corps tactical doctrine for Large Force Employment has, at its core, several divisions of Strike Fighters operating in briefed tactical formations. This training is a part-task trainer that will teach you how to function as a wingman (-2 or -4) in Division Tactical Formation while maintaining visual mutual support. The intent of this training is to expose you to the TAC ADMIN required to get a division to and from the fight while building your proficiency in basic TAC FORM maneuvers already executed in section but now executed in division.

701. ADMIN

One of the objectives of this part-task training mission is to expose you to a division TACAN or running rendezvous by sections. You may or may not have seen this in your division formation training but it is a common practice when joining a division if weather precludes a division interval takeoff. You will marshal as a division and check-in IAW SOP/TACSOP. Taxi and takeoff will be in sections as briefed by the Flight Leads. The Division Lead will brief a rendezvous game plan. This can be accomplished via a running rendezvous or TACAN rendezvous. As -2, fly the briefed formation. As -4, fly the briefed formation off of -3, but be sure to put -3 between your aircraft and the lead section when executing the join.

702. FORMATION

Flying safely and effectively in Division Tactical Formation requires good position keeping off of your Section Lead but also an awareness to the other members of the division. In this stage of training you will execute Division Wall and Fluid Four. In your follow-on training at the FRS and beyond, you will be introduced to other tactical formations.

703. DIVISION WALL

Division Wall is a flight of four fighters line abreast in combat spread. This formation allows the division to execute simultaneous attacks against air threats or surface targets while maintaining maximum visual mutual support. The center of the formation is -1 and -3 at 0.8-1.0 nm abeam. The outside is -2 and -4 maintaining the same abeam distance from their respective leads. An altitude de-confliction game plan will be briefed by the Division Lead. See Figure 7-1 below for an example altitude de-confliction game plan.

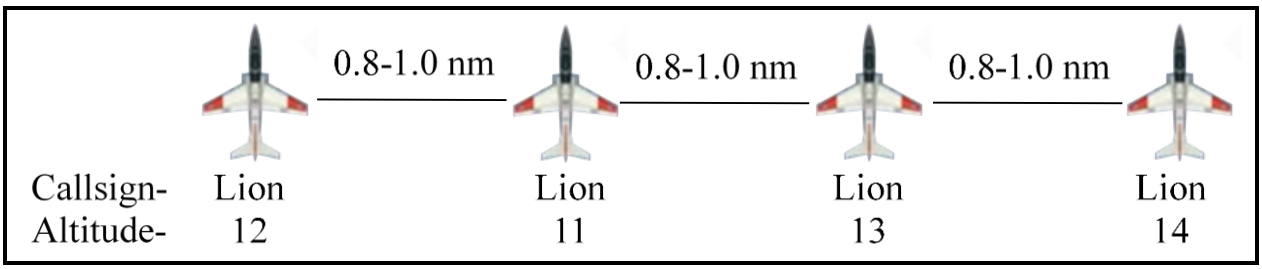

Figure 7-1 Division Wall Position

704. FLUID FOUR

The Fluid Four formation consists of -1 and -3 in combat spread in the center, and their respective wingmen in Tac Wing. This formation is commonly used during the administrative phase of flight to maintain visual mutual support between -1 and -3, but to also allow increased mission cross-check time and comfort for the wingmen during long transits. If operating in the National Airspace System, a slightly condensed version of this formation can be used to establish the FAA recognized "Standard Formation" or "ATC Spread," in which all aircraft are within 1nm and 100' feet of altitude from Lead. During the mission phase this formation can be used hold at a briefed location or specified race-track pattern, quickly change direction, and set a briefed tactical formation. Fluid Four provides an intermediate step between a purely administrative division Fingertip formation and a tactical formation such as Division Wall.

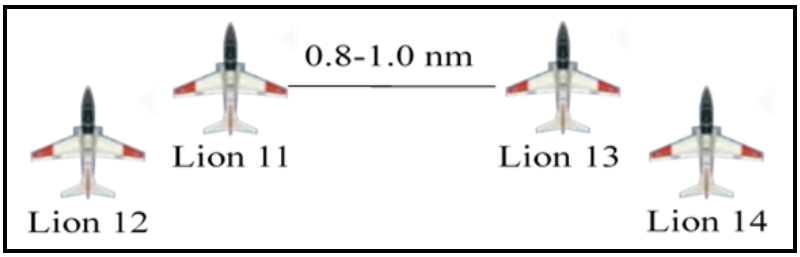

Figure 7-2 Fluid Four Position

705. TAC ADMIN

Division TAC ADMIN in CNATRA is accomplished in much the same manner as a section with a couple exceptions. Once the division is joined, the Division Lead will call a flow heading and deploy the division to a co-altitude Division Wall in preparation for the G-Warm.

Division Lead: *"Lion, flow 360, deploy."*

No response is required from the wingmen before initiating any maneuver. If a transmission is unclear, query the Division Lead for clarification. Of note, as -4, when directed to deploy from fingertip, simply maneuver to Tac Wing off of -3. Once -3 has reached an appropriate abeam distance from -1, continue to push out to Combat Spread. Additionally, the Master Armament switch will remain in the SAFE position during this stage of training to promote habit patterns consistent with those of your future fleet aircraft.

7-2 DIVISION TACTICAL FORMATION

706. DIVISION G-WARM (WALL FORMATION)

The Division G-Warm will be executed as in section but with four aircraft line abreast. After the G-warm, all flight members will established their briefed PADS and the Division Lead will initiate the "fenced in" call. Consult your local TAC SOP for specific guidance.

707. YARDSTICK GAME PLAN

The Division Lead will brief a yardstick game plan. Options include having the fighters range only within each section, ranging only between -1 and -3, and ranging within sections but with alternate ranging between -1 and -3 quickly available. For example, if you assign -1 40X, -2, 103X, -3 104X, and -4 41X, you will have ranging within the sections but also the ability for -3 to select one digit to the left and range to -1.

708. DIVISION COLLAPSE TO PARADE

During this stage of training you will practice collapsing the flight from Division Wall to parade. A common occurrence of this procedure in the Fleet is collapsing the flight to a fingertip parade, "loose cruise," or Tac Wing after the G-Warm in order to set up for a spacer pass, or to simply administratively rejoin the flight. Because we are not "Fencing Out," a "cleared to join" call will be used by the Division Lead to initiate the join. ***It is imperative that you execute a professional join.*** You must put your aircraft in a position to execute a join you have been taught, either CV or running rendezvous while maintaining SA to ALL other members of the division. An underrun may or may not be available depending on the position of the other joining members. As -4, you must keep -3 between yourself and -1.

709. FENCE-OUT

Once flight conduct is complete, the Division Lead will direct the flight to fence out. Since division battle damage checks are most commonly executed in section, a simple "fence out" call will instruct the wingmen to join on their respective leads. If the Division Lead desires to join the division, the following call will be made:

Division Lead: *"Lion, fence-out, you are cleared to join."*

710. DIVISION BATTLE DAMAGE CHECKS

When battle damage checks are to be done within a division, they should normally be done in separate sections from a fluid four formation. Another acceptable option is to have -4 check the rest of the division, and have -2 check -4.

When conducted as a three-ship, the standard is to execute the checks from fingertip formation with -3 checking lead and -2, then -2 checking -3.

711. DIVISION TACTICAL REJOIN

If battle damage checks were completed in section, -3 and -4 will join on -1. As -4, simply fly Tac Wing on -3 while he/she joins on the -1. Once -3 has stabilized in the briefed formation (parade, admin cruise, or Tac Wing), set the briefed formation off of -3. The Division Lead will initiate the "fenced-out" comm once the join is complete.

712. DIVISION TAC FORM MANEUVERS

Tac turns and in-place turns will be executed from Division Wall and Fluid Four. These turns will be initiated by the Division Lead with no response required from the wingmen. It is imperative that flight members maintain good positioning keeping off of their respective flight lead and execute sound timing with consistent basic air work. All maneuvers will be executed at 300 KIAS and 14 units AOA.

713. TAC TURNS IN DIVISION WALL

A tac turn in Division Wall is executed in much the same manner as in section. The wingman on the outside of the called turn will simply turn for 90 degrees and maintain 300 KIAS and 14 units AOA. The next aircraft on the inside of the turn will initiate the turn when the preceding aircraft's intakes are approaching. Each subsequent aircraft will turn when the preceding aircraft's intakes are approaching. Only tac turns for 90 degrees of heading change will be called. Figure 7-3 illustrates the maneuver.

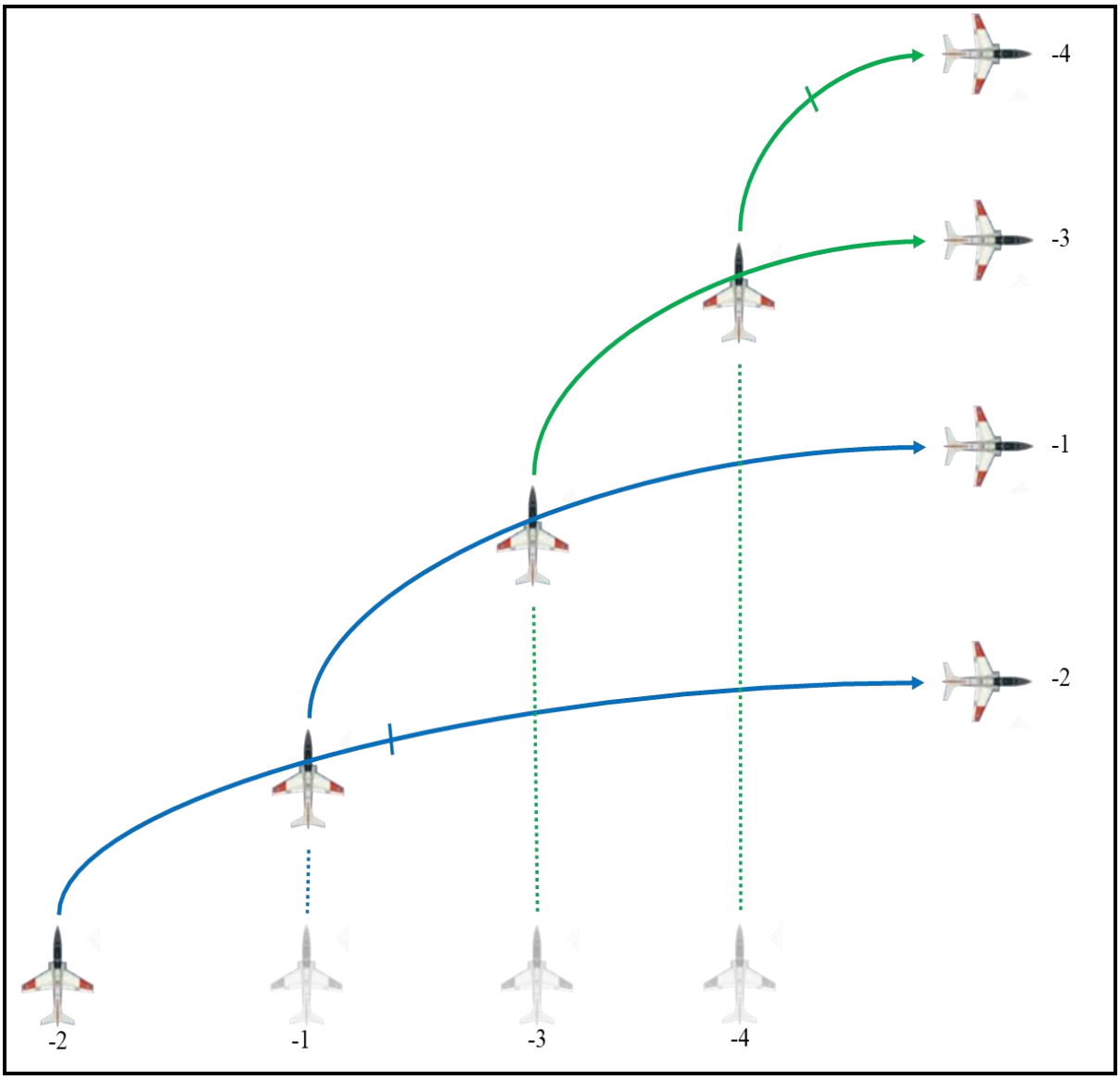

Figure 7-3 Division Wall Tac Turn

714. IN-PLACE TURNS IN DIVISION WALL

In-place turns in Division Wall are generally used to egress a target area after executing simultaneous air-to-surface target attacks. Execution is identical to that of a section in-place turn but with four aircraft line abreast. Only turns requiring 180 degrees of heading change will be called.

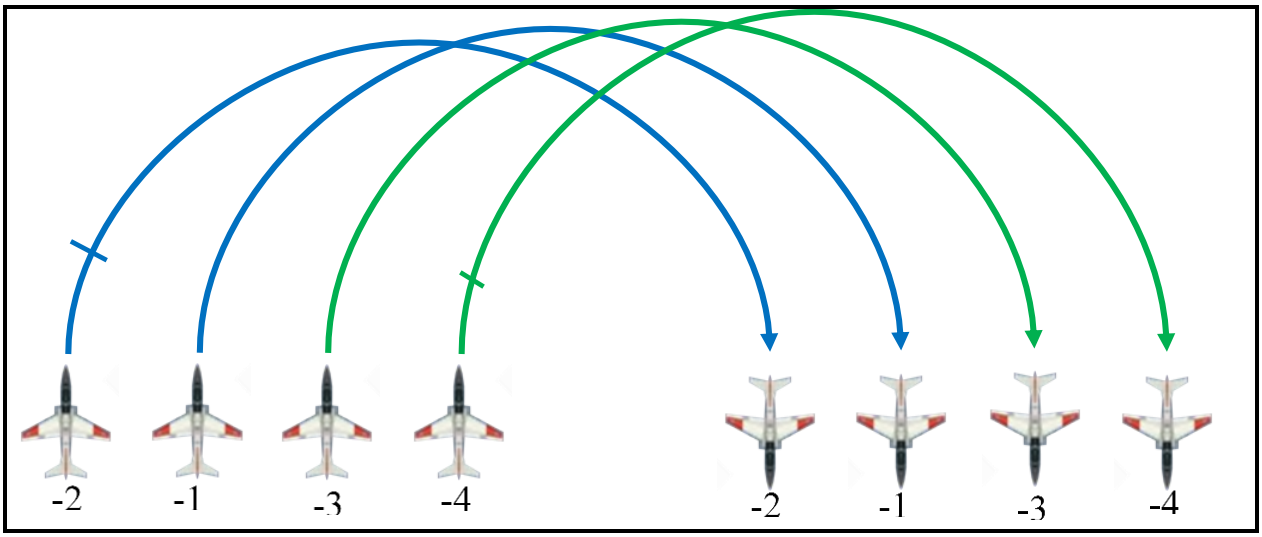

Figure 7-4 Division Wall In-Place Turn

715. TAC TURNS IN FLUID FOUR

A tac turn in fluid four simply maneuvers the division through 90 degrees of heading change. Depending on the direction called and formation, either -1 or -3 will initiate a 300 KIAS and 14 unit AOA turn into the other Section Lead while noting the position of the wingman on that side of the formation to ensure safe flight path de-confliction. The wingman in the first section to maneuver will simply fly Tac Wing off his/her Section Lead and flow to the inside of the turn. The second Section Lead to maneuver will execute a standard tac turn when the first Section Lead's intakes are approaching. The second wingman will fly tac wing off their lead utilizing energy and geometry to maintain Tac Wing position throughout the turn but end up on the outside of the formation looking through his/her Section Lead to gain sight of the other section. Figure 7-5 illustrates the movements of the wingmen. As wingmen, it is your goal to maintain position off of your Section Lead but also maintain sight of the other section to the maximum extent practical. Only tac turns for 90 degrees of heading change will be called.

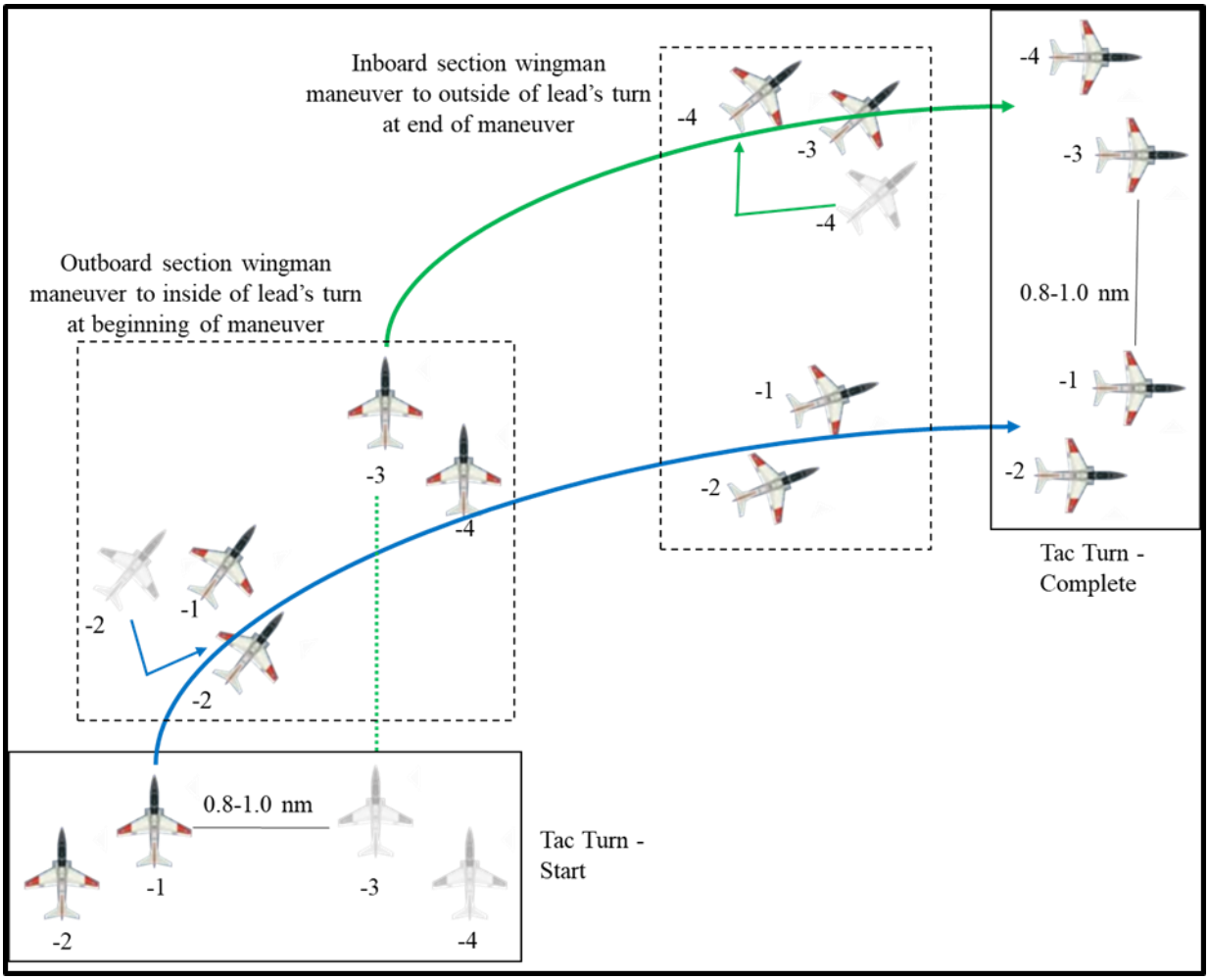

Figure 7-5 Fluid Four Tac Turn

716. IN-PLACE TURNS IN FLUID FOUR

An in-place turn in fluid four simply maneuvers the division through 180 degrees of heading change. Dash 1 and -3 simply execute an in-place turn. The wingman on the outside of the turn will maneuver to the inside of the turn in Tac Wing. The wingman on the inside of the turn will maintain Tac Wing position but will need to manage energy and geometry to roll out on the outside of the formation looking through the Section Lead to regain sight of the other section. Figure 7-6 illustrates initial formation and desired outcome with arrows to show the movements of the wingmen. Only in-place turns for 180 degrees of heading change will be called.

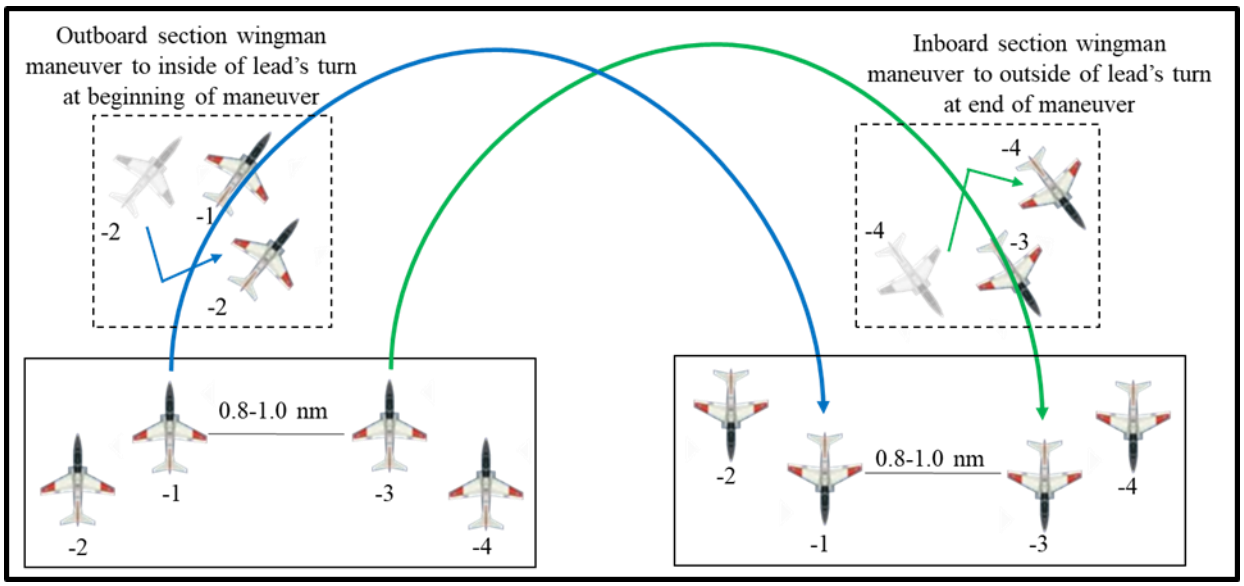

Figure 7-6 Fluid Four In-Place Turn

717. FLIGHT SEQUENCE

Division deploy to wall formation
Division G-warm
FENCE-in/set PADS (wall formation with altitude de-confliction)
    Tac turns
    In-place turns
Collapse to Parade
Deploy to fluid four formation
    Tac turns
    In-place turns
Battle damage checks
Division tactical rejoin

CHAPTER EIGHT
SAFETY/EMERGENCY SITUATIONS

800. EMERGENCY

Oil Pressure Warning Light**.** This typically occurs following an overly aggressive unload to gain energy prior to an Attack Window Entry. Negative G followed by a positive onset of G may cause a momentary OIL PRESS Warning according to NATOPS. Knock-off the fight and go through the Emergency Procedures. It is acceptable to continue training after both aircraft reset following a momentary illumination of this light after this kind of maneuver.

801. RELATIVE MOTION/EXCESSIVE CLOSURE

In maneuvering flight, own aircraft motion is evaluated by detecting motion with relation to the other aircraft. As a pilot in a maneuvering environment, we need to be able to realize how our aircraft motion and the other aircraft's motion combine for overall perceived closure. This requires a high level of proficiency, as well as a disciplined internal and external scan. The key is to be able to keep 90% of our scan outside the cockpit and on the other aircraft, while scanning 10% inside to obtain our own aircraft performance information. To achieve this scan balance, we need to know where the critical flight instruments are that will paint a picture of our energy state, and then be able to evaluate what we are seeing quickly. An example of this is the scan during a Cross Turn where we need to scan inside quickly to check airspeed, AOA, and altitude while maintaining situational awareness with respect to the other aircraft. Since our jet is moving in relation to the other, what he/she does will greatly influence what we need to do with our jet. Excessive closure can happen during any maneuver, and we need to assess the information we are seeing and react accordingly. The maneuver where this is likely to happen is the Gunsight Tracking exercise. There are many scenarios and reasons why you may see excessive closure. If you realize that you're in this situation, you need to get your lift vector and/or velocity vector off of the other aircraft, and assume lag pursuit while maintaining sight for safety of flight. In managing excessive closure, what we don't want is a belly-up turn away! If you are belly-up at close range you will lose sight of the other aircraft and cannot judge closure. ***Remember, your aircraft has momentum that will not change instantaneously!***

802. SPATIAL AWARENESS

This concept deals with the notion of knowing your energy state and the position of your aircraft in relation to the deck, the working area, and the other jets you're fighting with or against. You need to know where both aircraft are in relation to the deck, and understand what you can do with the airspeed, altitude, and lateral/vertical separation possessed at that moment in time. A snapshot of your energy state, and of how both your jet and the other jet are positioned in relation to each other, will enable you to make sound maneuvering decisions. Spatial awareness is paramount to maneuvering effectively in the air-to-air arena, and it takes time and experience to develop. We're all a work in progress so don't get frustrated — keep working hard!

803. LOST SIGHT/LOOKOUT

Lookout doctrine has been discussed thoroughly in previous sections of this FTI. Your scan needs to be divided appropriately in order to monitor your own aircraft parameters while staying in position and sanitizing the airspace around the section. Any breakdown in your visual scan will seriously jeopardize section integrity and, in the operational world, could get you or Lead killed.

As a tactical pilot, you need to be disciplined in your scan pattern and concentrate on your areas of responsibility. Lookout discipline is not just for flying in Spread. During maneuvers, we need to keep sight of the other aircraft while maneuvering our jet. It is not possible to keep sight all of the time during many of the maneuvers, but if we have spatial awareness, we will be able to know where to look and when we should have sight. This is a concept that all tactical pilots use. We know when we should have sight and when we should not. Spatial awareness can fill in the picture to give us an idea of where to look when we have the opportunity to regain sight. To be able to do this, you need to have sight just before the other aircraft enters your blind zone. This will enable you to see and evaluate aspect, track crossing rate, and separation. With this information you can assess, factoring in your own maneuvering, where he/she will be on the backside of the turn or maneuver.

If after a couple of seconds you think you should have sight and you do not, you need to call "blind." This call can be made to your trunk IP over the ICS during dual hops, or to Lead over the radio. Lead will brief what they want you to do, but it usually involves having the Wing trunk IP talk your eyes back on if they have sight. If not, or he/she doesn't say anything, call it out over the radio and then listen to Lead's comm. The other aircraft will either talk your eyes on or direct you how to maneuver to regain sight. If Lead doesn't have sight of you either there will be a KIO, followed by altitude splits and a flow heading for the section. You need to echo the KIO, altitudes, and headings. This will ensure both aircraft are de-conflicted laterally and vertically. Once de-confliction is assured, Lead will effect a rejoin through directive comm.

804. AIRSICKNESS

The air-to-air arena is extremely dynamic and the body is exposed to a myriad of physiological stress factors. You need to realize what your body is telling you and what you can do to help yourself. Airsickness is not uncommon early on, and it's nothing to be ashamed about. Let your IP know as soon as you don't feel right so a KIO or Training Timeout can be called. You can swap controls if you have an IP in your backseat, or ask for the lead if you are solo. ***Bring an airsickness bag with you on all TAC FORM flights.***

APPENDIX A
FOLLOW-ON BFM DISCUSSION

A100. FOLLOW-ON BFM DISCUSSION

Following your Attack Window Entry in your BFM flights, you will focus on some additional points and follow-on maneuvering that we don't refer to in the Gunsight Tracking exercise in TAC FORM. This is because TAC FORM is not BFM. Included here is an expanded discussion with regards to those options. This discussion starts with analyzing the Attack Window Entry (AWE), and subsequent defender maneuvering:

- If you are early to the AW, it will be easy to pull the defender forward on your canopy, possibly to your HUD. Use a lag maneuver to prevent an in-close overshoot. You can ease your pull or roll 45° nose-up, and out of plane momentarily, then re-establish your pull, or reorient your lift vector back on the Bandit. An early correction normally results in a slight flight path overshoot, similar to a slightly late AWE. If you break early (before the Attack Window) you stand the chance of turning in front of the Post, and overshoot in-close to the Bandit with high AOT.

- If late to the AW, you will be unable to stabilize the Bandit on your canopy while max performing. In this case, keep the pressure on the Bandit with your lift vector on, and maintain the pull to arrive in the rate band. Utilize an energy sustaining pull once in the rate band. Now it is time to be patient and utilize misaligned turn circles. Keep in mind the later your AWE, the more neutral the fight, and thus we are engaged in more of a turning rate war with the Bandit.

- With a 'nailed' AWE, and properly executed AWE mechanics, you will be able to stabilize the Bandit on your canopy right above the canopy bow with only a small amount of movement aft (i.e., a small flight path overshoot within the confines of the Control Zone).

The Bandit will slide aft on your canopy slightly during the flight path overshoot due to misaligned turn circles. Be patient, and do not bleed excessively. After the flight path overshoot the Bandit will stabilize on your canopy, then start to move forward. This is the time to perform an energy excursion with lift vector on the Bandit and a nibble of buffet pull, trading airspeed for nose position.

The best way to recognize misaligned turn circles is to reference the Bandit's position off your canopy. If the Bandit is moving forward on your canopy, then misaligned turn circles are working for you. If the Bandit is moving aft on your canopy, then you will have to wait for the geometry of MATC to start working for you. The time to start your energy excursion is as soon as the Bandit starts to move forward on your canopy. Assess weapons separation, put your lift vector on the Bandit, and perform a lift-limit pull. Employ the appropriate weapon and immediately lag off to preserve your position in the Control Zone. Adjust your pull to preserve airspeed and look for another shot opportunity. Do not bleed your airspeed without a reason to do so!

Redefinition Follow-on Mechanics

When the Bandit assesses your nose becoming a threat, a nose-low ditch maneuver will be performed. By maneuvering nose-low, the Bandit is attempting to create angles, and attempting to hold your nose in lag. Look to counter this by driving to the Bandit's point of departure. Max perform in the vertical to create turning room, if required. Check your altitude (6k required to follow pure nose-low), target 220 – 250 KIAS, and enter the AW in the vertical plane, keeping the Bandit on the canopy bow while adjusting your lift vector to align fuselages. As the deck becomes a factor, use the deck transition ten percent rule to prevent busting the deck (i.e., 4000 ft. above deck = 40 deg. nose low, 3000 ft. above deck = 30 deg. nose low, etc.). During this nose-low fight, if range or closure become a factor, modulate the throttle or reorient your lift vector to aid in controlling closure. Make sure you have turning room above the deck to follow the Bandit. If you do not have the altitude to perform a pure nose-low maneuver (6k above the deck) you need to maneuver in the oblique and intercept the 10% rule. Adjust your lift vector off of the vertical just enough to prevent busting the deck. You will learn more about the deck transition options in the discussion of defensive maneuvering. Most importantly, you need to maneuver aggressively and timely to counter the Bandit's nose-low maneuver.

On the Deck

Arriving on the deck, angles off nose will increase due to the fuselage misalignment. The more the fuselages are misaligned, more angles will be created. Be patient with your pull, using G to maintain airspeed on the deck until identifying a shot opportunity. The shot opportunity will come immediately following the deck transition with relatively aligned fuselages, or if the Bandit did not perform a proper deck transition. With a properly performed deck transition, or higher fuselage misalignment, the shot opportunity will most likely come in the form of misaligned turn circles and a timely energy excursion. The best way to recognize misaligned turn circles is to reference the Bandit's position off your canopy. If the Bandit is moving forward on your canopy, then misaligned turn circles are working for you. If the Bandit is moving aft on your canopy, then you will have to wait for the geometry of MATC to start working for you. The time to start your energy excursion is as soon as the Bandit starts to move forward on your canopy. Assess weapons separation, put your lift vector on the Bandit, and perform a lift-limit pull. Employ the appropriate weapon and immediately lag off to preserve your position in the Control Zone. Then adjust your pull to preserve airspeed and look for another shot opportunity. Do not bleed your airspeed without a reason to do so!

The overall objective is to arrive in the Control Zone with range, angles, and closure under control. Take shots of opportunity and apply follow-on BFM (e.g., a lag maneuver back to the Control Zone) to maintain your offensive advantage.

Conclusion

The key to mastering Offensive BFM is in understanding and solving the three BFM problems of range, angles, and closure. You must perform a timely and well executed offensive break turn, utilize proper redefinition follow-on mechanics, and intelligently perform an energy excursion to kill the Bandit in a timely manner. This takes solid knowledge of the concepts, sound execution, and aggressiveness.

A-2 FOLLOW-ON BFM DISCUSSION