# FLIGHT TRAINING INSTRUCTION

# BASIC FIGHTER MANEUVERING
# SECTION ENGAGED MANEUVERING

# T-45 STRIKE

**2016**

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

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N715
3 Mar 21

CNATRA P-1289 (REV. 01-16) CHANGE TRANSMITTAL 1

Subj: FLIGHT TRAINING INSTRUCTION, BASIC FIGHTER MANEUVERING SECTION ENGAGED MANEUVERING, T-45 STRIKE

Encl: (1) Change 1 pages including Change Transmittal Letter and pages 1-1, 1-2, 6-6, and 8-2

1. Purpose. To publish Change 1 to the basic publication.

2. Action.

   a. Remove pages 1-1, 1-2, 6-6, and 8-2 and replace with pages in enclosure 1.

   b. Record Change 1 on the Summary of Changes page.

3. Future printing of this Flight Training Instruction will incorporate the change. CNATRA POC is LCDR Geoffrey Dick, N715, DSN 861-3895.

D.F. WESTPHALL
By direction

Releasability and distribution:
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1. CNATRA P-1289 (Rev. 01-16) PAT, "FLIGHT TRAINING INSTRUCTION BASIC FIGHTER MANEUVERING SECTION ENGAGED MANEUVERING, T-45 STRIKE" is issued for information, standardization of instruction, and guidance for all flight instructors and student aviators within the Naval Air Training Command.

2. This publication shall be used as an explanatory aid to support the T-45 Advanced Strike Flight Training Curriculum. It will be the authority for the execution of all flight procedures and maneuvers herein contained.

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

4. CNATRA P-1289 (08-09) PAT is hereby cancelled and superseded.

C. J. HAYDEN
By direction

Distribution:
CNATRA Website

**FLIGHT TRAINING INSTRUCTION**
**FOR**

**BASIC FIGHTER MANEUVERING (1V1)**
**SECTION ENGAGED MANEUVERING (2V1)**

**T-45**

**P-1289**

## HOW TO USE THIS FTI

This Flight Training Instruction (FTI) is your textbook for the Basic Fighter Maneuvering (BFM) and Section Engaged Maneuvering (SEM) stages of your Advanced Strike pilot training and is the source document for all procedures related to BFM and SEM. In addition, it includes suggested techniques for performing each maneuver and making corrections.

Use your FTI to prepare for and afterward to review lessons and flights. This information will help you effectively prepare for lessons: know all the procedures in the assigned section(s), review the glossary, and be prepared to ask your instructor about anything that remains unclear. Then you can devote your attention to flying the T-45. After a flight, review the FTI materials to reinforce your understanding and to clarify any difficult maneuvers or procedures.

Note that this FTI also contains information on emergencies related to this stage. This section of the FTI amplifies but ***does not supplant*** the emergency procedures information contained in the T-45 NATOPS manual.

Reading requirements for flight procedures lessons (lectures) are listed in Appendix D, "Lesson Preparation," along with the course learning objectives. The end-of-stage exam will be based on these objectives. Complete the required reading prior to each lesson (lecture).

## LIST OF EFFECTIVE PAGES

*Dates of issue for original and changed pages are:*
Original... 15 Feb 07 (this will be the date issued)
Revision …1… 07 Oct 09
Revision …2… 29 Oct 12
Change Transmittal…1…15 Oct 13
Revision…3…07 Jan 16
Change Transmittal…1…03 Mar 21

**TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 178 CONSISTING OF THE FOLLOWING:**

| Page No. | Change No. | Page No. | Change No |
|---|---|---|---|
| COVER | 0 | 11-6 (blank) | 0 |
| CHANGE LETTER | 1 | 12-1 12-7 | 0 |
| LETTER | 0 | 13-1 – 13-13 | 0 |
| iii-xiii | 0 | 13-14 (blank) | 0 |
| xiv (blank) | 0 | 14-1 – 14-3 | 0 |
| 1-1 – 1-2 | 1 | 14-4 (blank) | 0 |
| 2-1 – 2-7 | 0 | 15-1 – 15-4 | 0 |
| 2-8 (blank) | 0 | 16-1 – 16-3 | 0 |
| 3-1 – 3-5 | 0 | 16-4 (blank) | 0 |
| 3-6 (blank) | 0 | 17-1 – 17-10 | 0 |
| 4-1 – 4-8 | 0 | 18-1 – 18-2 | 0 |
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| 6-1 – 6-5 | 0 | A-1 – A-8 | 0 |
| 6-6 | 1 | B-1 – B-4 | 0 |
| 6-7 – 6-16 | 0 | C-1 – C-2 | |
| 7-1 – 7-12 | 0 | | |
| 8-1 | 0 | | |
| 8-2 | 1 | | |
| 9-1 – 9-3 | 0 | | |
| 9-4 (blank) | 0 | | |
| 10-1 – 10-2 | 0 | | |
| 11-1 – 11-5 | 0 | | |

## INTERIM CHANGE SUMMARY

The following Changes have been previously incorporated in this manual:

| CHANGE NUMBER | REMARKS/PURPOSE |
|---|---|
| 1 | Changes made per change transmittal letter (03 Mar 21). |
| | |
| | |
| | |

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

| INTERIM CHANGE NUMBER | REMARKS/PURPOSE | ENTERED BY | DATE |
|---|---|---|---|
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## BFM INTRODUCTION

When the P-80 finally became operational in the mid-1940s, WWII was coming to a close, as was seemingly the age of aerial dog fighting. While these aircraft never took part during operations in Europe, they became an integral part of combat operations in Korea. In November, 1950, a P-80 flown by LT Russell Brown shot down a Russian MiG-15 in the world's first decisive all-jet aerial battle, acting as a reminder that BFM was still a very real possibility in combat operations. With the maturation of aerial warfare evolving into Beyond Visual Range (BVR), the decades that followed Korea exploded with the development and implementation of long range air-to-air missiles that could potentially eliminate the possibility of Within Visual Range (WVR) engagements. During the Vietnam conflict, however, aircrew often found themselves unable to employ their BVR missiles, forcing weapons employment into the WVR arena, ultimately relying on BFM skills to defeat their opponents. The days of Korea and Vietnam are long past, and we have achieved amazing successes with the accuracy and reliability of our current long-range missiles. As we, and our enemies, continue to improve our BVR capabilities, a combination of electronic attack, theater Rules of Engagement (ROE), switchology failures, or a momentary lack of attention to prescribed air-to-air timelines may ultimately bring us face to face with the enemy in a 1v1 engagement.

1. Combat Lessons Learned — Despite operating in an era of all-aspect BVR missiles, history has continuously proven that the majority of air battles are fought and won in the visual arena. Even in the largest engagements or multi-plane scenarios, for that brief moment when the decision is made to engage an opponent, we are involved in 1v1 BFM. Strike/fighter aircrew ***must*** be proficient at 1v1 air combat to minimize time-to-kill and ensure they leave merges unscathed.

2. Develop Fundamental Tactical Skills — Through BFM we are allowed to practice briefing, debriefing, stick/rudder/throttle mechanics, and tactical decision-making. The development of these core tactical skills and the confidence we gain in maneuvering our aircraft throughout its flight envelope improves our ability to perform and maintain situational awareness in other strike/fighter missions.

Fundamental tactics and maneuvers of air combat have changed little in the last 70 years. In this stage, we will introduce the classic fighter-versus-fighter maneuvers and discuss how to employ them in staged and dynamic situations. It is incumbent upon all strike/fighter aircrew to have a sound understanding of 1v1. The 1v1 BFM discussion will use a building-block approach, progressing from the basics behind maneuvering the aircraft, to weapons systems capabilities and limitations, and ultimately applying concepts specific to Perch and High-Aspect BFM.

By the time you complete BFM, you will not be an expert. That happens only in time through constant coaching, practice, and experience. BFM will probably be your most demanding stage of flight training, requiring immense concentration and attention to your instructors. You must go beyond mastering the procedures and concepts presented in the classroom; you must apply them in the air and begin to establish your skills as a strike/fighter pilot. BFM is in many ways an art form - the ultimate art form of aviation.

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# CHAPTER ONE
# BFM ADMIN

## 100. PREFLIGHT/START/MARSHAL/TAXI/TAKEOFF

These procedures are identical to TACFORM operations on deck.

## 101. DEPARTURE

Join all the way into parade position utilizing whatever rendezvous method lead briefs. Give lead a thumbs up, or head nod, to let him know you have a good jet and are ready to press on with the mission. Expect lead to push you out to cruise position or ATC spread as long as weather is not an issue.

## 102. FINAL RENDEZVOUS

During the final join-up, ensure that you have fenced out, and continue the join just as you did in the TACFORM stage. During the join-up, use proper under-run or over-run procedures if excessive closure or safety becomes a factor. Once joined in parade, give lead a thumbs-up or head nod to confirm you are fenced out so lead can initiate the battle damage checks.

Recall the Tactical Rejoin procedures from the Tactical Formation stage below:

The Tactical Rejoin gets the Fighters back into Parade formation prior to returning to base. It will be executed from Defensive Combat Spread (DCS) and initiated at the "Fence-out" call from Lead. If in a position other than DCS at the "Fence-out," utilize Tac Form corrections to establish DCS 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 bearing line. Expect Lead to be 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.***

To execute the rejoin for DCS, place the LV on to slightly below Lead, pull 17 units or 4G's (whichever limit is achieved first), to establish a 30-45 degree cut into Lead. 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 can be executed. Tactical rejoins from sucked positons require less than 30-45 degree 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 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; this will be a safety issue in follow-on multi-plane stages.

Once Parade is established, the Tactical Rejoin is complete.

# CHAPTER TWO
# BFM TACADMIN

## 200. INTRODUCTION

TACADMIN will be conducted the same as in the TACFORM stage. Expect to join-up in parade, transit via cruise or ATC spread, be pushed to combat spread, and execute the g-warm. Following the g-warm you will complete your combat checklist, fence in, and be ready to fight immediately. BFM flights are extremely fuel limited, so you can expect lead's tempo to be quicker than previous stages.

## 201. TACSOP

Be exceptionally familiar with the most current TACSOP, it will contain most of the TACADMIN and comm you will need to know for this stage. The BFM stage is an extremely difficult stage to learn. Knowing the TACSOP cold and executing it will enable you to worry about the bigger picture - learning BFM.

## 202. COMBAT CHECKLIST

All combat checks should be accomplished either on deck or enroute to the area, short of selecting the MASTER ARM switch to ARM; 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 boxed, WSPAN: 31 feet
- Master Arm switch – ARM
- VCR Switch – ON
- Environmentals – Write down sun, winds, and cloud decks

## 203. PADS

Once established in the area, the section will use Defensive Combat Spread (DCS) to maneuver in the operating area. The beginning of every BFM set should start with both aircraft meeting certain parameters. Figure 2-1 describes where you should place your aircraft in relation to lead. Expect to be at 300 KIAS until your lead calls "Set XXX" or "Unload for knots."

| | **P**osition | **A**ltitude | **D**istance | **S**peed | Initiated From |
|---|---|---|---|---|---|
| **SNAP SHOT DRILL** | Abeam | Deck + 5k | 1.0 nm | 300 | |
| **FLATS** | Abeam | Deck + 5k | 0.5 nm | 200 | |
| **ROLLER** | Abeam | Deck + 6k | 0.5 nm | 200 | |
| **6K' SET** | Abeam | Deck + 6k | 1.5 nm | 350 | |
| **9K' SET** | Abeam | Deck + 6k | 2.0 nm | 400 | Deck + 8.5k<br>300 KIAS |
| **BUTTERFLY** | Abeam | Deck + 6k<br>Deck + 2k | 1.0 nm | 350 | |
| **ABEAM** | Abeam | Deck + 6k | 1.5 nm | 350 | |
| All decks referred to for PADS will be the hard deck<br>Allowable Deviations: Altitude +/-100 ft; Distance +/-0.1 nm; Speed +/- 10 kts;<br>Bearing Line +/- 10° | | | | | |

**Figure 2-1 BFM PADS**

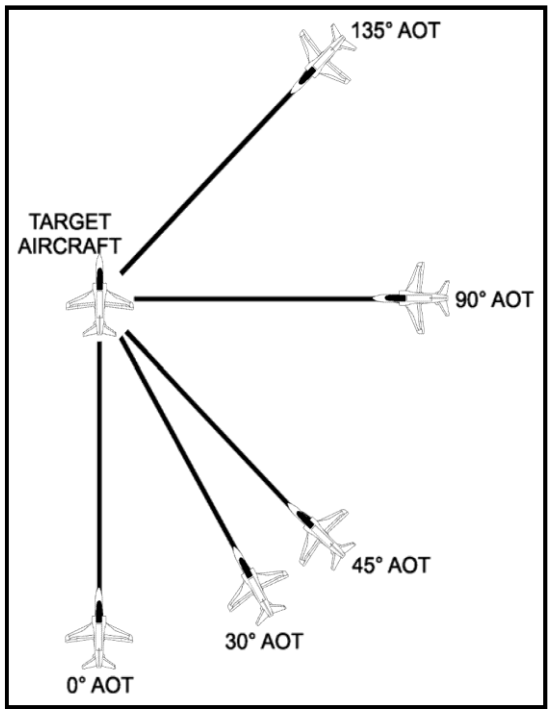


**Figure 2-2 Angle Off Tail Overview**

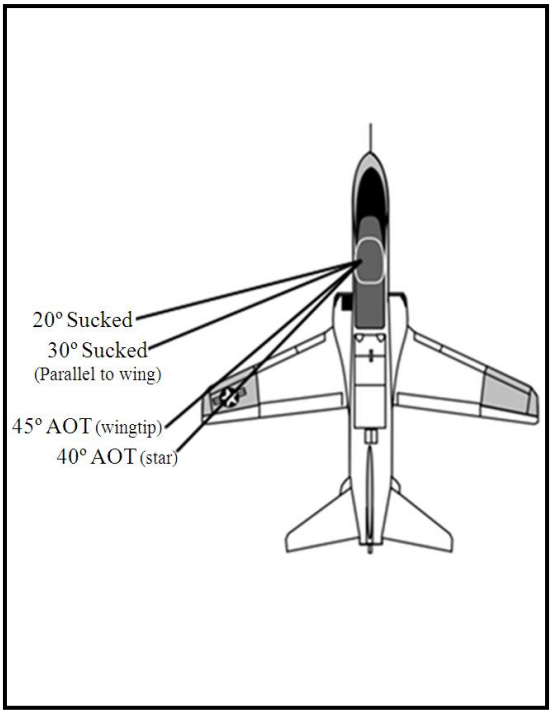


**Figure 2-3 Angle Off Tail (Front Cockpit)**

## 204. REFERENCE ANGLES

Use the above diagrams to reference Angle Off Tail (AOT), or degrees acute from lead's 3/9 line when in level flight. Use the diagram below to reference AOT when in a defensive position.

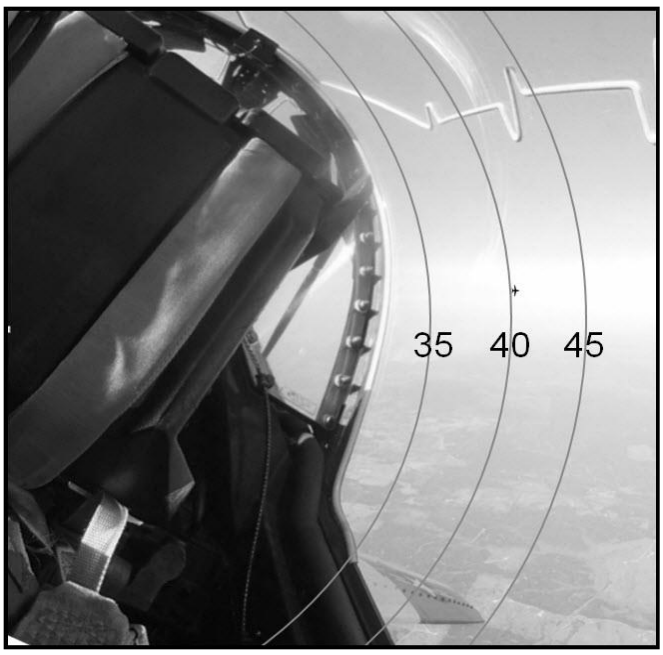


**Figure 2-4 Angle Off Tail (Defensive)**


**Figure 2-5 40° Angle Off Tail**

## 205. SPEED AND ANGELS

The bandit lead will set the geometry for follow-on sets based on area management. Your job is simple – maintain whatever heading the bandit has assigned you while getting into position, airspeed as appropriate, and at the proper altitude. Oftentimes the bandit will need to check the flight to a new heading (for geometry, area management, etc.). Echo the new heading, utilize a hard energy-sustaining turn, and get there. If the set starts at 200 KIAS you will maintain 300 KIAS until you are told to slow by lead; then, do whatever is necessary to stay in position as both aircraft decelerate.

We will accept slight deviations from the PADS, not to exceed the following:

- Altitude: ± 100 ft
- Distance: ± 0.1 nm
- Speed: ± 10 kts
- Bearing: ± 10°

When you are within these parameters make your speed and angels call. The lead will initiate the call when he feels the wingman is in a good position.

## 206. KNOCK-IT-OFF (KIO)

Upon the conclusion of each set, the IP in your jet (on dual hops) or the bandit (on solo hops) will call a ***Knock-it-Off***. Both aircraft will acknowledge the KIO (reference the TACSOP for the proper comm). The priorities, in order, for you as the fighter following the KIO are:

1. Stand up the throttle, stop fighting, and maintain sight.

2. Hard turn, or pull as necessary, to the flow heading to maintain deconfliction and arrive in position.

3. Capture the bearing line and set 300 KIAS. Set abeam distance for next set.

4. Climb to appropriate altitude.

5. G's and fuel, with general SA, and on heading/bearing line, in a 300 KIAS climb.

When in a climb, always reference 300 KIAS. For sets that start at slower airspeeds, lead will advise you when to decelerate. Use nose position and power to minimize your time to climb, trading airspeed for altitude when necessary.

## 207. VALID SHOT REQUIREMENTS

We cannot just pull the trigger and consider the shot to be successful. Certain parameters must be met in order for the missile to track to the target or have bullets actually hit and inflict damage on the enemy aircraft. The requirements that must be met to consider it a valid shot are in the list

below.

IR Missile:

1. Shooter within CNATRA Sidewinder Envelope.

2. Target in the HUD Field of View (FOV).

3. Wingman must not be in HUD FOV (shot deconfliction).

4. ***Pull the trigger (when steps 1, 2, and 3 met)***.

Gun Snap Envelope:

1. Shooter within snap gun envelope.

2. Pull trigger early (>1 sec. prior) to establish bullets downrange at target's distance.

3. Target must pass through pipper.

4. Two valid snap shots equal a kill.

Gun Tracking Envelope:

1. Shooter within tracking gun envelope.

2. Pull trigger with pipper on target.

3. One second of cumulative tracking time equals a kill.

Although not required for a valid kill, for training we must call our shots. The called shot must be appropriate for the weapon/envelope being employed after a valid shot has been taken:

1. IR missile shot – "(fighter call sign)…Fox-2."

2. Snap gun – "Trigger down, snap (assessment), (missed high/missed low/looked good)."

3. Tracking gun – "Pipper's on, tracking…pipper's off."

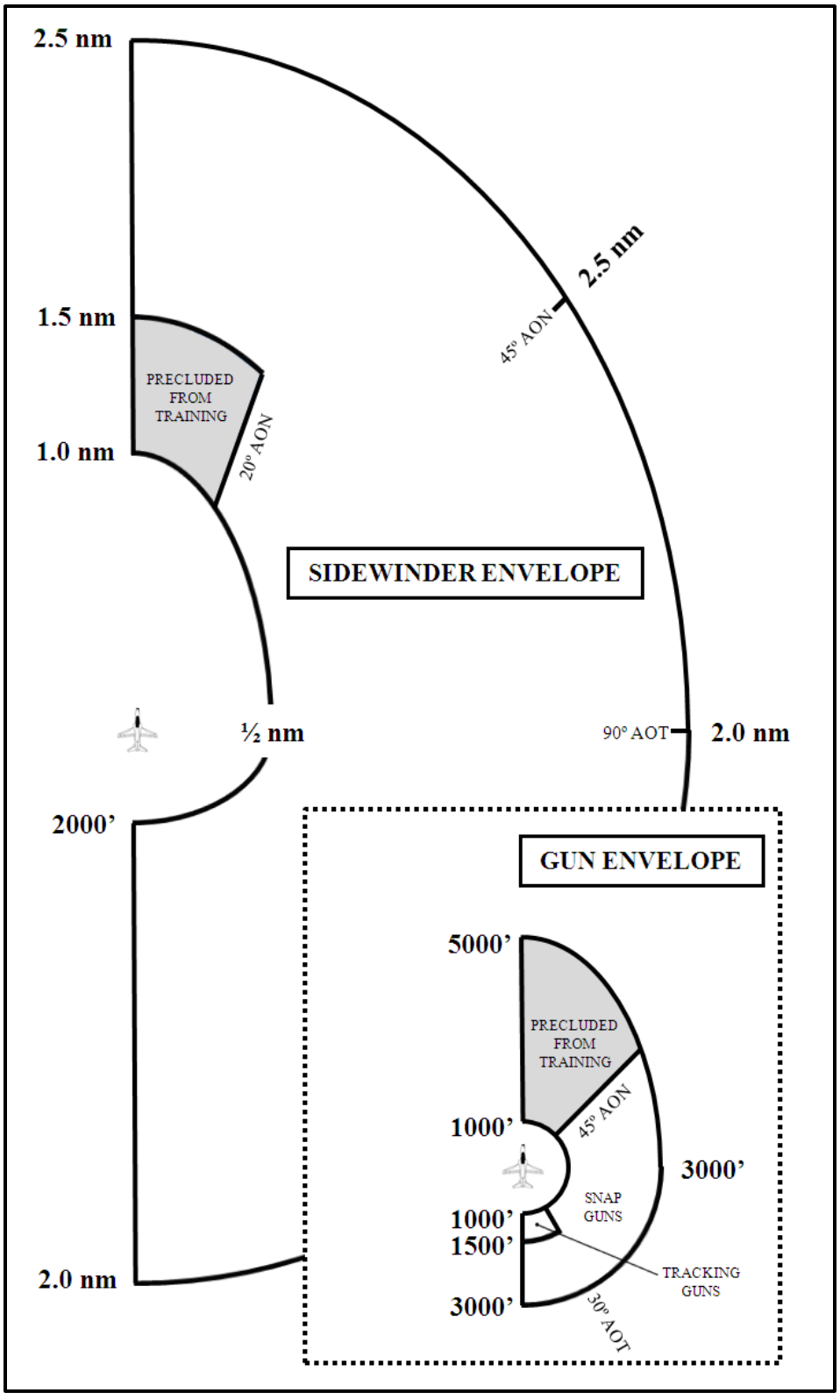


**Figure 2-6 CNATRA Weapon Envelopes**

## 208. DEFEATING SHOTS

In order to defeat shots we also must meet certain requirements. Performing these simple steps will let your instructor know that you recognized an impending shot.

**Missile Shots:**

Simultaneously perform steps 1 and 2:

1. Call "Chaff, Flare" no sooner than two seconds prior to the bandit's sensor nose, and no later than the "Fox-2" call from bandit.

2. Put your lift vector on the bandit and perform a defensive break turn.

**Gun Shots:**

Defeat shooter's Plane-of-Motion (POM) (Reference the defensive BFM Chapter for how to properly perform a "guns d").

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# CHAPTER THREE
# SAFETY/EMERGENCY SITUATIONS

## 300. TRAINING RULES

The following Training Rules apply to all BFM and SEM training. They shall be strictly observed. These rules include those found in OPNAVINST 3710.7U and should be read prior to your BFM training. It is a requirement to brief training rules prior to each flight. Do not let this repetition lead to complacency. It is important to note that these rules were developed over a long period of time and each is based not only on common sense, but also on situations where pilots were guilty of making serious and even tragic mistakes.

Administrative:

- Departure/spin and Compressor Stall/EGT/RPM. As the student you are responsible to brief OCF and engine stall EP's.
- Scheduled face-to-face brief. Each experience in Air Combat Maneuvering (ACM) is unique, requiring all aspects of BFM and SEM flights to be briefed and debriefed thoroughly.
- ACM authorized by cognizant commander.
- Designated ACM area.

Currency: All In Flight Have Flown: As a student you will probably fall under the < 750 hr category.

- < 750 hrs FPT in type/class:
  - Once within previous 6 days.
  - Twice within previous 14 days (1 dynamic in T/M).
- > or = 750 hrs FPT in type/class:
  - Once within previous 14 days.
  - Twice within previous 30 days (1 dynamic in T/M).

Weather, Decks and Blocks:

Weather:

- Daylight (from 30 minutes past sunrise until 30 minutes prior to sunset), VMC, 5 miles visibility and a defined horizon.
- Cloud separation – 2,000 feet vertically and 1 mile horizontally.

Decks (brief MSL altitudes for working area):

- Hard Deck:
  - Minimum 10,000 feet AGL (or 5,000 feet above an undercast). The undercast shall be no higher than 7,000 feet AGL solo/8,000 feet AGL dual.
- Soft Deck:
  - Minimum 5,000 feet above the hard deck.

- No slow-speed or high AOA maneuvering below the soft deck (less than 120 KIAS or more than 24 units AOA sustained for more than 3 seconds).

Blocks

- Established in assigned block by 10 nm without required SA on opposing force.

Comm Requirements

- Transmit/receive/monitor Guard/ICS (multi-place aircraft).

***Configuration changes other than speedbrakes are prohibited.*** You may not drop your flaps or gear.

Pre-commencement of ACM:

- Perform g-warm maneuver.
- Confirm:
  - Weather.
  - Announce local altimeter setting and any decks/blocks changes.

Commencement of ACM:

Collision Avoidance:

- ***500 feet separation between all aircraft at all times***. This safety rule applies for training, both in the training command and in the fleet. In the real world, though, you must consider your adversary. For instance, if you maintain 500 ft on a head-on pass with a bandit who has forward-quarter weapons, you may be putting yourself directly into his weapons envelope. In the real world, know your adversary's capabilities.
- ***Always assume the other aircraft does not see you.*** You are personally responsible for collision avoidance at all times.
- Head-on pass:
  - Maintain the established trend; if no trend established, give way to the right to create a left-to-left pass.
- Broadcast your own intentions.
- Converging flight paths:
  - Nose-high goes high.
  - Nose-low has collision avoidance responsibility. Nose-low aircraft will ensure safe separation and must make way if the nose-high aircraft departs controlled flight, or somehow can't stay nose-high (ballistic).
- Never intentionally maneuver to lose sight (blind lead turn). ***Do not make blind lead turns.*** A blind lead turn is when your nose is in front of the bandit's flight path, and you cannot see the bandit.
- Up-sun aircraft has the responsibility for collision avoidance. If down-sun aircraft lost sight, transmit "(call sign) blind sun" and turn away from predicted collision bearing. If up-sun aircraft still has sight of the down-sun aircraft and safe separation can be maintained, the up-sun aircraft shall immediately broadcast "(call sign) continue," otherwise Knock-it-off. If you are in the sun, you are using a tremendously powerful

tactic because it blinds the bandit. But because he is blind, it is your responsibility to maintain the safe separation. Also, if the weather is hazy, the sun creates a halo when you are looking down with the sun at your back. If the bandit is in the halo area, he cannot see you.

- If lost sight, transmit "(call sign) blind" and turn away from predicted collision bearing. Other aircraft shall transmit "(call sign) continue" or "(call sign) blind (altitude)." If two aircraft have lost sight the first aircraft to transmit blind shall deconflict via altitude. ***Knock-it-Off anytime deconfliction is not assured.***
  - BFM Events Only: Knock-it-Off if both aircraft have lost sight.
  - SEM Events Only: If lost sight of bandit use the term "no joy" vice "blind." Without a tally/visual on all fighters/bandits, aircraft shall conduct belly checks at a minimum of every 90 degrees of turn. Be sure to differentiate between "blind" and "no joy." "Blind" means you cannot see your wingman anywhere. It is a call made strictly to maintain safety. "No joy" means you can't see a threat aircraft described by your wingman.
- Call "ballistic" (for slow-speed [<100 KIAS] reduced maneuverability).
- Brief CNATRA Weapons Envelopes or the following (whichever is more restrictive):
  - No head-on missile attacks inside 9,000 feet (1.5 nm) and 20 degrees of the target's nose.
  - No forward-quarter gun attacks (45 degrees of the target's nose).
  - Break off all gun attacks at 1,000 feet.

Terrain Avoidance:

- No guns defense below the soft deck (aggressive nose-low, greater than 45° out-of-plane).
- Offensive aircraft will monitor the defensive aircraft's altitude, attitude, and airspeed and will break off the attack prior to pushing the defensive aircraft through the hard deck. Typically a "watch the deck" call is sufficient to warn the other aircraft; this is for safety and to continue the fight.

<u>Termination of ACM</u>:

- ACM shall cease when:
  - Any training rule is violated.
  - "Knock-it-Off" is called by anyone, all players echo, or an aircraft is rocking its wings.
- Knock-it-Off for:
  - Interloper.
  - Departure/spin. NATOPS calls for throttle to idle below 85 KIAS above 15,000 ft.
  - G-LOC (mandatory RTB).
  - Min altitude broken.
  - Nordo/ICS failure.
  - Overstress.
  - Bingo fuel. Don't forget about your fuel. You must keep your scan moving.
  - Inadvertent IFR.
  - Loss of situational awareness/any unsafe condition develops.

- 85 KIAS and decelerating for T-45.
- Training objectives attained. This is usually determined by the trunk IP (lead if Solo).
- In a BFM engagement, both aircraft lose sight approaching training area boundary.

Post Termination of ACM:

- Aircraft shall maneuver to maintain safety of flight and be aware of the high midair collision potential following the "Knock-it-Off" call.

## 301. RULES OF ENGAGEMENT (ROE)

Prior to every merge, both aircraft must know how to make a safe pass. In order for this to happen, each aircraft will acknowledge the pass. The most common calls are "high," "low," "right-to-right," and "left-to-left." Calling yourself high or low should be fairly obvious (the bandit will echo the opposite of your call). A left-to-left call is however not as intuitive. If you call left-to-left, you will be on the right side with the bandit passing down your left wing (picture driving down the right side of the road with opposing traffic passing down your left side). All passes are Earth-stabilized (when inverted the pass is reversed). Calling these passes needs to come early so both fighters have time to maneuver the aircraft safely.

## 302. COMMON T-45 BFM EMERGENCIES

Due to the high load put on the T-45 during these engagements, there are times when certain aircraft systems will fail or underperform due to the stress. Here are some common emergencies:

OIL PRESS Warning:

This occurs typically following an overly aggressive unload to gain energy prior to an attack window entry. The negative G's experienced followed by a positive G onset will cause a momentary OIL PRESS Warning according to NATOPS. Knock-off the fight and go through your emergency procedures. It is acceptable to continue training after both fighters reset following a momentary illumination of the light after this kind of maneuver.

Compressor Stall:

The majority of compressor stalls in the T-45 happen during this stage of training. They are easy to prevent as long as you are careful not to maneuver at high angles of attack, and/or maneuver above heavy buffet, when the engine is accelerating from low power settings, or when the engine is at high power settings. Typical characteristics of a stall are loud audible bangs, chugs, or knocks from the engine. Execute your emergency procedures. The flight will RTB if either aircraft experiences this emergency.

CABIN ALT Warning:

Do not confuse the CABIN ALT warning light with an engine flameout or compressor stall. This is typically experienced under high AOA when engaged in the flats. You will hear the

cockpit get quiet from the loss of cockpit ECS airflow, and there will be an audible warning tone and CABIN ALT warning light, with an associated loss of cabin pressure; RPM and EGT will however remain normal. Simply turning the ECS switch off for 1-2 seconds, then back on, typically clears the warning light and repressurizes the cockpit.

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# CHAPTER FOUR
# BASIC AERODYNAMIC REVIEW

## 400. INTRODUCTION

The measure of success in 1v1 air combat is simple, ***it is to kill or be killed***. In order to be successful, we must maneuver our aircraft into a position in which we can employ our weapon systems while denying our enemy the ability to employ his. We will begin with the first part of the equation: maneuvering the aircraft.

## 401. LIFT LIMIT

The forces acting on an aircraft in flight are thrust, weight, lift, and drag (Figure 4-1). The interactions and changes between these forces define the motion of an aircraft through the air.

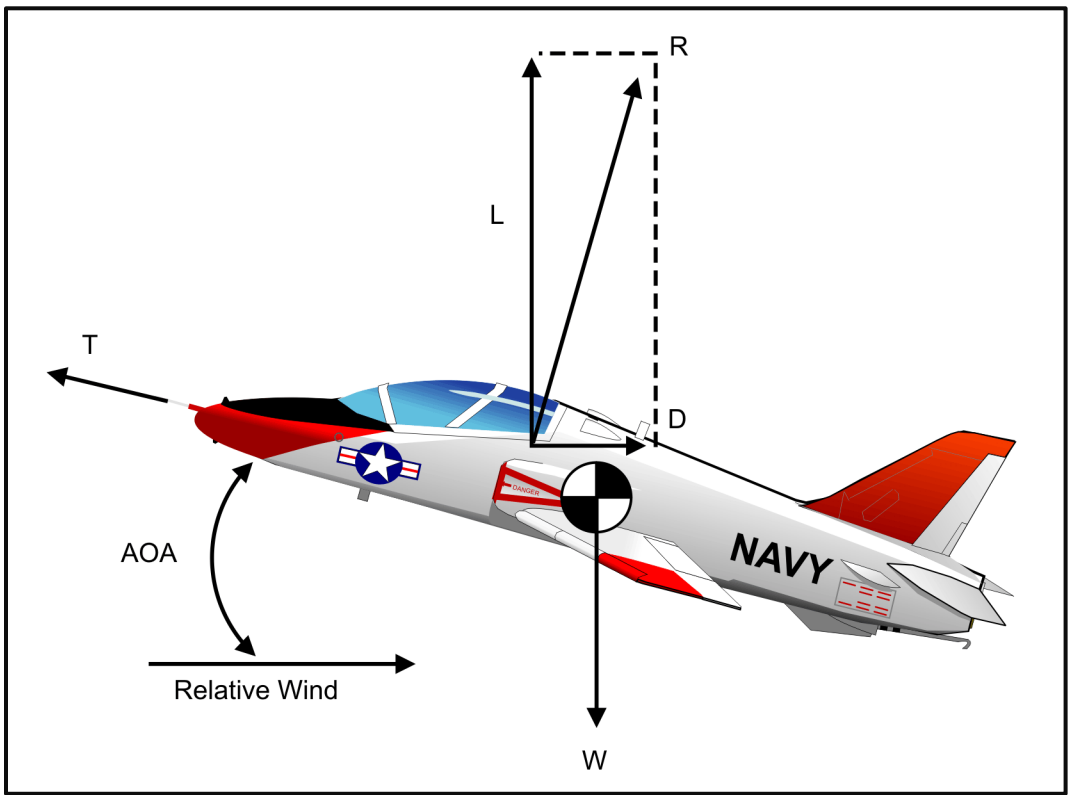



**Figure 4-1 Aerodynamic Forces Acting Upon an Aircraft in Flight**

During BFM, because thrust is usually at the maximum (MRT or full afterburner) and weight change is negligible at any given moment, thrust and weight will be considered constant during the aerodynamics review. This leaves the aerodynamic forces of lift and drag as the primary variables to consider when analyzing an aircraft's maneuvering performance.

We will introduce some definitions for our discussion:

1. Lift - Created by the resulting pressure differential as air flows over a wing.

2. Coefficient of Lift ($C_L$) - A non-dimensional constant that is based on the shape of the wing. It is a function of Angle of Attack (AOA). Figure 4-2 depicts the relationship between $C_L$ and AOA.

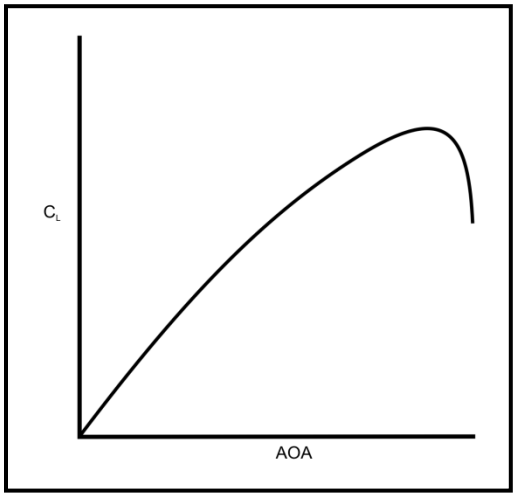



**Figure 4-2 Angle Of Attack**

As AOA is increased, lift is also increased up to $C_{LMAX}$. The steep drop in $C_L$ at high AOAs indicates the point at which a portion of the wing stalls. $C_{LMAX}$ occurs at 21 units AOA. ***At the lift limit the aircraft will be in heavy buffet.*** Lift and performance quickly diminish when pulling beyond $C_{LMAX}$.

## 402. ENERGY MANEUVERABILITY PERFORMANCE NUMBERS

Before discussing the maneuvers to use in order to achieve a positional advantage, you must first be familiar with the performance of your own machine throughout the flight envelope. Two of the most important source documents when familiarizing yourself with the full performance capabilities of the T-45 are Chapter 11 of NATOPS and the Energy-Maneuvering (E-M) diagram. Chapter 11 of NATOPS defines maneuvering characteristics and details the maneuvering limits that can prevent aircrew from departing controlled flight. The E-M diagram outlines aircraft turn performance during a level turn in the horizontal plane. It also allows us to define our tactical maneuvering options and reference airspeeds, as well as the structural and lift limit of our platform. Although engagements rarely remain level, understanding the principles behind the E-M diagram allows you to make smart tactical decisions based on energy states.

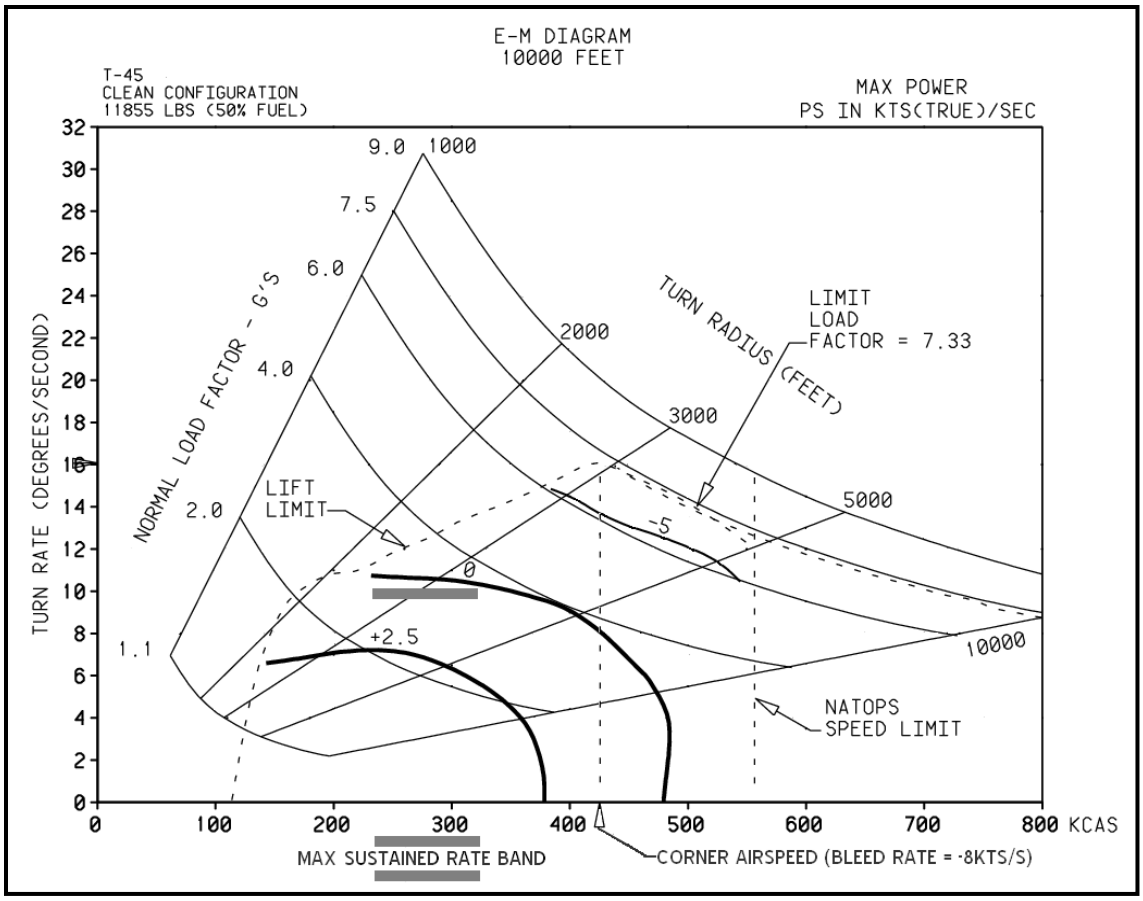



**Figure 4-3 10K E-M Diagram**

We are not going to build an E-M diagram in this chapter, but we are going to identify the main ideas and extract the most important information so as to arm you with the basic fundamental knowledge to execute BFM. Each diagram is specific for aircraft, configuration, and altitude, all of which can be found in the periphery of the diagram. Make sure to always read this information first to ensure you are deriving the correct performance characteristics for a specific aircraft in a specific scenario.

Although we do not fly with an E-M diagram in the cockpit, it is imperative that you commit certain performance numbers to memory. These numbers are required pieces of information. Do not show up at a merge without them!

## 403. T-45 PERFORMANCE NUMBERS

Max Performance:

- Pitch: Airspeed above corner airspeed: load limit pull, 7.33Gs (above 5,000 ft). Airspeed below corner airspeed: lift limit pull, 19-21 units (rumble of buffet) pull.
- Roll: Unload while utilizing coordinated stick and rudder. The slower the speed, the more rudder deflection you will be able to achieve due to lessoned aerodynamic loads.

Due to this, the use of rudder at slower speeds becomes more beneficial in achieving maximum roll rates.

Acceleration:

Unload to 0G with MRT selected.

Compromise Performance:

Good energy-sustaining turn performance without the bleed rates associated with maximum performance.

- Load Limit Pull - Ease pull by 1-2Gs.
- Lift Limit Pull - Target 17 units (light buffet).

Corner Airspeed: 410 KIAS

This airspeed yields the aircraft's best instantaneous turn performance, but also sustains the highest bleed rates.

Corner Bleed Rate: 8 knots/second

This is the rate at which the aircraft will decelerate in a max performance pull at corner airspeed.

Best Sustained Turn Rate: 240-330 KIAS

This band is found where the Specific Power (Ps) curve = 0; i.e., the aircraft is sustaining energy. 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). However, the aircraft's ability to trade airspeed for angles (energy excursion) is reduced below 300 KIAS. Furthermore, 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 airspeed excursion is necessary, is prudent in most cases.***

Minimum Radius Airspeed Band: 140-180 KIAS (all altitudes)

Minimum Vertical Airspeed: 300 KIAS

Minimum vertical airspeed will vary based on altitude and proficiency. As a technique, targeting a light nibble of buffet pull will optimize the execution of a minimum airspeed vertical loop. In general, 300 KIAS is a good airspeed to target. Remember that aircraft and engine performance in an over-the-top maneuver is altitude-dependent. Attempting to go over-the-top with less than minimum vertical airspeed may result in your aircraft going ballistic or even departing controlled flight.

## 4-4 BASIC AERODYNAMIC REVIEW

Tactical Vertical Airspeed: 350 KIAS

Tactical vertical airspeed corresponds to the airspeed required to initiate a tactical nose-high maneuver. Once the aircraft is nose high, you still have tactical options available, including vertical extension, lift vector reorientation, and/or airspeed excursions.

High-Aspect Merge Recommended Airspeeds:

- Nose High Gameplan: 350-420 KIAS
- Nose Low Gameplan: 270-350 KIAS
- Level Gameplan: 370-410 KIAS

Understanding the performance characteristics of our aircraft will enable us to fly our aircraft more effectively; however, as we maneuver to gain positional advantage, so is our enemy. It is important to understand the adversary's maneuvering capabilities, and reference those capabilities against our own. In the training command, this is simplified since we fly the same aircraft. The proficiency and capabilities of the pilot at the controls are the only unknown variable. The aviator that best understands the aircraft's performance and weapon systems capabilities, and who applies the principles of BFM to coincide with known performance characteristics, will reign victorious.

## 404. VERTICAL MANEUVERING

E-M diagrams only depict an aircraft's turn performance in a level turn. Once the fight shifts into the vertical realm, we can no longer reference E-M diagrams alone to accurately represent the aircraft's turn performance, as the effects of gravity will affect turn rate, turn radius, and the bleed rates associated with a given maneuver.

Nose-High Maneuver:

Figure 4-4 illustrates the effects of gravity on vertical turn performance. The Load Factor (LF) is illustrated with a constant G force of 4, and is controlled by the pilot. Gravity (G) equals the effect of gravity on the aircraft. Finally the Radial G (RG) is the combination of G and LF and denotes total performance.

Gravity can positively affect the turn rate and turn radius of an aircraft during a nose-high maneuver. The diagram shows a T-45 executing a pure nose-high loop. The pilot executing the maneuver maintains a constant 4G pull, but the aircraft overall performance (RG) must account for 1 unit of constant gravity. Remember the RG is the sum of the load factor the pilot applies and the one unit of gravity. Although the pilot pulls 4Gs at the beginning of the maneuver, the aircraft is fighting uphill against 1 unit of gravity and achieves only 3RG of turn performance. Conversely at the top of the maneuver, the aircraft achieves 5RG of aircraft performance, which produces a smaller turn radius and allows the aircraft to turn through more degrees per unit of time (greater turn rate). When the aircraft is bullseye nose-high, or nose-low, the effects of gravity are effectively zeroed, and a 4G pull results in 4RG of aircraft performance.

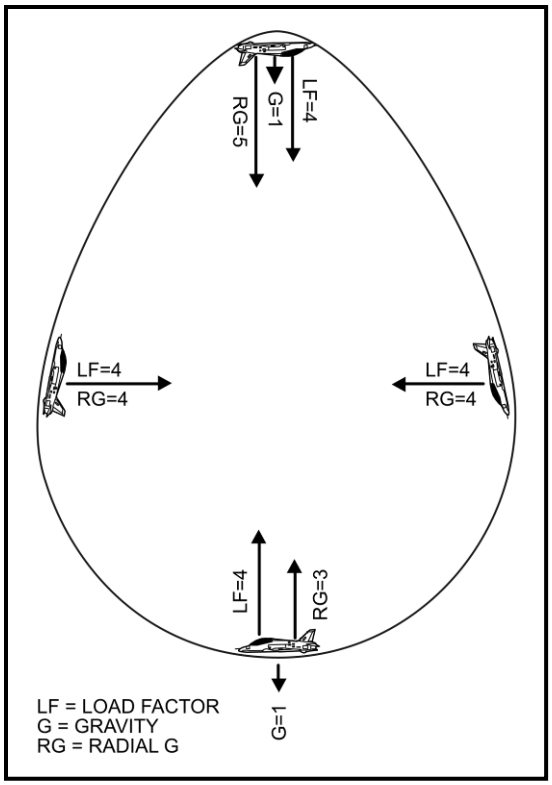



**Figure 4-4 Vertical Maneuvering – The Egg**

Nose-Low Maneuver:

While gravity can assist the aircraft's turn performance as it maneuvers nose-high, a combination of power, AOA control, and gravity can adversely affect turn performance as the aircraft begins to maneuver nose-low. The T-45 does not bleed energy in an extreme nose-low maneuver. The aircraft will accelerate when extreme nose-low despite max performing at MRT. Finally, an aggressive nose-low maneuver at airspeeds in excess of 350 KIAS will create a greater probability of the pilot succumbing to ALOC or GLOC without proper body positioning or Anti-G Straining Maneuver (AGSM).

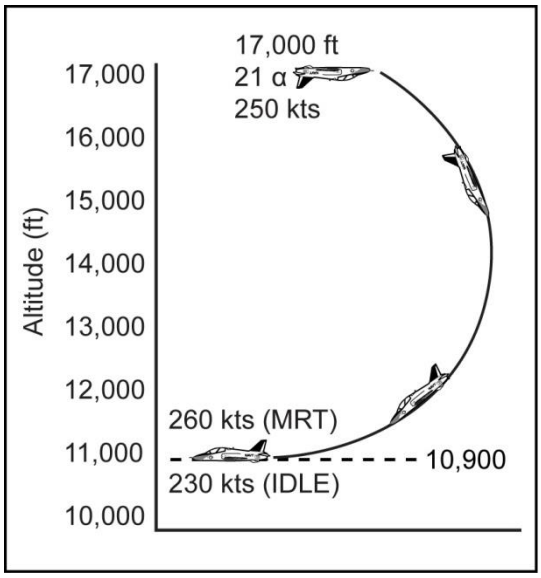



**Figure 4-5 Nose-Low Maneuver (250 kts)**

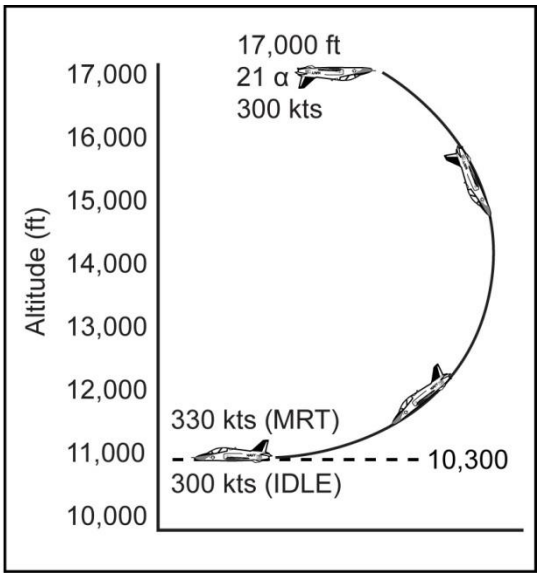



**Figure 4-6 Nose-Low Maneuver (300 kts)**

While performing a nose-low maneuver, the effects of gravity on turn rate and radius are reversed from the nose-high maneuver. If the aircraft maintains constant G, the turn rate will decrease and the turn radius will increase throughout the maneuver. Figure 4-5 illustrates a T-45 executing a nose-low maneuver, max performing on the lift limit at MRT. Due to the change in radius, the aircraft's post will shift from its original position. This lateral separation between the posts needs to be accounted for when timing the nose-low maneuver, as is the case during the slow-speed merge discussion in High-Aspect Basic Fighter Maneuvers (HABFM). If the pilot executes a pull that is above or below the lift limit, the turn radius will grow even larger.

A T-45 requires approximately 6,000-6,500 ft of altitude to execute a pure nose-low maneuver (split-s) when max performing at 19-21 units AOA. Slower airspeeds will generate a smaller turn radius and require less altitude to go pure nose-low. While a T-45 at 350-400 KIAS will require 7,000-7,500 feet for a split-s, the same jet at 200-250 KIAS will require only 5,500-6,000 ft. It is important to know that throttle position (idle vs. MRT) does not affect turn radius (i.e., altitude loss) in a max performance pure nose-low maneuver—airspeed dictates turn radius and altitude required. Keeping the throttle at MRT will generate approximately 30-40 knots more at the bottom of the turn than keeping the throttle at idle. Throttle position on the way down will depend on what BFM problem you are trying to solve (discussed later in set specifics).

Slow-Speed Vertical Reversal:

Typically, slow-speed (less than 150 KIAS) vertical reversals are used during BFM when reversing from a nose-high to a nose-low pitch attitude in minimal time and turn radius. Maintain the throttle at MRT and ensure to keep the nose tracking past vertical (bullseye nose high) outside +/- 20 degrees of pure vertical. It is paramount that you keep a light nibble of buffet pull. If you pull too hard or don't keep the nose tracking back to the horizon, a departure may occur. Although the jet is quite controllable during this parabolic maneuver at slow

airspeeds, the aircraft may still depart. If the aircraft ever starts to move in a direction that was not commanded, immediately neutralize the controls, reduce the throttle to idle, and follow NATOPS Out-of-Control-Flight (OCF) procedures. ***Remember, NATOPS states that the throttle needs to be at idle for altitudes above 15,000 ft MSL and airspeeds below 85 KIAS.***

Deck Transition Rule of Thumb (10% rule):

The deck transition rule of thumb provides a conservative flight path profile to transition from a nose-low attitude to level flight without flying through the hard deck. We will discuss when to use the rule of thumb later on in the FTI. With practice and experience you will be able to perform a more aggressive transition, but these recommended wickets provide a good starting point. Note that the max degrees nose-low translates to 10% of the altitude above the deck.

| Nose-Low | Altitude Above the Deck |
|---|---|
| 50° | 5,000 ft |
| 40° | 4,000 ft |
| 30° | 3,000 ft |
| 20° | 2,000 ft |
| 10° | 1,000 ft |

# CHAPTER FIVE
# OFFENSIVE BFM

## 500. OFFENSIVE BFM OBJECTIVES

The ultimate goal of offensive BFM is to kill the adversary as quickly as possible. If this primary goal is not achieved, ensure a positional advantage is maintained for follow-on weapons employment. Finally, if time to kill is up or you are losing the advantage, separate prior to becoming neutralized. Simply put, the goals of offensive BFM are, in order:

1. Maintain the offensive position.

2. Employ follow-on weapons.

3. Transition to High-Aspect BFM (HABFM) if neutralized.

**NOTE**

HABFM will not be executed until introduced on the first HABFM event.

## 501. INTRO TO BFM CONCEPTS AND DEFINITIONS

In order to achieve a victory, we must maneuver our aircraft into a position in which we can employ our weapons systems while denying our enemy the ability to employ his or her weapons. We have already covered some basic maneuvers. Combining offensive concepts with the cues in the cockpit will dictate when to maneuver the aircraft and employ a weapon.

3/9 Line:

The 3/9 line is an imaginary plane extending from wingtip to wingtip, perpendicular to the flight path. Positional advantage is generally defined by your aircraft's position relative to the bandit's 3/9 line, or vice versa.

Vertical 3/9 Line:

Vertical 3/9 line is similar to the 3/9 line, but oriented in the vertical plane; it is not represented by the lift vector. The vertical 3/9 line is 180 degrees off orientation from the weight vector. In a rolling scissors the vertical 3/9 line defines the horizontal overshoot.

Turning Room:

Turning room is any separation that exists between two aircraft. Exclusive-use turning room is any turning room that is available to only one aircraft in the engagement.

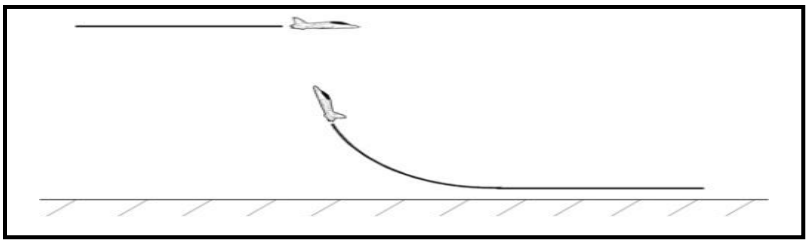


**Figure 5-1 Exclusive-Use Turning Room**

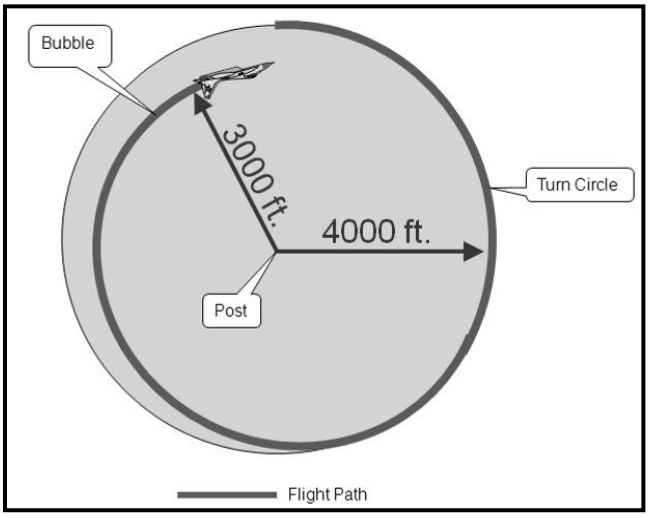



**Figure 5-2 Turn Circle, Post, and Bubble**

Turn Circle:

Turn circle is the actual turn an aircraft is scribing, based on current turn performance.

Bubble:

The actual turn an aircraft is scribing based on a current maximum performance turn. The visual cues in BFM are based on the aircraft's bubble. During your perch BFM briefs, the instructor will use a template that represents the average bubble of the T-45 in a BFM engagement; this should be a 3,000 ft turn radius. ***An aircraft cannot turn inside its own bubble; this means that if you are inside another aircraft's bubble you are, at least momentarily, immune from attack from that aircraft. This immunity, and its impact on the current engagement, is important to note, both offensively and defensively, and is by far the most important BFM concept to understand.***

## 5-2 OFFENSIVE BFM

Post:

The post is the center point of the turn circle. The post does not define pursuit curves.

Plane-of-Motion:

Plane-of-Motion (POM) is the two-dimensional plane in which the turn circle resides. When an aircraft is at a high energy state, or executing a symmetrical pull in the vertical, its POM is a close approximation of the Plane of Symmetry (POS), or the plane in which the LV lies. When at lower energy states (i.e., 130 KIAS level, 60-degree AOB turn), POM may be more difficult to determine.

Control Zone:

Control Zone (CZ) is a cone-like area, 2,000 ft to 4,000 ft behind a maneuvering aircraft, 20 degrees wide at the front and 40 degrees wide on the back side, centered on the aircraft's flight path. If an attacking aircraft arrives in a defending aircraft's control zone with range, angles and closure under control, there is nothing the defensive aircraft can do to deny the attacker positional advantage.

Attack Window:

The Attack Window (AW) is a location inside the bubble where, if we max perform an Offensive Break Turn (OBT), we will arrive in our opponent's CZ with Range, Angles, and Closure (RAC) under control.

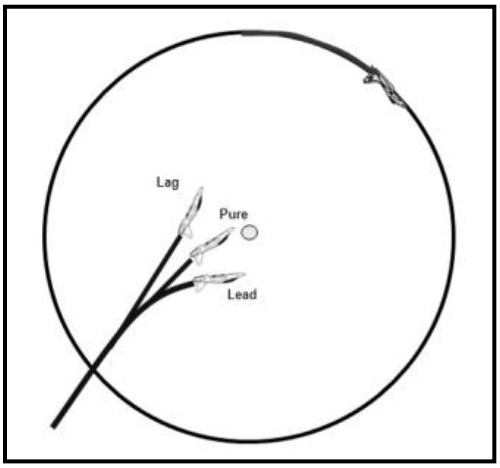



**Figure 5-3 In-plane Pursuit Curves**

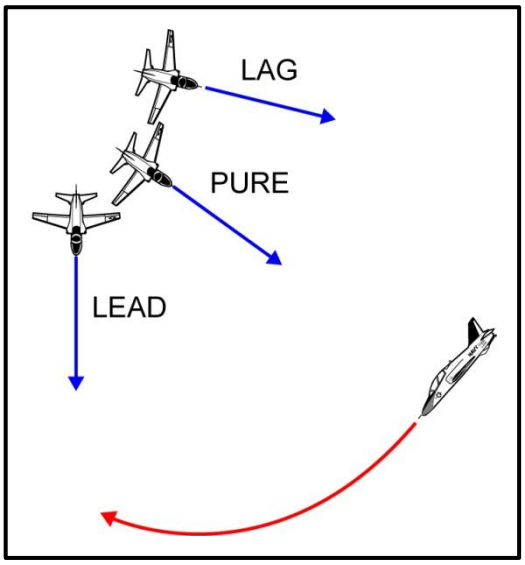
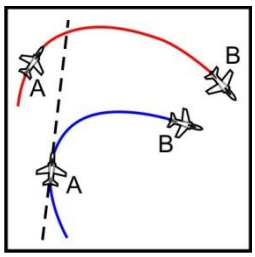



**Figure 5-4 Out-of-plane Pursuit Curves**

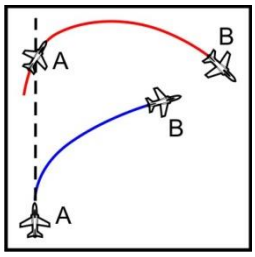
Pursuit Curves:

Pursuit curves are based on the fighter's nose position when in the bandit's POM, and the fighter's LV placement when not in the bandit's POM.



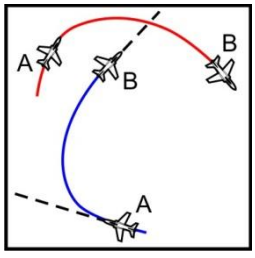

Lead Pursuit – Employ lead pursuit only for weapons employment, or when it is necessary to close nose-to-tail distance. Be ready to follow a lead pursuit maneuver with a lag pursuit maneuver to reduce $V_c$ (rate of closure) and the AOT developed while flying lead pursuit.

- Nose or LV in front of the adversary.
- Used to rapidly collapse the range and increase the closure without regard to angles.
- Maintaining lead pursuit for too long can potentially lead to an in-close overshoot.




Pure Pursuit – Utilize pure pursuit (i.e., have your opponent in the HUD field of view) when you are ready to employ a weapon, or when possibly attempting to enter the opponent's bubble (aspect/range dependent).

- Nose or LV on the adversary.
- Used to employ weapons.
- Leads to a moderate collapse in range and increase in closure without regard to angles.
- Maintaining pure pursuit for too long can potentially lead to an in-close overshoot.




Lag Pursuit – Mainly utilize maneuvers consisting of lag pursuit/out-of-plane techniques in order to correct back to the CZ, increase range or manage closure.

- Nose or LV aft of the adversary.
- Used to manage the range, angle, and closure problem.
- Maintaining lag pursuit longer than necessary can give away offensive advantage.

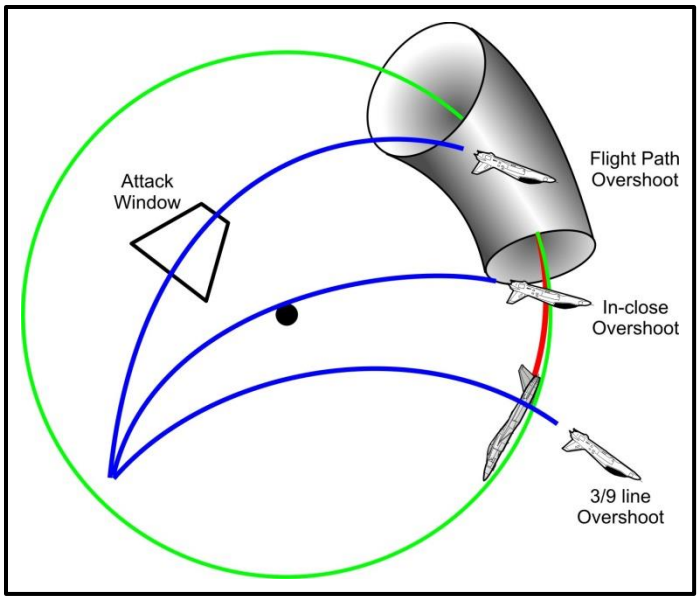
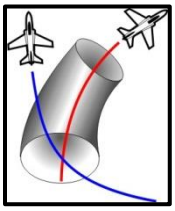
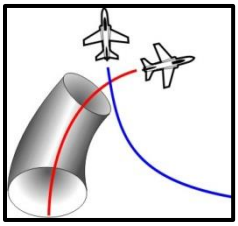



**Figure 5-5 The Three Overshoots**

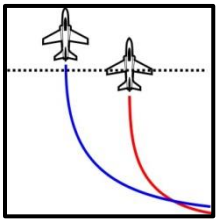
The Three Overshoots:



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.



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



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 the adversary).

In-Close Flight Path Overshoots (ICFPOS) are extremely significant in that an instantaneous reversal by the defender may also cause a 3/9 line overshoot, possibly resulting in a role reversal. A flight path overshoot that occurs well aft of the defender is often insignificant because the defender cannot perform a role reversal.

If the overshoot occurs at the defender's CZ, the attacker will be able to maintain nose-to-tail separation by continuing his original turn to the defender's reversal point. By reversing at a CZ overshoot the defender actually helps the attacker solve some of his "degrees-to-go" problem.

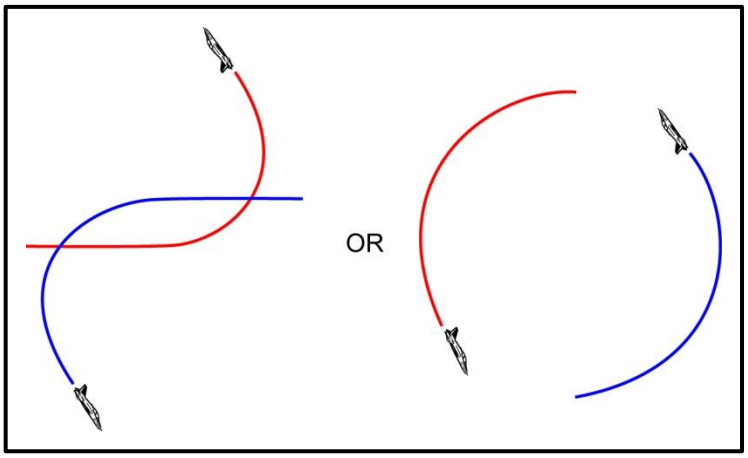



**Figure 5-6 2C Flow**

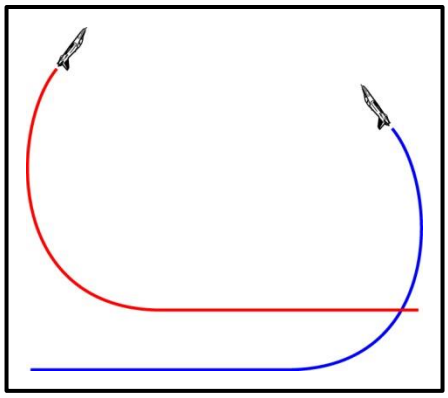


**Figure 5-7 1C Flow**

2C Flow:

While circle flow is often applied to neutral merges, the concept applies anytime two aircraft maneuver in relation to each other and the horizon. 2C flow is a rate fight and the angular advantage usually goes to the aircraft with the higher turn rate at its corner speed. A good technique often used is to trade some altitude for energy in order to continue maximizing turn rate. Often this kind of flow is referred to as a nose-to-tail, rate, or energy fight.

1C Flow:

During 1C flow, the fighter with the smaller turn radius will have the advantage. Pilots will often pitch up, out-of-plane, to help minimize turn radius. Since turn rate is of little importance during 1C flow, it is often called a radius fight. You can also hear it referred to as a nose-to-nose or positional fight.

Misaligned Turn Circles (MATC):

MATC generally applies to 2C flow and 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 MATC will enable an attacker's nose to eventually come to bear on the defender through pure geometry without having to perform an energy excursion.

## 5-6 OFFENSIVE BFM

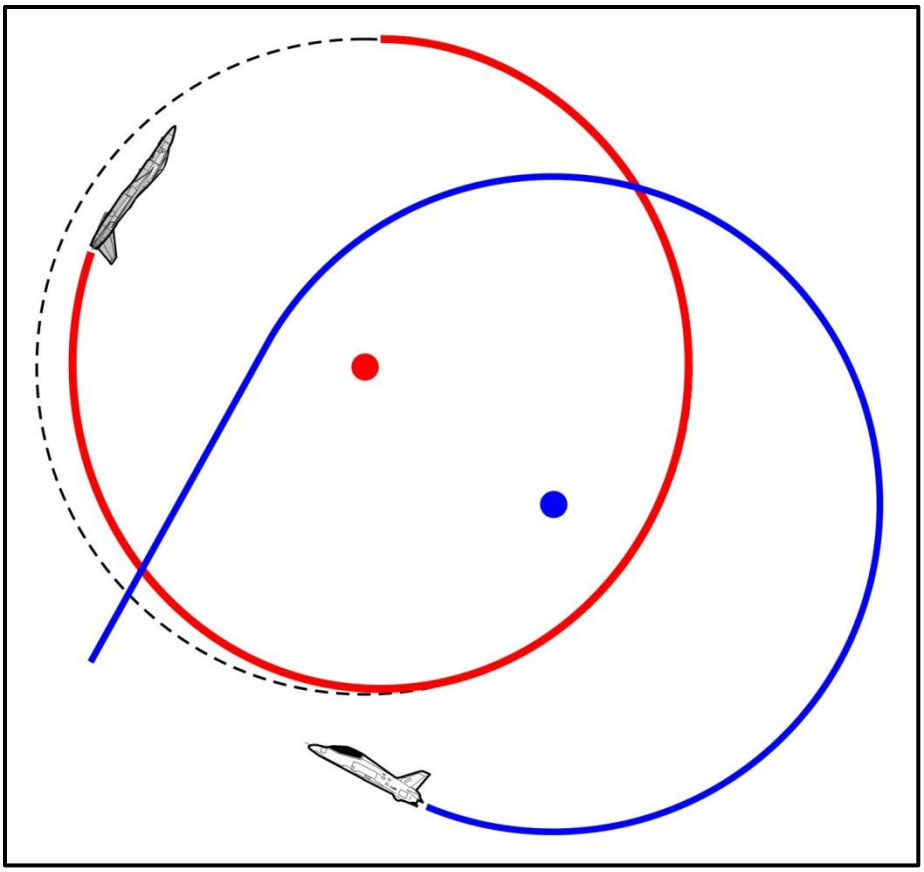


**Figure 5-8 Misaligned Turn Circles**

Energy Excursions:

An energy excursion is the conscious sacrifice of airspeed for angles. We are always willing to make energy excursions in order to take/deny a shot or to take/deny turning room.

BFM Cues:

Throughout an engagement, there are several visual cues that must be analyzed in order to make sound BFM decisions. The BFM problem can be measured by visual cues in the cockpit:

- Range: Being able to assess range is very important. This is accomplished by using the relative size of the aircraft or the information in the cockpit (A/A TACAN). Change in range will indicate closure or separation.

- Target Aspect (TA): the angular difference between the bandit's nose and your aircraft. A bandit that is pointing directly at your aircraft has zero target aspect. The ability to recognize the change in TA is very important.

- Angle off Nose (AON): AON is the angular measure that an aircraft is off your nose.

- Angle off Tail (AOT): AOT is the angular measure that an aircraft is off your tail. This is the best way to assess the angular problem of the engagement. AOT is used mostly in describing defensive BFM.

BFM Cue Assessment:

Being able to accurately assess the cues in a BFM engagement is very important. The most common cues are:

- Eyeball Calibration (EBC) – Perhaps the most important aid you have in the cockpit is your own set of eyeballs. For example, you will need to visually assess range, AON, AOT, TA, and closure, as well as Attack Window Entry (AWE) and MATC, all while making an overall assessment as to whether or not you are winning or losing the fight. A proper eyeball cal is something that develops over time. With your training here and at the FRS, you will soon begin to accurately recognize and assess all of the cues that are presented in a BFM engagement.

- Aircraft Cueing Systems – The T-45 has few onboard sensors to assess range, TA, closure, etc. Utilize a visual sight picture, A/A TACAN, and the gun reticle to aid in range assessment.

Utilizing the Gun Reticle:

- Lead Angle Computing (LAC) – Used for tracking non-maneuvering targets at 1000 ft range. The LAC reticle must be kept on the target for > 1 second. We don't use it.

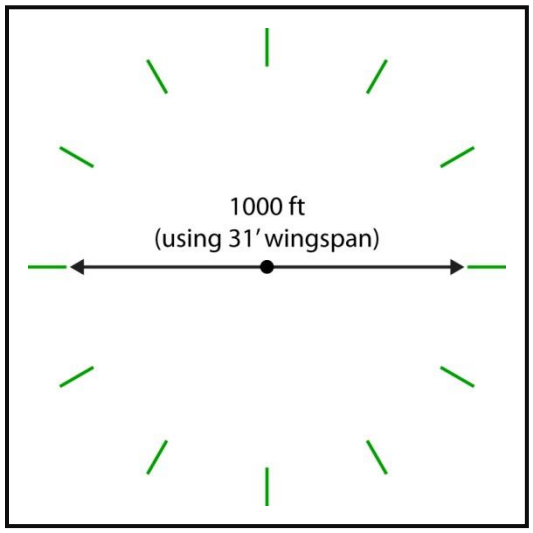



**Figure 5-9 The Gun Reticle**

- Real Time Gun Sight (RTGS) – Used for tracking a maneuvering target by aiming and keeping the reticle pipper ahead of the target (snapshot). The software positions the reticle on the point that a shell would reach in the time it takes to travel 1000 ft. If range is > 1000', you must shoot with enough lead for bullets to travel the required distance.

## 502. SNAP SHOT DRILL (SSD) AS THE SHOOTER

The aerial gun was the first weapon employed in dog fighting and still remains the most difficult weapon to use in the BFM arena. The snap shot is used when attacking at medium to high angles off an adversary in an attempt to achieve a quick kill. The snap shot drill is a cooperative maneuver designed to teach employment of the gun at high AOT for the shooting aircraft and a timely guns defense for the target aircraft. In order to achieve a valid snap there are three problems the shooter must solve:

1. Plane of Motion

2. Range

3. Lead

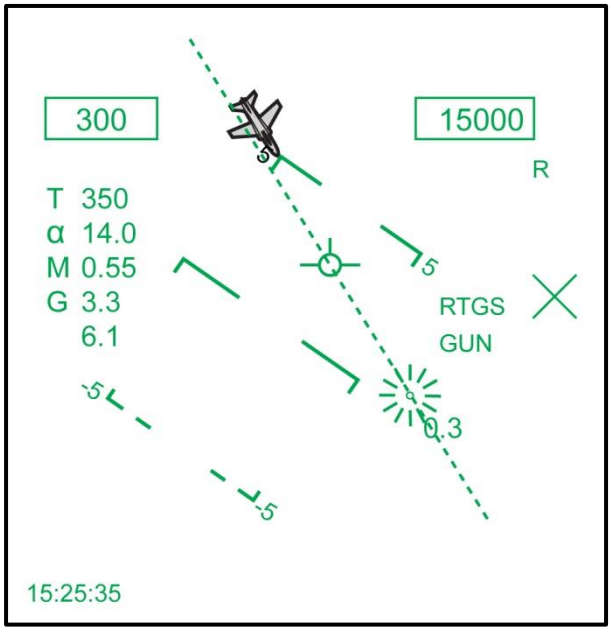



**Figure 5-10 Snap Shot Drill (SSD)**

Plane of Motion (POM):

Plane of Motion is the most important parameter to solve. It is typically the hardest to solve and therefore the easiest parameter for the target to defeat. The key to becoming accurate with the gun is to reference the defender's POM relative to the horizon. Achieve a good inside/outside scan, referencing the bandit's position (distance) above the horizon, relative to that of your pipper. You should make large corrections for POM early by varying AOB to place the pipper the same distance above the horizon as the bandit's aircraft. As range decreases, make smaller corrections. A good scan pattern is: bandit – horizon, horizon – pipper. The faster you scan the more deviations you will notice and be able to correct.

Range:

To solve range, tighten or ease your pull to have the bandit filling ¾ to all of your pipper, as "snap" is called (this indicates a 1,000 to 1,500 ft shot). If the shot looks like it will be long, ease your pull to travel further downrange. Then reset your pull. If you assess it to be close, tighten your pull to achieve your gun solution earlier.

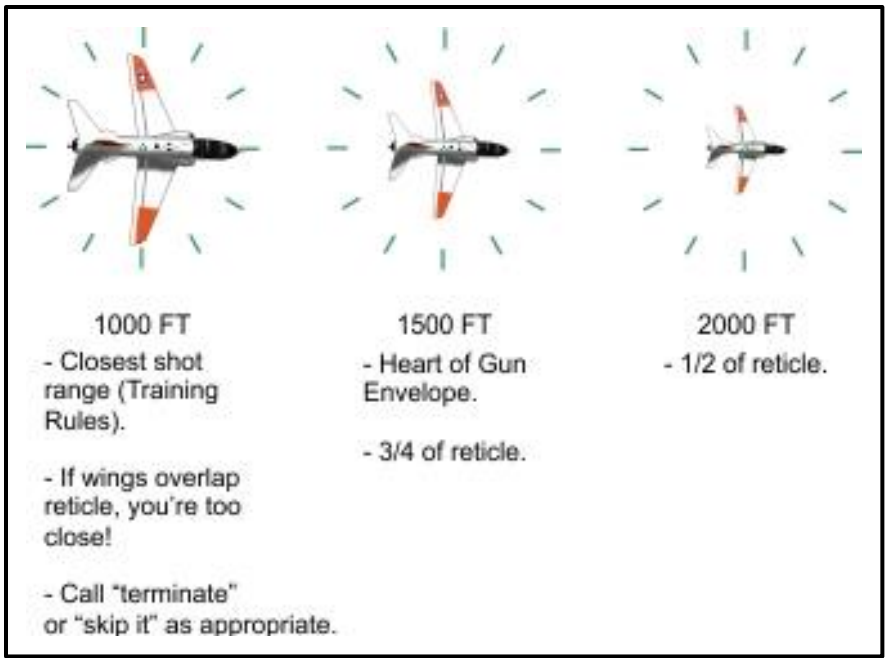



**Figure 5-11 Estimating Range with the Gun Reticle**

Lead:

Pulling the trigger when the bandit crosses the canopy bow and holding it down until he passes through your HUD is a good rule of thumb for establishing lead. This will account for ⅓ second pilot reaction time, ⅓ second gun spool-up time, ⅓ second bullet time of flight and allow the bullets to be at 1,000-1,500 ft downrange by the time the bandit crosses your pipper. If the trigger is pulled too early, bullets will be wasted. If the trigger is pulled too late, bullets will fall aft of the bandit. Therefore, in order to preserve ammunition, a disciplined and well-timed trigger squeeze is imperative. It is better to be a little early than late when pulling the trigger. Also, it is important to note that keeping the trigger down after the bandit passes through the HUD is also a waste of ammunition. Releasing the trigger as you say "snap" is a good technique to save bullets.

Counter to a Guns Defense:

As the shooter you will need to react quickly to counter an effective guns d. Decide early, then quickly roll to place the airspeed and altitude boxes two plane lengths out in front. The pipper will be unstable, and it may be difficult to determine a valid shot. With proper lead established, pull the trigger and evaluate the shot. Ideally the bandit would fly in between the airspeed and altitude boxes where the waterline symbol would be.

SSD Execution as the Shooter:

P – Abeam
A – Deck + 5,000 ft
D – 1.0 nm
S – 300 KIAS

The student will be the shooter on offensive BFM hops. The typical flow for the SSD will be four passes with a non-maneuvering target followed by four passes with a maneuvering target. Initially both aircraft will make their "speed and angels" call. Lead will then initiate the maneuver by calling "Hammer 11, in target." Wing will respond with "Hammer 12, in shooter."

The two aircraft will turn in towards each other utilizing a 2-3G pull. The shooter pulls to the inside of the turn while the target floats to the outside of the turn. The shooter controls the range while the target aircraft adjusts accordingly to maintain proper clock position for angles, targeting the 10/2 o'clock. Once the geometry has been set, both the shooter and the target will maintain a smooth pull so that as the shooter's nose starts to come to bear, the target will allow the shooter to track forward to aft for the snap shot. The shooter will then call "trigger down…snap, (looked good / missed high / missed low)." The "trigger down..." call should be made the same time as the trigger squeeze. 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. It is important for a timely "snap" call so the target can make an appropriate evaluation of the shooter's nose position for future defensive maneuvers. Following the snap shot, both aircraft shall reverse their turns and adjust their pulls to complete what resembles a shackle turn. You should strive to be back on the original PADS at the apex of the reversal. The shooter will then set the next pass.

On the maneuvering snap shots, lead will call "Hammer 11, in target, maneuvering," followed by wing calling "Hammer 12, in shooter, maneuvering." During these passes, the target will attempt to maneuver out of plane in order to defeat the initial gunshot without subsequent maneuvers. The shooter will attempt to counter the defensive maneuver. After the gun defense and counter, both aircraft will maneuver cooperatively for the next pass. The flight shall attempt to work back to the original PADS. If the target cannot make it back to original altitude, then lead has the option to call for a terminate. Both aircraft will strive to achieve PADS prior to turning back in for the next pass.

"Terminate" is a call used to temporarily cease SSD training for administrative purposes. For example, "terminate" may be used to pause the SSD in order to maneuver the section away from an area boarder or redress the flight back to PADS. It shall not be used for any reason related to safety-of-flight. Follwing a "terminate," the flight lead will restart the SSD by simply calling, "[Callsign] 11, in target/shooter."

1. Lead: "Ripper 11 speed and angels right"
   Wing: "Ripper 12 speed and angels left"
   Lead: "Ripper 11 in target"
   Wing: "Ripper 12 in shooter"

2. Wing: "Ripper 12 trigger down, snap, looked good"

3. Lead: "Ripper 11 in target"
   Wing: "Ripper 12 in shooter"

4. Wing: "Ripper 12 trigger down, snap, looked good"

   (Shooter takes four shots, then…)

   Lead: "Ripper 11 in target maneuvering"
   Wing: "Ripper 12 in shooter maneuvering"

   Wing: "Ripper 12 trigger down, snap, missed low"

   (Shooter takes four more shots, then…)

   Lead: "Knock-it-off"
   "Ripper 11 knock-it-off"
   Wing: "Ripper 12 knock-it-off"
   Lead: "Ripper flow XXX"
   Wing: "Ripper 12 XXX"

   Example terminate:
   Lead: "Hammer terminate" Wing: "Hammer 12 terminate"

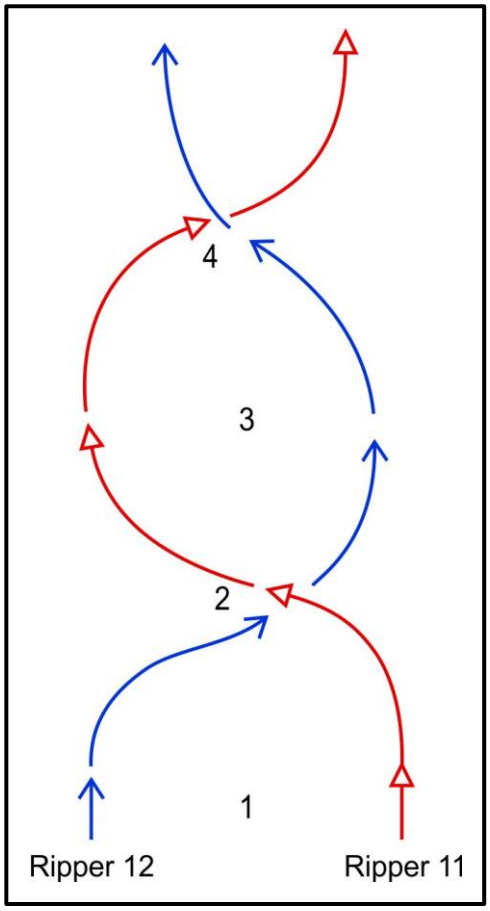



**Figure 5-12 Snap Shot Drill**

SSD Safety Considerations:

If it appears the shooter will violate the 500 ft bubble, either aircraft may call "skip it." If a "skip it" call is made, the shooter will deconflict by executing a loaded pull inside the turn, nose-low (in and down), max performing his aircraft. The target will then execute a loaded pull away and go nose-high (up and away). After a safe pass is affected, the maneuver may continue following the reversal unless a "knock-it-off" is called.

## 503. OFFENSIVE FLAT SCISSORS (FLATS)

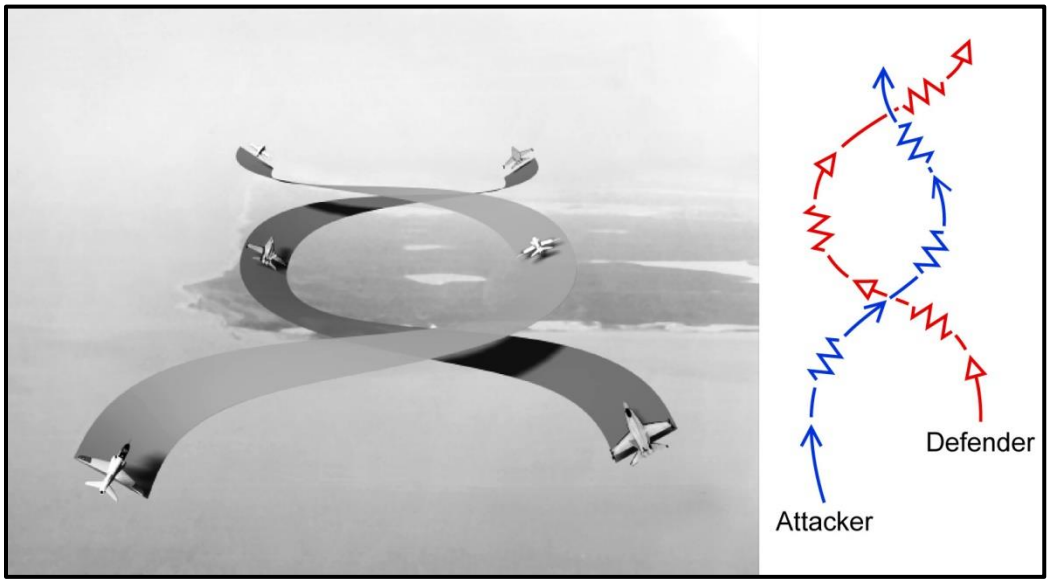



**Figure 5-13 Flat Scissors Flow**

The horizontal, or flat, scissors (flats) is a slow-speed, high-AOA radius fight where both fighters are in each other's bubble and are attempting to minimize their downrange travel to achieve a positional advantage. A flat scissors typically results from an in-close overshoot. There are several scenarios which may result in a flat scissors, such as a delayed or poorly performed lag maneuver, the offender pulling lead for too long on a guns tracking solution, poor BFM following a snap guns attempt, or follow-on flow from a rolling scissors. The flats may also be entered from a high-aspect merge where one fighter reverses to set 1C flow. The flats is not a 1C fight. In the flats you are inside each other's bubble (the bandit's target aspect and position on the canopy remain relatively constant). In a 1C fight, you are on the outside of each other's bubble which allows for the nose-to-nose type of fight. It is important to recognize the difference and fight your jet using the appropriate mechanics for the situation in which you find yourself.

Both aircraft will be attempting to decrease their downrange travel by performing a series of S turns. This effect of weaving in and out, or "scissoring," gives this fight its name. If both aircraft are flying at the same speed with one flying in a straight line and the other turning, the turning aircraft will eventually end up behind the aircraft flying straight because it has increased the distance it must travel before arriving downrange.

Kinetic energy (airspeed) is transferred to potential energy (altitude) by utilizing the vertical to aid in controlling both your airspeed and downrange travel. Lift vector placement, typically placed aft of the bandit's CZ, airspeed/AOA control, and reversal timing are keys to success in scissor maneuvering. You must utilize all three in the proper combination in order to prevail.

Offensive Flats Execution:

P – Abeam
A – Deck + 5,000 feet
D – 0.5 nm
S – 200 KIAS

Lead: "Ripper set 200"
"Ripper 11 speed and angels left"
Wing: "Ripper 12 speed and angels right"
Lead: "3, 2, 1, fight's on"
Wing: "Fight's on"

**(**Once established in the pull and you have altitude separation, turn in towards the bandit)

Wing: "Ripper 12 high"
Lead: "Ripper 11 low"

(Continue fighting until a logical conclusion when your IP calls for a KIO)

Flats Entry:

Lead will initiate the set by calling, "3, 2, 1 fight's on." Wing will respond, "fight's on." On the "3," select MRT. On the "F" in lead's "fight's on," smoothly start a vertical lift-limit pull. The bandit will delay his pull slightly (approximately two seconds after "fight's on") to establish a slightly offensive sight picture for the fighter. ***When both your pull and flight path deconfliction (in the form of altitude separation) are established, turn in towards the bandit***. If no clear trend has been established, call ROE for the most appropriate trend at the time and the low aircraft will give way to make that pass happen. The bandit will delay turning in until the wingman turns. While in the pull, trade your airspeed for altitude while the nose tracks towards the vertical. Then, turn into the bandit, thus minimizing turn radius and collapsing lateral separation. At a certain point, you will no longer have the airspeed to continue the nose-high pull; when this occurs, you have two options to recover to a sustainable nose-high position:

1. Overbank (roll past 90° AOB) while maintaining the lift limit pull and get the nose tracking downward. Prior to 20 degrees nose-high, roll upright to achieve 15-20 degrees nose-high attitude at 130-150 KIAS.

2. Push forward on the stick to get the nose down, and then reset back stick to achieve 15-20 degrees nose high at 130-150 KIAS.

A good rule of thumb is to initially pull 40-50 degrees nose-high, and at 150-160 KIAS, begin your recovery maneuver.

Flats Maneuvering:

While maneuvering in the flats, you must remember that we are attempting to minimize our downrange travel and turn radius. Simply flying as slow as possible wings level and having no energy for maneuverability is not the answer, nor is flying at 200 knots with hard turns level across the horizon. With minimum lateral separation and high fuselage alignment, flying slower than the minimum radius band may provide better results. This is due to the fight being a true high-AOA slow-speed flat scissors, vice a 1C fight (inside each other's bubble). With an increase in lateral separation however, we need to increase airspeed into the minimum radius band to achieve optimum turn performance (outside each other's bubble). When flying on the faster side of the minimum radius band, utilize more AOB while maintaining a lift-limit pull (slight nibble of buffet), to minimize your turn radius, to ultimately threaten the bandit with your nose. This is especially useful when you have altitude to spare, lateral separation exists, and you are turning away from the downrange direction of the fight. When maneuvering on the slower portion of the radius band you will not be able to utilize as much AOB but you will be minimizing your downrange travel due to your slower airspeed. This portion of the radius band is useful when your nose is pointed downrange (with respect to the fight) and little lateral separation exists between you and the bandit. Use a combination of both precise AOA control and smooth control inputs to fly your best jet. ***Don't forget to establish ROE deconfliction well prior to each merge.***

Reversal Timing:

Time your reversals with the following criteria in mind:

1. To work in phase, turn aft of the bandit's 3/9 line prior to flight path crossing.

2. If you notice a track crossing rate (line-of-sight rate), and assess you are slower than the bandit, you should turn a little early to deny lateral room and take advantage of your slower speed.

During your reversals, utilize rudder inputs to turn towards the bandit and appropriate back stick to maintain optimum performance while monitoring your aircraft's attitude, airspeed, and AOA. Be cautious not to over control the jet. If you do, you may stall, causing the nose to drop as you accelerate, flushing out downrange. If this happens, relax back stick pressure, get the wings underneath you and re-establish your pull, working your nose up and getting your airspeed under control. Then reorient your lift vector as needed. Lift vector placement is more important the wider the fight becomes. As lateral separation decreases, precise airspeed control with an emphasis on generating the maximum amount of lift, to minimize downrange travel, becomes more of a priority. A good rule of thumb is that your airspeed minus 100 is the max usable AOB (i.e., 130 KIAS ~ 30 degrees AOB).

After maneuvering in the flats we will eventually find ourselves in an offensive position. We will summarize the offensive positions in the following two situations with respect to energy and position.

Up and Aft:

Up and aft maneuvering is the most desirable. We have an energy advantage in the form of altitude and a positional advantage behind the bandit's 3/9 line. Look to work just slightly out of phase (not letting the bandit hide under your nose) and assess weapons separation. With sufficient separation, work your jet down to a valid weapons envelope using one of the following three methods:

1. Pulling beyond lift limit – This will increase drag and decrease lift, thus you will lose altitude without gaining airspeed. This is not desirable due to the T-45 being very difficult to control in this AOA regime, the increased possibility of departing controlled flight, or potentially causing an engine compressor stall.

2. Idle push over – Once you assess weapons separation, select idle/SBs and push the stick aggressively forward, then reset back stick prior to the nose coming on the bandit to prevent excessive altitude loss and airspeed increase. Select MRT and retract SBs once you have the nose tracking up and work yourself back into the radius band. This technique is effective when desiring a quick shot; however, it is difficult to time and will need a good amount of weapons separation due to building airspeed and the risk of flushing downrange. ***Care must be taken when resetting the nose-high attitude and advancing the throttle in order to avoid an engine compressor stall.***

3. Reduce throttle and slowly work down utilizing precise AOA and airspeed control. This is most desirable; however, you need to be patient and keep flying your best jet.

4. Overbank – If you assess prior to turning in after a reversal that adequate nose-to-tail separation exists for a shot opportunity, overbank the aircraft slightly to start the nose tracking down. You should visualize your nose crossing the defender's flight path. It is important to maintain a lift-limit pull to avoid gaining extra airspeed and flushing out. After taking the shot, level the wings, and reset a nose-high attitude in order to control your airspeed.

Down and Aft:

Attempt to work in phase by performing early turns prior to flight path crossing. When the bandit reverses, ease your pull momentarily to gain 20-30 knots, then use this extra energy to work your nose up into a weapons envelope. In order to get your nose on the bandit you will need to use less AOB with the wings underneath you to work the nose up and achieve a valid weapons solution.

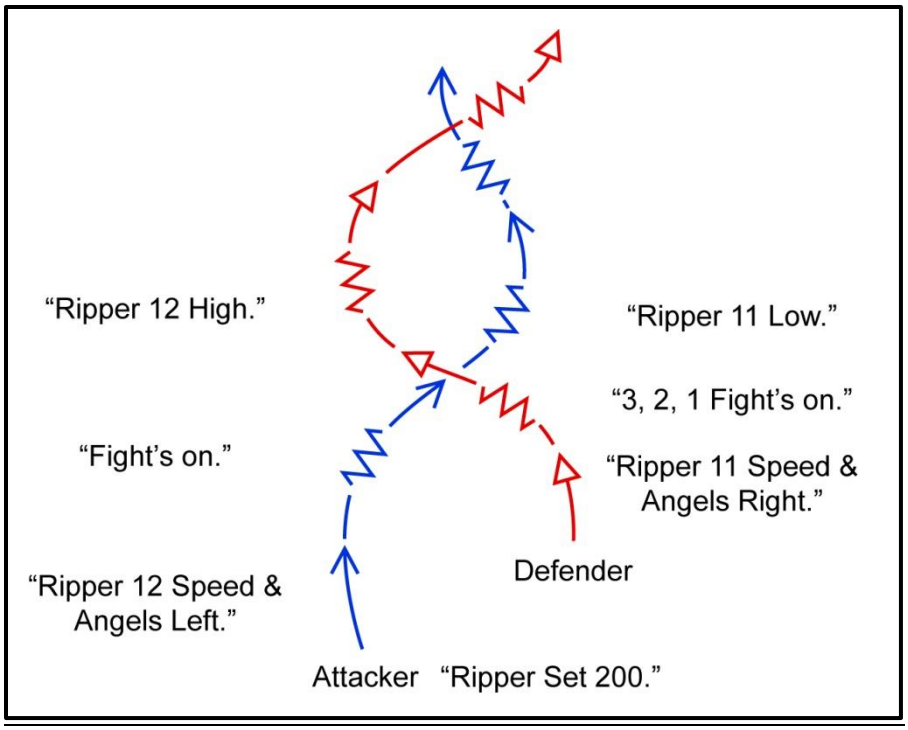



**Figure 5-14 Offensive Flats Execution**

Learning Objectives (emphasis) for the Flats:

1. PADS set up
2. 100% training rules adherence
3. AOA/airspeed control
4. Lift vector placement
5. Recognition of offensive/defensive position
6. Reversal timing execution
7. Shot opportunity recognition/mechanics
8. Guns d recognition/mechanics
9. Fight redefinition

## 504. OFFENSIVE ROLLING SCISSORS (ROLLER)

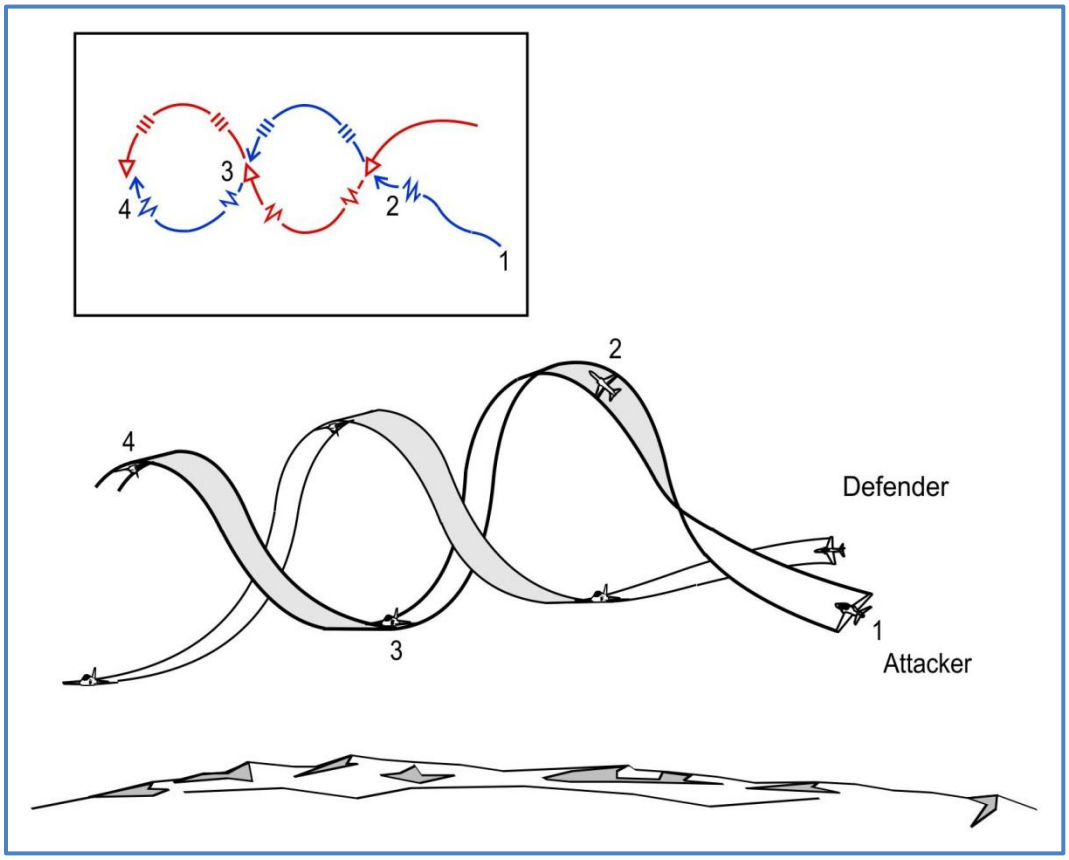



**Figure 5-15 Roller Overview**

The rolling scissors is a fight with both aircraft inside each other's bubble as long as the fight remains neutral. The rolling scissors may result from an in-close overshoot where the pilot attempts to stop his downrange travel by pitching up into the vertical without sufficient energy to execute a pure loop. The resulting fight is a series of vertical and horizontal overshoots where both pilots attempt to maximize their turn rate and minimize their turn radius in order to gain a positional advantage. Offensively, if you find yourself in a roller, you have made a mistake, which means you must strive to remain offensive or disengage at the earliest opportunity. A rolling scissors is not a desirable maneuver for an attacker because it limits opportunities for weapons employment.

Roller Entry:

P – Abeam
A – Deck + 6,000 feet
D – 0.5 nm
S – 200 KIAS

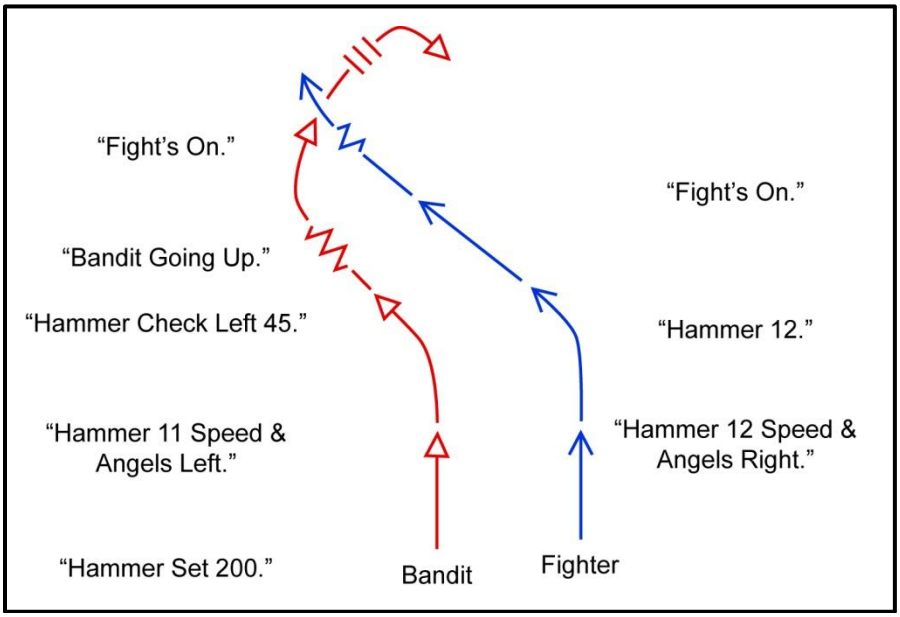



**Figure 5-16 Rolling Scissors Entry**

Lead will initiate the maneuver by calling "Hammer check (right/left) 45" to establish wing 45º AOT. After the aircraft arrive on heading, lead will call, "bandit going up." At this time select MRT. Lead will maneuver to arrive over the top of the fighter in a defensive position and then call "fight's on" with the fighter echoing "fight's on."

| | |
|---|---|
| Bandit: | "Hammer set 200" |
| | "Hammer 11 speed and angels left" |
| Fighter: | "Hammer 12 speed and angels right" |
| Bandit: | "Hammer check left 45" |
| | "Bandit going up" |
| | "Fight's on" |
| Fighter: | "Fight's on" |

Roller Maneuvering:

When lead calls "bandit going up," select MRT. At the "fight's on" call, perform a nibble of buffet wings-level pull to force a vertical overshoot. As you force the vertical overshoot, roll to place your lift vector over the top of the bandit, maneuvering your aircraft to force a 3/9 line overshoot. Be sure to keep your nose tracking above the horizon to preserve turning room

(altitude above the bandit). Prior to 3/9 line passage (when you are directly above him), note the bandit's nose position to determine whether you are offensive, or neutral/defensive:

- Offensive: If you predict the bandit will still be nose-low at 3/9 line passage, you have an offensive advantage. Perform an early turn by releasing back stick pressure, then rolling quickly to place your lift vector on to in front of the bandit, and recapture a nibble of buffet pull. This will help you get in phase with the bandit and reduce nose-to-tail separation. You should now feel like you are "chasing" him around. Keep the throttle at MRT to maintain energy for follow-on BFM. Continue to early-turn over the top as required until you have a shot opportunity, or until the fight is redefined.

- Neutral/defensive: If you predict the bandit will be level or nose-high at 3/9 line passage, you are neutral or defensive. Increase your turning room by staying nose-high until 3/9 passage (slowing your downrange travel while gaining altitude). After you fly over the bandit, perform a pirouette maneuver by reducing the throttle to idle, unload, and then input full bottom rudder. Once the nose starts slicing down, input lateral stick to quickly roll the aircraft. Neutralize the controls 10 degrees prior to the desired lift vector placement. Slowly advance the throttle back to MRT and reprogram a nibble of buffet pull. Place the lift vector on to slightly behind the bandit, when following across the bottom, maintaining a nibble of buffet pull. Your airspeed should be enough to force a vertical overshoot but not so much as to flush downrange (approximately 200-230 KIAS) at the bottom. As the bandit transitions above the horizon, assess lateral and vertical separation. If there is more vertical separation, look to get your nose up. If there is more lateral separation, look to collapse the fight by turning more level across the top. If you are becoming offensive with a positional advantage, then at the pirouette, put your LV in front of the bandit pulling lead to align fuselages and possibly gain a shot opportunity. However, if you do this you must avoid pulling too much lead and giving up your positional advantage. A good way to conceptualize lift vector placement is to place your lift vector on the bandit and vary it aft if you want to preserve/gain turning room. Vary your lift vector in front if you want to intimidate the bandit or take a shot. A key determinant in winning the roller is to strive to get your nose up when you are at the bottom before the bandit can get his nose down when he is at the top, and vice versa. If you can continually do this without sacrificing your position, you are then gaining the advantage you need to win in a rolling scissors. At a certain point, one aircraft will gain enough advantage to pull for a shot, or the roller will be redefined.

  You can also evaluate whether you are offensive, neutral, or defensive by assessing your nose position relative to the horizon when the bandit executes his pirouette. For example, if you are nose-high as the bandit pirouettes, you are probably offensive.

In general, a four-step process can be used during the roller:

1. Starting from the bottom of the roller, execute a compromise pull straight up until the bandit crosses the horizon (vertical overshoot).

2. Roll to place your lift vector above the bandit (about 60º AOB), executing a lift-limit pull until you pass overtop the bandit (horizontal overshoot), or as prescribed based on offensive or defensive sight pictures.

3. Execute the pirouette by selecting idle, unloading the jet, and rolling to place the lift vector as appropriate while inputting bottom rudder. Typically, lift vector placement should be slightly aft of the bandit.

4. Use a lift-limit pull while maintaining your lift vector in the desired location. Reselect MRT as the nose approaches the horizon. If you anticipate being slower than 230 KIAS, then re-select MRT early.

Redefining the Roller:

When redefining the roller, the important thing to recall is our smallest split-s altitude. On average 6,000 feet above the hard deck is a good number to remember when at 150 KIAS. If we lack the altitude required to optimize our LV placement during the roller, it may be time to transition to a 1C fight, or separate.

To perform a full iteration of the roller, you normally need 4,000 ft of turning room above the deck. If you are below 4,000 ft above the hard deck, you have three options:

- Option 1: Avoid committing your aircraft too nose-low, by placing your lift vector closer to the horizon. This option will allow you to perform a roller iteration whereas your opponent may not be able. To do this you most likely will be placing your lift vector in front of the bandit. In doing so, you are pulling lead and giving up turning room. So consider this option when you are offensive with sufficient nose-to-tail separation.

- Option 2: Redefine into the flat scissors. If you do not have sufficient altitude and turning room to perform another roller iteration, redefine the fight into a flat scissors. Keep max performing your aircraft and work for a 3/9 line overshoot. Once the overshoot happens, perform an aggressive nose-high reversal.

- Option 3: Utilize an energy rate-deck transition. Overbank in your current direction, trade altitude for airspeed, and transition to 2C flow.

Radial G affects your "sight picture" of being offensive, neutral, or defensive at various points in the maneuver. You will experience several optical illusions. At the top, your slower airspeed and Radial G give you a smaller turn radius (reference Figure 4-4), while greater airspeed at the bottom causes a larger turn radius. As a result, relative position of the aircraft alone does not determine actual advantage. For example, if you are neutral in the fight, at the bottom of the roller you are slightly ahead of the bandit, while at the top you are slightly behind the bandit.

Bug Recognition/Counter:

For many reasons, it is critical to recognize the bandit's bug as soon as possible, because you want to kill the bandit, not let him run away. Early recognition allows you to keep more airspeed

and reorient your LV to cut him off. Generally the bug will go opposite the direction of downrange travel. If your roller was progressing south, then the bandit will likely try to bug to the north. Keeping sight will be an issue because the bandit will try to bug towards your 6 o'clock. It is imperative that you do not lose sight since you may give away your offensive advantage, or worse, become defensive. You need to take whatever altitude you have and convert it to airspeed, typically with a nibble of buffet pull. Your lift vector placement should be leading the bandit's nose, especially if he is in a turn where we can cut across the circle to close the range effectively.

In the roller, the bandit will likely try to bug from the top. Therefore, when you see this you need to turn early to pull your nose towards his projected flight path. Try to keep your airspeed up as you initiate this pull by stopping your climb and using altitude for airspeed, without hitting the deck.

Learning Objectives (emphasis) for the roller:

1. PADS set up
2. 100% adherence to training rules
3. Lift vector placement
4. AOA/airspeed control
5. Flight path projection
6. Fight redefinition

## 505. OFFENSIVE PERCH BFM OVERVIEW

Perch BFM is partial task training to practice BFM with respect to an aircraft's relative location to the bubble. As described in earlier chapters, we know the average turn radius of the T-45 is 3,000 feet with a bubble of 6,000 feet in diameter. Thus, the 6k perch set starts you just outside the bandit's bubble and the 9k perch set starts you well outside the bandit's bubble. In the fleet you will be introduced to a 3k set that starts inside the bandit's bubble.

**NOTE**

Just because we are in a 2C fight does not mean we are in a pure rate fight. The less neutral the fight, the more it is a war of energy excursions, misaligned turn circles, and angles. As the fight becomes more neutral, it transitions to a true rate war.

All offensive perch sets will be executed as below with the exceptions/considerations noted for each set.

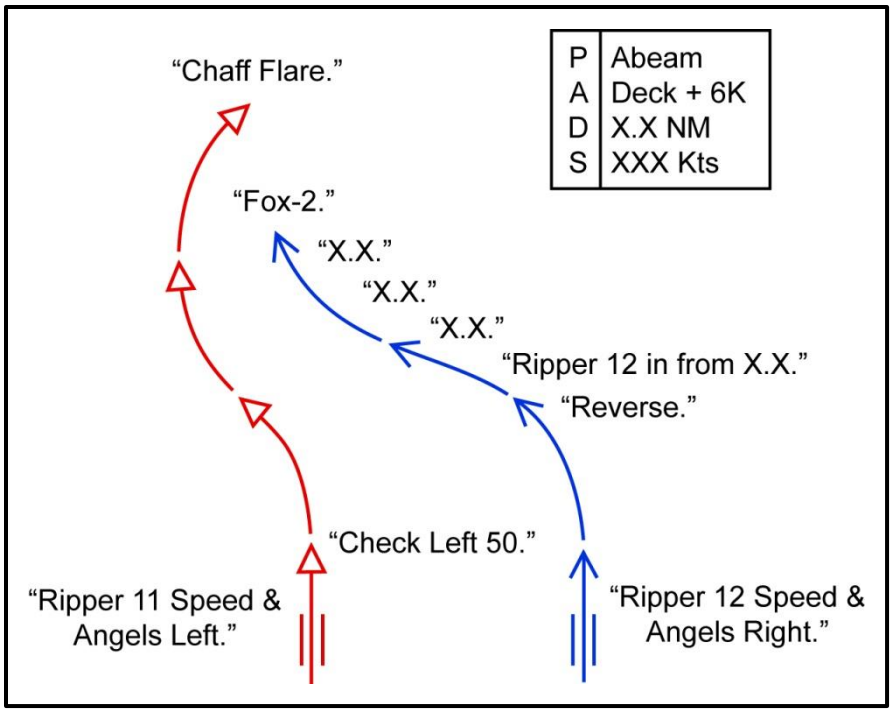



**Figure 5-17 Generic Perch Setup**

After a "speed and angels" call from both aircraft, lead will check the flight 50 degrees away from the fighter. The fighter will turn using 2-3 G's toward the bandit and direct a "reverse" when the bandit is at the fighter's canopy bow. The fighter will reverse the turn and fly a pure pursuit curve, maintaining airspeed and altitude, and putting the bandit between the airspeed and altitude boxes in the HUD. The fighter will call "Ripper 12 in from X.X" and count down the ranges in tenths of miles while directing the bandit to "tighten/ease your turn" to maintain 40º AOT. At the desired range, the fighter will call "Fox-2." If the IP deems the A/A TACAN is lagging too much, he can initiate with a "fight's on."

At the "Fox-2" or "fight's on" call, select MRT, lag the bandit, and drive to his point of departure. A good technique is to use a geo-reference point to drive to bandit's departure point (e.g., a cloud, ground ref, etc.). When aspect stops changing and the Line of Sight (LOS) rate explodes, you are inside the bubble and have arrived at the AW. You need to execute an OBT. Roll to place your lift vector on to slightly below and pull to stabilize the bandit in your canopy (about 1 fist above the canopy bow). Analyze the AWE and subsequent defender maneuvering.

1. 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˚ 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 entry.

2. 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 wait for misaligned turn circles. Keep in mind the later your AWE, the more neutral the fight, and the more of a rate war the engagement becomes.

3. With a "nailed" AWE and a properly executed OBT, 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 slight flight path overshoot). Do not bleed your airspeed below 300-330 KIAS unless making an energy excursion to take a shot.

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 below 300-330 KIAS. After the flight path overshoot the bandit will stabilize on your canopy momentarily before starting to move forward. This is the time to perform an energy excursion, placing your lift vector on the bandit and pulling to the nibble of buffet, trading airspeed for nose position. If the bandit is smart, he will recognize your nose coming on and perform a defensive energy excursion. If unable to counter your nose coming on due to a low energy state, the bandit will perform one of two nose-low maneuvers to make use of potential energy in the form of altitude: a radius defense or a ditch.

Radius Defense Follow:

When the bandit assesses your nose as becoming a threat, he will perform an oblique nose-low maneuver (i.e., a radius defense). By maneuvering nose low, the bandit is forcing you to decide between weapons employment and follow-on 2C BFM. Smart fighters should always choose follow-on BFM (OBFM Objective number one) to avoid a loss of angles upon arrival on the deck. This decision, however, will allow the bandit to create angles and hold your nose in lag. This can be compensated for by driving towards the bandit's point of departure where he first redefined to a radius defense. The cues for redefinition follow timing are the same in the vertical realm as they are in the horizontal. When you see the LOS rate "explode," it is time to follow and pull for the CZ. A good technique is to look for LOS rates in reference to the ground vice the canopy since the motion will be in the oblique. When LOS rate explodes, roll and place your lift vector on the bandit and max perform the aircraft. Do not attempt to gain vertical turning room while driving to his point of departure when countering a radius defense as this will keep you outside the bandit's bubble longer. The goal is to stop losing angles to the bandit by quickly entering his bubble. This concept differs from a ditch follow since those redefinitions are 1C in nature vice 2C.

1. If you nailed the entry (i.e., you see stable TA and canopy position from the bandit), you have maintained your advantage. The bandit will stabilize approximately 15 degrees below the horizon. Be sure to keep your lift vector slightly above him, and be patient. The deck will quickly become a factor and MATC will provide weapons employment opportunities if you manage your energy correctly.

2. If you are early, you will be able to pull the bandit forward on your canopy – even just a small amount – and you will see the bandit nearer to the horizon. This will result in more angles to solve for on the deck with less of an altitude advantage to help solve for them. If left unresolved, you will arrive on the deck and likely have an ICFPOS, neutralizing the fight. To fix

this, first you must ensure that any overshoot occurs inside the bandit's CZ. In order to avoid an in-close overshoot, either ease your pull to stabilize the bandit on your canopy, or perform an aggressive lag maneuver (depending on how premature the follow). Once executed, place your lift vector slightly above the bandit and continue the lift limit pull at MRT all the way to the deck. If you quickly recognize and fix your early follow, you can maintain your advantage on the deck. However, time to kill will increase.

3. If you are late, you will see the bandit move aft on your canopy. Essentially, the bandit is out-rating you. Additionally, the bandit will appear farther below the horizon than he would on a well-executed entry. Unfortunately, you have already lost those angles. To compensate, simply keep your lift vector on to slightly above the bandit, and follow him down to the deck. Do not perform a low yo-yo type maneuver to make up angles as this will only result in a loss of altitude advantage. Maintain your lift limit pull at MRT, but realize that being late on your follow effectively increases time to kill.

Ditch Follow:

A ditch can be thought of as a pure nose-low vertical 1C redefinition. The timing and cues when following a ditch are the same for the radius defense follow with a couple minor exceptions. First, an altitude advantage will help you compensate for the steeper POM. Attempt to climb while driving to the bandit's point of departure in order to maximize your altitude advantage. Second, attempt to match the bandit's POM down to the deck.

On the Deck:

As you approach the deck, use the 10% rule to avoid busting it. You will typically find yourself about 30 degrees nose-low. If there is any excess altitude between the bandit and the deck, the bandit has essentially allowed turning room, and you should immediately take advantage of it. If you see stable canopy position as you transition to the deck, maintain that current sight picture but do not bleed below 300 to 330 KIAS to avoid getting stuck in lag. As you capture the upper end of the rate band, MATC will develop, allowing you to arrive in a Launch Acceptability Region (LAR). MATC cues on the deck are the same as you used following your initial OBT. If you see the bandit tracking aft on the canopy, capture your airspeed. If you see the bandit tracking forward on the canopy, perform an energy excursion for a shot.

After each shot, ***immediately*** maneuver to lag to preserve your position in the bandit's CZ and, therefore, your advantage. As LOS rate once again takes off, perform another OBT assessing canopy motion, adjusting your pull appropriately. After a series of these shots/maneuvers, you will arrive in the near side of the bandit's CZ with RAC under control. The bandit will be out of airspeed, altitude, and options. Be cognizant of any closure problems the bandit may present in attempting to force an overshoot. Modulate the throttle to maintain your advantage. If the bandit reverses, realize you are now in a 1C fight. Use the vertical appropriately and control closure as required.

The overall objective is to arrive in the bandit's CZ with range, angles, and closure under control. Take shots of opportunity and apply follow-on BFM (e.g., a lag maneuver back to the

CZ) to maintain your offensive advantage.

### 506. 6,000 FT OFFENSIVE PERCH SET (6K)

Climb to PADS altitude at 300 KIAS abeam lead. To achieve 350 KIAS, we will perform a level acceleration for the extra 50 knots. Lead will call to "set 350." Select MRT. Keeping lead on the horizon, adjust the throttle to maintain abeam and arrive at PADS altitude and airspeed. Once established, the flight lead will initiate the "speed and angels" call.

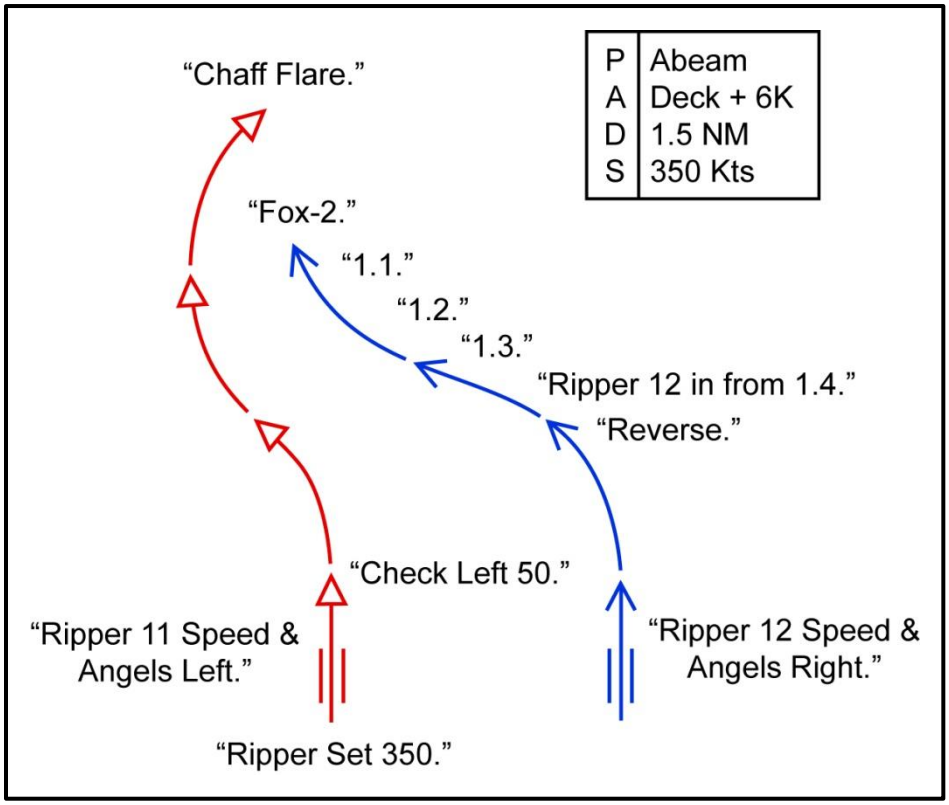



**Figure 5-18 6,000 ft Perch Setup**

The 6k set positions you just outside the bandit's bubble. Thus, after calling Fox-2 some angles will be gained by the bandit while you unload to the AW. Weapon selection should be primarily the AIM-9. During this set, if you nailed your AWE and performed an effective OBT, you should have a small flight path overshoot in the CZ. Following the overshoot, expect misaligned turn circles to work in your favor and either pull for a shot or follow the bandit through the deck transition. If a shot opportunity is not immediately available, utilize G to maintain airspeed and look for misaligned turn circles for an employment opportunity.

## 507. 9,000 FT OFFENSIVE PERCH SET (9K)

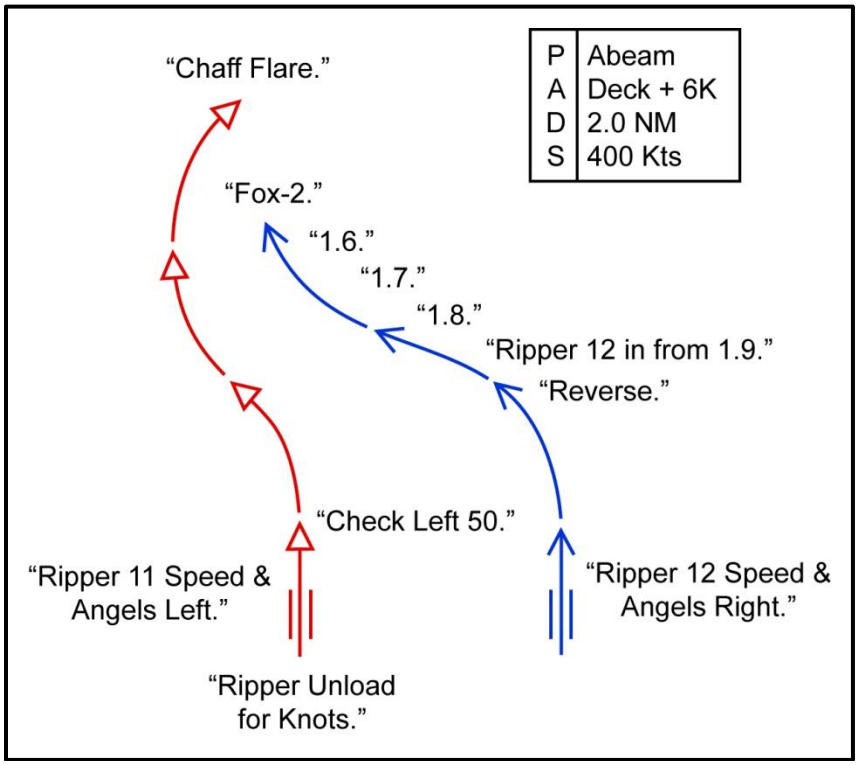



**Figure 5-19 9,000 ft Perch Setup**

Climb to PADS altitude + 2,500 ft at 300 KIAS abeam lead. To achieve 400 KIAS we will unload for the extra 100 knots. Lead will call to "unload for knots". Select MRT and unload to set 7 degrees nose low. Keeping lead on the horizon, adjust the throttle to maintain abeam and arrive at PADS altitude and airspeed. Once established, the flight lead will initiate the "speed and angels" call.

The 9k set positions you outside the bandit's bubble. While you are outside the bubble, the bandit will be able to generate angles via target aspect change prior to LOS rate explosion. Also, due to the range and misaligned turn circles, you will have two bubble entries. Weapons selection should be primarily the AIM-9. At 400 KIAS, you are close to corner airspeed, so care must be taken not to overstress the aircraft. Perform a smooth pull to target 7.0 Gs, or a lift-limit pull, during the OBT. With a nailed AWE and the bandit stable above the canopy bow, expect a flight path overshoot aft of the CZ with medium AON. Following the overshoot, you should recognize your second bubble entry. If available, take a follow-on shot and immediately go to lag. If a follow-on shot is unavailable, immediately lag in order to preserve your offensive advantage and drive to the new AW. From this point, the fight should look like the 6k set with the exception of greater AON. The resulting fight is more of a rate fight due to the larger AON. Therefore, you must ensure you are in your rate band, and time your energy excursions with misaligned turn circles to take valid shots.

## 508. OFFENSIVE BFM CONCLUSION

When executed correctly, offensive BFM can be one of the most challenging and exhilarating experiences in your career. These flights can be made infinitely more enjoyable when you have a solid understanding of BFM concepts and mechanics. This is your first chance to employ the T-45 as an air-to-air weapon versus a hostile bandit. Keep in mind that your first priority is to ***kill*** the bandit. Over time you will develop your own techniques and skill sets in order to best employ your aircraft and its weapon systems ultimately to achieve the desired outcome of defeating the enemy in an air-to-air battle.

Conclusion:

The key to mastering offensive BFM is understanding and solving the three BFM problems: RAC. You must perform a timely and well-executed OBT, 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.

Learning Objectives offensive perch sets include:

1. PADS set up
2. 100% adherence to training rules
3. AWE recognition/timing
4. OBT mechanics
5. Energy management
6. Fight redefinition recognition/follow
7. LAR/shot opportunity recognition
8. 100% valid shots

# CHAPTER SIX
# DEFENSIVE BFM

## 600. DEFENSIVE CONCEPTS AND DEFINITIONS

The concepts that we learned in OBFM also apply to Defensive BFM (DBFM). The difference is that we need to assess the BFM cues to create RAC problems for the bandit all the while looking over our shoulder. The better we can do this, the more successful we will be at achieving our DBFM objectives.

Defensive Objectives:

1. Defeat initial weapons employment.

2. Maneuver to deny follow-on WEZ.

3. Neutralize the fight.

4. Transition to HABFM.

**NOTE**

HABFM will not be executed until the first HABFM event.

Defensive maneuvering is hard work. While reading the following, you must remember that you cannot fight what you cannot see. In order to accomplish your goals defensively,

***You must maintain sight.***

There is a saying in the strike/fighter community, "lose sight, lose the fight." This concept cannot be overemphasized. If you lose sight of the bandit, you will get shot.

Sensor Nose:

In the fleet, as we train for fighting more advanced enemy aircraft, the definition of "sensor nose" will change depending on that aircraft's radar and other advanced systems. It is likely that sensor nose may be greater than 45 degrees off the actual nose position of one's opponent. For our purposes while training in and against the T-45, we will define sensor nose as "nose on."

To execute your defensive BFM objectives, you must do the following:

1. Keep sight/regain sight – you cannot fight what you cannot see. You will, however, lose sight at times. Think about the geometry of the fight and bias where you think the bandit should be. Be ready to execute the "Lost Sight Gameplan" found later in this section.

2. Max perform the aircraft – don't just float your turn and become a target.

3. Avoid the deck – this was a challenge during your offensive BFM training, but it's now more difficult due to the increased time you will be looking over your shoulder. A rapid inside-outside scan is necessary. Being able to fly close to the deck gives the bandit less turning room to solve his angle problem.

***Above all, no matter how dire the situation may seem, never give up!***

Defensive Axioms:

1. Survive:

    a. Deny sensor nose.

    b. Defeat shots.

2. Attacker moving forward on canopy = Keep pulling.

3. TA decreasing = Increase pull to hold attacker's nose off.

4. If the bandit is <60º AOT and unable to perform steps 2 and 3, redefine.

When defensive, if the opportunity to leave the fight presents itself, it's time to disengage and "live to fight another day." However, you must "earn the right to bug." This requires you to meet certain bug criteria.

Bug criteria:

1. 150°-180° pass – setting up a neutral merge and bugging towards the bandit's 6 o'clock will maximize the amount of degrees the bandit has to turn to arrive in a valid WEZ.

2. 500 ft pass – if below the bandit, climb to take out any turning room the bandit can use. If high, utilize the exclusive-use turning room and get nose-low just prior to the merge, to arrive at the merge with 500 ft of separation nose-low.

Bug mechanics:

1. MRT.

2. 40-50° nose-low (altitude dependent).

3. Unload – after pulling to the bandit's extended 6 o'clock in the nose-down attitude, unload to zero G. Don't look at the HUD to check your G's; just unload until you feel light in the seat. Note that the unload can occur at any nose position and AOB.

4. Keep sight – position your wings to ensure they are not blocking your view of the bandit. As the bandit moves to your aft visual limit, perform a check turn to keep the bandit off your six.

## 6-2 DEFENSIVE BFM

5. Check turn – Check turn 20°-30° away from the bandit's nose, then unload again. Check turn no more than twice in order to maximize your separation from the bandit.

6. Assess bug – if you look over your shoulder and the bandit is inside 1.0 nm with less than 90 degrees of turn remaining, you will not escape. If greater than 1.0 nm, or with more than 90 degrees of turn remaining, you should be outside of his weapons envelope.

If you assess the bug is not valid, roll to place your lift vector on and perform a max performance break turn back into the bandit. Then apply DBFM principals as stated above.

If you assess the bug will be valid, finish unloading down to the deck, gaining extra separation. As the bandit turns nose-on, he will call a shot and announce his airspeed, i.e., "Hammer 11, Fox-2, 300." When you hear this call, use your current airspeed and DME to determine if the bug was successful by using the "rules of two."

Rules of Two:

By quickly calculating the opening velocity between the two aircraft, and adding that to your range from the bandit, you can determine the success or failure of the bug attempt. The rules of two state that if your opening velocity plus your distance from the bandit equals the sum total of 2.0 or higher, the bug is successful and would kinematically defeat a missile launch. For example, if your airspeed is 400 KIAS and the bandit's is 300 KIAS, then you must be at least 1.0 nm away from the bandit for the bug to be successful. Conversely, if you are 1.5 nm from the bandit and his airspeed is 350 KIAS, your airspeed must be 400 KIAS or greater for the bug to be successful. If the sum total equals 1.9 or less, your bug was unsuccessful, and you can expect to be debriefed on which of the bug criteria weren't met, or if your mechanics were at fault. It is imperative that you sharpen your eyeball calibration for range in case your A/A DME (yardstick) is inoperative. See the below charts for further explanation.

| **SUCCESSFUL BUGS** | | | | |
|---|---|---|---|---|
| YOUR A/S | - BANDIT A/S | = OPENING VELOCITY | + RANGE | =RESULT |
| 390 | 300 | 0.9 | 1.1 | 2.0 |
| 410 | 270 | 1.4 | 0.8 | 2.2 |
| 400 | 250 | 1.5 | 0.8 | 2.3 |

| **UNSUCCESSFUL BUGS** | | | | |
|---|---|---|---|---|
| YOUR A/S | - BANDIT A/S | = OPENING VELOCITY | + RANGE | =RESULT |
| 390 | 310 | 0.8 | 1.0 | 1.8 |
| 410 | 290 | 1.2 | 0.7 | 1.9 |
| 390 | 300 | 0.9 | 0.8 | 1.7 |

As you can see in the preceding charts, changing just one parameter in the second table changes the outcome of the bug attempt. While bugging, you have two of the three numbers in front of you: your airspeed and the DME from the bandit. Strive to get a head start on the math to determine what airspeed you will need to hear in order to hit 2.0.

Lost Sight Gameplan:

If you have an idea of where the bandit was, max perform the jet in that direction. As you max perform, it will make a valid weapons solution for the bandit more difficult.

If on the deck, reorient your lift vector to remain unpredictable and defeat the POM of a potential gunshot. You should move out-of-plane approximately every 3-5 seconds, while attempting to regain sight by looking at your 5-7 o'clock position from high to level.

If you have excess altitude above the deck, stay in the direction that you were turning when you lost sight and max perform nose-low to the deck. This is usually a good bet as reversing your turn typically helps the bandit gain a weapons solution. Scan for the bandit, looking inside the turn from your aft visibility limit forward to your wing line.

If lost sight while on the bug, you must check turn at least one clock code, or 30°, in order to flush the bandit out from your 6 o'clock. If still no joy, break back into the fight.

Reversals:

Before we discuss reversal techniques we need to understand the circumstances leading up to the reversal. The question of when to reverse or redefine the fight can be difficult for novice aviators. We will start with the easy decisions and move to the harder ones later.

- Flight Path Overshoot – as the defender, if we observe a flight path overshoot where the attacker is in the CZ or aft and we attempt to reverse, we merely help his lag problem and aid in our own demise.

- In-Close Flight Path Overshoot (ICFPOS) – how close is "in-close?" If the overshoot occurs inside the forward limit of the CZ, we will consider it "in close." We also need high Angles Off Tail (> 60-degree AOT). If the defender does an immediate, aggressive reversal after the overshoot, he may be able to induce a 3/9 line overshoot from this flight path overshoot.

- 3/9 Line Overshoot – if you are defensive and see somehow we have induced an overshoot in which the attacker moves ahead of our wing line (forward of abeam), then we reverse. The attacker has been neutralized or the roles have reversed, and we should transition to offensive or high-aspect BFM as appropriate.

In order for the fighter to take advantage of the bandit's overshoot, three criteria must be satisfied:

1. The bandit must have an ICFPOS (< 2,000 ft) with greater than 60 degrees TA.

2. The bandit must pass the extended six o'clock with a high line-of-sight rate.

3. You must be able to visualize reversing inside the bandit's turn radius. You should know

## 6-4 DEFENSIVE BFM

these criteria like boldface.

***If ever in doubt, do not reverse.***

Reversal Technique:

Once the criteria have been met, perform an unloaded roll placing the lift vector on to slightly above the bandit, then perform a lift-limit pull, trading airspeed for angles and altitude to transition to scissor maneuvering. You are now pulling into a 1C fight, so you should bleed your airspeed down from 300 KIAS to hit your optimal 1C performance numbers. If you execute a break turn (21 units AOA), you will bleed airspeed while getting your nose position established. If you are already slow, a nibble of buffet pull might help you preserve some energy for the follow-on merge. Lift vector placement is crucial. Your lift vector needs to be on the bandit (to slightly high) in order to try to collapse the fight and flush the bandit forward of your 3/9 line. You must constantly reposition your LV to give the bandit as little turning room as possible. The use of speedbrakes is a technique that is often introduced here. You have now transitioned from a rate fight to a positional fight. Apply techniques discussed later in the flats and roller sections to gain an offensive advantage and/or look to disengage.

## 601. SNAP SHOT DRILL (SSD) AS THE TARGET

Although the geometry of the SSD will not change now that we have swapped roles, our mindset will change. Our goal now is to recognize what an impending gunshot will look like during the first four non-maneuvering sets and be able to defeat the shot by executing a proper guns defense during the last four maneuvering iterations.

Execution:

As the target aircraft, you will tighten/ease G initially to maintain the shooter at the 10 or 2 o'clock position, then allow the shooter to drift aft. During the maneuvering sets, the target should evaluate the nose position of the shooter and execute a properly timed guns defense to defeat the impending gunshot.

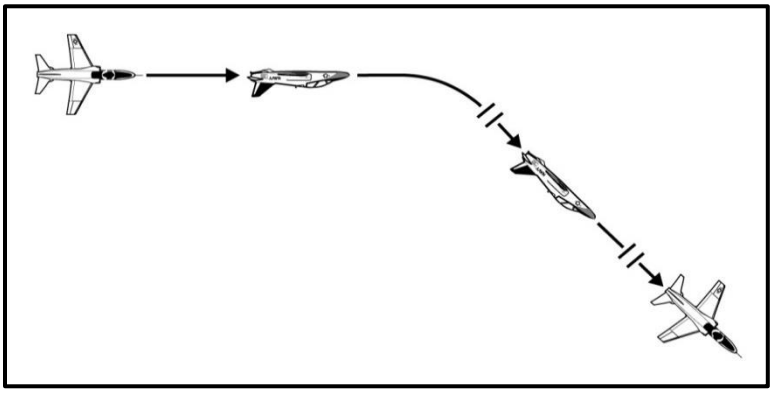


**Figure 6-1 Guns Defense**

Performing the Guns Defense (Defeating Plane of Motion):

As the target during the maneuvering sets, we have two goals. First, we need to present the bandit with as little surface area as possible by placing our wingtip on the bandit. Second, we need to maneuver out of plane in a timely manner to deny his ability to solve for plane of motion.

Timing:

It is imperative we time our guns defense (guns d) to defeat the shot. If we maneuver too late, we will fly through the shooter's pipper. If we maneuver too early, we are broadcasting our intentions, allowing the shooter to counter our maneuver and solve for POM. As the target aircraft, we developed a sight picture of the shooter's nose position during the "trigger down snap" call on the non-maneuvering sets. We will use this evaluation to time our guns d.

Maneuvering:

We have three basic maneuvers we can perform to defeat impending gun shots:

- = Goods
  - = Others

1 Near wingtip on, max performance pull nose high –
- May be your only option when on the deck.
- Quick to perform and easy to maintain sight. Allows for good aircraft displacement and good follow-on BFM.
  - Maneuvering against gravity.
  - Need some airspeed (energy) to displace aircraft.

2. Near wingtip on, bunt –
- Quick and may fake the shooter into going nose-high.
- Easy to maintain sight.
  - Little displacement out of aircraft and may accelerate farther out in front i.e., poor follow-on BFM.
  - Not an option when fighting less than 500 ft above the deck.
  - The amount of negative G needed to displace the aircraft can be extremely uncomfortable.

3. Far wingtip, on max performance pull nose-low –
- Best aircraft displacement due to increased G available from gravity (i.e., "God's G").
  - May broadcast intentions.
  - Hard to maintain sight and may cause disorientation.
  - Minimal option for follow-on BFM.
  - Not an option when fighting on the deck.

When trying to max perform, it is imperative that we pull to the lift limit. If we pull too hard (past lift limit) or too weak, we will not achieve maximum aircraft displacement. For the T-45, lift limit can be achieved by a rumble of buffet pull.

Safety:

Do not forget that if the 500 ft bubble looks like it might be broken, a timely "skip it" call shall be made for that pass.

## 602. DEFENSIVE FLAT SCISSORS

The flats entry and mechanics will remain similar to offensive BFM. The bandit will however, begin moving his jet to an offensive position early (on the "2" of "3, 2, 1") so that when he calls "fight's on," roles are clearly established. We will be looking to deny shots, defeat shots, or redefine, if required. In order to accomplish these tasks, we will now be looking to work out of phase with the attacker.

Reversal Timing:

If the bandit does not have his lift vector oriented towards you, continue to generate lateral separation. Once the bandit reverses and places his lift vector on you, you must honor this by placing your LV on the bandit. After the merge, time your defensive reversals with the following criteria in mind:

- To work out of phase, reverse after the bandit crosses your extended six. This will help increase the lateral separation needed to work towards a high-aspect/neutral pass.

After maneuvering in the flats, we may continue to find ourselves in a defensive position. We will summarize the positions in the following two situations with respect to energy and position:

- Up and forward – work to get out of phase and attempt to stack the flats to deny the bandit a guns solution. If you sense the bandit is working into a weapons envelope, look to redefine or execute a guns d.

- Down and forward – with a small amount of nose-to-tail separation, attempt to work below the bandit, potentially masking his view of you while working to get in phase. If the bandit has a good amount of nose-to-tail separation, look to redefine into a 2C fight.

Redefining Nose-Low:

If the bandit is able to flush you out in front to the point where he can take snap shots, or has worked in phase aft into your CZ for a possible tracking solution, it is time to get out of the flat scissors and redefine 2C. Remember, two valid snap shots equals a kill as does one second of tracking time. After a guns d, execute a ditch or positional deck transition (think 10% rule) if you do not have sufficient altitude to execute the ditch. This is ***not*** a bug, so ***do not*** level your wings. Once on the deck, assess the fight and execute your best defensive gameplan.

Learning Objectives (emphasis) for the flats:

1. PADS set up
2. 100% training rules adherence
3. AOA/airspeed control
4. Lift vector placement
5. Recognition of offensive/defensive position
6. Reversal timing execution
7. Shot opportunity recognition/mechanics
8. Guns d recognition/mechanics
9. Fight redefinition

## 603. DEFENSIVE ROLLING SCISSORS

Redefining a fight into a roller is not a bad gameplan if you find yourself defensive. If executed properly, the bandit will have to solve several BFM problems prior to being able to take a shot.

Execution:

The execution and maneuvering of the defensive roller will remain the same. The bandit will, however, maneuver to establish an offensive position prior to "fight's on."

Redefining the Roller:

- Slightly defensive (< 30 deg bandit advantage) – if you are slightly defensive and feel that staying in the roller or redefining into the flats is not prudent, look to bug. Create vertical turning room by exaggerating your nose-high attitude and make the roller "loopy." Look to bug out of the top of the roller with the bandit near the deck and his nose coming up. With the bandit on or near the deck, he will have to perform a level bug follow, denying him the option of gaining airspeed quickly. Pull to create as many angles as possible and use the vertical room above the bandit to bug towards his 6 o'clock. In other words, instead of pulling your nose above the horizon and doing a pirouette at the top of the roller, pull level (to slightly nose-low) across the horizon in order to place your lift vector on the bandit as he comes through the bottom. By immediately putting your lift vector on the bandit, you are setting yourself up for a close-aboard pass, denying the bandit turning room in order to give yourself the best chance for a successful bug. After the close-aboard pass, achieve 30-40 degrees nose-down (altitude

permitting), initially unloading. ***Keep sight of the bandit*** until you are assured a good bug.

- Defensive (> 30 deg bandit advantage) – if you are defensive, you are effectively in a 2C fight. Execute your best 2C defensive gameplan as discussed later in perch BFM.

Learning Objectives (emphasis) for the roller:

1. PADS set up
2. 100% adherence to training rules
3. Lift vector placement
4. AOA/airspeed control
5. Flight path projection
6. Fight redefinition

## 604. DEFENSIVE PERCH BFM OVERVIEW

Now we will take a look at defensive perch BFM. The sets are the same as the offensive perch sets, but with the roles reversed.

Execution:

After a "speed and angels" call from both aircraft, lead will check the flight 50 degrees into the fighter. Pull 2-3 G's to the new heading and reverse, but strive to maintain PADS altitude. If you are slow or have a weak pull, the bandit will direct you to "reverse." Reverse your turn and maintain airspeed and altitude, pulling the bandit to 40° AOT. The bandit will call "[tactical call sign] in from X.X" and count down the range in tenths of miles while directing you to "tighten/ease your turn" to maintain 40° AOT. At the prescribed range, the bandit will call "Fox-2."

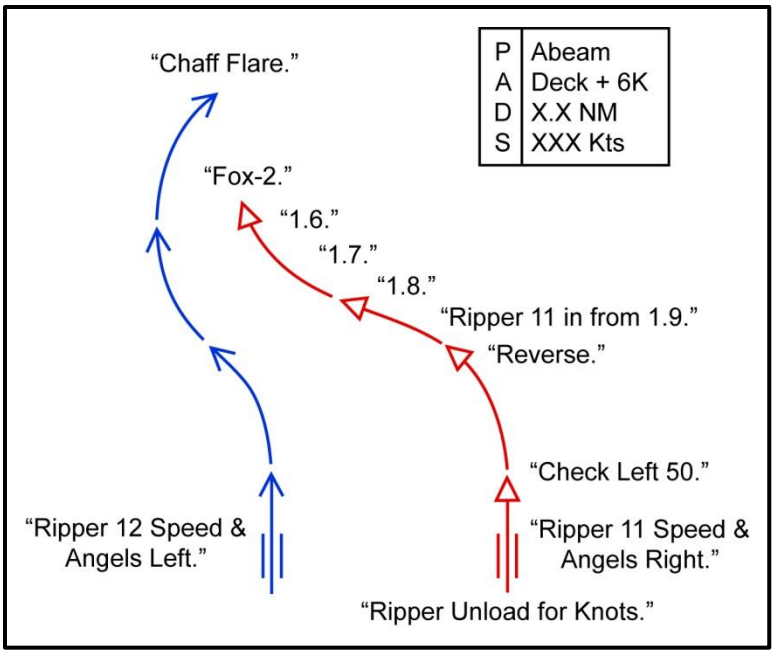



**Figure 6-2 Defensive Perch Setup**

At the "Fox-2" call, select MRT, roll to place your lift vector on to slightly below the bandit, and perform a lift or G limit pull (Axiom 1: survive). A proper defensive break turn should keep the bandit the same distance above the horizon throughout the defensive break turn (if you misplace your lift vector and break slightly nose-high or too nose-low, do not try to correct back; simply capture what you have.) Next, assess the bandit's AWE:

1. Early AWE (decreasing target aspect) – the bandit will appear to be nose-on and you will be able to hold the bandit stationary or pull him forward on your canopy (Axiom 2: attacker moving forward on canopy = keep pulling). If able to pull the bandit forward of 60 degrees AOT, regardless of sensor nose, keep pulling. Call "chaff, flares" denying a missile shot, and assess if a guns d is required. The fighter is defeating very low $P_k$ shots from the bandit, while attempting to force an ICFPOS, effectively neutralizing the fight. If the bandit does not maneuver to fix the early AWE, this is good. As you create an angle and closure problem, keep max performing down to gun range. When you assess the bandit has closed into gun range, perform an appropriate guns d, and then reorient your lift vector back into the bandit, looking to force an in-close overshoot. If the bandit gets too greedy, you will force an in-close overshoot, and you should now apply your reversal mechanics. If the bandit prevents the overshoot by performing a nose-high maneuver, you have two options:

    a. If you have vertical airspeed, match the bandit nose-high to collapse the range.

    b. If you don't have airspeed to counter nose-high, continue in the current turn, 5-10 degrees nose-low, and execute follow-on DBFM looking for opportunities to ease and regain energy.

2. Late AWE (increasing target aspect) – you will be able to create greater fuselage

misalignment and thus increase your time to live. Maintain your max performance pull down to the tactical rate band creating the greatest amount of angles possible. Assess AOT and TA:

a. With high AOT and high TA, fight your best rate war.

b. If low AOT and high TA, the bandit will still be able to benefit from MATC. The bandit will have a flight path overshoot. The greater the TA at the time of the overshoot, the longer it will take for the bandit's nose to threaten you. During the overshoot, you may lose sight of the bandit as he disappears behind your 6 o'clock. Prior to losing sight, if the bandit still has a high amount of TA, then ease your pull to maintain your airspeed in the rate band. If the bandit has a low amount of TA, then execute a max performance pull to deny sensor nose. MATC is working for the bandit when he reappears at your aft visual limit. If at this time the TA is decreasing, then execute a max performance pull. If with this pull you are able to hold the bandit in lag, continue your max performance pull, otherwise, redefine the fight.

c. If the bandit is so late to the AW that the fight becomes more or less neutral, you are now executing HABFM. Initiate a nose-low out-of-plane maneuver cutting across the circle. Left un-countered, you should find yourself with an offensive advantage. If the bandit counters, you will arrive at a neutral merge on the deck or perhaps in a rolling scissors.

3. Nailed AWE (stabilized target aspect) – you will only be able to pull the bandit forward while he is outside the bubble. The bandit will have a small flight path overshoot in, or aft of, the CZ. When the bandit reappears, max perform in order to hold off his nose (Axiom 3: TA decreasing = increase pull to hold attacker's nose off). If it looks like the bandit's nose is almost on, you are late and need to redefine (Axiom 4).

<u>Redefinition</u>:

If you are unable to pull the bandit forward on your canopy (i.e., create angles) and the bandit's TA is decreasing, you need to redefine. The most common mistake is being late on the redefinition. Avoid this by redefining well before sensor nose becomes a factor. The sight picture for this is when the bandit has about 30 degrees of turn to go before coming nose on to you. You must force the bandit to choose between weapons employment and follow-on BFM. If you are no joy, it is better to go early than late when executing your redefinition.

<u>Radius Defense (2C Redefinition)</u>:

A radius defense is used by aircraft with poor vertical turn performance and poor turn rate performance. Comparatively to most enemy aircraft, the T-45 meets both these criteria, so we must learn how to utilize smart BFM tactics to out-fly the bandit and exploit his weaknesses. A radius defense uses oblique nose-low out-of-plane maneuvering to minimize the aircraft turn radius while gaining energy for a 2C fight on the deck. The effect of minimizing the aircraft turn radius allows you, as the defender, to observe forward movement of the bandit on your canopy. This is desirable since anytime the bandit is moving forward on our canopy, we are taking angles

back. If the bandit does not execute a proper follow, the fighter can either gain angles, energy, or both, significantly increasing time to kill or perhaps neutralizing the fight.

The overall goal of the radius defense is to increase time to kill by attempting to hold the bandit on the edge of your bubble, or by gaining energy for a rate war on the deck. This prevents the bandit's nose from coming to bear, denying a weapons solution for a greater length of time. While a radius defense will not typically neutralize an attacker, it will significantly increase time to kill. Hopefully, this will allow enough time for your (notional) wingman to come help, or for the bandit to commit a BFM error of which you can take advantage. If the bandit fails to follow the redefinition correctly, more angles may be gained or a shot can be denied entirely. The radius defense is only useful if the bandit is acquired on the edge of, or outside of, our bubble (i.e., 6k set and 9k set).

The advantages of the radius defense in the T-45 are that it allows the ability to add energy even while using a lift limit pull, to slow the transition to the deck, and to maintain sight throughout the redefinition. Due to T-45 performance and visibility limitations, ***the radius defense is the primary defense and shall be used on the perch sets.***

To execute the radius defense:

Initially, perform a 135-degree overbank while maintaining a lift-limit pull (loaded rolls are ok) with the throttle at MRT. This will force the bandit outside of your bubble, allowing you to gain some angles back. Additionally, it will displace your aircraft below the horizon enough to force the bandit to choose between employing a weapon and follow-on BFM. This idea cannot be overstated enough. A weak overbank will result in the bandit being able to employ a weapon without sacrificing follow-on BFM. If you are visual when you initiate the overbank, the bandit should be two to three fists above the headbox, and forward of the opposite canopy spike. You should be able to see him, for example, in a left turn by placing your head to the right of the ejection seat headbox, and by looking up and aft. The bandit will typically be above your altitude, so you should see him above both the horizon and your lift vector.

If you are no joy, a mechanical 135-degree overbank will help pull the bandit forward and above your aft visibility limit. This should allow you to regain sight.

After the initial overbank, you must assess the bandit's redefinition follow. When executing a radius defense, the main objective is to overbank enough to force the bandit into lag, but not too much where you are fighting the deck and not the bandit. Maintain a maximum performance pull at MRT unless you have a good reason not to. Finally, attempt to hold the bandit in lag as long as possible, arriving on the deck with energy to survive, preferably within your 2C rate band.

1. If the bandit is early, you will see decreasing TA and forward LOS rates. This is due to the bandit's pursuit curve and is similar in concept to an early AWE described previously. Because you see forward LOS rates, you should raise your lift vector enough to stabilize the bandit on the canopy while maintaining a maximum performance pull at MRT. Use chaff/flares and a Guns D as required, and attempt to force an ICFPOS. If the bandit fixes his early follow, you can ease the pull to gain energy while he is not pressuring you. From here, it will look similar to a late or

nailed follow.

2. If the bandit is late, you will see increasing TA and forward LOS rates. This comes from the fact that you are "out rating" the bandit. You can raise your lift vector slightly, decrease AOB, and ease the pull to gain energy. Once the bandit turns to follow, tighten down to a maximum performance pull and vary AOB to keep the bandit on the same spot on your canopy. Because the bandit was late, you will see the bandit further forward than a nailed entry with greater TA, and you will have more energy for the rate war on the deck. All of these cues mean you are gaining angles back from the bandit. Remember, airspeed above your rate band can be turned into instantaneous turn rate, creating an overall increase in turn performance.

3. If the bandit nailed his follow, you will see stable TA. Simply adjust AOB to freeze the bandit's position on your canopy while maintaining a maximum performance pull at MRT. Remember, increasing AOB will stop aft motion and decreasing AOB will stop forward motion. This will result in about a 30-degree nose-low turn while your airspeed is increasing. You will have about five to ten seconds to manage the radius defense before the deck will become a factor. Don't forget to occasionally shift your focus inside the cockpit, scanning airspeed and altitude to intercept the 10% rule. Depending on how effective your lift-limit pull is, you can expect to have 330 to 350 KIAS on the deck.

Radius Defense Deck Transition and Fighting on the Deck:

As the deck becomes a factor, you will have to decrease your AOB to avoid busting the deck. The 10% rule is the best tool for deck preservation, and it is recommended that you target stabilizing approximately 500 feet above the deck when defensive. This will provide options, minimizing turning room below the deck and allowing you to spend more time looking outside at the bandit vice hawking your altitude.

The radius defense will result in 2C flow on the deck. All the concepts and sight pictures that were discussed at the initial break turn apply on the deck now. If you see the bandit ease and track aft on your canopy, you should ease your pull in order to conserve your energy on the deck. If you see the bandit tighten down and his target aspect starts to decrease, you should tighten down as well. All the while, try to keep the bandit on the same spot on your canopy as it will keep the fight tight, making it more difficult for the bandit to bring his nose to bear. As you play out this game, you are attempting to manage your energy to best deny him weapons separation, a valid shot, and angles. Being in your rate band is not as important as adjusting your pull based on what you see the bandit doing. In the end, you are significantly increasing time to kill. Remember, reversal criteria are just as applicable when stabilized on the deck as they are at altitude.

Ditch:

The ditch is a pure nose-low maneuver that uses precise lift vector placement to complicate the bandit's BFM problem. A ditch is useful in aircraft that have a very small vertical turn radius, using it as an advantage in an attempt to neutralize the fight. A ditch in the T-45 is challenging due to the large turn radius and poor aft visibility. As such, ditching will be used only sparingly

during your DBFM events but will play a significantly larger role in your fleet aircraft.

The only time a ditch is a valid BFM move in the T-45 is when the bandit is well inside your bubble (e.g., redefining out of a very defensive flat scissors). If altitude is available:

1. Perform a DBT to collapse the range and create as many angles as possible. It is optimum to have airspeed below 270 KIAS.

2. Roll, placing the bandit in the same place, but on the opposite side of the canopy (start by simply rolling inverted). Set a lift limit pull, and place your lift vector underneath the bandit. Throttle should be set to manage the BFM problem. If a closure problem is desired, select idle and consider using speedbrakes. If airspeed is desired for follow-on BFM on the deck, select MRT. Downrange travel will be greater with the throttle set to MRT, thus idle creates a closure problem which could result in an in-close overshoot if the bandit does not recognize it.

3. As your nose comes up to the horizon, turn to place your lift vector on the bandit to collapse the fight. If you lose sight, turn in the same direction in which you just performed the first ditch. Reversals can be used attempting to turn the bandit's lag into lead (1C redefinition).

An energy rate or positional deck transition typically follows a ditch. Ditches and positional deck transitions are 1C types of defense and involve reversals to maintain 1C flow, creating an angles and closure problem for the bandit. An energy rate deck transition typically results in neutral, to slightly defensive, 2C flow.

<u>Deck Transitions Following a Ditch and Fighting on the Deck</u>:

If you do not have the altitude above the deck to perform a pure nose-low maneuver (i.e., ditch), you will have to perform a transition in the oblique to prevent busting the deck. First, you need to assess relative fuselage alignment. When arriving on the deck, fuselage misalignment translates into greater AOT.

1. With ***low*** fuselage misalignment (low AOT and low AON – i.e., you're still defensive), perform a Positional Deck Transition (PDT). This maneuver trades altitude for angles, and uses reversals to force 1C flow. Roll to place your lift vector below the horizon to intercept the 10% rule. Utilize a lift-limit pull with the objective of creating angles without regard to airspeed while you attempt to turn the bandit's lag into lead. As you reverse, execute a Guns D if required. A closure problem may be your only chance at neutralizing the bandit and idle/speedbrakes may not be a bad option. Transition to HA or OBFM if appropriate. A flat scissors may also develop, so be prepared to fight this fight.

2. With ***high*** fuselage misalignment (high AOT and high AON – i.e., you anticipate arriving at a relatively neutral merge with little altitude delta), perform an Energy Rate Deck Transition (ERDT). This maneuver trades altitude for airspeed to ensure we arrive on the deck within our rate band. Target the 10% rule when committing nose-low. Adjust your lift vector and pull to arrive on the deck in your rate band. Greater airspeed is better, but don't ease the pull so much that you sacrifice angles and become even more defensive. Usually 30-40 degrees nose-low is a

good rule of thumb to achieve a good energy rate deck transition. You should be applying your HABFM gameplan at this point (discussed later).

3. If you find yourself 2C following a ditch, PDT, or ERDT, execute the 2C defensive gameplan outlined in the radius defense on the deck section above.

4. If you have transitioned to HABFM, execute the appropriate HABFM gameplan (discussed later).

### 605. 6,000 FT DEFENSIVE PERCH SET

The 6K set positions the bandit just outside your bubble. During your DBT, you will be able to generate angles as the bandit extends to the AW. Remember to keep pulling until you see the bandit moving aft on your canopy. You are attempting to cause a RAC problem for the bandit. The bandit is near a missile WEZ, so attempt to collapse the fight down inside minimum missile range. If the bandit nails the AWE there will be a small CZ overshoot. When you are unable to pull the bandit forward and observe decreasing TA, redefine using the radius defense.

### 606. 9,000 FT DEFENSIVE PERCH SET

The 9K set positions the bandit outside the bubble. While the bandit is outside the bubble, you will be able to generate angles. Continue the maximum performance pull until you see the bandit moving aft on your canopy. With a nailed AWE, the bandit should have a flight path overshoot at or beyond the far side of the CZ with significant TA. Following the flight path overshoot the bandit will have a second bubble entry. From that point the discussion is similar to the 6K perch set.

**NOTE**

To max perform the jet at 400 KIAS you will generate upwards of 7.0 G's. Prior to the onset of high G's, make sure to preposition your head to be able to keep sight of the bandit. Once the airspeed bleeds off and the G load decreases, it will become easier to move your head, reducing the possibility of neck/back injury.

**Learning Objectives (emphasis) Defensive Perch sets:**

1. PADS set up

2. 100% adherence to training rules

3. Defensive break turn mechanics (lift vector placement)

4. AWE timing recognition

5. Sensor nose recognition

6. Fight redefinition selection/mechanics

    a. Radius defense

    b. Ditch

    c. Positional

    d. Energy Rate

7. Deck transition

8. Energy management

9. Reversal criteria recognition

## 607. DEFENSIVE BFM CONCLUSION

Defensive BFM is extremely difficult and sometimes frustrating. A solid understanding of the aircraft performance capabilities and BFM concepts will, however, give you the tools you need to survive. This section has described many techniques in an effort to capitalize on the mistakes the bandit may make. You need to keep one thing in mind whenever you are defensive: ***never give up***. You may be able to turn the tables and kill the bandit, stay alive long enough for a wingman to help you, or perhaps disengage and live to fight another day.

# CHAPTER SEVEN
# HIGH-ASPECT BFM

## 700. HIGH-ASPECT CONCEPTS AND DEFINITIONS

High-Aspect BFM (HABFM) will call upon you to use all the skills you have learned thus far in perch BFM. The key to being successful in HABFM is recognizing what position you are in, or in which position you are likely to become, and fighting your best fight. This will take time, patience, and continuous assessment of angles and energy. The basics of LV placement, energy management, and controlling merges will aid you in molding your piece of art; no matter how well we execute those basics, the fight will quickly transition to offensive or defensive BFM, allowing you to then apply the principals discussed earlier to kill the bandit, or to live to fight another day.

**HA Objectives (in order):**

1. Deny weapons employment.
2. Achieve first weapons employment.
3. Gain positional advantage.
4. Employ follow-on shots.
5. Transition to OBFM/DBFM.
6. Separate or bug prior to becoming defensive.

**HA Basics (tools to become successful):**

1. LV placement combined with out-of-plane maneuvering.
2. Airspeed excursions (energy management).
3. Controlling merges.

In order to achieve our objectives we need to properly utilize the basics of HABFM.

Lift Vector Placement:

Generally you can utilize tactics involving placing your lift vector on the bandit and pulling. From that starting point, adjust your lift vector to achieve the desired effects on RAC:

Lead = collapse range and increase closure with no regard for angles.

Pure = utilized for ***weapons employment*** via collapsing range and closure, with ***little***

regard for angles.

Lag = manage RAC problem.

Energy Management:

Although not listed as a separate "basic" part of HABFM, we need to manage our energy properly to ensure we have the ability to utilize airspeed excursions when needed. We can manage and preserve our energy utilizing the following performance pulls:

1. Max performance pull (21 α or 7.0 Gs)

2. Compromise pull (17 α or ease G by 1 to 2)

3. Unload (7 α or 0 G)

Airspeed Excursions:

You need to be smart about energy excursions. Due to the poor thrust-to-weight ratio in the T-45, we have limited ability to regain lost energy. That being said, we need to trade airspeed for angles/nose position ***only*** when we are attempting to achieve the following:

1. Take a shot.

2. Deny a shot.

3. Take or create exclusive-use turning room.

4. Deny exclusive-use turning room.

Controlling Merges:

Lastly, we need to control merges. That is, you need to assess altitude, airspeed and angles, then plan your actions prior to, at, and after the merge to take advantage of your situation.

1. Altitude – look to utilize altitude to your advantage. If the fight is near the deck and you are low, the bandit is unable to commit nose-low, so the altitude to the deck becomes exclusive-use turning room for you. If high and slow, it is best to arrive at the merge stacked high which will yield an energy advantage to you.

2. Energy – not only do you need to know your energy state, but also utilizing the BFM cues, you need to assess the bandit's. The bandit may have an energy surplus over your own, allowing him to use the vertical; or, perhaps it would behoove you, in your current energy state (i.e., slow and on the deck), to force a 1C fight.

3. Geometry – angles equal a BFM advantage, so look to take advantage of any angles you might have, or can gain, at the merge.

## 7-2 HIGH-ASPECT BFM

4. Turning room – turning room belongs to whoever takes it. If you assess turning room exists, tighten down to take it out which will yield an angular advantage for you at the merge.

5. Check turn – as LOS rates take off, max perform across the bandit's tail to create a flight path crossing in the CZ. Check turns will take out any turning room from the bandit and make it easier to see the bandit post merge. Remember to preserve the 500 ft safety bubble for training at all times.

Initiating Flows:

After controlling the merge geometry that is most advantageous to you, set the flow to take advantage of your situation.

1. In-plane (<45 degrees):

    a. 1C – for this flow, ensure you have enough energy to counter a pure nose- high maneuver, but not so much airspeed that when you set 1C flow, you will be unable to perform a lift-limit pull, and thus flush out in front of the bandit. Utilize a combination of lift vector placement and an energy excursion to attempt to tighten your turn radius inside the bandit's. A good rule of thumb is to hit the merge with tactical vertical airspeed.

    b. 2C – it is best to be at corner airspeed. If you have an airspeed advantage at the merge, you will be able to create angles and turning room in the form of an energy excursion. If the bandit reverses 1C and you assess that you will be defensive in the resulting in-plane 1C fight, counter with an out-of-plane (OOPl) nose-low or -high maneuver. Refer to the discussion below for your best 2C OOPl fight.

2. Out-of-plane (>45 degrees): out-of-plane will result in one aircraft nose-high and the other nose-low:

    a. OOPl 1C:

        i. Nose-low – this flow is optimum to force a low-to-high merge. Continue with your current direction of turn, utilizing a nose-low (approximately 45°) nibble of buffet turn to maintain energy on the jet, and to maximize turn rate. You need to maintain enough energy that you have the ability to pitch nose-high to meet the bandit at the next merge. Prior to 90° TA, place your lift vector slightly below the bandit and pitch up into the fight. By placing your lift vector below the bandit you are attempting to make the merge more vertical.

        ii. Nose-high – maintain a lift limit pull in order to tighten your turn circle inside the nose-low bandit. If you assess the bandit does not have the energy to come up to meet you, unload above the bandit to create exclusive-use turning room. If you assess the bandit can come up to meet you, keep pulling and get your nose below the bandit in order to flatten out the merge. Make sure you adjust

nose position to meet the bandit at the next merge. Assess your airspeed at the merge, and determine whether the bandit is attempting an early turn.

b. OOPl 2C:

i. Nose-low – it is best to be at corner airspeed. In most cases, performing nose-low will be your best 2C flow (airspeed/altitude dependent). Tighten down the merge and utilize a max performance pull across the bandit's tail; then overbank, nose-low. This presentation does two things for you, it allows you to trade altitude for turn performance; and it achieves out-of-plane maneuvering. How nose-low you need to go is dependent on airspeed and altitude. Utilize a nibble of buffet pull. If you are above your rate band, maintain a more level turn to bleed your airspeed and preserve altitude. When approaching your rate band, commit nose-low to maintain your airspeed within the rate band. As the bandit pitches down to meet you, adjust your lift vector to make the next merge happen.

ii. Nose-high – to initiate this flow you will need airspeed above the rate band, in excess of 370 KIAS. First, you need to max perform across the bandit's tail utilizing an oblique, nose-high pull; you will be trading airspeed for altitude. When your airspeed bleeds down to the rate band, overbank to maintain your airspeed and pitch down to meet the next merge.

## 701. UNIQUE MERGES

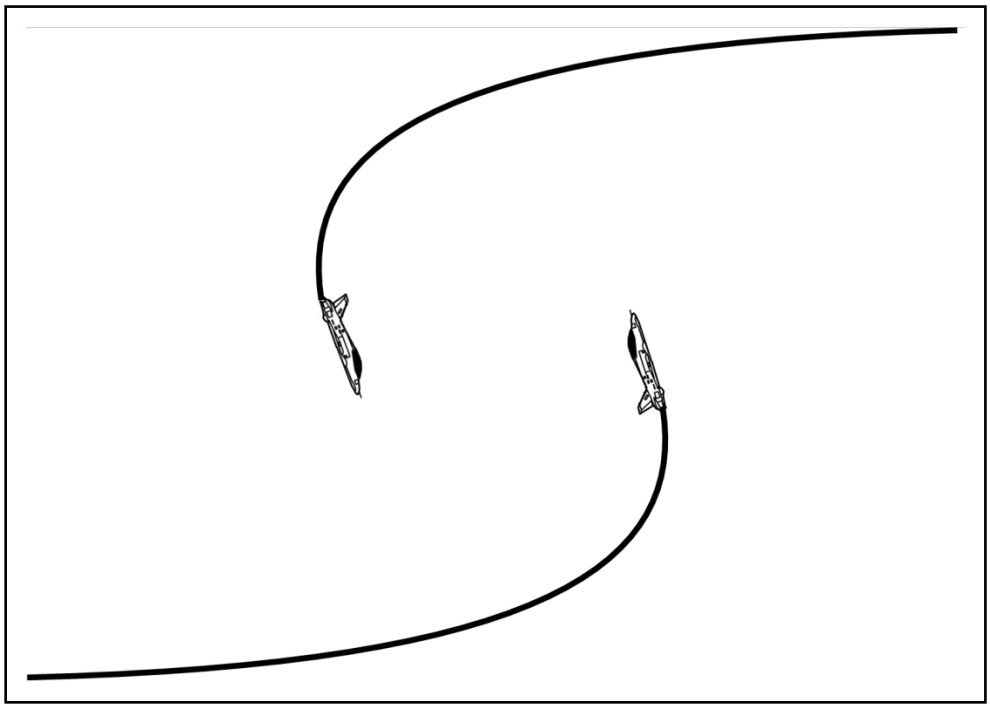
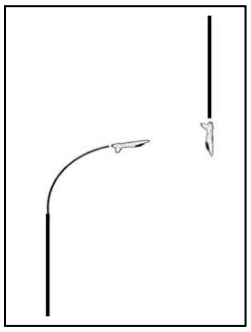


**Figure 7-1 Unique Merges**

## 7-4 HIGH-ASPECT BFM

Merges with a significant vertical component (> 45 deg):



Low to high – this is a desirable merge for the low fighter. You should attempt to make this merge as steep as possible by placing your lift vector underneath the bandit when pitching up into the fight. Ensure you have tactical vertical airspeed and execute an early turn ***prior*** to the merge while ensuring the 500 ft bubble is maintained, and you can keep the bandit in sight (i.e., no blind lead turns). Time your turn to have your nose on the horizon when the bandit passes through the horizon. If the bandit attempts to counter the early turn by pitching into the vertical prior to your early turn, look to extend momentarily in the vertical to deny the bandit exclusive-use turning room. Place your lift vector in lead, post-merge, to force 1C flow, and look to re-enter the bandit's bubble. When target aspect stabilizes (typically at 90 deg), maneuver to lag to maintain your positional advantage.

High to low – although less desirable, there are steps you can take to preserve your advantage. Make an early attempt to shallow out the merge. Prior to the merge, place your lift vector, or nose, below the bandit, and then slowly recover from your nose-low attitude as best you can prior to the merge. The earlier you can execute this, the more you can shallow out the merge. If the merge still has a substantial vertical component and the bandit executes an early turn, counter by performing a lift limit pull as soon as you recognize the early turn. This will collapse weapons separation. If you see the bandit extending in the vertical, unload for vertical airspeed and attempt a pure nose-high maneuver. You might not be able to go pure nose-high, but the more vertical your maneuver the better the subsequent merge. Attempt to force 2C flow by turning away from the bandit. If the bandit does not adjust, you can negate the early turn advantage.

Slow-speed merges:

You want to delay executing a pure nose-low maneuver due to the shifting of the post, and increase in turning radius. If you go nose-low right away, you are effectively performing an in-close overshoot pure nose-low; instead, pull across the horizon with the lift vector on, to slightly below the horizon. If the bandit commits nose-low, wait until LOS accelerates, then roll to place your lift vector in front, and perform an aggressive nose-low lift-limit pull.

## 702. GAMEPLAN DEVELOPMENT

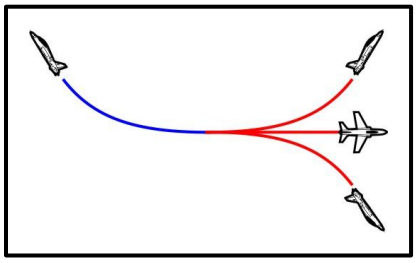
You should enter every high-aspect fight with a gameplan. Look to exploit the weaknesses of your adversary and capitalize on your strengths. Simply trying to get the first shot off without considering the implications of follow-on BFM is lacking in foundation and basic execution. Rather, consider an in-depth gameplan that continues beyond the first merge, such as "I am looking to force 2C flow, and fight a reactive conservative pressure fight." Having a gameplan gives you an idea of your desired initial energy package, how you would like to set up the merge, the follow-on flow, and your reactions based off the bandit's maneuvers. Finally, strive to think one merge ahead to develop a proactive fighting stance, instead of simply reacting to your adversary.

The following examples are not necessarily the best way to fight the T-45, but they are provided as discussion items to further your understanding of OOPl maneuvering and comparing advantages and disadvantages. In your future, you will see this similar discussion but it will compare dissimilar aircraft, where certain OOPl maneuvers will yield more advantages than others.

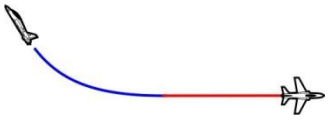
**NOTE**

For the following discussion, we will consider the maneuvers pure nose-high/-low/level.

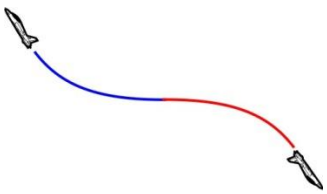
Fighter Nose-High vs.:



Bandit Nose-High: this is essentially a 1C fight in the vertical. The pilot that properly assesses the situation (i.e., the other aircraft's energy state and nose position), and adjusts his pull accordingly, should have a slight advantage at the follow-on merge. Look to max perform using a nibble of buffet pull. If you do not have an employment opportunity, look to extend in the vertical. You need to collapse the fight just enough to deny weapons employment. Then, momentarily unload with your nose above the bandit. As a technique, execute a vertical extension 20 degrees past pure vertical (e.g., after 110 degrees of pure nose-high turn). When your canopy bow reaches the horizon, roll upright. To maintain deconfliction, do not place the bandit inside your HUD FOV. The result should be a slow-speed merge with exclusive-use turning room.



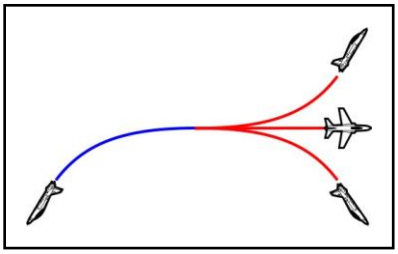
Bandit Level: this example is an uncountered OOPl maneuver. Initially, set your lift vector on the bandit executing a nibble of buffet pull. After coming over the top, shift your lift vector aft to create weapons separation. With weapons separation, reposition your lift vector in front of the bandit and aggressively pull for a shot. Left uncountered, this should result in 2C offensive flow.

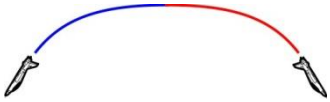


Bandit Nose-Low: This creates difficult flow for both aircraft due to the possibility of losing sight. As the nose-high aircraft, you will initially gain angles after coming over the top and should have the first shot opportunity. However, be wary of fishing for the shot as the bandit's nose starts to break the horizon. As the

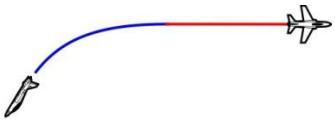
bandit comes up and you go down, the result is an extremely high-to-low follow-on merge. If no shot was available or it was defeated for Pk, look to come off in the oblique to flatten out the merge.

**Fighter Nose-Low vs.:**

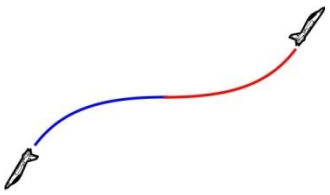




Bandit Nose-Low: this will most likely result in a neutral merge across the bottom. Look to gain exclusive-use turning room by repositioning your lift vector slightly off pure nose-low, which will displace your post above the bandit's. Control altitude loss by selecting idle and speedbrakes. Re-select MRT and speedbrakes in order to ensure you have tactical vertical airspeed. Against a pure nose-low bandit, you should have a stacked merge with the bandit below.

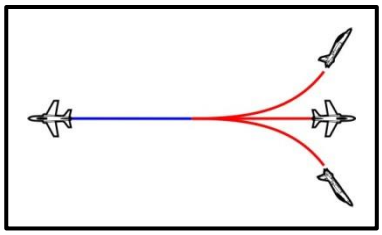


Bandit Level: this should result in an offensive advantage. Perform a lift-limit pull across the bottom. Consideration should be given to repositioning your lift vector into the oblique to minimize altitude loss, preserving turning room. Then, reposition your lift vector out in front of the bandit to align fuselages, and pull for a shot.



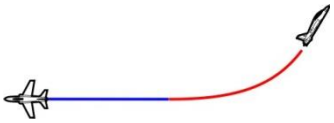
Bandit Nose-High: this flow is extremely difficult for both aircraft to maintain sight. Angles will be gained by the bandit when he is at the top. The follow-on merge should be an extremely low-to-high merge. Look to early turn the bandit in the vertical for an offensive advantage.

Fighter Turns Level vs.:

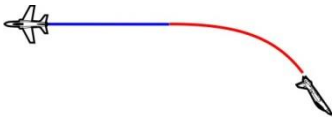


***This is not optimal and should only be done with no other options available.*** Fighter turning level is a reactionary gameplan and does not put the fighter in a position to take advantage of the vertical component, and therefore unable to execute his best 1v1. It provides options to counter the bandit but does not typically yield an offensive advantage. Against an aggressive bandit, angles can still be lost in the long term because you are behind every move the bandit makes.

Bandit Level: this essentially will be a rate fight with an advantage going to the aircraft that manages his airspeed the best. If above your rate band, perform an energy excursion to bleed down to your rate numbers. In this pure rate fight, it would be best to initially target the tactical rate band (300-330 KIAS). However, if the bandit is gaining angles, it would be prudent to take an energy excursion down to 240 KIAS to deny him turning room at the next merge. Doing so denies the bandit angles but will not diminish your turn rate in the long run.



Bandit Nose-High: as you turn level across the horizon, a positional advantage will be yielded to the bandit. Look to force a low-to-high merge by pitching up into the bandit before he comes down.



Bandit Nose-Low: again, the bandit will gain a positional advantage in this fight by utilizing an OOPl maneuver.

## 703. BUTTERFLY SETUP

The objective of the Butterfly set is for each fighter to arrive at a neutral, co-altitude, 500-1000 ft merge with an unknown airspeed. Each pilot is free to modulate the throttle to achieve the airspeed desired at the merge to best suit them for their preferred post-merge gameplan. You will have to utilize BFM cues to assess the other aircraft's energy state and fight accordingly.

1. Both aircraft will climb to PADS altitude at 300 KIAS. When lead calls "set 350," select MRT. Adjust the throttle to arrive at PADS altitude and airspeed. At this point, the flight lead

will initiate "speed and angels."

2. Lead will then call to take a cut away. Both aircraft will take a 30° cut away from each other. During the cut away, each fighter is free to adjust airspeed for the desired merge gameplan.

3. At 3.0 nm or visual limits (whichever occurs first), lead will call turning in, which you will then echo. The fighters will turn into each other for a cooperative merge. ***You, as wing, will immediately call ROE to establish deconfliction for the merge.***

4. Adjust your pull to set the neutral pass.

5. At 3/9 line passage, the flight lead will call "fight's on," and both fighters will begin executing their HA gameplan:

| | |
|---|---|
| Bandit: | "Set 350"<br>"Hammer 11 speed & angels right" |
| Fighter: | "Hammer 12 speed & angels left" |
| Bandit: | "Take a cut away"<br>"Hammer 11 turning in" |
| Fighter: | "Hammer 12 turning in"<br>"Left-to-left/Right-to-right" |
| Bandit: | "Left-to-left/Right-to-right"<br>"Fight's on" (at merge) |
| Fighter: | "Fight's on" |

Butterfly lost sight gameplan: if you go blind during the turn in, call it immediately. Lead will talk you to the merge. Listen to his directions and execute them, essentially letting lead fly your jet. Once tally is regained, call it. If both aircraft are blind, lead will climb 1,000 ft and wing will descend 1,000 ft with a KIO call from lead.

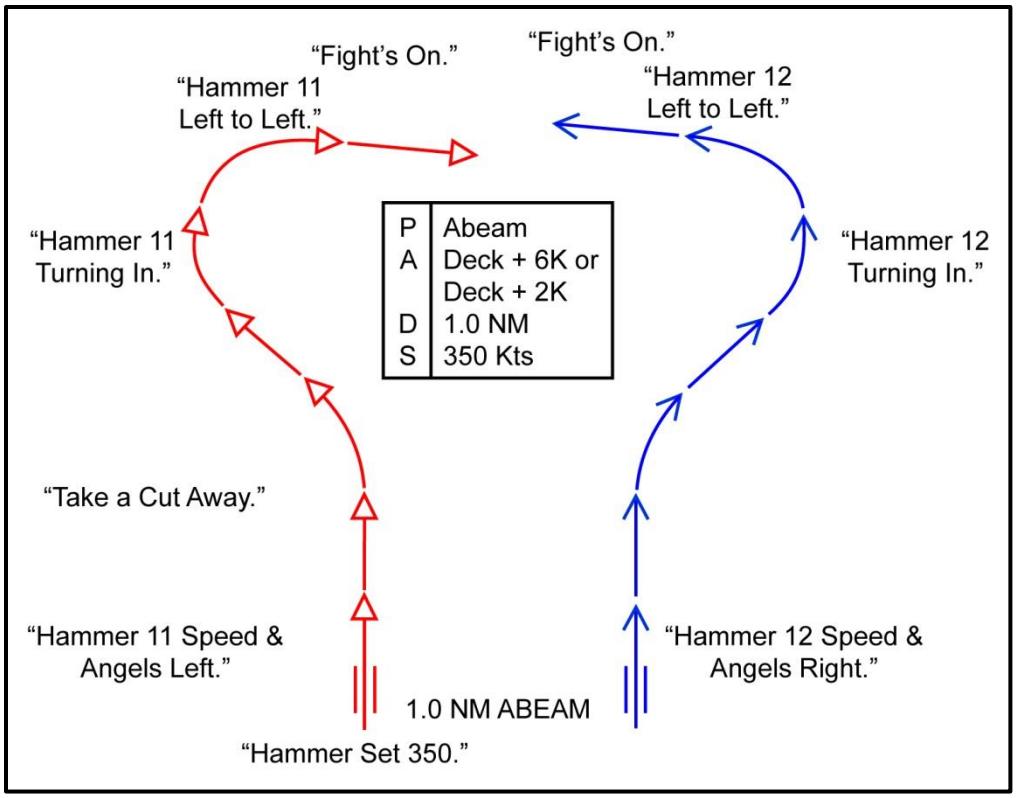



**Figure 7-2 Butterfly Setup**

## 704. ABEAM SETUP

For the Abeam set, the fight is on right away and is a neutral, known airspeed start. The initial abeam setup merge need no longer be co-altitude, allowing the fighters to add/subtract energy through the use of descending or climbing pre-merge. This allows each fighter to execute their respective BFM gameplan. Look to control that first merge so you can execute your HA gameplan.

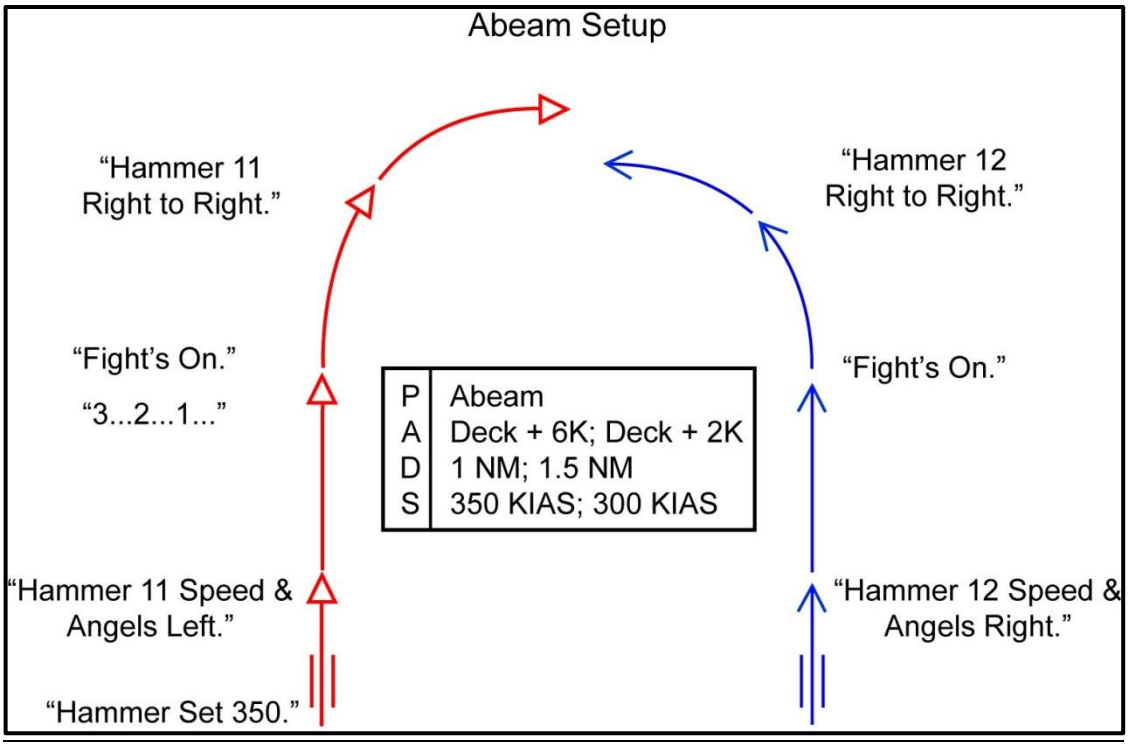



**Figure 7-3 Abeam Entry**

1. Both aircraft will climb to PADS altitude in combat spread at 300 KIAS. When lead calls "set 350," select MRT. Adjust the throttle to arrive at PADS altitude and airspeed. At this point the flight lead will initiate "speed and angels."

2. Following this call, lead will initiate the fight by calling "3, 2, 1 fight's on."

3. On the "3" both aircraft will select MRT.

4. At "fight's on," both aircraft are free to maneuver.

5. Wing will echo the "fight's on" while maneuvering ***and call ROE for the first merge immediately.***

| | |
|---|---|
| Bandit: | "Set 350"<br>"Hammer 11 speed and angels right" |
| Fighter: | "Hammer 12 speed and angels left" |
| Bandit: | "3, 2, 1 fight's on" |
| Fighter: | "Fight's on"<br>"Left-to-left/Right-to-right/High/Low" |
| Bandit: | "Left-to-left/Right-to-right/Low/High" |

## 705. HIGH-ASPECT BFM CONCLUSION

In conclusion, the training command BFM stage is designed to give you a solid foundation of concepts and definitions, as well as start you on the road to applying them in the air. While your next platform will be much more advanced in both performance and weapons systems, the lessons you learn here provide the fundamental basis for BFM engagements in any platform. BFM will make you a better pilot. Your utmost goal should be to master these skills, as you will expand upon them throughout your entire career.

# CHAPTER EIGHT
# SECTION ENGAGED MANEUVERING – ADMIN

## 800. INTRODUCTION TO SECTION ENGAGED MANEUVERING

Tactical fighter employment has continued to evolve due to advanced weapons technology and a deeper understanding of threat capabilities. Despite these changes, the fact remains that you may find yourself going to the merge with an enemy aircraft. Circumstances leading to this include an Electronic Attack (EA) environment, a visual identification requirement, an unobserved entry to delouse another fighter, or Beyond Visual Range (BVR) weapons that do not guide and/or fuse on the target. In any case, if a section of fighters finds themselves turning at the merge, they are executing engaged maneuvering. The fighters' ability to gain tallies, maneuver to achieve a timely kill, and then continue to execute their primary mission is driven by their ability to employ engaged maneuvering fundamentals.

As the name implies, Section Engaged Maneuvering (SEM) employs from the basic fighting element – the section. The most basic SEM environment is two fighters against one adversary, or 2v1. SEM is not, however, limited to 2v1. In the fleet, 2v2 engagements or 2v unknown engagements in the visual arena will be encountered. Understanding the basic principles behind 2v1 will allow you to develop your capabilities in more complex situations.

SEM is one of the most challenging missions for aircrew. It requires you to track multiple aircraft and make timely decisions while employing your aircraft to the edge of its capabilities. To be successful you must be able to apply your 1v1 BFM skills. Your training command experience will be a building block approach, giving you the foundation to be successful in future FRS and fleet experiences.

This section of the FTI will spend a considerable amount of time discussing SEM. While you prepare for your SEM events, do not, however, take the admin and tac admin for granted. Sound admin and tac admin demonstrate professionalism, good judgment, and forethought. Additionally, over the course of your Naval Aviation career you will find that the smoother the admin and tac admin goes, the better your overall tactical performance will be.

## 801. PRE-FLIGHT PLANNING

The bandit is the division lead and maintains overall responsibility for the event. In the FRS and fleet you will see many adversary call signs (e.g., Viper, Snake, Mutt, Dog, etc.). This FTI will assume the bandit's call sign for all examples is "Viper 1" (adversaries do not typically use two digit call signs). The kneeboard card should list the bandit as the division lead, the tac lead as -2, and the tac wing as -3. Air-to-air TACAN ranging will be setup between the two fighters.

## 802. GROUND OPS

Reference standard ground ops for a division tactical formation sortie.

## 803. DEPARTURE

The division will join as briefed, typically into the fingertip formation. The bandit will lead the division to and from the area and will pass the tactical lead as briefed. The tac lead will push the tac wing to DCS when appropriate. Regardless of the change in tactical lead, the bandit will typically maintain and initiate all admin-related items for the duration of the event unless briefed otherwise.

## 804. FINAL RENDEZVOUS/RTB

The bandit will take the lead back, and the final rendezvous will be initiated per the TACSOP following the final KIO. If the join-up is a running rendezvous, the fighters should deconflict by calling to join on the left/right side of the bandit. To maintain deconfliction during a running rendezvous, no one should cross the area directly behind the bandit. Maintain your side if an overrun situation develops. If the rendezvous becomes a CV rendezvous, then deconflict by calling who will join first/second on the bearing line. Reference Paragraph 102 for detailed Tactical Rejoin procedures.

The RTB portion will be conducted per the brief and previous stage guidance. Wingmen not in parade are expected to set the proper formation for the field entry.

## 805. DEBRIEF EXPECTATIONS

The students should have a debrief board ready with the following (at a minimum): fighter/bandit call signs, environmentals, any changes to decks/PADS, working markers, and an eraser. A designated IP will supervise and run the debrief. They will reconstruct each set by calling upon the fighters to fill in the gaps. Fighters will speak in order once called upon to expedite the flow of the debrief. Debrief items will focus on the training objectives and fundamentals.

## 806. COMMON ADMIN ERRORS

1. Poor, slow, or sloppy join-ups
2. Failure to adhere to briefed formation
3. Poor, slow, or sloppy final rendezvous
4. Sloppy rejoins from ATC Spread
5. Landing pattern work

## CHAPTER NINE
## SECTION ENGAGED MANEUVERING - TAC ADMIN

### 900. DIVISION FORMATION MANAGEMENT

While in the area, the bandit will typically maintain and initiate all TACADMIN requirements but may pass some responsibilities over to the TACLEAD as briefed. The fighters must focus on good basic air work, disciplined formation, and following proper procedures. The bandit may use directive comm to prepare the division for each set, but this does not relieve the TACLEAD of his or her responsibilities to lead the section. The TACWING may make appropriate recommendations when required. In general, allowing the bandit's experience to be a crutch will result in excessive maneuvering and less gas to fight. All formation maneuvers will mirror the TAC and BFM stages.

### 901. PADS

| | **P**osition | **A**ltitude | **D**istance | **S**peed | Initiated From |
|---|---|---|---|---|---|
| **All SEM Sets** | Abeam | Deck + 5/6K | 1.0 nm | 330 KIAS | 300 KIAS |
| All decks referred to for PADS will be the hard deck<br>Allowable Deviations = altitude +/-100 ft, distance +/-.1 nm, speed +/- 10 kts | | | | | |

The SEM PADS are referenced between the two fighters. The bandit will put himself where he needs to be, or he'll be directive with the fighters in maneuvering the formation to help him out.

The division will climb to the PADS altitude at 300 KIAS. When the fighters are at altitude the bandit will direct the division to accelerate for the next set (if required). Both fighters will acknowledge the call. Select military power and accelerate level to 330 KIAS.

When ready, the bandit will call set. The fighters will complete standard speed and angels comm, indicating they are tally/visual, and ready to fight. The bandit will maneuver as required to set the presentation. At the appropriate time, the bandit will call "fight's on" (no echo required). At this point the engagement has begun and the fighters should execute SEM. Tap-the-Cap setup is different and will be described independently in Chapter 19.

### 902. KIO MECHANICS

KIO comm and mechanics are important. They are outlined in the TACSOP. Once you hear the KIO call, all aircraft should stand the throttle up, clear their flight path and lift vector, and maneuver as required for safety of flight. Hold all formation management comm until after all aircraft have begun maneuvering to the flow heading.

If during the KIO you have low SA, maintain your altitude and make a hard turn to the flow heading while clearing your flight path and lift vector. Next, maintain your current altitude and, in the proper order, communicate your status: tally/no joy, visual/blind, one or two in sight. If

another aircraft has two aircraft in sight, that aircraft will own deconfliction. Now you may climb or descend with their permission, remaining predictable.

If you have high SA during the KIO (i.e., two other aircraft in sight), you are not required to stay at any altitude or immediately pull to the flow heading. How you maneuver is dependent on your situation. Apply sound judgment and tactical formation maneuvering to arrive in combat spread, on the flow heading. If at any time you have to turn belly up to another aircraft, you may do so with proper deconfliction. Deconfliction can be solved vertically or laterally, but must be maintained before, during, and after a belly-up turn. When making such a turn you cannot float the turn. You must be in a hard turn while clearing your flight path and lift vector. Follow tactical formation stage procedures for adequate deconfliction standards. Finally, use descriptive comm, or make recommendations to expedite the tac admin. Your priority is fixing the fighter's formation. The bandit will generally take care of himself, so hold any comm for the bandit until the end. Above all else, use good headwork, make sure you have the whole picture, and remember safety-of-flight trumps all. If you see a bad situation developing, communicate that SA immediately without regard to any recommendations or comm flow.

## 903. DIVISION REJOINS

The division can typically get back together with tactical formation maneuvers (examples below). If all players have low SA, a TACAN rendezvous may be used to rejoin the division. Any time altitudes are used to deconflict, you may not transit through an occupied altitude without verbal or visual deconfliction. Update any changes in a timely fashion. If your SA improves, use descriptive comm or make recommendations to expedite a rejoin. Calling for a wing-rock from a particular aircraft is a good tool you can use to differentiate between aircraft. If you have one or two in sight, ask someone for a wing-rock to improve your SA to visual tally or tally/visual.

Example comm flow for formation management:

Tac Lead: "Rage check left 150"
Tac Wing: "Rage 12, 150"

Bandit: "Showtime tac right"
Tac Lead: "Showtime 11"
Tac Wing: "Showtime 12"

Example comm flow for recommendations:

Tac Wing: "Rage 11, recommend flow 050"
Tac Lead: "Rage flow 050"
Tac Wing: "Rage 12, 050"

Example descriptive comm flow:

Tac Lead: "Rage 31, blind/no joy"

Tac Wing: "Rage 31, I'm at your right 4 o'clock, 10 low"
"Recommend check right 090"
Tac Lead: "Rage check right 090"
Tac Wing: "Rage 12, 090"

Example directive comm flow:

Tac Lead: "Rage 31, tally/visual, your left 7 o'clock, 2 miles, 15 low"
Tac Wing: "Rage 32, blind/no joy"
Bandit: "Viper 1, tally 1"
Tac Lead: "Rage 32, come hard left…Roll out…Come hard right…I'm coming out your right 3 o'clock, 5 low."
Tac Wing: "Rage 32, tally/visual"
Bandit: "Viper 1, tally 2"

## 904. COMMON TAC ADMIN ERRORS

1. Poor tactical formation keeping

2. Slow PADS setup

3. Poor KIO mechanics

4. Verbose and confusing KIO communications

5. KIO headwork

6. Failure to adhere to the TACSOP

7. Not recording environmentals

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# CHAPTER TEN
# SAFETY AND CONTINGENCIES

## 1000. SAFETY

Section Engaged Maneuvering is a highly dynamic and challenging mission. Each fighter must adhere to their responsibilities to mitigate risk and allow for proper tactical execution within the bounds of training and safety. Training rules dictate how this mission is flown, and you must understand how to apply them to this scenario. Easing your pull is not, on its own, a risk mitigation tool. Proper comm and a thorough understanding of the FTI are crucial.

There is a considerable amount of comm that happens in a very short timeframe during SEM. This underlines the need for clear and concise transmissions, as well as the need to ***listen***. There may be times when you are unable to call the pass, as you are familiar with from 1v1 BFM. Here, you must clearly show your intentions by exaggerating your aircraft movements (e.g., exaggerate your nose to the right to show you intend a left-to-left). During these times, it is prudent to aim for a slightly wider pass (e.g., 1,000 feet vice 500 feet) and then, when safety of flight has been established and the pass is set, tighten down.

OPNAV 3710 ACM training rules state all aircraft must be in sight of each other in the visual arena. A good dialogue of blind, no joy, visual, and/or tally is required. If the engaged fighter and bandit have lost sight of each other, utilize the training rules as in 1v1 BFM. Other instances are outlined below.

OPNAV 3710 element deconfliction states that "blind aircraft within an element shall immediately transmit 'blind,' and wingman shall respond 'visual' with his position. If the wingman is simultaneously blind, he shall transmit 'blind' with his altitude and maintain a level flight path. It is the responsibility of the first aircraft in the element that calls "blind" to establish altitude deconfliction. If communications are prohibited, each aircraft that remains blind shall maintain a level and predictable flight path, and his priority shall be to clear his flight path." As a good technique, if you ever become blind, transmit your altitude. If unable to communicate your blind status due to lack of radio time, prioritize deconfliction.

OPNAV 3710 engagement deconfliction states that "without a tally/visual on all fighters and bandits, aircraft shall conduct belly checks at a minimum of every 90 deg of turn." To conduct a belly check, roll out to approximately wings level. Spend two to three seconds scanning the area masked by your belly. Be sure to look level, slightly above and below the horizon, and then continue fighting.

Discuss these training rules with your instructors to determine how to apply them in the SEM environment.

SEM guidance allows a fight to continue with one blind/no joy aircraft. If SA degrades below this, deconfliction becomes primary. Use the radio to establish deconfliction. If deconfliction cannot be resolved in a timely manner, a KIO shall be initiated. The need for a sound scan of wingman, bandit and aircraft performance in SEM cannot be overstated! This isn't to say that

you will always be visual. The dynamic nature of the mission makes tracking multiple aircraft very challenging. If you should be unable to find your wingman and cannot call "blind," use good headwork. Discuss these overall concepts with your instructor to better understand the intent.

## 1001. CONTINGENCIES

Weather is the main contingency that must be dealt with during SEM. The fighters' setup altitudes may be adjusted to execute the event as long as the intent of the training is not significantly impacted.

# CHAPTER ELEVEN
# FORM – SENSOR – COMM

Any tactical sortie can be summarized with three key ideas: formation, sensors, and communication. A breakdown in any one of these usually results in a less than optimal situation. The following sections will describe each portion as it pertains to SEM.

## 1100. FORMATION

The fighters have two primary formations to choose from: Defensive Combat Spread (DCS) and Offensive Combat Spread (OCS). OCS provides better isolation of each aircraft, but it reduces the ability and effectiveness of the fighters to visually clear the airspace around each other. The fighters will employ out of DCS because it allows maximum visual mutual support. DCS is the best formation to use when "defensive" in nature and expecting to react to threats visually. The wingman must fly a disciplined formation, striving to be directly abeam lead, to maximize visual mutual support.

In the TRACOM your ability to detect the adversary is limited to visual lookout. The bandit may employ certain tactics designed to obtain an unobserved entry on the fighters. Therefore, the visual lookout doctrine used in the TRACOM will directly carry over to your FRS and fleet experiences.

An understanding of the environment and how it affects your event is important. On a hazy day, a tally may be hard to achieve until the bandit is inside of three nautical miles. This may result in only one of the two fighters, likely the closest fighter, being "tally" while the fighter on the far side of the formation remains "no joy" due to environmentals. Evaluating the environment and compensating for it is an important factor.

There are four quarters a bandit can be acquired: Forward quarter, Beam quarter (left/right), and Rear quarter. The four quarters are illustrated in Figure 11-1 and discussed in more detail in each respective section.

The primary scan volume for each fighter is to look inside the section. This is to say, you look through your wingman to find the threat. The fighters should prioritize their primary sector 75% of the time. The secondary scan volume is outside the section or away from your wingman. The fighters should prioritize their secondary sector 25% of the time. Don't forget to look within twenty degrees of the horizon as well as in front of and behind the section with a deliberate scan to effectively sanitize the airspace.

The fighters have the ability to clear the airspace while maneuvering. If executing a tac turn, the fighters will be able to clear their old and new six o'clock. The fighter inside the turn will be able to clear the new six o'clock. The fighter outside the turn will be able to clear the old 6 o'clock. An aircraft can be challenging to detect at three nautical miles, however, effectively employing these concepts can lead to a far less defensive scenario for the fighters.

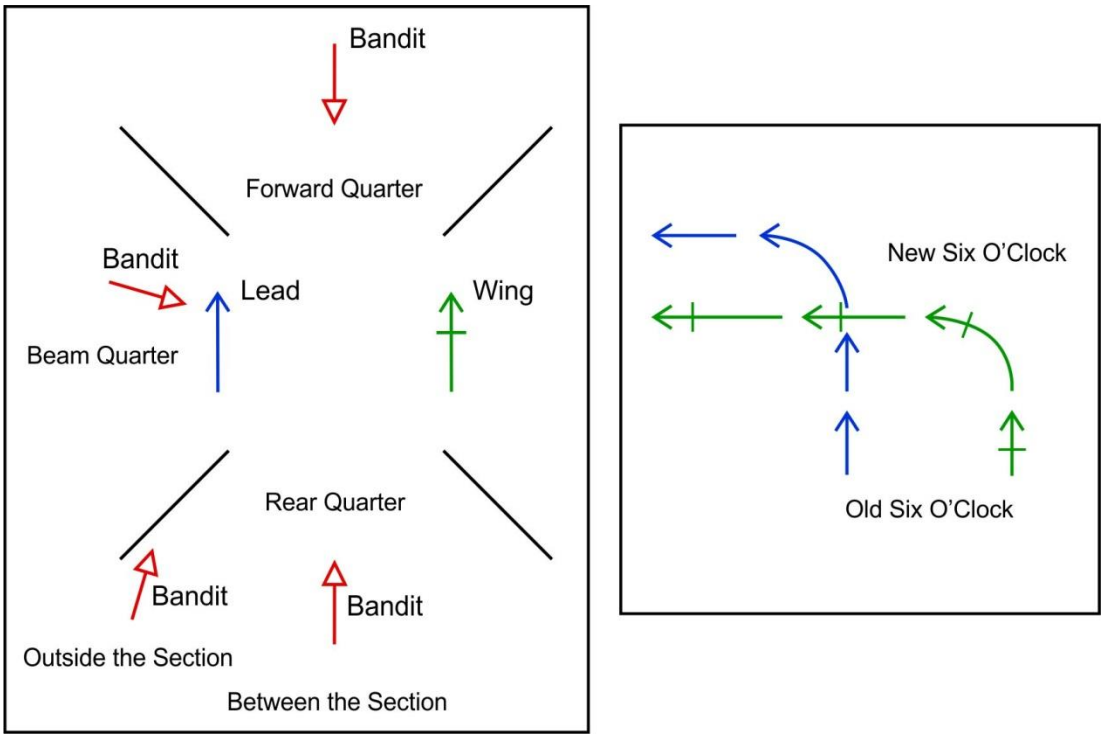


**Figure 11-1 Lookout Doctrine**

## 1101. SENSOR

The FRS and fleet will introduce a multitude of sensors and systems to enhance aircrew SA. These sensors can be overwhelming at times with almost too much information being delivered. Though the T-45 lacks these sophisticated sensors, we must always be prepared and able to visually keep sight of our wingman and pick up the bandit. A sound visual lookout cannot be sacrificed. By now you should have a good eyeball cal from your BFM sorties. It is now time to take your calibrated eyeballs and use them to max perform your aircraft in order to be as lethal as possible.

Although not truly a sensor, the A/A TACAN is a tool that must be used to improve your SA as well. Incorporate yardstick information into your HUD scan and you will be surprised at the dividends it will pay.

## 1102. COMMUNICATION

Lastly, before any tactics can be discussed, the fighters must be able to communicate effectively. Clear, concise comm is paramount in a dynamic environment with limited radio time. The section should strive to use proper comm to achieve this goal. As always, prioritize ***directive*** comm over ***descriptive*** comm, with any fill-ins at the end. training rules and safety-of-flight comm trumps all other communication.

Combine directive and descriptive comm to build the whole picture. Avoid running

commentaries. Update the fight as it changes.

Directive comm – used to immediately drive the section or an individual fighter in order to react to a threat or other situation. It is used to avoid a defensive situation, increase survivability, deconflict, or drive flow. Time is short, so be clear and concise.

Descriptive comm – used to provide amplifying information. It can be used to describe the location of the bandit or a wingman. It can also be used to deconflict the fighters, or to describe what another fighter is doing to build the picture. Descriptive comm is not required if you are describing something that is apparent to the other fighter. Use it to fill in the SA gaps or bring a low SA fighter back into the mix.

Communication Brevity Terms:

Anchored (location): turning engagement at the specified location.
"Rage 42 anchored Rock 295/42/18,000."

Blind: no visual contact with friendly aircraft, opposite of visual.
"Nickel 72 blind, 12,000."

Break (left/right): perform an immediate maximum performance turn in the direction indicated (default is a 180 degree turn).
"Combat break right, tally 1, right 5 o'clock, 1 mile, 10 low!"
"Showtime 62 break right, sensor nose!"

Break (left/right) 90: same as break (left/right), however limit the turn to 90 degrees of heading change.

Come off (direction): maneuver as indicated to either regain mutual support or to deconflict flight paths. Implies visual and tally. (Come off can be used if the free fighter became more offensive or to establish a clear field of fire)
"Smack 12, come off left, shot in 5."

Defensive: aircraft is under attack, maneuvering defensively, and unable to ensure deconfliction or mutual support. Implies engaged.
"Anvil 61 defensive."

Engaged: intra-flight call from an aircraft maneuvering in the visual arena to relinquish deconfliction responsibilities. Implies tally and in an offensive or neutral position. (Utilize descriptive or status (relationship) comm to increase SA.)
"Showtime 61 engaged left, 2C, 12,000 to the deck."

Extend(ing) (direction): a short-term maneuver to gain energy, distance, or separation with the intent of re-engaging. (Calling extend(ing) is not typically required.)

Free: intra-flight call from an aircraft in the visual arena indicating he is assuming the free fighter role. Used to deconflict fighter flight paths.

Hard (left/right): perform a high-G, energy-sustaining turn in the indicated direction (default is a 180-degree turn).

Hard (left/right) 90: same as hard (left/right), however limit the turn to 90 degrees of heading change.
"Nickel hard left 90, tally 1, left 10 o'clock, 2 miles."

Kill: in training within the visual arena, a fighter call to indicate kill criteria has been fulfilled.
"Taproom 41 kill Goshawk left turn, 12,000."

Merge(d): friendlies and targets have come together in the visual arena.

No Joy: aircrew does not have visual contact with the non-friendly aircraft, opposite of tally.

Padlocked: aircrew cannot take eyes off an aircraft without risk of losing tally and/or visual.

Posit: request for friendly position and altitude; response in terms of a geographic landmark or from a common reference point (e.g., the tail of the waypoint needle referencing bullseye). Implies blind/no joy.
"Showtime 31 Posit."
"Showtime 31 anchored Rock 143/25/12,000."

Set ____: set (or have set) a particular speed in KIAS or Mach.

Status (relationship): request for an individual's tactical situation. If the request is from the free fighter to the engaged fighter, use it to communicate relative position in a fight. Implies the free fighter has two in sight. The engaged fighter should respond with own ship position/attitude/relationship. If the request is from the engaged fighter to the free fighter use it to build SA between the fighters.

"Smack 12 status."
"Smack 12, east/left/high."

"Mace 42 blind."
"Mace 41 at your right 2 o'clock, 30 low, free, shot in 5."

"Hammer 21 status high/low"
"Hammer 21 low"

Switched: Bandit is changing from one aircraft to another. (Calling switched is not typically required.)

"Bandit switched."

Tally: sighting of a non-friendly aircraft, opposite of no joy.

"Combat 11 tally 1, right 1 o'clock, 2 miles, 5 high."

Tumbleweed: I have limited SA and require additional information.

Unable: cannot comply as requested or directed (call unable if a request or direction would result in a BFM or SEM error).

"Anvil 21 come off left."
"Anvil 21 unable."

Visual: sighting of a friendly aircraft, opposite of blind.

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# CHAPTER TWELVE
# SEM FUNDAMENTALS

## 1200. INTRODUCTION

Treat the SEM fundamentals listed below as boldface. These concepts are the tools to success during SEM, and all of your training will be centered on these fundamentals. Weapons envelopes, sight pictures, and techniques will all change at the FRS and fleet, but these fundamentals ***will never change:***

SEM Fundamentals (in order):

1. Kill the adversary.

2. Avoid becoming defensive.

3. Fly your best 1v1 BFM.

4. Work out-of-plane/out-of-phase (OOPl/OOPh).

5. Establish Engaged roles/responsibilities/communication.

In order to be successful at SEM, the fighters need to coordinate their attacks. Effective coordination and proper application of the SEM fundamentals requires both fighters to be tally/visual. You must strive to track both aircraft while flying your jet to the limit of its capabilities.

SEM is more than 1v1 plus 1. It is two fighters actively working together to achieve a quick kill. The fighters will be faced with multiple 1v1 BFM gameplan options. You must learn how to adapt your 1v1 BFM decisions based on the section's current situation or the other fighter's location. Do not however, do anything contrary to sound 1v1 BFM simply because you are working in section. If either fighter's best 1v1 breaks down, the bandit will be able to gain angles and achieve a Weapons Engagement Zone (WEZ). The bandit's job gets much easier once the fighters begin to make mistakes or commit BFM errors.

The fighters will start with the basic assumptions listed below. Any change in these factors must be updated in a timely manner.

SEM Assumptions:

1. Each fighter is visual.

2. Each fighter is no joy. This assumption changes to a tally assumption once tally has been communicated.

## 1201.KILL THE ADVERSARY

As you read the following section, keep in mind the overall goal of the fighters is both to survive and to kill the adversary. This starts by executing your best 1v1 BFM. The fighters will have a hard time taking a shot if they are not fighting their best BFM because they will never get to the Launch Acceptability Region (LAR). Next, use engaged communication and out-of-plane/out-of-phase maneuvering to achieve the kill. These are the tools to win the fight.

Weapons Employment Opportunities:

Refresh yourself on the valid shot requirements.

Oftentimes it is the free fighter that achieves the kill. It is the free fighter's responsibility to ensure overall deconfliction responsibilities. This deconfliction must be maintained before, during, and after the shot. Some engagements will yield shot opportunities that make deconfliction a challenge. Manage the fight to find a solution that best satisfies all responsibilities. Shots do not change the role status (this is discussed in a later section).

The sections below describe basic shot sight pictures for the free fighter with 2C and 1C engaged flow. Utilize these basic shots to build upon your understanding of SEM and how to achieve a LAR. There will be other shot opportunities during engagements that this section does not cover. For instance, the engaged fighter may also have weapons employment opportunities. These shots will be similar to those seen in 1v1 BFM. If the bandit presents a weapons employment opportunity and you can honor your other responsibilities, then ***take the shot***.

When a shot presents itself, a clear field of fire must be ensured. A clear field of fire is defined as having friendly/neutral aircraft outside the HUD FOV at trigger squeeze.

Realize a defensive scenario may bias your decision away from this rule of thumb. Take into account the severity of the defensive situation before you pull the trigger. If you assess that sensor nose will not be a factor before your missile would impact the bandit, then wait for a clear field of fire.

Shot and Kill Removal Comm:

Engagements will continue until there is proper kill removal comm. Shot comm consists of your call sign and the weapon employed. Kill comm is descriptive and should be adequate enough to determine which aircraft has been employed upon. ***If a shot is determined to be invalid after the shot call, do not call the "kill."*** This will allow the fight to continue. Also, if the shooter is not descriptive enough with his kill comm, the fight may continue. This is called Shooter-Controlled Kill Removal (SCKR), and is necessary to kill and remove a bandit in training:

| | |
|---|---|
| Fighter (shot comm): | "Sweep 72, Fox-2." |
| Fighter (kill comm): | "Sweep 72 kill Goshawk to the North." |
| Bandit: | "Copy kill." |

The bandit may call "$P_k$ continue" negating the previous shot/kill call. A "$P_k$ continue" is to

simulate actual ordnance Probability of Kill ($P_k$ ) limitations (not every weapon works every time). The fighters should continue to execute SEM. The reason for negating the kill will be debriefed.

The bandit may call shots during the fight, but fighters will not remove themselves from the fight. Any shots by the adversary will be debriefed.

## 1202. AVOID BECOMING DEFENSIVE

The second SEM Fundamental is for both fighters to survive. You may wonder why "avoid becoming defensive" is a basic fundamental. During all the confusion of SEM, it is very easy to accidentally turn in the wrong direction while trying to set out-of-phase flow, regain SA, or even keep sight. As you read the following paragraphs, you will understand why each fighter needs to assess and make appropriate decisions in order to avoid a defensive situation. One wrong turn could lead to your demise if the bandit can capitalize by achieving a weapons solution. If necessary, forego out-of-plane, out-of-phase, and/or any ideal flow to survive, and then look for other opportunities to employ SEM fundamentals to achieve a kill.

## 1203. 1V1 BFM EXECUTION

Each fighter needs to execute his best 1v1 BFM while coordinating his attack. All the lessons you have learned about 1v1 perch and HABFM apply. Your ability to apply those skill sets to SEM will influence your success in this environment. Coordination and roles will ultimately resolve any deconfliction issues and questions about initial moves.

The engaged fighter is responsible for executing his best 1v1 BFM gameplan. By pressuring the bandit, he will be forced to choose between focusing all his energy on the engaged fighter, or attempting to find and track the free fighter. Also, an arcing engaged fighter is giving the bandit an opportunity to achieve an offensive position and/or a WEZ.

Often the engaged fighter will be neutral and unable to achieve a LAR. Therefore, the free fighter often achieves the kill. You have to "earn the right to be free" by controlling merges and working hard to set out-of-plane and out-of-phase flow.

Sound BFM keeps the fight tight. A tight fight yields less turning room and weapons separation for the bandit. The fighters want to control these critical BFM tools. A fighter can use an extension if he needs to gain energy or separation. An extension is a short-term maneuver used to gain energy, distance, or separation with the intent to re-engage.

The separation can then be used as weapons separation for a shot or to gain an offensive advantage. Increased energy may also allow a fighter to more easily pitch into the fight. To perform an extension, unload (altitude permitting) varying the duration of the unload to meet the separation and/or energy requirements. You can extend wings level or in an angle of bank. As a rule of thumb, a three-second unload will yield a twenty-knot airspeed increase. A short ease from a pull may be enough to gain required separation. However, easing a pull for too long is less effective than an extension because it will increase your turn radius and decrease your turn

performance with little energy addition.

Recall from 1v1 HABFM that the fighter, at each merge, must assess geometry, altitude and energy (both yours and the bandit's). This is done when you check turn across the bandit's tail to take out any turning room. After the check turn, set the desired flow. The bandit can always turn to change the flow. Proactive BFM will, however, force the bandit to turn in the direction that will set the flow the fighters desire. Reactive BFM allows the bandit to control the merge, making him less predictable.

There will be times when setting 1C flow will be the most advantageous. ***Remember, you need to have a close-aboard pass if you are planning to reverse for 1C flow***. Otherwise, you will be giving the bandit too much turning room and possibly enough separation for him to enter a WEZ.

### 1204. OUT-OF-PLANE / OUT-OF-PHASE

The most basic idea that the fighters need to understand and execute is how to work out-of-plane and out-of-phase. ***It is the responsibility of the free fighter to establish out-of-plane and out-of-phase flow without committing a BFM error.*** If out-of-plane/out-of-phase will result in a BFM error, continue to execute quality BFM and look for the next opportunity to set proper flow. Out-of-phase flow, in a basic sense, is turning in the opposite direction of the engaged fighter. It can also be visualized as having the fighters on opposite sides of the bandit's canopy. It often presents itself as a 1C fight for one fighter and a 2C fight for the other fighter.

The free fighter must watch and take into account the actions of the engaged fighter, and then control the impending merge. The free fighter must then force a tight merge to avoid giving up turning room. As the free fighter approaches the merge, he must assess if a turn to set out-of-phase would be a BFM error. Do not set out-of-phase if it would be a BFM error. This may result in a defensive situation (fundamental number two). Once out-of-phase is set, the fight will appear as a 1C fight to one fighter and a 2C fight to the other fighter. The fighters can reference the bandit's lift vector placement to determine roles. Out-of-phase flow eliminates the possibility for the bandit to put his lift vector on both fighters simultaneously, and, thus the bandit must commit to only one fighter. This leaves the free fighter to maneuver as necessary to quickly achieve a WEZ.

Ideally, the free fighter would control the merge orientation to best establish out-of-phase while attempting to set the desired flow (1C or 2C). For example, if out-of-phase 1C flow away from your wingman is desired, set the pass so you would check turn across the bandit's tail and reverse to set the flow. Be proactive with BFM and SEM fundamentals.

Out-of-plane complicates the bandit's problem. It forces him to look high and low to maintain tally-two. Out-of-plane maneuvering can be used to gain angles on the adversary as well. Finally, it provides a discriminator to bandit lift vector placement which helps the fighters determine roles. Out-of-plane does not have to be 12,000 feet of separation, nor is it 2,000 feet. Too little out-of-plane simplifies the bandit's problem. Too much out-of-plane can complicate the fighters' situation as it may cause them to lose sight of each other and/or the bandit. Vertical separation must be managed to optimize the BFM and SEM picture.

## 12-4 SEM FUNDAMENTALS

The fighters must also recognize when out-of-plane/out-of-phase is not required. If the bandit commits a BFM error or presents a LAR, forego out-of-plane/out-of-phase and kill the adversary (fundamental number one). Roles still define deconfliction, so proper SA and communication is required regardless of the scenario.

## 1205. ENGAGED ROLES / RESPONSIBILITIES / COMMUNICATION

Defining roles is of paramount importance so each fighter knows their responsibilities. ***The reason roles are defined is to establish deconfliction between the fighters, and to coordinate their individual responsibilities.***

There will be times that the fighters need to have a "first guess" role definition. These initial roles may only last a couple seconds or they may last the duration of the fight. They are used to define initial moves, to eliminate confusion when there is little time to use comm, or as a tiebreaker in certain scenarios. The circumstances and the bandit ultimately decide who is engaged. The roles may be redefined as often as necessary to best optimize the fighters' situation. Be patient to communicate the roles and know your responsibilities before and after the roles are communicated. It should be noted that you cannot call "free" before a fighter has called "engaged."

Both fighters should never pull for the bandit's CZ at the same time. ***By definition the engaged fighter owns the bandit's CZ!*** Apply sound judgment to this rule. If the engaged fighter is unable to enter the bandit's CZ (e.g., he is defensive), do not forego weapons employment opportunities or chances to transition to an offensive position. Additionally, should the free fighter become the most offensive fighter, entry to the CZ is acceptable and, with proper communication, a role swap is warranted. The free fighter is always responsible for coordinating deconfliction until a role swap is completed.

<u>Engaged Fighter Criteria (in order)</u>:

1. Most defensive fighter – use this if one or both fighters are defensive. A good way to conceptualize this is to think of who will be shot first or who has the least angles off the bandit's nose. The bandit's lift vector placement, angles off your tail, and range to the bandit may be of little consequence. Additionally, if one fighter is defensive, and the other is neutral or offensive, the defensive fighter is engaged.

2. Most offensive fighter – use this if one or both fighters have an offensive advantage.

3. First fighter to the merge – use this if the bandit merges with one or both fighters. The first fighter executes his HABFM gameplan while the other fighter maneuvers accordingly.

4. Lead (by exception) – the wingman always owns deconfliction with his lead. When in doubt as the tac wing, watch the tac lead, deconflict, and then execute smart SEM.

Engaged Fighter Responsibilities:

- Execute 1v1 BFM gameplan.
- Clear the bandit's sensor nose.

Free Fighter Responsibilities:

- Kill the adversary.
- Maintain overall deconfliction responsibilities.
- Maintain overall SA to the fight and the surroundings.

Defining Roles/Responsibilities:

Sometimes the engaged fighter criteria does not intuitively determine who is engaged. During these times ***to best determine who the bandit is actively fighting, reference the bandit's lift vector placement. When the bandit's lift vector placement does not show greater preference to one fighter or the other, utilize the engaged fighter criteria.*** You must learn when and how to apply these concepts.

Engaged Communications:

In any fight your altitude, attitude (nose-low/nose-high/level), and the offensive/defensive/ neutral situations are excellent pieces of information to provide. Additionally, altitude and attitude calls help set out-of-plane and also reduce the scan volume for a low-SA fighter. ***The idea is for every transmission to add SA to the current engagement.*** Speak clearly and be concise. Work big to small and give the other fighter time to process the information. Refer to the lost sight gameplan section for examples of status comm.

- 1C – all 1C fights travel downrange. Communicate the axis of the fight using a cardinal/sub-cardinal heading. Neutral fights have the engaged fighter and bandit's flight paths cross each other. Offensive and defensive 1C fights may transition to 2C or redefine nose-low:

  "Sweep 11 engaged 1C, nose-high, Northwest, 18,000."

- 2C – 2C fights will stay over a certain point, otherwise known as being "anchored." The engaged fighter needs to communicate the direction of turn. Altitude information can also be helpful in giving the free fighter SA. Neutral fights will come to merges or the aircraft will be cross-circle from each other:

  "Sundown 81 engaged left 2C, 11,000, the bandit's cross-circle."

  "Anvil 32 defensive, right 2C, 14,000, to the deck."

- Attitude – Nose-high/nose-low/level.

- Altitude – Current altitude and any trends (e.g., to the deck).

Examples:

"Showtime 41 tally 1 left, 11 o'clock, 1 mile, level."
"Showtime 42 tally 1."
"Showtime 42 engaged 1C, nose-high, West, 17,000."
"Showtime 41 free, shot in 5."

"Rage 32 going nose-high to the right."
"Rage 31 engaged left 2C to the deck."
"Rage 32 free."
"Rage 31 the bandit is going nose-high."
"Bandit switched."
"Rage 31 tally/blind."
"Rage 32 merge in 5."
"Rage 31 visual."
"Rage 32 engaged 1C, level, West."
"Rage 31 free."

"Taproom 41, engaged 2C, right, 11,000."
"Taproom 42 free, shot in 5."
"Taproom 42 no shot."
"Taproom 41."
"Bandit switched."
"Taproom 42 engaged 1C, nose-high, North."
"Taproom 41 free."
"Taproom 41 Fox-2."
"Taproom 41 kill Goshawk, right turn, in the West."

If comm ever begins to break down, the fighters are losing mutual support and the adversary will be able to exploit this lack of coordination. In other words, fighters begin to die. Also, a breakdown in comm leads to diminishing SA for the fighters and can lead to safety-of-flight situations. ***Prioritize listening to the radio and speak only when adding SA.*** Be patient, using comm brevity terms and plain language to be effective.

Conclusion:

As you can see, SEM is a dynamic environment. Comm will be used to drive the fighters, or to build SA. Referencing the SEM basic assumptions outlined above, all that must be communicated are the roles of the fighters; however, briefly describing the fight is a good technique and should be attempted. If the fighters are tally/visual, comm will be minimal.

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## CHAPTER THIRTEEN
## FIGHTER GAMEPLANS

The fighter's initial moves at the merge typically define how long the fight will last. A poor decision could potentially put a fighter defensive throughout the rest of the engagement. A good decision, however, can make for a quick kill. Read these paragraphs carefully as these scenarios will help define each fighter's initial moves at the merge.

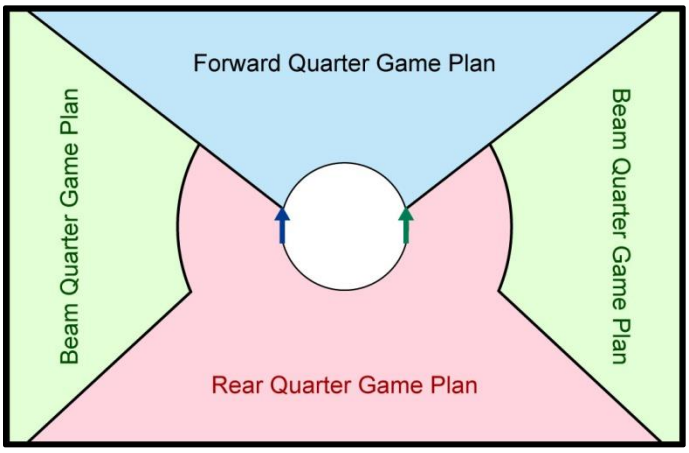


**Figure 13-1 Fighter Gameplans**

We will divide the fighter's gameplans into three scenarios based on where the fighters visually acquire the bandit:

1. Forward quarter visual pick-up.

2. Beam quarter visual pick-up.

3. Rear quarter visual pick-up.

Here are some good rules of thumb for the fighters regardless of the scenario:

1. If the first fighter can make a neutral, tight merge and has minimum vertical airspeed, he should strive to go nose-high 1C to keep the fight collapsed and possibly bleed down the bandit's energy.

2. The fighters must avoid in-plane defensive flow with the bandit behind both fighters. Getting the fighters out-of-plane is highly encouraged. Redefining early is acceptable as long as the bandit is inside your bubble.

3. Do not commit a BFM error in order to set out-of-plane or out-of-phase flow.

## 1300. FORWARD QUARTER VISUAL PICK-UP

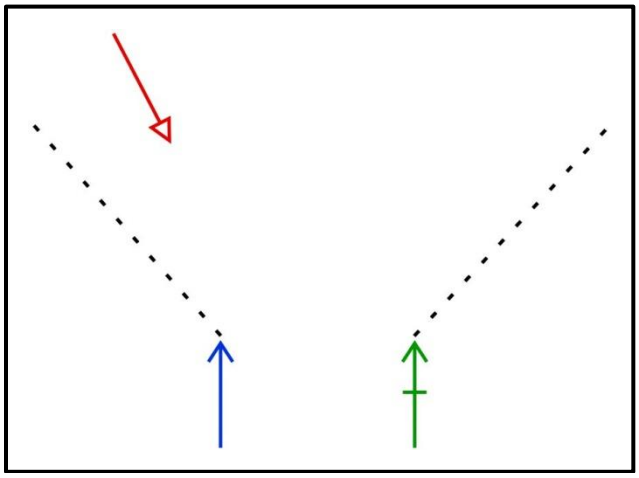

**Figure 13-2 Forward Quarter Visual Pick-up**

A visual pick-up in the forward quarter is the most offensive situation for the fighters; however, it has the highest closure rates. Forward quarter closure is, on average, three seconds per nautical mile, so time is limited, requiring expeditious comm and maneuvering:

"Mace 32 tally 1, left 11 o'clock, 2 miles, 5 low."
"Mace 31 tally 1."

Both fighters must execute the appropriate engaged comm while immediately turning nose-on to the bandit, in order to collapse any available turning room. The fighters should apply engaged fighter criteria to determine the "first guess" roles based on the geometry of the initial merge. After the initial merge, the fighters must communicate their roles that are now defined by the bandit's lift vector placement. Additionally, the second fighter to the merge should use descriptive comm, as required to build SA for his wingman.

The initial engaged fighter should execute his best 1v1 BFM. ***If possible, a good gameplan for the first fighter is to take out any turning room at the merge, and then maneuver pure nose-high 1C, with his lift vector in lead of the bandit.*** This keeps the fight tighter, affording less weapons separation for the bandit, and provides the best chance for the free fighter to set out-of-plane/out-of-phase flow.

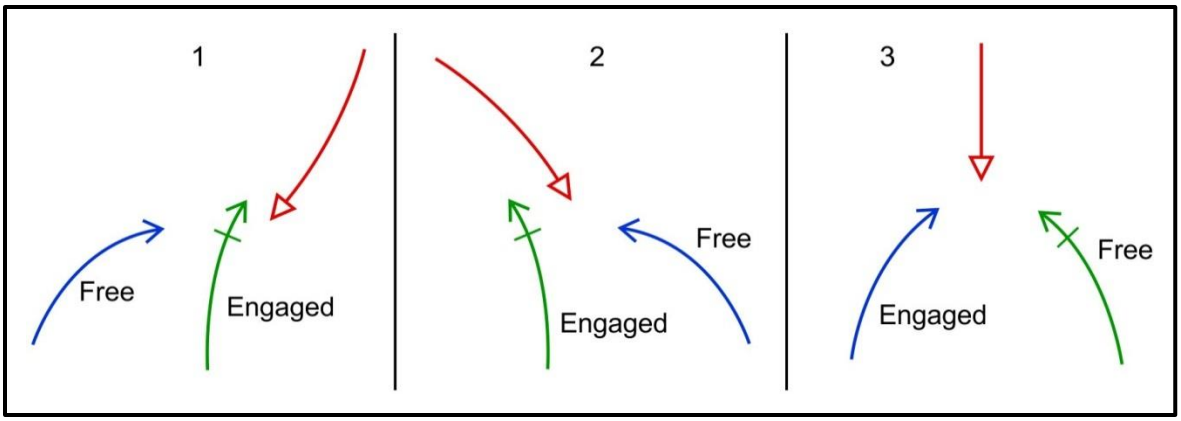


**Figure 13-3 Initial Engaged/Free Fighter Roles**

**Defining Roles and Initial Moves:**

When we breakdown the forward quarter scenario we see that if the bandit is outside the section, both fighters must immediately and aggressively turn nose-on to the bandit to avoid giving up turning room. If the bandit is between the section, and favoring one side of the formation, then the near fighter should make a tight, neutral merge, and the far fighter should aggressively maneuver nose-on to the bandit to take out any turning room. In either case the first fighter to merge is initially engaged. If the bandit comes directly between the section, then the tac lead is by default the engaged fighter, and is expected to aggressively maneuver to engage the bandit. The tac wing should take out turning room and watch for his wingman to make his initial move.

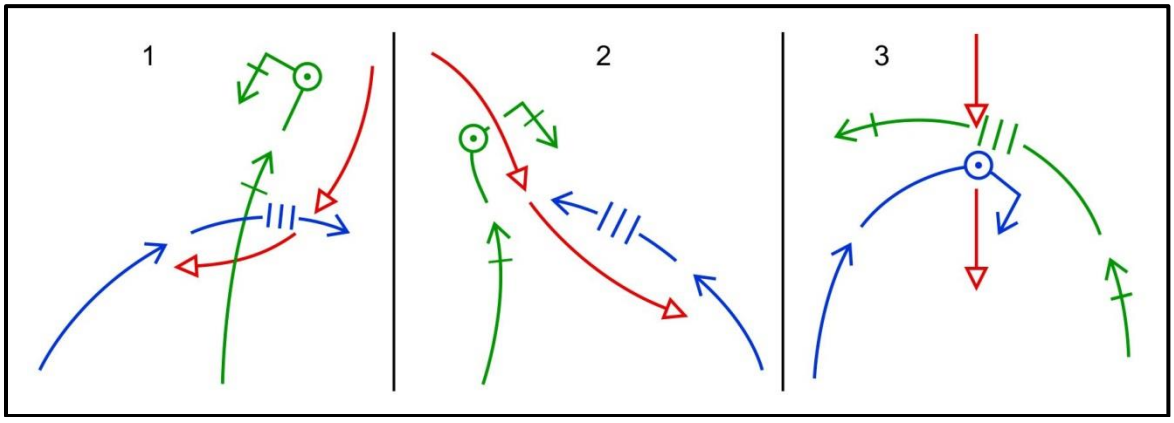


**Figure 13-4 Fighters' Initial Moves**

In all three cases, the engaged fighter should maneuver pure nose-high 1C, and assess. The free fighter now has a 2C option to create out-of-plane and out-of-phase flow.

One Fighter No Joy:

If one fighter is no joy approaching the merge, the fighter with higher SA should use directive and descriptive comm to drive flow and communicate the bandit's position. The no joy fighter

should maneuver aggressively per the directive comm. If the bandit is on your side of the formation, an immediate hard turn to the stated clock-code will take you to the merge. Then, scan forward of your nose to gain tally. If the bandit is on the opposite side of the formation, point your nose slightly ahead of your wingman, scanning in front of your wingman's nose for a tally.

Bandit Only Tally One:

If the section enters unobserved, maneuver to take advantage of this situation. Utilize the turning room available to obtain an offensive advantage and a quick kill. The bandit may be tally one and turn his tail to a fighter with his initial move. Should this happen, the bandit has committed a BFM error, and the fighters should aggressively maneuver for the quick kill.

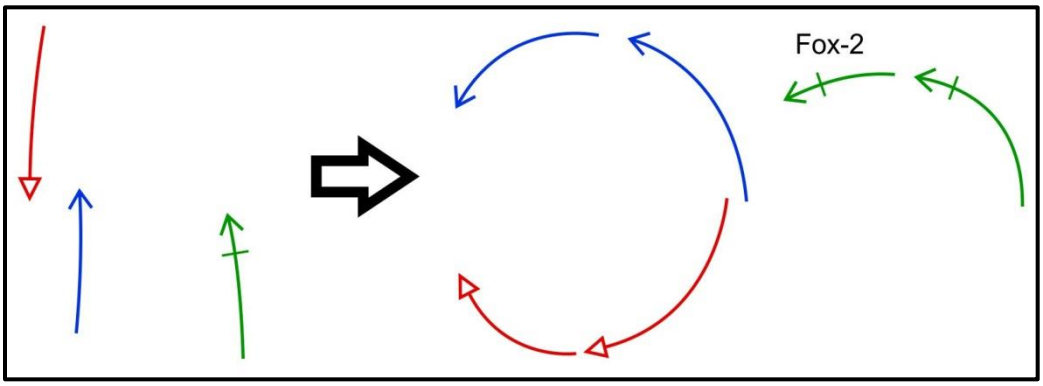


**Figure 13-5 Forward Quarter Quick Kill Scenario**

## 1301. BEAM QUARTER VISUAL PICK-UP

When the fighters pick up a tally in their beam quarter, they should execute a break turn into the bandit using proper engaged comm. A break turn for 180 degrees, however, is inappropriate for this scenario. Therefore a "break left/right 90" call is used. Both fighters should continue the break turn only as long as required to take out turning room. Once a tight pass is achieved, ease your pull to conserve your energy. "First guess" roles define the engaged fighter as the first fighter to the merge:

"Nickel break right 90, tally 1, right 3 o'clock, 2 miles, level."
"Nickel 62 tally 1, chaff/flares."

Initial moves at each merge will heavily depend on merge geometry and each fighter's energy state. The fighters will have an energy deficit in reference to the bandit and may be at an angular disadvantage as well. ***A good gameplan is for the first fighter to turn across the bandit's tail, level to slightly nose-low, and for the second fighter to check turn across the bandit's tail, and reverse (nose-high if able) in order to set out-of-phase and out-of-plane flow.*** After the initial merges, the fighters should assess the bandit's lift vector placement and communicate roles accordingly. The second fighter to the merge should use descriptive comm, as required to build SA for the near fighter.

## 13-4 FIGHTER GAMEPLANS

In general, if at the merge the engaged fighter is below minimum vertical airspeed, nose-high is not wise. A level-to-slightly-nose-low initial move across the bandit's tail, capturing the upper end of the rate band, is the best and perhaps only option for the first fighter to the merge. However, if the engaged fighter's energy state allows for a nose-high gameplan, he may execute one. An example of this may be a low-to-high stacked merge in which the engaged fighter can early turn nose-high and gain angles. Remember to communicate your intentions in this case as this was not the fighter's pre-briefed gameplan. Either way, the free fighter must monitor the engaged fighter's initial move and adjust accordingly.

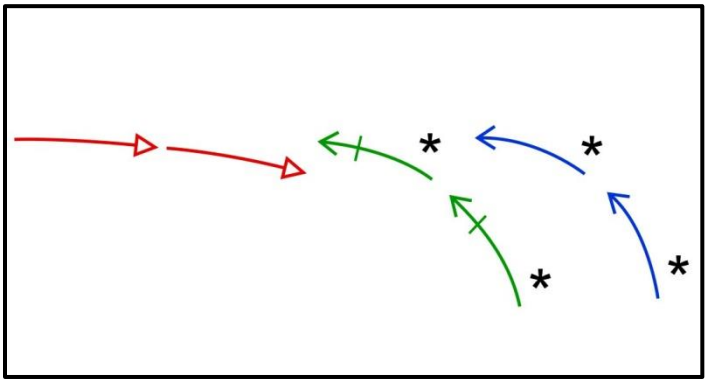

**Figure 13-6 Beam Quarter Maneuvering (Initial break turns)**

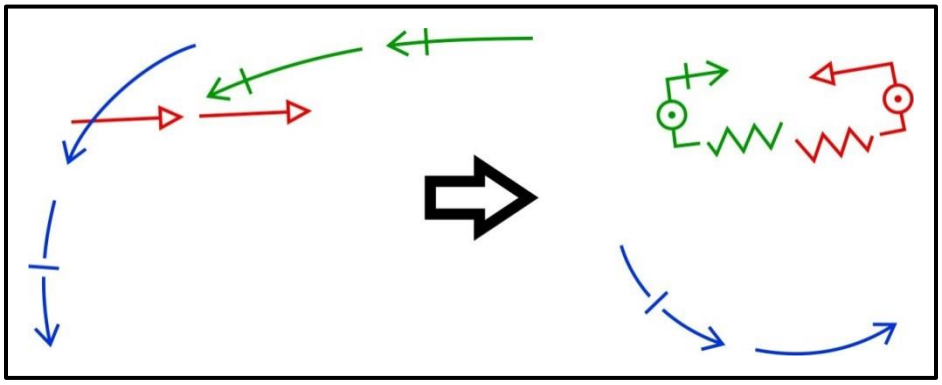

**Figure 13-7 Beam Quarter Maneuvering (Forward of 3/9 Line)**

Initial Geometry:

During the initial visual pick-up, the more aft the bandit is relative to the fighters, the more defensive the fighters will be. For example, if the fighters pick up the bandit forward of their 3/9 line, they both should be able to take out all turning room, and force high-aspect merges. If the fighters pick-up the bandit aft of their 3/9 line; however, the near fighter will not be able to take out the turning room. He will have a wide pass with the bandit and may not be able to deny the bandit angles. The free fighter should still be able to take away turning room, but at the cost that his airspeed will likely be less than minimum vertical airspeed; his ability to set out-of-plane may be difficult. The fighters are at a significant energy disadvantage in this case, which may lead to an angular disadvantage if the engagement lasts too long. Timely maneuvering and

comm are required to survive.

An even more defensive scenario is if the bandit is not acquired until inside 1 nm of the fighters; in this case, neither fighter will be afforded the ability to take out turning room, and the flow will look more like the flow for a rear quarter gameplan, which we will talk about in the next section.

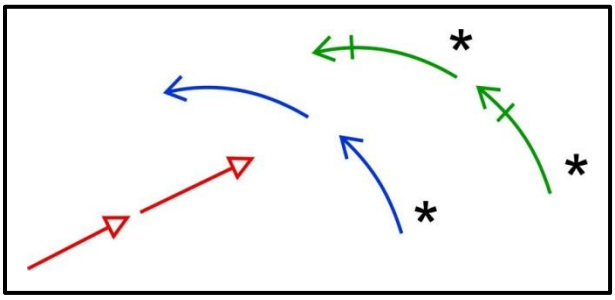

**Figure 13-8 Beam Quarter Maneuvering (Aft of 3/9 Line)**

Bandit Tally One:

If the section enters unobserved by the bandit, maneuver to take advantage of this situation. Utilize the turning room available to obtain an offensive advantage and the quick kill. The bandit may be tally one and turn his tail to a fighter with his initial move. If this is the case, aggressively maneuver for the quick kill.

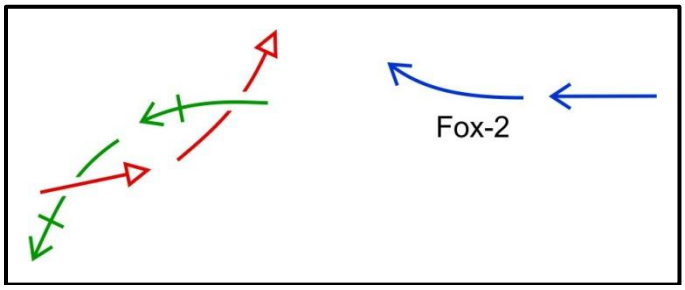


**Figure 13-9 Beam Quarter Quick Kill Scenario**

## 1302. REAR QUARTER VISUAL PICK-UP

A visual pick-up in the rear quarter is the most defensive scenario for the fighters. Each fighter must initially assume an engaged fighter role, and execute his best DBFM. As the fight progresses, reference the bandit's lift vector placement to define roles. Since both fighters are initially engaged, both fighters are responsible for deconfliction.

The initial break turns from the fighters will be determined by the bandit's location. Both fighters should break into the bandit, dispensing chaff/flares. Typically the fighters will break in the same direction; however, if the bandit is between the fighters, opposite direction break turns should be used, somewhat resembling a cross turn. ***When in doubt, the fighters should break in the same direction.***

## 13-6 FIGHTER GAMEPLANS

Same Direction Break Turns:

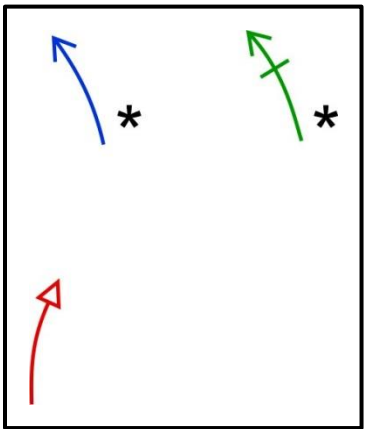

**Figure 13-10 Rear Quarter Initial Break Turns**

Typically if both fighters break in the same direction into the bandit, it will afford the biggest RAC problem for the bandit to solve. ***An immediate nose-low, or nose-high break turn/maneuver from either fighter, would be a BFM error and should be avoided.*** The fighters should keep their lift vector on to slightly below the bandit when executing their break turns:

"Anvil break left, tally 1, left 7 o'clock, 1 mile, level."
"Anvil 11 tally 1 chaff/flares."
"Anvil 12 chaff/flares."

When the bandit is acquired behind the section, it is possible that his nose may sweep through, or toward, each fighter as the bandit engages. It is paramount that a fighter only redefines if his criteria have been met! If both fighters redefined nose-low, it would allow the bandit to be offensive on both fighters on the deck where survival options would be extremely limited.

If the bandit turns to engage the near fighter, it will look very similar to a defensive perch set. The near fighter should redefine as appropriate, while the far fighter pulls for a shot. The bandit's error will lead to a quick kill.

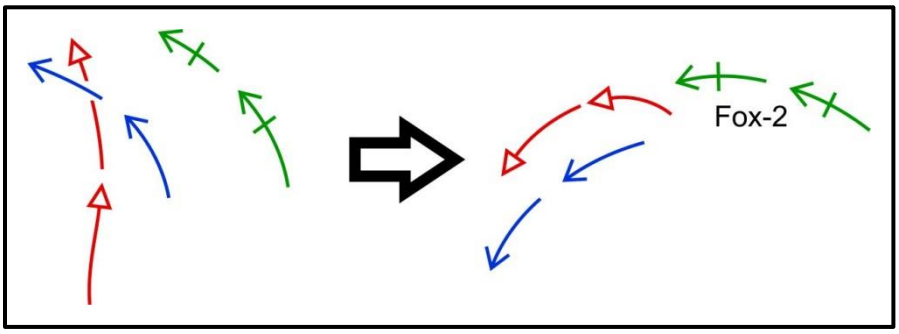


**Figure 13-11 Rear Quarter Quick Kill Scenario**

If the bandit is proficient, and tally two, he will not turn his belly to the far fighter. The bandit will try to lag both fighters in an attempt to execute an OBT at the AWE of the far fighter. As long as you can pull the bandit forward, continue with the energy excursion. Recall from DBFM, as soon as you can no longer pull the bandit forward on your canopy, you should intercept a compromise pull. Be patient and assess the bandit's actions to make the most appropriate SEM and DBFM decisions.

As the far fighter, if you can still pull the bandit forward on the canopy regardless of sensor nose, keep pulling him forward. By continuing to pull him forward you may be able to force a high-aspect pass, or an ICFPOS. Use expendables and continue to fight your best DBFM 1v1 to survive.

As the far fighter you need to continue the pull and assess the bandit's pursuit:

1. Can you force a high-aspect pass?

2. Can you force an ICFPOS?

3. Does the bandit initially lag, attempting to enter your AW?

4. Did the bandit lag too long and get stuck in lag?

Let's look at each of these situations:

Far Fighter Creates a High-Aspect Pass:

If the far fighter can force a high-aspect pass (<1000 ft) after the initial break turn, he should assume the engaged fighter role, and attempt to set 1C flow away from his wingman. The engaged fighter should use descriptive comm as required to build SA for the free fighter.

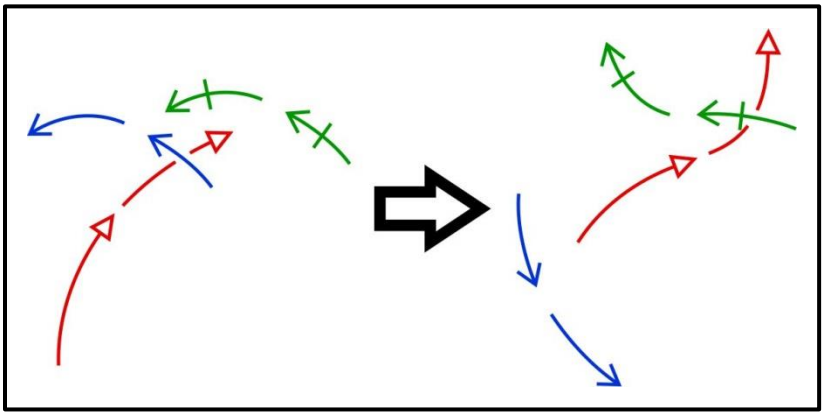

**Figure 13-12 Far Fighter Makes a Merge**

Bandit Overshoots Far Fighter:

If the bandit flies pure pursuit, there is a chance for an in-close overshoot. The far fighter should

defeat any shots and then take advantage of this overshoot, reverse, and engage the bandit in the flats or 1C away from his wingman.

Bandit Stuck in Lag:

If, during the 2C defensive fight, the bandit is having difficulty bringing his nose to bear on the fighters (e.g., stuck in lag), the fighters should not continue in this lufberry with altitude below them. Since the engaged fighter does not want to sacrifice his altitude unnecessarily, the free fighter should use the available altitude to set out-of-plane flow, all the while potentially gaining angles on the adversary.

Bandit lags to attempt an AWE of the Far Fighter:

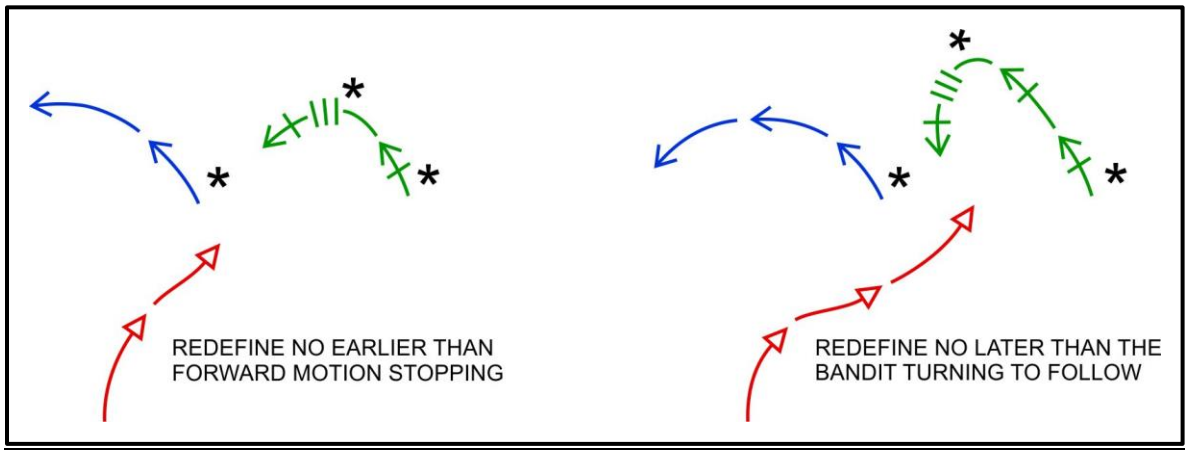


**Figure 13-13 Far Fighter Redefines**

If the far fighter assesses the bandit is attempting to lag to his AW, then it is time to redefine before sensor nose is a factor. Think about the sight picture from your basic DBFM perch sets and redefine when your criteria have been met (as a rule of thumb, do not redefine any earlier than forward motion stopping on your canopy, or any later than the bandit reversing his turn to follow. This redefinition should come within the first 90 degrees of turn for the far fighter.) ***It is highly recommended to avoid in-plane, 2C defensive flow with the bandit behind both fighters.*** You can afford to be flexible with DBFM Axiom number three (target aspect decreasing), because as long as the bandit is inside your bubble, a redefinition is not a BFM error, and will greatly aid the section's SEM gameplan. When a fighter redefines, it creates out-of-plane flow and forces the bandit to choose which fighter he wants to engage--the nose-low fighter, or the level fighter.

If the far fighter misses his redefinition opportunity due to a late tally, fight geometry, or poor headwork, the fighters will be stuck in-plane, defensive 2C flow. As MATC play out, the bandit's sensor nose will become a factor to one of the fighters, potentially to the outside fighter first. This fighter must now execute his redefinition.

In either case, the redefining fighter must be visual of his wingman before executing the

redefinition. ***Sacrifice tactics for safety in a training environment.*** A "redefining" call should be made to increase fighter SA:

"Rage 32 redefining, chaff/flares."

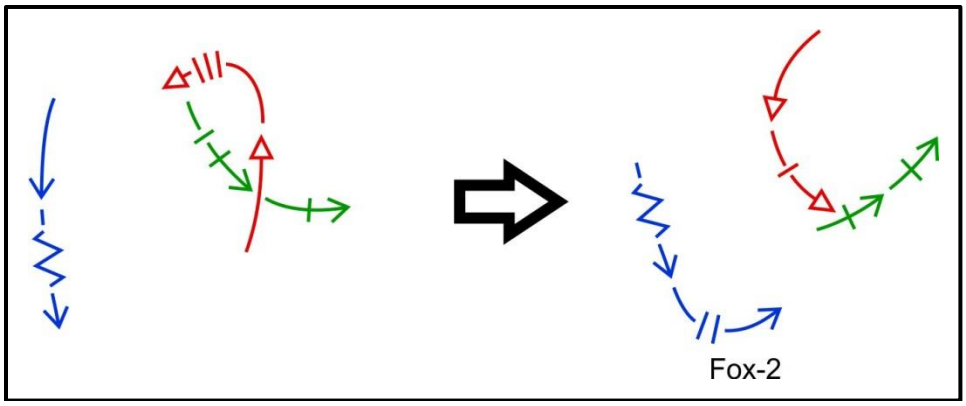


**Figure 13-14 Far Fighter Redefines (Bandit Follows)**

Now that the fighters are out-of-plane, reference the bandit's lift vector placement to determine roles. If the bandit follows the nose-low fighter, he is engaged. The free fighter should be able to see the fight translating down. Manage weapons separation by either climbing for vertical separation, or by easing your pull for lateral separation (or a combination of both). Getting out-of-phase is not required. Once you have weapons separation, place your lift vector on the bandit and execute an energy excursion for a shot.

If the bandit stays with the level fighter, he is engaged and the nose-low fighter is free. As the defensive flow plays out, the engaged fighter may need to execute his own redefinition. The free fighter is more than likely still below the engaged fighter. If both fighters are blind, use altitude to deconflict; this scenario will likely result in a KIO, vice continuing the fight. In the training command, due to safety, the bandit shall not intentionally present this scenario.

Opposite Direction Break Turns (Cross Turn):

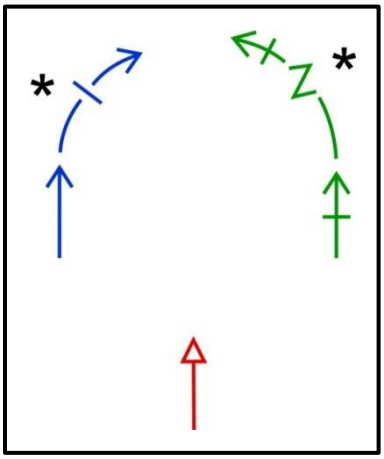

**Figure 13-15 Rear Quarter Cross Turn Option**

If a bandit is detected directly aft and between the section, then a cross turn is a valid choice. The advantage of the cross turn is it immediately sets out-of-phase and out-of-plane flow, forcing the bandit to make an early decision. The cross turn is like the one you learned in TACFORM, however the high fighter will break slightly nose-high (3-5º), and the low fighter will break slightly nose-low (3-5º). The slightly nose-high and nose-low break turns cause the flight paths to diverge, increasing the out-of-plane problem for the bandit without negatively impacting DBFM and forces the bandit to choose which fighter to engage.

To initiate the flow, be directive and call for a cross turn while describing your tally. This directive and descriptive comm, along with this pre-briefed understanding, will provide the requisite SA to perform this non-standard cross turn. Once the bandit chooses to engage a fighter (i.e., defined by bandit's lift vector placement), define the roles:

"Anvil cross turn tally 1, 6 o'clock, 1 mile, level""
"Anvil 11 low"
"Anvil 12 high"
"Anvil 11 chaff/flares"
"Anvil 12 tally 1 chaff/flares"

The engaged fighter should continue the defensive break turn for as long as he can pull the bandit forward on his canopy. As the bandit turns to follow, monitor his target aspect and motion on the canopy. If the fighters' flight paths have crossed and redefinition criteria (DBFM Axiom number four) have been met, redefine. ***For deconfliction purposes, do not redefine until after the fighters' flight paths have crossed.*** In this scenario, the engaged fighter can be slightly liberal with DBFM Axiom number three (target aspect decreasing). As long as the bandit is inside your bubble, a redefinition is not a BFM error. The advantages of the out-of-plane maneuver are tactically significant in SEM. Establish deconfliction early and avoid in-plane maneuvering. A "redefining" call should be made to increase fighter SA. The bandit is now forced to decide to follow nose-low or stay level:

"Anvil 11 defensive, redefining, chaff/flares."

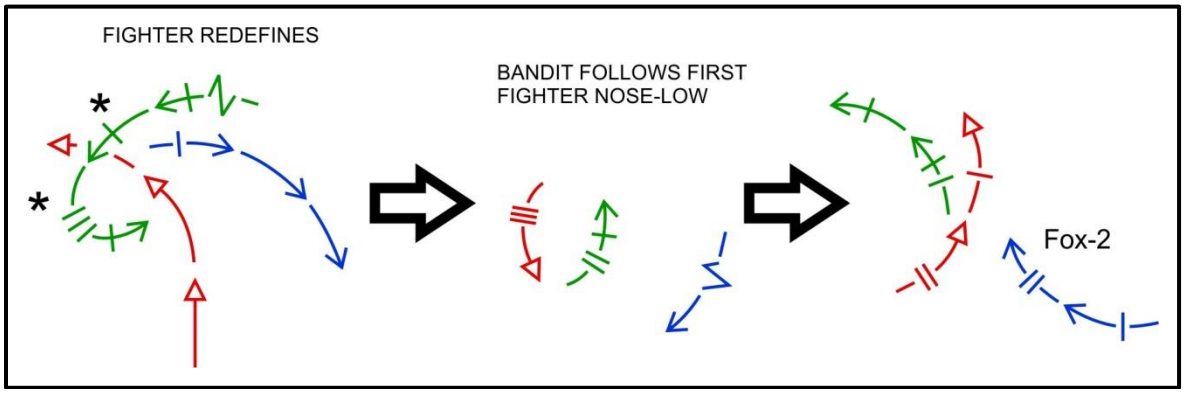


**Figure 13-16 Bandit Follows Redefining Fighter**

If the bandit follows the nose-low fighter, then he is the engaged fighter. The fighters should communicate the now-established roles accordingly. When the free fighter sees the bandit execute his redefinition follow, extend if required, and reposition the lift vector on the bandit as appropriate, performing an energy excursion for a weapons employment opportunity. The free fighter also has the opportunity to use descriptive comm to aid the engaged fighter in determining the bandit's actions (e.g., "the bandit's following you"). Sound comm will keep fighters alive and provide a timely kill.

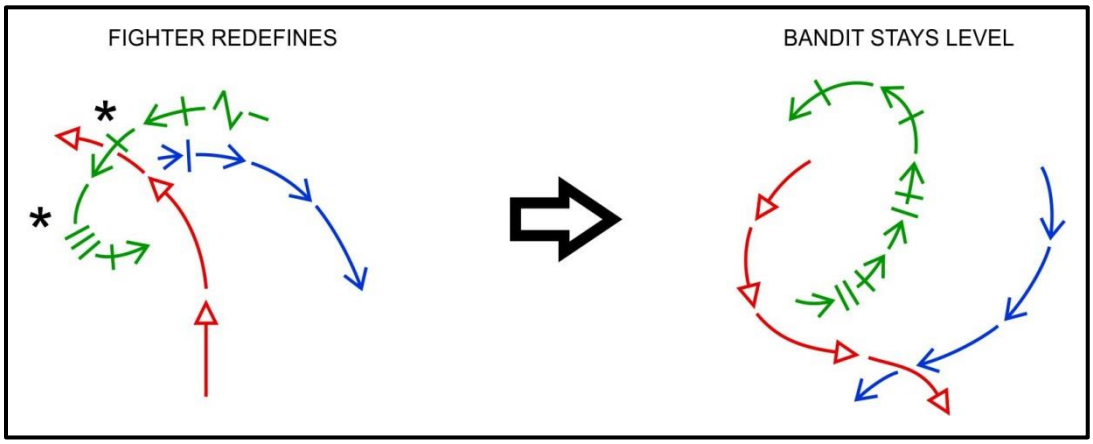


**Figure 13-17 Bandit Does Not Follow Redefining Fighter**

If the bandit stays level, bandit lift vector placement dictates the roles. The engaged fighter (high fighter) may have a shot opportunity after another 180 degrees of turn. If not, the engaged fighter should control the merge so the bandit is between the fighters (i.e., the bandit is bracketed), as long as it will not be a BFM error. Check turn across the bandit's tail, then attempt to set 1C flow away from your wingman without making a BFM error. The engaged fighter should use descriptive comm, as required, to build SA for the free fighter. Continue to update roles as required. In any case, out-of-plane and out-of-phase flow will provide shot opportunities. Utilize sound comm to keep SA high throughout the fight.

## 13-12 FIGHTER GAMEPLANS

## CHAPTER FOURTEEN
## REGAINING SITUATIONAL AWARENESS

### 1400. LOSE SIGHT, LOSE THE FIGHT

It is critical that both fighters, particularly the free fighter, maintain tally/visual not only to execute SEM, but also for safety of flight. ***You must learn to be able to track both your wingman's position, and the bandit's position, while fighting your best jet.*** The engaged fighter cannot clear the bandit's sensor nose (i.e., engaged fighter responsibility number two) if he is blind and/or no joy. Similarly, the free fighter cannot kill the adversary or maintain overall deconfliction (i.e., free fighter responsibilities one and two), if he is blind and/or no joy.

If a fighter becomes blind and/or no joy, use proper comm to build SA. Prioritize listening to the radio, deconflict, and avoid arcing around the sky. If you are blind/no joy, first deconflict via altitude, and then determine what piece of sky you need to avoid. Typically in the T-45, 2C fights descend, and 1C fights go uphill or stay level.

### 1401. LOST SIGHT COMM AND FOLLOW-ON MANEUVERING

If the engaged fighter is no joy, the free fighter should describe the bandit's position in relation to his wingman. The free fighter may also have to be directive to maintain pressure on the bandit, or prevent a weapons employment opportunity for the bandit:

Engaged fighter: "Sundown 41 no joy."
Free fighter: "Sundown 41, the bandit's at your right 2 o'clock, 1 mile, 10 high."
Engaged fighter: "Sundown 42 tally."

If the free fighter is blind or no joy, similar descriptive comm can be used to regain visual or tally. Additionally, the engaged fighter must use directive comm to prevent a shot, or to deny a defensive situation for the free fighter. If the engaged fighter is blind as well, he should assess the situation, communicate his position, and continue fighting:

Free fighter: "Rage 61 blind 16,000."
Engaged fighter: "Rage 61 I'm at your right 3 o'clock, 1 mile, 20 high."
Free fighter: "Rage 61 visual."

Free fighter: "Combat 21 no joy, 18,000."
Engaged fighter: "Combat 21 break left, bandit at your left 8 o'clock, 1 mile, 10 low."
Free fighter: "Combat 21 defensive."

The free fighter, when "tumbleweed" (meaning limited SA, requiring additional information), should place the downrange direction of a 1C fight on his 3/9 line, and then assess lateral and vertical separation via a "posit" or "status" call, and/or the use of A/A TACAN. To collapse range, maneuver in the same direction of a 1C fight, climbing, if necessary, while considering deconfliction. With one or two in sight, execute reversals into the direction of the fight until you are tally/visual or ready to pitch-in for weapons employment. Time the reversals to keep the

engagement within ten to twenty degrees of your 3/9 line. If you are blind/no joy, reverse every fifteen to twenty seconds, continuing to assess the fight's position in relation to yours.

A 2C fight will typically stay over a certain location. The free fighter, when blind/no joy, should use the A/A TACAN and/or a "posit" call to determine lateral and vertical separation from the fight. If you are directly below the fight, extend away from the fight. 2C fights tend to travel downhill towards the deck, thus climbing and using comm will help maintain deconfliction.

Either fight has the potential to travel uphill or downhill. Amplifying information should be included in descriptive comm to further build the picture. As the free fighter, you must continue to provide deconfliction. Altitude is an excellent way of ensuring deconfliction while aggressively maneuvering to gain SA. If anything changes, the fighters need to update each other in a timely manner:

Free fighter: "Taproom 11 blind/no joy, 12,000."
Engaged fighter: "Taproom 12 blind, engaged 1C, nose-high, West, 18,000."
Free fighter: "Taproom 12 posit."
Engaged fighter: "Taproom 12 Vegas 153/60/19,000."
Free fighter: "Taproom 11 blind, climbing to 16,000."
Engaged fighter: "Taproom 12."
Free fighter: "Taproom 11 two in sight."

Free fighter: "Rage 21 blind/no joy, 12,000."
Engaged fighter: "Rage 22 blind, engaged left 2C, nose-low, 15,000 to the deck."
Free fighter: "Rage 21 extending West, under you at 10,000."
Engaged fighter: "Rage 22 will stay above 12,000."
Free fighter: "Rage 22 posit."
Engaged fighter: "Rage 22 anchored Depot 345/33/12,000."

## 1402. ONE IN SIGHT / TWO IN SIGHT

Eventually, a tumbleweed fighter will start to regain SA. "One in sight" is used when a fighter sees one aircraft but is unsure whether that aircraft is his wingman or the bandit. When a fighter communicates "one in sight," use descriptive comm outlined above to gain two in sight.

- 1C engagement – look left/right and above/below the aircraft to gain two in sight.
- 2C engagement – use the offensive/defensive/neutral status to narrow down your scan volume. If offensive or defensive, look forward and aft of the aircraft in sight. If neutral, look across the circle or wait for a merge.

"Two in sight" means you see both aircraft but you don't know which aircraft is the bandit. ***When a fighter transmits "two in sight," use status relationship comm describing your own relative position to avoid blue-on-blue (fratricide).*** The engaged fighter should differentiate using several relationships, as described in the following section.

## 1403. RELATIONSHIP DESCRIPTORS

1. Position (Offensive/Defensive/Neutral).

2. Vertically (High/Low).

3. Laterally (Cardinal/Sub-Cardinal Direction/Left/Right).

4. Attitude (Nose-High/Nose-Low/Level).

5. Heading.

Relationship Descriptor Examples:

"Anvil 52 one in sight"
"Anvil 51 engaged left 2C, 12,000, the bandit's cross-circle."
"Anvil 52 two in sight."
"Anvil 51 my nose coming through North."
"Anvil 52 tally/visual."

"Mace 32 two in sight."
"Mace 31 engaged 1C Northwest, high, offensive."
"Mace 32 tally/visual."

"Nickel 71 two in sight, status high/low."
"Nickel 72 high."
"Nickel 71 tally/visual."

***You can see that anything other than tally/visual is a question and the trigger should never be pulled unless you are 100% sure you are tally/visual***. In these examples, the free fighter is looking for additional information to complete the picture. Mace 31 provided descriptors in both the vertical and horizontal to aid the free fighter. Nickel 72 answered Nickel 71 using the requested relationship.

Another effective technique is to communicate when a merge is occurring or impending, i.e., "standby for the merge…merge, merge, Nickel 72 on the right." By communicating merge descriptors, if a fighter has one in sight, he can gain two in sight or tally/visual by following an aircraft to the merge.

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# CHAPTER FIFTEEN
# COMMON SHOT OPPORTUNITIES

The training command introduces students to SEM by using canned setups. You will find when you are the free fighter, your shot opportunities will more than likely be one of the following:

1. Bandit engaged 2C:

    a. Free fighter above and out-of-phase.

    b. Free fighter above and in-phase.

2. Bandit engaged 1C:

    a. Free fighter below and out-of-phase.

    b. Free fighter below and in-phase.

## 1500. BANDIT ENGAGED 2C (FREE FIGHTER ABOVE)

The geometry of this engagement is important to understand. The free fighter must be able to assess his relationship to the bandit. Nose-to-tail separation, lateral separation, altitude delta, angles off nose, and AOT all influence the geometry of the engagement and possible shot opportunities. The free fighter does not want to yield a WEZ or offensive position to the bandit (e.g., the free fighter does not want to fly out in front of the bandit's nose). If poor geometry is assessed too late by the free fighter, there may be little chance to salvage the current situation and avoid becoming defensive. Decisions on which weapons employment opportunities to take, and the risks associated with follow-on BFM, are situation-dependent. Always consider the impacts of your present actions to follow-on BFM and SEM should the shot not guide and fuse.

Out-of-plane shots can be difficult due to the poor turn performance of the T-45. "Fishing for the shot" can result in a loss of 1,000 to 2,000 more feet than a normal nose-low maneuver. Typically, 4,000 to 5,000 feet of altitude separation is required if the shot is taken from the oblique. A pure nose-low shot and recovery may result in about 8,000 feet of altitude loss.

***In all cases, the free fighter must maintain deconfliction before, during, and after the shot.*** Deconfliction is typically most challenging if the engaged aircraft is neutral or offensive, because the engaged fighter is typically in or close to the bandit's CZ. In a defensive situation, follow-on maneuvering is not as much an issue since the defensive fighter cannot occupy the bandit's CZ.

<u>Free Fighter above and out-of-phase</u>:

Out-of-phase flow generally yields forward quarter shot opportunities from the oblique. Assess the geometry of the fight to determine if a valid shot and proper follow-on mechanics are possible. Patience is required during this scenario. Be mindful of the follow-on maneuvering before committing nose-low. For the shot, place your lift vector on the bandit and perform an

energy excursion to achieve a valid LAR, pulling the trigger with a clear field of fire. The free fighter's attitude at trigger squeeze will dictate the amount of altitude lost during the shot. The ideal shot would come at thirty degrees AON. To achieve this, execute your energy excursion for the shot just prior to the thirty degrees AON sight picture. This type of shot is the earliest available and results in the least amount of altitude lost.

Immediately after the shot, pull to maintain at least 1,000 to 2,000 feet of altitude separation from the fight, while calling the shot and kill. Then, trade airspeed for altitude to reset out-of-plane. Next, assess the geometry to determine if in-phase or out-of-phase flow is appropriate.

If the free fighter's shot was forward quarter, aggressively re-establishing out-of-plane and out-of-phase flow best fulfills the free fighter's responsibilities. If the shot was aft of the bandit's 3/9 line, or if out-of-phase would be a BFM error (e.g., you think you might fly out in front of the bandit), re-establish out-of-plane but turn in-phase with the engaged fighter. Always remember the hierarchy of the SEM fundamentals. While out-of-plane and out-of-phase are important, avoid becoming defensive is a higher priority. Sacrifice out-of-plane and out-of-phase flow to avoid a defensive situation.

Free Fighter above and In-phase:

If a large amount of lateral or nose-to-tail separation exists, in-phase flow may be the best option. In-phase with a 2C engagement requires the free fighter to execute a sound rate fight. For proper shot mechanics, place your lift vector on the bandit and execute an energy excursion to achieve a valid LAR, pulling the trigger with a clear field of fire. Use sight pictures from 1v1 OBFM for the timing of the shot. Immediately after the shot, re-establish out-of-plane flow. If you have transitioned to a more offensive position than the engaged fighter, coordinate a role swap.

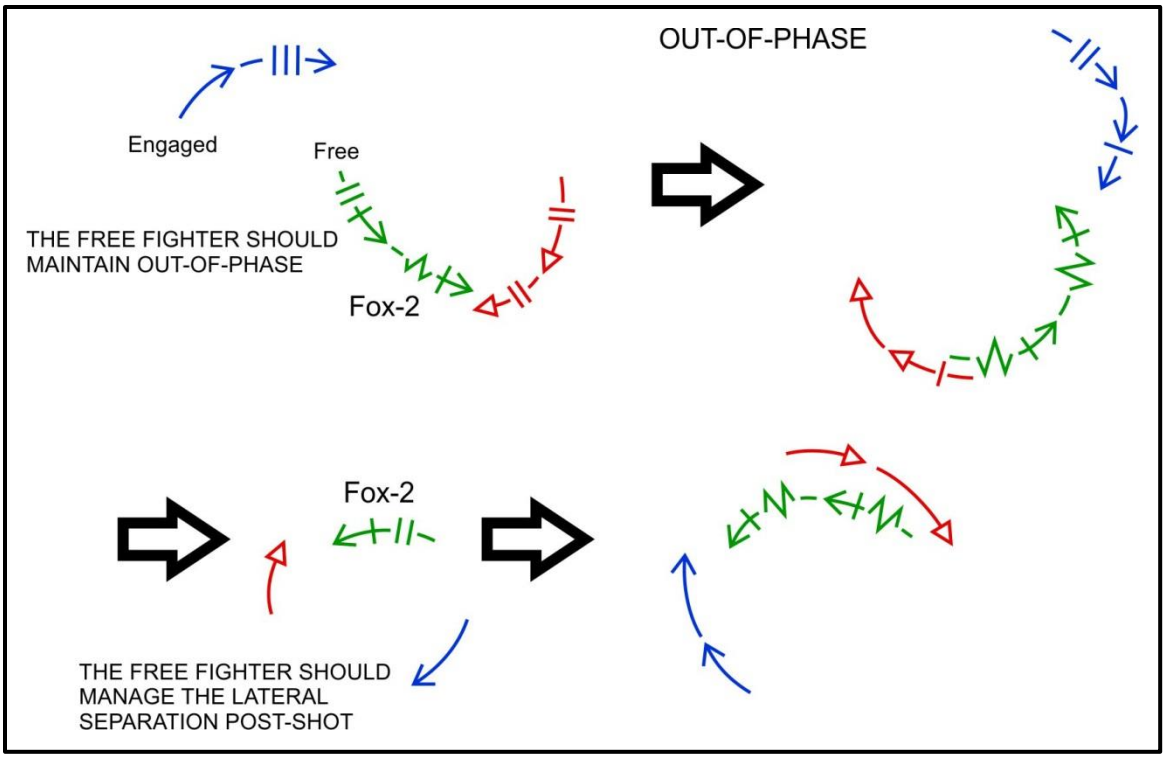


**Figure 15-1 Basic 2C Shots and Follow-on Flow**

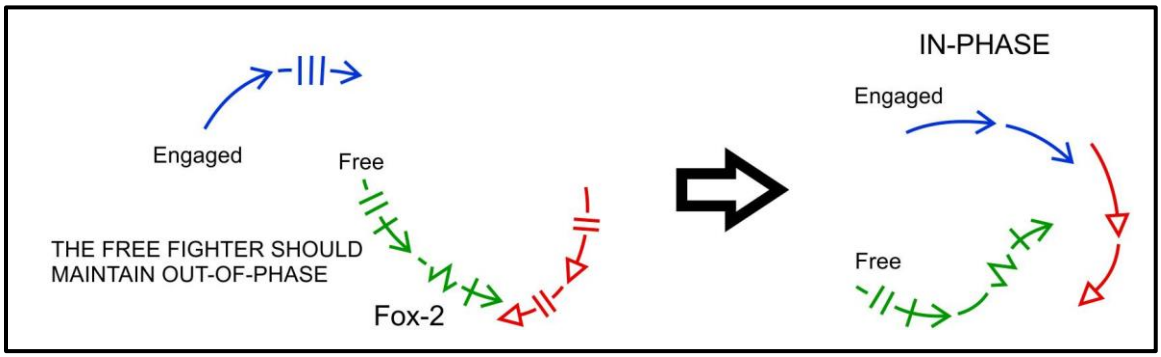


**Figure 15-2 Basic 2C Shots and Follow-on Flow (in phase)**

## 1501. BANDIT ENGAGED 1C (FREE FIGHTER BELOW AND BEHIND)

If the bandit is engaged in 1C flow with your wingman, their fight is typically traveling downrange in one direction. Your goal should be to establish yourself behind that engagement and, more importantly, behind the bandit. When you have sufficient weapons separation, place your lift vector on the bandit and perform an energy excursion to take the shot when the bandit and engaged fighter merge. Pull the trigger when a clear field of fire is established (i.e., your wingman has exited your HUD field of view). While calling the shot and kill, maintain your weapons separation. You can do this by trading altitude for airspeed or by extending with the engagement at your 3/9 line. This will maintain your lateral separation from the engagement. As you continue to follow the bandit, assess your energy state and follow-on weapons

employment opportunities.

You must be careful if, due to geometry, you find yourself taking shots forward of the bandit's 3/9 line. These shots are less desirable because it puts you in front of the bandit's nose, which may allow him to switch and negate a shot opportunity. If this situation occurs, employ weapons, but realize the possible outcomes from this scenario.

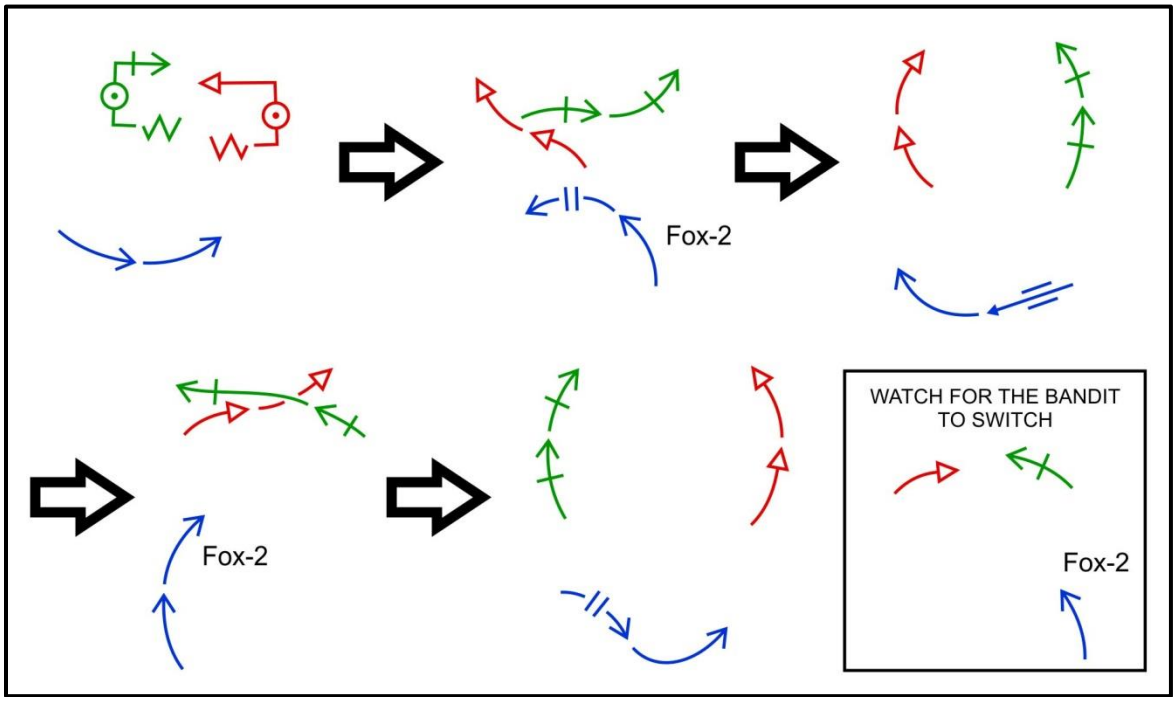


**Figure 15-3 Basic 1C Shots and Follow-on Flow**

# CHAPTER SIXTEEN
# SWITCHES

Understanding the bandit's 1v2 gameplan can help the fighters make decisions. A bandit who is proficient with high SA will have an energy-sustaining gameplan, attempting to merge with one fighter while fighting the other. When the bandit switches from one fighter to the next, it complicates the fighters' problem, forcing decisions to be made. ***A switch does not necessarily change the roles.*** The redefinition of roles is determined after a switch by the bandit's actions post-merge. Continue to use the engaged fighter criteria, and the bandit's lift vector placement, to determine if a role swap is advantageous or warranted.

The advantage for the bandit in switching is that he is able to pressure the free fighter; the disadvantage in switching is that he is momentarily disregarding the engaged fighter. When switching he is not max performing his aircraft in reference to one or both of the fighters. In switching he is giving up angles and possibly a weapons employment opportunity. The free fighter must maintain his role and responsibilities regardless of the switch. This includes maintaining fighter deconfliction, and controlling the merge to set out-of-plane and out-of-phase flow. The bandit can always choose to do what is best for his gameplan (i.e., continue fighting the original engaged fighter, or choose to engage the original free fighter). Controlling merges may force the bandit to reverse to set the flow he desires, allowing the fighters to better assess the bandit's actions. Controlling merges and forcing desired flow (i.e., out-of-plane/out-of-phase) is the most important concept to be learned in SEM.

If the bandit places his lift vector on the free fighter post-merge, it is time to redefine the roles. If both fighters are tally/visual, the fighters can be aggressive with their gameplan. Sound engaged communication and role adherence will provide the fighters with a timely kill. If a fighter is blind and/or no joy during a switch however, use the appropriate comm to be directive and build SA between the fighters. Lagging the merge may be prudent. Do not stick your nose into a merge without total SA! If blind, the free fighter is typically off the bandit's nose or on his lift vector. If no joy, lag the last known position of the bandit and allow your wingman to build SA and talk your eyes onto the bandit. If both fighters are blind, clear your flight path and lift vector, deconflict via altitude, and KIO.

Two common switches are shown below and are an initial guide. Use the concepts to build your gameplans for varying scenarios.

## 1600. BANDIT ENGAGED NOSE-LOW 2C (FREE FIGHTER ABOVE)

When the bandit is engaged in a 2C fight, he will be striving to gain tally of the free fighter to deny possible shots. If he acquires the free fighter, and is not currently pressured by the engaged fighter, he can easily get his nose up to deny the free fighter's shot, and force a merge. As the bandit switches from low-to-high, his turn rate will suffer greatly and both fighters should capitalize by looking for a weapon employment opportunity. The free fighter must recognize an impending undesirable high-to-low merge and control it appropriately (e.g., try to flatten out the merge). Do not sacrifice sound BFM to set out-of-plane or out-of-phase. If possible, however, the free fighter should strive to bracket the bandit, take out turning room, and have a ***reactionary***

***1C flow mindset***. Bracketing allows the free fighter to better assess the bandit's actions after the merge. Also, if the bandit is bracketed and does engage the free fighter, the bandit must now turn his tail to the engaged fighter. If the free fighter successfully brackets the bandit, and the bandit pulls across the free fighter's tail, the free fighter should reverse to set 1C flow, and swap engaged roles. If the bandit does not pull across the free fighter's tail, the free fighter should still continue in 1C flow, and work to get out-of-phase. The engaged fighter should have been able to transition to OBFM while the bandit merged with the free fighter.

If the free fighter is unable to bracket, his gameplan should not change; however, now the bandit can deny angles from the engaged fighter by pulling across the free fighter's tail. It will also be more difficult to determine who the bandit is engaging since both fighters will be on the inside of the turn.

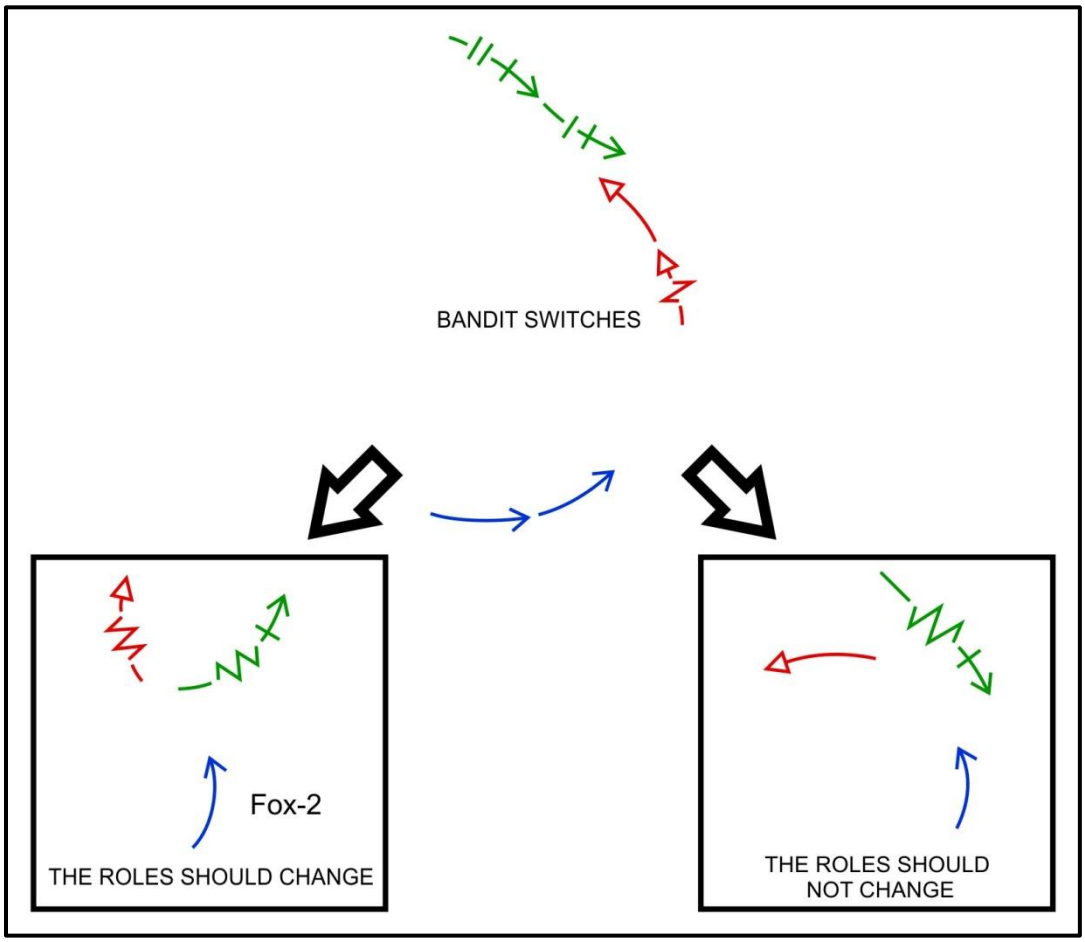


**Figure 16-1 Basic 2C Switch**

## 1601. BANDIT ENGAGED NOSE-HIGH 1C (FREE FIGHTER BELOW)

When the bandit is engaged in a 1C fight, he will be striving to gain tally of the free fighter to deny possible shots. If he acquires the free fighter, and is not about to get shot by the engaged fighter, he has the option of overbanking and getting his nose down to deny the free fighter's

shot opportunity, and force a merge. When the switch is recognized, the engaged fighter should turn in the shortest direction toward the bandit and maneuver for a shot. Vary lift vector placement to control range and angles. The roles have not swapped as of yet so maintain the engaged fighter mindset.

The free fighter should adjust his pull and attitude to control the impending desirable low-to-high merge. If possible, the free fighter should strive to bracket the bandit, take out turning room, and have a reactionary 1C flow mindset. Bracketing the bandit affords all the same benefits as described in the previous section.

Remember to assess the bandit's intentions following the merge, and swap roles if warranted.

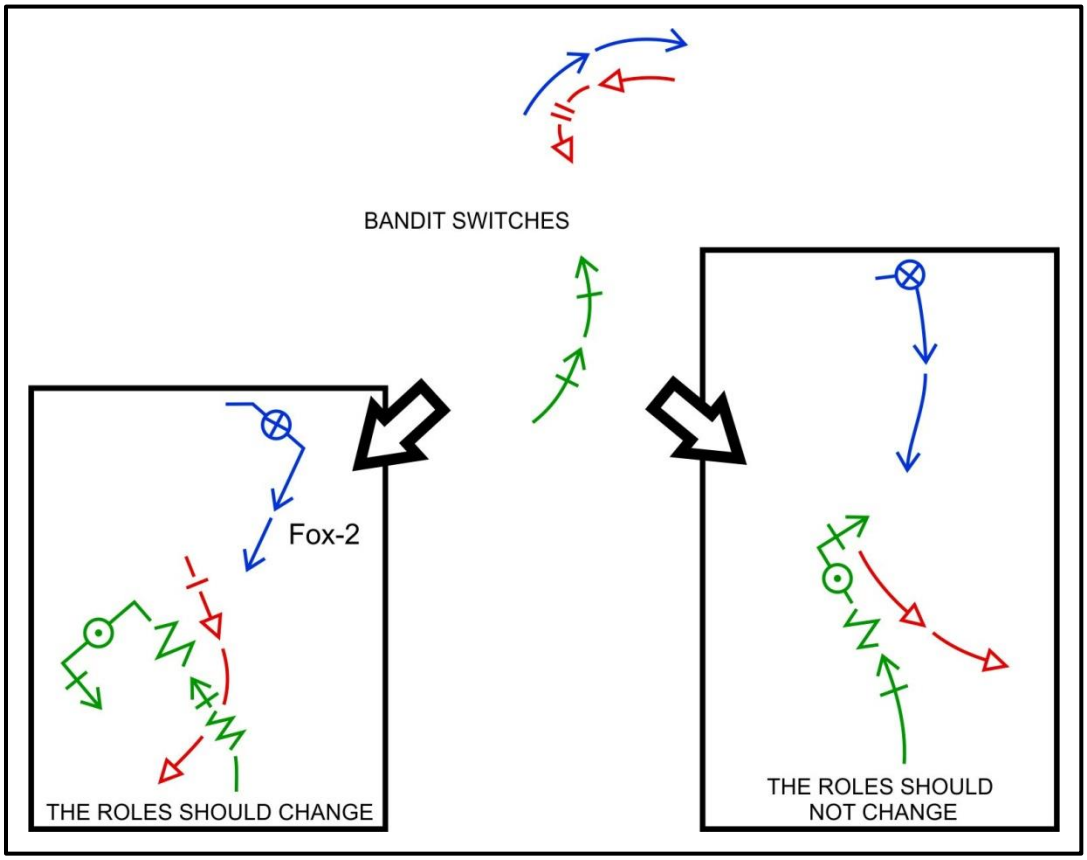


**Figure 16-2 Basic 1C Switch**

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# CHAPTER SEVENTEEN
# SEM CANNED SETS

## 1700. OVERVIEW

The SEM sets will introduce you to a visual pick-up from each quarter. You will begin with three canned sets where the initial pick-up, merge, and bandit move will be known. From there, you will move on to sets where the pick-up and merge will be set, but the bandit move and, therefore, flow will be unknown after the initial merges. Finally, you will finish with the Tap-the-Cap scenario where the bandit will not be handcuffed, and can jump the fighters from any quadrant, leaving all other factors of the fight to be determined.

On your first SEM flight, the engagements will be canned with the fighters knowing who the bandit will engage and the flow of the entire engagement. These "canned sets" provide a foundation for future engagements and reinforce basic engaged/free fighter responsibilities. The purpose of the canned sets is to control the merges and perform the initial moves correctly all the while utilizing effective communication between the fighters. Additionally, they are an exercise for the free fighter to practice shots from out-of-phase flow, and practice the mechanics for maintaining the free fighter role. While time to kill is very important, it is not the most important training objective on the first event. You must know the initial moves and the associated comm cold! Focus your studies on the canned sets and, as your experience grows, try to understand the more advanced concepts talked about in the fighter gameplans chapter.

As you move to your second flight, the engagements will start just like the canned sets. With the canned sets the bandit can engage either fighter after the initial merges. Additionally, if one of the fighters makes a BFM or SEM error, the bandit will be allowed to switch, therefore potentially causing a change in engaged/free fighter roles.

Finally, your SEM training will culminate with the "Tap-the-Cap" exercise, where all that is known to the fighters is which quadrant the bandit will be coming from, in which the bandit can brief or audible real time. Initial merges and follow-on flow are unknown. Tap-the-Cap will require sound formation keeping and a good lookout doctrine. During every engagement, you will utilize SEM fundamentals to achieve a timely kill on the bandit.

> Focus your studies on the canned sets. You are, however, responsible for reading and preparing for ***all*** concepts and possibilities outlined in this FTI, as they may be tested any time after your first flight.

| **SEM 4101** | **SEM 4102** |
|---|---|
| 1. Canned RQ demo x 2 | 1. Canned FQ x 2 |
| 2. Canned RQ x 2 | 2. RQ demo Switch x 2 |
| 3. Canned BQ x 2 | 3. RQ x 1 |
| 4. Canned FQ demo x 2 | 4. BQ x 1 |
| 5. Canned FQ x 2 (if done) | 5. FQ x 1 |
| | 6. TTC demo x 1 |
| **SEM 4103** | **SEM 4201** |
| 1. RQ x 1 | 1. RQ x 1 |
| 2. BQ x 1 | 2. BQ x 1 |
| 3. FQ x 1 | 3. FQ x 1 |
| 4. TTC x 1 | 4. TTC x 1 |

Canned Sets (Known Start/Known Flow):

1. Canned rear quarter

2. Canned beam quarter

3. Canned forward quarter

Unknown Flow Sets (Known Start/Unknown Flow):

1. Rear quarter

2. Beam quarter

3. Forward quarter

Unknown Start/Unknown Flow:

1. Tap-the-Cap

## 1701. CANNED REAR QUARTER SET

The bandit will be 45° AOT, co-altitude, and 1.0 nm from the near fighter. He will then call for the fighters to accelerate to 330 KIAS. When the bandit is ready, he will call set. When the fighters are ready, they will call "speed and angels." The bandit will turn in towards the fighters to arrive nose on within the fighters' rear quarter. The bandit will then initiate the "fight's on" comm. The fighter furthest from the bandit will call for the break turn to initiate the engaged comm. The bandit will present a high-aspect merge (< 1000 ft) with the far fighter after about 120º of turn.

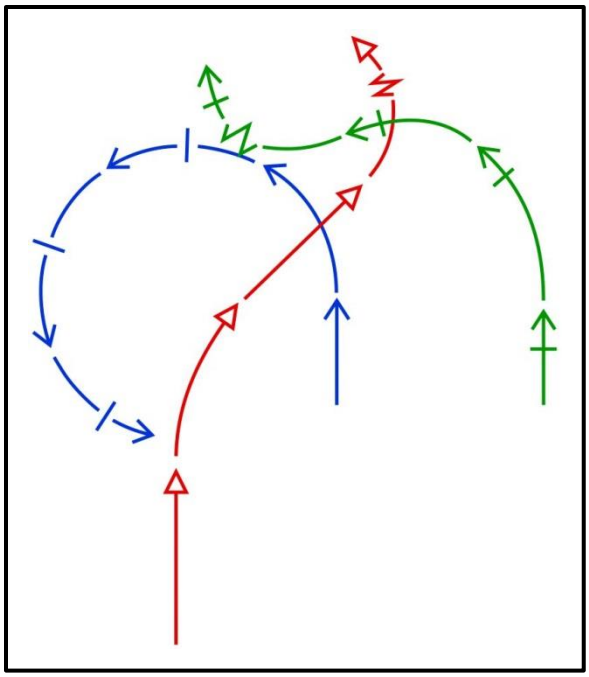


**Figure 17-1 Canned Rear Quarter Initial Moves**

NEAR FIGHTER INITIAL MOVES:

As the near fighter, break level into the bandit. When the bandit lags to your wingman, reset your nose 5-10° nose low, ease to a compromise pull to maintain energy, and assess the bandit's intentions.

FAR FIGHTER INITIAL MOVES:

As the far fighter, make the initial break comm while breaking into the bandit, and assess the bandit's pursuit. If executed well, a good break turn into the bandit will force a high-aspect pass. At the merge, reverse your turn to set nose-high 1C flow away from your wingman. As the bandit follows you nose-high 1C, his lift vector has now dictated that you are ***the engaged fighter***. Communicate your engaged role and use descriptive comm as required to build SA for the free fighter. Continue to fight 1C flow away from your wingman until the free fighter is able kill the bandit. You should always fight your best 1v1 BFM, and take shots if the opportunity presents itself, instead of simply waiting for your wingman to kill the bandit. The bandit may elect to continue the fight for the free fighter's training, however.

FOLLOW-ON FLOW:

As the near fighter, you will see the bandit lag towards your wingman. When the bandit engages your wingman, you are now ***the free fighter.*** Communicate your free role, and adjust your pull to place your lift vector on the bandit, maintain sight and ultimately kill him as he is flowing away from you 1C, engaged with your wingman.

COMM FOR THE CANNED REAR QUARTER SET:

| | |
|---|---|
| Viper 1: | "Viper 1 setting up on Rage 31 for the canned rear quarter set." |
| | "Rage set 330." |
| Rage 31: | "Rage 31" |
| Rage 32: | "Rage 32" |
| Viper 1: | "Viper 1 set." |
| Rage 31: | "Rage 31 speed & angels left." |
| Rage 32: | "Rage 32 speed & angels right." |
| Viper 1: | "Viper 1 in." |

(Viper will maneuver to set the presentation)

| | |
|---|---|
| Viper 1: | "Fight's on." |
| Rage 32: | "Rage break left, tally 1, left 8 o'clock, 1 mile, level, chaff/flares." |
| Rage 31: | "Rage 31 tally 1, chaff/flares." |
| Rage 32: | "Rage 32 Left-to-left" |
| Viper 1: | "Left-to-left" |

(Rage 32 reverses and the bandit engages Rage 32 in 1C flow)

| | |
|---|---|
| Rage 32: | "Rage 32 engaged 1C, nose-high, North, 19,000" |
| Rage 31: | "Rage 31 free." |
| | "Rage 31 Fox-2, kill Goshawk to the West." |
| Viper 1: | "Copy kill, knock-it-off." |
| | "Viper 1, knock-it-off, flow 270" |
| Rage 31: | "Rage 31, knock-it-off, flow 270" |
| Rage 32: | "Rage 32, knock-it-off, flow 270" |
| Rage 31: | "Rage 32, Rage 31 coming out your right 3 o'clock, low" |

| | |
|---|---|
| Rage 31: | "Rage flow 360" |
| Rage 32: | "Rage 32 visual" |

## 1702. CANNED BEAM QUARTER SET

The bandit will be 20° acute, co-altitude, and 2.0 nm from the near fighter when he calls for the fighters to accelerate to 330 KIAS. When the bandit is ready, he will call "set." When the fighters are ready, they will call "speed and angels." The bandit will turn in towards the fighters to arrive nose on at the fighter's beam quarter. At no closer than 1.5 nm to the fighters, the bandit will initiate the "fight's on."

During this set, the bandit is handcuffed to a 2C nose-low gameplan with the first fighter to the merge. The canned nature of this set will handcuff the bandit and engaged fighter to continue 2C flow on the deck.

SECTION MINDSET AND INITIAL MOVES:

The far fighter will call for the section to break left/right 90 to initiate the engaged comm per the fighters' lookout doctrine concept. The fighters will execute a break turn into the bandit. Both fighters will continue their energy excursion until all the turning room has been taken out, and will then ease to a compromise pull to make the merge happen. ***The bandit will merge to the inside of the turn with both fighters,*** and then engage in 2C flow.

This initial geometry leads to a lead/trail formation and defines the initial engaged/free roles for the fighters.

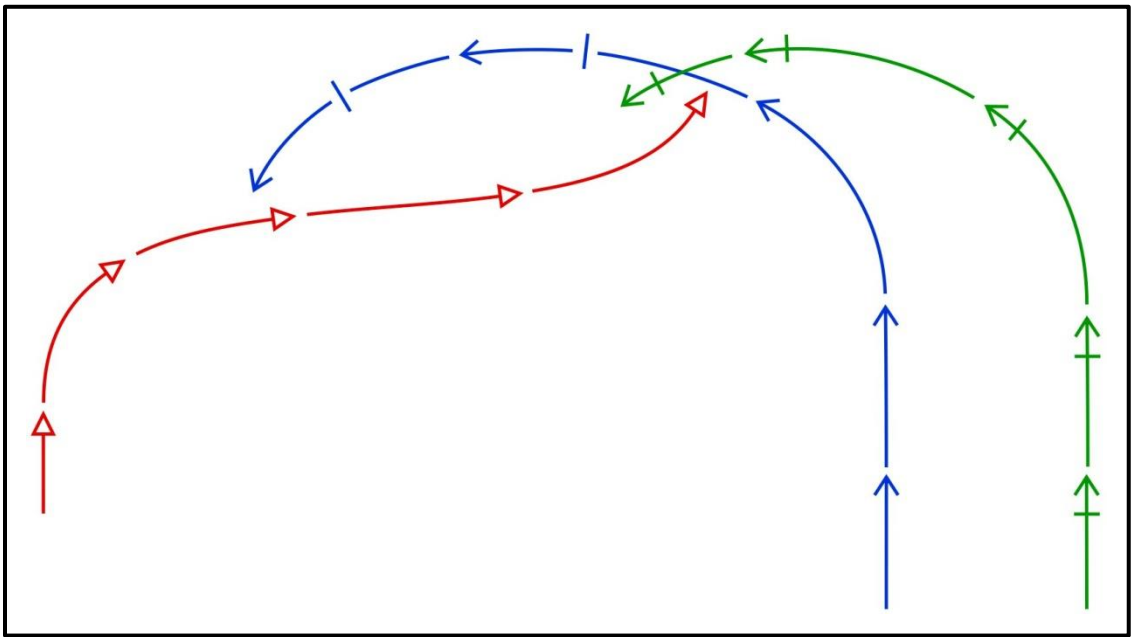


**Figure 17-2 Beam Quarter Setup and Initial Break Turn**

NEAR FIGHTER'S INITIAL MOVES:

The near fighter will be the first fighter to the merge. Often, no discernable merge will occur between you and the bandit, but if you recognize an impending merge that requires ROE, call it in the same transmission as your "chaff/flares" call. More than likely, you will be below vertical airspeed because of your defensive break turn, so after the merge, turn level to slightly nose-low across the bandit's tail, targeting the upper end of the rate band using a compromise pull. Maintain tally and regain visual while you are assessing the bandit's actions. Monitor your wingman's merge and the bandit's engaging move.

FAR FIGHTER'S INITIAL MOVES:

The far fighter will be the second fighter to the merge. While you are in your break turn, watch your wingman's initial move when he merges with the bandit. You will see your wingman pull across the bandit's tail slightly nose-low; after you merge with the bandit, check turn across the

bandit's tail to take out any turning room. Then reverse and execute a nose-high initial move (targeting 60 to 80 degrees nose-high), setting out-of-plane and out-of-phase flow away from your wingman. Use descriptive comm as required to build SA for your wingman. Maintain tally to assess the bandit's reaction.

BANDIT GAMEPLAN:

During this canned set, the bandit is handcuffed to 2C flow with the first fighter he merged with. After the bandit merges with the first fighter, he will honor the second merge and then turn across the second fighter's tail. The bandit will then maneuver nose-low cutting across the circle to merge with the first fighter. This maneuver defines the roles.

ENGAGED FIGHTER MECHANICS (First fighter to the merge):

When the bandit goes nose-low, he will position his lift vector on or below the first fighter he merged with, assumed to be you for the purpose of this discussion. The bandit's lift vector placement now defines the new roles, and you should communicate this appropriately. You are now the ***engaged fighter*** and must execute your best 1v1 BFM (2C fight) while utilizing proper engaged comm. As the bandit attempts an out-of-plane maneuver by cutting across the bottom of the circle, you must react and counter by going nose-low with him. After each merge, continue 2C flow. If possible, take any shots available, but do not call them. Finally, if possible, attempt to gain a visual of your wingman above to increase your SA but not at the risk of committing a BFM error. Fight your best 1v1!

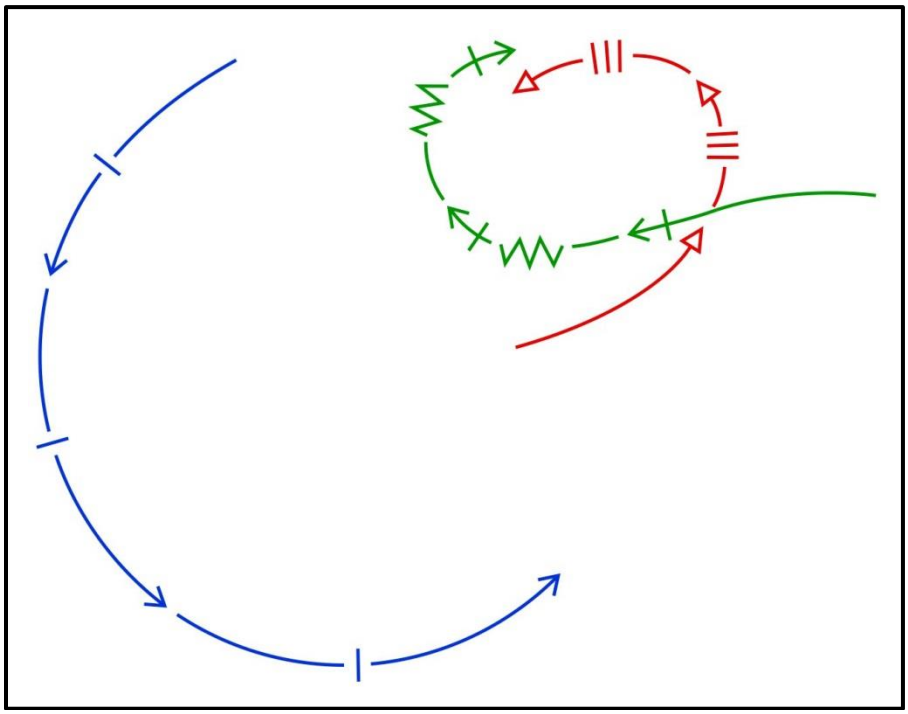


**Figure 17-3 Canned Beam Quarter Initial Moves**

FREE FIGHTER MECHANICS (Second fighter to the merge):

For the purposes of this discussion, we will assume that you are now the second fighter to the merge. After the bandit goes nose-low and engages your wingman, you have now become the ***free fighter*** and should adjust your lift vector to manage vertical separation. Maintain tally during your initial nose-high maneuver. You will see that the bandit did not go nose-high with you and is engaging your wingman. Reorient your lift vector as required to set/maintain out-of-phase, 1C flow. After about 180° of turn, your first shot opportunity will be a forward quarter shot. When you see the bandit cross-circle from you (approximately ninety degrees target aspect), roll and place your lift vector on him and pull. Perform an energy excursion for the shot. You will find yourself in a nose-low attitude, so, after the shot, roll wings level and pull to stay at least 1,000-2,000 feet above the fight. Remember, as the free fighter you are responsible for deconfliction. Call your shot and kill appropriately. Your decisions to achieve a valid shot and stay deconflicted will be tested.

If at any time you lose sight of the engagement, communicate with your wingman to regain SA and stay above 12,000 feet. ***Whatever happens, do not stick your nose into a fight without having two in sight.***

COMM FOR CANNED BEAM QUARTER SET:

| | |
|---|---|
| Viper 1: | "Viper 1 setting up on Showtime 51 for the canned beam quarter set." |
| | "Showtime set 330." |
| Showtime 51: | "Showtime 51" |
| Showtime 52: | "Showtime 52" |
| Viper 1: | "Viper 1 set." |
| Showtime 51: | "Showtime 51 speed & angels left." |
| Showtime 52: | "Showtime 52 speed & angels right." |
| Viper 1: | "Viper 1 in" |

(Viper will maneuver to set the presentation)

| | |
|---|---|
| Viper 1: | "Fight's on." |
| Showtime 52: | "Showtime break left 90, tally 1, left 9 o'clock, 1 mile, level, chaff/flares." |
| Showtime 51: | "Showtime 51 tally 1, chaff/flares" |
| Showtime 52: | "Showtime 52 left to left." |
| Viper 1: | "Left to left." |

(When the bandit engages Showtime 52 in 2C flow)

| | |
|---|---|
| SE 51: | "SE 51 engaged left 2C nose low" |
| SE 52: | "SE 52, free" |
| SE 52: | "SE 52 Fox-2, kill Goshawk neutral in the South" |
| VR 1: | "Copy Kill, knock-it-off" |
| | "VR 1, knock-it-off, flow 320" |
| SE 51: | "SE 51 knock-it-off, 320" |

SE 52: "SE 52 knock-it-off, 320"
"SE 51, SE 52 is coming out your left 8 o'clock, high"
SE 51: "SE 51 Visual"

## 1703. CANNED FORWARD QUARTER SET

The bandit will be directly abeam, co-altitude, and 2.0nm from the near fighter. He will call for the fighters to accelerate to 330 KIAS. When the bandit is ready, he will then call set. When the fighters are ready, they will call "speed and angels." The bandit will direct the fighters to tac turn into him and provide a flow heading. When the near fighter starts his turn, the bandit will also begin to turn in towards the fighters to arrive nose on within the fighters' forward quarter. The bandit will call "fight's on." ***It is imperative that the far fighter completes his tac turn prior to engaging the bandit.*** The fighters will flow to bracket the bandit while the near fighter begins the engaged comm. For safety of flight, the fighter wing should descend in the tac turn to arrive co-altitude with the fighter lead no later than rolling out on the final heading.

BANDIT GAMEPLAN:

After turning in and calling "fight's on," the bandit will merge with the near fighter. After this merge, the bandit will turn and try to merge with the far fighter while engaging him in 2C flow.

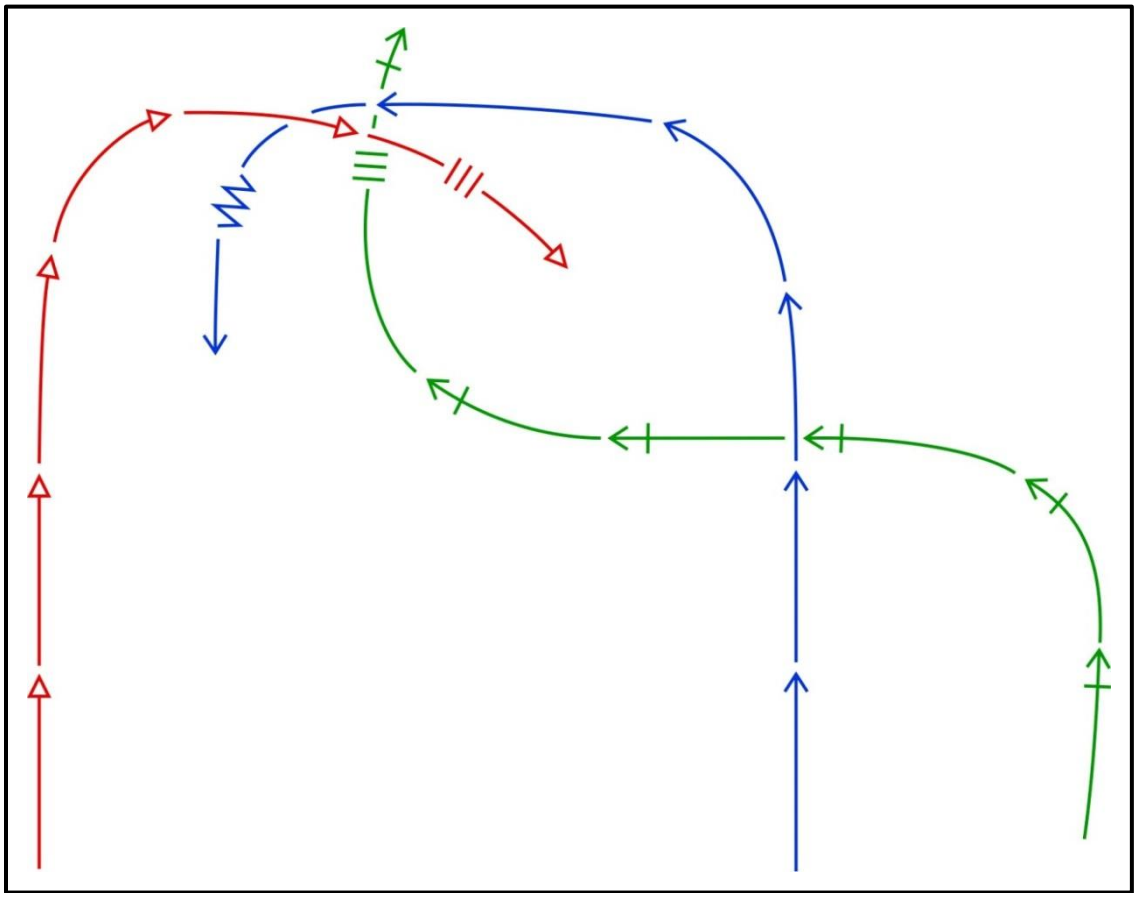


**Figure 17-4 Forward Quarter 2C Initial Moves**

FIRST FIGHTER TO THE MERGE INITIAL MOVES:

Let's assume you are the near fighter. "First guess" roles define you as the ***initial engaged fighter***. You should merge with the bandit and then maneuver pure nose-high, 1C (lift vector in lead). Monitor your wingman's merge and assess the bandit's actions. After the bandit engages your wingman in 2C flow, you should assume the role and responsibilities of the ***free fighter***.

SECOND FIGHTER TO THE MERGE INITIAL MOVES:

If you are the second fighter to the merge, you should tighten down the merge to take out turning room or gain an offensive advantage at the merge. While you, as the far fighter, are trying to be aggressive and take out turning room, ***your primary responsibility at this merge is flight deconfliction!*** If performed correctly, the first fighter to the merge will be maneuvering nose-high in your direction. Assuming the first fighter to the merge maneuvers as described above, you should turn across the bandit's tail to set out-of-plane and out-of-phase flow. The bandit's lift vector placement has now identified you as ***the engaged fighter***. Communicate your role accordingly, and execute your best 2C fight.

COMM FOR CANNED FORWARD QUARTER SET:

| | |
|---|---|
| Viper 1: | "Viper 1 setting up left of the section for the canned forward quarter set." |
| | "Shield set 330." |
| Shield 81: | "Shield 81" |
| Shield 82: | "Shield 82" |
| Viper 1: | "Viper 1 set." |
| Shield 81: | "Shield 81 speed & angels left." |
| Shield 82: | "Shield 82 speed & angels right." |
| Viper 1: | "Shield tac left flow 330." |
| Shield 81: | "Shield 81 330" |
| Shield 82: | "Shield 82 330" |

(Viper will maneuver to set the presentation)

| | |
|---|---|
| VR 1: | "Fight's on" |
| SD 81: | "SD 81, tally 1, 12 o'clock, 1 mile, level, left-to-left" |
| VR 1: | "VR 1 Left-to-left" |
| SD 82: | "SD 82, tally 1" |

(When the bandit engages Shield 82 in 2C flow)

| | |
|---|---|
| SD 82: | "SD 82 engaged right, 2C, 15,000" |
| SD 81: | "SD 81, free" |
| | "SD 81 Fox-2, kill Goshawk defensive coming through East" |
| VR 1: | "Copy kill, knock-it-off" |
| | "VR 1 knock-it-off, flow 310" |
| SD 81: | "SD 81, knock-it-off, flow 310" |

| | |
|---|---|
| SD 82: | "SD 82, knock-it-off, flow 310" |
| SD 81: | "SD 82, SD 81 is coming out your right 3 o'clock, high" |
| SD 82: | "SD 82, Visual" |

(When the bandit engages Shield 82 in 2C flow)

| | |
|---|---|
| Shield 82: | "Shield 82 engaged right, 2C, 15,000." |
| Shield 81: | "Shield 81 free." |
| | "Shield 81 Fox-2, Kill Goshawk in right turn coming through East." |
| Viper 1: | "Copy kill." |
| Free fighter IP: | "Knock-it-off." (when deconfliction is resolved) |
| Viper 1: | "Viper 1 knock-it-off." |
| Shield 81: | "Shield 81 knock-it-off." |
| Shield 82: | "Shield 82 knock-it-off." |

| | |
|---|---|
| Shield 81: | "Shield flow 090" |
| Shield 82: | "Shield 82 090" |

# CHAPTER EIGHTEEN
# ADVANCED SETS (UNKNOWN FLOW)

## 1800. OVERVIEW

Now that you have learned the basic fundamentals and studied the flow for the canned sets, we will discuss some more advanced sets. The initial set-up for these scenarios and initial merge geometry will be exactly the same as the canned sets. After the initial tallies/follow-on merges however, the bandit will be able to choose which fighter he will engage. The bandit will also have the luxury of being able to switch between fighters if one of them makes a BFM error, or if he is not being pressured by the engaged fighter.

The fights will continue until the bandit calls, "copy kill." Don't be caught off guard if the bandit calls "$P_k$ continue" after your shot as the free fighter. Always be thinking about follow-on flow, and deconfliction while you take your shots.

## 1801. REAR QUARTER (UNKNOWN)

This set has a canned setup just like the previous canned rear quarter set. After the "fight's on" call, the far fighter will call for the break turn to initiate the engaged comm, at which time both fighters will execute a break turn into the bandit, and assess the bandit's intentions. The bandit will merge with the far fighter in a high-aspect pass, if that fighter performs a good break turn to deny angles. When the far fighter creates a high-aspect pass, he should try to set 1C flow away from his wingman. The flow will look familiar to the canned RQ set if the bandit engages 1C. If the bandit goes aggressively nose-low however, the far fighter is now free because the bandit is engaging the original near fighter.

## 1802. BEAM QUARTER (UNKNOWN)

This set begins similarly to the canned beam quarter set. After the "fight's on" call, the far fighter will call for the break turn to initiate the engaged comm. The fighters will execute a break turn into the bandit. Both fighters will continue their energy excursion until all the turning room has been taken out, and then ease to a compromise pull to make the merge happen. ***The bandit will merge to the inside of the turn with both fighters.***

After the bandit merges with the far fighter, he will choose which fighter to engage. The fighters will not know ahead of time who the bandit will engage. Both fighters must watch diligently to see where the bandit places his lift vector. If the bandit pulls level or nose-low, his lift vector has determined that the first fighter to the merge will be engaged. If, after the second merge, the bandit reorients his lift vector up, then the second fighter to the merge who went nose-high is now engaged. Communicate the roles accordingly, and execute the fighter's beam quarter visual pick-up gameplan.

## 1803. FORWARD QUARTER (UNKNOWN)

This set will begin exactly the same as the canned forward quarter set. After the bandit calls for

the fighters to tac turn into him, he will initiate the "fight's on" call. The near fighter will initiate the tally, and ROE comm. At the initial merge, the near fighter should go nose-high, and set 1C flow. The far fighter should deconflict from his wingman's merge, but also attempt to get an aggressive bite on the bandit. After the far fighter merges, he should pull across the bandit's tail and set nose-low 2C flow. The bandit will have the option to choose which fighter to engage. Watch for the bandit's intentions, and communicate the roles appropriately.

## 18-2 ADVANCED SETS (UNKNOWN FLOW)

# CHAPTER NINETEEN
# TAP-THE-CAP

## 1900. OVERVIEW

In the FRS and fleet, Tap-the-Cap is often used to train and test the fundamentals of section engaged maneuvering by limiting what is known about the bandit's location and intentions. The fighters must be able to apply visual mutual support and lookout doctrine to this environment and immediately react to a threat. A thorough understanding of the mechanics, communication, and initial moves for each visual pick-up is imperative to success. Apply sight pictures and fundamentals familiar to you from the known starts to achieve the kill.

## 1901. BLOCKS

Once the fighters are visual of each other, the bandit will detach. Blocks will be utilized to deconflict forces until required SA is gained, per training rules. The fighters will be in the 14,000 to 17,000-foot block, and the bandit will be in the block immediately above, or below the fighters. Should circumstances dictate (e.g., inclement weather), the bandit may modify the blocks during the course of the event in the name of safety. Both fighters must acknowledge the new blocks verbally over the radio, reading them back specifically. Being out of your block is a serious Training Rule violation; even 20 feet high or low is ***unacceptable***. It is prudent to give yourself at least two to three hundred feet of buffer from the bottom or top of the block. As fighter lead, this is also true of your wingman, so take his position into consideration once established in the block. Finally, a fighter cannot leave his own block until after the "fight's on" call, ***and*** tally/visual. The bandit may be above, or below the fighters, but must have two in sight in order to be in the fighters' block. Maneuvering within your block is acceptable. Good headwork applies when a high SA fighter is directing a low SA fighter's movements.

Once cleared off, the fighters will maneuver to get into their block in a timely manner. Establishing deconfliction early is prudent should the bandit lose sight.

## 1902. CAP LOCATION

Once the fighters are visual of each other, the bandit will detach himself to setup his presentation. The fighter lead will call on/off heading shackles, check turns, tac turns, and in-place turns to maneuver the fighters towards the center of the working area. There is no specific starting point, or cap to maintain. A pre-briefed point can be used as a "get well" point should the bandit lose sight. At any time the bandit may call standby or recommend flow headings to aid in presentation setup. But it is the responsibility of the fighter lead to maneuver the section.

## 1903. FORMATION KEEPING

The tac wing should use small airspeed changes to stay in position. Overly aggressive maneuvering increases pilot workload leading to a less efficient scan, making it harder to detect a threat. If the tac wing is out of position before a turn, the fighters should work together to fix the position error. If the tac wing is grossly out of position following a turn, a shackle may be used. In the end, it is the responsibility of the wingman to fly disciplined formation, striving to be directly abeam lead to maximize visual mutual support. The fighters should utilize the concepts discussed in the

"form – sensor – comm" chapter to gain early tallies, and avoid defensive scenarios.

## 1904. FIGHT INITIATION

The bandit will call "Anvil set 330" and when ready, he will call "Viper 1 set." After the bandit's set call, the fighter lead will initiate the speed and angels call for the section. The fight will start with a "fighter's set" call made by the fighter lead. "Speed and angels" in TTC assumes the following:

- Visual.
- DCS at 330 KIAS.
- In the fighter block.

Following the set calls, the bandit will initiate the "tape's on, fight's on" with the tac lead echoing the "tape's on, fight's on."

At any time the bandit may be directive with the fighters to expedite the flow or to set a specific presentation. Follow the bandit's instructions and keep your eyeballs out of the cockpit. The bandit will use a "threat" call in the BRAA format (Bearing, Range, Altitude, Aspect) to bias the fighters' scan in order to set a presentation (e.g., "Rage, threat, left nine o'clock, low, hot, hostile" or "Rage threat BRAA 120, 5, high, hot, hostile").

Resetting the Fight:

Each engagement will end with a KIO. The bandit will detach himself to set up the next presentation. Once everyone is reset, the fight will initiate just like before.

Tap-the-Cap Comm Flow:

Once the fighters are visual each other:

Viper 1: "Viper detaching for an FQ Tap-the-Cap."
Anvil 11: "Anvil."

Anvil 11: "Anvil Tac left."
Anvil 12: "Anvil 12."

VR 1: "Anvil set 330"
"VR 1 set"
AL 11: "AL 11, speed and angels left"
AL 12: "AL 12, speed and angels right"
AL 11: "Fighters set, fight's on"
VR 1: "Fight's on"

(As required to gain SA):
Anvil 11: "Bluetail Picture."
Viper 1: "Anvil 11, Bluetail, Threat, BRAA 090, 5 low, hot, hostile."

(Once tally):
Anvil 11: "Anvil hard left 090."
Anvil 12: "Anvil 12 090, tally one, left 10 o'clock, 2 miles, level."
Anvil 11: "Anvil 11 tally."

## 1905. SECTION ENGAGED MANEUVERING TRAINING OBJECTIVES

1. 100% Training Rule adherence

2. Tactical formation:

    a. Visual mutual support/lookout doctrine

    b. Setup adherence

3. Minimize time to kill

4. Sound BFM execution:

    a. 100% valid shots

    b. Clear field of fire

    c. Proper shot/kill removal comm

    d. Controlling merges

    e. Avoid becoming defensive

5. Work out-of-plane and out-of-phase flow when appropriate:

    a. Capitalize on BFM errors presented by the bandit because of out-of-plane/out-of-phase

    b. Don't become defensive just to set out-of-phase

    c. Re-evaluate flow, when required, to best set out-of-plane/out-of-phase

6. Efficient/effective engaged communication

    a. Establishment of roles

    b. Role responsibility adherence

    c. Maintain tally/visual

7. Correctly assess the environment and adapt

    a. Recognize switches

    b. Maneuver and communicate changes in the fight appropriately

## 1906. COMMON SECTION ENGAGED MANEUVERING ERRORS

1. Poor engaged communication
2. Improper mechanics and decisions leading to in-phase and/or in-plane maneuvering
3. Poor 1v1 decisions resulting in a defensive situation
4. Poor 1v1 mechanics and decisions
5. Employing weapons without a clear field of fire
6. Wide/poor merge mechanics
7. Controlling merges poorly
8. Failure to maintain SA post shot by free fighter.
9. Poor switch SA and mechanics
10. Lost sight
11. Poor recognition of role reversals

# APPENDIX A
# GLOSSARY

## A100. GLOSSARY

**Admin Lead:** The flight lead.

**Anchored:** Orbiting or engaged in a certain point in space.

**Angels:** Altitude of aircraft in thousands of feet.

**Angles Off Nose (AON):** Angular difference between the offender's twelve o'clock (longitudinal axis), and the defender's position. The offender looking at you directly nose-on would be zero degrees AON.

**Angles Off Tail (AOT):** Angular difference between the defender's extended six o'clock (longitudinal axis), and the offender's position. Directly behind the defender would be zero degrees AOT.

**AOB:** Angle of bank.

**Arcing Turn (Arc):** A turn executed at less than the optimum rate of turn, or an extension maneuver executed other than in a straight line.

**Aspect:** Angular description of an aircraft in reference to your current position.

**Attack Window:** A piece of sky located aft of the defender's post where, if an attacking aircraft max performs at the right time, he will arrive in the defensive aircraft's CZ with RAC under control.

**Bandit:** Aircraft identified as an enemy.

**BFM:** Basic fighter maneuvering (synonymous with air combat maneuvering for our purposes).

**Belly Check:** Changing AOB on the aircraft to check areas masked from view by your own aircraft.

**Beyond Visual Range (BVR):** Situation where an intercept through radar or GCI identifies a group that is beyond the visual ACM arena.

**Blind:** Call from fighter meaning, "I do not see my lead/wingman/friendly."

**Bogey:** Unidentified air contact.

**Bracketing:** Forcing the bandit to pass head-on between the section of fighters.

**Break Turn Exercise:** A 9,000 ft Perch set where the offensive fighter begins his attack 9,000 ft away from the defensive aircraft.

**Bubble:** A representation of an aircraft's turn circle, in all three dimensions, if max performing at the aircraft's current energy state.

**Bug Out (verb):** To disengage from ACM in order to exit safely from the fight; also, bugout (adj.; noun).

**Check Left/Right (Degrees):** To alter heading any number of degrees to the left or right.

**Combat Air Patrol (CAP):** The area of responsibility when a section is on patrol.

**Control Zone (CZ):** A cone-like area, 2,000 ft to 4,000 ft behind a maneuvering aircraft, 20 degrees wide at the front to 40 degrees wide on the back side, centered on the aircraft's flight path where if an attacking aircraft arrives with angles and closure under control, the defensive aircraft can do nothing to deny him positional advantage.

**Corner(ing) Airspeed:** The airspeed at which the lift limit meets the load limit (410 KIAS @10,000 ft); this airspeed provides the best instantaneous turn rate, at the highest bleed rates.

**Daisy Chain:** An unfavorable situation where three or more aircraft are turning in phase, in the same plane.

**Degrees to Go:** The number of degrees of turn that an offensive aircraft has to turn in order to enter a suitable weapons envelope.

**Displacement Roll:** An offensive maneuver used to reduce excessive closure while displacing the aircraft to a different plane of maneuvering; used in low- to medium-AOT, and medium-range situations.

**(The) Egg:** A three-dimensional oval showing the effects of gravity on an aircraft maneuvering in all three planes.

**Energy Package:** The combination of the aircraft's altitude (potential energy) and airspeed (kinetic energy), establishing the aircraft's total energy.

**Energy Rate Deck Transition:** Trading available altitude for airspeed as a result of low fuselage alignment (neutral fight); reference the "ten percent rule."

**Engaged Fighter:** In multi-plane engagements, the aircraft that is fighting an aggressive 1v1 against the bandit; the bandit's lift vector placement will determine which fighter is engaged.

**Engaging Turn:** An efficient combination of turn rate and radius that maintains energy.

**Engaging Turns:** The type of turns used by a section to engage an enemy contact, i.e., tac turns (both into and away), in-place turns, and cross turns.

**Extension:** A maneuver performed to achieve either range and/or angular separation to employ weapons or exit an engagement.

**Eyeball:** Identifies the fighter who has a tally/radar contact, and will take the bandit close aboard to obtain visual identification (VID) in section forward-quarter tactics.

**Feet Dry/Wet:** Flying over land or water.

**Flat Scissors:** Defensive maneuver used to take advantage of an attacker's horizontal overshoot; also results from the flattening of rolling scissors, most likely due to deck proximity.

**Flight Path:** The imaginary arc that an aircraft scribes in the sky. The aircraft's velocity, G, and LV placement determine the geometry of the flight path. An aircraft that is straight and level has a straight flight path while one in a hard break turn has a very dynamic flight path. The smoke from an aircraft's engine is an excellent indication of an aircraft's flight path.

**Flow (1C/2C):** When two aircraft meet head-on, one of two types of flow is established in a turning fight after the merge occurs. If, after the merge, both aircraft turn across each other's tail, the flow is said to be "2C" because each aircraft is still on its own distinct turn circle. Both aircraft will be turning the same direction, i.e., both in a left-hand turn; note that in 2C flow, the two aircraft are fighting nose-to-tail. If, at the merge, one aircraft reverses towards the other aircraft, the flow is now said to be "1C" because both aircraft are now on the same turn circle but in opposite directions, i.e., one is turning left, the other is turning right. This is described as a nose-to-nose fight.

**FOX-2:** A call indicating the release of an IR (heat-seeking) guided missile made by the aircraft releasing the missile.

**Free fighter:** In multi-plane engagements, the aircraft that is able to maneuver to achieve a shot while not having to aggressively counter the attacker.

**Group:** An airborne contact that may be composed of one or more aircraft.

**Guns:** Rear-quarter steady state or snap guns firing solution.

**Hard Turn:** Compromise between a maximum rate turn and energy conserving turn (17 units AOA), typically, the nibble of buffet.

**Heads Up:** Call indicating that an "enemy got through," or "I am not in position to engage target."

**High Yo-Yo:** Offensive maneuver designed to hold or increase range by decreasing closure rate and opening nose-to-tail in low-to-medium angle off situations.

**Intentions (in terms of ACM training rules):** This term is used to ensure we have deconflicted flight paths when two aircraft are converging (e.g., "Hawk 1, High/Low/Left/Right").

**Joker:** Fuel state above Bingo fuel which allows for two minutes at MRT, which would allow a successful bugout, normally transmitted to notify lead/wingman.

**Knock-it-off:** Call made to stop the fight or current maneuvers.

**Lateral Pitchback:** A defensive maneuver used after a bug or separation maneuver to re-engage. Usually started at high airspeeds, the fighter performing a lateral pitchback will roll to place the LV on or slightly above the horizon, and then execute a 19-21 unit pull to bleed down to tactical turn rate airspeed, while taking away as many angles as possible while the attacker is outside the bubble.

**Lateral Separation:** Lateral distance between two aircraft.

**Lift Vector:** The vector created through the production of lift, perpendicular to the wingplane; the vector extends vertically, perpendicular to your waterline. If straight and level, it would point pure vertical. Picture yourself looking directly up and through the MDC on the canopy; used to define pursuit curves when in a different plane of motion from the adversary.

**Line of Sight (LOS):** An imaginary straight line from the fighter's eye to the bandit's aircraft.

**Low Yo-Yo:** An offensive maneuver designed to decrease range and angles by increasing closure rate, typically through the use of out-of-plane maneuvering.

**Lufberry:** Horizontal or slightly oblique, stalemate-type engagement where both aircraft are across the circle from each other, turning in the same direction at a low energy state, typically on the deck.

**Merge:** RADAR tracks have come within three nautical miles of each other; in the visual arena, used to describe two aircraft coming to a close-aboard pass.

**No Joy:** Call made meaning "I do not see the bandit/bogey."

**Nose-to-Tail:** Reference to the distance between the nose of an attacker and the tail of the defender. It is used synonymously with range.

**1C Flow:** An engagement between two aircraft that are turning nose-to-nose, through opposite AOB. This fight is referred to as a "radius fight" since the aircraft with the smallest turn radius is likely to achieve the advantage.

**Overshoots:** Flight path - occurs anytime the offensive aircraft flies through the defensive aircraft's flight path, at or aft of the defensive aircraft's 3/9 line.

3/9 Line - occurs anytime the attacker flies from aft of the defender's 3/9 line, to in front of the defender's 3/9 line (i.e., flushing out in front).

**Out-of-Plane Maneuvering (OOP):** Anytime your aircraft is maneuvering out of the plane of motion with respect to your opponent's plane of motion (> 45 degrees).

**Padlocked:** Call meaning I have a tally and cannot take my eyes off the bandit, or I will lose contact due to visibility/range, etc.

**Parrot:** The IFF equipment. "Strangle your Parrot" means turn off your IFF.

**Pigeons:** Magnetic bearing and distance of home base (or unit indicated).

**Plane of Motion (Plane of Turn):** The flat plane of the turning circle. An aircraft's plane of motion is generally determined by assessing nose attitude and lift vector placement, or more simply put, the two-dimensional plane the aircraft is currently scribing.

**Positional advantage:** Describes one aircraft is aft of his opponent’s 3/9 line. A combination of angular advantage (i.e., less than 180-degrees of turn) to your opponent's flight path on the same heading, with 3/9 line advantage, and/or lateral turning room.

**Positional Deck Transition:** Trading available altitude for angles due to high fuselage alignment between defender and bandit (i.e., very defensive).

**Post:** The center of an aircraft's turn circle.

**Pursuit Curves:** Pursuit curves are based on the nose position when in the adversary's POM and the LV placement when not in the adversary's POM:

Lead – pointing in front of the adversary.

Pure – pointing at the adversary.

Lag – pointing behind the adversary.

**Radius Fight:** See 1C flow.

**Range:** Linear distance between two aircraft stated in nm or feet.

**Rate Fight:** See 2C flow.

**ROE:** Rules of Engagement. This term is used to ensure we have deconflicted flight paths when two aircraft are converging. e.g., "Hawk 1, High/Low/Left/Right."

**Rolling Scissors:** Resulting fight with a series of horizontal and vertical overshoots with both aircraft in each other's bubble, and neither fighter has energy to use the pure vertical.

**State:** Fuel remaining in thousands of pounds.

**Shackle:** Turn made to redress the section by crossing one member to other side, thus reassuming proper combat spread position.

**Shooter:** As applied to section forward-quarter tactics, the fighter who pulls for a shot while his wingman (eyeball) passes close aboard the bogey to visually identify (VID) the bogey as hostile (bandit).

**Situational Awareness (SA):** A person's perception of reality and how it reflects actual reality.

**Skip It:** Call made to indicate, "do not attack" or to "cease attack/intercept." In general, the offensive aircraft (shooter) owns in and down and the defensive aircraft (target) owns up and away from the merge.

**Slice Turn:** A hard turn with minimal energy/speed bleed, performed by rolling to place the lift vector below the horizon at some oblique angle and tightening the pull.

**Snap Shot Drill:** Exercise designed to develop the skill of maneuvering into a snap guns solution, and firing on a moving adversary.

**Snap Guns:** A non-tracking guns solution, targeting 60-90 degrees AOT, at a range of 1,000 ft to 1/2 mile.

**Speed and Angels:** A call made prior to an engagement to signify that the aircraft is in parameters to start the maneuver. Assumes for all engagements, with the exception of TTC, that all aircraft are in sight. This call will be made only when the aircraft is within the following parameters for the engagement:

+/- 100 ft altitude

+/- 0.1 miles

+/- 10 kts

+/- 10 degrees

**Steady:** Call meaning "I am on prescribed heading."

**Steer:** Call meaning to "fly heading indicated."

**Tac (Tactical) Lead:** Member of the flight having the most SA, and is responsible for directing the section's maneuvers. Note: this may not always be the admin lead.

**Tac Wing**: Member of the section not acting as the tac lead; assumes the role and

responsibilities of the wingman.

**Tally:** Call meaning "a bandit/bogey visually sighted."

**Three/Nine Line (3/9 Line):** A line drawn through the aircraft, perpendicular to the longitudinal axis through the aerodynamic center, which determines whether an opponent is in front of or behind that aircraft.

**Ten Percent Rule:** Used in any deck transition as an aid to avoid hitting the deck. Use 10% of altitude available above the deck to determine max nose-low depression (i.e., 4000 ft above deck = 40 deg nose low, 3000 ft above deck = 30 deg nose low, etc.).

**Track Crossing Angle (TCA):** Angular difference in velocity vectors at any instant. (See also "Angle Off" for distinction.)

**Track Crossing Rate:** The speed at which the opposing aircraft appears to move across the fighter's canopy.

**Turn Circle:** The circle scribed by an aircraft's turn as it moves through the sky. The radius of this turn circle is constantly changing depending upon the "G" and velocity of the aircraft. We will generally discuss turn circle based on a generalized maximum performance turn as having a 3,000-ft radius, or 6,000-ft diameter.

**Turning Room:** Any separation that exists between two aircraft.

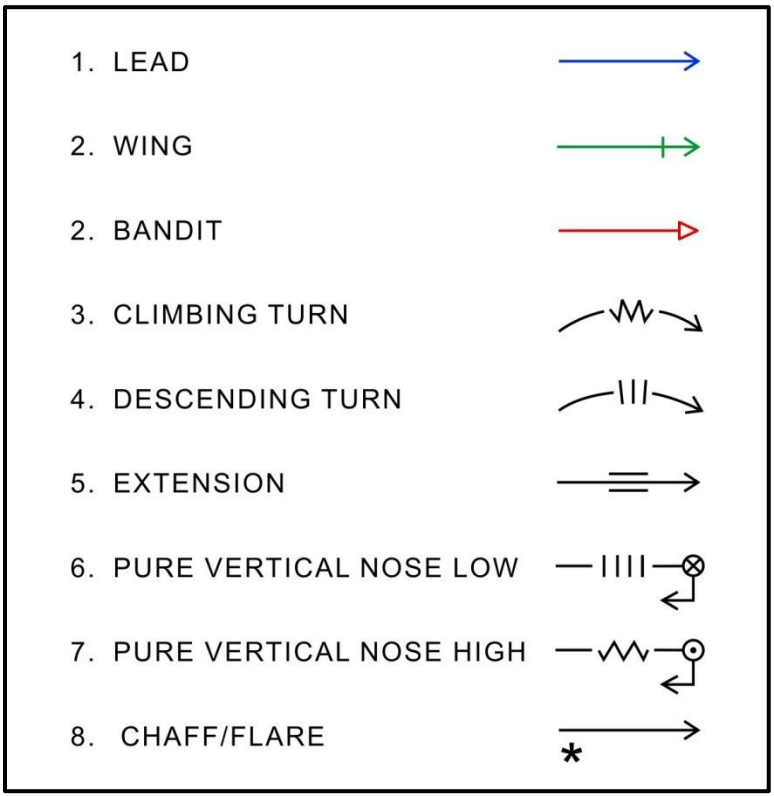
**2C Flow:** An engagement between two aircraft that are turning nose-to-tail through the same direction of turn. This is referred to as a rate fight because the aircraft with the faster rate of turn is likely to achieve the advantage.

**Vertical 3/9 Line:** Line extending vertically 180 degrees out from the force of gravity, used to define the horizontal overshoot when in a different plane of motion from the adversary (e.g., when to execute the corkscrew/pirouette maneuver in a rolling scissors).

**Visual:** Call meaning “wingman is in sight.”

## A101. SYMBOLOGY

You will see and use the following symbols in diagramming a BFM engagement.



## APPENDIX B
## ACRONYM GLOSSARY

**1C:** One-Circle

**2C:** Two-Circle

**ACM:** Aerial Combat Maneuvering

**AGL:** Above Ground Level

**AGSM:** Anti-G Straining Maneuver

**AIM:** Air Intercept Missile

**ALOC:** Almost Loss of Consciousness

**AOA:** Angle of Attack

**AOB:** Angle of Bank

**AON:** Angle off Nose

**AOT:** Angle off Tail

**ATC:** Air Traffic Control

**AW:** Attack Window

**AWE:** Attack Window Entry

**BFM:** Basic Fighter Maneuvering

**BQ:** Beam Quarter

**BRAA:** Bearing, Range, Altitude, Aspect

**BVR:** Beyond Visual Range

**CNATRA:** Chief of Naval Air Training

**CV:** Carrier

**CZ:** Control Zone

**DBFM:** Defensive Basic Fighter Maneuvering

**DBT:** Defensive Break Turn

**DCS:** Defensive Combat Spread

**DME:** Distance Measuring Equipment

**E-M:** Energy-Maneuverability

**EA:** Electronic Attack

**EBC:** Eyeball Calibration

**EGT:** Exhaust Gas Temperature

**EP:** Emergency Procedures

**ERDT:** Energy Rate Deck Transition

**FOV:** Field of View

**FQ:** Forward Quarter

**FRS:** Fleet Replacement Squadron

**FTI:** Flight Training Instruction

**G-LOC:** G-induced Loss of Consciousness

**G:** Gravity

**HABFM:** High Aspect Basic Fighter Maneuvering

**HUD:** Heads-Up Display

**IAW:** In Accordance With

**ICFPOS:** In-Close Flight Path Overshoot

**ICS:** Intercom System

**IFR:** Instrument Flight Rules

**IP:** Instructor Pilot

**IR:** Infrared

## B-2 ACRONYM GLOSSARY

**KIAS:** Knots Indicated Airspeed

**KIO:** Knock-It-Off

**LAC:** Lead Angle Computing

**LAR:** Launch Acceptability Range

**LF:** Load Factor

**LOS:** Line-of-Sight

**LV:** Lift Vector

**MATC:** Misaligned Turn Circles

**MRT:** Military Rated Thrust

**MSL:** Mean Sea Level

**NATOPS:** Naval Air Training and Operating Procedures Standardization

**OBFM:** Offensive Basic Fighter Maneuvering

**OBT:** Offensive Break Turn

**OCF:** Out-of-Control Flight

**OCS:** Offensive Combat Spread

**OOPh:** Out-of-Phase

**OOPl:** Out-of-Plane

**PADS:** Position, Altitude, Distance, Speed

**PDT:** Positional Deck Transition

**$P_k$:** Probability of Kill

**POM:** Plane of Motion

**RAC:** Range, Angles, Closure

**RG:** Radial G

**ROE:** Rules of Engagement

**ROT:** Rule of Thumb

**RPM:** Revolutions per Minute

**RQ:** Rear Quarter

**RTB:** Return to Base

**RTGS:** Real Time Gun Sight

**SA:** Situational Awareness

**SB:** Speedbrake

**SCKR:** Shooter Controlled Kill Removal

**SEM:** Section Engaged Maneuvering

**SN:** Sensor Nose

**SSD:** Snapshot Drill

**TA:** Target Aspect

**TACAN:** Tactical Air Navigation System

**TACSOP:** Tactical Standard Operating Procedures

**TR:** Turning Room

**TRACOM:** Training Command

**TTC:** Tap-the-Cap

**VCR:** Videocassette Recorder

**VMC:** Visual Meteorological Condition

**WEZ:** Weapons Employment Zone

**WSPAN:** Wingspan

## APPENDIX C
## SEM ENGAGEMENT MECHANICS

Multi-plane engagements can seem daunting. Fighters can, however, break down each engagement into a series of steps to afford the best possible opportunities for success. The following flow/checklist takes you from the visual pick-up of an adversary through the assessment of the flight and any available weapons employment opportunities. This is a tool that can aid in preparation of SEM events, but does not cover all the considerations and variations of every engagement that you might encounter. Used as an aid in preparation, chair-flying, briefing and de-briefing, this checklist may provide a useable flow to consider possible presentation.

1. Visual pick-up
    a. Maneuver
        i. Towards the threat sector
        ii. Maintain mutual support
        iii. Assess turning room available
    b. Comm
        – Directive over descriptive
    c. Control merges
        i. Take out turning room
        ii. Check across the tail
2. Initial moves
    a. Shots
        i. Are you in a LAR?
        ii. Will you sacrifice follow-on flow?
        iii. Can you maintain deconfliction?
    b. Establish “first guess” roles
        – Maneuver OOPl/OOPh
            – Second fighter to merge’s primary responsibility

c. 1v1 BFM

i. Establish gameplan

ii. Fight best jet

d. Decisions

3. Engagement assessment

a. Role responsibilities

i. Keep bandit predictable

ii. Remember engaged/free fighter priorities

b. Engaged comm

i. Directive over descriptive

ii. Communicate roles and status

iii. Execute lost sight gameplan

(a). Call “No Joy/Blind”

(b). Request “Status”

c. Shots

d. Switches

i. Call the switch/get SA out there

ii. Control follow-on merges

iii. Maneuver OOPl/OOPh if IAW sound BFM

## APPENDIX D
## STUDY RESOURCES FOR BFMFP/SEMFP

**Study Resources for Basic Fighter Maneuvering and Section Engaged Maneuvering Flight Procedures:**
[A] T-45C NATOPS Flight Manual, A1-T45AB-NFM-000
[B] Basic Fighter Maneuvering Section Engaged Maneuvering Flight Training Instruction (FTI)

**BFM1101: "Introduction to BFM,"0.8 hr, Classroom**
**Lesson Preparation:**
* [B] Read "Introduction" and "Background" sections with special attention to symbology and terminology

**Lesson Objectives:**
* Relate environmental components to BFM performance
* Relate fixed aircraft factors to BFM performance
* Relate variable aircraft factors to BFM performance
* Identify energy management components for the T-45C
* Recall procedure for the performance characteristics exercise
* Recall basic BFM considerations
* Recall the actions which lead to a 1C fight
* Recall the advantages/disadvantages of a 1C fight
* Recall the actions which lead to a 2C fight
* Recall the advantages/disadvantages of a 2C fight
* Recall out-of-plane (OOP) maneuvering tactical considerations
* Recall procedures for maintaining sight/lookout doctrine
* Recall BFM terminology and descriptions
* Recall BFM symbology
* Recall training rules for BFM exercises
* Recall procedure for lost comm situation in BFM
* Recall procedure for lost sight situations in BFM
* Recall procedures for conducting g-warm turns

**BFM1102: "BFM 1v1 Offensive Maneuvering,"1.0 hr, Classroom**
**Lesson Preparation:**
* [B] Read "Offensive Flight Procedures" section

**Lesson Objectives:**
* Recall the concepts and tactics applicable to offensive BFM
* Recall the purpose and application of the snap guns exercise in BFM (offensive)
* Recall the procedure for performing the snap guns exercise (offensive)
* Recall the purpose and application of the high yo-yo in BFM
* Recall the purpose and application of the low yo-yo in BFM
* Recall the purpose and application of the horizontal scissors (offensive)
* Recall procedure for performing horizontal scissors (offensive)
* Recall the purpose and application of the rolling scissors (offensive)
* Recall procedure for performing rolling scissors (offensive)
* Recall the purpose and application of the offensive counter to the defensive pitchback
* Recall procedures for performing Perch set (offensive)

* Recall procedure for the break turn exercise (offensive)
* Recall the offensive considerations for disengagement
* Recall the procedures for execution of offensive disengagement

**BFM1103: "BFM 1v1 Defensive Maneuvering,"1.0 hr, Classroom**
**Lesson Preparation:**
* [B] Read "Defensive Maneuvering Flight Procedures" section
**Lesson Objectives:**
* Recall the concepts and tactics applicable to defensive BFM
* Recall factors/techniques for defensive disengagement
* Recall disengagement follow-on options
* Recall the purpose and application of the snap guns exercise in BFM (defensive)
* Recall the procedure for performing the snap guns exercise (defensive)
* Recall the purpose and application of the horizontal scissors (defensive)
* Recall procedure for performing horizontal scissors (defensive)
* Recall the purpose and application of the rolling scissors (defensive)
* Recall procedure for performing rolling scissors (defensive)
* Recall purpose and application of Perch sets (defensive)
* Recall procedures for performing a Perch set (defensive)
* Recall the purpose and application for break turn exercise (defensive)
* Recall procedure for the break turn exercise (defensive)
* Recall the purpose and application of the Lufberry
* Recall the purpose and application of the diving spiral
* Recall procedure for performing a diving spiral
* Recall the purpose and application of the high "G" roll
* Recall the procedure for performing a high "G" roll
* Recall the purpose and application of jink-out maneuvers
* Recall procedures for performing jink-out maneuvers

**BFM1104: "BFM 1v1 Neutral High-Aspect BFM,"0.8 hr, Classroom**
**Lesson Preparation:**
* [B] Read "1v1 Engagement Concepts and Tactics" section
**Lesson Objectives:**
* Recall the concepts and tactics applicable to basic fighter maneuvers (BFM)
* Recall the parameters which constitute a neutral start
* Recall the actions which lead to a 1C fight
* Recall the advantages/disadvantages of a 1C fight
* Recall the actions which lead to a 2C fight
* Recall the advantages/disadvantages of a 2C fight
* Recall out-of-plane (OOP) maneuvering tactical considerations
* Recall the actions which lead to vertical fight/merges
* Assess the neutral 1v1 tactical situation

**SEM1101: "SEM 2v1 Flight Procedures,"2.7 hrs, Classroom**

**Lesson Preparation:**

* [B] Read "2v1 Mission Procedures/Maneuvers" section

**Lesson Objectives:**

* Recall procedures/guidelines provided by BFM briefing
* Recall rules of engagement (ROE) for conducting BFM training
* Recall parameters of the weapons envelope used by CNATRA
* Recall BFM working areas and enroute/RTB procedures
* Recall weather minimums/requirements for ACM
* Recall BFM tactical communications plan/usage
* Identify energy management components for the T-45C
* Recall tactical considerations and BFM brief board information
* Recall procedures for conducting G-LOC turns
* Recall engaged/free fighter tactical doctrine applicable to BFM
* Recall 2v1 mutual support tactical and procedural considerations
* Recall the 2v1 considerations for disengagement
* Recall procedures for 2v1 disengagement
* Describe the correct position and purpose of the DCS formation
* Recall other tactical formations used in BFM
* Recall tactical communications requirements for BFM
* Recall additional tactical considerations for BFM
* Assess 2v1 tactical situation (used for all engagements)
* Recall the concepts and tactics applicable to 2v1 BFM
* Recall responsibilities of each aircraft in the "Call the bandit" exercise
* Describe actions of engaged/free fighter response to Counterflow rear quarter attack
* Describe actions of engaged/free fighter in response to forward quarter visual pick-up
* Recall methods for regaining section integrity
* Describe actions of engaged/free fighter in response to beam quarter visual pick-up
* Describe actions of engaged/free fighter in response to rear quarter visual pick-up
* Describe actions of engaged/free fighter to single-switch exercise
* Describe action of engaged/free fighter in response to Multi-Switch Exercise
* Describe actions of engaged/free fighter in VFQ attack
* Recall the procedures executing Tap-the-Cap engagements
* Recall the procedures for completing a VID
* Recall the procedures for egressing an engagement area
* Recall methods for regaining section integrity
* Recall the procedures for Beyond Visual Range engagements

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