**NAVAL AIR TRAINING COMMAND**

**NAS CORPUS CHRISTI, TEXAS** **CNATRA P-825 (Rev. 09-10)**

# FLIGHT TRAINING INSTRUCTION

# AIR TO AIR INTERCEPT PROCEDURES WORKBOOK

**2010**

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

CNATRA P-825
N712
4 Feb 11

CNATRA P-825 (Rev. 09-10)

Subj: FLIGHT TRAINING INSTRUCTION, AIR TO AIR INTERCEPT

1. CNATRA P-825 (Rev. 09-10) PAT "Flight Training Instruction, Air to Air Intercept" is issued for information, standardization of instruction, and guidance to all flight instructors and student aviators within the Naval Air Training Command.

2. This publication shall be used as an explanatory aid to the Advanced Multi-Service Navigator Training System Flight 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 CNATRA P-825 (Rev. 03-08) PAT is hereby cancelled and superseded.

THOMAS E. BRODERICK
Chief of Staff

Distribution:
CNATRA N71 (5) Plus Original
TRAWING SIX (100)

**FLIGHT TRAINING INSTRUCTION**

**FOR**

**AIR TO AIR INTERCEPT PROCEDURES WORKBOOK**

**Q–2D-0094**

## LIST OF EFFECTIVE PAGES

*Dates of issue for original and changed pages are:*
Original...0...31 Aug 98 (this will be the date issued)
Revision 1…0…31 May 02
Revision 2…0…25 Mar 08
Revision 3…0…04 Feb 11
**TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 254 CONSISTING OF THE FOLLOWING:**

| **Page No.** | **Change No.** | **Page No.** | **Change No** |
|---|---|---|---|
| COVER | 0 | 12-1 – 12-7 | 0 |
| LETTER | 0 | 12-8 (blank) | 0 |
| iii –xiv | 0 | 13-1 – 13-5 | 0 |
| 1-1 – 1-6 | 0 | 13-6 (blank) | 0 |
| 2-1 – 2-4 | 0 | 14-1 – 14-6 | 0 |
| 3-1 – 3-9 | 0 | 15-1 – 15-9 | 0 |
| 3-10 (blank) | 0 | 15-10 (blank) | 0 |
| 4-1 – 4-9 | 0 | 16-1 – 16-19 | 0 |
| 4-10 (blank) | 0 | 16-20 (blank) | 0 |
| 5-1 – 5-7 | 0 | 17-1 – 17-16 | 0 |
| 5-8 (blank) | 0 | 18-1 – 18-7 | 0 |
| 6-1 – 6-10 | 0 | 18-8 (blank) | 0 |
| 7-1 – 7-13 | 0 | 19-1 – 19-34 | 0 |
| 7-14 (blank) | 0 | A-1 | 0 |
| 8-1 – 8-8 | 0 | A-2 (blank) | 0 |
| 9-1 – 9-12 | 0 | B-1 | 0 |
| 10-1 – 10-17 | 0 | B-2 (blank) | 0 |
| 10-18 (blank) | 0 | C-1 – C-12 | 0 |
| 11-1 – 11-7 | 0 | D-1 – D-8 | 0 |
| 11-8 (blank) | 0 | | |
| | | | |

## INTERIM CHANGE SUMMARY

*The following Changes have been previously incorporated in this manual:*

| CHANGE NUMBER | REMARKS/PURPOSE |
|---|---|
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*The following interim Changes have been incorporated in this Change/Revision:*

| INTERIM CHANGE NUMBER | REMARKS/PURPOSE | ENTERED BY | DATE |
|---|---|---|---|
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# CHAPTER ONE
# FIGHTER PURPOSE

## 100. INTRODUCTION

The primary purpose of fighter aircraft is to obtain and sustain air superiority over contested airspace. To successfully accomplish this, the fighter aircrew must execute an intercept in a manner designed to:

1. Attain a position in space between the attacking aircraft and the defended force (positional advantage).

2. Control the intercept geometry to achieve an optimal weapon's Launch Acceptability Region (LAR) and manage the enemy's Weapons Employment Zone (WEZ). This is done to maximize the probability of kill ($P_k$), while simultaneously preventing the enemy from achieving weapons release.

3. Arrive at the merge with a tally of all bandits and an advantage in position and/or energy. Then the fighter must use basic fighter maneuvers (BFM) to deter or destroy the enemy.

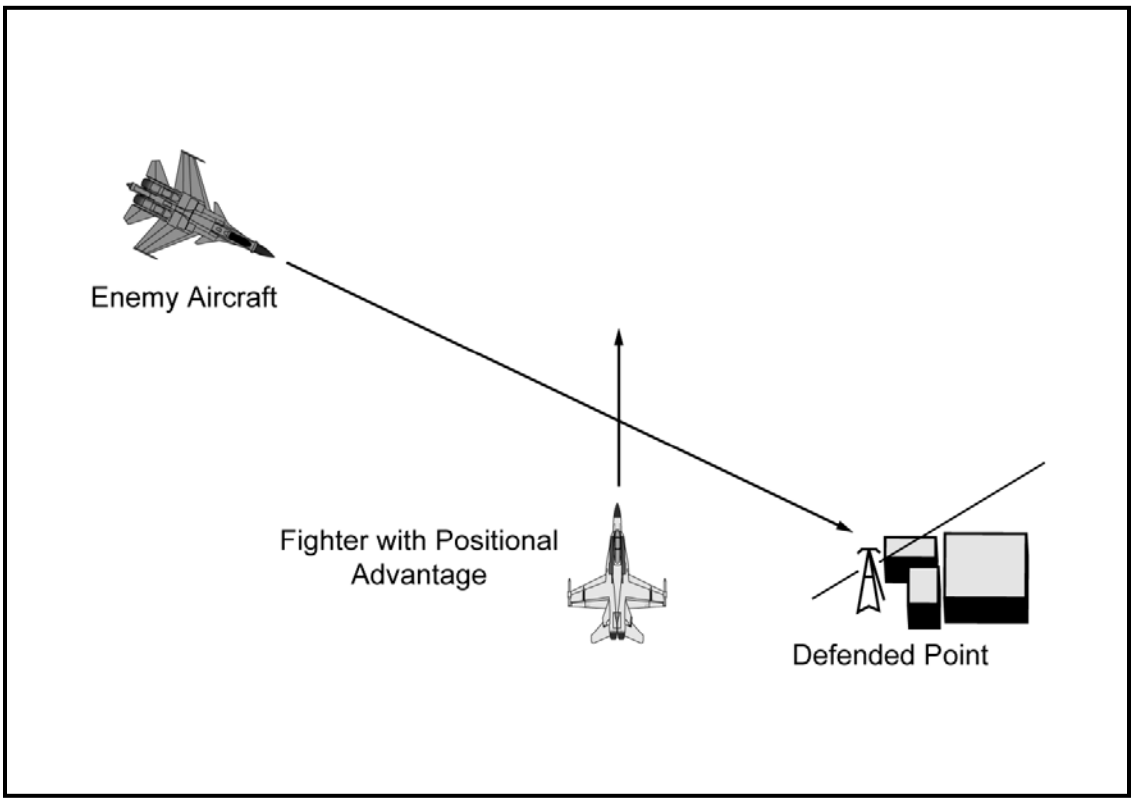


**Figure 1-1 Positional Advantage**

## 101. METHODS OF INTERCEPTING

Normally, there are two primary methods that a fighter may use to close on a bogey:

1. Establish a cut-off vector in order to obtain positional advantage.

2. Establish a collision course.

A cut-off vector is one that will place the interceptor in a position between the bogey and the defended point (Figure 1-1). A collision course is a vector that will allow the fighter to close on the bogey in the fastest possible manner.

A collision course is a straight-line course where the angle at which the fighter sees the bogey (angle off) and the angle at which the bogey sees the fighter (target aspect) remains constant with decreasing range. In a co-speed situation, the two angles will be equal, but in opposite directions. This situation is also known as constant bearing, decreasing range (CBDR). When a speed differential exists, the angles will not be equal. However, if the fighter is on a collision course, the angle off (AO) and the target aspect (TA) will remain constant. There exists only one collision course for a given speed ratio.

If a collision course is pursued to zero range, with both aircraft at the same altitude, a midair collision will occur, as shown in Figure 1-2.

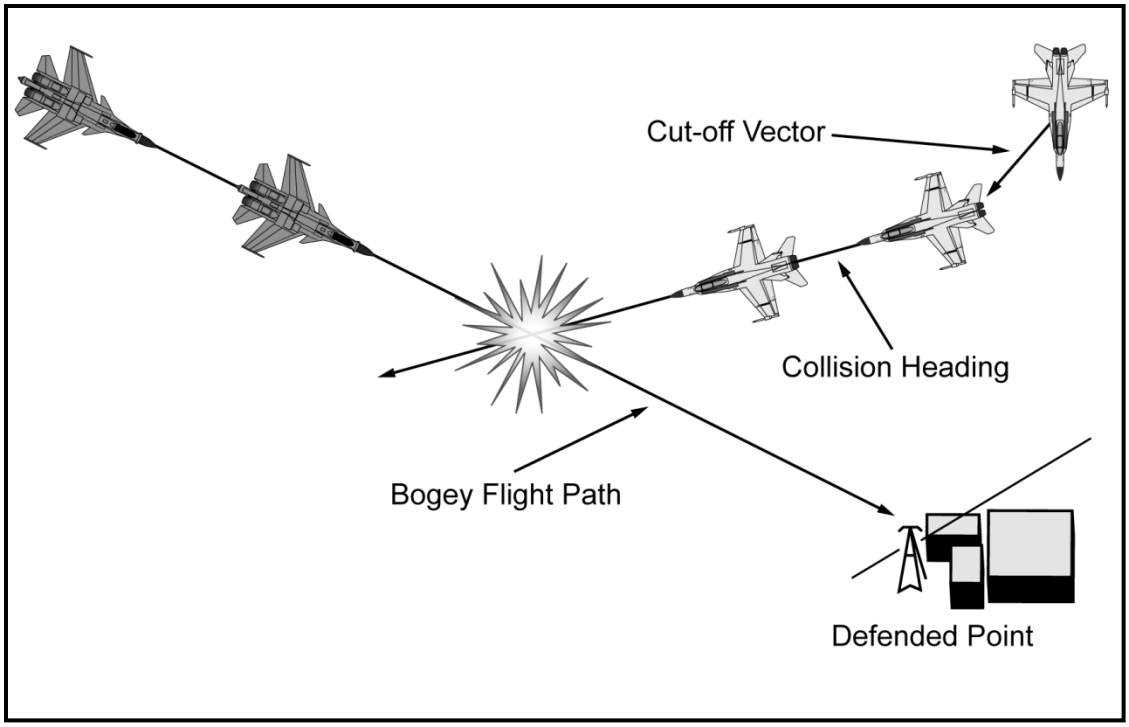


**Figure 1-2 Collision Course**

## 1-2 FIGHTER PURPOSE

## 102. TYPES OF INTERCEPTS

There are three types of pursuit intercepts: Pure Pursuit, Lead Pursuit, and Lag Pursuit.

## 103. PURE PURSUIT

Pure pursuit is the primary intercept for achieving position in the rear quarter of the bogey. Pure pursuit occurs when the fighter constantly turns in order to keep the nose of its aircraft pointed directly at the bogey. Depending on the initial geometry, increasingly harder turns may be required to achieve a position at the bogey's six o'clock.

Pure pursuit as shown in Figure1-3 may be used to give the bogey a difficult target to visually acquire.

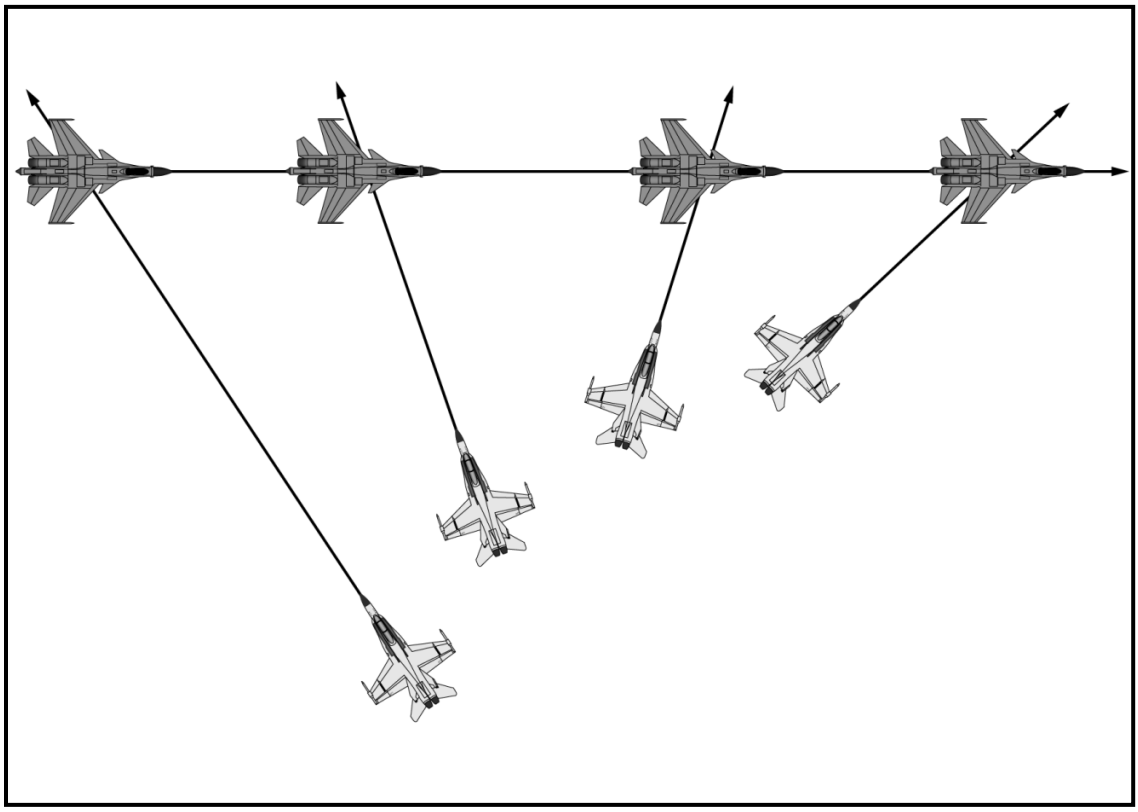

**Figure 1-3 Pure Pursuit**

## 104. LEAD PURSUIT

Lead pursuit is a situation where the fighter places its nose in front of the bogey. The amount of lead is determined by how far in front of the bogey's nose the fighter is pointing. A collision intercept is a form of lead pursuit.

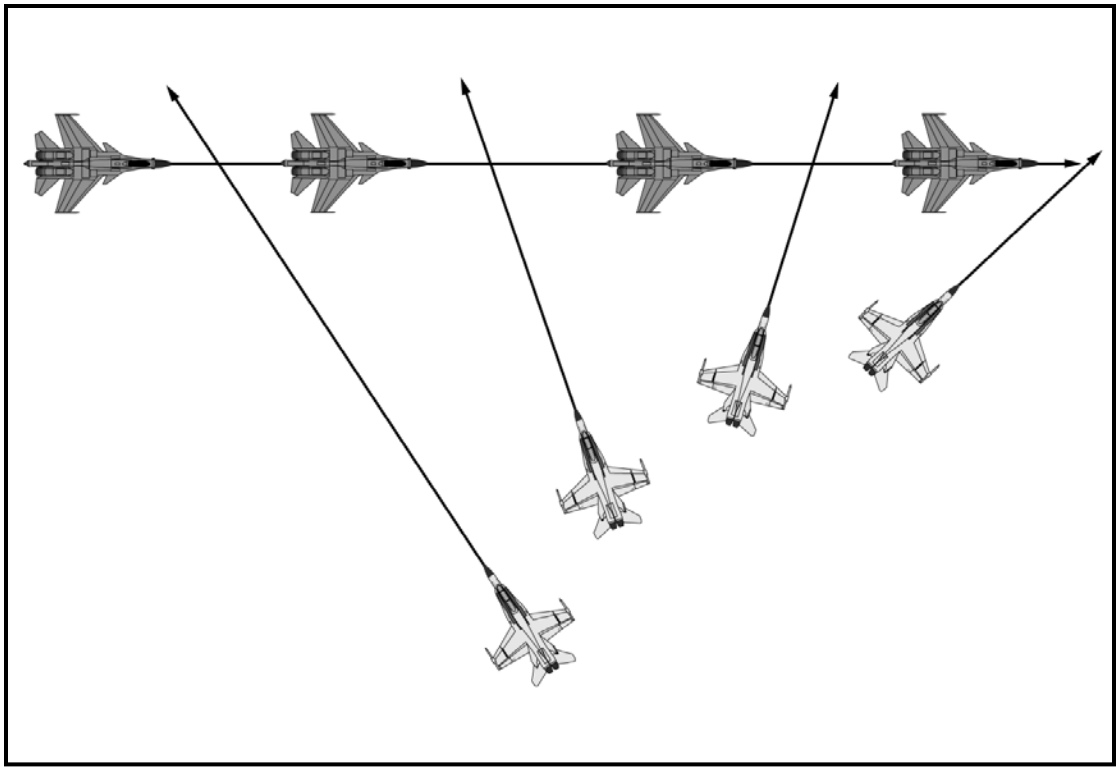

**Figure 1-4 Lead Pursuit**

Lead pursuit (Figure 1-4) may be used to:

1. Fire a Sparrow or AMRAAM missile from a position forward of the target.

2. Increase closure and decrease range to the target.

3. Allow for a gun solution in the rear quarter.

## 105. LAG PURSUIT

Lag pursuit is a situation where the fighter places its nose behind the bogey. The amount of lag is determined by how far behind the bogey the fighter places its nose.

Lag pursuit (Figure 1-5) may be used to:

1. Extend range in the rear quarter to complete a sidewinder missile solution.

2. Decrease closure and increase range.

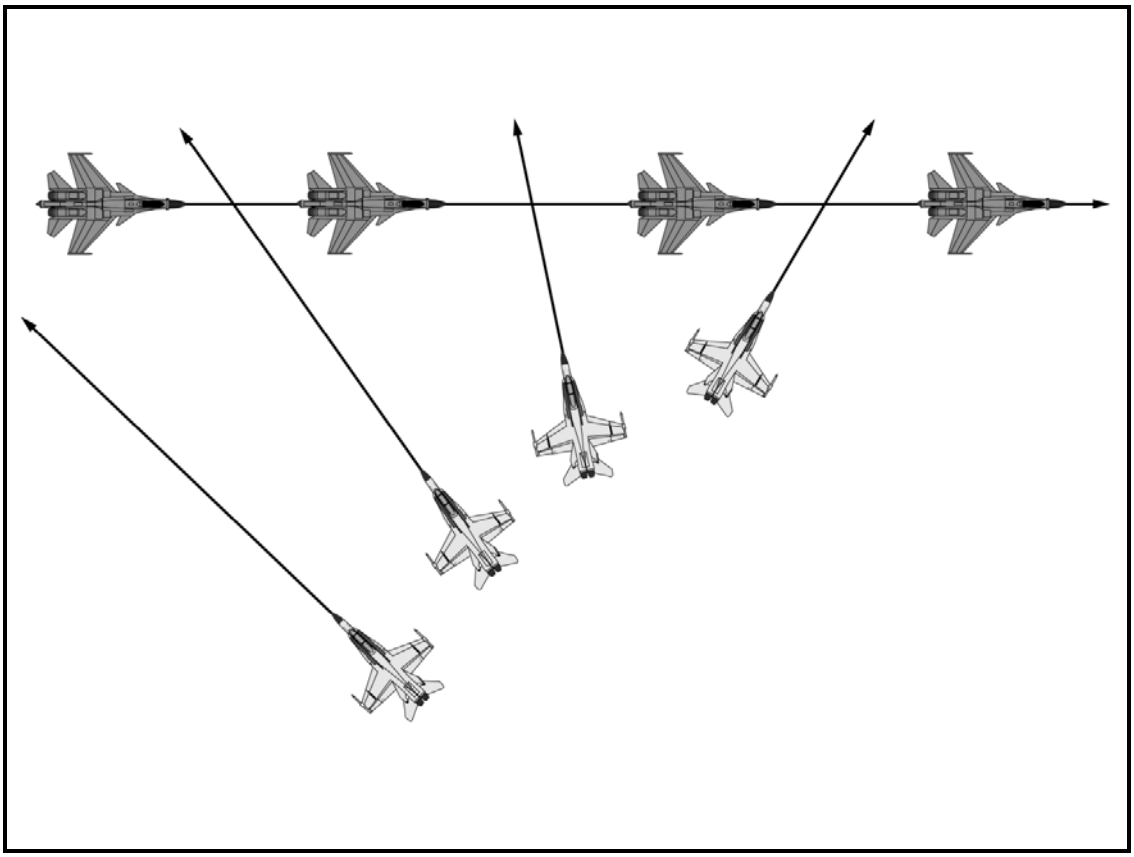

**Figure 1-5 Lag Pursuit**

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*"As to gunnery passes, the best was when you dived with speed, made one pass, shot an opponent down quickly, and pulled back up...The secret was to do the job in one pass; it could be from the side or from behind and I usually tried to open fire at about 150 feet."*

Major Erich Rudorffer, Luftwaffe
WWII, 222 Victories (13 in one mission)
Knight's Cross with Swords

# CHAPTER TWO
# AIR INTERCEPT CONTROL

## 200. INTRODUCTION

For the fighter to fully understand and appreciate the often difficult tasks of air intercept control, an awareness of the conditions under which the controller operates, the procedures in use, and the complexity of command and control are useful. This unit will introduce the student to the Fighter/Controller relationship, with the express purpose of stressing the importance of teamwork.

## 201. BASIC RADAR

Basic search radars have a range of approximately 250 miles. They are capable of identifying Identification, Friend, or Foe (IFF) returns out to 200 miles. They are also capable of seeing through all forms of weather, enabling the air controller to close-control the fighter into lock-on range without any appreciable difficulty.

## 202. E-2 HAWKEYE AND E-3 AWACS

The E-2 Hawkeye is the carrier-based Airborne Early Warning (AEW) platform with a 24-foot diameter saucer-shaped radome housing the APS-138 or APS-145 radar. The E-2 can detect targets more than 230 miles away, track over 250 targets, and provide control for more than 30 separate Airborne Intercepts (AI). Passive detection devices can alert the E-2 aircrew to electronic emissions more than 500 miles away. The Hawkeye crew is also responsible for the “big picture” coordination of surface and air warfare assets.

The E-3 Airborne Warning And Control System (AWACS) is the Air Force's specially modified Boeing 707 that houses a sophisticated airborne command and control center. The operating altitude of the E-3, combined with the capability of the radar, allows it to detect targets from 200 to 300 nautical miles, depending on target size. Like the E-2, the E-3 AWACS is resistant to electronic jamming by enemy forces. The E-3, like all long-range radar platforms, is limited in its ability to provide close control to the fighters at the merge.

## 203. PLANNED POSITION INDICATOR (PPI) SCOPE

The PPI scope is the type of radar display that air intercept controllers use to detect aircraft and control fighter aircraft. It gives the controller what is best described as a “God's eye view” of the area. It has many features incorporated to assist the air controller, namely an off center function, a roving cursor, and a variable range control.

The equipment used by the VT-86 GCI controllers, call sign “Gritrock,” is relatively old and very labor-intensive. The Gritrock controllers here at VT-86 will typically be fleet-experienced Navy Operations Specialists (OS). They are able to “paint” raw returns, but will usually rely on IFF.

## 204. RADAR TRAINING FLIGHT PROCEDURES

Upon check-in with the warning area (W-155) controller, "Seabreeze," you will be under positive control. Seabreeze will assume responsibility for keeping the aircraft in the assigned area and clear of other aircraft. However, the responsibility for the position and safety of the aircraft ultimately rests with the aircrew.

Before the intercept begins, the ground controlled intercept (GCI) controller will provide information about other aircraft, enemy and otherwise, in the area of operations where the fighter is on Combat Air Patrol (CAP). There are three essential transmissions given by a GCI controller that can help build an aircrew's SA and prepare them for the upcoming intercept. They are:

1. BH and maneuver-CAPing, marshalling, turning hot, etc.

2. Composition and altitude: an estimate of the size and makeup of any aircraft that may become a factor to the fighter.

3. Picture call: defines the position of the other aircraft in relation to either a known point (Bullseye) or the fighter's nose (BRAA). Bullseye: Bearing and range of bogey from a reference point such as a lat/long, geographical reference, or NAVAID. BRAA: Bearing (Magnetic bearing from the fighter to the bogey), Range, Altitude (hi, med, low, or hits), and Aspect (hot, cold, beam, drag, flank, or cap) of the bogey/group.

Once the fighter commits on a bogey/group, the fighter will become the primary provider of bogey information, with GCI/Air Intercept Controllers (AIC) filling in the gaps with information that the fighter may not be able to see (Tactical Control). Typically, at some predetermined range, the format of the calls will switch completely to the BRAA format so as to provide the best possible SA for the aircrew during their intercept. Some of the transmissions may appear repetitious during training, but they are required for the air controller and will help out the aircrew when the missiles and enemy aircraft are real.

At VT-86, GCI will provide BRAA control once the fighter is headed down range towards the bogey. During phases where bogey heading (BH) is not required (advanced), controllers will provide Broadcast bullseye control followed by Tactical bullseye and eventually, BRAA control.

There are two procedures for acknowledging calls from GCI/AIC. The first is communications (comm) cadence, where the fighter responds to all controller calls over the radio to show that they have heard and understood the information being passed to them. The second is comm priority, where only controller / aircrew with new information speaks, thus minimizing the amount of radio traffic. This can be important in an environment with many players, as frequencies can become jammed with too many people saying too many things. At VT-86, the students will practice comm cadence to ensure that they are listening to every call made by the controllers. Once you are flying in real world scenarios, comm priority will be the norm.

**NOTE**

Acknowledge all calls from the Controller.

## 205. CONTROLLER/FIGHTER TEAMWORK

It is crucial for the success of the mission to develop a strong working relationship between the intercept controllers and the fighter aircrew. Many intercept problems can be attributed to a breakdown in the radar picture, the loss of effective communications, and/or eroded teamwork between the aircrew and the controllers. When these problems develop, they can result in bad setups and missed intercepts. At worst, these problems can cause the fighter to be killed by an untargeted enemy aircraft, friendly assets to be destroyed by enemies who slip through our fighter screens, or “blue-on-blue” engagements.

Intercept controllers can direct the fighter to target certain high threat bogeys, and have access to information from higher command authority. Proper exchange of this type of information will allow rapid and correct decisions to be made in the air. Bear in mind that, while the fighter aircrews are honing their tactical skills, the controllers are also improving theirs. Professional briefs and debriefs between the fighter and the controller will improve team effectiveness and emphasize the information the fighter needs to stay alive in the combat arena.

At certain times, working area constraints may present specific challenges. Area limitations may require less than ideal setups and, at times, require early termination of the intercept as the fighter closes into firing range. Remember, if under positive control, the aircraft must remain within the area or risk a flight violation. This may be particularly applicable when working in a foreign defense zone. There are many countries that thrive on trying to embarrass the United States by catching our aircraft with a boundary violation.

## 206. CONCLUSION

It is very important that the fighter have some knowledge of the capabilities and limitations of the air intercept controller in order to develop a closer working relationship. Aircrew should take the opportunity to get to know the air controllers to develop better teamwork in the air. Often, a fighter squadron's reputation and effectiveness can be traced to their rapport with the intercept controllers. This close working relationship will result in more successful intercepts during combat.

Fortunately, at VT-86, your “Gritrock” controllers are almost always experienced fleet Navy OSs. They are usually familiar with your capabilities and can anticipate any difficulties you might have. You may not be as fortunate in an operational squadron. Control from an AWACS or a Navy Aegis-class cruiser, with more advanced radar systems, will be significantly better than that of older platforms still in use.

Your training here and at the Fleet Replacement Squadron (FRS) or Formal Training Unit (FTU) will give you the necessary tools to perform flawlessly in the complicated arena of air superiority.

**This page reserved for Notes**

*"Months of preparation, one of those few opportunities, and the judgment of a split second are what makes some pilots an ace, while others think back on what they could have done."*

Colonel Gregory "Pappy" Boyington, USMC
WWII, 28 victories
Medal of Honor

# CHAPTER THREE
# DIRECTIVE AND DESCRIPTIVE COMMENTARY

## 300. INTRODUCTION

Effective communication is a critical element of crew coordination. It is paramount that any information known to one member be made available to the other. With the limited time available for transmission of information in the air, standard terminology allows complex ideas to be expressed with minimal verbiage. These terms must be concise, comprehensive, and free of any confusing qualities. The aircrew at VT-86 will be responsible for knowing and applying the comm brevity words at the end of this unit. These terms are taken from unclassified portions of MCM 3-1, Volume 1, the standard reference for communication procedures. The aircrew will become quite familiar with this classified publication in their operational squadrons.

## 301. TYPES OF COMMENTARY

There are two types of intra-cockpit aircrew commentary: directive and descriptive:

1. Directive commentary is specific instructions to members of the aircrew. At VT-86, directive commentary is used to direct the pilot to change the aircraft's altitude, heading, or airspeed in order to attain the optimal position for intercept control and employment of weapons.

2. Descriptive commentary provides the aircrew information concerning the progress of the intercept and the relative position of a bogey from the fighter. At VT-86, it is used to "paint a verbal picture" of the intercept for the pilot.

A successful intercept and combat engagement is dependent on the appropriate and timely flow of both types of information.

**NOTE**

The rule to follow for communication is simple:

Directive commentary always takes precedence over descriptive commentary.

## 302. VOICE MODULATION

Voice control is just as important to effective communication as proper terminology. Speech must be calm and void of any tendency to become loud and high pitched with excitement. However, increasing one's volume and pitch is certainly one way to express the importance of the words being spoken. Commands must be definitive and positive. Avoid long pauses, periods of indecision, expletives, and unnecessary talking to one's self. Enunciation must be clear and concise. Words should be clipped and sharp so that syllables are not drawn out.

Remember, the objective of proper communication is to pass the maximum amount of information using the minimum number of words. Learning the commentary vocabulary and practicing clear and precise enunciation will allow maximum information flow in a high stress and confusing combat environment.

Constant practice here at VT-86 will make voice communication with the pilot clear, concise, and effective.

## 303. DESCRIPTIVE COMMENTARY (BRAA/AREO REPORTS)

The purpose of descriptive commentary is to keep GCI, your wingman (when applicable), and the pilot informed of the progress of the intercept. Specifically, you are giving the bogey's position in relation to the fighter. In VT-86 there are two separate formats for formalized descriptive comm. They are BRAA and AREO reports.

## 304. BRAA AND BULLSEYE

As already mentioned, the BRAA report is given to describe the contact's position referenced from the fighter to the bogey. The initial contact call to GCI/AIC should be as accurate as possible and given in the BRAA format. Realize that the bogey's aspect is left out because it is used more as an informative call from the controller to the fighter. This confirms and correlates with the controller that the contact you have is in fact the bogey they intend for you to intercept. Subsequent BRAA calls can be made as appropriate during the intercept over the fighter formation's tactical frequency to build SA for wingmen that may not have radar contact because their primary search responsibility is in another altitude block. Remember, once identified as your bogey, subsequent BRAA calls continue to be considered descriptive comm and will not take priority over directive comm.

The initial BRAA report consists of Bearing, Range, Altitude and Aspect information, followed by the word "declare," which queries the controller on the status of the contact and should be followed by a response from them. It is a two-way communication over UHF. An example of a BRAA call with a declaration request attached to the end is "Hammer, Group, BRAA 100, 22, medium, declare." Hammer is the tactical call sign of the fighter and Group is any aircraft within 5NM and 5K' of each other.

The BRAA and declaration information follows. The fighter can expect one of four responses to the declaration request:

1. Hostile - weapons release is authorized.

2. Stand-by – meaning weapons release authority is not available at this time but may be released shortly.

3. Bandit - confirmed enemy, weapons release not authorized.

4. Bogey - unknown contact, proceed with intercept, weapons release not authorized.

The bearing information is given in terms of magnetic bearing from the fighter to the bogey. If, for example, the fighter is heading 130 and the bogey appears at 30 left AO, the bogey's magnetic bearing is 100°.

The Range information in the BRAA report is the miles from the fighter to the bogey. The fighter does not have to state the word "miles" as it is understood in the BRAA format that the second number is the range in miles.

The Altitude information is given in relation to the bogey's altitude in thousands of feet. This information is given in either of two formats, the first being the altitude block "hi," "med," or "low." Different fighter communities may define high, medium, and low differently. At VT-86, the low altitude block runs from 0-11, 999 feet, the medium block is from 12,000-19,999 feet, and the high block is 20,000 feet and above. The second format references an exact altitude in 1000's of feet based on a radar lock with Data Block on (Advanced only). An example declaration call incorporating exact altitude would be, "Hammer, Group, BRAA 100, 22, 18,000, declare."

Once in the Fleet or Operational Air Force, other descriptive formats will be used in place of BRAA. An example of a basic, Broadcast Bullseye call would be "Sweep, Bull-180, 30, hits medium, track North." Everyone operating in the arena would know where the bullseye location was, so all involved would immediately know the position of the contact as 30 miles south of the bullseye position, in the medium altitude block, and heading north.

## 305. AREO

The AREO report states, in order, the bogey's azimuth, range, elevation, and overtake (rate of closure (ROC)). It is primarily for the pilot; therefore, AREO calls will be made on the ICS within the aircraft. Descriptive comm should be given smoothly in a natural tone of voice. The AREO reports should be given every four to five miles (beyond visual range) as long as the bogey information remains relatively constant (on collision). When inside visual range, or when the bogey is drifting, AREO reports should be given as often as possible to better describe the bogey's position to the pilot and help the pilot get a tally. Once a tally by the pilot is achieved, AERO calls are no longer required.

**NOTE**

> AREO reports should not be given when the intercept situation requires directive commentary to control intercept progression.

Visual contact is usually made between 6-10 nautical miles under favorable visibility conditions with radar cues on the pilot's Heads Up Display (HUD). Since the T-39 has no HUD, AREO reports are particularly important.

## 306. AZIMUTH ANGLE REPORTING

Azimuth is reported as degrees right or left of the longitudinal axis (nose) of the fighter. When referring to the azimuth angle and drift movement of the bogey, the terms “right” and “left” must be used. When the bogey is neither “right” nor “left” of the fighter, it is said to be “Dead ahead” (DA) or, “On the nose” (pure pursuit).

## 307. RANGE REPORTING

Range to a radar bogey on the B-scope presentation is read in nautical miles and is determined by the vertical displacement of the bogey contact above the bottom of the scope. Range should be reported to the nearest mile. If the bogey were 25° left of the fighter’s nose at a range of ten miles, the first part of the AREO report would be “25 left, 10 miles.” Notice the word “degrees” is assumed and thus omitted in the AREO report but “miles” is emphasized for clarity. This is done, because AREO reports are used during dynamic portions of the intercept and unlike BRAA calls may be interrupted to be directive.

1. Elevation Reporting

Elevation is reported in degrees high or low from the fighter. For example, if the bogey contact were 2° high at a range of ten miles, the elevation portion of the AREO report would be “2 high.” When there is no altitude or elevation scale differential, the bogey is reported “Level.”

2. Overtake Reporting

After a lock has been established, ROC information is presented on the scope in knots. Overtake is always true airspeed and not indicated airspeed. Since closure is difficult to estimate when operating in the search mode, it is acceptable to use simply “closing” or “opening.”

Positive ROC means the fighter is closing on the bogey. Overtake will be reported using knots read from the scope; for example, “400” means 400 knots of overtake. The words “knots” and “overtake” are omitted.

When the overtake is negative, it will be reported as opening. In the case of minus 100-knot closure, it will be reported as “100 opening,” since opening is a deviation from the norm.

## 308. AREO REPORTS

At long range, when sufficient time is available, the AREO report will be given as a complete four-part report. At medium and short ranges, when task loading increases, it may be abbreviated to azimuth, range, and elevation (ARE).

During the busier phases of an intercept, there is a tendency to report azimuth and range but neglect elevation information. Any such tendency should be avoided because it fails to keep the aircrew informed of significant tactical information.

Additional Descriptive Commentary:

It is important for the weapons officer to announce bogey tendencies as they occur while remaining cognizant of the fighter's attitude. Bogey drift patterns plus any movement of the bogey not caused by the fighter should be noted. Some examples of supplementary information worthy of mention, in addition to the standard AREO call, are listed below:

1. It is always significant when the bogey shows drift and should be reported as "Bogey drifting left/right."

2. When the bogey is not drifting, it may be reported as "Bogey holding (degrees) left/right." In this case, it may be further noted that "Bogey is on collision."

3. When a speed differential is realized, it should be reported as "Bogey's fast" or "Bogey's 350 true," etc.

4. Changes in BH ("jinking") will cause scope indications that should be noted in descriptive comm. They should be noted as "Bogey's jinked right," "Bogey's jinked into us," "Bogey's slowing," "Bogey's descending," "Bogey's speeding up," etc.

5. When pitch, bank, or speed maneuvers were previously directed, their effect should be noted later. Example: "We're climbing," "Speed set .6," "We're descending," etc.

## 309. DIRECTIVE COMMENTARY

Directive comm instructs the pilot to take specific positive action necessary to execute an intercept. In effect, the weapons officer controls the fighter via commands to the pilot. A fighter may be maneuvered by changing its bank, pitch, and/or airspeed. Directive comm controls the aircraft in these three dimensions.

Remember, directive comm always takes precedence over descriptive comm. The weapons officer should never hesitate to break off an AREO report to give a necessary directive command. Directive comm should be given with a sharp authoritative voice and with a different inflection to preclude any possibility of misinterpretation as descriptive comm.

Any time a maneuver is directed which exceeds the fighter's performance capabilities, the pilot will comply with the direction up to the fighter's limits. Upon achieving a directed parameter change, the pilot will inform the weapons officer with descriptive commentary, such as "Speed set," "Steady," "Level," or "Altitude set."

## 310. TURN COMMANDS

Turn commands control both the heading of the fighter and the AO of the bogey. Airspeed and "g" determine the rate of turn and turning radius. Turn radius and rate will vary with the airspeed and "g" of the fighter. When a turn command is given, the pilot will establish the

appropriate bank angle with a moderate roll rate and apply "g" as necessary to maintain the turn parameters. Roll out to steady will also be moderate. The turn commands are:

1. **"Easy left/right."** When given this command, the pilot will roll into a 15° angle-of-bank, half-standard rate turn, while maintaining airspeed and altitude if straight and level, or while maintaining attitude if climbing or descending.

2. **"Standard left/right."** This is the standard turn for intercept work. It is a 30° angle-of-bank, standard rate turn, while maintaining airspeed and altitude if straight and level, or while maintaining attitude if climbing or descending.

3. **"Hard left/right."** The pilot will maintain a 45° angle-of-bank turn. Airspeed, altitude, and attitude will remain constant.

4. **"Hard as poss(ible) left/right."** The pilot will use the maximum angle-of-bank possible that permits the fighter to maintain airspeed and altitude with full military power. In the T-39, this usually equates to a 60° angle-of-bank.

5. **"Harder."** After any bank angle is established, the command "Harder" is used to establish the next higher increment of bank.

6. **"Ease."** This command establishes a slow roll to a wings-level position.

7. **"Hold."** The pilot will hold the present bank angle. This command follows an "Ease" command and is used to establish any bank angle desired.

8. **"Steady up."** The pilot will roll the fighter to a wings-level position.

9. **"Reverse."** The pilot will immediately turn in the opposite direction utilizing the same angle-of-bank already established. The rate-of-roll will be rapid. A different angle-of-bank can be commanded, as in "Reverse hard as poss."

All turning commands can be modified to direct the pilot to stop turning automatically by specifying the number of degrees to turn to a specific heading on which to steady-up.

**Example:**

"Hard left 40, steady 1-6-0," or "Hard as poss right to 1-6-0."

## 311. ELEVATION CONTROL COMMANDS

The pilot will execute all altitude commands by climbing or descending as appropriate.

1. **"Descend to ____."** The pilot will descend to the designated altitude, while maintaining airspeed. The pilot will descend by retarding the throttles and using the speed brake as required.

2. **"Climb to ____."** The pilot will climb to the designated altitude, maintaining airspeed. With a climb limit, the pilot will stop after climbing the designated number of feet or reaching the designated altitude.

3. **"Level off."** The pilot will resume level flight.

The aircrew must be aware of exactly what a particular command means. If a command requires a follow-up order, the pilot will continue until the appropriate command is given. Make sure to use the proper terminology and always scan to verify that the pilot complies with directions.

## 312. PITCH CONTROL COMMANDS

Pitch control command is a nearly instantaneous aircraft pitch up or down. They are not altitude control measures; they are pitch control maneuvers that over time will convert airspeed to a climb with a concurrent speed/closure loss in a nose high pitch or an altitude loss and speed increase for a nose low pitch. If all weapons parameters are met except for elevation, the commands "nose high for dot" or "nose low for dot" may be given.

## 313. SPEED CONTROL COMMANDS

Speed control commands alter fighter airspeed as required to complete a successful intercept.

1. **"Buster."** This command requires full military power. Speed is increased to the aircraft's maximum allowable airspeed.

2. **"Buster, set speed ____."** Full military power is used to accelerate to the IAS or IMN designated by the weapons officer.

3. **"Throttle back, set speed ____."** The pilot will decrease airspeed to the IMN desired by the weapons officer.

4. **"Throttle right back."** The pilot will decrease airspeed as rapidly as possible by retarding the throttles and using the speedbrake. The pilot will continue to slow to minimum flight airspeed or until a **"Hold speed"** command is given.

The prospective weapons officer should understand that the performance of the F-15E and F/A-18 are considerably different from that of VT-86 training aircraft. Although possible in any of the aforementioned aircraft, the weapons officer should realize that "Climb," "Buster," and "Hard as poss" may not be available simultaneously in the T-39.

## 314. COMM BREVITY GLOSSARY

An unclassified portion of the Comm Brevity Glossary from the Multi-service Tactical Brevity Codes (MCM 3-1), March 1996 is included in the back of this textbook.

It is mandatory that the weapons officer commits these communication terms to memory. These terms will be used not only in VT-86, but also in operational squadrons.

**This page reserved for Notes**

*"In fighter flying, a panic message is the greatest of all crimes. Practice on the ground the exact words you will use to cover any situation in the air. Say it over and over again until it becomes automatic."*

Captain Reade Tilley, RAF
WWII, 7 Victories

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# CHAPTER FOUR
# INTERCEPT DISPLAYS AND FLIGHT PATH VISUALIZATION

## 400. INTRODUCTION

The aircrew must correctly position the fighter's weapons system in preparation for weapons release. Prior to aircrew learning the procedures involved, they must understand the orientation of the basic angles of the intercept. Correctly orienting the fighter and bogey flight paths will allow aircrew to advantageously position the weapons system.

## 401. DISPLAYS

There are three ways the intercept may be viewed: from a God's eye view, from the aircrew's viewpoint in the fighter, and from the viewpoint of the aircrew in the bogey aircraft.

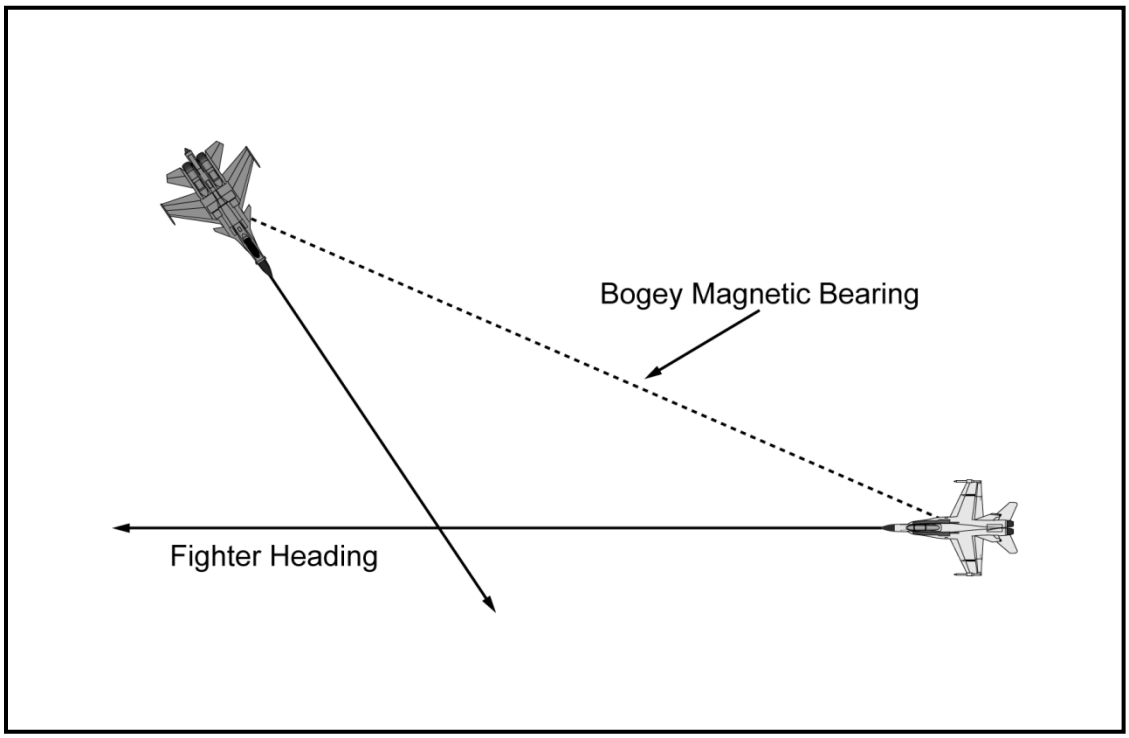


**Figure 4-1 Displays**

All aircrew should attempt to visualize the intercept as it would appear from the position in the fighter aircraft. The two basic displays are the Electronic Horizontal Situation Indicator (EHSI), with fighter heading (FH) at the top, and the airborne intercept (AI) radar scope, the center of which is in line with the longitudinal axis of the aircraft.

To utilize these two displays effectively, the aircrew should envision the fighter's projected flight path as extending through the center of the EHSI and the scope.

## 402. EHSI AND AI SCOPE

The fighter's flight path runs vertically through the center of the EHSI. The EHSI has left and right-hand fiducials, located 45° left and right of the center. There are also fiducial markers at 90° and 135° left and right of the dead ahead position. The AI scope is a B-scope used to display azimuth and range of airborne targets.

Think of the AI scope as a big window centered on the longitudinal axis of the fighter, with the window edges extending out 60° left and right. The bottom of the radar represents the nose of the aircraft. The AO is the angle from the fighter's flight path (fighter's nose) to the bogey. AO is always stated in degrees right or left. With the 20 mile range scale selected, the range on the scope is measured from 0 miles at the base of the scope to 20 miles at the top of the scope, with horizontal lines dividing the scope into 5 increments (in this case, 4 miles each).

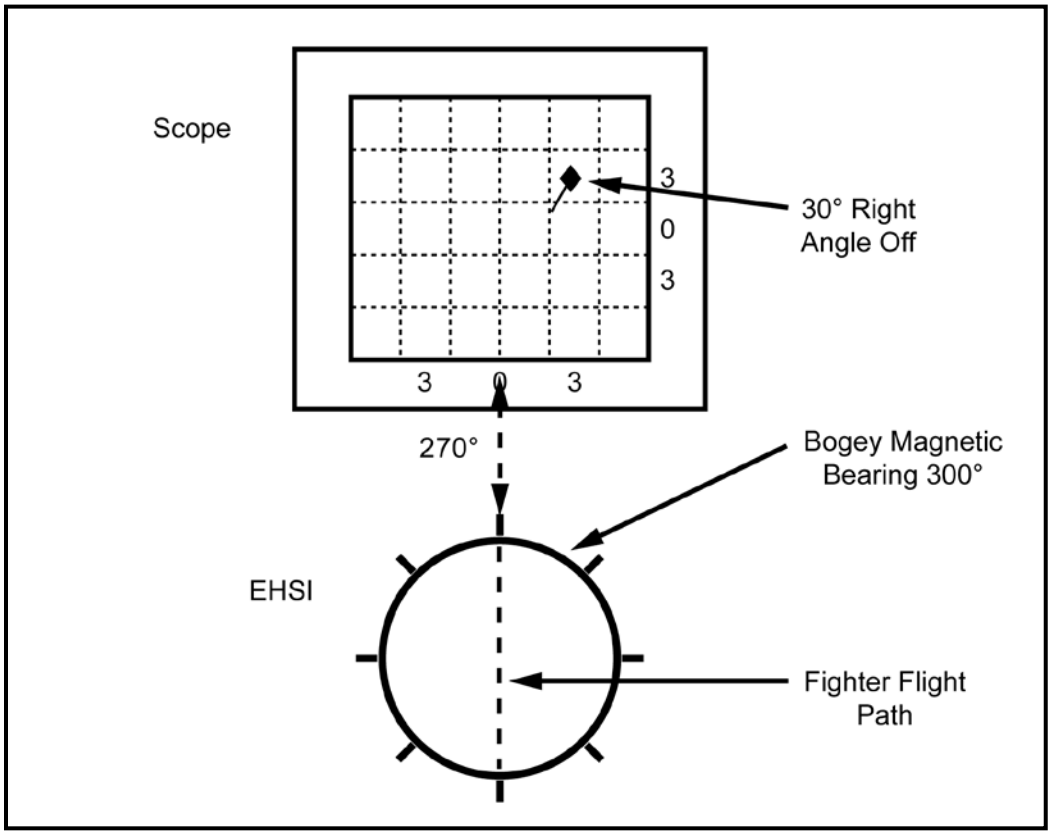


**Figure 4-2 EHSI and Scope 1**

## 403. SPATIAL RELATIONSHIP

The magnetic bearing call or bogey bearing (BB) call, provided by the GCI controller, is the bearing from the fighter to the bogey, independent of fighter heading (FH) or bogey heading (BH). The relative azimuth Angle Off (AO), however, changes as a result of the fighter's turn and changes in the same amount but in the opposite direction of the turn. To illustrate this, look

through a window directly in front and see an object 45° right. Now turn your gaze 90° to the right with the window still directly in front.

Before turning, the object appeared 45° right (AO) and after turning 90° right the object appeared to move left 90° to 45° left (AO). Note that the position in the room has not changed, but the angle to the object has changed.

**NOTE**

The magnetic bearing call will not change instantaneously with a change in FH, but will change as the fighter travels through space.

**Example:**

FH = 270°. Bogey bearing (BB) = 300°. AO = 30° right.

After turning right 70°, the FH is 340°, magnetic bearing is still 300° and the AO is now 40° left.

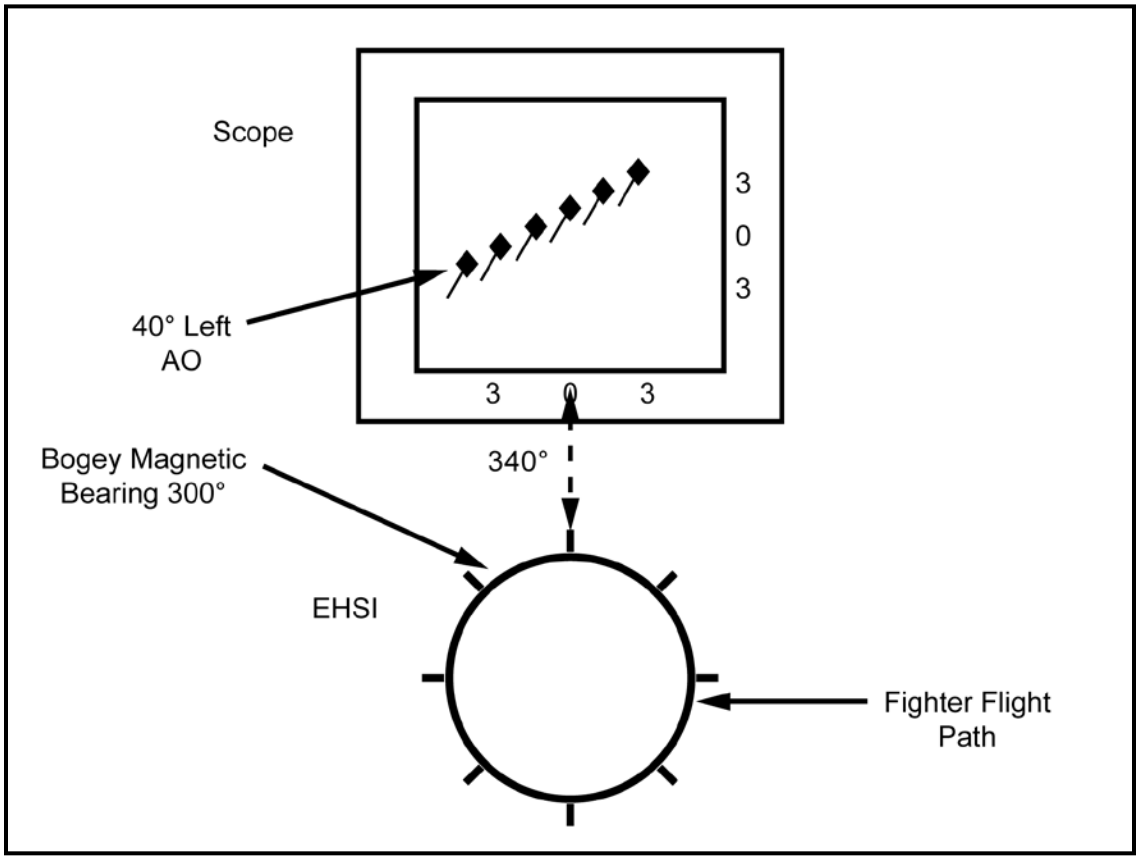


**Figure 4-3 EHSI and Scope 2**

## 404. GCI INFORMATION

The first two items provided by GCI during a normal intercept are BH and BB from the fighter to the bogey. With these two items, the aircrew can determine the proper heading on which to initiate the intercept.

Bogey reciprocal (BR) is the direction that is opposite from BH (180°) (e.g., BH 270°; BR 090°). To execute the intercept, aircrew must be able to accurately and instantaneously determine heading reciprocals around the compass rose. This requires constant practice!

A basic premise during the initial training phases is that once the BH is given, it will not change. Hence, BR needs to be determined only once, since it will not change throughout the intercept.

## 405. CUT DEFINED

Once the aircrew has determined the proper FH, they may also determine the orientation of the bogey and Fighter's Flight Path (FFP). **The angle from FH to BR is defined as the cut.** This is the angle at which the two flight paths intersect. It must always be expressed in both magnitude and direction, such as a 40 LEFT or 20 RIGHT cut.

The direction of pass (DOP) is the direction the bogey would pass from one side of the fighter's flight path to the other. The DOP alone makes no implications of where the bogey and fighter are located along their flight paths, but simply gives a direction to the bogey's flight path expressed relative to the fighter's flight path. Therefore, the DOP is called as a right-to-left, left-to-right, or head-on pass. Figure 4-4 provides an example of a right-to-left pass, indicating that the bogey's flight path is oriented such that the bogey would come from the right of the fighter's flight path and pass to the left of it.

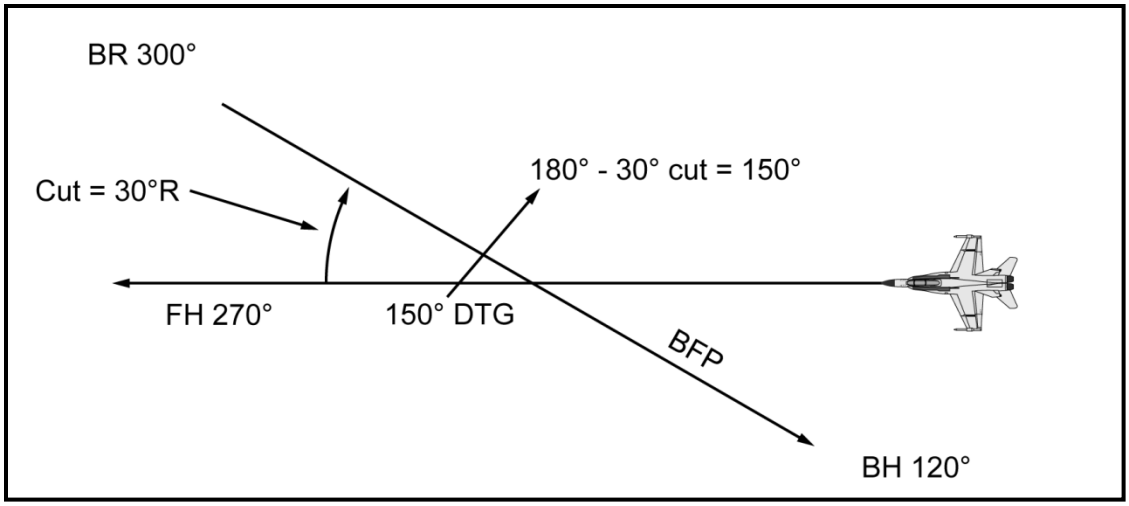


**Figure 4-4 Right to Left Pass**

## 406. DTG DEFINED

Degrees-To-Go (DTG) is the shortest number of degrees the fighter needs to turn to parallel the bogey's flight path, or turn to the bogey's heading. Because the DTG and cut form a straight line (the bogey's flight path), their sum equals 180°. The recommended procedure for computing DTG is to subtract the cut from 180°.

## 407. TARGET ASPECT AND ASPECT ANGLE DEFINED

TA is the line of sight angle from the target's nose to the fighter (how the bogey sees the fighter). It is analogous to the fighter's AO. It is measured in direction right or left of the target's flight path.

AA is the angle from the bearing line of the tail of the target to the fighter. It is also measured in direction right or left of the target's flight path.

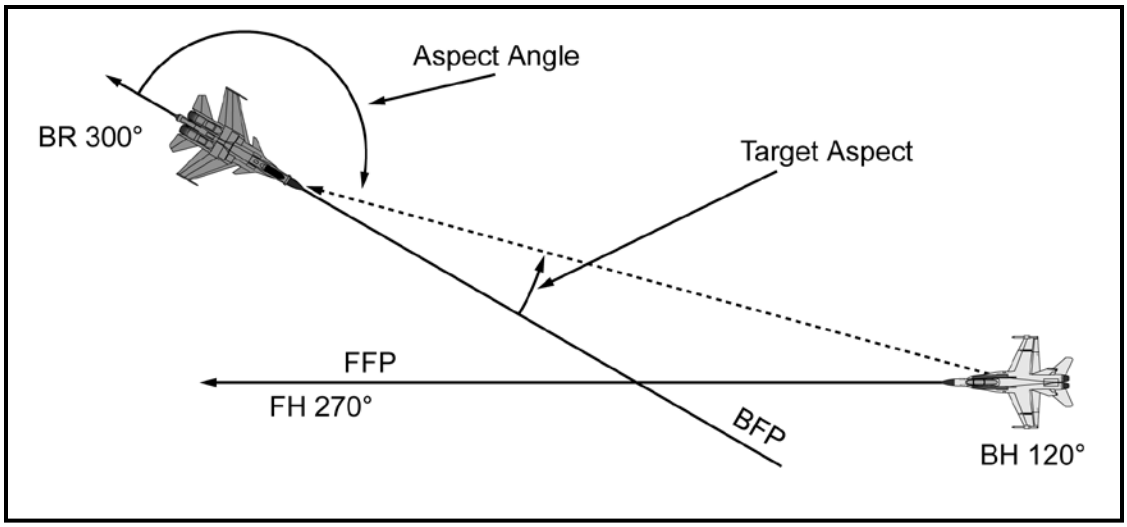


**Figure 4-5 Target Aspect and Aspect Angle**

## 408. INTERCEPT TRIANGULATION

Once aircrew establish the bogey and fighter positions on their respective flight paths, a triangle is formed by the flight paths of the aircraft and the bearing line between aircraft.

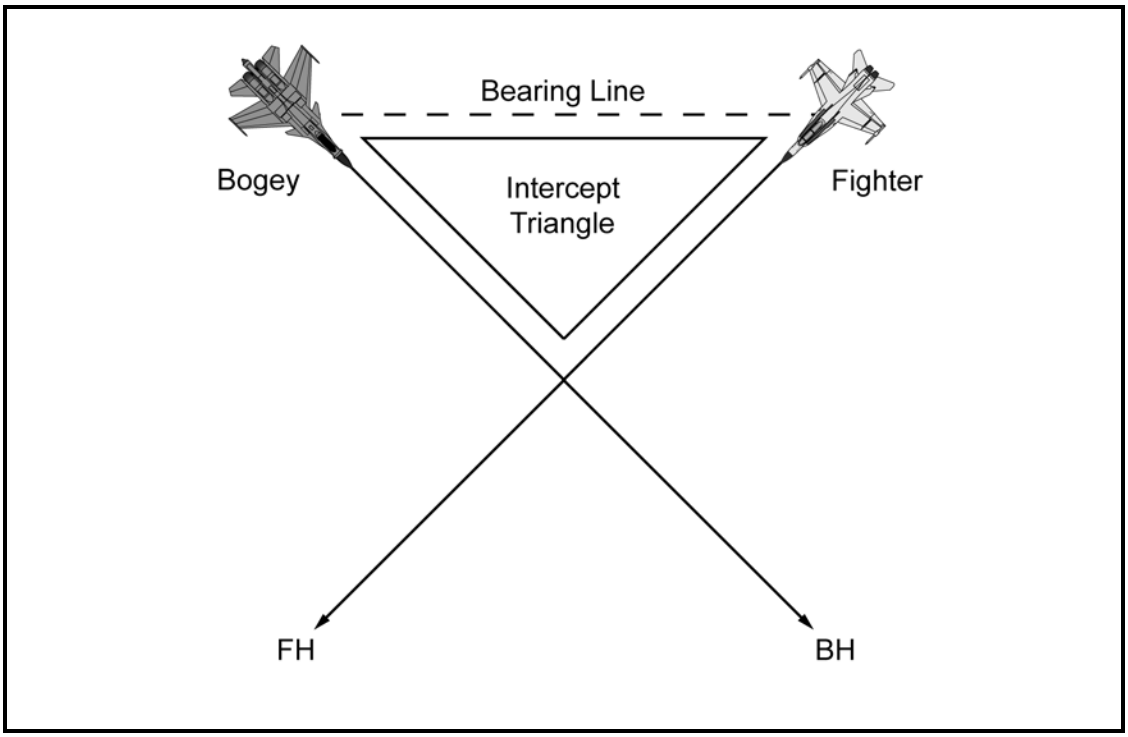


**Figure 4-6 Intercept Triangulation**

This intercept triangle is a useful tool to visualize angles such as DTG, cut, AO, and TA. When combined with the fact that the three interior angles a triangle always add up to 180°, a more complete spatial picture can be obtained. TA and consequently AA, can always be calculated if either BB or AO and DTG are known.

## 409. FLIGHT PATH VISUALIZATION PROCEDURES

The procedure for flight path visualization must make use of the cut, DTG, and DOP. The BH and BB are received from the GCI controller. After receiving this information, aircrew must first determine the proper FH for a successful intercept. Then the aircrew can visualize the orientation of the fighter and bogey flight paths using the following five steps:

STEP 1 Visualize the FH on the EHSI (for example, 180°).

STEP 2 From the BH (for example, 320°) determine the BR (140°) and visualize its position relative to FH on the fighter's EHSI. Visualize the bogey's flight path as extending from the bogey's reciprocal through the bogey's heading.

STEP 3 Compute the cut. The cut is the angle from fighter’s heading to the BR. (180° to 140° = 40° Left cut).

STEP 4 Compute DTG using the recommended formula: 180° - cut (40°L) = 140 DTG.

STEP 5 The DOP is determined from the cut (relative to the FH). For instance, if bogey recip is left of FH (as in the above example), the DOP is left-to-right; if bogey recip is right of FH, the DOP is right-to-left.

**Example 1:**

By now aircrew should be able to orient the fighter and bogey flight paths given one aircraft heading and either the cut or DTG/DOP.

Given a FH of 030° and 150 DTG R-L pass

STEP 1 Since we have a 150 DTG R-L, we have a 30° R cut (180° - 150° = 30°)

STEP 2 Since cut = FH to BR, we go from FH of 030° to BR of 060°

STEP 3 If BR is 060°, then BH is 240°

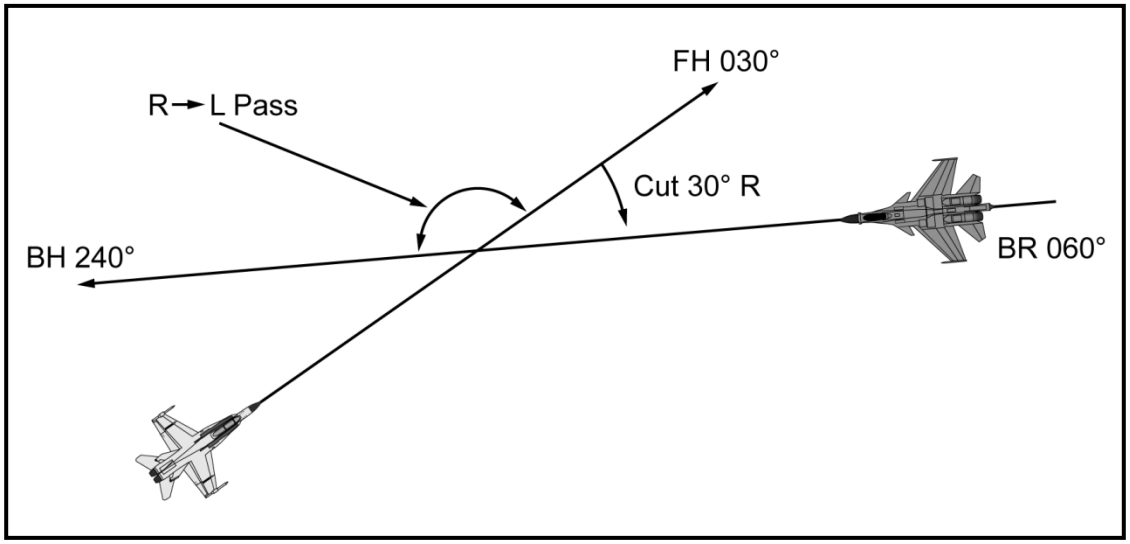


**Figure 4-7 R-L Pass**

Note that aircraft positions on their respective flight paths do not come into play. Only the flight paths themselves and the angles made by their intersection are significant at this time.

**Example 2:**

Given 140 DTG L-R
with 30° L AO

140° + 30° + TA = 180°
TA = 10° R
AA = 180° - 10° R = 170° R

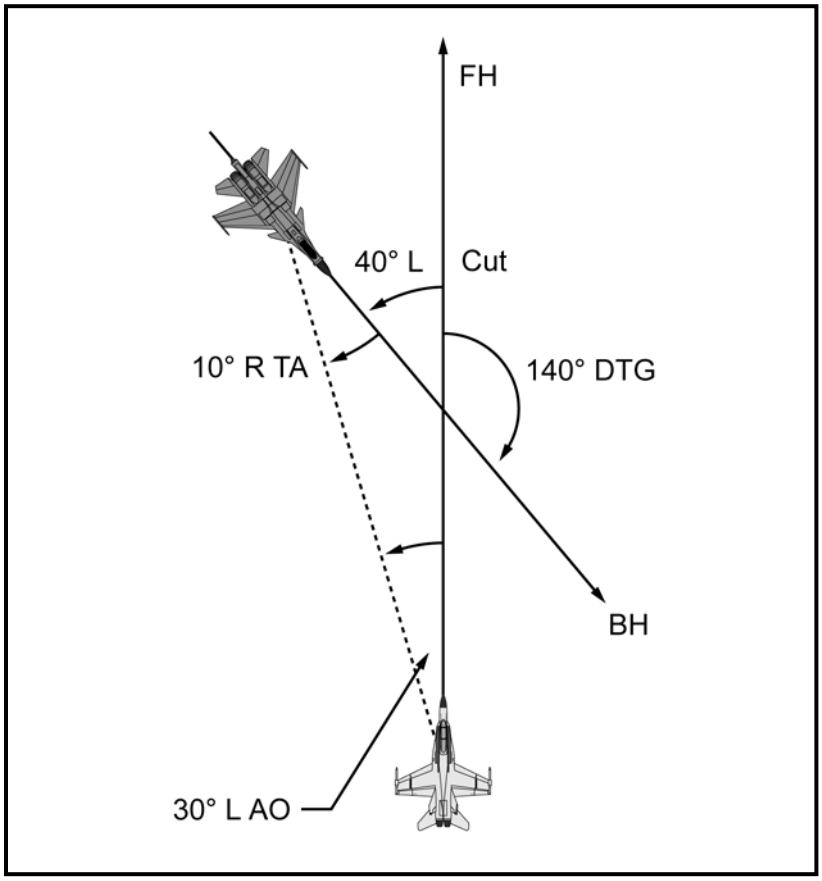


**Figure 4-8 L-R Pass**

While this method of drawing intercept triangles helps the aircrew visualize the spatial picture, it takes far too long to be practical during an actual intercept. Consequently, aircrew should practice drawing these triangles until AO, cut; DTG, DOP, and most importantly, TA are firmly defined and visualized. Once this has been accomplished, aircrew should be ready for the real thing.

**This page reserved for Notes**

*"As long as I look right into the (gun) muzzles, nothing can happen to me. Only if he pulls lead am I in danger."*

*Hauptmann* (Captain) Hans-Joachim Marseille, *Luftwaffe*
WWII, 158 Victories (17 in one day)
Knight's Cross with Diamonds

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# CHAPTER FIVE
# FUNDAMENTALS OF INTERCEPT GEOMETRY I

## 500. INTRODUCTION

An air-to-air intercept is a relative motion problem in which the weapons officer is constantly striving to control the position of the fighter in relation to the bogey aircraft. The weapons officer must not only know the correct intercept procedures in their entirety, but must also be able to consistently execute them with speed and accuracy. The ultimate goal is to continually visualize the spatial picture between the two aircraft. The weapons officer must automatically analyze the problem and take corrective action to ensure a successful intercept.

## 501. INTERCEPT TERMS

The intercept terms that have been introduced already are listed below:

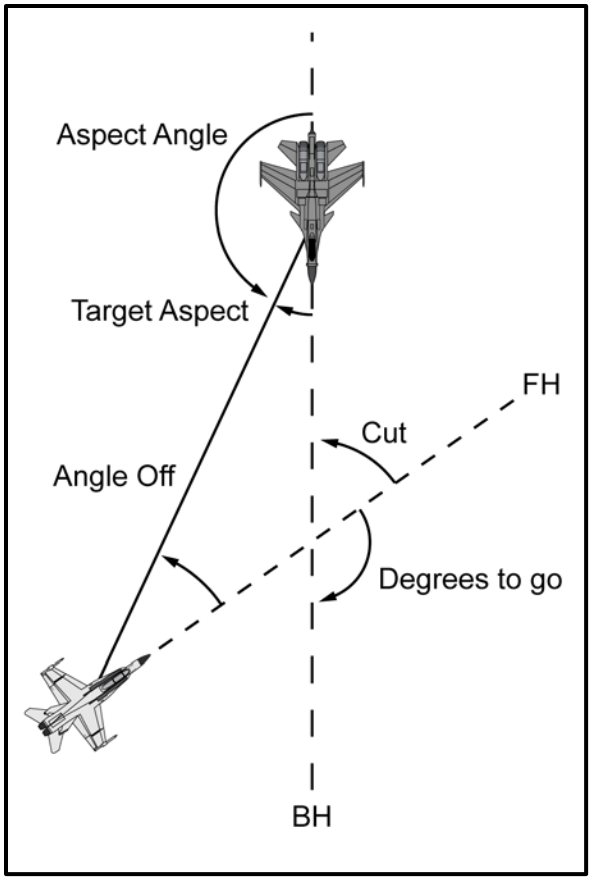


**Figure 5-1 Intercept Terms**

## 502. FIGHTER POSITIONS

During the intercept, there are four approach quadrants that influence the way we accomplish the intercept.

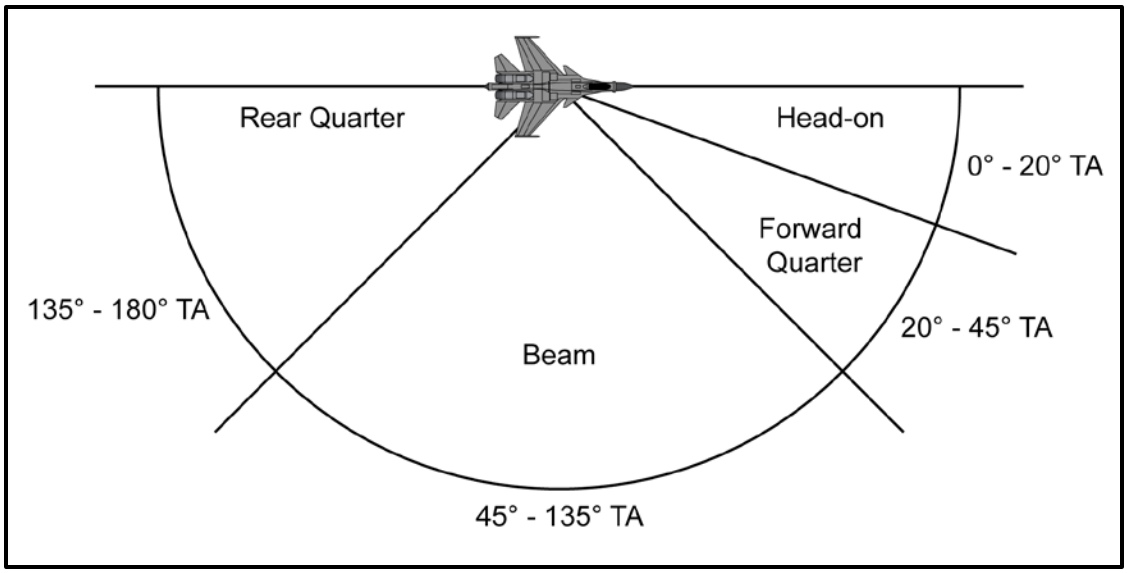


**Figure 5-2 Fighter Positions**

## 503. POSITION ADVANTAGE

For our purposes at VT-86, positional advantage is a relative term used to describe the fighter's ability to defend an asset (i.e., the carrier) or some other defined point against an attack from the enemy. With a BH towards a defined point, less TA means the fighter will be in a more advantageous position from which to defend against the bogey. Hence, as TA decreases, positional advantage increases. This is true at ranges from which forward quarter missiles are used. Once a forward quarter missile is employed, the fighter will attempt to increase TA in order to achieve a position at the bogey's six, thus gaining a rear quarter positional advantage with high TA. This is the goal you will strive to achieve while at VT-86.

## 504. COMPUTING LATERAL SEPARATION

Lateral separation is the perpendicular distance from the fighter to the bogey's flight path. Lateral separation (lat sep, also called lateral displacement, or LD) occurs in the horizontal plane. It may be measured in terms of feet or nautical miles and is determined from TA and slant range.

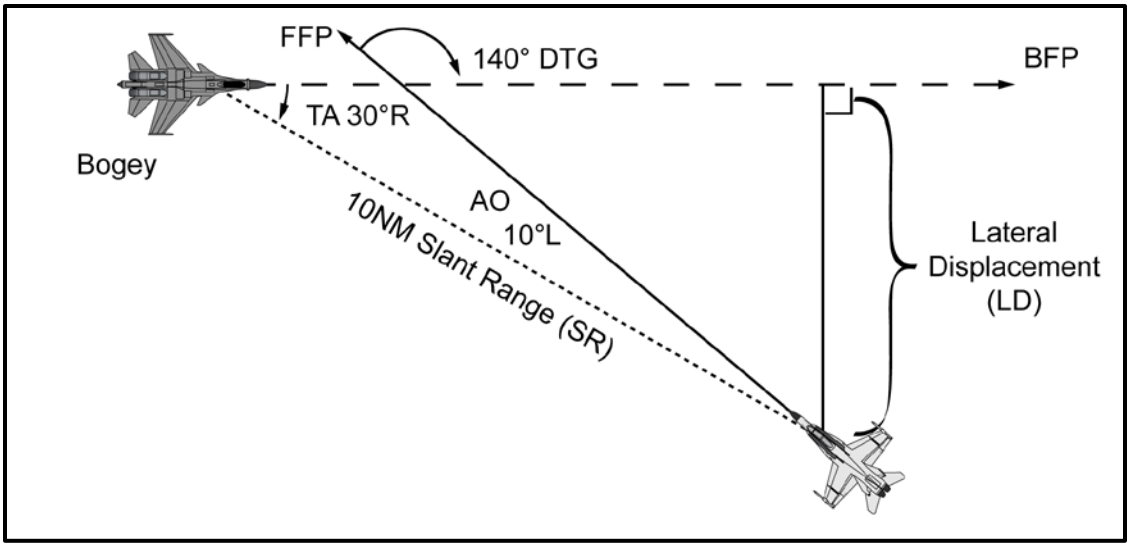


**Figure 5-3 Lateral Separation**

Lateral separation (feet) = TA X SR X 100, which in the above example would be 30 (TA) X 10 (NM) X 100 = 30,000 feet. The actual formula involves trigonometric functions, but the above formula is accurate enough for intercept execution.

Further, lat sep may be computed in miles by simply taking the feet of lat sep divided by 6000 (6000 feet = approximately 1 nautical mile).

$$\frac{TA \times SR \times 100}{6000} \quad \text{or} \quad \frac{TA \times SR}{60}$$

The formula for computing lateral separation in feet is:

LD' = TA x SR x 100

## 505. VERTICAL DISPLACEMENT

Vertical displacement is the perpendicular distance the fighter is located above or below the bogey's flight path. This represents the altitude difference between the fighter and bogey and should be computed in feet. Note that the formula for vertical displacement is the same as the one for LD with the exception that degrees of elevation are used instead of TA.

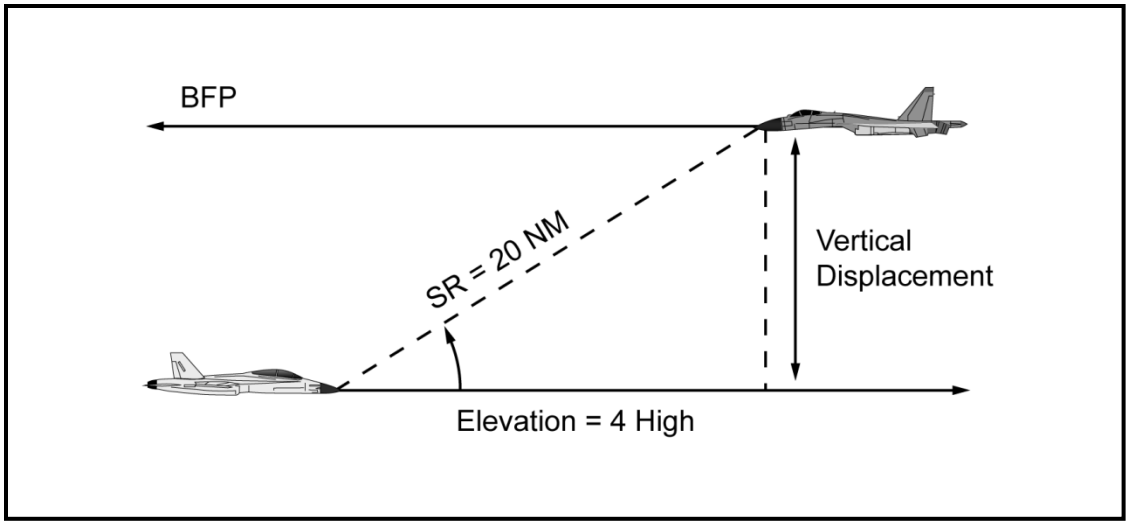


**Figure 5-4 Vertical Displacement**

**NOTE**

Vertical displacement (feet) = Elevation X SR X 100

In the example above, the bogey is 4° high at 20 miles; therefore 4 x 20 x 100 means that the bogey is 8000 feet above the fighter.

## 506. ELEVATION ANGLE

During real world intercepts, you will frequently be told the altitude of the bogey and must compute the elevation in order to determine where to look for it. Therefore, you must be able to work the vertical displacement problem in reverse.

**Example:**

The bogey is at 30,000 feet at 20 miles with the fighter level at 10,000 feet. Where do you look for the bogey with your radar?

30,000 feet - 10,000 feet = 20,000 feet of vertical displacement

$$\frac{20{,}000 \text{ feet}}{20 \text{ NM} \times 100} = \frac{20}{2} = 10° \text{ of elevation}$$

This formula may be simplified by dropping the two zeros from the altitude difference and then dividing by the slant range.

20,000 feet -- dropping the two zeros = 200, divided by a SR of 20 miles = 10° of elevation.

## 507. RATE OF CLOSURE (ROC)

The ROC is the sum of the fighter's and bogey's true airspeeds measured along the bearing line between the aircraft. The variables that affect the ROC are:

1. TA
2. AO
3. Bogey true airspeed
4. Fighter true airspeed

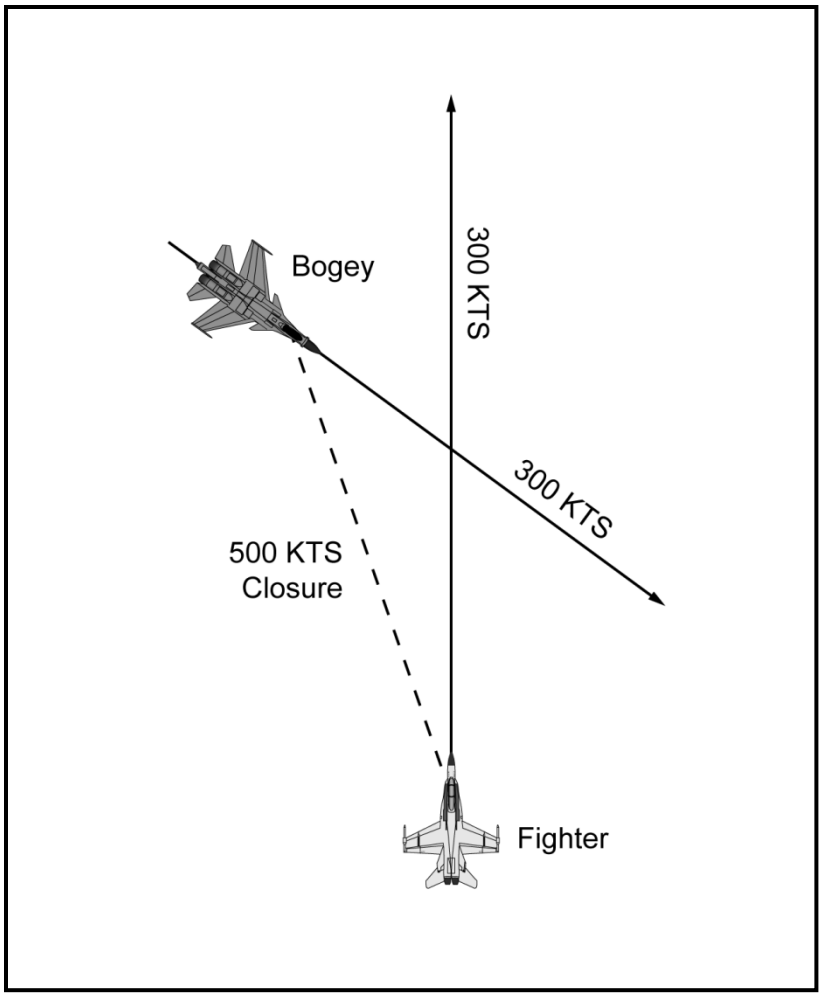


**Figure 5-5 Rate of Closure**

## 508. TARGET ASPECT AND RATE OF CLOSURE

The smaller the TA and AO, the higher the ROC. With zero degrees TA and zero degrees AO, and both aircraft traveling at 300 knots the ROC will be 600 knots. The illustration provided below should help you to visualize this concept.

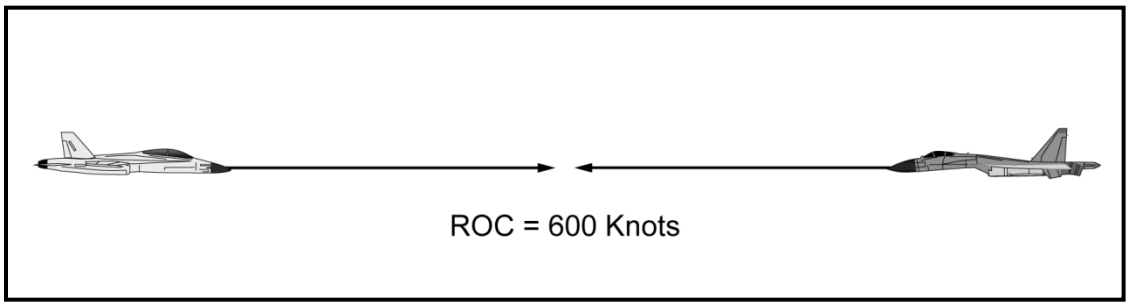


**Figure 5-6 Target Aspect and Rate of Closure**

With varying degrees of TA and/or AA, the ROC will always be less than it is for zero degrees of TA. The aircrew can interpolate the drop in ROC as TA increases from 0 to 90. At the 90 DTG position, the ROC will be the airspeed of the fighter aircraft.

## 509. CONCLUSION

The concepts presented in this unit must be committed to memory because they are the fundamentals for all intercepts. Proper understanding of these principles must become automatic to correctly execute an intercept.

**This page reserved for Notes**

*"No guts, no glory. If you are going to shoot him down, you have to get in there and mix it up with him."*

Major Frederick C. "Boots" Blesse, USAF
Korean War, 10 Victories

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# CHAPTER SIX
# FUNDAMENTALS OF INTERCEPT GEOMETRY II

## 600. INTRODUCTION

The ultimate manner of controlling drift is establishing a collision course. A collision course is defined as the course flown by the fighter that will result in a mid air collision. A contact which is on collision will not drift. A contact which is not on collision must drift and it will always drift away from collision bearing (CB). CB has a direct impact on intercept control.

## 601. COLLISION BEARING

CB is defined as an angle equal to one-half the cut angle and in the same direction as the cut (assuming a co-speed intercept). CB is also referred to as Collision Antenna Train Angle (CATA).

**Example:**

40° Left cut

$$\frac{40°\text{L cut}}{2} = 20° \text{ Left CB}$$

When a co-speed collision intercept is established, the AO will be equal to the CB. For example, 150 DTG, 30°R cut, AO 15°R. (1/2 of 30°R = 15°R)

On the B-scope presentation shown in Figure 6-1, note that the bogey starts off of CB. The important point to note is that once a contact is off of CB; its drift is always away from CB.

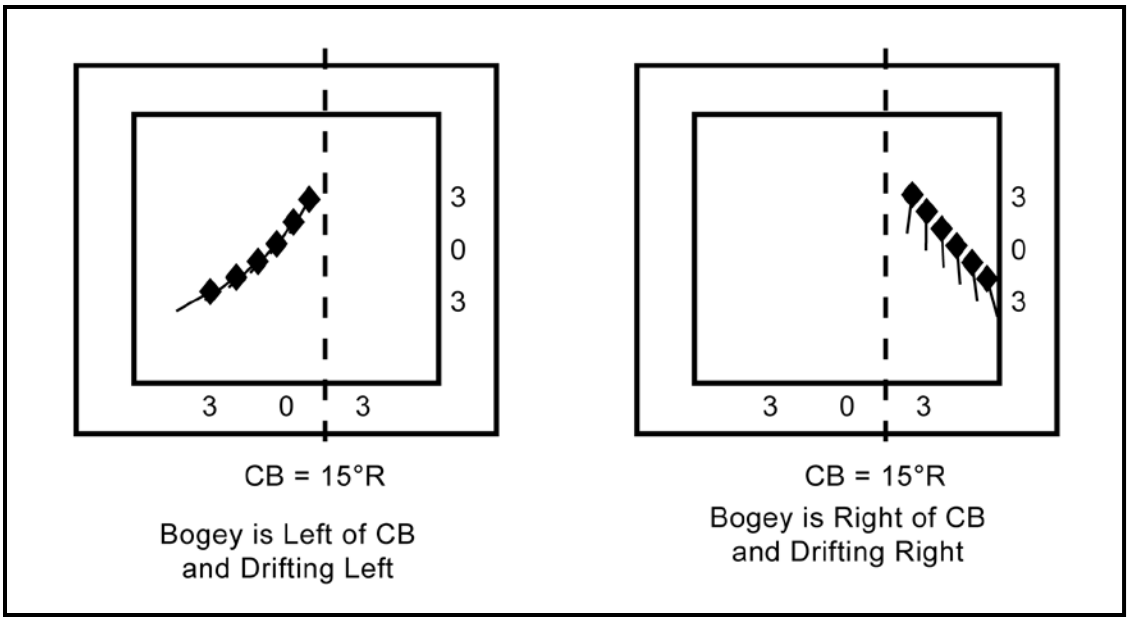


**Figure 6-1 Collision Bearing**

**NOTE**

A bogey off CB will always drift, and the drift will always be away from CB.

## 602. DRIFT

To visualize the concept of drift when a bogey is off of CB, imagine driving down a straight highway and seeing a billboard off to the right up ahead. Since your car and the billboard are not on collision, the sign will appear to drift across your windshield to the right.

Drift is measured as the degrees of change in AO per mile of slant range.

There are five categories of drift rates:

1. Intercept: On CB; a vertical line on the B-scope.

2. Visible: 5° azimuth change per mile of slant range.

3. Moderate: 1° azimuth change per mile of slant range.

4. Sharp: 2° azimuth change per mile of slant range.

5. Flat: 3° or greater azimuth change per mile of slant range.

When a CB is established, AO = CB = CATA.

Once this is accomplished, the appropriate descriptive commentary will be: *"Bogey is on collision."*

## 603. BOGEY OFF COLLISION COURSE

If a CB intercept is not established, then one of two things can happen:

1. Either the bogey will pass in front of the fighter as represented in Figure 6-2 (a good thing at close range).

2. Or the fighter will pass in front of the bogey as represented in Figure 6-3 (a bad thing).

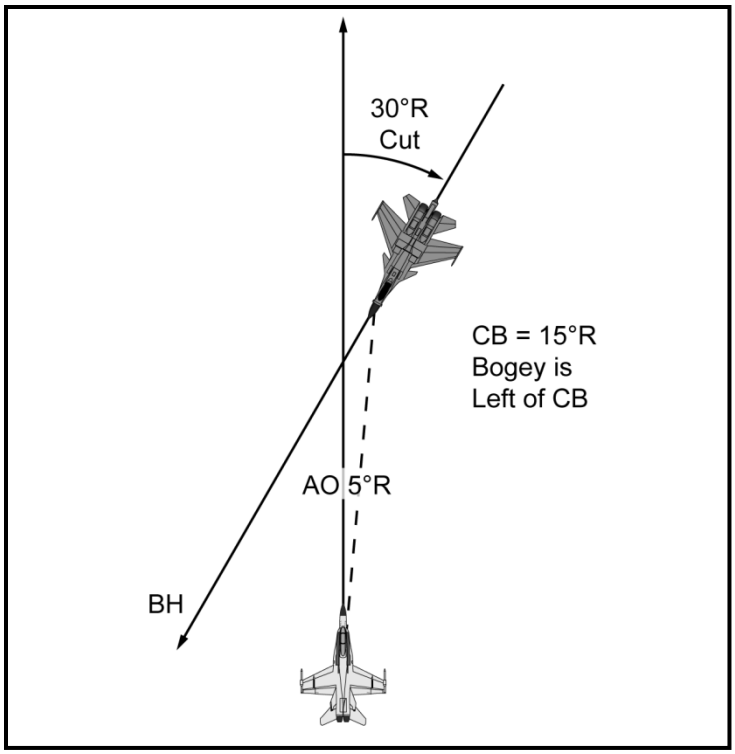


**Figure 6-2 Bogey Pass**

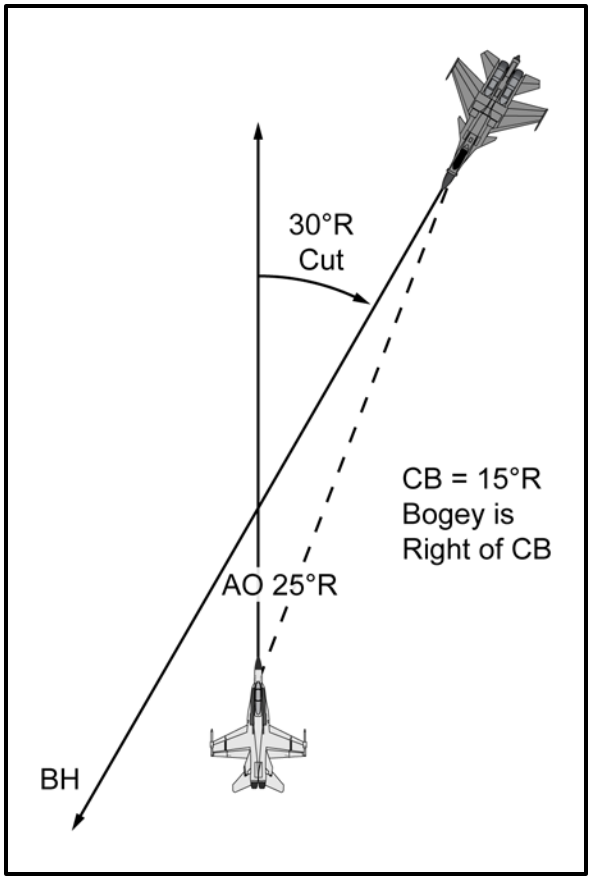


**Figure 6-3 Fighter Pass**

## 604. PREDICTING ANGLE OFF

We know the bogey will always drift away from collision if it is not on CB. Provided there is no change in the BH or FH, AO can be predicted by utilizing the following formula:

**NOTE**

As the range halves, the number of degrees the bogey is off CB will double.

In Figure 6-4, DTG is 160, R-L pass, with CB at 10°R. (Remember, since CB is always 1/2 the cut, you must therefore have a 20°R cut). If the bogey has an AO of 20°R at 20 miles, how can you predict the future AO?

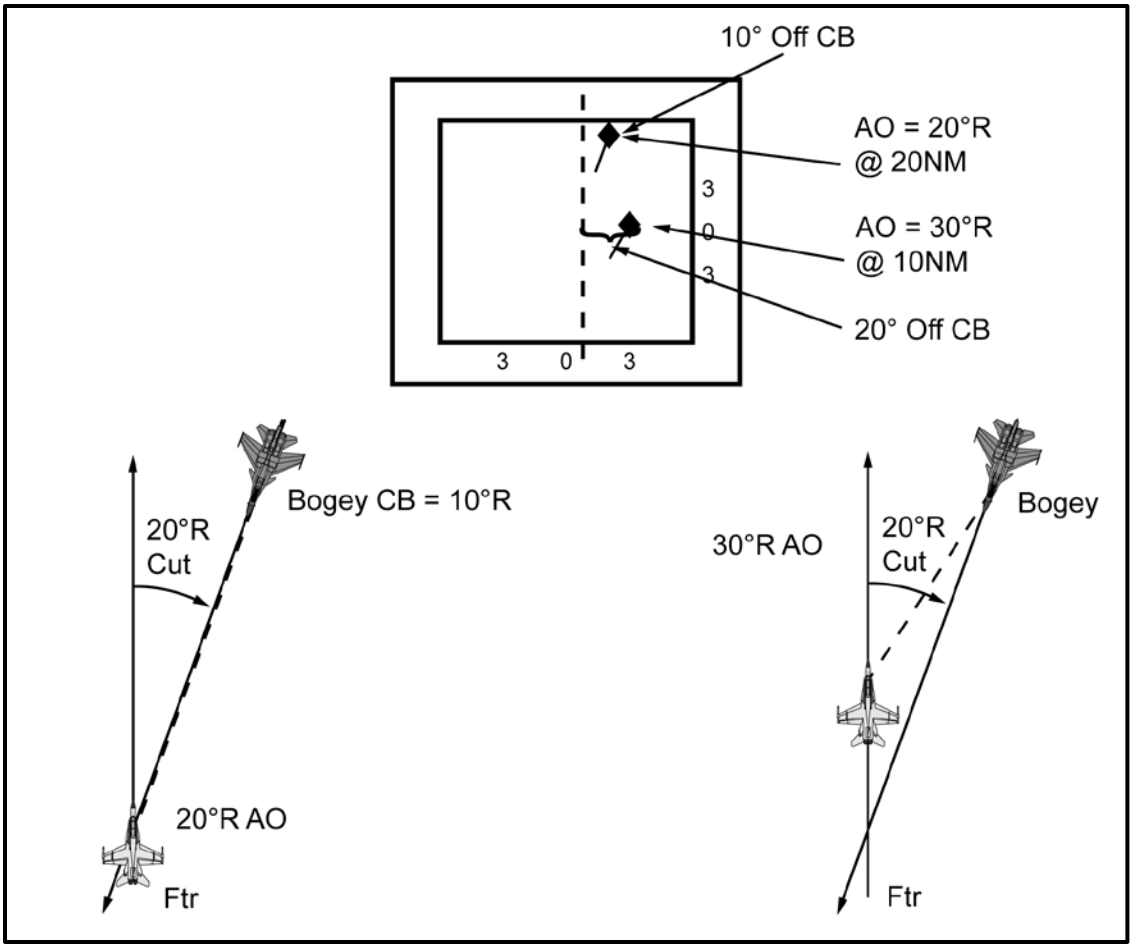


**Figure 6-4 Bogey Positions**

Use the formula provided to work through this example:

**Example 1:**

With 160° R-L, 10°R CB and 20°R AO at 20 miles, the bogey is 10° off CB.

**Example 2:**

The bogey will be twice the distance off CB at 10 miles, or the bogey will be 20°R of CB provided neither aircraft changed heading. Additionally, the cut and CB have remained constant (20°R cut and 10°R CB). The bogey is now 20°R of the 10°R CB, putting the bogey at 30°R AO.

## 605. CHANGING TARGET ASPECT

We have established that if the bogey is not on CB, or AO does not equal collision bearing (CATA), drift will occur. For every degree the bogey drifts in AO, there will be an equal amount of change in TA.

For example, in Figure 6-4 note the change in TA in a 160 DTG, R-L situation where the CB is 10°R (20°R cut) with the bogey at 20°R AO and the TA 0°. The bogey is 10° right of CB and will, therefore, drift to the right. After 10° of drift the bogey will be 30°R and, since the set-up is the same, the TA will have changed by an amount equal to the amount of drift. Consequently, the TA would be 10°R; 10° of drift changed the TA by 10°.

## 606. PROOF WITH A 180 DTG SET-UP

The previous rule can be proven most easily in the special case of a set-up with 180 DTG (or 0° Cut), depicted in Figures 6-5 and 6-6. Assume 0° Cut with 10°R AO at 20 miles.

**NOTE**

With 180 DTG, AO = TA in both amount and direction.

The LD is 20,000 feet, and will remain constant since the fighter flight path (FFP) is parallel to the bogey flight path (BFP).

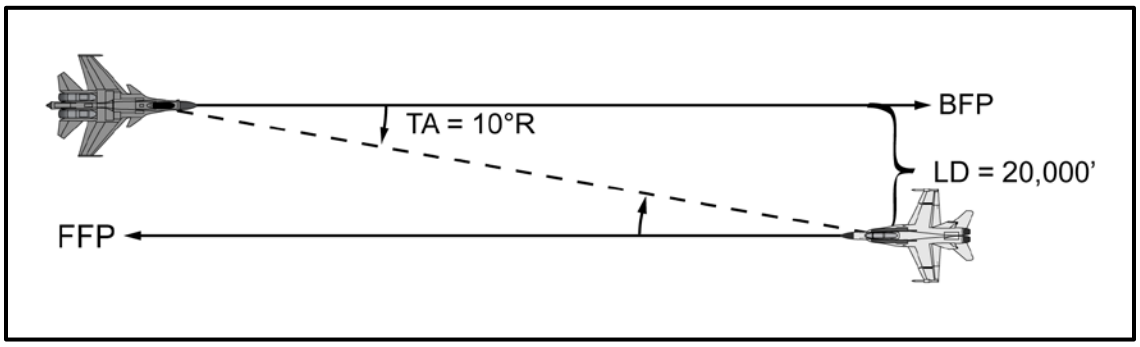


**Figure 6-5 180 DTG**

Therefore, at 10 miles, the TA will have to be a quantity such that TA x SR x 100 = LD of 20,000 feet. Working backwards, 20,000 = 10 NM x 100 x TA; TA = 20,000/1000 = 20°R.

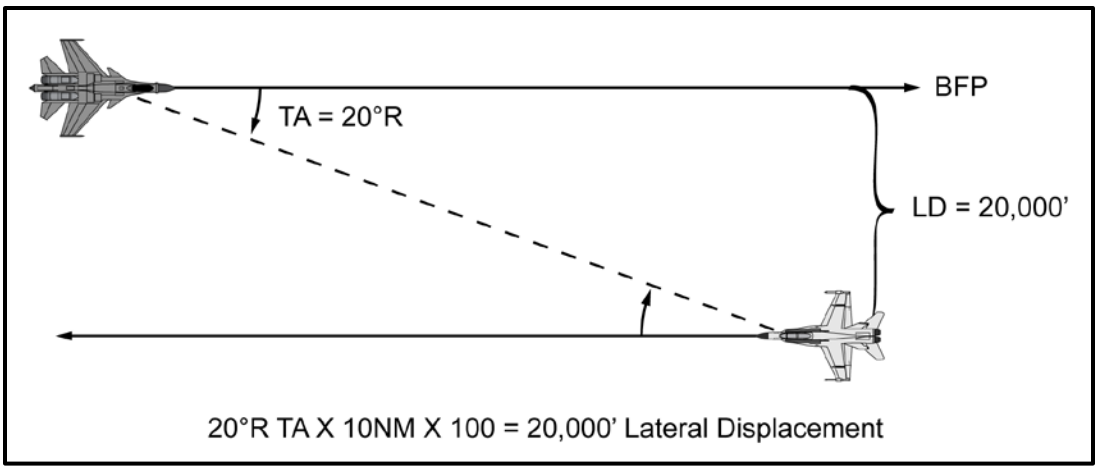


**Figure 6-6 20,000 feet Lateral Displacement**

It should be re-emphasized that CB with 0 Cut is 0° AO 180 DTG is dead ahead (DA) and the bogey was 10°R of CB at 20 miles and is now 20°R of CB at 10 miles, verifying the drift projection rule.

## 607. SPATIAL PICTURE

To comprehend the fighter's positional advantage or disadvantage, it is paramount to have a good understanding of the spatial relationship between the fighter and the bogey.

At VT-86, TA is the most important variable in the fundamental intercept triangle. It is this angle that determines the type of intercept that should be accomplished, the amount of LD available for a reattack (counterturn), and the parameters required for a valid missile shot.

There are only three possible situations in which the fighter and bogey can be oriented. Each situation should be carefully studied and completely understood before proceeding.

**Situation 1:**

Spatial picture - Fighter and bogey are short of each other's flight path, on collision.

Recognition - AO is less than the cut. Direction of AO is the same as the direction of the cut.

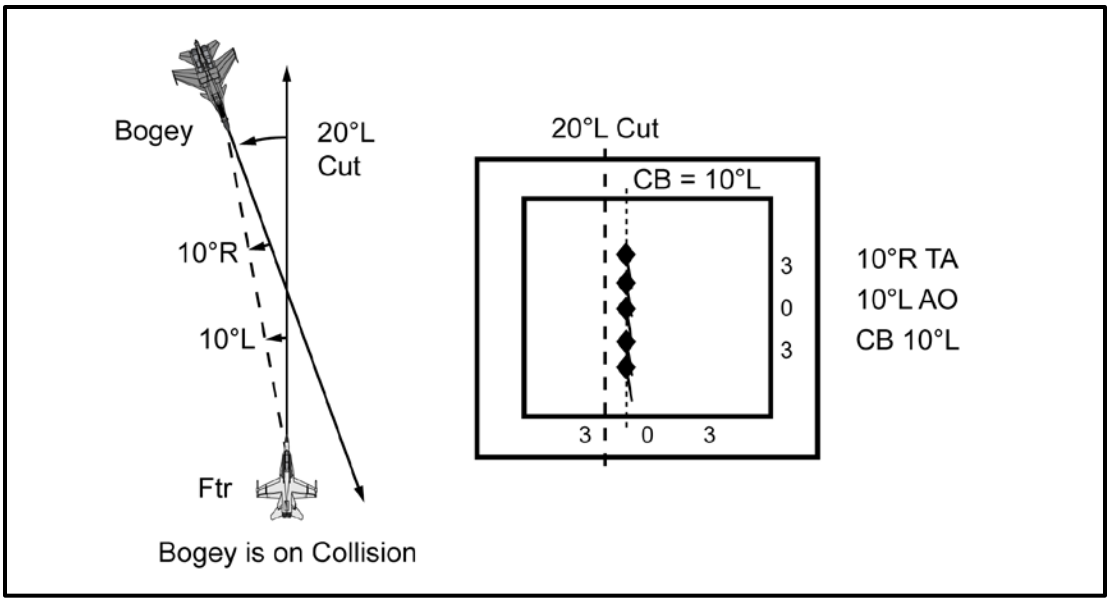


**Figure 6-7 Situation 1**

**Situation 2:**

Spatial Picture - Fighter is near or about to cross BFP.

Recognition - AO is greater than the CB. AO is in the same direction as the cut.

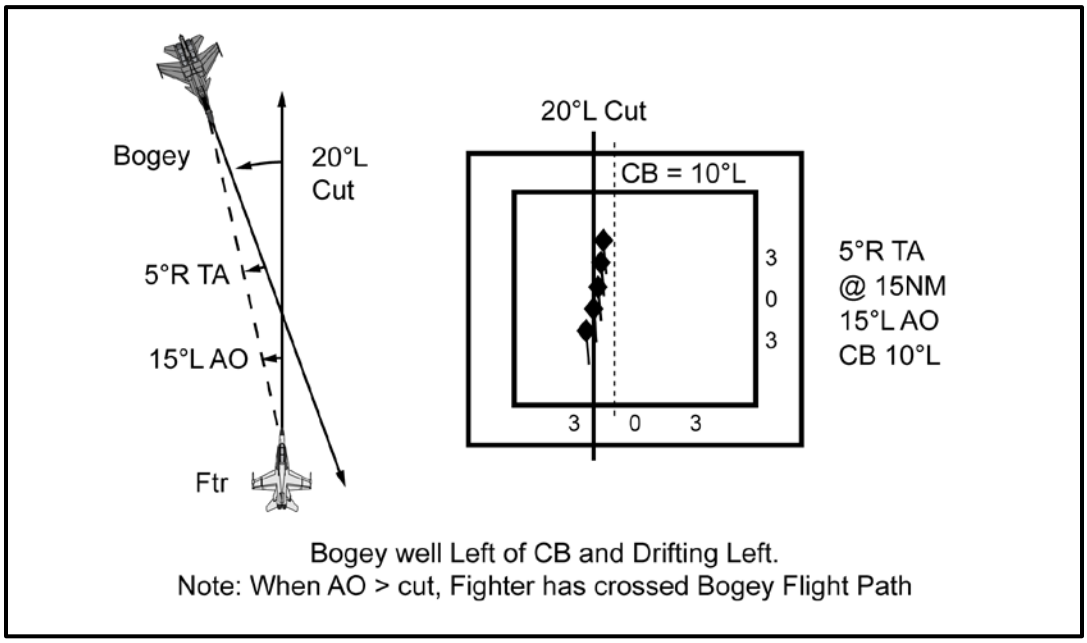


**Figure 6-8 Situation 2**

**Situation 3:**

Spatial picture Bogey is near or about to cross FFP.

Recognition - AO is less than the CB, positioned dead ahead or on the opposite side of scope.

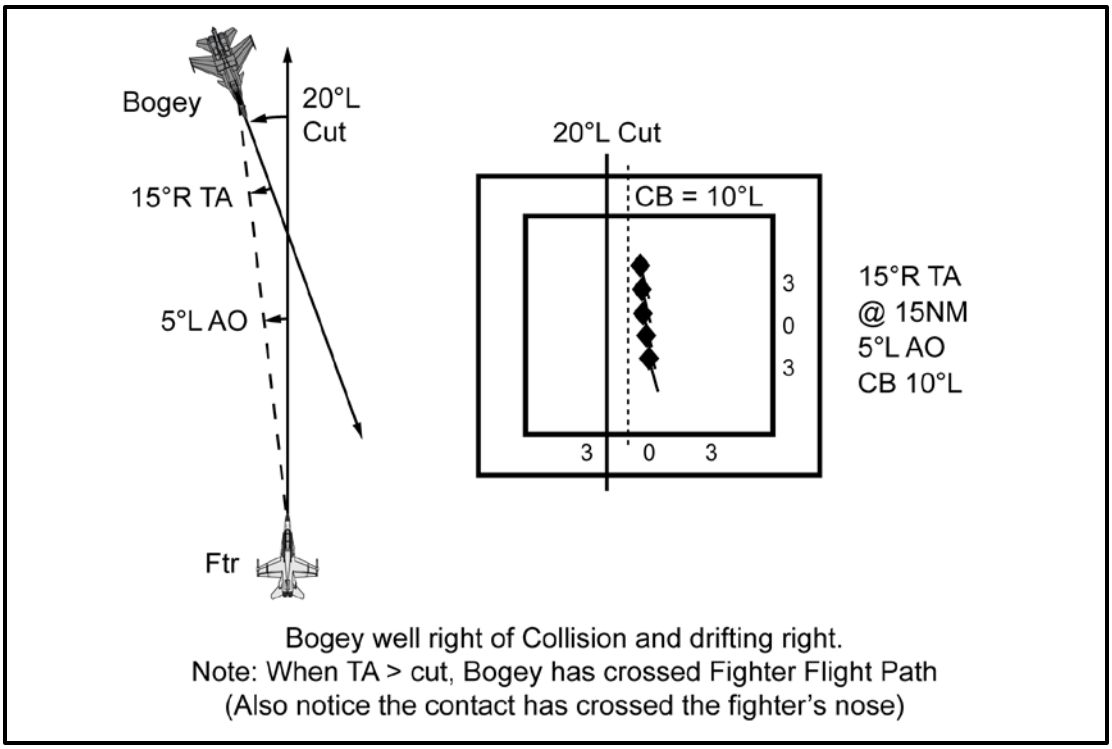


**Figure 6-9 Situation 3**

An appreciation for these spatial pictures may be established by the following exercise. Select any cut, DTG, and DOP. Make these with any AO and direction of AO. Then arrive at the appropriate spatial picture by comparing the AO and computed TA with the recognition features. Granted, this appears to be a mechanical approach at first, but after doing several hundred exercises, the spatial picture will come almost automatically.

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*"The smallest amount of vanity is fatal in airplane fighting. Self-distrust rather is the quality to which many a pilot owes his protracted existence."*

Captain Edward V. 'Eddie' Rickenbacker.

# CHAPTER SEVEN
# TARGET ASPECT FORMULA AND COLLISION COURSE CORRECTIONS

## 700. INTRODUCTION

This unit will review some basic concepts from the previous chapters to include TA, AA, and Collision Heading. The chapter will then go on to discuss how a fighter can manipulate his own heading to ensure that a collision course is established.

## 701. TARGET ASPECT VISUALIZATION

TA is the angle formed by the intersection of the bogey's flight path and the magnetic bearing line between both aircraft. TA is always expressed in degrees with a direction. Quite simply:

**NOTE**

TA is the angle by which the bogey sees the fighter.

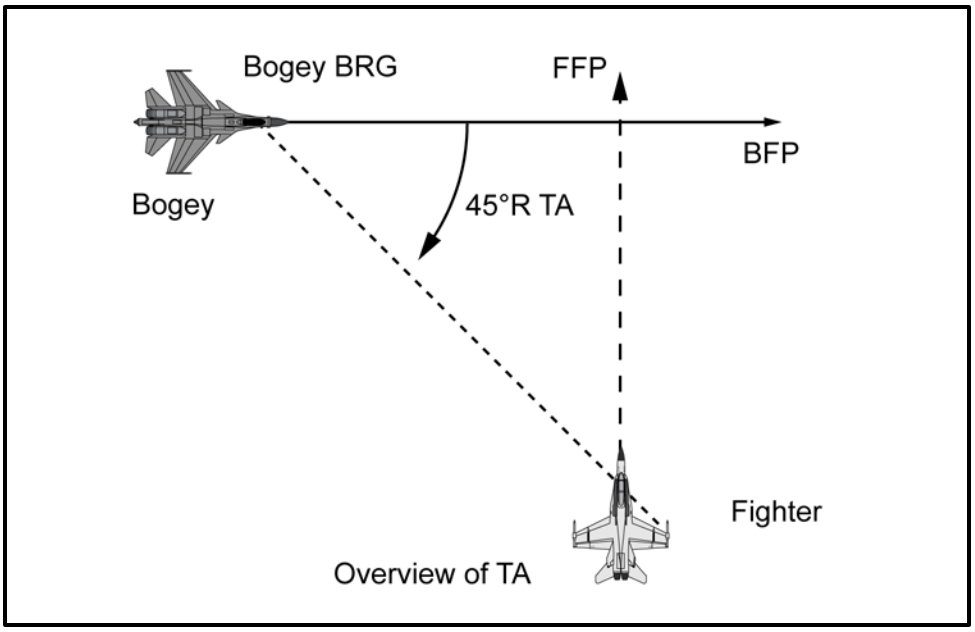


**Figure 7-1 Overview of TA**

**NOTE**

TA will not instantaneously change when the fighter maneuvers.
TA will change over time when the fighter maneuvers if the bogey is not on collision.

## 702. RELATIONSHIP OF FIGHTER HEADING TO TARGET ASPECT

During an intercept, the fighter will maneuver his aircraft in space relative to the bogey in order to employ their weapons. Since the fighter must change heading to intercept the bogey, all angles of the intercept associated with the fighter's heading are also subject to change. These angles include: AO, degrees-to-go, and cut. Conversely, if the bogey does not change heading (which it will not do for the first stage of the Strike Fighter Syllabus), its flight path remains fixed in space. Therefore, the TA changes only when the fighter changes its position in space relative to the bogey.

TA must be monitored during the intercept because it provides the only fixed reference to the bogey's flight path.

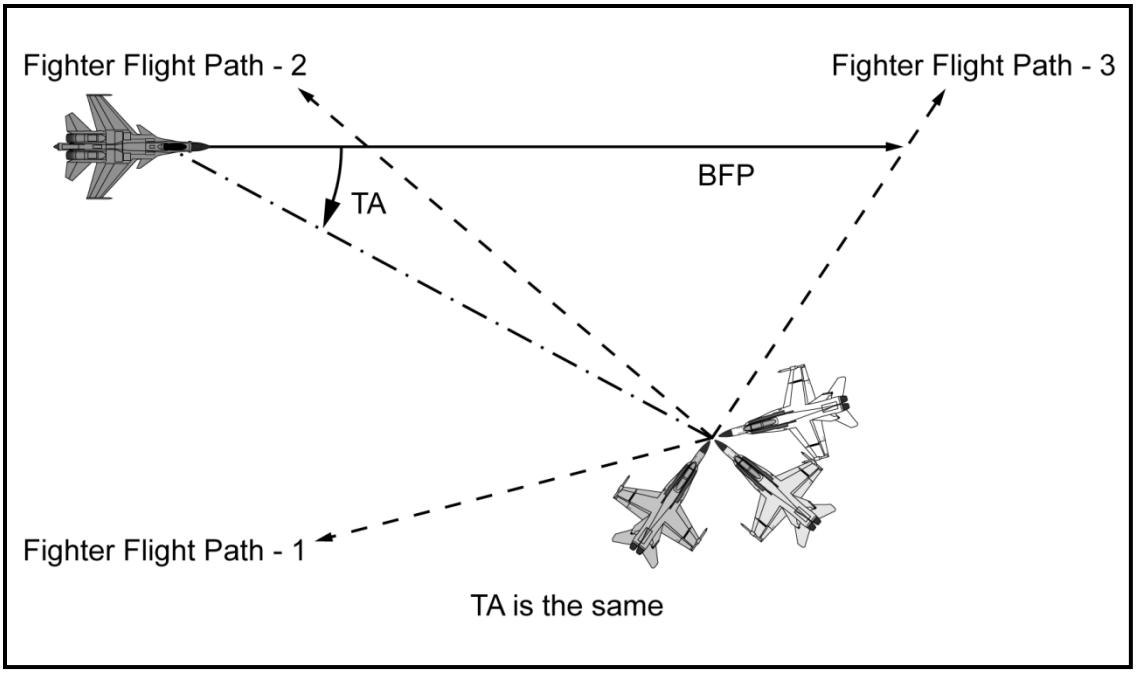


**Figure 7-2 TA is the same**

## 703. CALCULATING THE TARGET ASPECT

There are two primary methods used for determining TA.

The first formula uses the bogey's reciprocal heading (BR) and the magnetic bearing from the fighter to the bogey, known as bogey bearing (BB). TA is the angle from the bogey’s reciprocal to the BB line. Remember that TA is given as a direction and a magnitude. Therefore, always start from the BR and then go to the BB to not confuse the direction of TA.

**NOTE**

Formula 1: BR to BB = TA (L or R)
Formula 2: Cut to AO = TA (L or R)

TA is also equal to the angle from the cut to the AO. When using this formula, always start from the cut and go to the AO so as not to confuse the direction of TA.

In actuality, these formulas are identical. If considering the definition of cut (FH to BR), then it is apparent that both formulas use BR (cut) as the starting point and BB (AO) as the finishing point to determine TA in degrees and direction. The reason the TA formula is stated in two ways is to help aircrew determine TA under different circumstances.

In the initial phase of an intercept, the aircrew will be using GCI information to set up a collision course. In this case, Formula 1 would be most appropriate. Once the weapons officer has a radar contact, it is more desirable to use Formula 2.

## 704. TARGET ASPECT FORMULA VISUALIZATION

The first formula for determining TA, BR to BB, uses the EHSI.

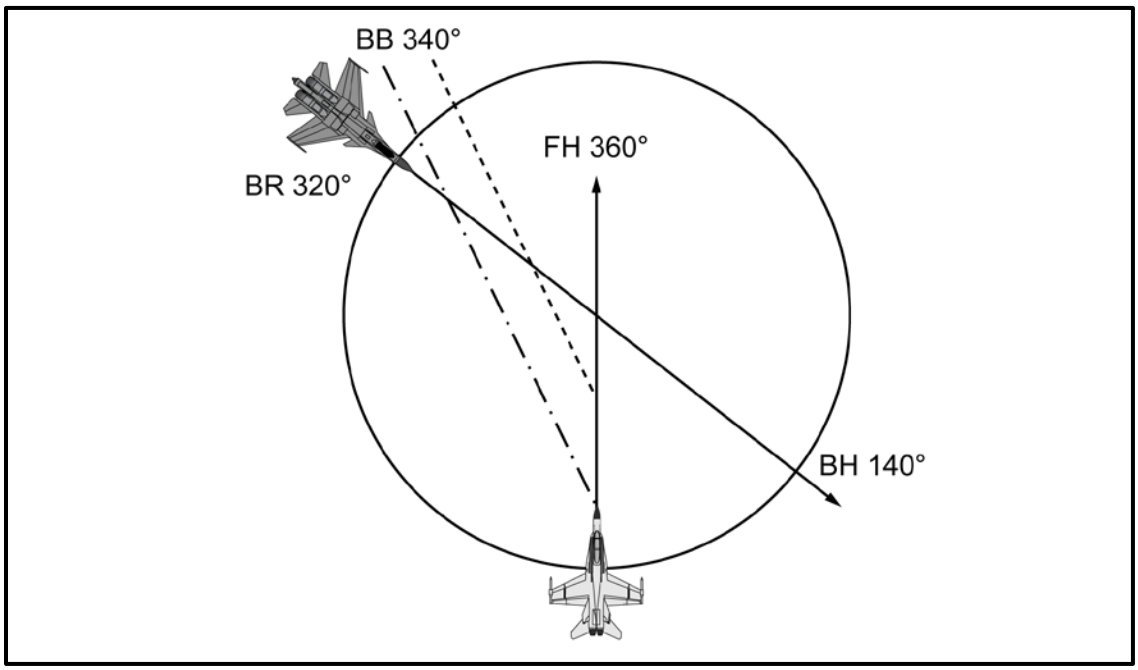


**Figure 7-3 TA Formula Visualization**

In Figure 7-3, the angle measured from the BR over to the extended BB is the same as TA measured from the bogey's nose over to the BB line. Remember, TA has a magnitude in degrees and a direction.

When visualizing an intercept on the scope, TA is measured from the cut to the AO. In Figure 7-4, the cut is 40°L and the AO is 20°L. TA is then 20°R.

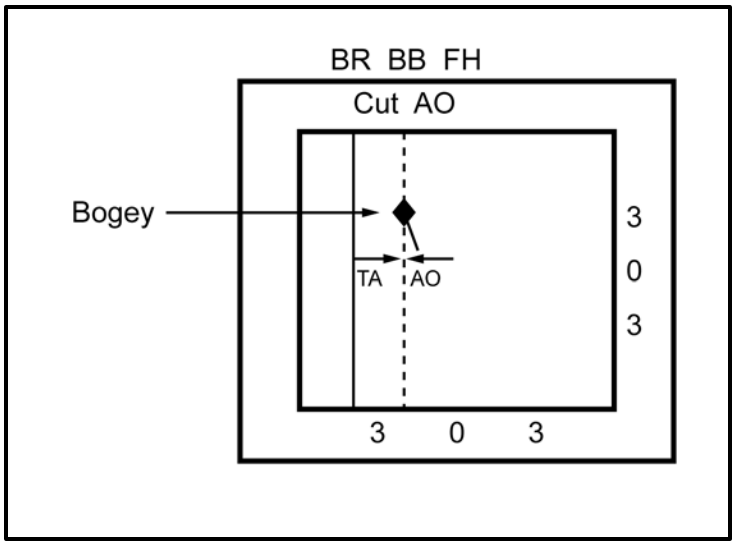


**Figure 7-4 TA Measurement**

## 705. THE CO-SPEED INTERCEPT

For the reattack phase, establishing the collision course will be the initial long-range objective of the fighter. This allows the fighter to close on the bogey in the quickest way possible. The collision course is normally terminated at a point in the intercept and the fighter transitions to a firing position. If a collision course was continued and the fighter and bogey were co-altitude the result would be a mid-air collision between the two aircraft.

A basic assumption during the initial phases at VT-86 is that the fighter and bogey will be co-speed. If both aircraft are co-speed and on collision course, the distance the fighter and bogey will travel to the impact point is the same. As a result, the intercept triangle is an isosceles triangle.

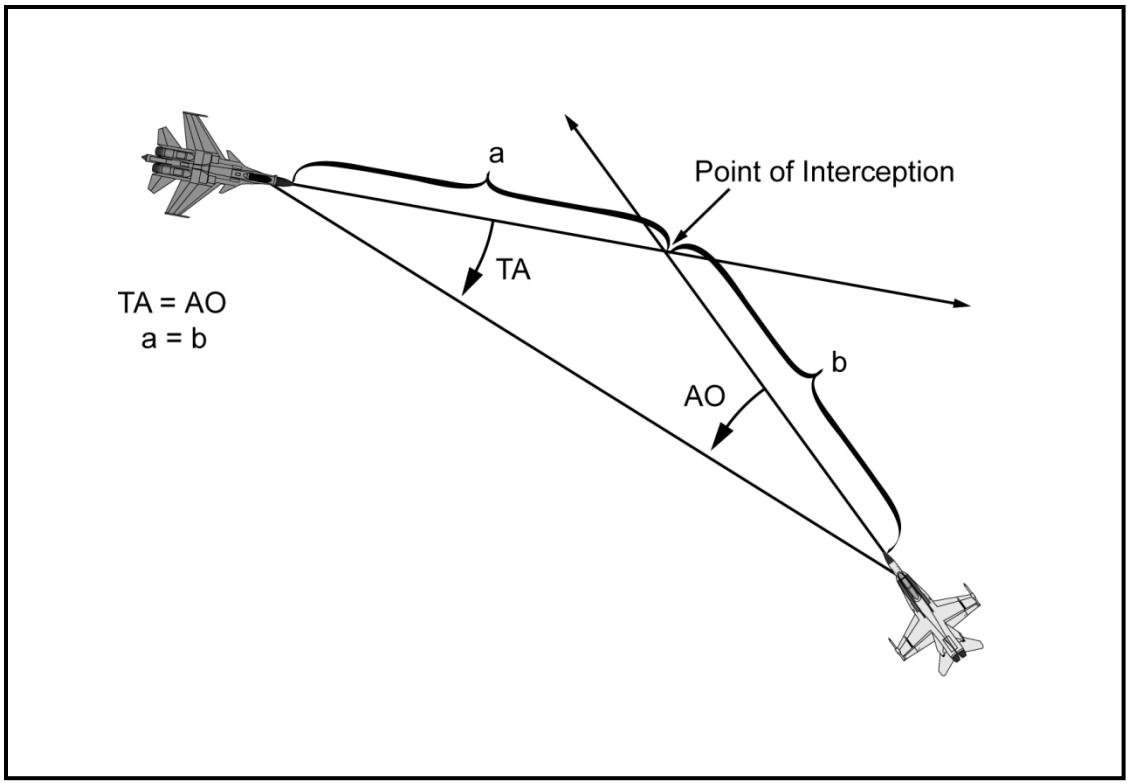


**Figure 7-5 Co-Speed Intercept**

If the intercept triangle is isosceles with the above conditions established, TA must equal AO in magnitude. However, in the above example, note that TA = AO in quantity but they are opposite in direction. The fighter is right of the bogey's nose and the bogey is left of the fighter's nose. Since both aircraft are the same distance from the point of impact and are traveling at the same speed, TA will continue to equal AO in quantity as both aircraft approach the point of impact. This is also known as establishing CBDR (Constant Bearing Decreasing Range).

## 706. COLLISION COURSE DEFINITION

Knowing that TA will always equal AO when a collision intercept has been established in a co-speed situation, the fighter can establish a collision intercept by adjusting its heading to match the AO with the previously calculated TA.

**NOTE**

When co-speed, a collision course is the FH that makes AO equal in quantity, but opposite in direction to TA.

In the following example, if given a 20°R TA, the fighter must turn left to yield the bogey to 20°L AO. This would establish equal and opposite angles of an isosceles triangle or a collision intercept, assuming a co-speed set-up.

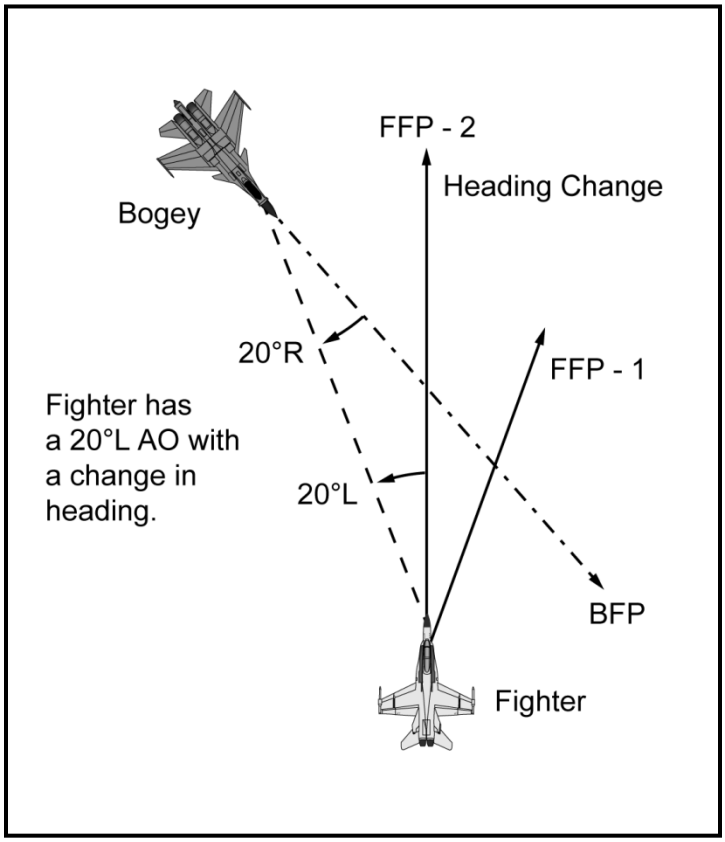


**Figure 7-6 Collision Intercept Example**

## 707. COLLISION COURSE CORRECTION FORMULA 1

During the initial part of an intercept it is the weapons officer's responsibility to establish a collision course based on GCI information. It is imperative to keep speed and accuracy in mind when making collision course corrections (CCCs).

At the beginning of an intercept, the GCI controller will assign a heading to the bogey and recommend the fighter turn left or right for the bogey (this is called the commit phase). The weapons officer will then receive the first bearing call. Since the weapons officer has a BR and a BB, TA can be computed.

The first CCC method goes one step further since it is known that AO must equal TA in a co-speed environment.

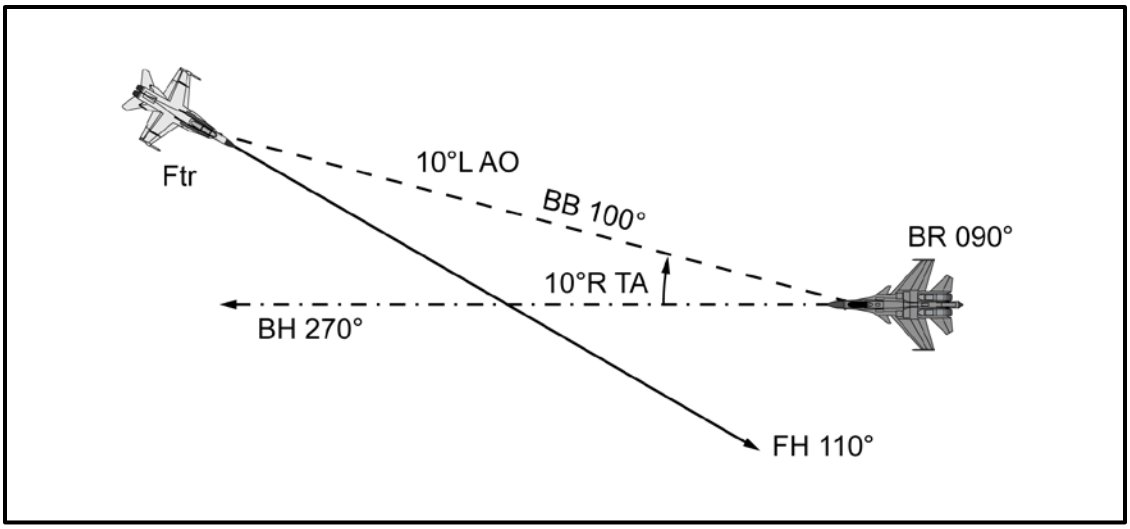


**Figure 7-7 Collision Course Illustration**

The intercept triangle can be visualized on the face of an EHSI with the center representing the intersection of the two flight paths. Note that the dashed BB line can be transposed to the center of the EHSI. Since the two dashed lines are parallel, they form equal angles when cut by a transversal line represented by the bogey or the FFP. Note that the TA and AO within the intercept triangle can be depicted within the cut, where they are shown to be equal in magnitude but opposite in direction.

The previous example (Figure 7-7) illustrated right TA, where we added the degrees from BR to BB and then added that same number of degrees (continuing in the same direction) to find the collision course.

## 708. COLLISION COURSE CORRECTION FORMULA 2

Further CCCs with a contact on the scope will be done according to the second formula. This method is important since the GCI controller's BB calls are less accurate than the fighter’s radar scope information. After the bogey is on the scope, aircrew can read AO directly off the scope and compare it with the cut. The purpose is still to make AO equal in quantity but opposite in direction to TA.

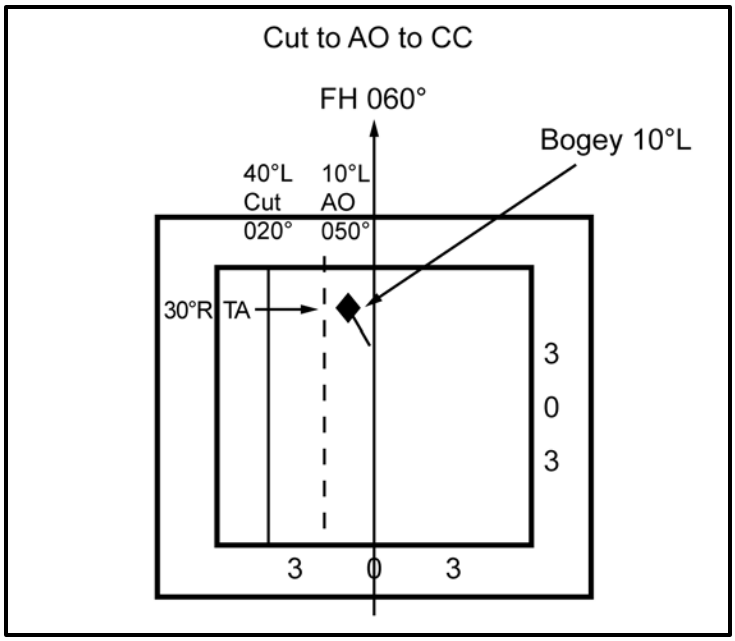


**Figure 7-8 Collision Course Correction Example 1**

In the preceding example, the aircrew can visualize TA as the angle from the cut to AO, or 30°R TA. The collision course for this set-up can be visualized as a line located from the AO line by the same amount and direction as the TA. In relation to the fighter's nose, 30 right of the AO (10°L) is 20 right of the fighter's nose, or collision course is 20°R. Looking at the formula again:

This method is referred to as “bouncing the ball.” To determine the CCC, bounce the ball from the cut to AO, and then bounce it in the same direction and distance to discover the CCC.

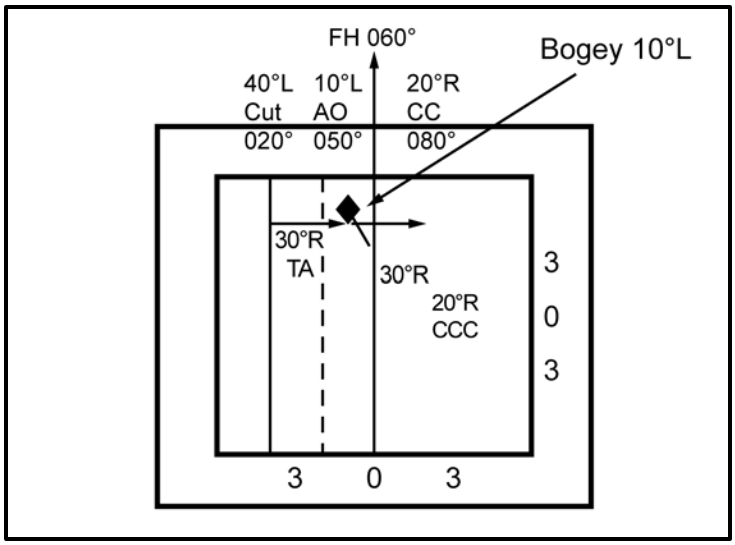


**Figure 7-9 Collision Course Correction Example 2**

Once the collision course is determined, the fighter must alter its heading as appropriate to establish the collision intercept. In this case, the CC is 20°R of the fighter's nose. The command should be "*Right hard 20, steady 080.*" After executing the CCC, AO = TA in magnitude but will be in the opposite direction.

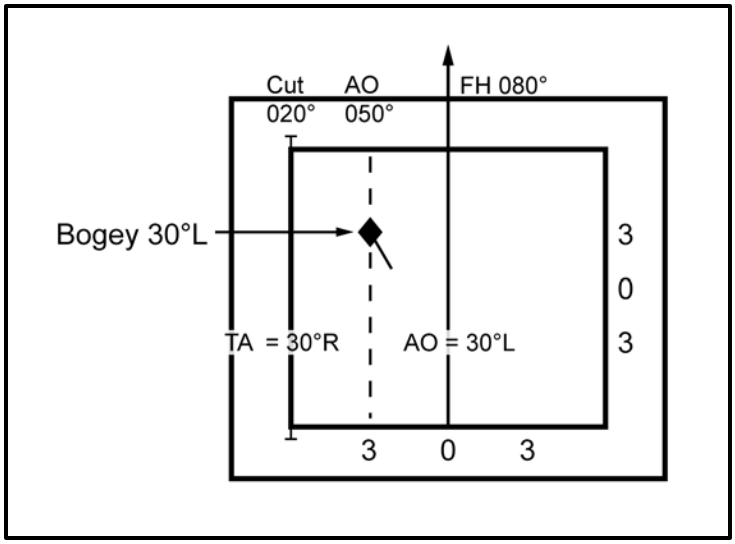


**Figure 7-10 Collision Course Correction Example 3**

Note that in the previous examples, FH was adjusted to establish an AO that was equal to but opposite in direction to the TA. When the FH coincides with the collision course for a given TA, the CB (remember, CB = 1/2 cut) coincides with the BB. The bogey is now said to be "on CB." When TA equals AO in amount but opposite in direction, an isosceles triangle is set up. If a co-speed situation is assumed, then the aircrew should receive constant BB, decreasing range calls from GCI. With a contact on the scope, the bogey will track straight down the scope at a constant azimuth (i.e., the bogey will not drift).

## 709. ILLUSTRATION OF COLLISION COURSE COMPUTATION

**Example:** AO = 5°L, Cut = 30°R, BH = 290°, FH = 080°

1. Compute the cut, DTG, and DOP

2. Visualize these parameters on the fighter scope

3. Cut to AO = TA = 35°L

4. Continue to the left of the 5°L AO another 35° to determine CC at 40°L

5. Since collision course is 40 left, command "*Left hard 40, steady 040.*"

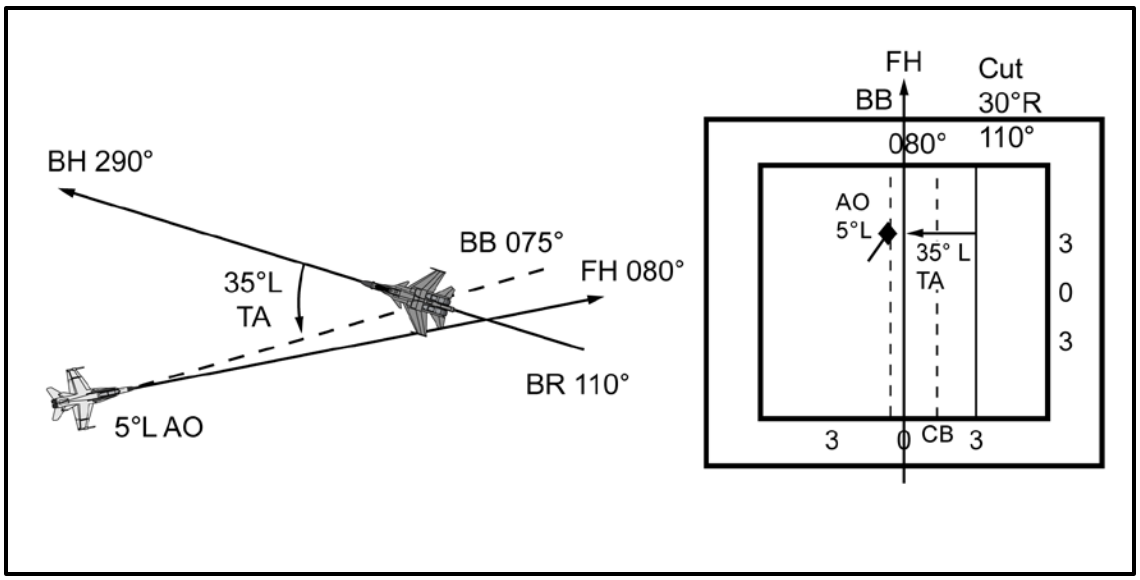


**Figure 7-11 Illustration of Collision Course Computation 1**

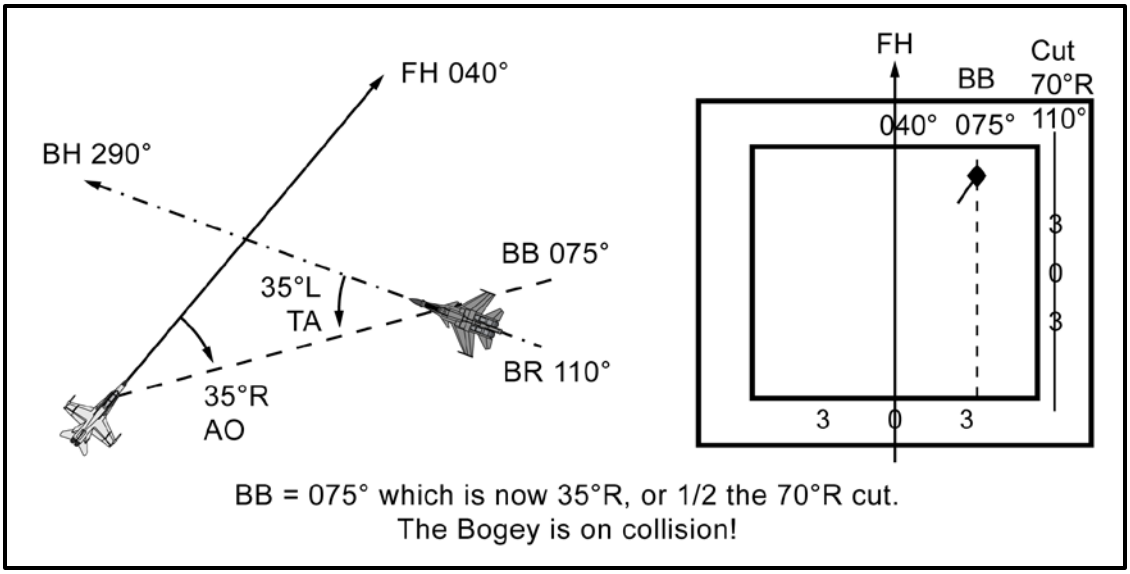


**Figure 7-12 Illustration of Collision Course Computation 2**

## 710. ROUNDING

In the previous examples, the final collision course has always been an even heading (a heading that ends in a zero, i.e., 240°, 050°, 120°, etc). In all subsequent problems, the collision course will still be an even heading. This is the result of rounding.

Before the BB or AO is used to make a CCC, it is first rounded off to the nearest five or zero using the following convention:

**0, 1 or 2 rounds to 0**
**3-7 rounds to 5**
**8, 9 or 0 rounds to 0**

The BH, and hence the BR, will always be an even heading in this syllabus. Setting AO equal to but opposite in direction to the TA will always result in an even heading for a collision course. If the NFS comes up with a collision course that does not end in a zero, then the answer must be wrong.

Rounding permits faster math for faster CCCs and results in fewer arithmetic errors. It is the weapons officer's responsibility to round the BB call from GCI or the AO from the scope.

## 711. INITIAL DESCRIPTIVE COMM

Once the aircrew has received BH and bearing and has determined the proper FH for collision, they will need to describe fighter and bogey flight path orientation. The following format should be used:

**Example:**

BH is 320°, BB is 160°, making the FH 180° which forms a 40° left cut, 140 DTG, left-to-right pass.

Commentary: *"Steady 180, I have a 40 left cut, looking 20 left for 20 right TA, 140° to go, left-to-right pass, steady 180."*

The Student is allowed one CCC within the initial turn to a steady heading (SH) if the BB crosses the round. After that CCC, the student cannot make another correction in the turn unless the BB crosses a 0 or a 5. Once on a SH and the student finds the bogey on the radar-scope, a CCC should be made prior to taking a lock to place the bogey on collision within rounds based on scope interpretation. All subsequent CCCs must wait until the bogey drifts to a 0 or 5 bearing.

Control of the intercept takes precedence over taking a lock. A lock cannot be attempted until the student has a bogey on collision within rounds.

## 712. RECHECKING THE WORK

It is common to initially make errors when computing CCCs.

**NOTE**

Always recheck computations, starting with a re-evaluation of the cut from the EHSI!

Without a recheck procedure, errors perpetuate themselves throughout subsequent CCCs. To prevent and detect errors, the aircrew should scan the EHSI and know exactly what cut they are on. First determine where the BR falls (left or right of fighter's nose) and by how much. This angle is the cut regardless of what previous computations yielded. The cut and the AO provide the necessary raw data for further correct CCCs regardless of previous errors. Aircrew must not be concerned with where or how previous mistakes were made, as this will only put them farther behind the aircraft and delay recovery.

## 713. INTERCEPT GEOMETRY FORMULA REFERENCE

1. Aspect Angle (AA) = 180 - Target Aspect (TA)
   AA = 180 - TA (same direction as TA)

2. Cut = Fighter Heading (FH) to Bogey Reciprocal (BR)
   Cut = FH to BR

3. Target Aspect (TA) = Bogey Reciprocal to BB
   TA = BR to BB

4. Collision Bearing (CB) = ½ Cut
   CB = ½ Cut

5. CB = Collision Antenna Train Angle (CATA)
   CB = CATA

6. Lateral Separation = Target Aspect x Slant Range x 100
   LATSEP = TA x SR x 100

7. Altitude Differential = Elevation Angle x Slant Range x 100
   ALTDIFF = Elev x SR x 100

8. Angle Off (AO) = Antenna Train Angle
   AO = ATA

9. Degrees to Go (DTG) = Fighter Heading to Bogey Heading
   DTG = FH to BH
   DTG = 180 – Cut

**This page reserved for Notes**

*"In combat, you must survive your first few missions to get the hang of it. Then, good tactics pay off - seeing the other pilot first, getting in close, shooting accurately, and avoiding action when judicious. But with all that said, luck still plays a role in whether you survive or not. And fate."*

*Oberst* (Colonel) Erich "Bubi" Hartmann, *Luftwaffe*
WWII, 352 Victories
Knight's Cross with Diamonds
World's Leading Ace

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# CHAPTER EIGHT
# LEAD COLLISION INTERCEPTS

## 800. INTRODUCTION

Obviously a collision course will not be maintained all the way to a midair collision. It will be broken off at a point that will enable the fighter to employ forward quarter weapons and maintain a tactical advantage over adversaries. The need for the aircrew to control the intercept, determine TA, establish CB, and accurately achieve proper firing parameters for all weapons remains the highest priority.

## 801. SPARROW ATTACK

The fighter applies the same basic procedures that have been utilized thus far in the reattack intercept. To provide guidance for an AIM-7 Sparrow, the fighter must place the radar in the automatic tracking mode. Acquiring a lock (single target track (STT)) will furnish the missile with the continuous wave guidance necessary for successful employment.

### Locking the Bogey

The bogey may be locked once the intercept is under control. A bogey with less than 47 TA may be locked under the following three conditions:

1. On collision within rounds, outside collision course corrections stopping.

2. Once inside collision course corrections stopping.

3. At lead or after displacement with drift stabilized.

4. Good spotlight and a hard turn or less.

The bogey may be locked prior to the 90 DTG. This does not mean that stab locks or loss of intercept control (including forsaking TA analysis) is permitted at the expense of getting a lock.

## 802. FACTORS AFFECTING SUCCESS

Forward quarter weapons, such as the Sparrow, rely on a Doppler frequency shift for their targeting. As you recall from your radar theory class, a Doppler shift is the change in a pulse's frequency caused by the downrange travel to or away from the fighter. This is also known as closure. Therefore, targets with greater components of closure (lower TAs) will have a higher probability of being targeted accurately than those with lower components of closure (higher TAs).

The "probability of kill," or $P_k$, is a measure of the likelihood that a missile will guide to, impact, and destroy the target. Higher rates of closure (ROC) will increase the $P_k$ for the Sparrow, as well as the maximum range that this missile can be employed.

Closure rates, and hence maximum range, can be increased three ways:

1. Making a faster missile.

2. Flying the aircraft faster.

3. Lowering the TA.

At VT-86, the aircraft speed will be limited and our simulated missiles fly at a constant velocity. Therefore, a change in TA is the only way we can affect maximum range and $P_k$.

## 803. LEAD COLLISION

Recall from Chapter 1 that lead pursuit places the fighter's nose in front of the target's nose to decrease range and increase closure. Lead collision is still a form of lead pursuit, but the fighter's nose is placed in front of the target by an amount that allows the faster missile to complete its own collision intercept. Because the missile is faster than the target, it will fly a longer distance than the target to the impact point (similar to a fighter with a speed advantage).

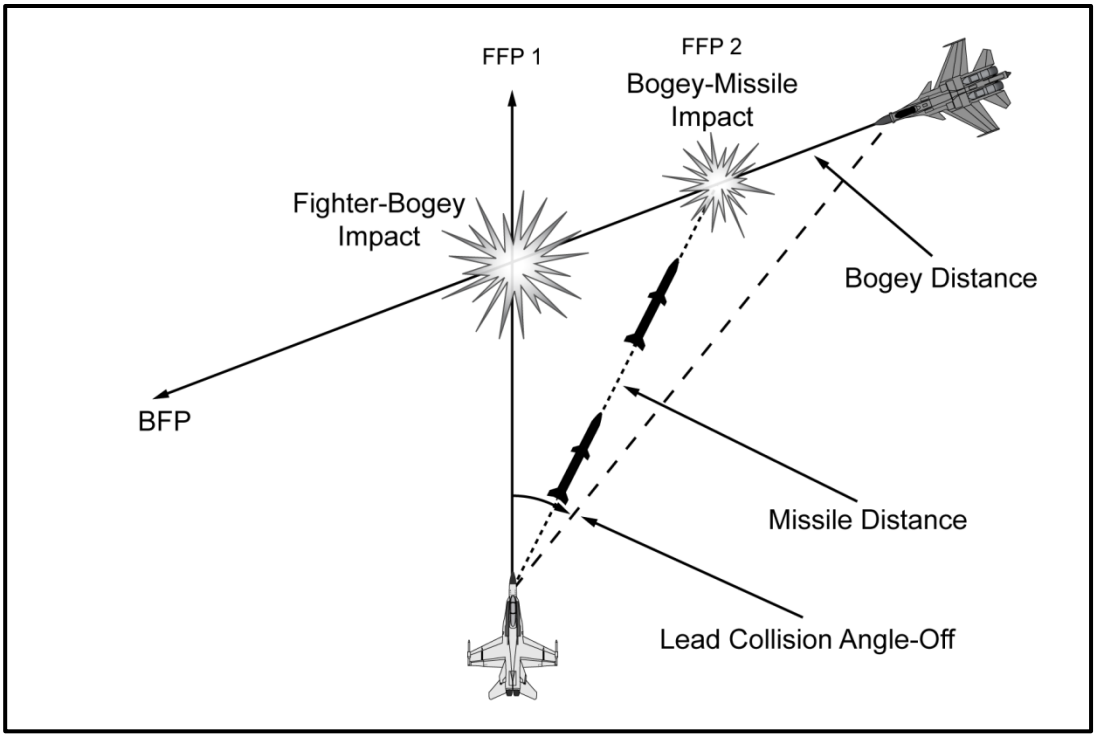


**Figure 8-1 Lead Collision**

The speed of the missile requires that the bogey be placed off CB so that the lead collision angle-off is satisfied. Due to this, three things occur:

1. TA will be greater than fighter's AO.

2. The bogey is placed inside CB and will drift away from it. As a result, TA will increase over time.

3. The missile is on a collision course with the bogey.

The fighter's task is to establish a collision course at long range in order to close on the bogey in the quickest possible manner. At a range slightly greater than Rmax, this collision is broken off to position the bogey inside CB. This will establish the bogey at the correct lead collision point for the missile at or just inside Rmax.

## 804. LEAD ANGLE OFF

Because the speed of the missile and that of the bogey are not equal, an isosceles triangle will not exist. The AO of the bogey, when the fighter is in the correct position for firing the Sparrow, is known as “lead.” In Figure 8-1, it is the smaller of the two angles shown from the fighter's nose position.

The fire control computer of a modern fighter will provide the necessary steering information to the aircrew for this lead AO. The fighter then maneuvers to position the aim dot to the proper position. Once the dot is within the Allowable Steering Error (ASE) Circle and range requirements for the missile have been met, the AIM-7 can successfully be deployed.

## 805. EFFECT ON TARGET ASPECT IN LEAD COLLISION

Lead collision comes at the expense of maintaining TA equal to AO, but opposite in direction, to each other. With AO now less than TA, the bogey will drift in such a way that TA increases over time.

Because the lead requirements are dependent upon TA, the fighter will only be in the proper position to fire the missile for a short period of time. If any undue delay occurs, the fighter will no longer be in a position to satisfy the lead requirements. The dot will drift out of the circle, and the fighter will miss a valid shot opportunity. See Figure 8-2.

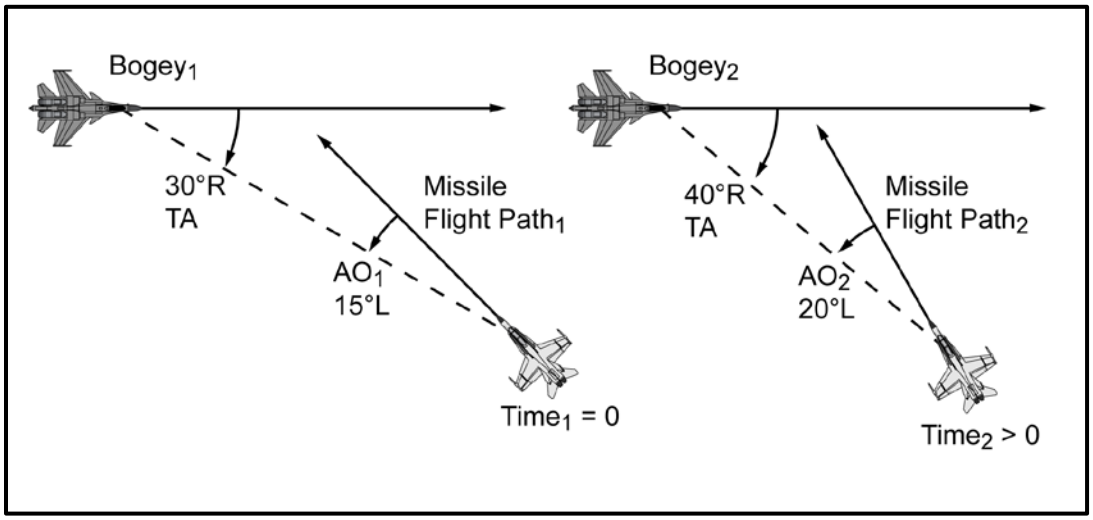


**Figure 8-2 Effect on Target Aspect in Lead Collision**

## 806. ESTABLISHING LEAD ANGLE OFF

Without the benefit of a fire control computer in the T-39N, the fighter must rely on a general rule of thumb for establishing lead AO. A knowledge of missile and aircraft speeds indicates that for TAs of 0 to 47 degrees, the lead required is roughly one-half the TA. For example, with 30°R TA, the fighter needs to have its nose pointed 15° in front of the bogey (15°L AO) at Rmax. See Figure 8-3.

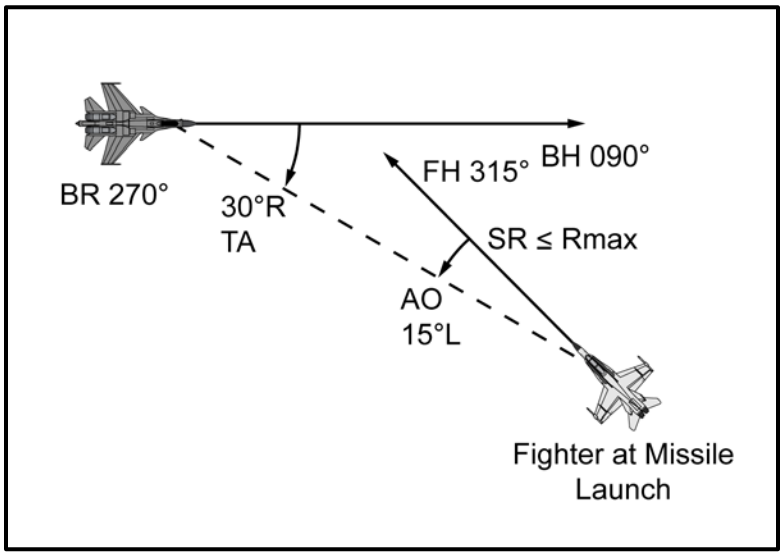


**Figure 8-3 Establishing Lead Angle Off**

## 807. CONDITIONS FOR EMPLOYING THE AIM-7

Because of the stringent lead requirements for employing the AIM-7, the fighter must be in the proper position to take a valid shot. The ASE circle and the AIM dot are useful tools to achieve proper lead. However, it is TA that determines the correct conditions.

**NOTE**

Accurate TA analysis is the decisive factor in employing the AIM-7 Sparrow.

The Sparrow has a greater maximum range against a target with low TA than one with high TA. The lower TA means higher ROC and thus higher $P_{k.}$ For the correct ranges and lead AO required for different TAs, refer to the following chart:

| TA | STOP CCC | LEAD AO | FOX-1 RNG | MIN DT |
|---|---|---|---|---|
| | | | | |
| 0° | 14 NM | 0° | 12 NM | 8 NM |
| 5° | 14 NM | 2½° | 12 NM | 8 NM |
| 10° | 14 NM | 5° | 12 NM | 8 NM |
| 15° | 14 NM | 7½° | 12 NM | 8 NM |
| 20° | 14 NM | 10° | 12 NM | 8 NM |
| 25° | 12 NM | 12½° | 10 NM | 6 NM |
| 30° | 12 NM | 15° | 10 NM | 6 NM |
| 35° | 12 NM | 17½° | 10 NM | 6 NM |
| 40° | 12 NM | 20° | 10 NM | 6 NM |
| 45° | 12 NM | 22½° | 10 NM | 6 NM |

**Figure 8-4 TA Chart**

CCCs stop at 14 NM for 0 to 20 TA and 12 NM for 25 and higher TA. Inside 14/12 NM, take a lock immediately and analyze TA. Continue to analyze TA, and if it goes over the round before the turn to lead, call the new TA and take it to the appropriate lead point at the appropriate range.

The TA determined during the next two miles is the TA that the fighter takes to lead, displace, and then run an appropriate counterturn for. This will be discussed in follow-on chapters, but if TAA was inaccurate, you may not get a valid shot and will have a hot or cold counterturn. This penalty for inaccurate TAA drives home the importance of precise TAA and helps recognize hot/cold counterturns and their repercussions.

## 808. LEAD ANGLE AND DOT RELATIONSHIP

Once the correct lead AO is established, the dot should be located within the ASE circle. To allow for some error in steering, the ASE circle will accommodate lead AO within +/- 3° of the proper lead AO. Since the dot is 6 times more sensitive, this implies that the ASE circle will be +/- 18°. Also recall that the dot is aircraft stabilized, it will indicate to the aircrew which attitude position the nose should be in to correctly fire the missile. It is that the "Dot" is an AO dot prior to lead range. This means it tells the aircrew where to turn for collision—and at lead range it becomes a lead computing "Steer to Dot" in order to put the aircraft in firing parameters.

**Example:**

1. TA = 20°R

2. Lead AO = 10°L

3. Elev = 3° low

4. Dot centered, but slightly low

5. Valid Shot!

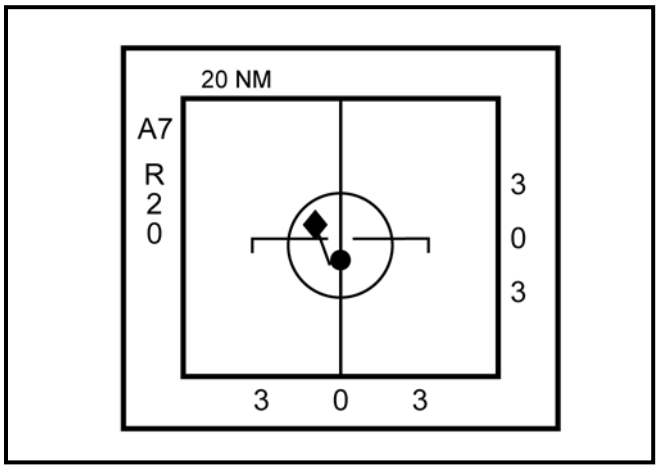


**Figure 8-5 Dot Centered, Slightly Low**

The turn to lead collision is usually a standard rate turn. An exception is when the turn is 5° or less, in that case the fighter may use an easy turn. Late turns to lead or turns commenced when the contact is not on collision may require a harder turn. Commands are "*Left/Right for lead,"* followed by *"10° to Go, Steady Up"* when proper lead AO is established. If all conditions are met, the student says "*Your dot*" and the instructor broadcasts "*Fox-1"* on UHF to simulate a missile launch.

## 8-6 LEAD COLLISION INTERCEPTS

## 809. CONDITIONS FOR LAUNCH

There are four possible conditions that may exist when the bogey is taken to lead. The fighter must be prepared to adjust to each condition:

| Condition | Shot? | Action |
|---|---|---|
| Target AO within +/- 3° of Lead AO and dot in circle | Valid | Call "*your dot*" and shoot the AIM-7 |
| Target AO within +/- 3° of Lead AO and dot out of circle | Invalid | 1. Have patience, wait until min displacement range (allow for the computer to catch up)<br>2. If dot is above or below ASE circle, call "*nose high/low for the dot*" |
| Target AO outside+/- 3° of Lead AO and dot in circle | Invalid | Relead target to get within +/- 3° |
| Target AO outside +/- 3° of Lead AO and dot outside circle…Invalid…Relead Target to get within +/- 3° | | |

Pre-lead Bogeys:

For bogeys on collision; 0, 1, 2, 5, 6, 7, 12 TA are pre-lead. Do not sweeten pre-lead bogeys. If bogey is +/-3° of lead AO, do not re-lead.

## 810. THE SIDEWINDER REATTACK

Following the Fox-1 call, you displace the bogey as outlined in Chapter 9. Early displacement should not be a factor. It is good headwork for the fighter to wait for the correct displacement range even after getting a quick Fox 1. Minimum displacement is a procedure learned later, but in no case should the displacement turn (DT) be delayed beyond the minimum ranges listed on the lead AO chart. This allows the fighter 4 NM to place the bogey at the proper lead AO, acquire a lock, and achieve the shot before DT minimums are reached. If a shot cannot be taken, the Sidewinder reattack becomes the priority. You have until MIN displacement range to try and get a valid Fox 1, but good headwork applies. Don't push a bad situation. AIM-9 should be selected immediately after the Fox 1.

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*"Courage atrophies from lack of use."*

Author unknown

# CHAPTER NINE
# DISPLACEMENT TURN FUNDAMENTALS

## 900. INTRODUCTION

In a two dimensional representation of an intercept, the Fighter's flight path can be separated into two vector components: down range separation and lateral separation. Combined, these two components make up the slant range from the fighter to the contact. For intercept purposes, the lateral separation may be thought of as turning room available to the fighter as he attempts to maneuver around the bogey. Sufficient turning room is necessary for any successful intercept.

## 901. LATERAL DISPLACEMENT/TURNING ROOM

After employing a forward quarter missile, the fighter wants to execute a turn to arrive in the bogey's rear quarter. By knowing TA and slant range, we can then calculate Lateral Displacement (LD), also known as turning room.

The weapons officer must compute TA correctly prior to breaking the collision course. Therefore, at VT-86, you will initially be taught to stop making CCCs 2 miles prior to the lead turn. This allows time to observe drift and, if necessary, update TA prior to commencing the turn to lead.

The displacement turn (DT) is a turn made by the fighter to reorient the flight path in order to gain, maintain, or slow the rate of loss of lateral separation.

Following extensive, and often dangerous, flight testing, we pushed the T-39N to the edge of the envelope and concluded that 20,000 feet (roughly 3 1/2 NM) is the ideal amount of turning room for the reattack intercept. As you can imagine, the T-39N needs more LD than high performance fighters.

Remember the LD formula: TA x SR x 100 = LD

An example of the amount of turning room available for certain TAs are shown in Figure 9-1.

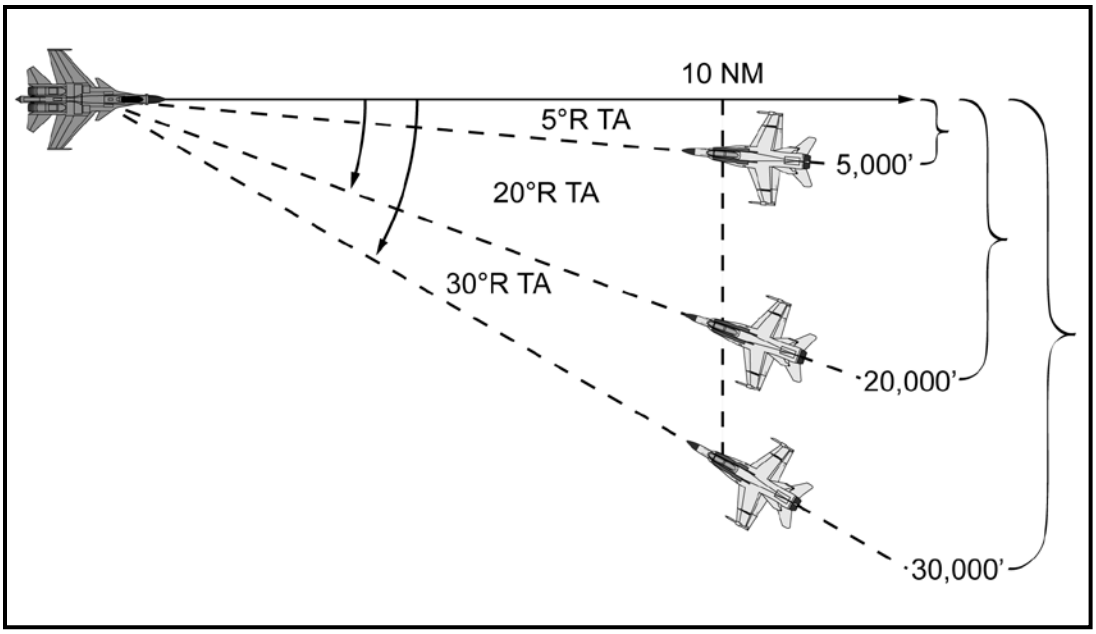


**Figure 9-1 Turning Room**

At 10 NM, any TA greater than 20° equates to an excess of turning room, while any TA less than 20° indicates that sufficient turning room may not be available and more must be gained.

## 902. OBJECTIVES OF THE DISPLACEMENT TURN

The two objectives of the DT are:

1. To orient the fighter's flight path (heading) so as to: gain, maintain, or slow the rate of loss of LD as required.

2. To establish the bogey at approximately the same distance from CB (after displacement) for all amounts of TA. This is done so that the drift rate after displacement is constant for all TA situations.

Once the fighter is steady after executing the DT, his flight path will be oriented in one of three ways:

1. If TA indicates less than the desired displacement (20,000 feet), then the fighter's flight path should be pointed away from the bogey's flight path to increase LD (Figure 9-2).

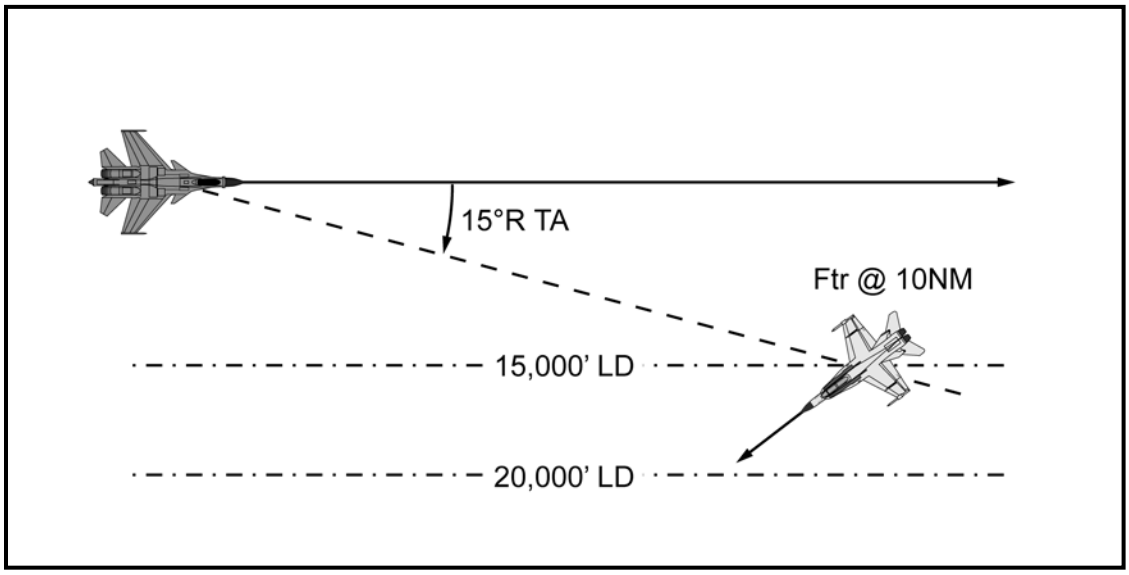


**Figure 9-2 Pointed Away**

2. If the TA indicates that lateral separation is equal to the ideal amount of turning room, then the fighter's flight path should be oriented parallel to the bogey's flight path, maintaining the LD that already exists (Figure 9-3).

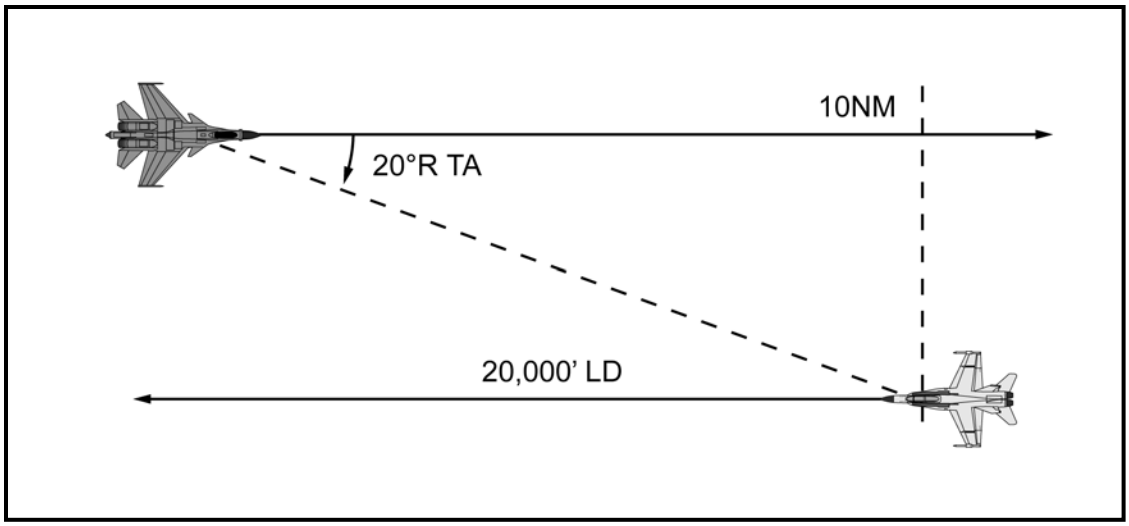


**Figure 9-3 Parallel**

**NOTE**

The objective of this DT is to maintain LD. Since aircraft do not turn instantaneously, to maintain the ideal amount of LD, point the fighter nose slightly away from BFP after the DT.

3. If the TA indicates that LD is greater than the desired turning room, then the fighter's flight path should be pointed slightly toward the BFP, so as to gradually decrease the LD. This decreases it at a slower rate than would occur if a collision course were maintained (Figure 9-4).

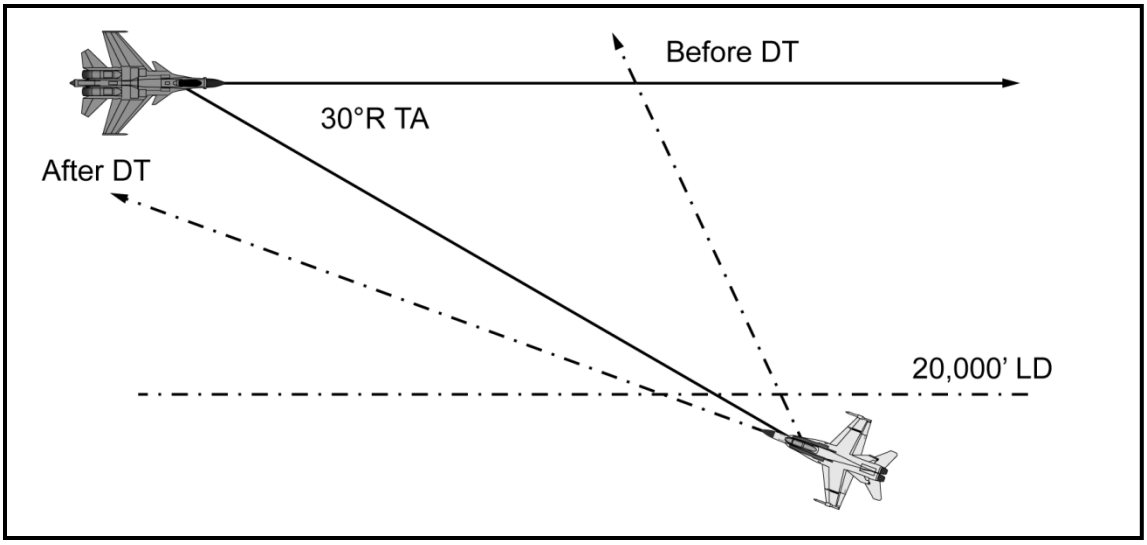


**Figure 9-4 Pointed Toward**

## 903. ACCOMPLISHING THE DT OBJECTIVES

1. Determine TA. It should be obvious at this point that this number is extremely important. With a bogey on the scope, use the cut→AO = TA formula. If contact is lost, use the BR→BB = TA formula.

2. Determine the correct displacement range. With what rounds to 20° TA or less, displace the bogey at 10 NM. With what rounds 25° TA or more, displace the bogey at 8 NM. Note that with 20° TA, the formula for calculating LD gives us 20,000 feet at 10 NM and that the same is true for 25° TA at 8 NM.

3. Determine the correct displacement point (AO), left or right of the fighter's nose in accordance with the calculated TA.

4. Command the pilot to use a hard turn in the direction necessary to place the bogey on the displacement point. The command would be "*Hard Right (or Left) for displacement.*"

The goal in determining proper displacement points is to place all amounts of TA the same number of degrees from CB so that the resulting drift will be similar for all intercepts.

**NOTE**

Displacement points at VT-86 will place the bogey approximately 25° from CB.

**Example:**

If the TA is 25°L, the CB is 25°R with a 50°R cut. The displacement point for that is 25°L. Reference Table 9-5. To move the bogey from 25°R to 25°L would take a right turn of 50°. After the turn, your new cut is 0° (50°R cut, turn right 50°= 0° cut). CB (always 1/2 the current cut, co-speed), = 0° (Dead Ahead (DA)). The bogey is now 25° left of our "new" CB and will therefore drift to the left.

Because of the complexity of the above procedures, it is necessary that the weapons officer memorize the following table so that displacement points and ranges can be instantly recalled.

| TA | DISP RNG | DISP POINT | TA | DISP RNG | DISP POINT |
|---|---|---|---|---|---|
| 0°L | 10 NM | 50°L | 0°R | 10 NM | 50°R |
| 5°L | 10 NM | 45°L | 5°R | 10 NM | 45°R |
| 10°L | 10 NM | 40°L | 10°R | 10 NM | 40°R |
| 15°L | 10 NM | 35°L | 15°R | 10 NM | 35°R |
| 20°L | 10 NM | 30°L | 20°R | 10 NM | 30°R |
| 25°L | 8 NM | 25°L | 25°R | 8 NM | 25°R |
| 30°L | 8 NM | 20°L | 30°R | 8 NM | 20°R |
| 35°L | 8 NM | 15°L | 35°R | 8 NM | 15°R |
| 40°L | 8 NM | 10°L | 40°R | 8 NM | 10°R |
| 45°L | 8 NM | 5°L | 45°R | 8 NM | 5°R |
| 50°L | 8 NM | 0° | 50°R | 8 NM | 0° |
| 55°L | 8 NM | 5°R | 55°R | 8 NM | 5°L |
| 60°L | 8 NM | 10°R | 60°R | 8 NM | 10°L |
| 65°L | 8 NM | 15°R | 65°R | 8 NM | 15°L |
| 70°L | 8 NM | 20°R | 70°R | 8 NM | 20°L |

**Figure 9-5 Table – Displacement Point**

Tips to help in memorizing the table:

1. DTs are normally about 50°, assuming the bogey was originally on CB.

2. Displacement points are normally on the same side of the nose (scope) as the direction of TA except when TA is greater than 50°. (i.e., Left TA normally goes to the left side of the scope, etc.).

3. If the TA and the displacement point are added up, they will total 50.

**Rule of 50**

So, what do all these numbers and calculations mean to us? To simplify matters, we take what is known as the rule of 50 when applying the proper DT. Do not make the mistake of assuming that the amount of turn required to place the bogey on the correct displacement point will be 50°, as it is based on TA. If the bogey is on collision, the turn will be 50°. Here's how to apply the rule of 50. For TA ≤47, you simply subtract from 50 and put the bogey at that AO in the same direction as the TA (i.e., 30L goes to 20L AO); 50TA goes on the nose to 0 AO. For TA ≥ 53, subtract 50 and then place the bogey on that AO in the opposite direction of the TA (i.e., 65L goes to 15R AO).

## 904. DISPLACEMENT TURN ILLUSTRATIONS

**Preserving Lateral Displacement**

The fighter stops CCCs 2 miles prior to the determined lead range. For what rounds to 20° TA, stop CCCs at 14 NM, lead at 12 NM, and displace the bogey at 10 NM with a hard turn. After steadying up, the fighter nose will be in lag pursuit, pointed slightly away from the BFP (greater than 180 DTG) in an effort to prevent losing any LD. (20° TA × 10 NM × 100 = 20,000 feet LD, or just the right amount).

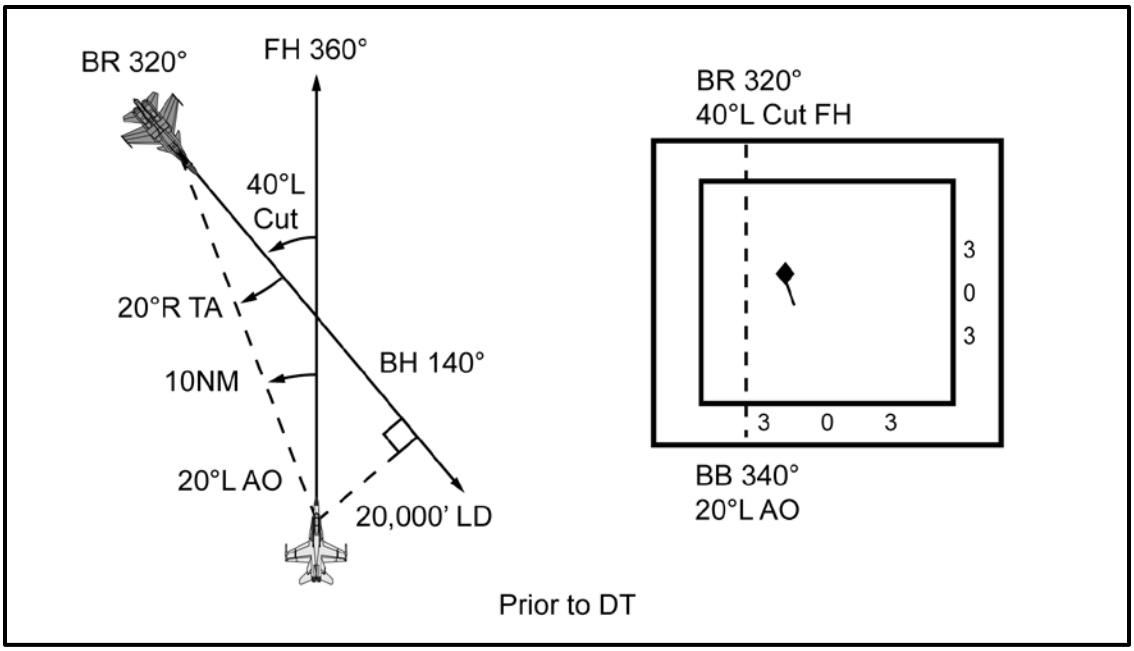


**Figure 9-6 Lateral Displacement 1**

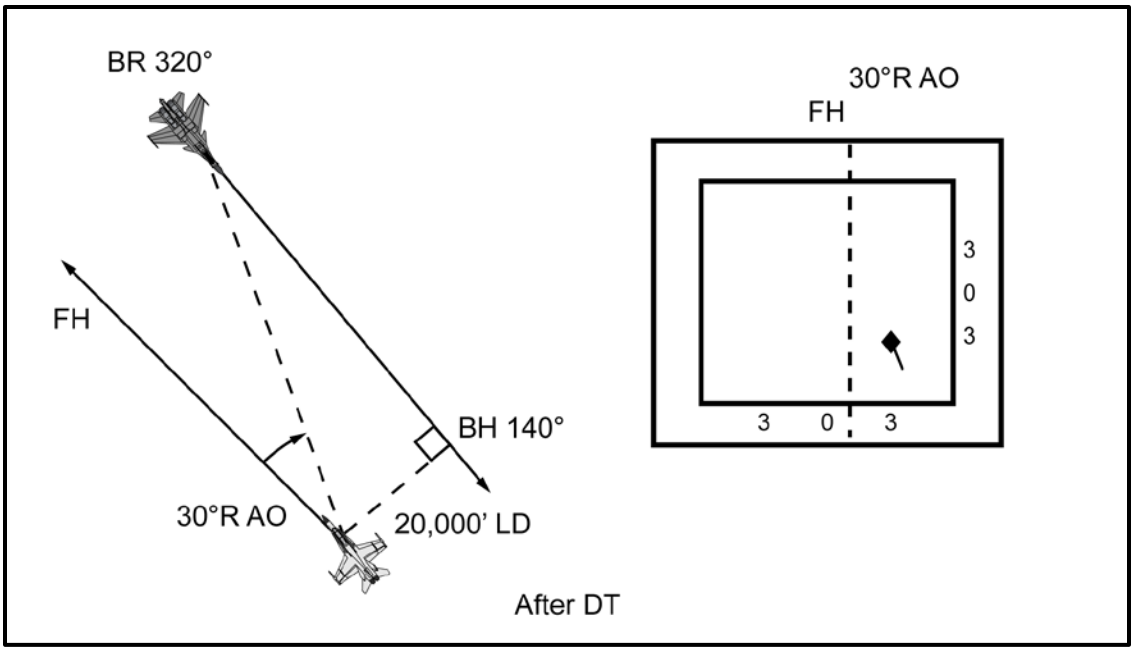


**Figure 9-7 Lateral Displacement 2**

Notice that the DT was a 50° turn and the bogey has been repositioned to 30°R on the scope. The fighter now has 190 DTG.

LD is a function of TA and SR only. Turning room has no relationship to DTG or whether the bogey is on CB. All you need to know is the TA, both in amount and direction, to properly execute the DT.

For example, given a 160 DTG L-R, set-up (20°L cut) with the bogey DA at 10 NM, the weapons officer determines TA to be 20°R; 20°R TA is displaced to 30°R AO at 10 NM.

**Slowing Loss of Lateral Displacement**

In all situations with what rounds to greater than 25° of TA, the fighter will have an excess of turning room. In this case, the purpose of the DT will be to slow the rate of loss of LD. Again, the bogey will be repositioned 25° off of the new CB once the fighter is steady after the DT. Also remember that right TA displaces to the right side of the scope and left TA displaces to the left side of the scope.

**Example 1:**

BH 240°, FH 360°, BB 025°, AO 25°R at 9 NM, TA 35°L

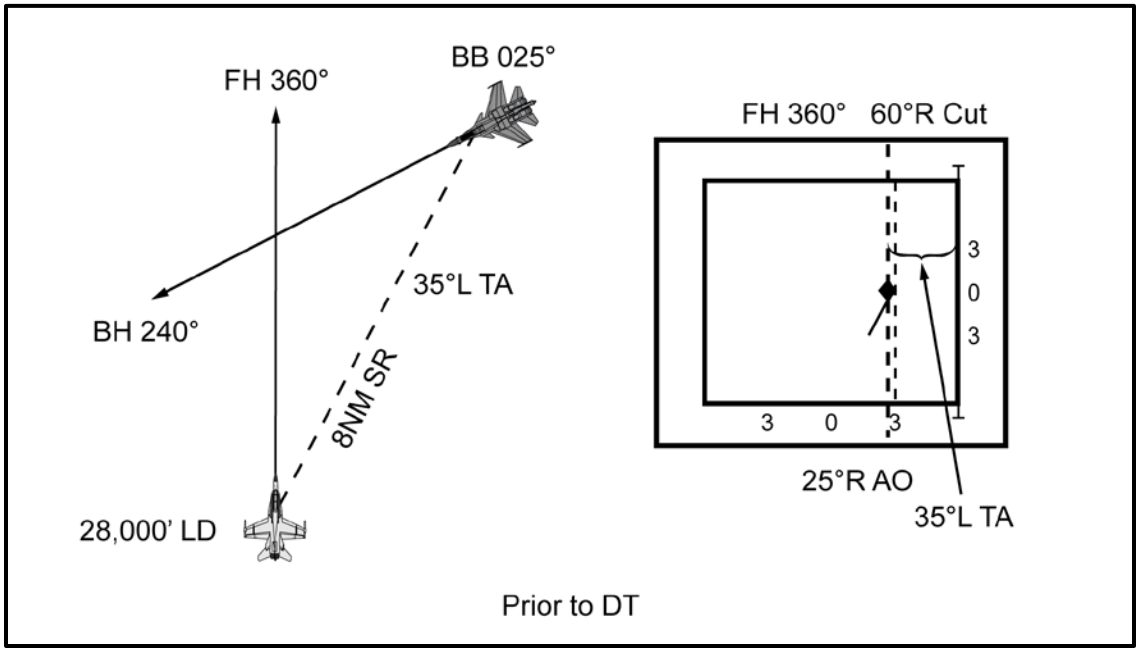


**Figure 9-8 Prior to DT**

Note that 35°L TA at 8 NM gives the fighter more than 20,000 feet of LD (28,000 feet to be exact). The fighter needs only to slow the loss of LD. A right DT of 40° repositions the bogey to 15°L.

Note that the DT itself is not necessarily 50°, but that the bogey will be repositioned at a point 25° from the new CB for the amount of TA.

## 9-8 DISPLACEMENT TURN FUNDAMENTALS

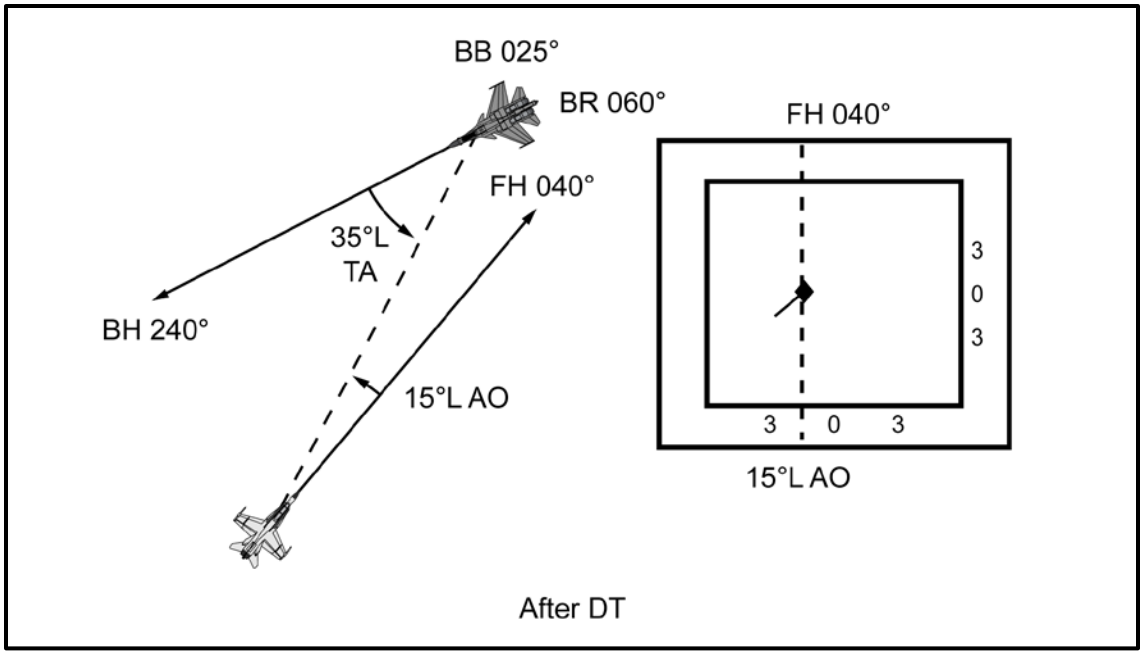


**Figure 9-9 After DT**

**Example 2**:

BH 180°, FH 360°, AO DA @ 10 NM, TA/LD = 0, BB = 360°

In this example LD must be increased. The weapons officer has the option of turning either way for his DT. Moving the bogey to a new position so that it will be 25°R from CB can be achieved by a turn either 50° left or right.

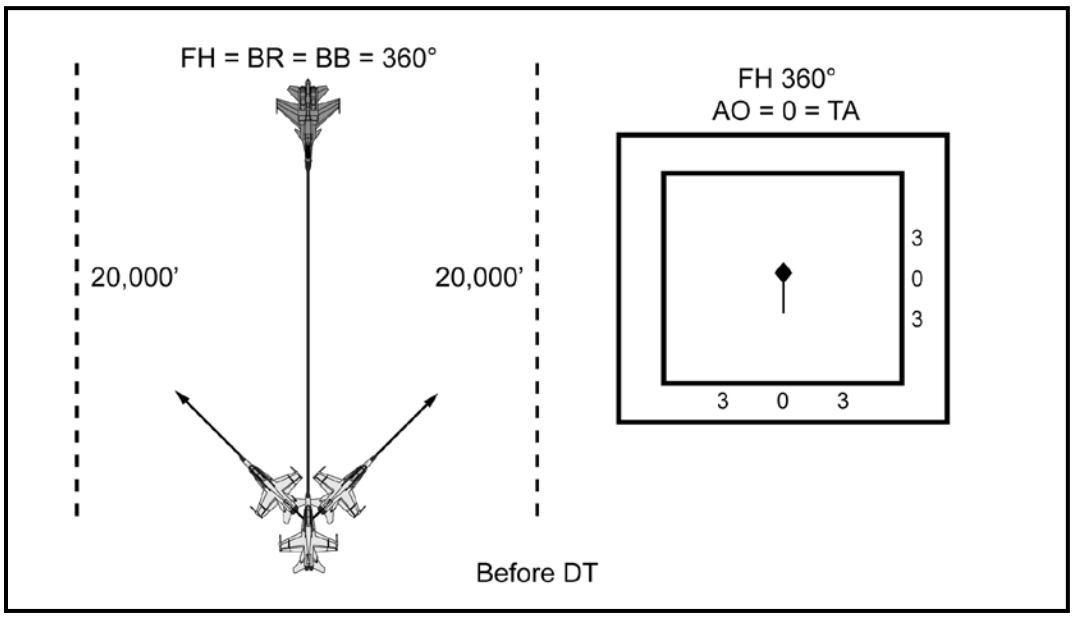


**Figure 9-10 Before DT**

Particular care should be taken in situations where the TA rounds to 0°. For example 2°R TA must be displaced to 50°R AO. The reason is twofold. First, on a turn that incorrectly puts 2°R TA to 50°L AO you would cross in front of the bogey (with a large wing flash advertising your position). Second, based on the LD formula, you would have 2000 feet of lat sep on the right. A turn to put the bogey 50°L AO would mean traveling an extra 4000 feet to get where you started (in terms of LD) had you simply placed the bogey to 50°R AO.

Something that can help determine the correct TA when rounding to 0 is the ASE circle dot with the missile selected. For example, if the contact is tracking down the center scribe on the scope and you can not tell the difference between left and right, take a look at the dot. If the dot is on the left side of the scope, then apply left TA. If it is on the right, then use right TA and apply the appropriate DT.

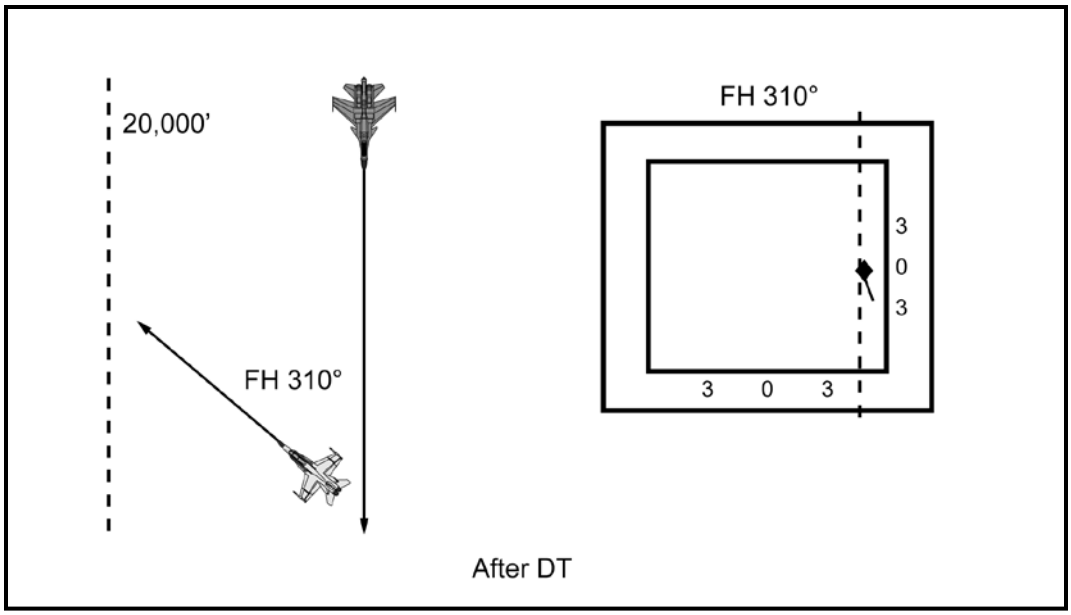


**Figure 9-11 After DT**

Note that the fighter now has 230 DTG. After the DT, the fighter has a 50° cut away from the BFP and will continue to gain LD.

## 905. MINIMUM DISPLACEMENT

As previously discussed, these DTs are figured for specific ranges. 20 TA and less displace at 10 NM, 25 TA and greater displace at 8 NM. Inside these ranges, the standard "rule of 50" does not quite work, so we need to help it along. This subject will be addressed once again when timeline considerations are taken into account. For what we will be working with VT-86, the minimum ranges will be 8 NM (20 TA and less) and 6 NM (25 and greater). If for whatever reason, we exceed these limits, we need to make corrections to offset those errors. As a general rule of thumb, 5° of over-displacement for every 1 NM past minimum displacement the DT is delayed will be sufficient to correct. In the event the fighter over-displaces for a late displacement, the drift curve will still be for the TA taken to lead.

## 906. REVIEW OF DT PRINCIPLES

1. The DT is used to gain, preserve, or slow the rate of loss of LD.

2. The amount of LD available at any time is a function of only two things: TA and slant range.

3. The amount of LD available is unaffected by the existence (or lack of) of a collision intercept. TA and slant range will correctly orient you to the BFP.

4. The DT repositions the bogey 25° away from CB

5. The DT is not necessarily a 50° turn. The rule of 50 is based on TA. It is only 50°of turn if the bogey started on CB.

6. With TA < 47 right TA is displaced to the right side of the scope, left TA is displaced to the left. 50 TA goes to the nose. 55 and greater TA will end up on the opposite side of the scope as TA (65R TA goes to 15L AO).

Using these principles, a table can be drawn for all amounts of TA showing the ranges, displacement points, new DTG, and the result of the DT.

| TA | DISP RANGE | DISP POINT | NEW DTG | RESULT OF DT ON LD | DEGREES OFF CB |
|---|---|---|---|---|---|
| 0° | 10 | 50° | 230 | Gain | 25 |
| 5° | 10 | 45° | 220 | Gain | 25 |
| 10° | 10 | 40° | 210 | Gain | 25 |
| 15° | 10 | 35° | 200 | Gain | 25 |
| 20° | 10 | 30° | 190 | Preserve | 25 |
| 25° | 8 | 25° | 180 | Preserve | 25 |
| 30° | 8 | 20° | 170 | Slow loss | 25 |
| 35° | 8 | 15° | 160 | Slow loss | 25 |
| 40° | 8 | 10° | 150 | Slow loss | 25 |
| 45° | 8 | 05° | 140 | Slow loss | 25 |
| 50° | 8 | DA | 130 | Slow loss | 25 |
| 55° | 8 | 05° | 120 | Slow loss | 25 |
| 60° | 8 | 10° | 110 | Slow loss | 25 |
| 65° | 8 | 15° | 100 | Slow loss | 25 |
| 70° | 8 | 20° | 90 | Slow loss | 25 |

**Figure 9-12 Table – TA amounts**

**This page reserved for Notes**

*"The reality of fighter combat...losses...you are a trained killer...no second chances...you win or you die...not a task for the meek...movies, books, general position in society...to the few...noblesse oblige."*

--Author Unknown

# CHAPTER TEN
# COUNTERTURN FUNDAMENTALS

## 1000. INTRODUCTION

After displacement, the fighter will begin a counterturn to arrive in the bogey's rear quarter in parameters for a Sidewinder shot. Recall from Chapter 9 that the fighter needs 20,000 feet of lateral separation for the counterturn. Therefore, depending on TA, the fighter will either have too little, just enough, or too much lateral separation at displacement. In order to get the desired amount of turning room, the fighter will use different combinations of turn drift and intercept drift to preserve or arrive at the desired amount of lateral separation.

## 1001. DRIFT

During any part of the intercept, several types of drift are occurring at the same time. Understanding these different types of drift is crucial to understanding the counterturn. The drifts are:

1. Turn Drift: Occurs strictly as a result of turning the fighter.

To illustrate, if the fighter makes a turn 30° to the right, the target will appear to drift to the left by the same amount and rate as the fighter's turn.

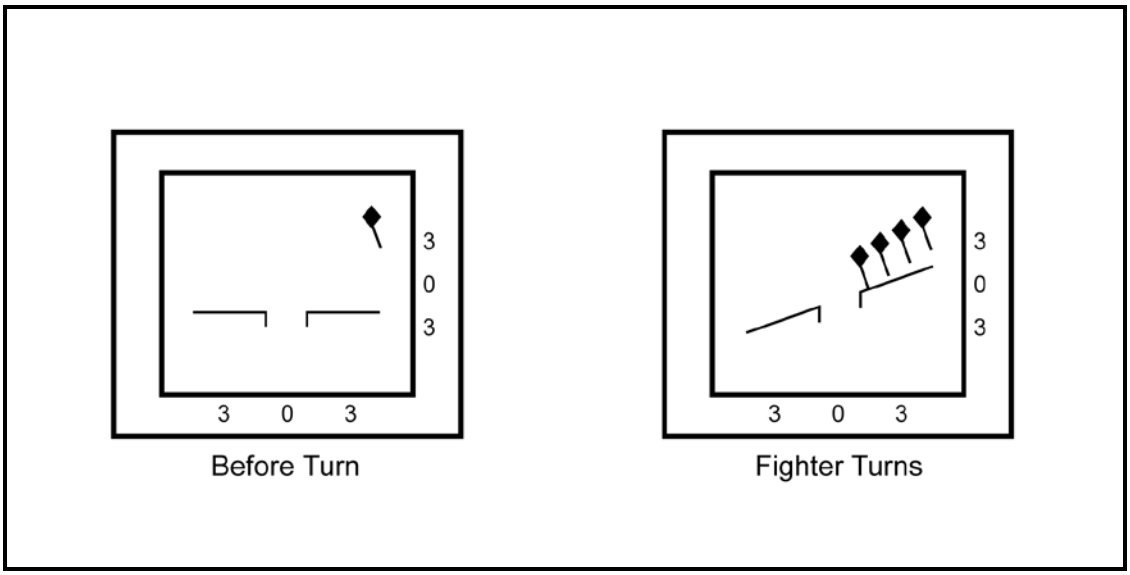


**Figure 10-1 Turn Drift**

2. Intercept Drift: Occurs when a bogey is not on collision.

This can best be seen when both the bogey and fighter maintain a constant heading even though they are not on collision.

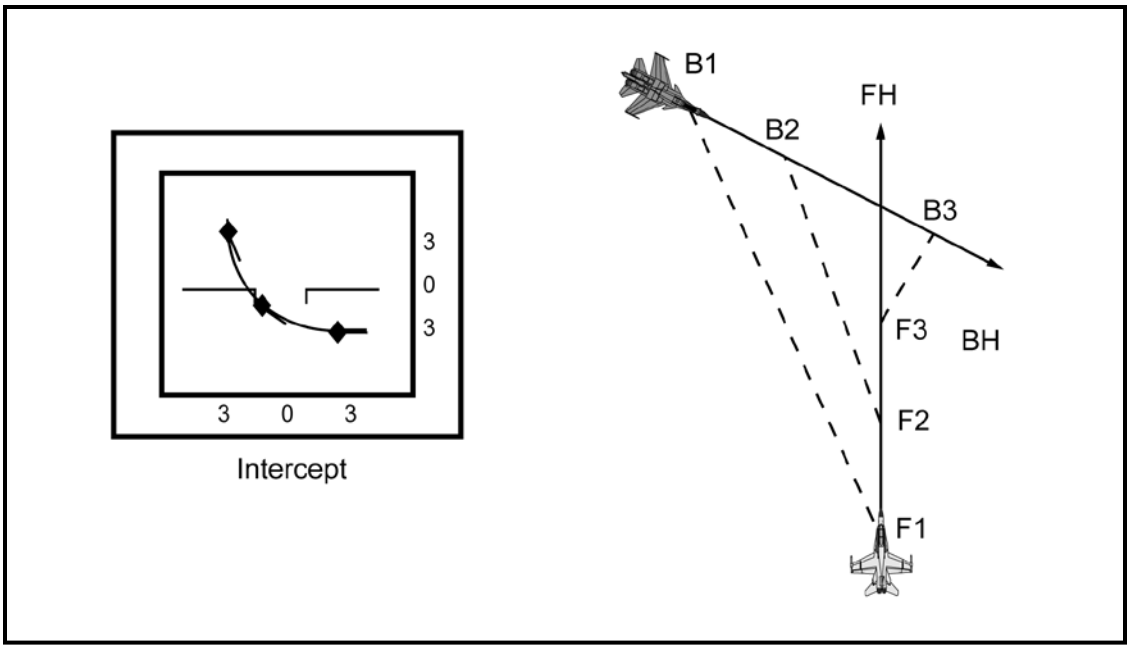


**Figure 10-2 Intercept Drift**

Recall that drift occurs away from the CB and that the rate of drift will increase as the bogey gets further away from CB. (As range halves, degrees off CB will double).

3. Scope Drift: This is the resultant drift that is perceived on the scope, for whatever reason. If the fighter is not turning, then any drift on the scope will be due to intercept drift. If the fighter is turning, then drift on the scope will be due to both turn and intercept drift.

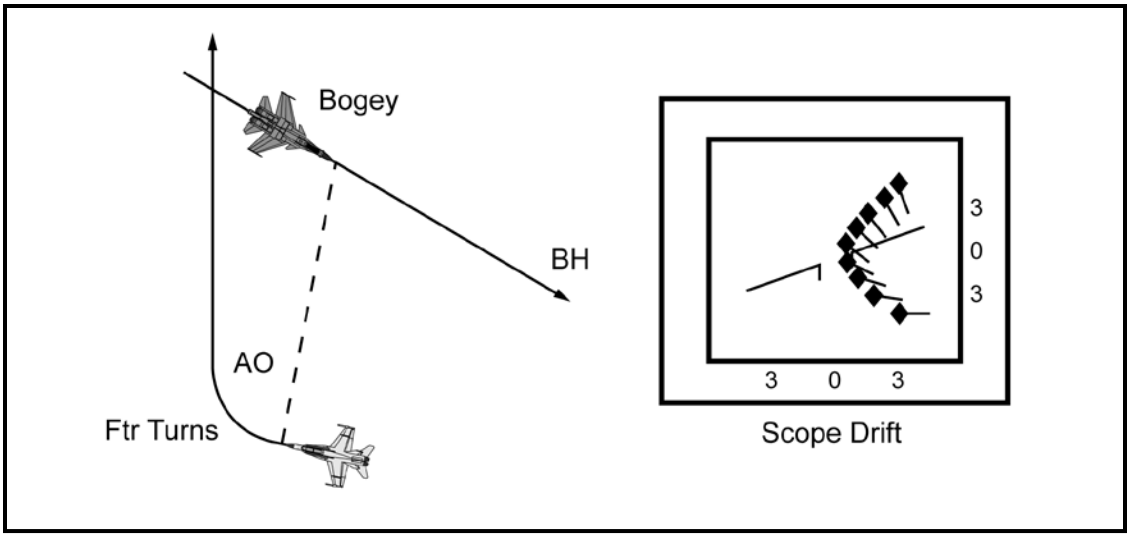


**Figure 10-3 Scope Drift**

## 1002. COUNTERTURN OBJECTIVES

After the DT, the fighter is in a position to increase, maintain or decrease the lateral separation. Since the DT has placed the target approximately 25° off CB, intercept drift will occur. Since the DT also moved the target outside CB, the drift will occur away from the fighter's nose.

At this point, the objective of the fighter is to start a turn to counter this outward drift. The exact position of where to place the target on the scope will vary, depending on the amount of turning room available at the start of the counterturn.

The outward intercept drift is countered by maintaining a turn into the target thus inducing turn drift. This turn drift is in the opposite direction of the intercept drift, thereby maintaining the bogey at the desired AO.

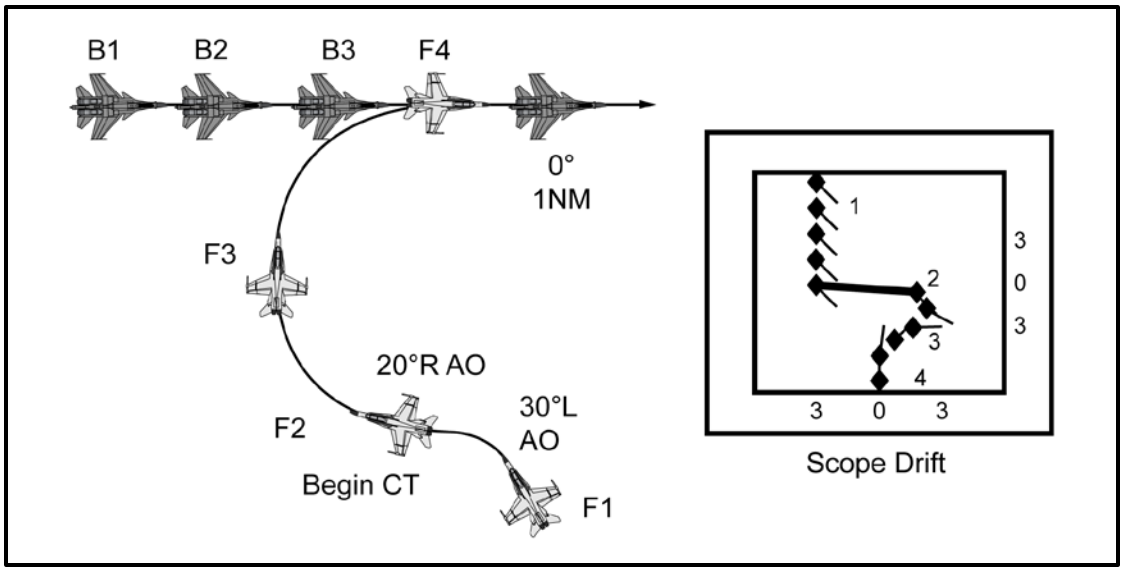


**Figure 10-4 Counterturn**

## 1003. ANALYZING THE DRIFT

Certain factors must be taken into consideration when analyzing drift during the counterturn.

1. Turn drift is countering the intercept drift.

2. When scope drift = 0, then the fighter's turn rate = intercept drift rate.

Figure 10-5 shows the fighter in a right turn, with AO at 10°R. As long as the fighter can keep the bogey at 10°R AO, the turn drift is equal to the intercept drift.

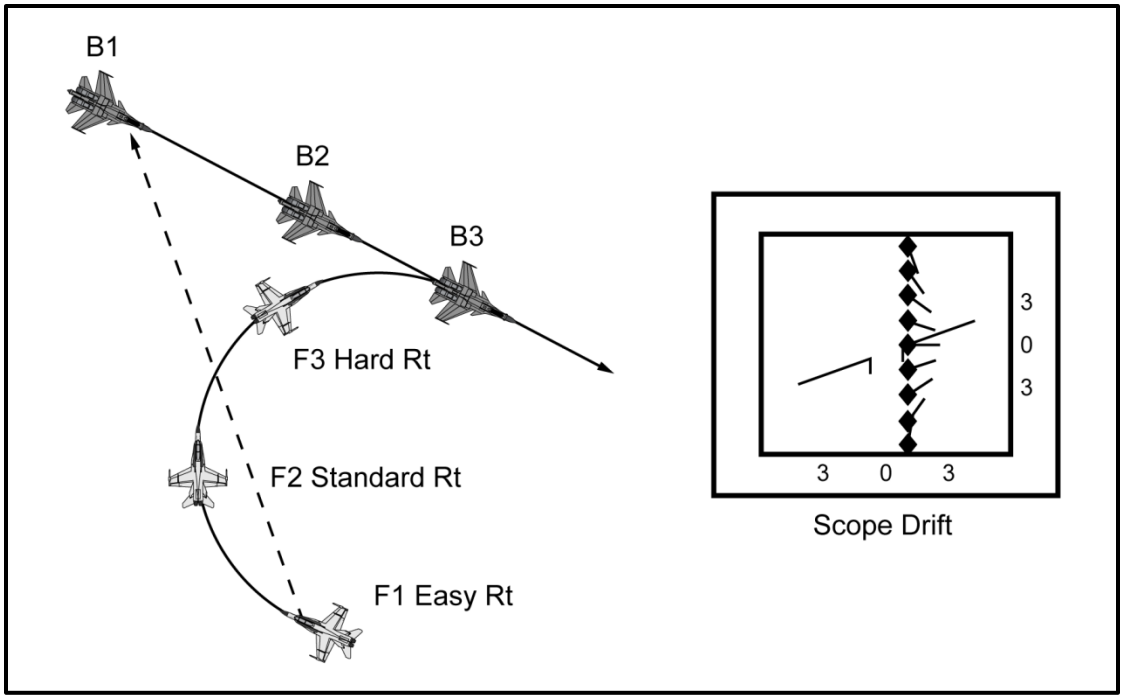


**Figure 10-5 Right Turn**

Notice that as the slant range decreases, the amount of turn required to hold the bogey at the same AO increases. This happens because, as slant range decreases, the number of degrees off CB increases. Subsequently, the intercept drift rate also increases, necessitating a faster turn rate from the fighter.

## 1004. MAXIMUM DRIFT RATES

The aircrew can utilize this knowledge of intercept drift to predict when intercept drift will be at a maximum. At this maximum point, the turn rate of the fighter must also be at a maximum to counter the drift.

Since intercept drift is a function of degrees off CB, the maximum intercept drift will occur when the bogey is the furthest away from the CB. This happens at the pure beam position, which is 90 DTG, with the bogey on the nose.

**Example**:

At 90 DTG, cut = 90° (cut = 180° - DTG)
CB = ½ cut = 45°
Bogey is 45° off CB at the beam

It must be noted that these maximum drift rates occur with the bogey on or close to the fighter's nose. A 90° cut, with the bogey on collision, has 90 DTG but no drift.

## 10-4 COUNTERTURN FUNDAMENTALS

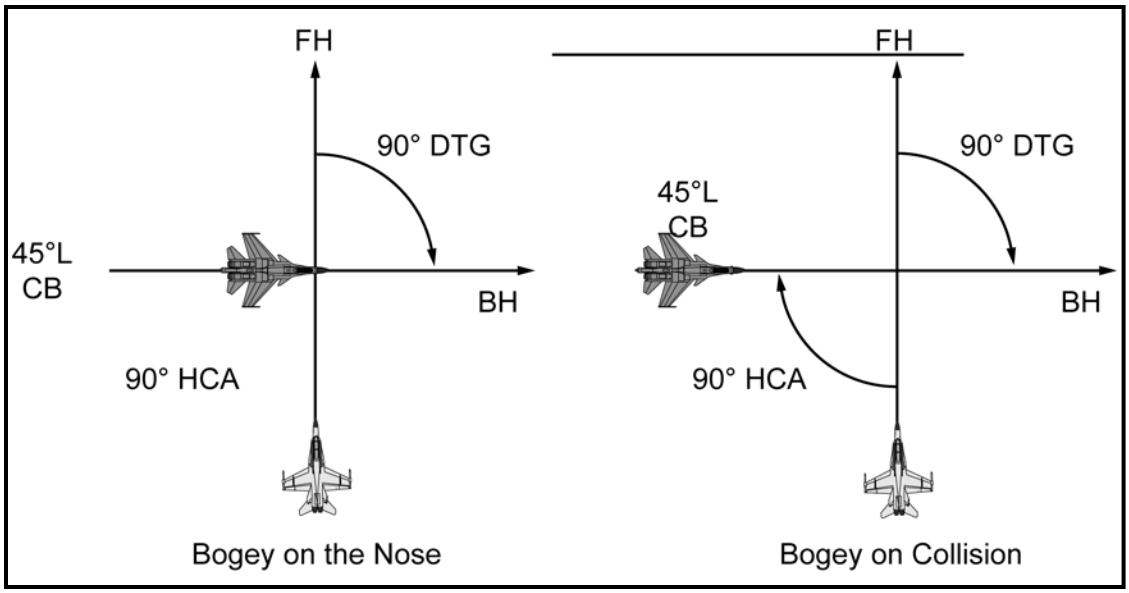


**Figure 10-6 On the Nose-On Collision Diagram**

## 1005. IDEAL DRIFT PATTERN AND COUNTERTURN SEQUENCE

Counterturns are divided into three major categories, each with its own ideal drift pattern for controlling the intercept. The determining factor is the LD available for the CT. Remember, LD is computed from TA and slant range. Knowing TA tells us indirectly which drift pattern we will try to follow.

## 1006. LOW TARGET ASPECT

With low TA (0-15 degrees), the DT drives the fighter away from the bogey flight path. Ideally, the fighter will obtain 20,000 feet of LD. Whenever outward drift is observed, it is countered initially with an easy turn. The bogey should be held at a constant AO in order to gain maximum lateral separation. This may require either easing the turn of the fighter or hardening it as appropriate.

As the fighter continues driving for maximum LD, there comes a point when the AO cannot be maintained with a standard rate turn or less. That point should occur near the 180 DTG position in the CT. Once passing through this position, the fighter’s nose is now pointing toward the BFP, reducing lateral separation. When a standard rate turn will not hold the bogey at a constant AO, the fighter should bring the bogey to the nose with a hard as poss turn.

As the bogey approaches the fighter’s nose position, DTG decreases and the bogey's distance from CB increases. Ideally, the fighter will have the bogey on the nose at the 90 DTG position, where drift rates are the highest.

Once passing through this position, the fighter should attempt to roll out in the rear quarter between ½ and 1½ NM, in order to be in range for a Sidewinder missile shot.

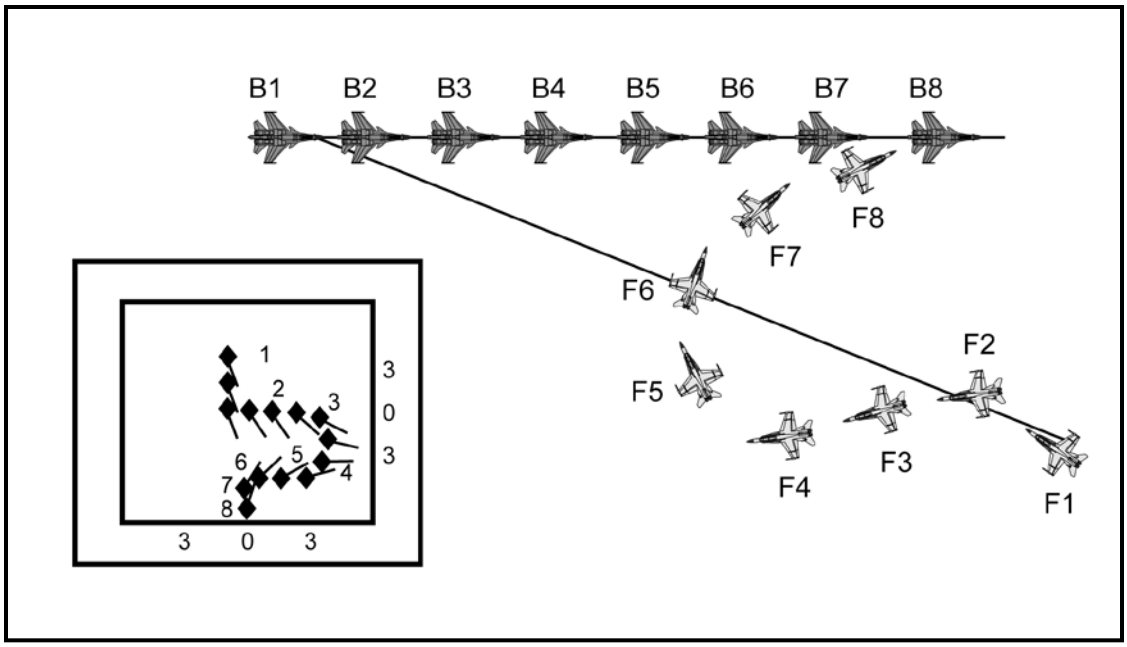


**Figure 10-7 Low Target Aspect**

## 1007. MEDIUM TARGET ASPECT

With medium TA (20-25 degrees), the DT maintains the fighter's position relative to the bogey's flight path. The fighter already has 20,000 feet of LD. Whenever outward drift is observed, it is countered initially with an easy turn (standard turn for situations that rounds to 25° TA). The bogey should show a slight but steady inward drift to allow maximum control of the loss of lateral separation.

In order to maintain a slight steady inward drift towards the fighter's nose, the weapons officer has to increase or decrease the turn rate as necessary. The bogey should end up on the nose at the 90 DTG position with 2 NM slant range.

Use "Ease," "Hold," and, "Harder" commands to maintain the bogey on the nose through the rear quarter. The fighter is attempting to roll out within ½ and 1½ NM.

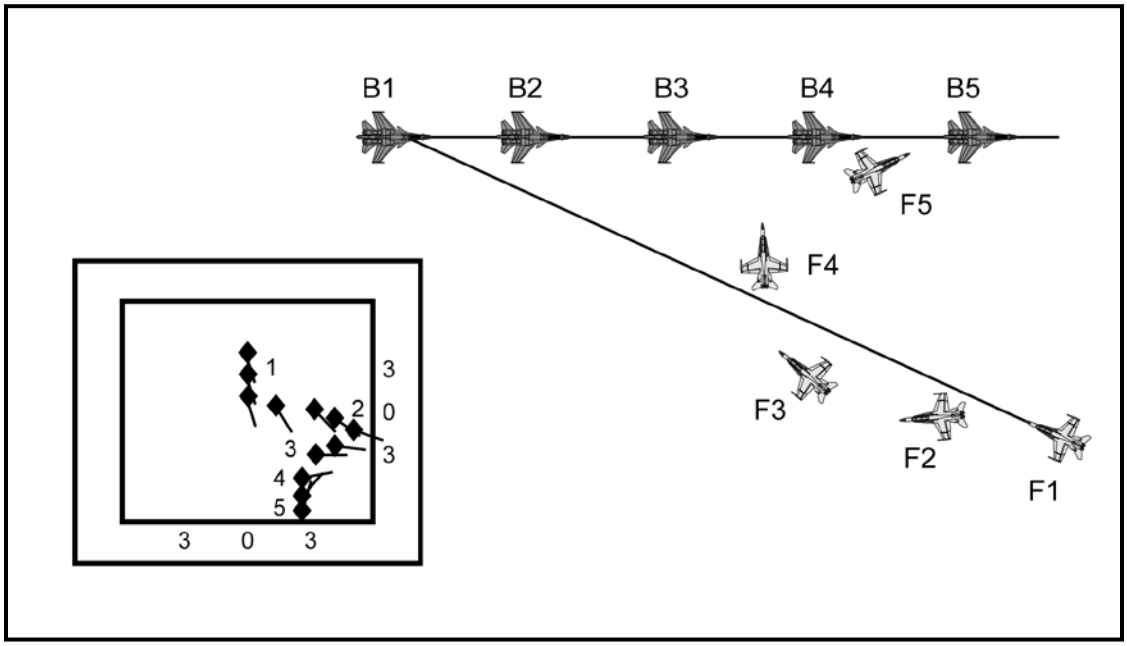


**Figure 10-8 Medium Target Aspect**

## 1008. HIGH TARGET ASPECT

With high TA (30° or greater), the DT drives the fighter toward the bogey's flight path, but at a slower rate than collision. Outward drift will be countered initially with a standard rate of turn. The bogey should drift in with a steady inward drift to allow maximum control of the loss of lateral separation.

In order to maintain a steady inward drift towards the fighter's nose, the weapons officer has to increase or decrease the turn rate as necessary. The bogey will be on the nose well before the 90 DTG position.

Use "Ease," "Hold," and, "Harder" commands as necessary to maintain the bogey on the nose through the 90 DTG position and into the rear quarter. The fighter attempts to roll out within ½ and 1½ NM.

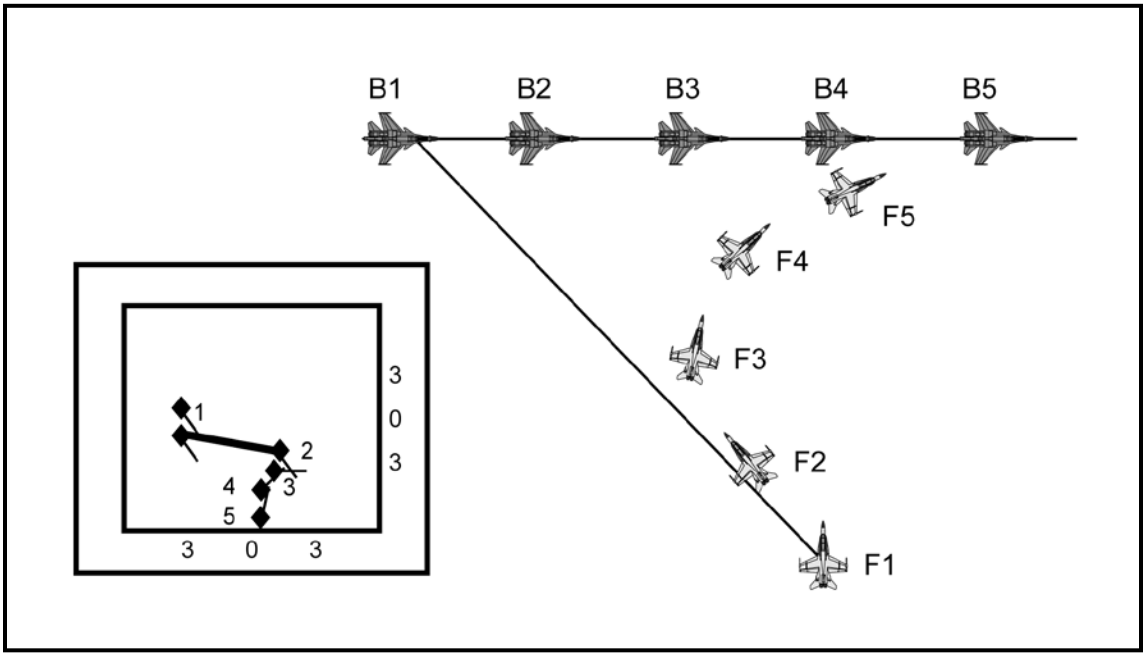


**Figure 10-9 High Target Aspect**

## 1009. COUNTERTURN SEQUENCE CHART

The correct counterturn sequences are listed below. They must be committed to memory for instant recall. They are useful guides for all counterturns, both here and in operational tactical aircraft. In order to maintain the ideal drift curve, it may be necessary to ease out of a given turn rate before increasing it again.

| TA | LEAD RANGE | DISP RANGE | DISP AO | COUNTERTURN SEQUENCE AFTER DT | | |
|---|---|---|---|---|---|---|
| 0° | 12 NM | 10 NM | 50° | Easy | Standard | Hard as poss |
| 5° | 12 NM | 10 NM | 45° | Easy | Standard | Hard as poss |
| 10° | 12 NM | 10 NM | 40° | Easy | Standard | Hard as poss |
| 15° | 12 NM | 10 NM | 35° | Easy | Standard | Hard as poss |
| 20° | 12 NM | 10 NM | 30° | Easy | Standard | Hard - Hard as poss |
| 25° | 10 NM | 8 NM | 25° | Standard | Hard | Hard as poss |
| 30° | 10 NM | 8 NM | 20° | Standard | Hard | Hard as poss |
| 35° | 10 NM | 8 NM | 15° | Standard | Hard | Hard as poss |
| 40° | 10 NM | 8 NM | 10° | Standard | Hard | Hard as poss |
| 45° | 10 NM | 8 NM | 5° | Standard | Hard | Hard as poss |
| 50° | 10 NM | 8 NM | DA | Standard | Hard | Hard as poss |

**Figure 10-10 Counterturn Sequence Chart**

## 1010. HOT AND COLD

"Hot" refers to a low, or less than desirable, TA or LD situation at a particular range. "Cold" refers to a high, or more than desirable, TA or LD situation at a particular range. Although it may be initially hard to grasp this concept, using an ideal drift pattern as a spatial orientation reference helps.

**Situation:**

Bogey is 30°L AO with 30° TA and on CB until DT. After DT, if bogey is right of ideal drift curve, bogey is "Cold." If left of ideal drift curve, bogey is "Hot."

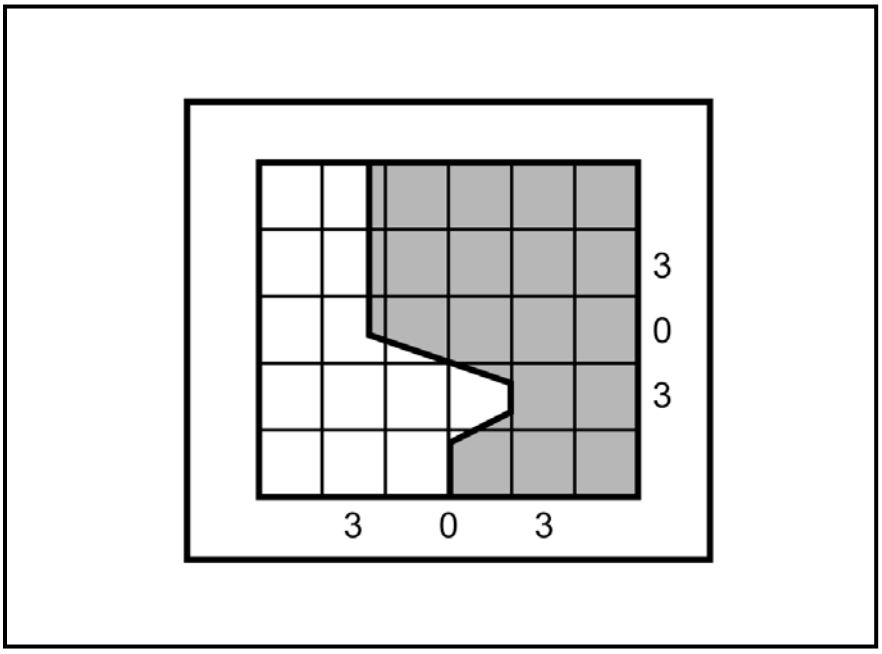


**Figure 10-11 Hot and Cold Diagram**

In Figure 10-11, the shaded portion of the scope is cold and the clear side is hot. At range (prior to DT), drift into the clear side is a "Hot Drift" of CB with decreasing TA. Conversely, drift into the shaded side is a "Cold Drift," with the bogey inside collision with increasing TA.

**NOTE**

Hot drift decreases LD. Cold Drift increases LD with respect to the ideal drift pattern.

After displacement, even though the bogey is on the cold side of the scope, either a hot or cold drift may occur in relation to the ideal drift pattern. Drift to the shaded area is cold drift. The fighter's nose is further behind the bogey and further off CB than the ideal. Drift into the clear area is hot drift. The fighter's nose may still be behind the bogey but is closer to CB than the ideal drift.

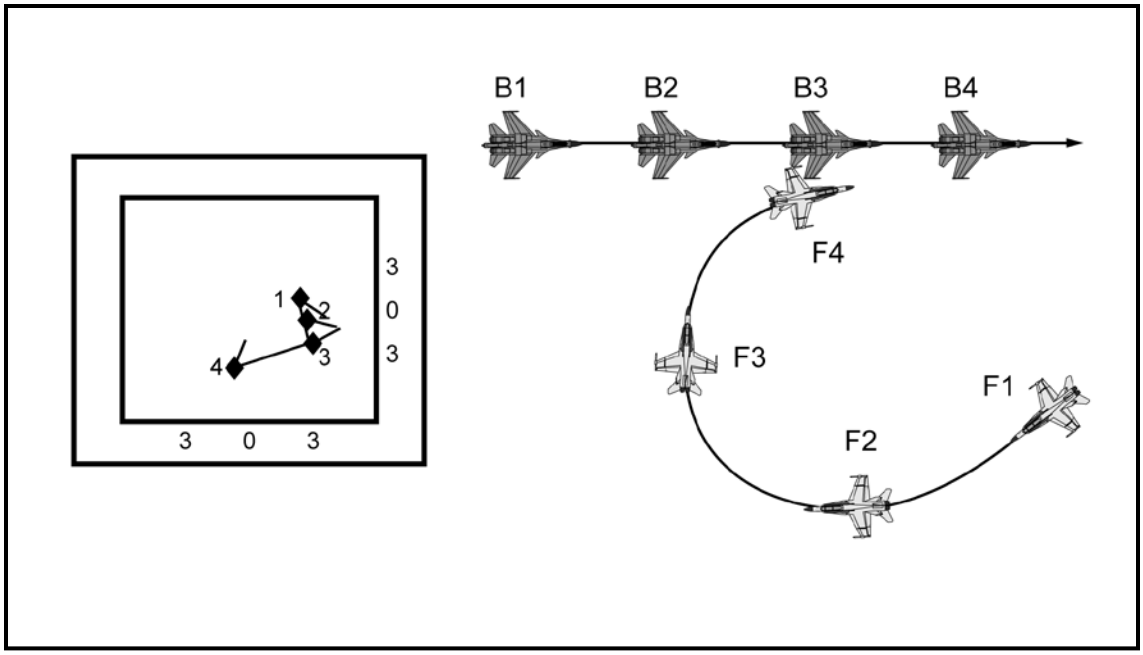


**Figure 10-12 Cold Counterturn**

A “cold counterturn” is one in which the bogey is never brought back to the ideal drift path after outward drift is observed.

Figure 10-12 shows the bogey on the cold side of the scope throughout the counterturn. Since the LD was not diminished quickly enough, the fighter will end up in the rear quarter at a greater range than required for a Sidewinder missile shot. At this point the only recourse the weapons officer has is to add a buster to get within Fox-2 range.

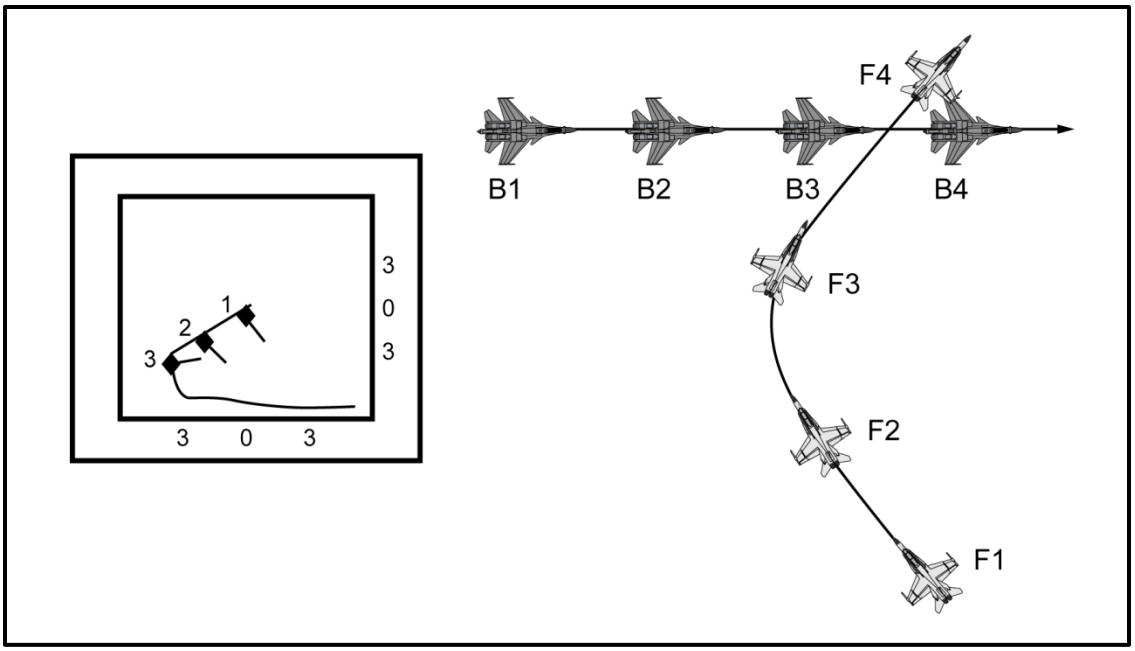


**Figure 10-13 Hot Counterturn**

A "hot counterturn" is one in which the bogey is brought closer to the fighter's nose faster than the ideal pattern. In figure 10-13, the bogey was brought to the nose too quickly and overshot the bogey's flight path.

## 1011. DISPLACEMENT TURN VARIATIONS

A proper DT is critical to a proper CT. The effects of displacing differently than the prescribed amount in the DT will place the bogey in the hot or cold areas of the CT. A guideline to correct for a less than perfect DT is below. In all cases, the weapons officer will strive to displace at the appropriate range for the given TA.

| DT Problem | Type Drift | Correction |
|---|---|---|
| Overdisplaced > 5° | Cold | Redisplace immediately |
| Overdisplaced < 5° | Cold | Start Counterturn |
| Underdisplaced > 5° | Hot | Redisplace immediately |
| Underdisplaced < 5° | Hot | Let drift to proper AO |

## 1012. INTERPRETING THE RATE OF CLOSURE (ROC)

After completing the DT, the scope display of ROC (in a track mode only), will normally be approximately 500-600 knots. The ROC after a DT is always lower than it was while on collision. As the fighter progresses through the counterturn, the ROC will decrease slowly until it is zero, as long as the aircraft are co-speed. At 5 NM the bogey should have 500 knots ROC. When the bogey is on or near the fighter's nose, with a ROC close to the fighter's airspeed, this

is the beam area. The transition from the forward quarter to the beam is indicated on the scope by a more rapid drop in ROC. This ROC drop is a result of the ROC becoming more a function of the fighter's airspeed as both aircraft are no longer heading directly at each other.

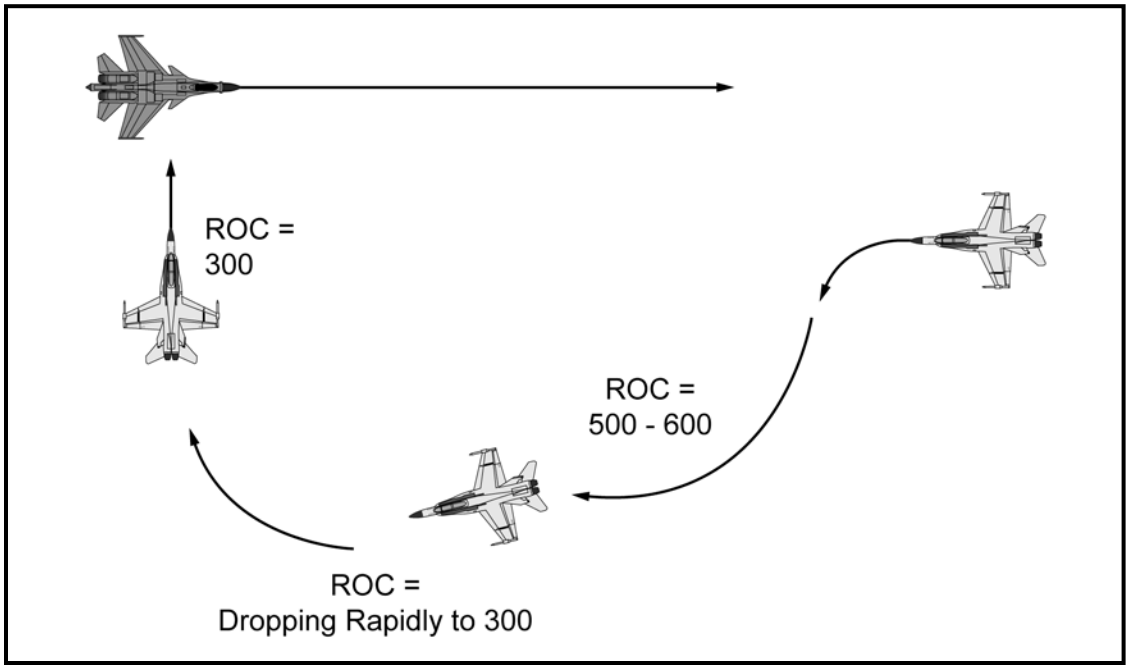


**Figure 10-14 Rate of Closure**

## 1013. COMPASS RECOVERY

A compass recovery is a maneuver used to salvage the intercept when an extremely hot CT caused a lost contact. If a counterturn is hot due to misanalysis of TA, a late DT, running the wrong CT, or any combination of these, lateral separation will be lost with decreasing slant range and high ROC. The fighter could overshoot the bogey's flight path and lose radar contact.

The weapons officer must be able to recognize a hot overshoot on the scope. The first indication will be a bogey that is maintained on the hot side of the ideal drift curve for too long. If the bogey is brought to the nose too quickly, without checking the EHSI to see how many DTG are still left, the fighter might get the false impression that the 90 DTG position has been reached. But, with ROC still very high, the bogey will rapidly drift off to one side of the scope and result in a lost contact situation.

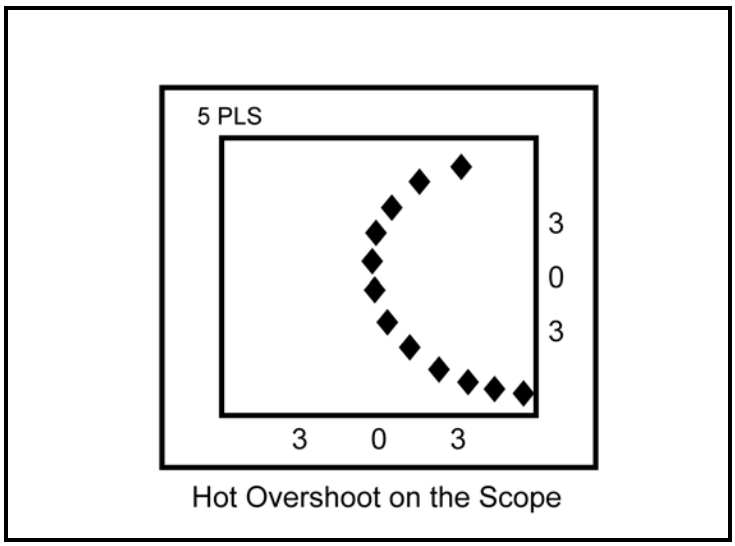


**Figure 10-15 Hot Overshoot on the Scope**

To regain control of the intercept, the fighter should command a "Hard as poss" turn to a heading 30° beyond the bogey's heading and call "*lost contact*" to GCI. This brings the fighter back towards the bogey flight path as rapidly as practical. Radar contact should be anticipated near the nose, drifting toward BH. If no contact is acquired within approximately 5 seconds, and if no GCI information has yet been given, the fighter should turn towards BH with a "standard" turn. This entire procedure is called a "compass recovery."

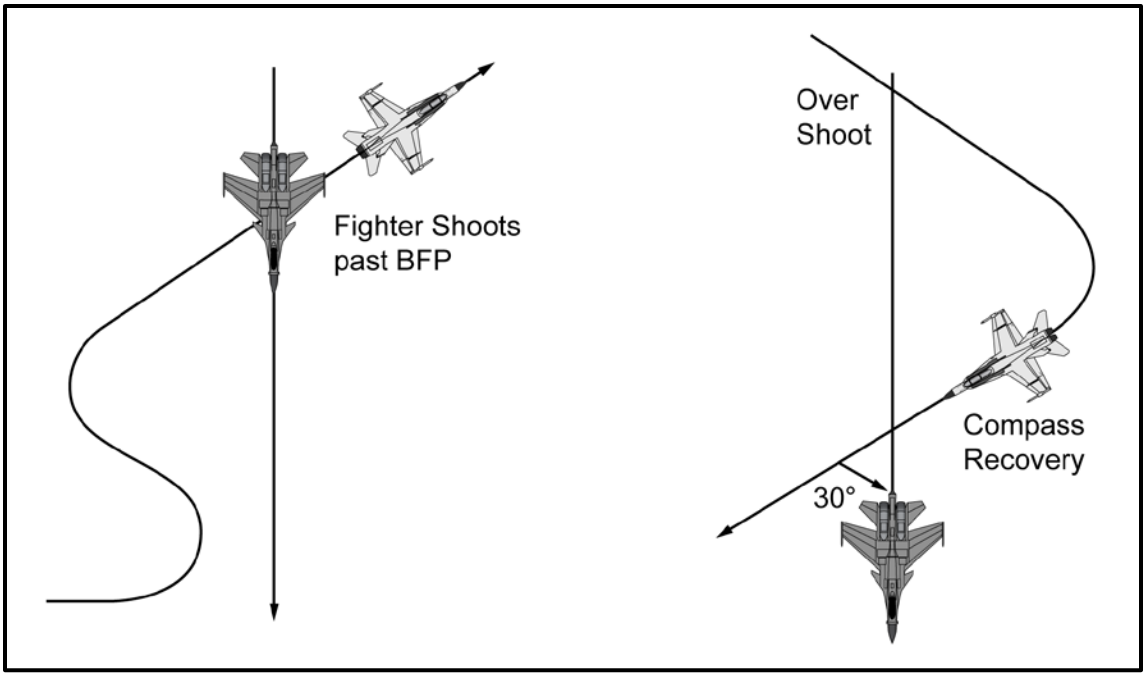


**Figure 10-16 Compass Recovery**

The compass recovery is not a remedy for all break-lock or lost contact situations**.** If the bogey had been allowed to drift cold with low TA (i.e., 5° TA displaced to 45°, and the bogey drifts off the scope), executing a compass recovery places the fighter somewhere inside BFP, possibly abeam the bogey, as shown below.

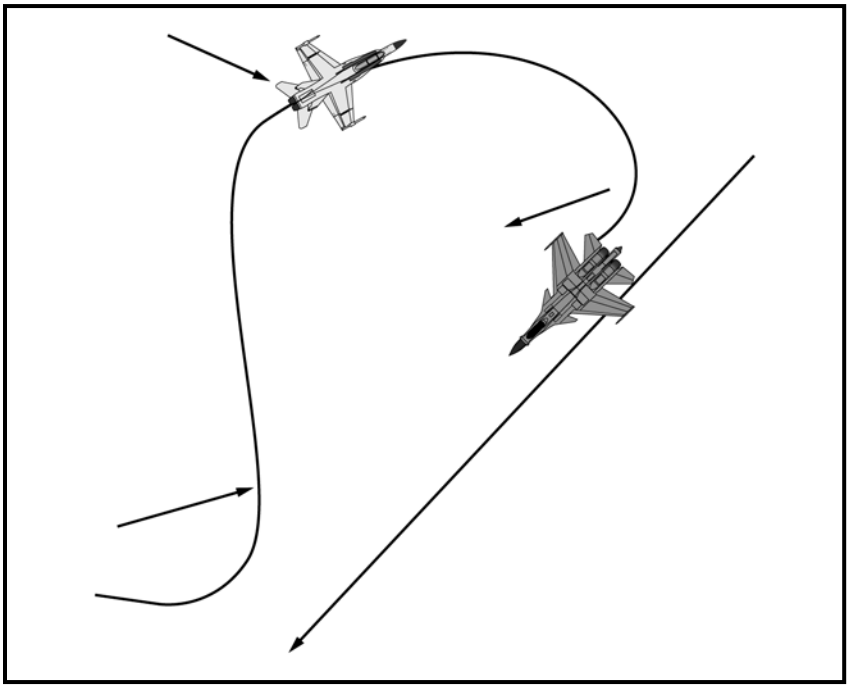

**Figure 10-17 Abeam the Bogey**

## 1014. REAR QUARTER DRIFT CONTROL – WITHOUT RADAR CONTACT

If during the counterturn, the bogey is allowed to drift excessively and go off the scope, or the fighter loses radar contact for whatever reason, the fighter should:

1. Continue turning with increasing turn rates as necessary and attempt to run the proper drift curve via the EHSI until approximately 45° DTG.

2. Call "*Lost contact*" to GCI (immediately after losing contact - simultaneously with Step 1).

3. Listen for GCI's first call of BB.

4. Steady up on a heading half way between BB and BH, once in the rear quarter (45° DTG).

The rationale for the procedure is simple. The BB is a line from the fighter to the bogey. The BB allows the aircrew to orient the fighter's position with relation to bogey flight path. The same number of degrees that the FH is off of the BH is the same number of degrees the fighter is off BFP.

Analyzing the possible options available, the aircrew can:

1. Turn to BB

2. Turn to BH

3. Turn to a heading between BH and BB

Turning to BH places the fighter on a parallel path with the bogey. This maneuver arrests drift but may not allow the fighter to arrive at the bogey's 6 o'clock. Turning to BB will induce fighter weave. Option 3 is the best choice. This procedure is commonly known as "splitting the difference."

**NOTE**

Turning to a heading between BB and BH is lead pursuit, and will cause the range to decrease and control the drift when in close.

With another BB call from GCI, the fighter will readjust its heading, reducing the amount of lead to gradually decrease range and control drift. When BB = BH, the fighter is situated on the bogey flight path, somewhere directly astern of the bogey. This simplifies the radar search and controls drift. All three options are shown in Figure 10-18.

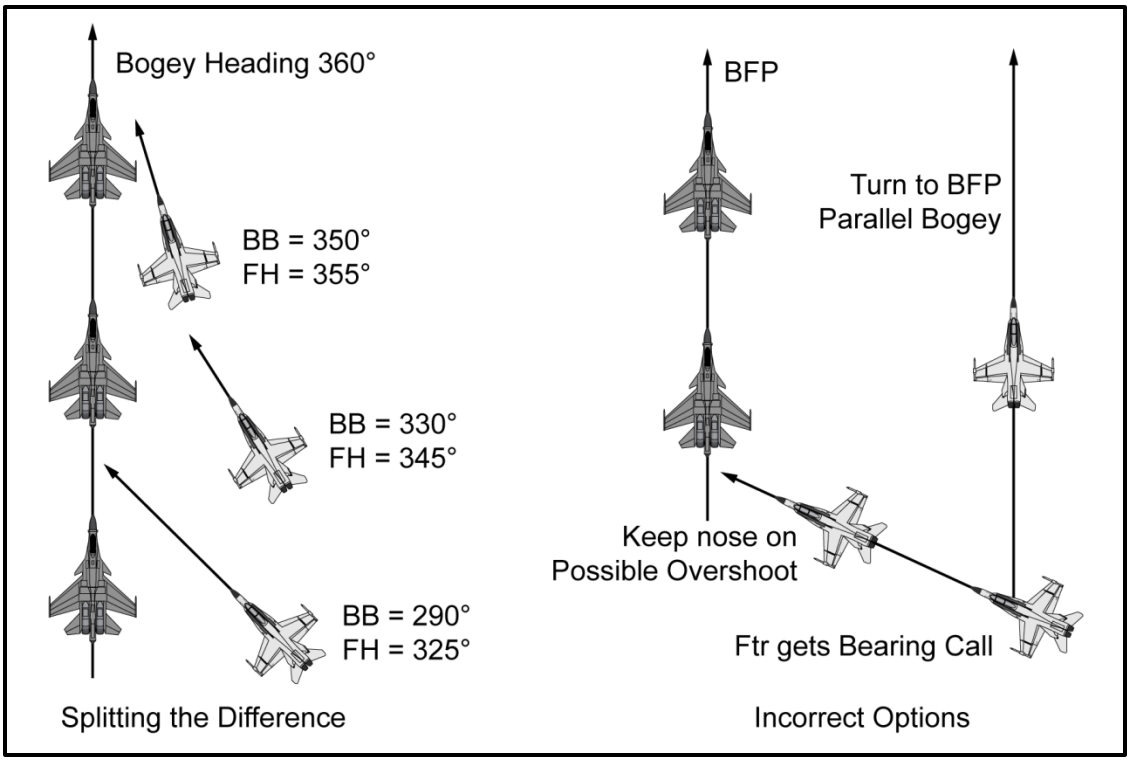


**Figure 10-18 Splitting the Difference**

## 1015. REAR QUARTER DRIFT CONTROL – WITH RADAR CONTACT

Once in the rear quarter with a low ROC, the fighter should turn to keep the bogey on its nose. Eventually, the drift will become minimal and the fighter will be on the bogey flight path, in a position to launch a Sidewinder missile. Failure to hold the bogey on its nose will result in the fighter crossing the bogey's flight path. Overshooting of the bogey's flight path, however small, is known as "fighter weave" and is undesirable.

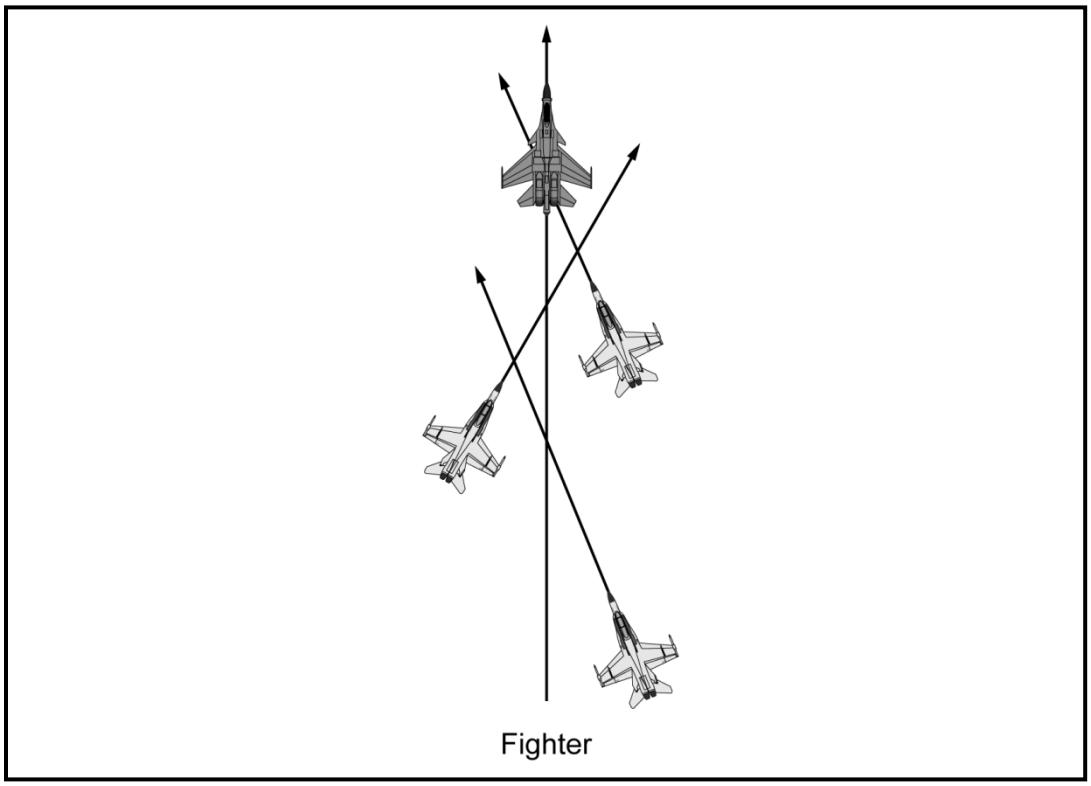


**Figure 10-19 Fighter Weave**

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*"Turn to kill, not to engage."*

CDR Willie Driscoll, USNR
Vietnam, 5 Victories as a RIO

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# CHAPTER ELEVEN
# SPEED VARIATIONS

## 1100. INTRODUCTION

Anything made by man has limitations. The collision intercept procedures covered work well for a given set of TAs. However, intercepts can and must occur beyond this TA range. Geometry is a powerful tool in excelling beyond the physical limitations of the radar. By departing the realm of the co-speed intercept, we can increase the range of TAs for which our radar is effective.

## 1101. LIMITATIONS OF THE RADAR

The mechanical azimuth (gimbal) limits of the APG-66NT radar are 60°L and 60°R. However, because of errors near the edges, the functional limits are only 55°L and 55°R. A bogey with greater than 55°L/R TA presents the fighter with an unusual problem. For a co-speed intercept, the fighter would have to place the bogey outside the limits of the radar scope to establish collision for a co-speed intercept.

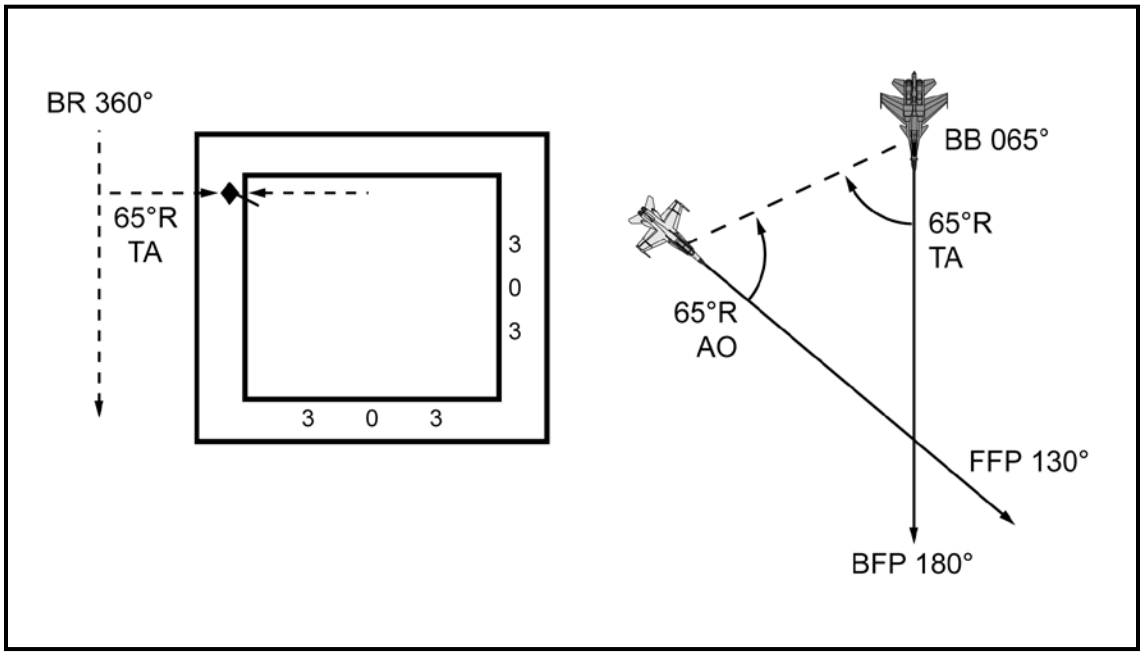


**Figure 11-1 Radar Limitations**

## 1102. GEOMETRY

When the TA exceeds the limits of the radar, the fighter must employ a different set of procedures to place the bogey on collision.

In a co-speed collision intercept, the bogey and fighter travel the same distance over the same amount of time. In Figure 11-2, the fighter and bogey will be on collision when T1 = T2.

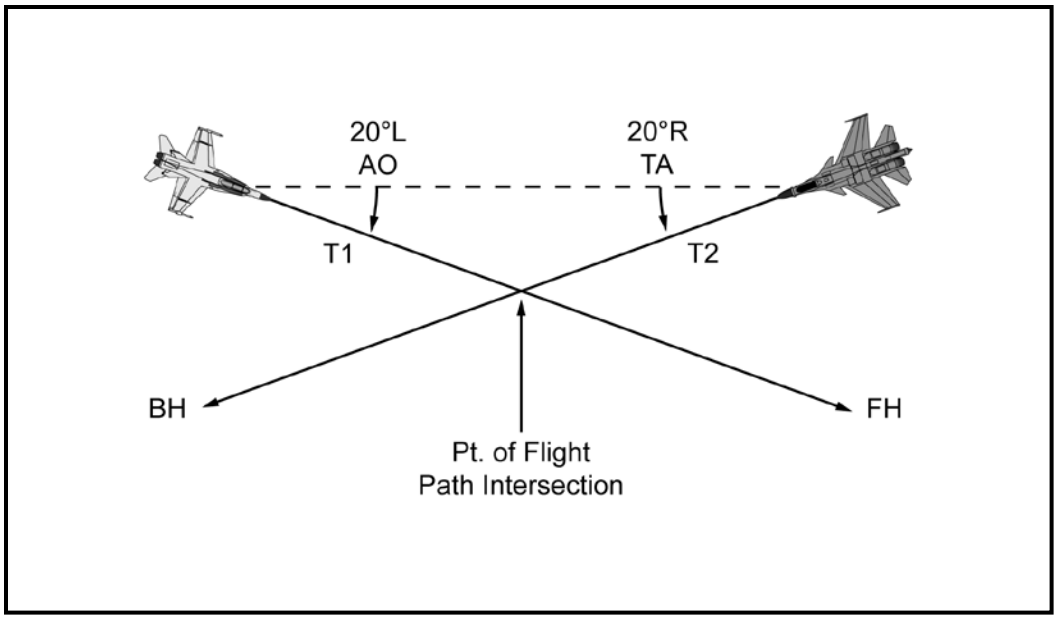


**Figure 11-2 Geometry**

The figure below shows the approximate flight path distance of both aircraft when TA is 65°R and the bogey is within the functional limits of the scope (±55°). The actual flight path distance computation involves trigonometric relationships not relevant to practical execution. The computations below are provided for illustration purposes.

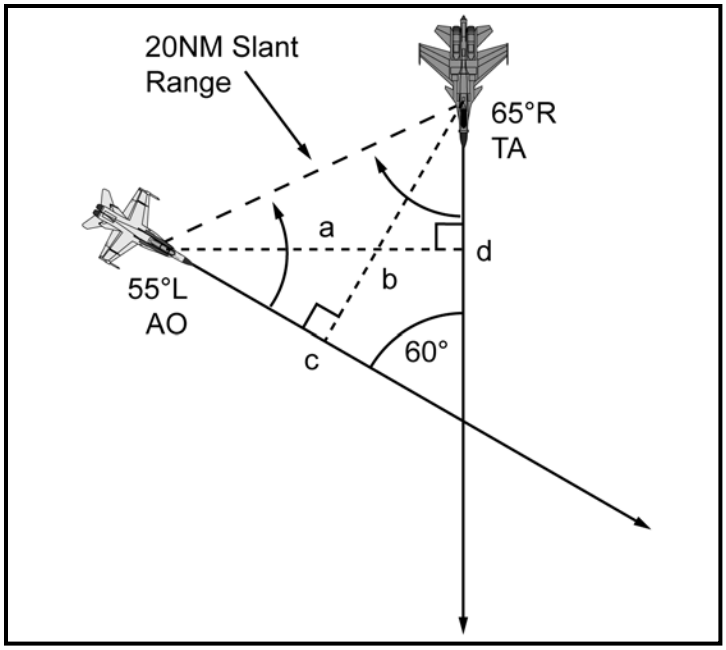


**Figure 11-3 Flight Path Distance**

## 11-2 SPEED VARIATIONS

Approximation of distances traveled:

a = 20NM X sin65° = 18.13 NM

b = 20NM X sin55° = 16.38 NM

c = 18.13 / (sin60°) = 20.93 NM

d = 16.38 / (sin60°) = 18.91 NM

In this example, a conventional CCC of "*Right hard 10, steady _____*" places the bogey outside the scope limits at 65°L. However, the bogey has a shorter distance to travel than the fighter. So if the fighter takes no action, the bogey drifts across the fighter's nose.

The fighter in this case must cover approximately 20.93 NM in the same time the bogey travels approximately 18.91 NM. To do this, the fighter must increase airspeed. This increase is determined by complex mathematical formulas. Without going through the entire math, at VT-86 the required speed advantage for these high TA intercepts are 0.1 IMN over the bogey's airspeed.

The following chart provides all of the required cuts for each of the "cold 100" set-ups. These aspects are a compromise between keeping the bogey on the scope and controlling the drift by having the bogey as close as possible to CB.

| TARGET ASPECT | CUT | ANGLE OFF | DISPLACES TO |
|---|---|---|---|
| 50° L/R | 100° R/L Cut | 50° R/L | 0° |
| 55° L/R | 100° R/L Cut+B | 45° R/L | 5° R/L |
| 60° L/R | 110° R/L Cut+B | 50° R/L | 10° R/L |
| 65° L/R | 120° R/L Cut+B | 55° R/L | 15° R/L |
| 70° L/R | 120° R/L Cut+B | 50° R/L | 20° R/L |
| 75° L/R | 130° R/L Cut+B | 55° R/L | 25° R/L |

**Figure 11-4 Required cuts for "Cold 100" Setups**

## 1103. NON-ISOSCELES INTERCEPT TRIANGLE

The command required to accelerate the aircraft is "*Buster, set speed 0.6.*" The pilot accelerates and holds 0.6 IMN until directed to change airspeed.

Since this speed advantage allows the fighter to reach the point of flight path intersection at the same time as the bogey, the fighter and bogey are on collision. Even though an isosceles triangle no longer exists, the following characteristics of a collision course will remain true:

1. TA will remain constant with decreasing range.

2. BB and AO will remain constant with decreasing range.

3. If the fighter's airspeed is held at 0.6 IMN and the bogey's airspeed is held at 0.5 IMN, the two aircraft will collide if slant range is allowed to decrease to zero (co-altitude).

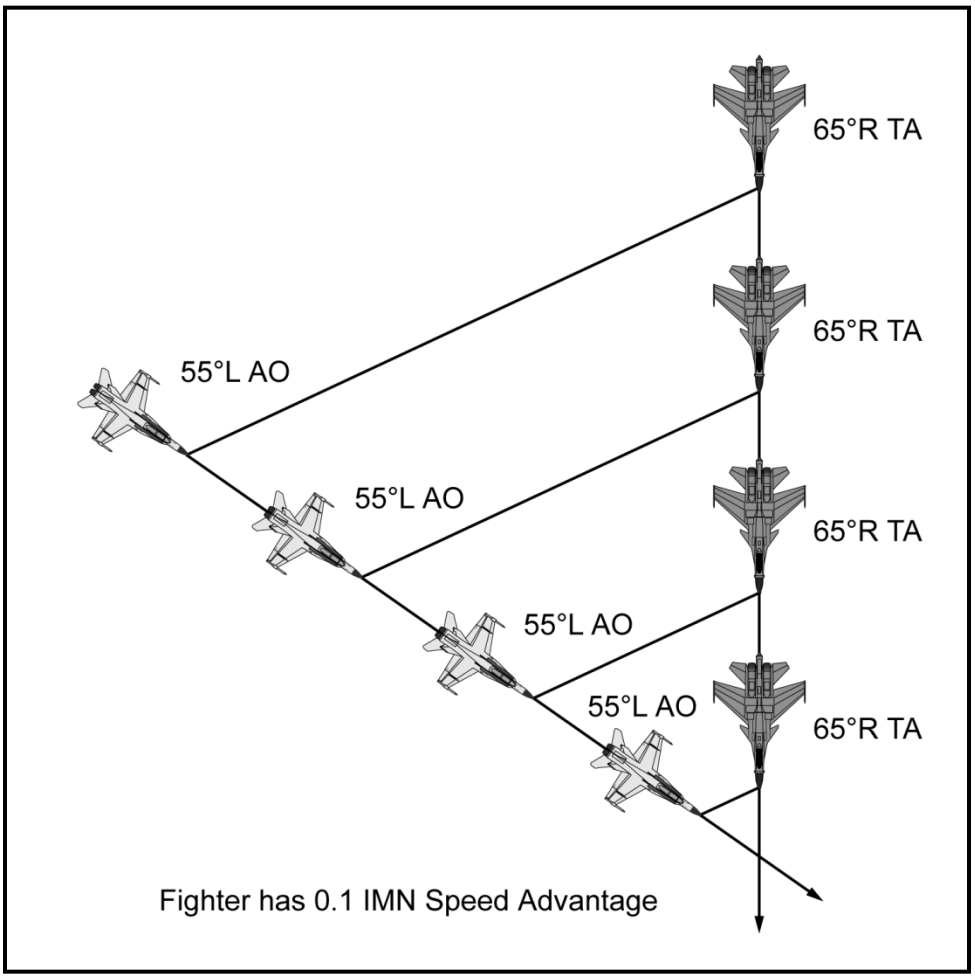


**Figure 11-5 Non-Isosceles Intercept Triangle**

The figure above shows 65° TA at 55° AO (120° cut) with the fighter and bogey on collision due to the fighter's 0.1 IMN speed advantage. Because CB is 1/2 the cut (in this case 1/2 of 130° cut is 65°L), AO is now 10° smaller than the TA.

**NOTE**

A 0.1 IMN speed advantage moves CB in by 5°.

With 55° or greater TA the fighter will command *"Left/Right hard for displacement"* at 8 NM and commence a DT, just as it would with a lower TA. The rule of 50 still applies, but note that

## 11-4 SPEED VARIATIONS

50° of heading change may not be required, and the bogey will not go across the fighter's nose. The bogey will then be allowed to drift inward towards the fighter's nose.
A counterturn is then initiated to hold the bogey on the fighter's nose. When assured of rolling out in range, the fighter will remove the buster by commanding "*Throttle back, set speed .5.*"

## 1104. "SNEAK A PEEK"

Due to a combination of the limits of the scope and GCI error, there may be an occasion when the actual position of your contact is beyond the limits of the scope. Therefore, when the initial setup is such that the weapons officer has a 90° cut or greater, and after properly searching each of the three altitude blocks using good search techniques, the student will sneak a peek.

In essence, a sneak a peek is a 20° turn into the cut. It is important to remember there will be a new cut, once a sneak a peek is executed. For example, the student is on a 110°R cut looking 50°R for 60°L TA but cannot find the contact. The student should direct a RT Hard 20° turn for a 90°R cut. One of two things may happen:

1. The contact is now on the scope, in which case the student makes a BRAA call to identify the contact and then places the contact on CB using the cut→AO formula. (Pay attention to requirement for the buster).

2. There is still no contact, in which case return to the original cut (or to the proper cut if the bogey has drifted based on GCI) and then use the GCI information to run the intercept.

Use of AZ Full or sector scan in sneak a peek is purely technique. However, once back on your cut (based on GCI information with no contact), use AZ full ≤ 18NM. Sneak a peek inside 18NM may be AZF or AZ3. Headwork applies.

## 1105. PROCEDURES

It is apparent that TA is the determining factor in the use of the buster during these "cold 100" set-ups. In the beam area, an increase of .1 IMN by the fighter allows the fighter to hold the bogey on a CB that is 5° closer to the fighter's nose than in a co-speed situation.

The procedures for "cold 100" setups are:

1. Compute TA.

2. Command the speed increase, "*Buster, set speed .6.*"

3. Compute or change the fighter's heading as necessary to generate the proper AO.

4. Make CCCs until 2 NM prior to the DT.

**NOTE**

Not all collision corrections will require a heading change.

5. Displace the bogey according to the rule of 50 at 8 NM.

6. Allow the bogey to drift to the fighter's nose, and then commence a counterturn to keep the bogey on the nose (the fighter may not need to command a hard or hard-as-poss turn to maintain the bogey on the nose).

7. Command a speed reduction, "*Throttle back, set speed .5,*" when assured of rolling out in range.

## 1106. CONCLUSION

Modern radar systems have similar limitations to the APG-66NT. The procedures here can be applied to any high TA intercept encountered in an operational squadron.

**This page reserved for Notes**

*"Everything I had ever learned about air fighting taught me that the man who is aggressive, who pushes a fight, is the pilot who is successful in combat and who has the best opportunity for surviving battle and coming home."*

Major Robert S. Johnson, USAAF
WWII, 27 victories (91 missions)

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# CHAPTER TWELVE
# INTERCEPT PROGRESSION I

## 1200. INTRODUCTION

At this point, the aircrews are exposed to the various spatial relationships and their functions in the intercept triangle. We discussed CCCs, displacement points and ranges, and proper drift control during the counterturn. Each part of the intercept was introduced individually. Now we separate a reattack intercept into three distinct phases, giving the aircrew a logical framework to approach all intercepts.

## 1201. INITIAL PHASE OF THE REATTACK INTERCEPT

The term reattack refers to the breaking-off of a collision intercept after either employing a forward quarter radar missile "attack" or having forgone the beyond visual range (BVR) missile shot, proceeding to displacement and executing a counterturn in order to arrive in the rear quarter with a second shot opportunity or "reattack."

In the initial phase, GCI is used to determine TA and establish a collision course. Once a collision course is established and the bogey is acquired, the aircrew makes a contact call. The weapons officer must then carefully analyze the scope to ensure that a collision course has actually been established. If the contact is not on CB within rounds, a CCC is required. This assumes CCCs have not stopped due to the timeline (see Mid-Phase of the Reattack Intercept). If the contact is on CB within rounds, a lock should be taken if the following criteria are met:

1. Fighter is in a hard turn or less

2. Drift is stabilized

3. Good spotlight

During the initial phase of the intercept, proper radar search technique greatly increases the probability of early bogey detection. Use of the appropriate sector scan plus realistic elevation search increments and limits must be used. Elevation differential (degrees) should be converted to altitude differential (feet). The fighter will eventually need to make altitude corrections to achieve a co-altitude situation in the rear-quarter of the bogey.

## 1202. MID-PHASE OF THE REATTACK INTERCEPT

The mid-phase of the intercept is a period for planning and observation. The AREO report, which starts at 10 NM, is now an essential tool, for it aids the pilot in getting a tally. The weapons officer must keep track of the intercept and make any necessary directive calls to the pilot. Directive communication always takes precedence over descriptive communication.

The weapons officer continues to scan the scope and EHSI in order to confirm a no-drift (collision) situation. If the bogey is still not acquired, elevation search increments and limits are increased as the range decreases, using a methodical search technique. Two miles prior to the lead range (12 or 14 NM) TA analysis will be finalized and should be voiced.

**NOTE**

> It should be emphasized again that lead and displacement range points are based solely on TA. For example, 20 right TA will always be displaced to 30 right AO regardless of whether or not the bogey is on CB at 12 NM.

Now is the time to note any drift that would change TA and, therefore, affect the displacement and counterturns. The 10 NM range is a convenient checkpoint for altitude analysis since it is easily workable using the altitude difference formula. The fighter should have determined by this point if the bogey is high or low in relation to the fighter. Altitude differential should be computed and the appropriate directive commentary given to the pilot for any necessary altitude corrections.

At 12 or 10 NM (depending on TA), the fighter leads the bogey appropriately and will "pass the dot" if the criteria are met for an F-1. At 10 or 8 NM, the fighter displaces the bogey to the appropriate AO and starts the counterturn.

At this point, the weapons officer commands *"Left Hard for displacement ...10 to Go, Steady Up"* in order to achieve the proper displacement point (in this case, 30°R AO). Although most DTs require 50° of turn (provided the bogey started on CB), the weapons officer never commands "*Left Hard 50*" since the turn can be any number of degrees depending on the last computed TA, and bearing in mind that the bogey will drift in the DT.

In a proper DT the fighter simply commences a hard turn in the appropriate direction, then, leading the roll-out somewhat give the "10 to go" call, then pilot is commanded to "*Steady Up"* with the bogey now properly displaced.

Note on the example below:

1. Bogey was not on CB at displacement range.

2. 20°R TA displaced to appropriate AO (30°R).

3. DTG > 180° after DT, allowing a small amount of Lateral Separation (lat sep) to be gained.

4. When the fighter begins a right CT, it will pass 180 DTG (340°) almost immediately while bringing the bogey to the nose.

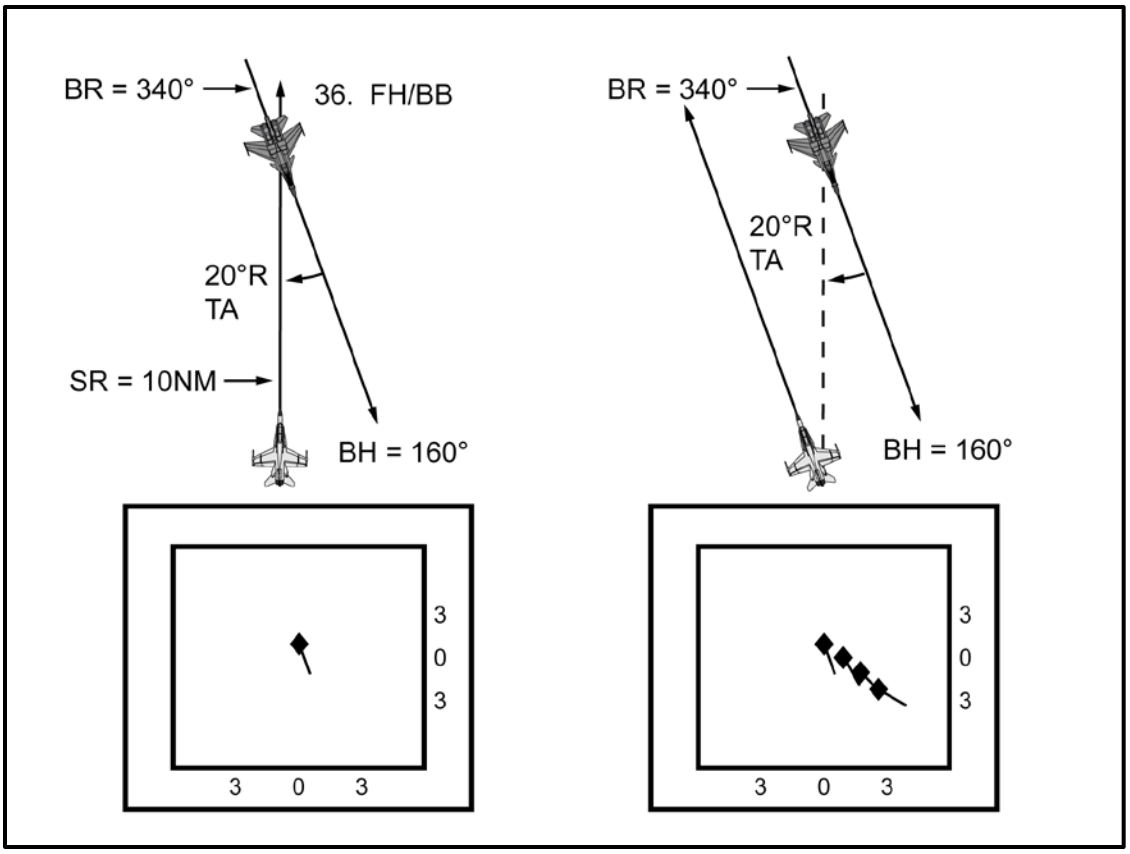


**Figure 12-1 Mid-Phase**

## 1203. FINAL PHASE OF THE REATTACK INTERCEPT

Up until lead range, proper TA analysis is the number one priority. However, once the fighter breaks collision course with the LT and begins the displacement turn, TA will be constantly changing. The aircrew can now dismiss TA for the reattack phase of the intercept as proper drift control becomes the primary task. In situations with 0°-15° TA, it is essential that no inward drift is accepted prior to passing the 180 DTG position in the CT. During the CT with 20° TA or greater, no more lat sep can be gained, and the bogey can be allowed to drift to the nose.

Remember that the fighter is striving to arrive at a “window” in space: Bogey on the nose at 2 NM with 90 DTG and, if the bogey is locked, a ROC roughly equal to that of the fighter aircraft, (300 knots here at VT-86). As the ROC approaches 300 knots, the fighter is approaching the beam area of the bogey and drift rates will increase.

A buster should be used if necessary to assure proper roll out distance. As the fighter enters the bogey's rear quarter, drift becomes progressively more a function of the fighter's actions. Also, the turn rate required to keep the bogey on the fighter’s nose will lessen.

Appropriate directive commentary to ease the turn must be given to keep the bogey as close to the nose as possible. At this point in a search run, the fighter should ideally try to achieve a radar lock before rolling out in the rear quarter. Valid Sidewinder shot criteria are as follows:

## 1204. "FOX 2" OR AIM-9 SIDEWINDER CRITERIA

1. Bandit locked up (STT)

2 In range (.5 to 1.5 NM)

3. Pitch +/- 8° (dot inside the ASE circle)

4. Azimuth +/- 8° (dot inside the ASE circle)

5. Closure 0 - 100 knots (no opening, i.e., -0 is invalid)

6. Drift stabilized (slight inward drift OK)

7. Hard turn or less

It is important to note that meeting these parameters will allow the missile to reach its target. However, good headwork dictates that the contact has been declared Hostile by GCI or visually identified to GCI as a Hostile A/C before "passing the dot."

When the fighter is in the bogey's rear quarter, the flight path is very predictable. A timely shot by the fighter will minimize exposure to the enemy in this position and minimize Time To Kill (TTK).

| Reattack | Intercept Procedures | Radar Functions |
|---|---|---|
| At range | -GCI info (BH & BB). | -Move antenna using proper search increments. |
| | -Compute BR, TA, and CC. | -Select proper range and sector scan. |
| | -Check EHSI-Confirm cut/CC. | -Attempt STT. |
| | -BRAA upon contact. | |
| | -Begin climb or descent out of middle block if required. | |
| 15-10 NM | -Check BB calls from GCI for drift that requires CCC. | -Continue to move antenna by appropriate increments (if no STT). |
| | -Confirm cut on EHSI. | -Adjust video and gain if required. |
| | -Confirm bogey on CB, make CCC if necessary. | |
| | -Evaluate and give game plan concerning LT, DT and CT. | -Move antenna to fine tune spotlight (if no STT). |
| | -Stop CCC 2 NM prior to LT. | -Note bogey elevation/altitude. |
| 12-8 NM | -Lead bogey to correct lead point. | |
| | -Displace bogey to desired AO. | |

| Reattack/ Pursuit | Intercept Procedures | Radar Functions |
|---|---|---|
| 8-1 NM | -Execute desired CT. | -Give directive commentary in CT to control drift. Spotlight or continue search as required. |
| | -Fine-tune bogey altitude and climb or descend with tally. | -Give abbreviated AREO. |
| | -Note range approaching 90 DTG for possible use of BUSTER (if needed). | -Anticipate larger EL strobe movement. |
| | -Control drift and stabilize in RQ. | -Lock bogey when lock criteria met (if required). |
| | -Shoot when F-2 parameters are met. | -Select sidewinder with good STT. |

**This page reserved for Notes**

*"Orders to protect fixed objects were very much disliked by fighter pilots. Their element is to attack, to track, to hunt, and to destroy the enemy...tie him to a narrow and confined task, rob him of his initiative and you take from him the best and most valuable qualities he possesses: aggressive spirit, joy of action, and the passion of the hunter."*

*Generalleutenant* Adolph Galland, *Luftwaffe*
WWII, 104 Victories
Knight's Cross with Diamonds

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# CHAPTER THIRTEEN
# INTERCEPT PROGRESSION II – GCI INTERCEPTS

## 1300. INTRODUCTION

Anything made by man is fallible. Intercept control must be achieved and maintained even without a fully functional radar. A combination of GCI information and a solid spatial picture can be used to analyze drift and control the intercept even with no radar. We never give up on our radar but we must know how to survive without it.

## 1301. INITIATING A GCI INTERCEPT

Certain tactical situations may require the fighter to complete the intercept using only GCI information. These include, but are not limited to:

1. Radar degradation or failure.

2. The need to suppress any radar signals from the fighter that may set off the enemy's Radar Warning Receiver (RWR) equipment.

3. Electronic jamming emissions that degrade the fighter's radar picture.

When faced with these factors, the fighter relies on the only information available, information from the GCI controller. This information is accurate at long range, but decays as slant range decreases. Because a GCI radar scope does not update as fast as a fighter's, the information must be interpolated by the controller at range and by the fighter in close. These limitations require the fighter to visualize the intercept as if it were occurring on the scope, and anticipate when procedures should be accomplished.

## 1302. PLACING THE BOGEY ON COLLISION COURSE

An intercept originates from a relationship in space between the fighter and the bogey along a bearing line. The lack of a bogey on the scope does not change this relationship. The fighter can establish a collision course if given the BH and bearing from GCI.

The initial setup of an intercept is the same regardless of the status of the fighter's scope. The fighter establishes collision with the following formula: BR to BB to CH

Although the bogey is not acquired, collision is established as long as the bogey does not drift. Once steadied, if the bogey does drift to a “0” or “5” based on a GCI call, the fighter employs the same formula to reestablish collision.

To aid in visualization of the intercept, the EHSI is utilized. The procedure for doing this is known simply as the "ABC" method.

(A) Set the CDI bar of the EHSI to the bogey's heading.

(B) Set the EHSI Heading Bug to the BB call.

(C) After collision course is established, the heading bug should be positioned half-way between the tail of the CDI bar and the fighter's heading.

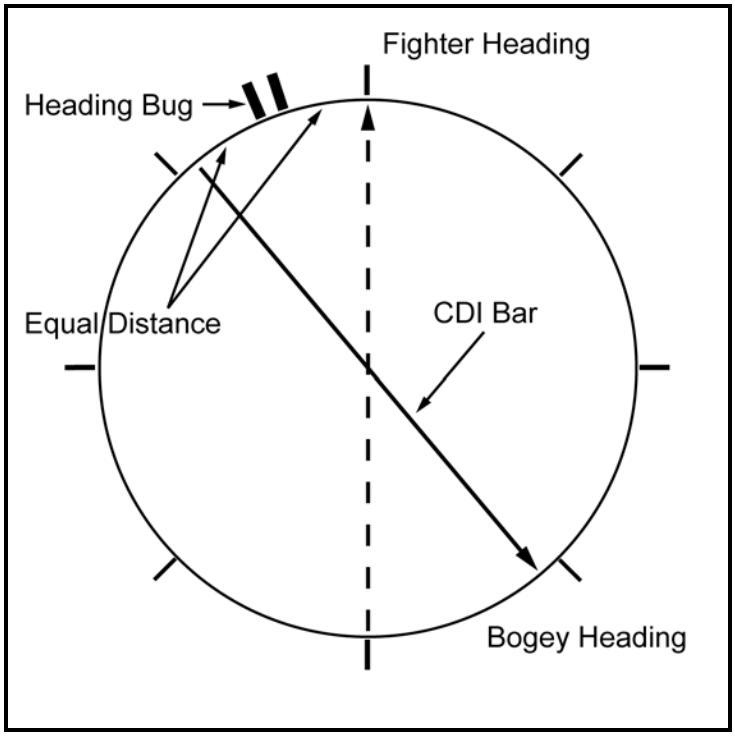


**Figure 13-1 ABC method**

This method is useful for visualizing the intercept, however timing does not make it practical to use when completing an intercept. Therefore, this method is highly discouraged from use in either the simulator or during intercept flights.

## 1303. DISPLACEMENT TURN

Once TA has been determined and the intercept is under control (i.e., the bogey has stopped drifting), the fighter needs to execute a DT at the appropriate range.

For illustration purposes, assume that TA is 20°R and the fighter is on a collision heading of 350°. At 14 NM, all CCCs will stop, at 12 NM the fighter will turn to lead, and at 10 NM the bogey will be displaced to 30°R AO. The fighter needs to turn until the BB call is $30^{o}$ right of the nose. Using the heading bug will help because it will stay on the last commanded position

thus giving a visual cue of where 30° right is located. Use of the 45° fiducial is another guide for the weapons officer.

The *"steady up"* call should be led by a few degrees, just as in a normal DT. The task is to place the BB in a certain position on the top portion of the BDHI, exactly as it would be done if the bogey were on the scope.

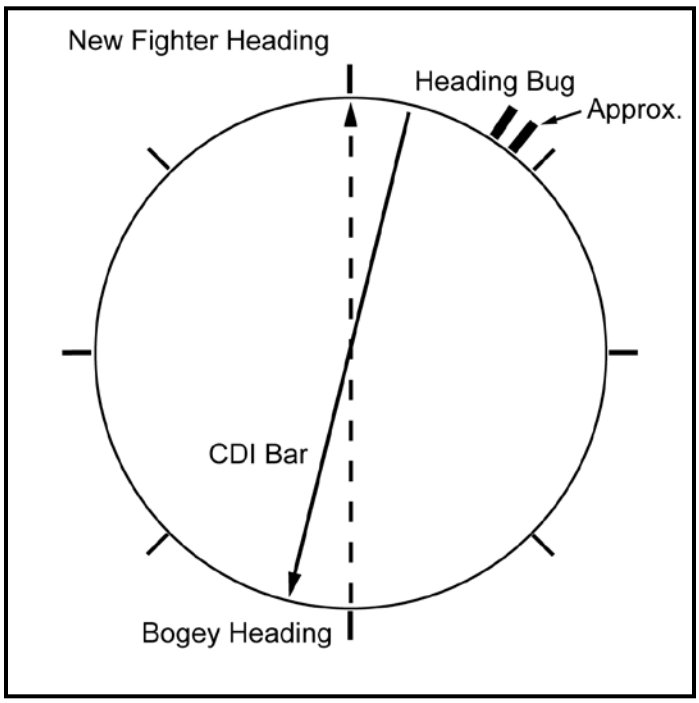


**Figure 13-2 Displacement Turn**

## 1304. GCI COUNTERTURN

Without the normal counterturn cues of ROC and intercept drift, the fighter has to correlate BB position on the EHSI to ensure proper drift control. Drift should match the appropriate ideal drift curve for the TA.

As soon as GCI gives a bearing call that indicates outward drift, or no later than 1-2 seconds after steady up, the fighter should start the CT. The turn rate is the same as if a contact was on the scope, and the fighter should vary it as necessary to control drift with respect to the ideal curve. As noted before, the delay in updating the GCI scope requires some interpolation by the fighter. A hot or cold situation will not be readily apparent. GCI counterturns tend to be cold even if run correctly due to the GCI update rate.

The CDI bar on the EHSI is one tool to help the fighter anticipate important positions of the CT, such as through the 180 DTG and the 90 DTG positions. However, the CDI bar should never be used as a replacement for good intercept situational awareness.

It is highly discouraged for use during the intercept, as it slows down the Weapons Officer and takes time away from the primary duty of controlling the intercept.

**NOTE**

Patience and an internal sense of timing will assist the fighter in controlling drift throughout the CT.

## 1305. GCI REAR QUARTER DRIFT CONTROL

Once past the 45 DTG position, with the BB within 20° of the nose, drift rates will decrease rapidly. To prevent fighter weave, the fighter should use no more than a standard rate turn. The rear quarter drift control procedures of splitting the difference apply.

In the rear quarter, the weapons officer should concentrate less on the EHSI and more on proper search increments to acquire the bogey. A good rule of thumb is to never move the thumbwheel while scanning the EHSI in order to avoid missing a radar contact. Discipline and patience are critical.

As a reminder, the antenna elevation search limits increase as the range decrease. A bogey on the fighter's nose at 1½ NM and 2000 feet above the fighter will be approximately 15° high. Utilizing the altitude differential formula will expedite searching for the bogey if altitude is known.

**NOTE**

Altitude Difference = Elevation x S.R. x 100.

At VT-86, the bogey will be anywhere within a 16,000 feet altitude block (8,000’ – 24,000’). Understanding the altitude differential formula and the limits of the bogey helps prevent the wasted time of looking where the bogey cannot possibly be.

## 1306. SPEED CONTROL

The fighter must listen carefully to GCI for range information. If a buster appears necessary, put it on early. Do not forget to take it out when in range to avoid too much closure and/or a break X situation when radar contact is acquired.

**This page reserved for Notes**

*"Fly with the head and not with the muscles. That is the way to long life for a fighter pilot. The fighter pilot who is all muscle and no head will never live long enough for a pension."*

Oberst Willie Batz, Luftwaffe
WWII, 237 Victories

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# CHAPTER FOURTEEN
# AIM-9 SIDEWINDER MISSILE

## 1400. AIM-9 INTRODUCTION

The AIM-9 Sidewinder is a supersonic, short-range, all-aspect, heat-seeking, air-to-air missile carried by fighter aircraft. It has a high-explosive warhead and an active infrared guidance system. The Sidewinder has proven itself to be the weapon of choice because of its simplicity, reliability, and high probability of kill. Throughout its history, the Sidewinder has seen vast improvements in its basic design. However, it remains limited to the in-close, visual combat arena. The Sidewinder is the most widely used air-to-air missile in the West, with more than 110,000 missiles having been produced for 27 nations besides the United States.

## 1401. AIM-9 HISTORY

The AIM-9 missile project was initiated in the early 1950s with production models entering operational service in 1956. The Sidewinder was developed by the US Navy for fleet air defense and was adapted by the U.S. Air Force for fighter aircraft use. Early versions of the missile were extensively used in the Southeast Asian conflict. In September 1958, Chinese Nationalist (Taiwan) F-86s fired the first guided Sidewinder air-to-air missiles to down 11 communist Chinese MIG-17s during the Formosa Straits conflict. Until that time, aircraft defensive means were primarily limited to pilots and tail gunners firing small caliber ammunition in dog-fight situations. Also during this conflict, an unexploded AIM-9 was recovered by the Communists and eventually turned over to the Soviets. They exploited the technology to develop the AA-2 Atoll. The early Sidewinders suffered from poor seeker head discrimination (i.e., could not distinguish one heat source from another) and a very limited firing envelope. During the Vietnam War, the Sidewinder received improved seeker head capabilities with the Sidewinder Expanded Acquisition Mode (SEAM). This enabled the missile to have a wider field of view for acquiring targets.

During the 1970s, the Sidewinder received a new seeker head, fuse, and warhead combination that gave it all-aspect capability. Since then, additional improvements included better turn performance, flare rejection capabilities, and smokeless motors.

## 1402. AIM-9 DESIGN

The AIM-9 is a small, lightweight, low-cost missile. The price is approximately $41,300, which is relatively economical when compared to radar-guided big variants. The AIM-9 has a cylindrical body with a roll-stabilizing rear wing/rolleron assembly. Also, it has detachable, double-delta control surfaces behind the nose that improve the missile's maneuverability. Both rollerons and control surfaces are in a cross-like arrangement.

The Sidewinder has four major sections: an infrared homing guidance section, an active optical target detector, a high-explosive warhead, and rocket motor.

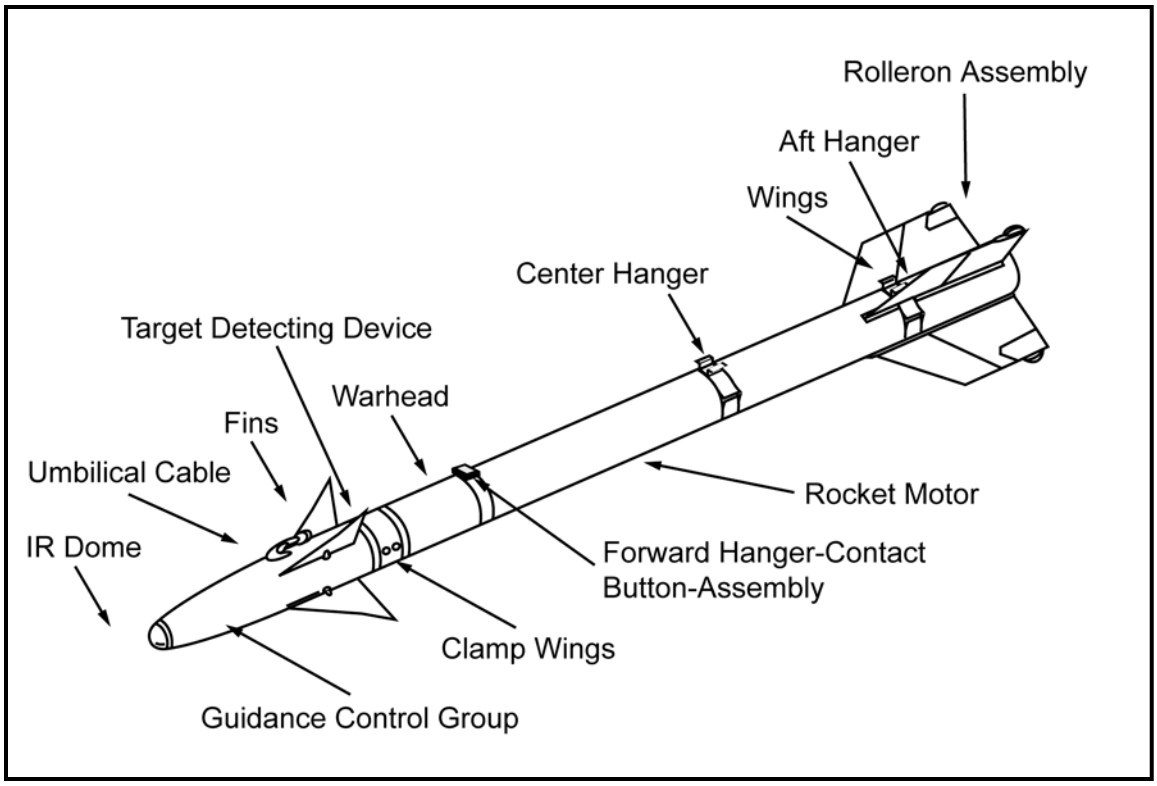


**Figure 14-1 AIM-9**

| AIM-9 Physical Characteristics | | | |
|---|---|---|---|
| Fusing | Contact/Prox | Diameter | 5 inches |
| Minimum range | 1000 feet | Weight | 190 pounds |
| Maximum Range | 10+ miles | Length | 9 Feet 5 inches |
| Gyro tracking | 24° per second | Fin-Span | 25 inches |
| Thrust | 2880 pounds | Turning | 54 g |
| Warhead | ABF (25pounds) | Gimbal limit | +/- 40° |
| Velocity | 2.0+ mach | Seeker FOV | 3.5° |

## 1403. AIM-9 GUIDANCE AND CONTROL

The guidance and control section consists primarily of an infrared (IR) seeker head that is cooled by compressed nitrogen and contains indium antimonide (InSb). This makes it very sensitive to IR emissions. A thermal battery provides power for 60 seconds time of flight. The IR guidance head enables the missile to home on a target aircraft's engine exhaust. An IR unit costs less than other types of guidance systems, and can be used in day/night and electronic countermeasures conditions. The IR seeker also permits the pilot to launch the missile, then leave the area or take evasive action while the missile guides itself to the target.

Target acquisition is indicated by a sharp tone in the pilot's headset. The tone increases in intensity as the target approaches the center of the seeker head field of view. The missile is maneuvered by the deflection of the 4 forward fins that are pneumatically controlled by a gas generator ignited at launch.

## 1404. AIM-9 FUSE

The AIM-9 utilizes 2 types of fusing mechanisms, contact and proximity. The contact fuse feeds a firing pulse to the warhead upon missile impact.

The proximity fuse is a laser-optical system that detects when the missile is within a lethal range, sending a firing pulse to the warhead.

The Sidewinder employs a safe and arm device that senses missile launch and will not allow the warhead to arm until the missile is safely ahead of the firing aircraft.

## 1405. AIM-9 WARHEAD

The AIM-9L/M has an annular blast fragmentation (ABF) warhead consisting of a high explosive encased by titanium rods and a zirconium disk. The titanium rods penetrate an aircraft's skin and the zirconium disk fragments will set fire to any combustible material.

## 1406. AIM-9 ROCKET MOTOR

The Mk-36 solid-propellant rocket motor produces 2880 pounds of thrust for a 5.0 second burn time that accelerates the AIM-9 to approximately 2.0 Mach above the launch aircraft's airspeed. The “smokeless” motor is actually 95% smoke free, leaving only a thin wisp of smoke in its trail, virtually imperceptible to the enemy.

## 1407. AIM-9 VARIANTS

Throughout history many variants of the Sidewinder missile were produced. The development process has produced increased capabilities with each missile modification.

The AIM-9A prototype of the Sidewinder was first fired successfully in September 1953. The initial production version, designated AIM-9B, entered the Air Force inventory in 1956 and was effective only at close range. It could not engage targets close to the ground and it did not have nighttime or head-on attack capability. Subsequent versions eliminated these shortcomings.

The AIM-9G provided aircraft the capability to lock on and launch against a target offset from its longitudinal axis.

The AIM-9H configuration replaced vacuum tubes with solid-state modules and a thermal battery replaced the turbo alternator. The AIM-9H was configured with a continuous-rod bundle warhead.

The AIM-9J, a conversion of the AIM-9B and E models, had increased maneuvering capability for dog fighting, and greater speed and range, giving it greater enhanced aerial combat capability. Deliveries began in 1977 to equip the F-15 and other Sidewinder compatible aircraft.

The AIM-9L added a more powerful solid-propellant rocket motor and tracking maneuvering. Improvements in the heat sensor and control systems provided the AIM-9L missile with an all-aspect attack capability and improved guidance characteristics. The L model was the first Sidewinder with the ability to attack from all angles, including head-on. An improved active optical fuse increased the missile's lethality and resistance to electronic countermeasures. A conical scan seeker increased seeker sensitivity and improved tracking stability. The AIM-9L is configured with a 20.8 pound annular blast fragmentation warhead. Production and delivery of the AIM-9L began in 1976.

The AIM-9M missile utilizes a guidance control section with counter-countermeasures (CCM) and improved maintainability. The AIM-9M, has the all-aspect capability of the L model, and provides all-around higher performance. The M model has improved defense against infrared countermeasures, enhanced background discrimination capability, and a reduced-smoke rocket motor. These modifications increased the ability to locate and lock-on a target and decreased the missile's chances for detection. Deliveries of the M model began in 1983.

The AIM-9P, an improved version of the J model, has greater engagement boundaries, enabling it to be launched farther from the target. The more maneuverable P model also incorporated improved solid-state electronics that increased reliability and maintainability. Deliveries began in 1978.

The AIM-9P-1 has an active optical target detector instead of the infrared influence fuse; the AIM-9P-2 added a reduced-smoke motor. The most recently developed version, the AIM-9P-3, combined both the active optical target detector and the reduced-smoke motor. It also has added mechanical strengthening to the warhead and the guidance and control section. The improved warhead uses a new explosive material that is less sensitive to high temperature and has a longer shelf life.

The AIM-9M-9 has expanded infrared counter measures detection circuitry.

The AIM-9X is a supersonic, air-to-air, guided missile. It employs a passive IR target acquisition system, proportional navigational guidance, and a closed-loop position servo Control Actuation Section (CAS). The AIM-9X is launched from an aircraft after target detection to home in on IR emissions and to intercept and destroy enemy aircraft. The missile interfaces with the aircraft through the missile launcher using a forward umbilical cable, a mid-body umbilical connector and three missile hangars. The AIM-9X has three basic phases of operation: captive flight, launch, and free flight. It is employed on US Air Force and Navy/Marine Corps fighters. Utilizing infrared guidance, the missile is used for offensive and defensive counter-air operations as a short range launch and leave air combat missile. The AIM-9X complements longer range radar guided missiles such as the Advanced Medium Range Air-to-Air Missile (AMRAAM). The new missile is required to reestablish the parity of United States aircraft in short range air combat, vis-à-vis improved foreign export aircraft and missiles. Specific deficiencies exist in the

current AIM-9M in high off-boresight angle capability, infrared counter-countermeasures robustness, kinematic performance, and missile maneuverability. The MiG-29 and its AA-10/AA-11 missiles is the major threat to United States forces.

Additionally, there are a number of other missiles on the world market that outperform the current the AIM-9M weapon system in the critical operational employment areas. The AIM-9X expands the capabilities of the current AIM-9M by developing a new seeker imaging infrared focal plane array, a high performance airframe, and a new signal processor for the seeker/sensor. The current acquisition strategy seeks to retain the warhead, fuse, and rocket motor of the current design in order to capitalize on the large existing inventory of AIM-9 weapons.

**This page reserved for Notes**

*"When actually firing at an aircraft you are most vulnerable to attack. When you break away from an attack always break with a violent skid just as though you were being fired at from behind. Because you probably are."*

*Captain Reade Tilley, RAF*
*WWII, 7 Victories*

# CHAPTER FIFTEEN
# AIM-7 SPARROW AND AIM-120 AMRAAM MISSILES

## 1500. AIM-7 INTRODUCTION

The AIM-7 Sparrow is a supersonic, medium range, all-aspect, all-weather, semi-active radar guided missile with Defensive Counter Countermeasure (CCM) capabilities, which includes Electronic Protection from Electronic Attack. The AIM-7 Sparrow is employed during air-to-air combat missions by Navy and Marine Corps F/A-18, and Air Force F-15 and F-16 aircraft. The AIM-7 series is primarily used to neutralize the threat of high performance enemy aircraft. In addition to its air intercept role, Sparrow variants have been utilized as air-to-surface and surface-to-air weapons since the missile's inception in 1946. Unlike many of its predecessors, the current Sparrow (AIM-7M/P) is a reliable and highly lethal weapon.

## 1501. AIM-7 HISTORY

The Sparrow project began in 1946 when the US Navy contracted out to develop a beam-riding guidance system for a standard 5 inch High Velocity Aerial Rocket (HVAR). The original designation for this missile project was KAS-1, but this was later changed. The 5 inch diameter version soon proved to be too small, so an 8 inch diameter version was developed soon thereafter. The first non-powered flight tests of the earlier model prototypes occurred in 1948. Development was difficult, however, and it wasn’t until December 1952 that the first successful air-to-air interception was made. This was the first recorded test firing of the AIM-7 Sparrow missile; though it was then called the AAM-N-2 missile. The missiles entered service and became operational in 1956 with the F3H-2M Demon and F7U-3M Cutlass fighters.

The Sparrow I was a beam-rider, requiring the missile to remain centered in the launch aircraft's radar beam from launch until impact, severely limiting its range and capability. Because of the inherent disadvantage of beam-riding guidance, along with poor low-level performance, only 2000 Sparrow I missiles were produced. It was withdrawn from service in 1956, after only a few years of being in testing. Another drawback of the Sparrow I was that the guidance beam was slaved to an optical sight in the aircraft, which necessitated visual identification of the target, making the Sparrow I a short-range VFR missile only.

Alternative guidance methods for this missile were researched almost from its beginnings. As early as 1950, engineers began studying the possibility of equipping the Sparrow with a radar-homing seeker. By 1955, these same engineers were proposing an active radar homing seeker for the Sparrow II, using an AN/APQ-64 radar. Raytheon began development of the modern Sparrow began in 1955, with the new missile being designated Sparrow III. The Sparrow III and all subsequent versions of the Sparrow used semi-active radar homing, requiring the aircraft to maintain a radar lock on the target until impact. This allowed the missile to maneuver outside the radar beam and fly a proportional navigation profile, thereby improving its performance and capability. About 2000 of the Sparrow III missiles were built.

The height of the Cold War demanded a missile that could bring down a high-altitude, non-maneuvering bomber type aircraft. This type of target was rarely encountered during the Vietnam War, leading to the Sparrow's unearned poor reputation for performance and reliability. In 1963, production switched to the AIM-7E version. It used a new propulsion system, a solid-fueled rocket motor. The new motor significantly increased range and performance of the missile. Effective range of course depended greatly on firing parameters like launch speed and relative velocity of the target.

About 7500 AIM-7D and 25000 AIM-7E missiles were built. The Sparrow was used extensively in Vietnam by the USAF and USN. The first combat kill was scored on 7 June 1965, when USN F-4B Phantoms shot down 2 MiG-17s. However, the initial combat results were very disappointing. The potential long range of the AIM-7 could not be used, because the unreliable IFF capabilities of the time effectively required visual identification (VID) of all targets. This coupled with the high minimum range of the missile and poor performance against maneuvering and/or low-flying targets led to a kill probability of less than 10%. Therefore, the improved AIM-7E-2 was introduced in 1969 as a "dogfight missile." It had a shorter minimum range, clipped wings for higher maneuverability, and improved autopilot and fusing. The AIM-7E-3 had further improved fusing and higher reliability, and the AIM-7E-4 was specially adapted for use with high-power fighter radars, like the F-14's AN/AWG-9. Despite all these problems, more than 50 aircraft were shot down by Sparrow missiles during the Vietnam air war.

In January 1972, Raytheon began development of the AIM-7F. It featured a new dual-thrust; boost/sustain rocket motor, greatly increasing the missile's range. The AIM-7F also had a completely new solid-state electronic guidance and control system, compatible with modern pulse-Doppler radars. Production began in 1975, and continued through 1981. With the AIM-7F, the official name of the missile changed from Sparrow III to simply, Sparrow.

The AIM-7G incorporated a new seeker. This missile was developed specifically for the USAF around 1970 for use by the F-111D aircraft. A few prototype missiles were built, but this version never entered production.

The next version of the AIM-7 was the AIM-7M. It's main new feature was its look-down/shoot-down capability. There is no evidence of any Sparrow variants officially designated -7J/K/L (although the designation AIM-7J is sometimes associated with the AIM-7E license-built in Japan). The suffix "M" was deliberately chosen to mean "mono-pulse," suggesting that suffixes J/K/L were indeed skipped. The mono-pulse seeker improved missile performance in the low-altitude and ECM environments by improving its anti-jamming capability. Other new features of the AIM-7M were a digital computer, an autopilot, and an active fuse. The autopilot enabled the AIM-7M to fly optimized trajectories, with target illumination necessary only for mid-course and terminal guidance. The AIM-7M also had an improved blast-fragmentation warhead. The first firing of an AIM-7M occurred in 1980, and the AIM-7M entered production in 1982.

The RIM-7M Sea Sparrow is the ship-launched equivalent of the AIM-7M. In addition to the Navy's 8-cell MK 29 box launcher, the RIM-7M and the later RIM-7P, missiles can also be fired

from MK 41 (AEGIS) and MK 48 VLS (Vertical Launch System) launchers. Recent improvements include greater maneuverability, improved fusing, a shorter minimum range, and solid-state electronics.

The next chronological designation, the AIM-7N, is an upgraded version of the AIM-7F for use with the F-15. This version was not produced in quantity.

The AIM-7P is an improved version of the AIM-7M. The current inventory of AIM-7P missiles consist of new production missiles and retrofitted AIM-7Ms. The AIM-7P features improved guidance electronics and on-board computer, a new radar fuse, and an uplink to the autopilot. The AIM-7P improves Sparrow performance especially against small and/or low-flying targets. There are two variants of the AIM-7P, known as Block I and II. The main difference between these two variants is in their guidance systems. Additionally, the Block II variant also features a new rear receiver. The combat record of recent Sparrow missiles AIM-7M/P is much better than the AIM-7D/E of the Vietnam era. In Operation Desert Storm, 22 Iraqi aircraft and 3 Iraqi helicopters were shot down with AIM-7 missiles, with 71 AIM-7s being fired. That is a hit rate of 37%.

No “7Q” designation Sparrows were built. The final variant is the AIM-7R. The AIM-7R was designed in the early 1990s as an improved AIM-7P Block II. A new seeker was developed to improve the missile’s terminal phase performance. It also included a considerably improved on-board computer for the higher processing requirements of active terminal homing. An equivalent ship-launched version was projected as RIM-7R. Although it was initially planned to upgrade many AIM/RIM-7M/P missiles to AIM/RIM-7R standards, in December 1996 high costs canceled the AIM-7R program.

Raytheon is still producing the AIM-7P. They upgraded existing Sparrow missiles to AIM-7P standard. Although the AIM-7 is replaced by the AIM-120 AMRAAM, the Sparrow will probably remain in service for some time, because it is significantly cheaper than AMRAAM. As of 2001, more than 62000 AIM-7 Sparrow, and 9000 RIM-7 Sea Sparrow missiles (all versions) were built. Today, a Sparrow costs approximately $125,000.00 to produce.

## 1502. AIM-7 DESIGN

The AIM-7’s length is 12 feet and it weighs 510 pounds. Although it is not a launch-and-leave missile like the Sidewinder, the high reliability and performance level of the later Sparrow variants make it a viable weapon of choice in the ACM arena. The missile has five major sections: radome, radar guidance system, warhead, flight control (autopilot plus hydraulic control system), and solid-propellant rocket motor. It has a cylindrical body with four wings at mid-body and four tail fins. Although the external dimensions of the Sparrow remained relatively unchanged from model to model, the internal components of newer missiles represent major improvements with vastly increased capabilities.

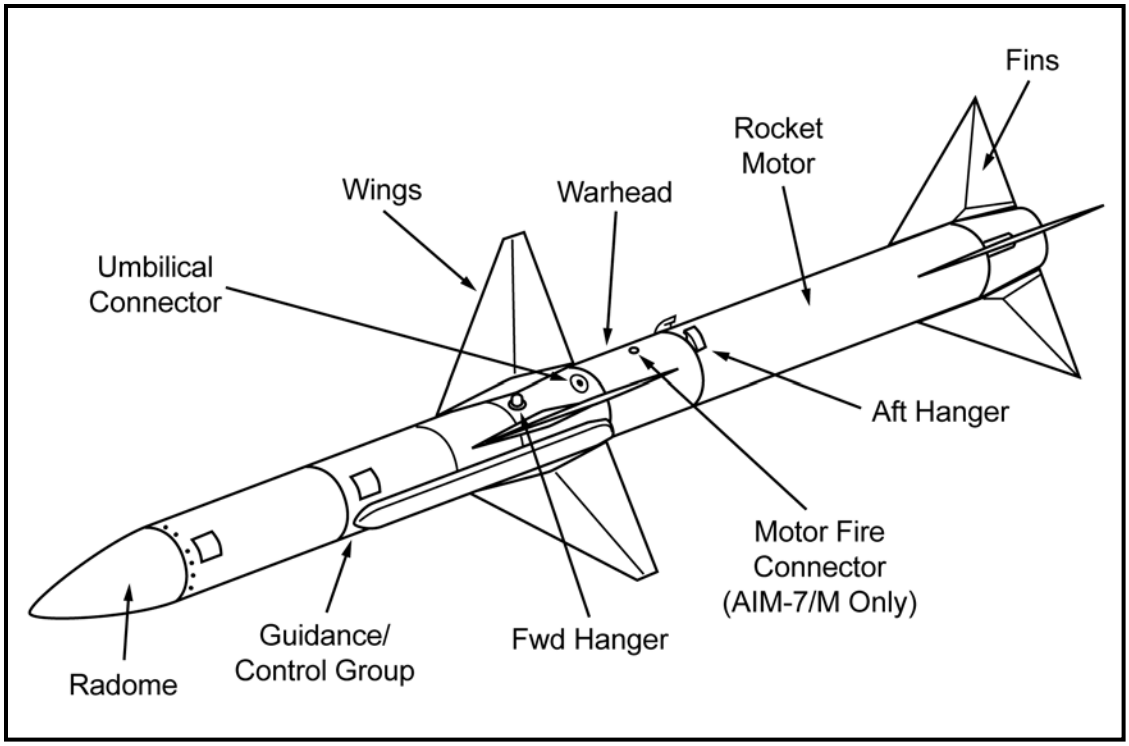


**Figure 15-1 AIM-7**

| AIM 7 Physical Characteristics | | | |
|---|---|---|---|
| Length | 12 feet | Diameter | 8 inches |
| Wingspan | 40 inches | Weight | 510 pounds |
| Motor Burn Time | 3.5/12.5 secs | Warhead | 85 pounds |
| Kill Radius | 40 feet | Turning | 25g |
| Minimum range | 1000 feet | Velocity | 2.5 mach |
| Max. Target Alt | 89,000 feet | Launch time | 1.5 seconds |

## 1503. AIM-7 GUIDANCE AND CONTROL

When the fighter has illuminated the target with a radar lock, the Sparrow guides on the targets reflected energy by using its forward-looking planar-array antenna. It simultaneously processes radar signals received from the launch platform's radar system, via its rear signal receiver antenna, located at the aft end of the Sparrow missile. The AIM-7M/P is controlled in flight by four movable delta platform wings. Missile stability is provided by these four fixed delta fins, which are located in-line with the forward wings. The missile's forward movable delta wings are controlled for maneuvering by an open-loop hydraulic system that is pressurized when the trigger is squeezed during the missile firing sequence. A hydraulic accumulator supplies the hydraulic power to move the wings in response to guidance command signals from the autopilot. Once the hydraulic fluid is used, it is vented out of the missile. When the fluid has been exhausted, the missile can no longer maneuver.

## 1504. AIM-7 FUSE

The AIM-7 has a safe and arm device that delays arming of the missile until it has traveled a safe distance in front of the launch aircraft. The Sparrow has both a contact fuse and a proximity fuse, either reacting to an active radio frequency (RF) through its fusing circuit in the guidance section, or by an impact switch located in the control section. This fusing action is used for detonating the warhead (missile) when it is within lethal range of the target; or in other words, when it reaches its closest point of approach to the target.

## 1505. AIM-7 WARHEAD

The AIM-7M employs an 85 pound annular blast fragmentation warhead that explodes into thousands of steel fragments. The hot gases that propel these fragments also serve to ignite all combustible materials in the immediate area.

## 1506. AIM-7 ROCKET MOTOR

Missile propulsion is provided by a dual-thrust, Mk-56 boost-sustained solid propellant rocket motor. The initial boost lasts for approximately 3.5 seconds and propels the missile to its cruising speed of 2.5 mach over the launch aircraft's speed. The motor then sustains the thrust for an additional 12.5 seconds to allow the missile to maintain its speed over a much greater range.

## 1507. AIM-120 INTRODUCTION

The AIM-120 Advanced Medium-Range Air-to-Air Missile (AMRAAM) is a new generation air-to-air tactical missile, designed as a follow-on to the AIM-7 Sparrow missile series. Compared to the AIM-7 missile, the AIM-120 missile is much faster, smaller, lighter, and has improved capabilities against low-altitude targets. It incorporates active radar with an inertial reference unit and micro-computer system. This makes the missile less dependent upon the fire-control system (radar) of the launching aircraft. Once the missile closes on a target, its active radar guides it to intercept. This enables the pilot to aim and fire several missiles simultaneously at multiple targets. The pilot may then perform evasive maneuvers while the missiles guide themselves to their targets.

AMRAAM, a joint program with the USAF and USN, was designed to have higher capabilities, performance, and lethality, at a lower cost, than that of the AIM-7. The AIM-120 has an all-weather, beyond-visual-range capability and is scheduled to be operational beyond 2020. The AMRAAM is being procured not only for the USAF and USN, but also for its allies. This program will improve the aerial combat capabilities of US and allied aircraft in order to meet current and future threats of enemy air-to-air weapons. AMRAAM is compatible with the F-15, F-16, F-22, F/A-18 C/D/E/F and the British Sea Harrier aircraft.

## 1508. AIM-120 HISTORY

The USAF selected Hughes Aircraft and Raytheon to continue into the validation phase upon completion of the AMRAAM conceptual phase in February 1979. During the 33-month validation phase, missile development continued. The program phase concluded in December 1981 after demonstrations proved that flight-test missiles could satisfy USAF and USN. The USAF competitively selected Hughes Aircraft Co.'s Missile System Group, as the full-scale developer. During the full-scale development phase, Hughes Aircraft Co. completed missile development and Raytheon was selected as a follower producer. A production contract to both vendors was awarded in 1987.

More than 200 of the test missiles were launched during flight tests at Eglin AFB, Florida; White Sands Missile Range; New Mexico and Point Mugu, California. AMRAAM is combat tested, scoring two kills during Operation Southern Watch, and one kill in Bosnia.

## 1509. AIM-120 DESIGN

The AMRAAM is slightly smaller in size and weight in comparison with the AIM-7, but with many of the same features as the AIM-54. The airframe is divided into four major sections: guidance, warhead, propulsion, and control. Its appearance is similar to that of an AIM-7 Sparrow.

The AMRAAM has three variants, the AIM-120A/B/C. The AIM-120A is the first production AIM-120, and was delivered in 1988 to the 33d TFW at Eglin AFB, Florida. The AIM-120B missile was the result of the two block AMRAAM Producibility Enhancement Program. The B-model incorporates a new digital processor, erasable programmable read only memory, and five major electronic unit hardware chassis upgrades. The AIM-120C includes a redesigned warhead, improvements to the rocket motor, fusing logic, guidance algorithms, and ECCM logic. Modified for internal carriage on the F-22A, the AIM-120C has “clipped wings” to reduce its box size from 17.4 to 12.5 inches. Both the “A” and variants are currently in production AIM-120B deliveries began in FY 94, and AIM-120C deliveries commenced in FY 96.

The AMRAAM is housed in a lightweight structure of steel and titanium. The four wings and fins are detachable. The guidance section features an active X-band radar terminal seeker using a high power solid-state transmitter, a low-side lobe, wide-gimbal antenna, and a built-in radio-frequency processor. Navigation, autopilot, radar, data link, fusing, sequencing, and self-test functions are all handled by a single microprocessor. The propulsion section consists of an advanced solid-fuel rocket motor to achieve a speed of Mach 4 and a range in excess of 30 miles.

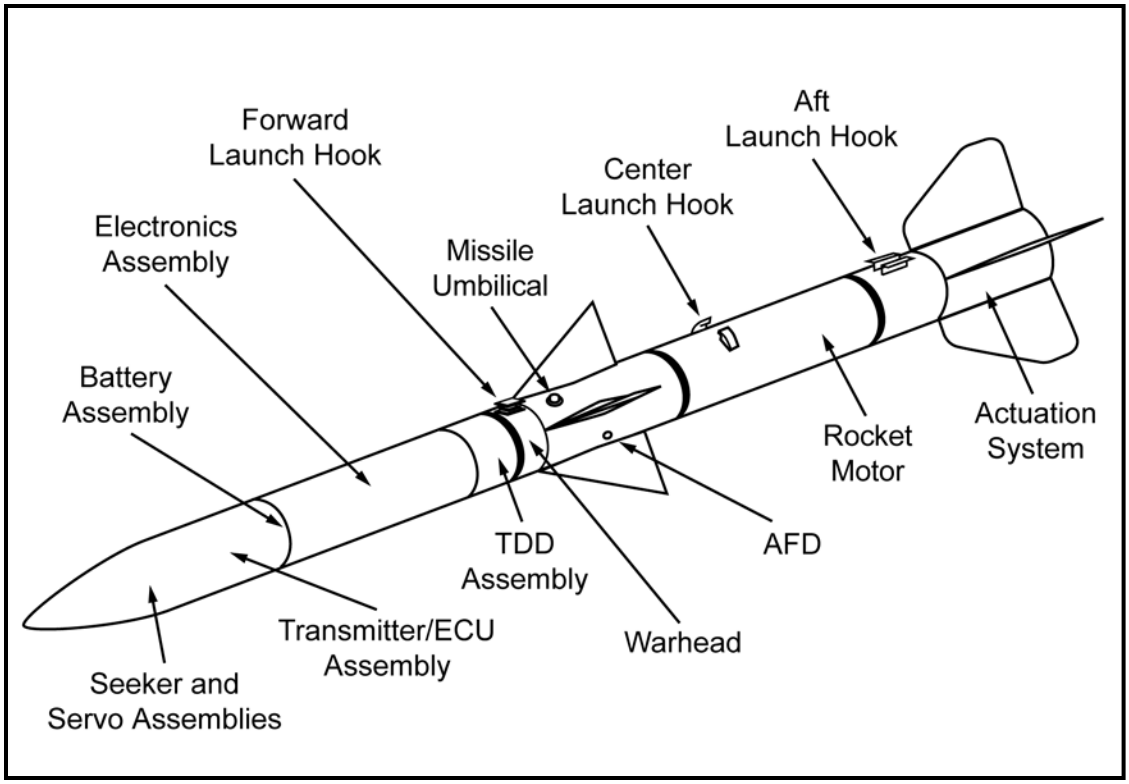


**Figure 15-2 AIM-120**

| AIM-120 Physical Characteristics | | | |
|---|---|---|---|
| Length | 12 feet | Diameter | 7 inches |
| Wingspan | 21 inches | Weight | 356 pounds |
| Kill Radius | 50 feet | Warhead | 50 pounds (blast frag) |
| Velocity | 4 mach | Warhead | ABF |
| Cost | $386,000 | Max Range | 30+ miles |

## 1510. AIM-120 GUIDANCE AND CONTROL

In long-range engagements, the AMRAAM heads for the target using inertial guidance and receives updated target information. The AIM-120C includes a redesigned warhead and improvements to the rocket motor, fusing logic, guidance algorithms, and ECCM logic. Modified for internal carriage on the F-22, the AIM-120C has “clipped wings” to reduce its box size from 17.4 to 12.5 inches. It transitions to a self-guiding terminal mode when the target is within range of its own mono pulse radar set, operating in high-PRF mode.

This seeker uses its own active radar (unlike the Sparrow). It does not require the launch aircraft to illuminate or track the target. In case the target tries to protect itself with active jamming, the AMRAAMs seeker switches to a medium-PRF “home-on-jam” mode.

With its sophisticated avionics, high closing speed, and excellent end-game maneuverability, chances of escape from the AMRAAM are minimal. At closer ranges, the AMRAAM guides itself all the way to intercept using its own radar, freeing the launch aircraft to engage other targets. These advanced tracking modes allow any fighter carrying the AMRAAM to have multi-target capability, even without a multi-targeting radar system.

## 1511. AIM-120 FUSE

Like all previously mentioned missiles, the AIM-120 also has a safe and arm mechanism that delays the arming of the missile for the safety of the firing aircraft. The AMRAAM also uses a laser scanning device to verify external shape, and thus confirm aircraft type, in its fusing mechanism. Upon intercept, the active-radar proximity fuse detonates the 40-pound high-explosive warhead to destroy the target.

## 1512. AIM-120 WARHEAD

The AIM-120 employs a 40 pound annular blast fragmentation (ABF) warhead that explodes into thousands of tiny fragments. Although one third smaller than the warhead of the AIM-7M, the AMRAAM utilizes higher density gases to propel fragments more explosively. The lethal range of the 40 pound blast fragmentation warhead has not been disclosed.

## 1513. AIM-120 ROCKET MOTOR

The AMRAAM has a high-impulse motor giving rapid acceleration to a Mach number higher than 4.0 above aircraft airspeed.

**This page reserved for Notes**

"*Fighting in the air is not sport. It is scientific murder*"

Eddie Rickenbacker, 'Fighting the Flying Circus,' 1919.

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# CHAPTER SIXTEEN
# CONVERSION PROCEDURES

## 1600. INTRODUCTION

A conversion is a long-range (30 NM) set up where the bogey is purposely taken off collision in order to manipulate the given TA. Previously, the main goal of the intercept was to place the bogey on collision in order to close on the bogey in the fastest way possible. The initial TA was preserved with the knowledge that lateral separation, which equates to turning room in the CT, was going to be different for each TA. By conducting a conversion intercept, the fighter can optimize TA or lateral separation for a particular situation.

There will be times and circumstances where certain specific TAs or LDs are appropriate. Consider a few:

1. Sun position, terrain, and other environmental considerations

2. Lack of one type of missile

3. Section tactics and restrictions

4. Enemy formations and tactics

5. Position of defended forces, or enemy SAMs

6. Requirement to VID the bogey

The goal of this unit is to introduce conversion fundamentals so that the weapons officer gains a better understanding of maneuvering to gain a valid WEZ. A successful conversion intercept includes achieving (as close as possible) the lateral separation and/or TA dictated by the tactical situation, while properly employing the Sparrow and Sidewinder missiles. In order to maneuver around the bogey's flight path, the fighter will be faced with what might initially be an uncomfortable situation: a drifting bogey. The fighter will have to keep track of drift and the changing TA to perform the conversion intercept successfully.

One more concern of real-world intercepts will be addressed in this unit: jinking bogies. Most bogies will not maintain a steady heading (SH) throughout the intercept. The procedures to recognize and counter jinking bogies will be introduced following the discussion of the conversion intercept.

## 1601. ADVANCED RADAR MODES

Students should be familiar with the advanced modes of the APG-66NT, in particular the Down Look Search (DLS) mode. The DLS mode will be the primary mode for all conversion intercepts. The advantage of DLS with the data block on is that all target parameters are displayed, including the bogey’s altitude, speed, heading, closure, aspect, and range. A bogey

can, therefore, be put on collision or converted rapidly. Students should be prepared to successfully complete all conversion intercepts with DB off.

## 1602. HEAD-ON SPARROW ATTACK: ADVANTAGES OF LOW TA

The Sparrow missile guides more accurately with the higher rates of closure associated with low TAs. The highest probability of kill ($P_k$) for a Fox-1 shot is from the head-on (0° TA) position, which also allows for the longest possible maximum range ($R_{max}$) shot.

No turn to lead from collision is required and the missile will require minimum in-flight guidance corrections. However, should the Sparrow not guide to a kill, the lack of initial LD could limit the fighter's ability to run a successful Fox-2 reattack.

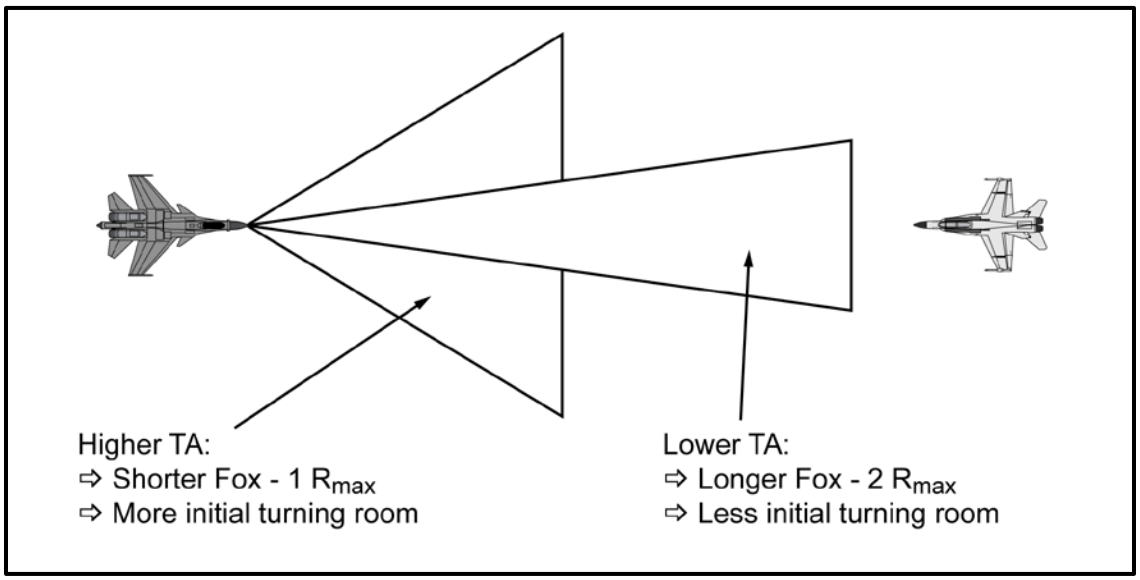



**Figure 16-1 Advantages of Low TA**

## 1603. FORWARD QUARTER SPARROW ATTACK-DISADVANTAGES OF HIGHER TA

The forward quarter Sparrow attack (25-45 degrees TA) provides sufficient lateral separation for a Sidewinder reattack, but the $P_k$ of a Sparrow shot taken at this higher TA is much lower. In addition to the reduced $P_k$, the following disadvantages exist:

1. The lower ROC yields a shorter $R_{max}$.

2. A larger turn to lead is required.

3. The Doppler differential between the target and ground return is lower, potentially masking the target in the radar ground return (the “clutter notch”).

4. Greater TA and LS (poor positional advantage) allows the bogey to penetrate much closer to the defended force.

5. Chaff-type countermeasures by the bogey are more effective closer to the beam.

Based upon these factors, in a real world situation the fighter will most likely seek a lower TA situation rather than accept whatever initial TA is presented. The knowledge of how to manipulate TA gives the fighter a flexible game plan that takes into account the factors already mentioned.

## 1604. CONVERSION AREAS DEFINED

To fly a successful conversion intercept, the fighter must visualize its starting position relative to the bogey's flight path and the goal TA/LS. This spatial picture is achieved by picturing the bogey flight path paralleled by a LS line representing the goal lat sep at lead.

Now picture a line representing the goal TA at lead. The intersection of the goal LS line, the goal TA line, and the lead range line is the position in space that the fighter is aiming for (the "goal"). This picture can be divided into four different areas:

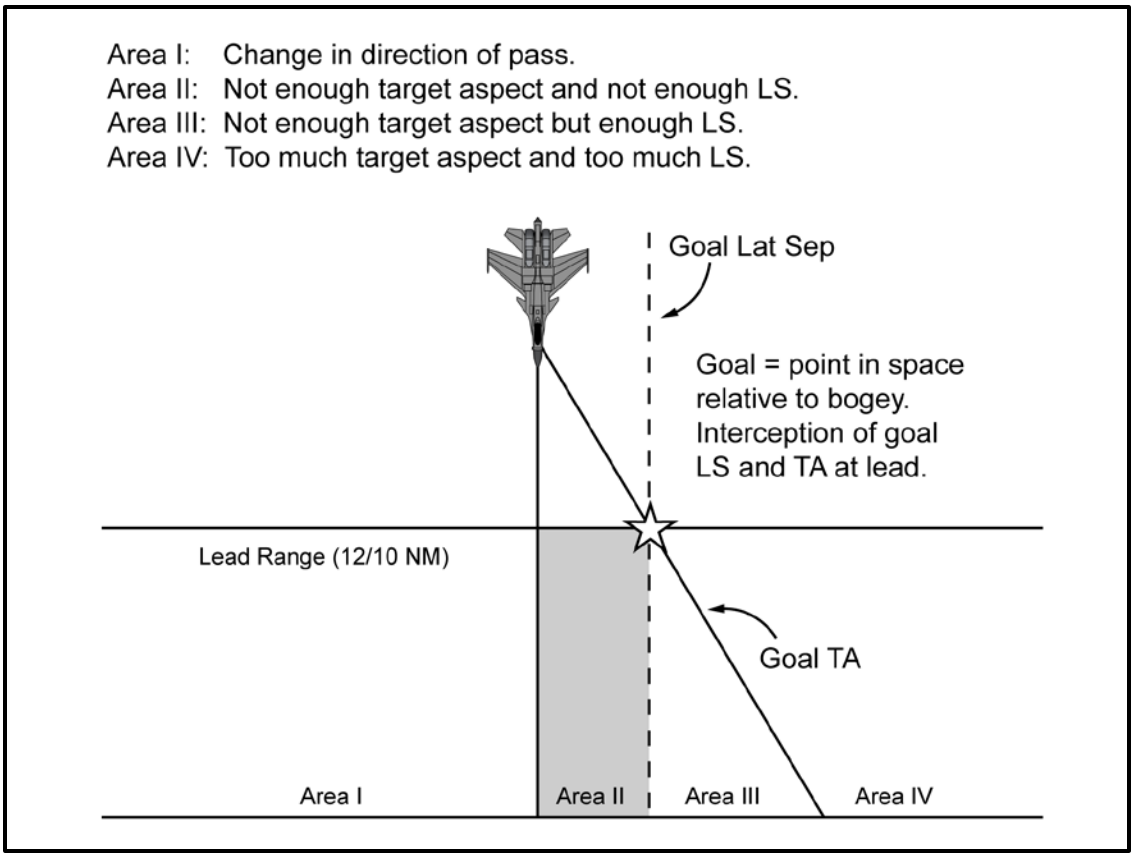



**Figure 16-2 Conversion Areas**

## 1605. STARTING PARAMETERS FOR ALL CONVERSIONS

The conversion intercept begins with 45° or less TA with 30 NM separation. The first task is to determine the existing TA and lat sep. Remember, LS (in thousands of feet) = TA x Range. Once current TA and LS are known, they are compared to the goal TA and LS given by the instructor to determine which area the fighter is in. This determines both the direction and amount of cut necessary to meet the goal. Standard attack-reattack procedures will be used to complete the intercept.

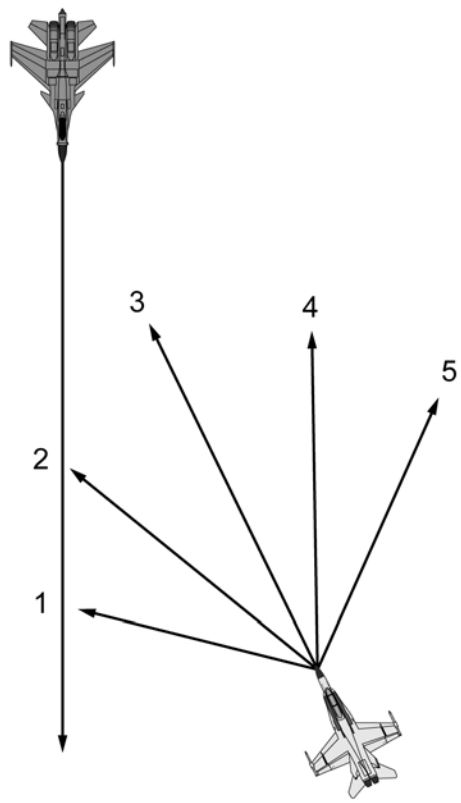
## 1606. THE CUT

Once the initial TA is determined, establish a cut that points the fighter toward either the LS line or the goal TA line, whichever is achieved first. Most likely this cut will not equal collision, thus causing TA to increase or decrease as desired. Bogey drift can be predicted based on the number of degrees the bogey is off CB and the range. It follows that the number of degrees a bogey is off CB (magnitude of the cut) will be determined by the amount of TA to be gained or lost.

If your goal is to decrease TA, you must fly toward the BFP with a cut “into” that is larger than the collision cut. TA is increased in three ways: the fighter can establish a cut “into” that is

smaller than a collision cut, the fighter can turn to a zero cut, or it can take a cut “away” from BFP. Obviously, to maintain current TA a collision cut is used.

Figure 16-3 outlines the effects of the five possible types of cuts on current TA and LS.




| Cut Type | TA | LS |
|---|---|---|
| 1 Into > Coll | ▼ | ▼ |
| 2 Cut = Coll | — | ▼ |
| 3 Into < Coll | ▲ | ▼ |
| 4 Zero Cut | ▲ | — |
| 5 Cut Away | ▲ | ▲ |

**Figure 16-3 Cut Types**

## 1607. CALCULATING GOAL LATERAL SEPARATION

To calculate the LS that the fighter will have at lead range, simply multiply the TA times the range at which the normal lead turn occurs. For example, 10 TA goes to lead at 12 miles, so LS would be 12,000 feet. On the other hand, 25 TA goes to lead at 10 miles, so LS is 25,000 feet. All TAs > 22 equate to a LS equal to the TA.

**Example**:

Instructors will provide only the TA / LS goals listed in the table below.

| TA (rounded) | Lead Range (NM) | Lat Sep (thousands of feet) |
|---|---|---|
| 0 | 12 | 0 |
| 5 | 12 | 6 |
| 10 | 12 | 12 |
| 15 | 12 | 18 |
| 20 | 12 | 24 |
| 25 | 10 | 25 |
| 30 | 10 | 30 |
| 35 | 10 | 35 |
| 40 | 10 | 40 |
| 45 | 10 | 45 |

## 1608. AREA I/II – NOT ENOUGH TA, NOT ENOUGH LS

In an area I intercept, the fighter needs TA on the opposite side from what it has at the start of the intercept. Area I problems turn into area II problems once the fighter crosses the bogey's flight path to the desired side. In effect, the cut into > collision of the area 1 problem instantly becomes a cut away when the DOP changes.

Once the fighter is located in area II, LS is between 0 feet and the goal LS. Because there is not enough LS or TA, the fighter needs a cut away from the bogey's flight path. This cut places the BB on the opposite side of BR with respect to FH.

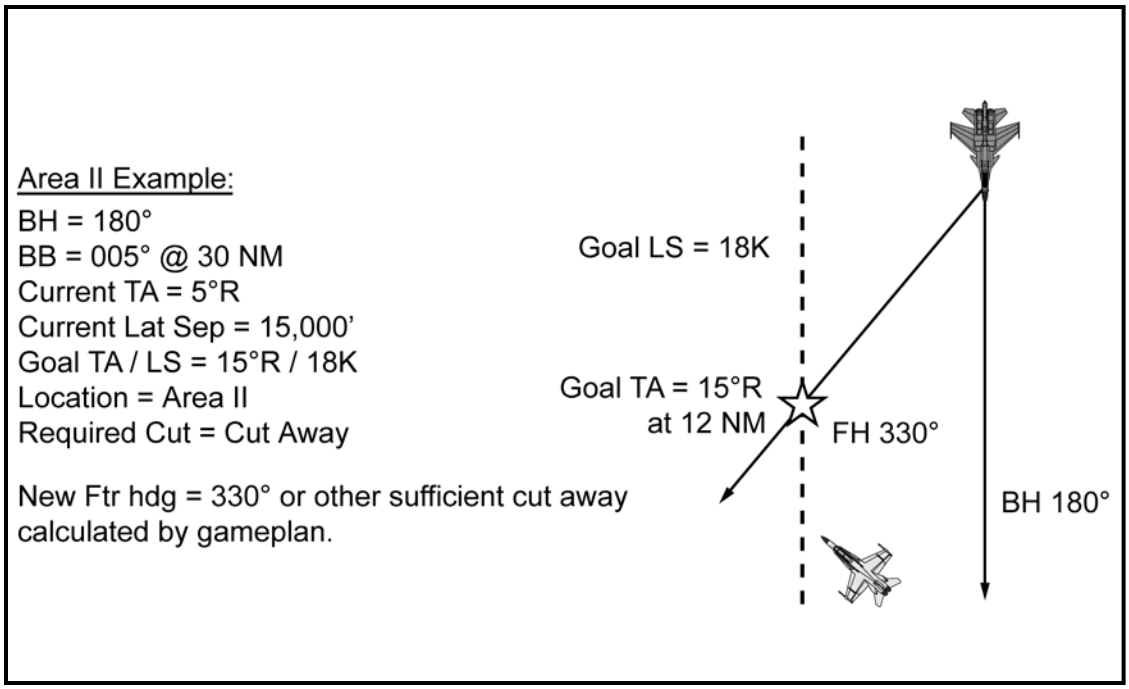



**Figure 16-4 Area II Example**

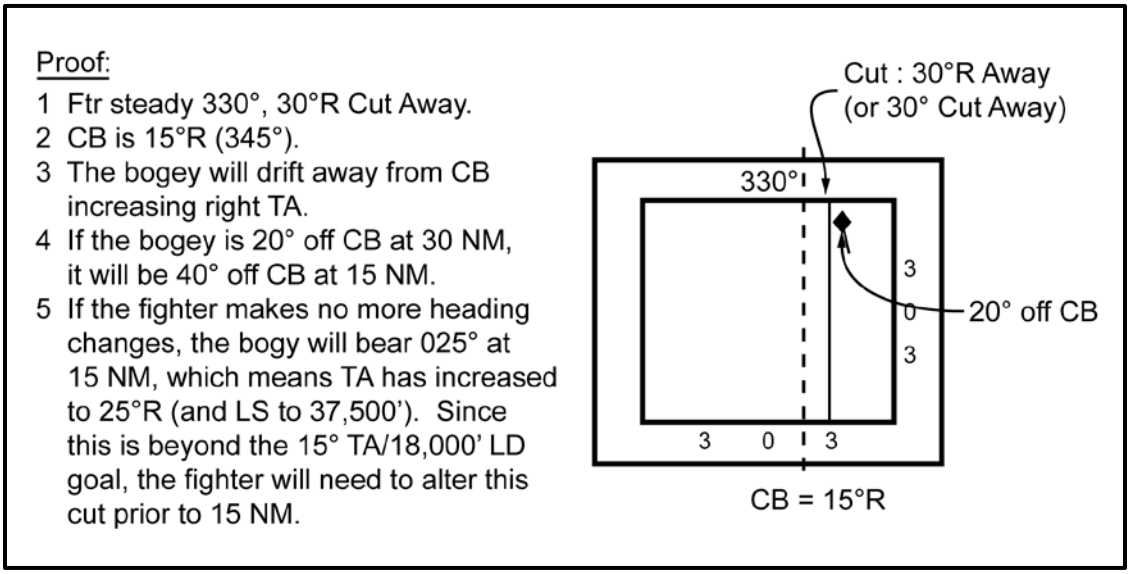



**Figure 16-5 Proof**

## 1609. AREA III ENOUGH LS, NOT ENOUGH TA.

A fighter in area III is outside the goal LS line, but has insufficient TA to turn to collision. The fighter should turn to a zero cut, paralleling the bogey's flight path. This preserves lateral separation while increasing TA. The fighter will fly the bogey's reciprocal until the required geometry for the goal TA is met. At that time, a turn will be made to attack heading (AH), creating a collision intercept.

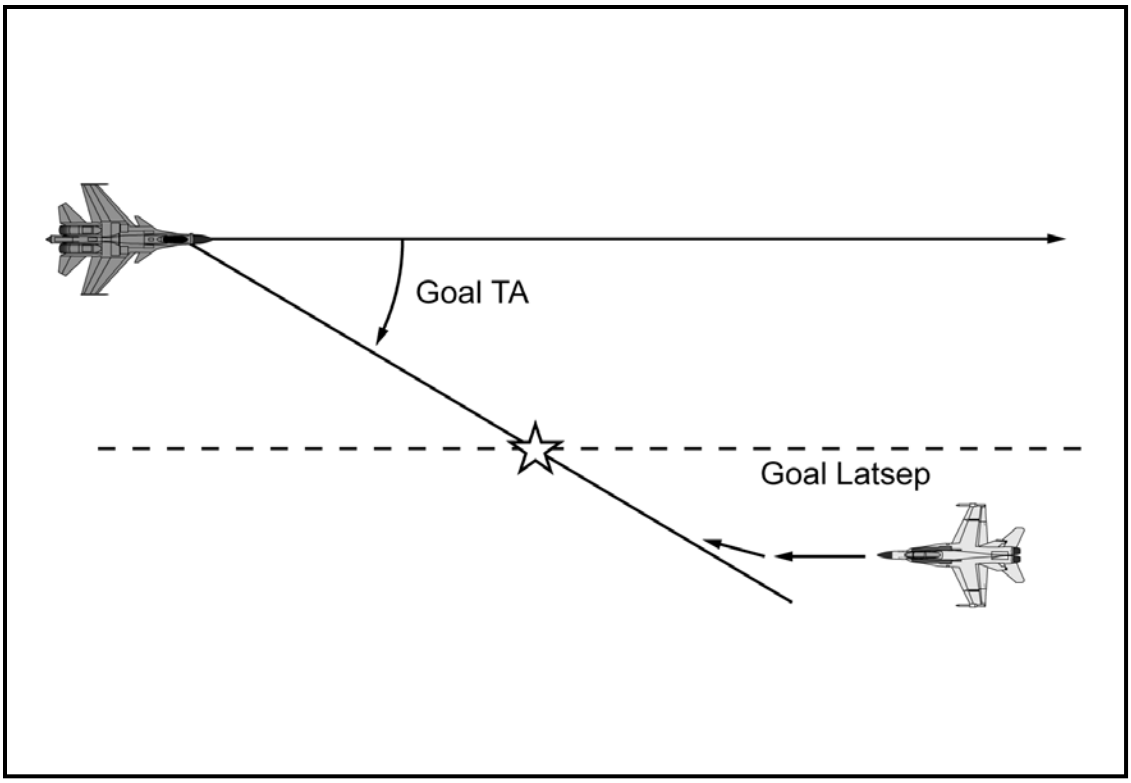



**Figure 16-6 Area III Enough LS, Not Enough TA**

## 1610. AREA IV – TOO MUCH TA, TOO MUCH LS

A fighter in area IV must turn towards the BFP, generating a cut into > than collision for the current TA. Lateral separation is more than sufficient and, more importantly, TA is greater than desired. Goal TA will likely be met before goal LS, requiring a turn to AH (collision) which will preserve TA while lat sep continues to decrease until the turn to lead is made.

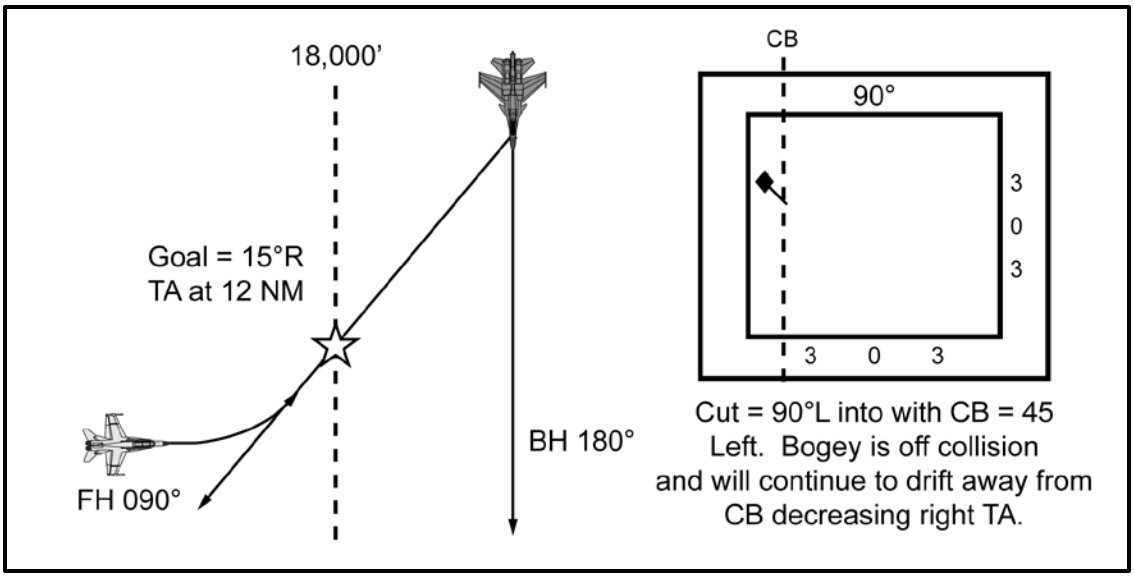



**Figure 16-7 Area IV Too Much TA, Too Much LS**

## 1611. VARYING TURN RATE TO INITIAL CUT HEADING

This is a valuable tool to use in tactical conversions. Typical intercepts up to this point in your training start with GCI turning the bogey and fighter in opposite directions with both aircraft in hard turns. Because both aircraft have the same turn rate and radius the bearing remains constant throughout the turn. Only upon steady up can TA/LS begin to change.

By using standard rate or hard as possible turns to steady up on the initial cut, the fighter can increase or decrease its turn radius and thus increase or decrease TA/LS while in the turn.

**NOTE**

1. If the fighter must turn through the BB to arrive at the desired cut, increase to a hard as possible turn.

2. If the fighter is not turning through the BB, ease to a standard turn.

## 1612. ATTACK HEADING

AH is the FH that will result in the bogey being on collision once the goal TA/LS has been achieved. AH can be calculated early by bouncing the ball from the BR to the BB that would place the GTA on collision then to the FH that would generate the appropriate cut. Occasions will arise, however, where the goal is not achieved (short setup, poor procedures, late turn to AH, faulty GCI, degraded radar, etc).

**NOTE**

> Despite the given TA or LS goal, the ultimate goal is to correctly assess existing TA to take a Fox-1 shot followed by a successful Fox-2 reattack.

## 1613. LEADING TURNS: ACCOUNTING FOR DRIFT IN TURNS

Most conversion cuts are not equal to collision. So, the number of degrees the fighter must turn to AH (the heading required to put the goal TA on collision) and the resulting bogey drift while in the turn must be considered.

The main concern is the number of degrees of turn from cut heading to AH or directly to lead for an F-1 shot. This turn amount and its accompanying bogey drift varies from one situation to another, but is in all cases compensated for by “leading the turn.”

Leading the turn takes into account the fact that drift is a function of SR and the bogey's degrees off of CB. If the fighter were to wait to achieve the exact goal TA before turning to AH the bogey would continue to drift past the goal while the fighter was in the turn. This drift is due to the fact that the fighter does not instantaneously change heading and establish itself on a collision course. However, the tighter the turn rate, the less effect the turn will have on TA drift.

Understanding this, the turn to AH or lead must be made prior to reaching the goal TA. The larger the turn, the more lead is required. Similarly, more lead is required for shorter slant ranges because the bogey is drifting faster.

A basic rule-of-thumb to calculate lead points for various cuts is determined by assuming that there will be 1° of drift for every 20° of turn to AH / directly to lead. Slant range is taken into account by starting with a standard rate turn to AH outside of 20 NM, a hard turn from 20-16 NM, and a hard as possible turn to AH or lead inside of 16 NM.

Additionally, a hard as possible turn should be used for instances where the fighter turns late. The preceding rule-of-thumb for calculating how much to lead turns by must be tempered with headwork. The rate at which a bogey drifts is a function of both range and degrees off of CB.

The NFS must understand when and why particular turn rates will be better in some situations than in others. Use good headwork to decide which turn rate to use to go to AH/lead. The NFS will be graded on leading the turn to AH whether or not it is verbalized.

## 16-10 CONVERSION PROCEDURES

## 1614. CONVERSION RULES

There are only four rules that apply to tactical conversions at VT-86:

1. The maximum cut allowed is 90° plus .1 IMN speed increase.

2. The BB must be within the scope limits no later than 20 NM.

3. There will be no re-conversions inside 14 NM. However, inside of 14 NM, the fighter may turn to:

   a. AH (collision heading with TA goal achieved)

   b. Collision heading (not at goal TA within rounds and TA is drifting in the wrong direction, i.e., TA / LS goal blow-through)

   c. A 0° CUT

   d. Keep the bogey on the scope

   e. Lead for an F-1 shot.

4. The bogey must be successfully attacked and reattacked.

## 1615. RE-CONVERSION RULES

The conversion intercept starts with the initial setup spiel to include turn rate, buster if needed, and steady up heading. Any change to the initial cut as a result of subsequent radar or GCI information is considered a re-conversion. Re-conversions are mandatory if the fighter is more than 1° off of the desired goal TA and as dictated by changing TA and LS during the intercept. Students will be held accountable for their re-conversion game plan. "Re-conversions as appropriate" is not a specific enough game plan. Brief a game plan you understand and can execute.

**NOTE**

Re-conversions stop at 14 NM.

Re-conversion rules are:

1. If on a cut into or a 0° cut with less than goal LS, use a cut away large enough to achieve the goal, but not as large to place the contact off the scope.

2. If on a cut away and having achieved the goal LS, turn to a 0° cut.

3. If new GCI calls or radar contact on the scope puts the fighter in a different spatial category (I, II, III or IV) change the cut as required by the new area problem. If on a cut larger than required by the new information, the current cut can be maintained.

4. Once the fighter has turned to AH, reconvert as required to make the goal exactly if > 14 NM.

5. Re-conversions are usually hard as poss turns; however use the turn rate that is appropriate for the situation based on range and degrees to turn.

90° cuts with a buster are the largest cuts allowed for conversions and re-conversions. If TA can't be converted using a 90° cut with a buster (i.e., TA > 49) the conversion is over. Use cold 100 procedures to control drift instead.

There is no requirement to have the buster out by 14 NM. If it is still working leave it in and take it out at lead. Realize that a buster in a low TA situation does little more than eat up distance and time between the fighter and bogey. Busters should not be left in through the counterturn unless required (i.e., cold 100s or if the CT is otherwise cold).

## 1616. TACTICAL CONVERSION PROCEDURES

The objective of the conversion is to convert the existing intercept geometry to maximize a tactical advantage and successfully employ weapons. At the start of each run, the instructor specifies a TA or LS as the objective. If the stated goal is not attainable, the student strives to get as close as possible to the goal and execute a successful attack/reattack on the correct timeline.

This portion of the text discusses the effects of various cuts on TA and LD.

### 0° cut

While steady on a 0° cut, lateral separation remains constant and TA increases. The fighter is paralleling the bogey flight path. As range halves, the degrees off CB doubles.

With 180 DTG, the cut and CB are both equal to zero. While established on a 0° cut, TA will double in half the range (by 15 NM assuming a 30 NM set-up.)

**30,000 feet of Lateral Separation**

| | |
|---|---|
| 10° TA | 30 NM |
| 20° TA | 15 NM |

### 0° Cut ± 10°

For every 10° of cut from a 0° cut, lat sep will change by 7500 feet in 15 NM. A 10° cut into the bogey flight path will decrease lat sep by 7500 feet in 15 NM. A 10° cut away will increase lat sep by 7500 feet.

**Example 1:**

BH = 180°
BB = 360°
TA = 0°
LS = 0'

Fighter steadies on a heading of 350° (10° cut away). CB is 355° with the bogey 5° off CB at 30 NM. As range halves, the degrees off CB doubles. The bogey bears 005° at 15 NM. LS has increased from 0 feet to 7500 feet (5° TA at 15 NM).

**Example 2:**

BH = 180°
BB = 010°
TA = 10°R
LS = 30,000'

Fighter steadies on a heading of 020° (20° cut into). The bogey is on CB so TA will not change. LS will decrease by 15,000 feet, from 30,000' at 30 NM to 15,000' at 15 NM (10° TA at 15 NM).

**NOTE**

7500 feet of lateral separation change per 15 NM has the same relationship as 5000 feet per 10 NM. The important thing to remember is that the greater the cut, the greater the gain/loss in LS.

**Collision Course**

TA will remain constant and LS will decrease while established on collision course. As range halves, lateral separation is reduced by half.

**15° Target Aspect on Collision**

| | |
|---|---|
| 15° TA @ 30 NM | 45,000 feet of Lateral Separation |
| 15° TA @ 15 NM | 22,500 feet of Lateral Separation |

**Collision Heading ± 10°**

For every 10° of cut greater than or less than collision heading (CH), TA decreases/increases by 5° in 15 NM (assuming a 30 NM intercept).

**Example 1:**

BH = 180°
BB = 010°
TA = 10°R
CH = 020°

Fighter steadies on a heading of 010° (10° cut into less than collision heading). New CB is 005°, with the bogey 5° off CB at 30 NM. BB is 10° off CB at 15 NM. TA will increase 5° (from 10°R to 15°R).

**Example 2:**

BH = 180°
BB = 010°
TA = 10°R
CH = 020°

Fighter steadies on a heading of 350° (30° cut away from collision heading). New CB is 355° with the bogey 15° off CB at 30 NM. BB at 15 NM will be 025°. TA will increase 15° (from 10°R @ 30 NM to 25°R @ 15 NM).

**Example 3:**

BH = 180°
BB = 010°
TA = 10°R
CH = 020°

Fighter steadies on a heading of 060° (40° cut into greater than collision heading). New CB is 030° with the bogey 20° off CB at 30 NM. BB at 15 NM will be 350°. TA will decrease to zero then grow in the opposite direction a total of 20° over 15 NM (from 10°R to 10°L).

## 1617. MONITORING LATERAL SEPARATION DURING THE INTERCEPT

It is important to recognize LS goals as they are met. Using the formula LS = TA X SR X 100, compute the LS from GCI calls or the radar and reconvert if necessary. The key to staying on top of LS growth is calculating it early during the intercept and then continually monitor LS as it continues to grow. Unlike TA, which changes exponentially as range decreases, LS grows at a constant rate with respect to range if the same heading is maintained. In area I, II, and III problems, the fighter should calculate LS once they have rolled out on their initial cut using the TA and range derived from either GCI calls or scope analysis.

From that point on, the fighter can monitor LS and get a feel for how quickly the LS goal is being reached. Because adequate lat sep is essential for a successful counterturn with no hot

overshoot, do not lead lat sep goals as one would lead TA goals. Turn to a zero cut only after your calculations show that you have met your lat sep goal.

**NOTE**

Because time is critical, round off numbers so they are easier to multiply. For example: 19° TA x 21 NM ≅40K

Remember, LS goals also apply to a TA problem since the TA at Fox-1 range determines the available lat sep.

## 1618. SELECTING A GAME PLAN

When selecting a game plan, keep the following information in mind:

1. Be aggressive on initial cuts. The bogey must be within the limits of the scope by 20 NM, which will then take some of the initial aggressiveness out.

2. Some goals may be unattainable. Be aggressive at range, but control the intercept for the FOX-1.

3. Use buster if required, but don't forget to remove it when it is no longer needed. Your airspeed should be a part of your scan. If it is not, make it so!

4. Analyze TA quickly upon initial contact (cut to AO). Reconvert if necessary.

5. If on a cut away with a TA goal, calculate LS (anticipate reaching the LS goal first), monitor it throughout the run, and then turn to a 0° cut when the LS goal is attained. Then remain on the cut until a turn to AH is required.

6. There is no requirement to have the bogey on collision. Anticipate a drifting TA prior to lead and/or displacement.

## 1619. JINKING BOGEY

Conversions will be your first look at jinking bogeys. A “jinking bogey” is a bogey that changes heading, airspeed, and/or altitude during the course of the intercept.

At this point in the syllabus, the bogey will only jink in heading, and only inside Fox-1 range. The fighter must be able to recognize and react to all BH jinks.

In conversions at VT-86, the bogey may jink toward the fighter as long as the bogey does not change the DOP, or it may jink away from the fighter so as to increase TA to any aspect that does not exceed 50.

1. 0-22 TA – Jinks may occur between 10 and 8 NM.

2. > 23 TA – Jinks may occur between 8 and 6 NM.

3. Plan on briefing and executing a plan to deal with jinking bogeys.

## 1620. SPATIAL RELATIONSHIPS CREATED BY A HEADING JINK

Remember that the displacement points place the bogey roughly 25°off CB after the DT. As a result, the bogey is expected to drift at approximately the same rate for all amounts of TA immediately after the DT. If the bogey jinks in any direction, TA is instantaneously changed. AO does not change immediately.

Following the Fox-1 and subsequent bogey jink, the displacement point (AO) will be incorrect because that point was determined by the TA prior to the jink. During the CT, the drift will appear as if the bogey was over displaced or under displaced.

From the discussion above, several conclusions can be drawn:

1. As a result of a heading jink, TA will be instantaneously changed.

2. The radar drift indications of jinks away/into are the same as those in the cases of over/under displacement:

   a. If the bogey jinks into the fighter, TA is decreased, the bogey will be closer to CB, and the rate of outward drift will be less than expected.

   b. If the bogey jinks away from the fighter, TA is increased, the bogey will be further from CB, and the rate of outward drift will be greater than expected.

## 1621. TECHNIQUES

A jink results in one of the following situations and requires the following reactions:

| Bogey's Action | Indication | Fighter's Reaction |
|---|---|---|
| Jink into fighter | Less rapid outward drift (hot) | Redisplace further out to cool off CT |
| Jink away from fighter | More rapid outward drift (cold) | Harden turn to heat up the CT |

## 1622. ROC AND RANGE RATE OF CLOSURE

The ROC is the most valuable aid in determining the direction of the bogey's jink. If the bogey jinks toward the fighter, TA is instantaneously decreased. Therefore, since the bogey has effectively placed the fighter closer to the forward quarter or head-on aspect than it was prior to the jink, the ROC will stagnate and read higher than expected for that TA.

Should the bogey jink away from the fighter, TA will be immediately increased and the ROC will decrease more rapidly than expected for the displaced TA. This is because a jink away puts the fighter closer to the bogey's beam where the ROC approaches the value of the fighter's own TAS.

Range ROC is another valuable aid in determining the direction of the bogey's jink. If the bogey's progression down the scope slows down a noticeable amount, then assume a jink away. If it starts to move quickly down the scope during the CT, assume a jink into.

Four indicators can be used to determine a heading jink:

1. ROC

2. Heading or TA vector

3. Drift

4. RROC

These indicators are arranged in descending order of occurrence. While it may seem easy at first to just rely on ROC to identify a jink, this will lead to problems in the advanced phase. Remember, ROC will not be available in search.

## 1623. COUNTERTURN CONSIDERATIONS

Conversions are your first look at hot or cold bogeys. It is important that you remember the drift curves that you perfected during reattacks, so you can readily identify any deviations. Changes to the expected ROC, drift curve, and/or RROC should be your first clue to a hot or cold bogey. NFSs are required to brief a game plan designed to recognize and remedy a hot or cold situation. “Heat up or cool off as necessary” is not an acceptable answer.

Successful drift control in the counterturn begins with accurate analysis of TA and is aided by aggressive application of the previously learned CT procedures. Still, abnormal drift in the counterturn may occur. This may be caused by several factors, including misanalysis of TA or poor drift control.

Abnormal drift includes:

1. Immediate inward drift with a standard rate turn or less. The bogey is closer to CB and the TA is less than previously estimated. The fighter must ease or reverse to cool the bogey off and then allow a controlled inward drift to begin.

2. Immediate outward drift after the DT. The bogey is farther from CB and more TA exists than previously estimated. Use a harder turn to bring the bogey back to the fighter's nose.

In addition to the drift curve, ROC is very useful in the recognition of hot/cold CTs. For co-speed intercepts flown at 300 KTAS, certain range/ROC gates are helpful. An actual ROC significantly higher than an ROC gate indicates a hot situation. An actual ROC significantly less than an ROC gate indicates a cold situation. ROC range gates for VT-86 CTs are:

| Range (NM) | ROC (KTAS) |
|---|---|
| 5 | 500 |
| 4 | 450 |
| 3 | 400 |
| 2 | 300 |

## 1624. "HEATING UP" OR "COOLING OFF" A COUNTERTURN

To correct for a hot counterturn, immediately reverse your turn HAP to overdisplace the bogey by an additional 30° (not to exceed the limits of the scope) and assess ROC. Increase turn AS NECESSARY.

To correct for a cold counterturn, immediately turn HAP to underdisplace the bogey by 30° and assess ROC. Increase turn AS NECESSARY.

Once the ROC gates have been obtained, run appropriate drift curve to bring bogey to the nose.

Keep in mind:

1. Once the fighter has less than 90 DTG, heating of the bogey becomes less effective. However, cooling is always effective.

2. A small correction at the beginning of the CT is as effective as a large correction at the end. This reinforces the importance of early, aggressive corrections.

## 1625. CONCLUSION

The conversion intercept is a long-range setup, which requires the application of all previously learned material. A solid understanding of conversion procedures greatly improves the spatial picture. Executing tactical conversion intercepts is challenging. There are no strict procedures to follow, only a set of guidelines that enables the development of individual game plans. The goal is to pick a game plan that is aggressive enough to meet the required goals, yet simple enough to be applied quickly and accurately during the beginning moments of the intercept.

**This page reserved for Notes**

*"Great pilots are made not born...a man may possess good eyesight, sensitive hands, and perfect coordination, but the end product is only fashioned by steady coaching, much practice, and experience."*

Air Vice-Marshal (2 star) J.E. "Johnnie" Johnson, RAF
Leading RAF Ace in Europe
WWII, 38 Victories

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# CHAPTER SEVENTEEN
# ADVANCED INTERCEPTS

## 1700. INTRODUCTION

Real world intercepts happen in an extremely dynamic environment, and often when the modern multi-role fighter is performing its primary task of putting bombs on target. Mission success depends heavily on the weapons systems officer's ability to simultaneously drive the fight in both the air-to-air and air-to-ground arenas--the complex environment where most single seat fighters fall critically short.

Up to this point in the syllabus, you have learned basic intercept principles and are expected to competently detect, target, identify, intercept, and employ weapons against a relatively unaware bogey. The Advanced Block is designed to build on these skills to employ against an aware and maneuvering bogey in a dynamic environment that more closely simulates real world situations.

This chapter provides the procedures and guidelines to help understand the game plan designed to intercept a non-cooperative bogey and employ the AIM-120, AIM-7 and AIM-9 missiles against it during a 1v1 intercept as well as on a Strike Route.

## 1701. RULES AND RESTRICTIONS

Due to the more dynamic nature of Advanced Intercepts, a few basic rules must be highlighted in order to achieve the best possible training in a safe environment. Reference COMTRAWINGINST 3710.17 for the most current air-to-air training rules.

### Administrative

1. Fighter sanctuary altitudes remain 12K', 16K', and 20K'.

2. The operating block in the airspace remains 7K' to 25K' (unless cleared otherwise by a controlling agency).

3. Both aircraft must maintain VFR and OPNAV 3710 (series) cloud clearance and weather restrictions.

### Safety of Flight

1. A 1000' "bubble" shall be maintained by BOTH aircraft during all runs.

2. Forward quarter missile attacks are broken off at 1.5 NM to maintain the 1000' bubble.

3. All advanced runs are completed during daylight hours, 30 minutes after sunrise until 30 minutes before sunset.

4. The fighter may climb or descend to the corresponding high or low sanctuary altitude (as required) NET 15 NM.

5. Except to transit between FSAs, fighter will only leave its FSA with a tally.

**Bogey Jinks**

1. BH will be unassigned. The bogey may jink to any heading at any time, but DOP shall be preserved post Fox-1.

2. The bogey may change speed by +/- 0.1 IMN from the base airspeed at any time.

3. The bogey may change altitude, but will not fly through the fighter's current FSA inside of 15 NM and must be set in the block by 10 NM.

4. The bogey will not leave the high or low block for the medium block inside 15 NM, but may leave the medium block for the high or low block as long as the restrictions in 3 above are met.

**The Merge**

1. All advanced merges are scripted scenarios coordinated by the Mission Commander. Ideally, all merges will be right to right passes. If a left to left pass occurs, the same rules still apply, but using left TA and AO.

2. The bogey sets 10R TA by 3 NM. The fighter sets 10R AO by 1 NM.

3. A pilot tally is required to start maneuvering post merge. A pilot or student tally is required to continue maneuvering post merge (depending on DOP).

4. A maximum of 180° of turn is allowed post merge by the fighter, and a maximum of 90° of turn forcing one circle flow (left turn for a right to right pass or right turn if a left to left pass) is allowed by the bogey. The bogey will not deviate from its altitude inside 10 NM (level turn) and use a hard turn or less.

5. Both aircraft calls tally and DOP at the merge:

Fighter: "*Fighter tally, right to right*."
Bogey: "*Bogey tally, right to right.*"

6. If either aircraft is no joy at the merge, that aircraft responds with its current altitude. If the fighter is no joy, it will separate from the fight:

Fighter: *"Fighter tally, right to right."*
Bogey: *"Bogey no joy, 1-7 thousand."*

or

Fighter: *"Fighter no joy, 1-6 thousand."*
Bogey: *"Bogey no joy, 1-7 thousand."*

When bogey runs off of the scope:

Fighter: *"Gritrock, Hammer 1; bugging out west, live bandit Vegas 180-66."*

7. If either aircraft loses the tally during post merge maneuvers, it will immediately roll wings level and broadcast no joy, altitude, and heading to the other aircraft. The bogey will assume responsibility for deconfliction and reply with "continue" to evaluate the separation (bogey). If the tally is lost by the fighter, it will not maneuver in the direction of the bogey.

Bogey: *"Bogey no joy, 1-7 thousand, heading 090."*
Fighter: *"Continue."*

When fighter is in Fox-2 parameters:

Fighter Instructor: *"Hammer 1, Fox-2. Fighter terminate."*
Bogey Student: *"Bogey terminate."*

8. Blind turns or "no-sight" defenses are not allowed. If both aircraft lose the tally, both should roll wings level, broadcast knock it off (KIO), altitude, and heading and continue to separate.

Fighter: *"ROKT 503 KIO, 1-6 thousand, heading 360."*
Bogey: *"ROKT 504 KIO, 1-7 thousand, heading 150."*

9. If at any time any member of the crew sees an unsafe situation develop, loses SA, or otherwise feels uncomfortable in the merge environment, they immediately direct the aircraft to stop offensive maneuvering and broadcast KIO, altitude, and heading to the other aircraft.

**Weapons Employment**

1. All missile shots must still be taken at the proper lead point, in LAR, and with an appropriate declaration in accordance with the Rules of Engagement (ROE).

2. Weapons load-out is 2 AIM-120s, 2 AIM-7s and 2 AIM-9s.

3. Students will no longer "pass the dot" for AIM-120 and AIM-7 shots, but will make the proper shot call on the radio:

FTR Student: *"Hammer 1, Fox-3 single group, 1-9 thousand."*
FTR Student: *"Hammer 1, Fox-1 single group, 1-9 thousand."*

4. AIM-120 AMRAAM Employment Parameters:

   a. Target locked in STT, at lead, AIM-54 selected on the radar, dot in the ASE circle.

   b. Target range 20 to 25 NM.

   c. TA 20° of less displayed in the data block.

   d. Fighter aircraft wings level.

5. Forward Quarter AIM-9 Employment Parameters:

   a. $\leq$ 85 TA.

   b. Target locked in STT, AIM-9 selected on the radar, dot in the ASE circle.

   c. Target range 1.5 to 5 NM.

## 1702. THREAT PICTURE WITH BULLSEYE CONTROL

Bullseye control allows multiple friendly forces in different locations, to be able to assess bogey locations with respect to a universally known reference point, generically known as Bullseye. The Bullseye location is usually chosen based on tactical or geographical significance and radial and distance information from that point is used just like a navaid. Once the location of a Bullseye is established among friendly forces, controllers can provide contact positions with bearing and range from Bullseye. In this way, anyone listening to the common AIC frequency can gain SA concerning the location of bogey, bandit, hostile, neutral, or friendly forces.

Bullseye calls can come in one of two formats. The first, using cardinal and semi-cardinal headings, gives a rough estimate of the bogey's position. The second, and more common, is digital bullseye, which most modern aircraft are able to show on at least one cockpit display. The following is an example of a digital bullseye call where Vulcan is the name of the bullseye:

"Gritrock, single group, Vulcan 155-57, medium, capping."

As shown above, a number of pieces of information may be given during a picture call, to include: AIC call sign (the one providing the info), the number of groups, the name of the bullseye point (there may be more than one in a given area of operations), magnetic bearing from the bullseye point, range from the bullseye point, contact altitude, and any other information relevant to the group.

Before the fighters actually commit on the contacts, the information is called Broadcast Control Digital Bullseye format--the calls are used to provide general SA to everyone in the immediate area. Once the fighters commit, the calls are called Tactical Control Digital Bullseye--they are aimed at providing specific targeting information to the fighters who will be engaging the targets. In the 1v1 syllabus we will focus on the Bullseye format.

## 17-4 ADVANCED INTERCEPTS

No matter how general the AIC picture, it should provide enough accuracy for fighters to point their sensors in the correct piece of sky in order to gain contact. True correlation comes when the fighter gains acquisition and gives a contact call with a precise digital bullseye or BRAA call. The controller can then provide declaration information when they feel the contact has been sufficiently correlated between fighter and controller. At VT-86, since our radars are not equipped with digital Bullseye capability, fighter contact calls will always be in the BRAA format. However, during the Advanced Block, initial acquisition will be achieved utilizing AIC Bullseye format.

## 1703. THE BULLSEYE CARD

An excellent tool for gaining radar contact or general SA when given Bullseye information is the Bullseye card. This can quickly be sketched on a blank kneeboard card with the center of the card being the bullseye.

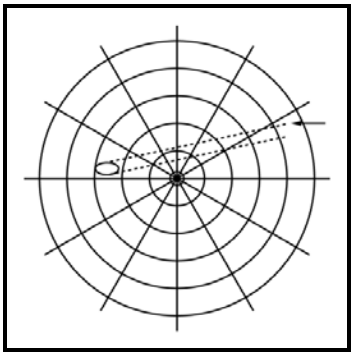

**Figure 17-1 Bullseye**

The above Bullseye card shows a fighter CAP located at Bullseye 280° – 25 NM where to point their radar to obtain radar contact on a bogey ENE of the fighter position given a picture call:

“Gritrock, single group, Bullseye 070-50, medium, track west.”

A prudent operator can quickly draw a dot (or any symbol) at his own position and draw an arrow (dot, x, or any symbol if heading info is not given) indicating bogey position and heading.

Then the fighter can visualize the magnetic relative bearing where the radar can be pointed in order to obtain contact. For simple intercepts, the picture can be visualized completely in one's brain. However, for more complicated battle situations, such a diagram is useful to track multiple groups of friendlies, bandits, and neutrals over a short period of time.

## 1704. ADVANCED INTERCEPT PRINCIPLES

The most obvious difference between the previous blocks and advanced is that the bogey is no longer a non-maneuvering, unaware target. Just like “blue” forces, the enemy aircraft has a mission of its own to perform. Therefore, you may observe jinks because the bogey could be:

flying a pre-planned route, manning a defensive cap, running an intercept on you, reacting defensively to your actions, or attempting to lure you into a SAM ring or an ambush cap.

By using the game plan to deal with this more advanced threat you will need to bring together everything you have learned so far. You will be graded on your ability to interpret the information provided by all resources and instruments in the simulator or jet and successfully execute your game plan.

The underlying objective is still to control the intercept. You also need to effectively operate the radar, use basic intercept principles, communicate, operate the aircraft, and manage the flight.

**Intercept Stages**

The advanced intercept is broken down into three stages, and these correspond to the opportunities during the intercept to employ the AIM-120, AIM-7 and AIM-9 given the VT-86 rules for weapons employment.

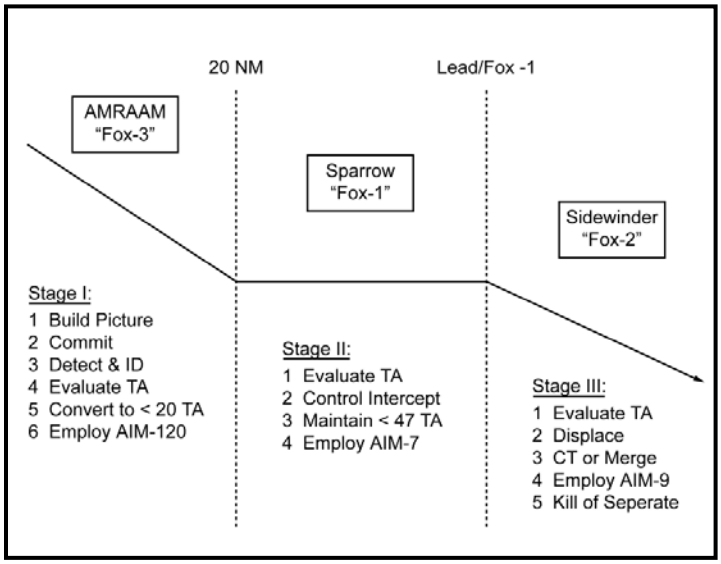


**Figure 17-2 Intercept Stages**

**Radar Setup and Scan**

Advanced runs are completed in DLS with Data Block ON. Data Block usage frees up more time during the intercept to quickly deal with the 'tactical' problem at hand, but only if it is thoroughly scanned on a regular basis. The radar must be treated as any other instrument. A thorough scan of the available data shows you the trends. Trend analysis allows you to make smart decisions throughout the intercept.

The Data Block displays the following information in the top right portion of the radar scope (with a lock):

1. Bogey altitude

2. Bogey ground speed

3. BH

4. ROC

5. Bogey TA

6. Range

Your initial radar setup should remain fairly standard. You have the freedom to change it based on your game plan and a few basic guidelines:

1. 40 NM scope (80 NM as required)

2. AZ3

3. 1 bar scan

4. Medium notch (use Low notch to assist in detecting a bogey in the beam as required)

5. Cursors/acquisition gates initially set at 30 NM, el-strobe centered.

Also note your radar's altitude coverage with the cursors at 30 NM, and understand how the coverage changes using standard search increments.

**Commit Criteria**

It is very important to understand when it is appropriate to actually commit on a bogey. In the real world, AIC is not going to call the fighter and bogey to both turn towards each other at the start of the fight like a duel. The fighter needs to build the picture using its own radar and AIC information, and also consider its mission objectives, fuel required, ROE, airspace rules (e.g., crossing international borders), and any other applicable factors before leaving the cap to press downrange.

For training purposes at VT-86, understanding when to commit is based on the bogey's current TA, and the range to it. We need to know the TA in order to understand whether the bogey's current track will be a factor to our own route or cap, as well as its ability to detect us with its radar and employ weapons against us. Considering the range is important to our intercept timeline as well as how much fuel we burn pursuing a bogey.

**Example:**

Consider this. If GCI calls out a group "…BRAA 090-50, medium, hot," we know the bogey has low TA and is 50 NM away. Evaluating the TA tells us the bogey will be a factor, but considering the range it cannot employ its weapons against us yet, and our own first launch

opportunity isn't for another 25 NM. So committing now would not make much sense—the fighter can continue to build the picture and monitor the group using AIC information while saving fuel in the cap. With 25 NM before we can even employ the AIM-120, the bogey could maneuver just about anywhere and drag the fighter on a wild goose chase if we did commit.

Gameplan commit criteria for an advanced setup is: NLT 30NM and 60 TA or less. This allows 5 NM at least to turn in, acquire, and ID the bogey, use intercept geometry to convert (as required), and employ the AIM-120 at 25 NM. The 60 TA limit means the bogey track is generally towards us, and we are within its radar scope limits (i.e., the bogey is a threat).

**Resetting and Recommitting**

When the fighter terminates an intercept to return to its cap, it is resetting. There are circumstances which triggers this—much like commit criteria, if the bogey maneuvers, is no longer a threat, pursuing it wastes fuel, and the fighter cannot rapidly achieve a kill, it makes most sense for the fighter to turn away and return to the cap.

What criteria are used to terminate an intercept and reset? This is range dependent. Outside of 20 NM, TA $\geq$ 65 TA would cause the fighter to reset. Inside of 20 NM, the bogey would have to maneuver > 95 TA. Inside of 10 NM, you will use geometry to decrease range and employ valid Fox-2 shots. Once the bogey has a 60 TA or greater, the fighter will not be on its scope and therefore the bogey is not an immediate threat. However, it could maneuver again and become a factor very quickly.

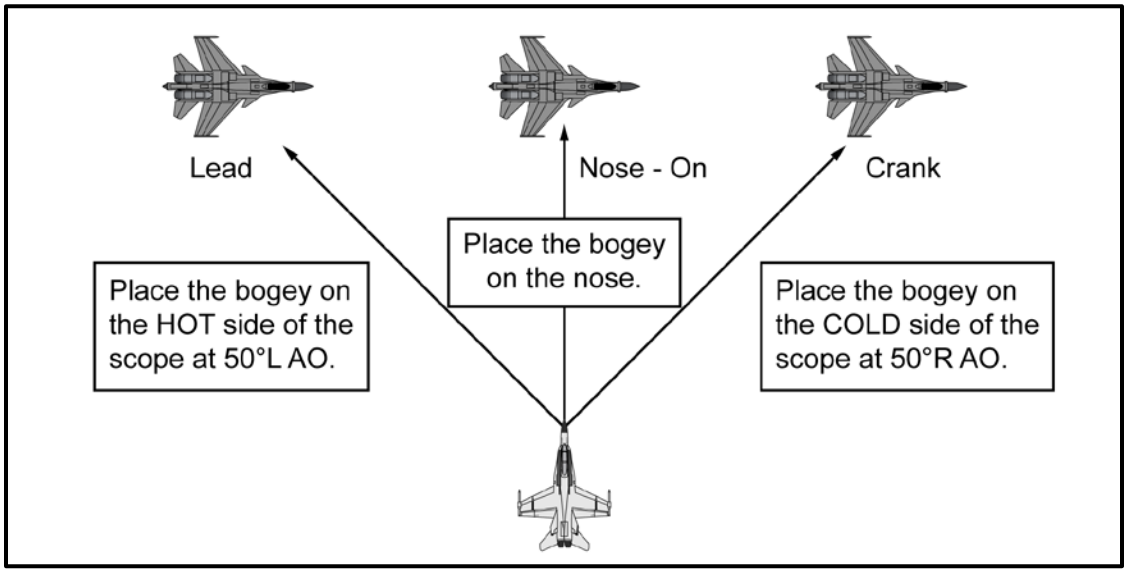


**Figure 17-3 Geometry Options**

Lag pursuit may be used to speed up the intercept and remain very offensive. Range will decrease more quickly than nose-on or cranking, and if the bogey maneuvers, the fighter will be potentially very close to a lead point from which to employ weapons.

A nose-on position allows the fighter to monitor the bogey from an offensive position as well, but range will not decrease as quickly as using cut-off. If the bogey maneuvers and sets left or right TA, the fighter will have roughly the same amount to turn to place him on lead, collision, or start a conversion.

Stiff-arming is best for preserving or building range and slowing the intercept. It is, however, the least offensive position for the fighter.

The gameplan will consider what the geometry is going to accomplish, as well as what range the bogey maneuver occurs before choosing which option to use. Similarly, you may elect to use cutoff if the same maneuver occurred at 15 NM to remain offensive.

If the bogey maneuvers to > 90 TA, the fighter should monitor the bogey briefly and then reset. The bogey can either be monitored for a fixed time once it reaches > 90 TA (e.g., for 5 sec > 20 NM, for 10 sec < 20 NM) or preferably for a brief time once it has stabilized with > 90 TA and a SH. This prevents a knee-jerk reaction and potentially dropping radar SA from a bogey that continues its maneuver and turns back hot to the fighter after a few seconds.

To execute the reset once the fighter has monitored the bogey per the game plan, start a HAP turn in the shortest direction to put the BB at your six o'clock, unload and extend, direct the buster to set 0.6 IMN if this is part of your game plan, and make a radio call to GCI:

Fighter: "*Gritrock, Hammer 1 dropping group BRAA 069-22, beam south; resetting west.*"

or

Fighter: *"Gritrock, Hammer 1 resetting west; monitor group BRAA 069-22, beam south."*

If subsequent GCI calls indicate constant or decreasing range, or "hot" is called, the fighter needs to quickly evaluate range and TA and recommit. Throttle back and set 0.5 IMN, and direct a HAP turn to bring the bogey on the scope again and make a call to GCI:

Fighter: "*Gritrock, Hammer 1 committing.*"

**NOTE**

Advantage – increases separation from bogey.
Disadvantage – increased fuel consumption.

**Merges**

One of the more difficult bogey maneuvers to detect and correctly react to is a hot jink or jink into during Stage III that forces a merge. A standard hot jink instantaneously changes TA and also reduces lateral separation, or turning room required by the fighter to continue the counterturn. The fighter can react to the jink and still run the CT successfully if it is recognized.

However, a bogey that continues to jink into the fighter is taking turning room away and will eventually roll out in the fighter's rear quarter if the fighter keeps trying to cool off the hot CT!

Thus if the bogey continues to maneuver nose-on, the fighter needs to stop the counterturn and strive to employ a forward quarter AIM-9 shot before going to the merge.

**Initial Merge Procedures**

1. Recognize the initial bogey jink into after the DT and start of the CT, then aggressively move the jet to cool off the CT.

2. If the bogey trend continues to jink nose-on resulting in steady or decreasing TA and the BH continues to change, bring the bogey to the nose with a HAP turn.

3. Steady up with the dot in the AIM-9 ASE circle and continue AREO calls.

4. Between 5 and 1.5 NM, with a hostile declaration, pass the dot or call "Gritrock, Hammer 1, MiG-29, declare" if VID. If only the pilot has a tally, call "Your VID" to the pilot and get a declaration from GCI.

Once you have employed the FQ AIM-9, it is essential to maintain tally, evaluate whether you have an angular advantage or not, and determine your post merge game plan.

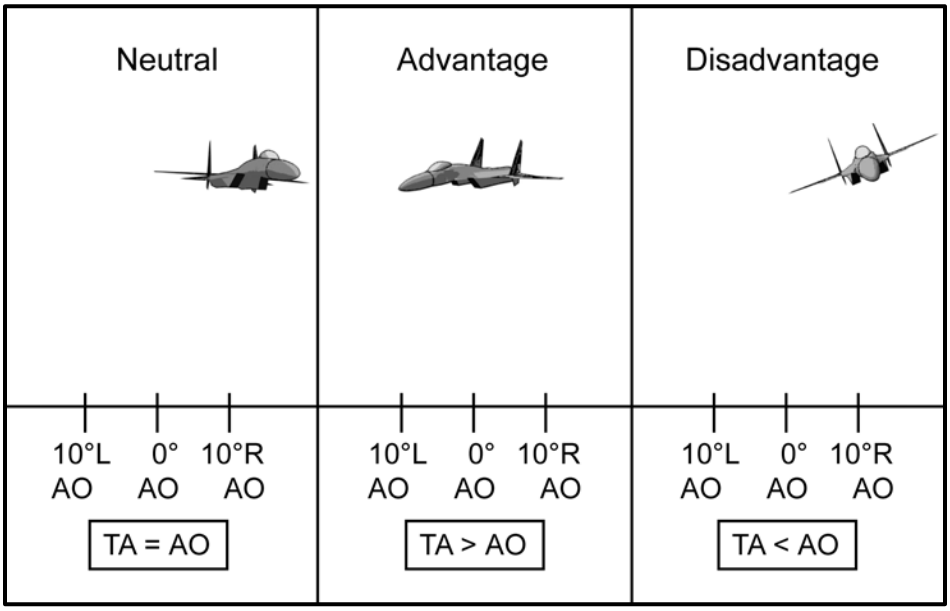


**Figure 17-4 Situations**

In the Neutral situation, the fighter sees the bogey at the same position in his canopy as the bogey sees the fighter—the TA and AO are equal.

In the Advantage situation, the fighter has the bogey on the nose and is looking at the side of the

bogey fuselage—TA is greater than AO.
In the Disadvantage situation, the fighter sees the bogey to the right or left of the nose, but is looking directly at the bogey's nose – TA is less than AO.

Advantage at the merge depends on more than just the angular advantage described above. You need to consider things like altitude, sun angle, clouds, jet performance, remaining missiles and most importantly if and when you achieved the tally. If you reach the merge and have an advantage or are neutral, you have the option to turn with the bogey once 3-9 line passage occurs to attempt a follow-on RQ AIM-9 shot. If you evaluate that you are at a disadvantage at the merge, the fighter needs to neutralize or get the advantage before bugging out. If you lose SA or tally at any time, the fighter needs to separate or "bug out." For training purposes the fighter needs to set up for a safe pass to satisfy the merge safety requirements as well (see Rules and Restriction, The Merge). In either case, it is required to inform the crew of your decision and game plan as early as possible!

**Safe Pass and Turning Fight Procedures**

1. After taking the FQ AIM-9 shot, use an easy or standard turn to put the bogey at 10 AO by 1 NM to maintain the 1000' bubble (10 AO at 1 NM = 1000' lat sep). Right TA goes to 10R AO, Left TA goes to 10L AO.

2. Follow the comm and safety procedures from *Rules and Restrictions, The Merge* for flight events.

3. When 3-9 line passage occurs, maintain the tally and direct a HAP turn into the bogey. If the pass is right to right, the student is responsible for the tally and informing the crew about what the bogey is doing. If it is left to left, the pilot is responsible for maintaining the tally.

4. Once the pilot has regained a tally after a right-to-right pass to put the bogey within limits of scan, select ACM Slewable and slew in the direction of the turn.

5. Lock the bogey and employ a RQ AIM-9.

**Separation/Bug Out Procedures**

For bogey advantage/low fighter SA at the Merge:

1. Unload, buster, and continue straight ahead.

2. Make a *"live bandit"* call to GCI.

   Fighter: *"Gritrock, Hammer; bugging out west, live bandit Vegas 185-69."*

3. Maintain visual lookout and adjust heading to place BB at your 6 o'clock.

For lost contact/low fighter SA inside 10 NM:

1. Select ACM-S.

2. Call *"lost contact"* or request "bogey dope" from CGI.

3. Use a hard turn or less to bring the BB within scope limits.

4. Execute ACM-S search.

5. If radar contact is established by 5 NM, execute merge procedures.

or

If radar contact is not established by 5 NM:

a. Fighter will make a *"clean"* call on UHF-1 and maintain current heading.

b. Bogey will maintain sanctuary altitude and deconflict.

c. Make a "*live bandi*t" call to GCI.

**R.O.E. Changes and Additions**

The declarations that GCI can provide from previous phases remain unchanged. However, the fighter retains the inherent right to self defense. Therefore if the bogey demonstrates hostile intent, the fighter may declare the bogey hostile without further input from GCI if:

1. The fighter sees a missile smoke trail from a clock position that correlates to the bogey on the radar, indicating that the bogey is firing on the fighter. For training purposes the instructor will inform the student what he "sees." Expect to hear something to the effect of "Smoke in the air, right one o'clock."

2. The fighter hears an "Alamo" or "Archer" called on the radio. Obviously a real enemy will not tell you when he is employing weapons, but during training these calls are made to highlight a fighter error and demonstrate that the bogey was able to enter a Weapons Employment Zone.

**Game Plan**

**Commit Criteria**
NLT 30 NM and ≤ 60 TA **OR** Factor on the Route

**≥20 NM-objective: maintain or convert to achieve F3 parameters**

| | |
|---|---|
| 0 – 15 TA: | Coll/Lead/F3/Crank |
| 20 – 60 TA: | 50 AO Hot + B/Lead/F3/Crank |
| ≥ 65 TA: | Monitor 10 sec/Drop |

**Crank (post F3)-objective: slow down range travel and achieve F1**
HAP 50 AO Cold until 40 TA, THEN Coll/Lead/F1
45 – 90 TA: 50 AO Hot + B until ≤ 20 TA or 12NM/Lead/F1/F2

**Offset (no F3)-objective: maintain or convert to achieve max range F1 parameters**
0 – 20 TA: Coll/Lead/F1/F2
25 – 90: HAP 50 AO Hot + B until ≤ 20 TA or 12NM

**≥95 TA**
> 10NM: Monitor 10 sec/Drop
≤ 10NM: CT/F2 if able

**Maneuvering Bogey (≥ 40 Deg Hdg Change)**
If within 2 nm of max shot range down to min radar missile shot range: Nose/Wait for Steady TA/Gameplan
Otherwise: Maintain AO/Wait for Steady TA/Gameplan

**Egress**
Aware Bogey: Execute Gameplan until F1/FQ F2/Merge/Bugout
Unaware Bogey: Stiff Arm, 50 AO cold, until a safe drop can be executed.

**NoShow**
>10nm: BB on nose/access drift/30 AO hot
≤10nm: BB on nose/merge
@5nm Call "Clean" with heading and altitude

Remember, you are being evaluated on your ability to absorb information and execute the game plan based on that information. Be prepared by asking questions, studying your gameplan and practicing in the simulator. Just because you are not required to put the bogey on collision or reach a TA goal does not mean you can ignore executing intercept fundamentals.

## 1705. 1 V 1 INTERCEPTS

This section will briefly cover the remaining procedures you require to deal with bogey jinks that go beyond just changes in heading, speed, and altitude jinks.

The two situations you will most likely encounter are: the high fast bogey often referred to as a High Fast Flyer (HFF) and the low slow bogey. Of course it is possible that you may encounter a high slow or low fast bogey, but tactically speaking it is more likely to encounter the HFF (e.g., a MiG-25 at Mach 2+ attempting to shoot down AWACS) or the low slow bogey (e.g. an enemy MiG-24 attacking a friendly convoy). No matter what kind of jinks the bogey makes, a solid scan of the data block is required to recognize them and react accordingly based on procedures and your game plan.

**The High Fast Flyer**

The primary advantage for a bogey that is both high and fast is that it will improve its maximum shot range against another aircraft. Every extra knot of speed the bogey carries means the missile rocket motor will do less work accelerating to top speed and therefore will have more time sustaining top speed, which equals greater range. Launching a missile from a higher altitude also provides less air resistance to the missile, which also makes its acceleration easier.

Additionally, the HFF will cause other problems for the intercept. A bogey with a 0.1 IMN speed advantage over the fighter will drift (collision has moved outwards on our scope by 5°) and will eventually create opening as the fighter rolls into the rear quarter during the counterturn.

In order to successfully complete the intercept, it will be very important to detect the HFF and implement these procedures:

1. Direct the buster to set 0.6 IMN as soon as you recognize the bogey's speed advantage and NLT Fox-1 lead range. While the intercept will happen faster, controlling TA and drift will be easier with a co-speed bogey.

2. Confirm the bogey altitude using the Data Block and GCI (and the el-strobe as required), and start your climb to 20K' at 15 NM.

3. Evaluate TA prior to the DT:

    a. For TAs of 20 and greater, under displace the bogey by 10° and ensure the ROC is run 100 knots HOT throughout the counterturn.

    b. For TAs of 15 and less, displace normally and ensure the counterturn is run 50-70 knots HOT.

    c. If the bogey jinks into the fighter to force the merge, apply merge procedures.

If you only recognize that the bogey is high or fast, you may force yourself into a situation where you will never be able to get a RQ AIM-9 shot—a late climb to the high sanctuary altitude will tend to bleed speed quickly, and a late buster may not prevent bogey opening in the RQ.

It will also take practice to get comfortable with running a counterturn that appears hotter than normal. However, if the fighter does not run a standard drift curve with higher ROC gates it runs the risk of rolling out in the RQ outside of AIM-9 range.

**The Low Slow Bogey**

A low slow bogey also presents problems to the intercept. The fighter speed advantage will move CB inwards on our scope by 5°, and you can anticipate closure problems in the RQ.

Unlike dealing with the HFF, the fighter is not going to give up the speed advantage to match the bogey's airspeed—speed is life as it provides improved shot ranges, increases 'G' available and

the potential to maneuver, and the ability to separate from a fight. Be aware that your gameplan will be affected by maintaining the speed advantage in terms of bogey drift.

Use the following procedures for a low slow bogey:

1. Continue to look for bogey jinks and make adjustments to your intercept geometry as required to account for bogey drift.

2. Confirm the bogey altitude using the data block and GCI (and the el-strobe as required), and start your descent to 12K' at 15 NM.

3. Confirm the bogey's speed prior to the DT:

   a. If the bogey remains slow, over displace by 10° and run a standard counterturn. Ensure the ROC gates are run approximately 50 knots colder than normal.

   b. Evaluate range to the bogey at 90 DTG with the bogey on the nose:

      i. If the range is > 2 NM, continue the counterturn normally.

      ii. If the range is 2 NM or less, ease the turn to cool off the counterturn and reevaluate ROC gates and range before bringing the bogey back to the nose.

   c. Employ the RQ AIM-9 quickly and be prepared to execute Break-X procedures.

Corrections made to counter both the HFF or low slow bogeys are made in addition to any corrections you need to make for late displacement. They are cumulative and will affect your ROC gates adversely if the proper displacement point is calculated incorrectly. Displacing 1 NM late on a HFF with 25R TA should result in displacing to 20R AO. 25R TA→25R AO, 25R AO - 10° (under displace for HFF) + 5° (over displace for late by 1NM) = 20R AO.

**This page reserved for Notes**

"*The first time I ever saw a jet, I shot it down.*"

General Chuck Yeager, USAF,
describing his first confrontation with a Me262

# CHAPTER EIGHTEEN
# THE STRIKE ROUTE

## 1800. INTRODUCTION

In this portion of the advanced block, you will be required to execute the game plan you have developed in a more dynamic and realistic environment. You are tasked to fly a simulated Self Escort Strike (SES) profile - which means simply that you will fight your way into a target, simulate delivering a weapon, and then fight your way back out. Referred to as a "Strike Route," these runs will test your ability to multitask using the radar to run intercepts while you also get the jet to a target on time.

Ideally you should execute the game plan to smartly manage route timing and an intercept simultaneously. Remember that your job is to survive long enough to kill the target--so ignoring the intercept or route timing at the expense of the other is not an option!

### Role

The fighter will execute a self-escort strike mission. The profile will simulate a medium altitude ingress/egress (16,000') and will be flown at 0.5 IMN. Load-out will be 2x2x4 and 1 laser guided bomb (LGB), with a weather backup of 1 JDAM.

### Threat

The standard threat will be an enemy fighter (e.g., SU-27 or Mig-29) with a 10 NM forward quarter AIM-7 equivalent shot (Alamo) and a 3NM forward quarter and 1.5 to 0.5 NM rear quarter AIM-9 equivalent shot (Archer).

### Objectives

The basic mission objectives are to make your Time on Target (TOT) within ± 30 secs and live. These objectives are briefed in a standard manner:

1. Bombs on time, on target (BOTOT)

2. Target all factor groups

3. No blue losses

### Scenarios

Students will be required to develop a simple threat scenario for all events from SS-1 to FS-2X to add a slightly more realistic feel to the event. Scenarios are optional on events prior to SS-1.

The scenario will briefly cover the threat nation, air order of battle (AOB), ground threats, target, and purpose of the mission. Students are encouraged to use imagery, charts, or any other

mission planning type products that might enhance their scenario and brief. The scenario does not have to reflect real world events, but should be somewhat believable and entertaining. Simulated scenario inputs such as radio calls from support assets and/or updated target coordinates may be incorporated at the instructor's discretion.

**Routes**

Refer to the current version of the Strike Fighter Stan Notes, or the Strike Fighter Briefing guide for a list of current routes and coordinates for the route points.

The Stan Officer has compiled several routes in the W-155 airspace (A and B) as well as the W-453. Just like the Core Phase of training, each student is required to produce a route card for each route using PFPS. As a minimum, the route card should include the following:

1. Student name and route number.

2. Bullseye (like a standard bullseye card).

3. Route points and labels.

4. Bullseye cuts and distances for each route point.

5. Route point ETAs and distances.

6. Route point coordinates.

An overview card showing the general layout of all routes in the airspace along with their respective coordinates is required to allow the student to flex based on weather, airspace restrictions, etc. Each student may choose an appropriate route for the event based on the assigned or expected airspace, but be prepared to fly any route on any event.

**GPS Usage**

Students will familiarize themselves with the T-39N/G Flight Management System (FMS) and global positioning system (GPS) (reference NATOPS). GPS will be used as the primary navigation instrument for the Strike Route only.

Students should also be prepared to navigate on their route using DR and/or point-to-points using the route bullseye cuts if the GPS fails. Strike Route points shall be entered into the GPS prior to leaving the chocks on flight events. Expect the pilot to leave VOR selected as the primary navigation instrument for area management along with A/A TACAN, and the student will select FMS to display GPS information on the EHSI. Solid crew coordination will be required.

**Setups**

Each strike route will consist of a pre-target bogey presentation, and a post-target bogey presentation. Bogey profiles and maneuvers will be scripted by the Mission Commander.

Students will need to coordinate with Gritrock when airborne to let them know when the Strike Route will be flown. The bogey will proceed to the pre-briefed cap point, and the fighter will proceed to the push point.

The setup will begin when the student calls "*COMEX, COMEX, COMEX*" on the primary radio frequency 2 minutes prior to the Push point. Gritrock will begin building the picture with standard radio comm.

There is no requirement to fly the route black line. The student will direct the flight as required to start the route on parameters and on heading. The student will maintain the route until the air-to-air threat dictates a reaction according to the student game plan.

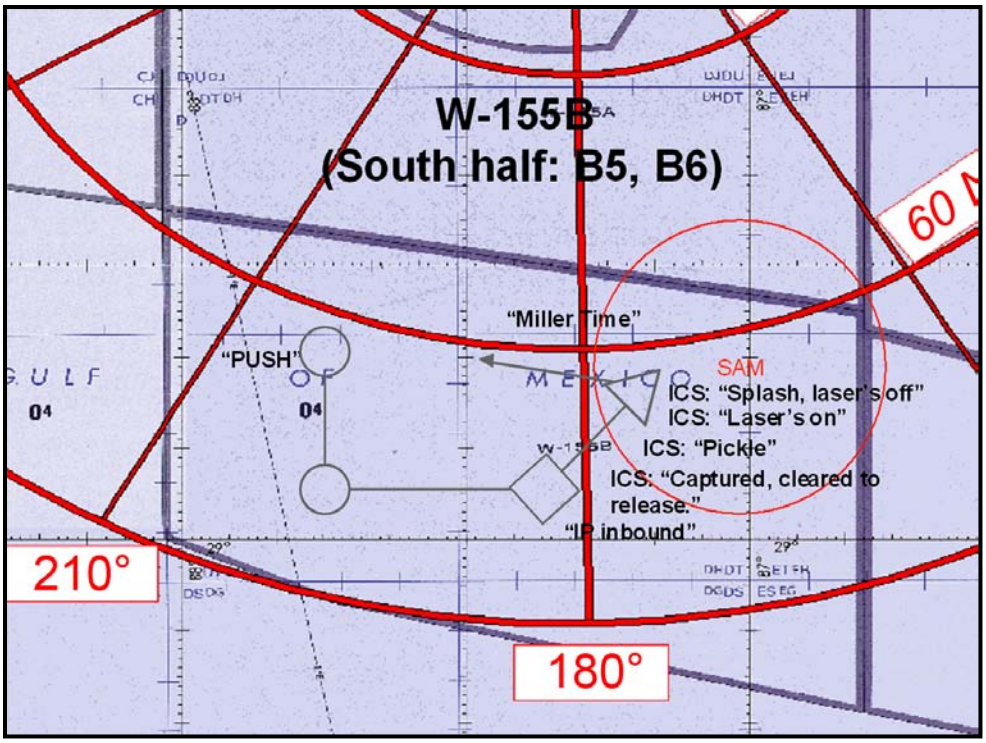


**Figure 18-1 Strike Route**

**Communications**

The comm required on a strike route is simple, but goes beyond just passing intercept information back and forth to GCI. A strike mission of this sort may have other airborne assets assigned that are there to support YOU striking the target. In order to properly deconflict in time and space and provide the most effective support, they need to know the basics of where you are and what you are doing.

| | |
|---|---|
| "COMEX, COMEX, COMEX." | 'Commence exercise' called 2 minutes prior to the start of the route. AIC starts Broadcast Control Digital Bullseye calls. |
| "Hammer 1, pushing." | Informs all players that you are at the start of your route. |
| "Hammer 1, IP inbound." | Informs all players that you are at the IP making your run to the target. |
| "Hammer 1, Miller Time." | Informs all players that you are egressing the target. |
| "Hammer 1, target direct." | Informs all players that you are proceeding directly to the target from your present position—assumes you are NOT on the black line. |

**Timing Problems and Corrections**

Throughout the route, students need to continuously evaluate where they are, whether they are on time, early, or late, and how their actions will affect their timing to the target. You cannot just think of the problem at hand. You have to get ahead of the jet and anticipate consequences and follow on problems.

Students may use speed corrections of ±0.1 IMN from the base airspeed as required, and are free to use whatever geometry makes sense to arrive inside the attack heading cone at the target within the TOT window. Students shall not make the target leg run-in at less than 0.5 IMN, weave, or fly S-turns to burn extra time.

Keep in mind the big picture on timing. If you cut to the "inside" of the route (north side of the route in Figure 18-1) you will be early; if you cut to the "outside" of the route (see same diagram above) you will be late.

**Weapons Delivery**

A medium altitude delivery of a single GBU-12/16/10 series LGB is simulated. Release range is 3.0 NM from the target. You must, however, be steering directly to the target within +/- 30° of the planned run-in heading at release range in order for the bomb to make it to the target. Successful crew coordination during the attack requires a little comm:

"Captured," at 5 NM from the target, informs the pilot that you have located and identified the target in your Targeting Pod (which means you are able to guide it), and that he may release the weapon.

"Pickle," at 3 NM from the target, informs the crew that the weapon has been released. The student will call this at release range.

"Laser's on," at 1.5 NM from the target, informs the pilot that you are guiding the weapon.

"Splash, laser's off," when marking on top of the target, informs the pilot that the weapon impacted the target and you are done guiding it.

**Gameplan Considerations**

1. Role and Mission: your priority is to get to the target and destroy it. All jets will experience reduced performance when carrying air-to-ground weapons and you should avoid placing yourself into a situation where you might have to jettison your weapons in order to defend yourself. Only proceed with an air-to-air engagement on the way to the target if you have to.

2. Radar Setup: adjust your starting scope range and azimuth scan in order to help build your SA on the route. Know how much airspace along your route will be covered by your radar. Rule of Thumb: for a given range on the radar scope, your lateral coverage is equal to 2 times the range for the full 120° scope width, and is equal to the range for half scope width (60°). e.g., at 30 NM on a 40 or 80 NM scope, the width of the scope is 60 NM, and half of the scope is 30 NM.

3. Pre Commit Geometry: stiff-arming is useful in trying to get around the bogey entirely which is highly desirable, but will impact your timing depending on which direction you turn.

4. Commit Criteria: your 1v1 criteria may not be applicable to successfully making it to the target in the TOT window. Consider the overall length of the route and how far you are willing to stray from the black line in order to complete an intercept. Commit criteria is such that you leave the route only when you have to. Also consider that while the bogey may not be a threat to you NOW, it may become a factor on the follow on leg.

5. Committing on the bogey DOES NOT require putting the bogey on the nose—simply placing the BB on the scope will allow you to evaluate TA and stay close to the black line, minimizing the impact to your timing problem.

Post Commit Intercept Geometry: you have two primary intercept options which may assist your timing problem:

a. Forcing a merge may help you catch up on time, and may be the best option against an aware bogey. Just remember that forcing a merge to turn with a bogey is not a smart idea while carrying bombs.

b. Executing a standard counterturn is a useful technique if you are early and need to burn time. It may also be ideal if the bogey appears unaware—take the RQ AIM-9 shot as quickly as possible and turn back on course once the missile is off the rail.

6. Post Shot Maneuvering: there is no set requirement to use the same TA game plan as in 1v1's. Consider using a stiff-arm maneuver while the AIM-120 is in flight (called a 'Crank,' see the 2vX chapter for more information). Good SA dictates that you will pitch back in to the fight

to control TA before losing the opportunity for an AIM-7 shot. Also give some thought to how bogey jinks will affect you in those situations.

7. Kill Removal: the bandit will "kill remove" when learning objectives are met IAW the VT-86 Fighter and Gritrock Employment Standards.

8. Egress: once the target is destroyed and the "Miller Time" call is made your priorities change. You only need to survive. Build the picture using the radar and GCI. You are not limited to flying the black line during the ingress, and you are not limited to flying directly to the push point during the egress. Stiff-arm to acquire and ID the threat, and take advantage of every shot and separation opportunity presented. Your only goal is to get your jet and crew home safely. Try to separate, avoid getting dragged into a SAM ring and save the chance to notch up another kill for another mission. Use the buster (fuel permitting) and geometry to get around the threat if possible, but do not ignore or allow lazy timeline execution against an aware and aggressive bogey that forces an engagement.

## 1801. CONCLUSION

In conclusion, the advanced block is designed to build on your basic skills to employ against an aware and maneuvering bogey in a dynamic environment, which more closely simulates real world situations. This is accomplished through 1v1's and the Strike Route. You will not be graded on tactics, but on your ability to effectively operate the radar, use basic intercept principles, communicate, operate the aircraft, and manage the flight. These fundamentals are demonstrated by:

1. Understanding Advanced Rules and Restrictions.

2. Understanding Advanced Principles and Procedures.

3. Executing the air-to-air game plan.

4. Executing 1v1 and Strike Route procedures.

Advanced Block will definitely be a challenge, but that is what being part of the fighter community is all about. So step up and enjoy!

**This page reserved for Notes**

*"No guts, no glory. If you are going to shoot him down, you have to get in there and mix it up with him."*

Major Frederick C. "Boots" Blesse, USAF
Korean War, 10 Victories

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# CHAPTER NINETEEN
# INTRODUCTION TO 2 V X

## 1900. INTRODUCTION

The purpose of this chapter is to introduce you to using multiple jets/radars in order to kill more than one enemy. You will become familiar with the standard terminology and basic procedures to use in these situations. It is important to understand that there are both subtle and significant differences in the way the AF, Navy and Marines execute these procedures. In many cases, there is no "right" answer. However, by learning the various perspectives you will have a wider knowledge base and be better prepared to learn the specific procedures used at your FTU/FRS.

Additionally, because of classification issues as well as aircraft and simulator limitations, many of the procedures used in VT-86, will not correspond with what is done in the real world. Essentially, VT-86 has taken what we can from real world execution and combined it with our capabilities. The end result is that VT-86 training is not exactly what the various services do, nor is it 100% tactically sound, but it is a good compromise that will teach you the basics within the framework and limitations of the training environment. These differences will become evident as you proceed through this final phase of training.

In order to distinguish between how it is done in the real world with what happens in VT-86, this chapter will present the two separately. First you will find general discussion intended to help you understand real world intercepts. This will be followed by some specifics regarding how we want you to execute at VT-86.

The objectives of this phase are to introduce you to the following intercept procedures and the communications required to properly brief and execute them:

1. Commit

2. Labeling

3. Targeting

4. Meld/Sort/Shoot

5. Crank

6. Decision/Abort Ranges

7. Merge/Separate

It is our goal to teach you these concepts and give you the opportunity to practice them. We do not expect perfect execution of these procedures, however, you will be evaluated on your ability to understand and brief them.

In addition to learning the concepts, we want you to become familiar with the comms used to execute the procedures. You are likely to have "Clear, concise, correct, SA-building comm" ("$C^3$ SA Comm") as a training objective for nearly every flight for the remainder of your career. To get your tactical communication skills started on the right foot, you can expect a heavy emphasis on communications throughout this phase. According to student critiques from the RTU/RAG, this portion of training applies most directly to what you will be doing in the future. Therefore, you should give it your best effort. By the way, it is also the most fun you can have in the simulator.

## 1901. TYPICAL INTERCEPT OVERVIEW

An intercept consists of determining the picture, deciding which threat is the highest priority, committing on that threat, searching for and detecting the target(s) with your radar, sampling target parameters, sanitizing around the target, and then sorting into the target formation in order to ensure you shoot the correct bandit. Following the sort and Fox-3, stiff arm the bandit until missile impact. However, in VT-86 we will turn back into the bandit for Fox-1, counterturn or merge, then an F-2 to conclude the intercept. Following the merge or counterturn and the conclusion of the engagement, a separation is performed in order to exit the area safely. This section looks at the different phases, and the tasks performed in each phase.

### Picture Building

Each intercept will begin with GCI painting a picture. This picture will be communicated with very standard comm, but with slight variations in form, format, and even style, depending on the phase of the intercept (i.e., how far away the bandits are from you) and who your controller is (AWACS, E-2, NATO, ground controller, USN, USMC, USAF, etc.). However, the bottom line is that you will be given the tactical picture. It is your job to listen, properly interpret, and plot this picture in order to determine which group poses the most threat and needs to be committed to or engaged first.

### Commit

Based on GCI actions, ROE, and/or threat status, the commit should occur with sufficient range to perform the intercept tasks of targeting, sorting, locking, shooting, and cranking in order for the missile to achieve active status and attain a BVR F-3 timeout kill. Generally, after the initial picture, it is ideal to have a minimum of 30 NM between you and the first group you intend to commit to, in order to properly execute all of these procedures. If necessary, adjust the geometry to control the intercept. In other words, unlike previous advanced intercepts in VT-86, you will more than likely not put the BB on the nose. You may elect to offset or lean the formation initially in order to slow the intercept down or to change the picture.

### Labeling/Naming

Labeling groups can be done in many ways (tactically, geographically, etc.), but it is very important, because it will minimize comm and build SA for the entire package. It also builds SA for the entire package, because a BRAA only makes sense in relation to you. But it will not

make sense to another flight in another area of the fight. After the commit is made, AIC attaches labels to the groups described. Generally, geographic labels make the most sense to all players. For example, if AIC describes two groups, one of which is directly north of the other, both groups headed south toward your section AIC will name them Lead Group and Trail Group.

**Targeting**

Since we intend to kill both groups in the picture described by AIC, we must decide which group to kill first and have AIC monitor the other group. After the first group is destroyed, we must move on to kill the second group. (Due to limitations in VT-86, we cannot kill multiple bandits and multiple groups at the same time. You will get to do that later in the fleet.) Therefore, we have to make a call to target the most threatening group. This is a required call to AIC, because we are taking responsibility for killing that group. Each time you commit to a picture (multi groups), you will quickly make a call to target the most threatening group after AIC label/names the picture.

**Detection**

Keep the acquisition symbols short of the target's anticipated range. Cover the required airspace at the designated range. If you know the threat's approach axis, use of a 60° sweep is a viable option in order to decrease frame time. After acquiring the target, 60° sweep will increase the refresh rate of the hits. Keep the acquisition symbols at least 5 NM short of the target. You are looking for long-range contacts that will enable you to get started on your sampling, sanitizing, and sorting. As a minimum, establish the altitude of the target to aid in reacquisition later.

**Sanitize/Sample/RESAN**

This phase is extremely important. The task is to determine intercept geometry, develop a plan of action, and build SA through sampling in order to determine how many targets are in the group and the parameters (airspeed, heading, aspect) of each target. This is also the time to ID the targets. Sampling is performed by repeated radar locks of approximately 5 seconds or just long enough to get valid target parameters displayed and to read them. The sample lock should not exceed 10 seconds during the sampling phase, sanitize the area around the target for brief periods between the sample locks. If needed, move the search pattern to other possible threat axes and/or altitudes. This must be done in order to prevent unseen bandits from entering the engagement. Sampling, sanitizing, and sorting are accomplished in near simultaneous fashion by highly experienced aircrews. However, less experienced/proficient aircrews need to consciously realize which task is the current priority so they can optimize the radar for that particular task. For sanitizing, a wide search volume is required. For sampling or sorting, optimize the radar against the observed target(s) or against the smaller volume of airspace around the target formation. STT is a pure sample mode. Search is the purest surveillance mode while offering some target information. Resanitizing is the last task before meld and usually occurs 5 NM before meld, 35 NM here at VT-86. One full frame and coverage of your AOR is required to ensure that an unknown threat is not threatening you before you meld.

**Meld**

In most cases the lead and wingman have different radar search responsibilities. One will search high while the other looks low. Melding is the act of putting both fighter radars at the proper altitude search in order to see the targeted group and prepare for sorting. Meld mechanics are established to shorten the search pattern to give you more hits and a higher refresh rate. This will assist you in getting a breakout of the target formation.

**Meld Mechanics**

Range down to 40 NM and shorten the search pattern to 60° sweep, (AZ3) set the acquisition gates 1-2 NM in front of the called meld range. Center the elevation search (SAD gates) to the altitude called. Melding of the radars usually occurs 5 NM before lock range, 30 NM here at VT-86.

**Sorting/Lock**

Sorting is the process that ensures both radars are locked to the appropriate contact/bandit prior to taking shots.

**Example**:

"*Eagle One sorted left"*
*"Eagle Two sorted right*" or:

"*Eagle One sorted near"*
"*Eagle Two sorted far"* or:

*"Eagle One sorted high"*
*"Eagle Two sorted low"*

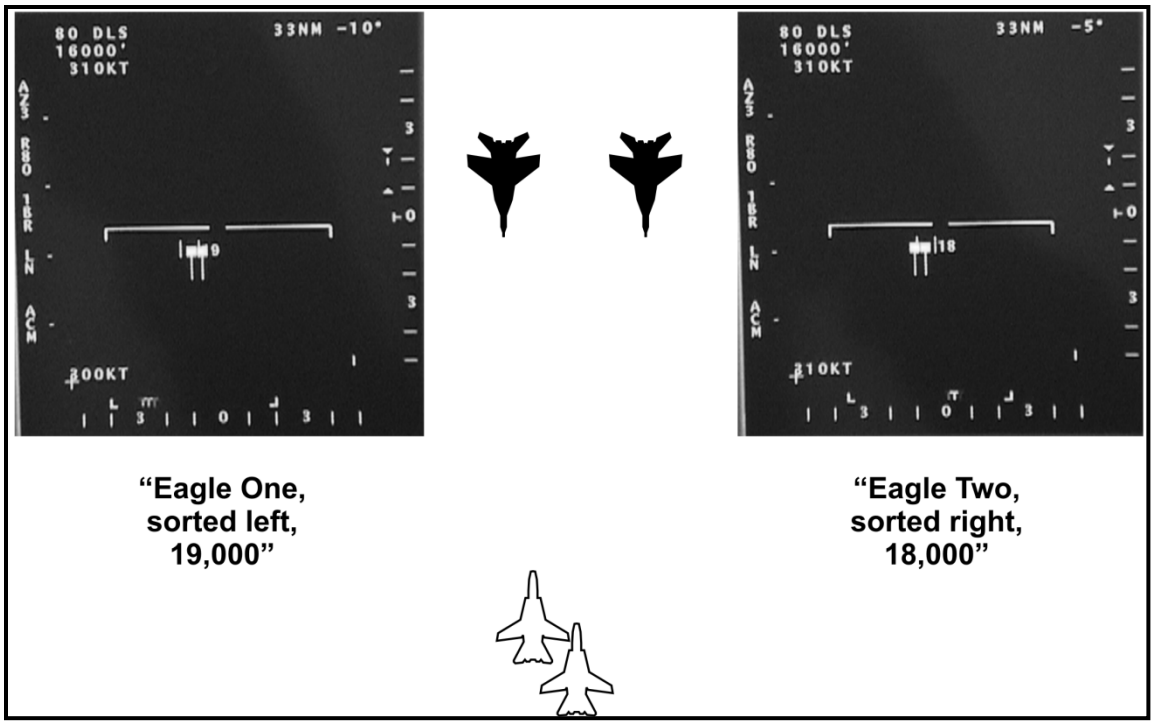


**Figure 19-1 Sorted/Lock**

The plan for sorting is defined during the brief, but is generally flexible enough to allow for changes and to compensate for mistakes in flight. The final lock range will be briefed and must be adhered to in order to enable all flight members to see the same radar picture and therefore lock the correct bandit.

**Crank/Intercept Geometry**

After shooting, the formation will crank to put the target "cold." This will allow you to keep your distance from the bandit as your missile travels downrange. Additionally, it will decrease the bandit WEZ by showing him a higher TA. A crank is a hard turn (4-5 Gs) executed as quickly as possible after the shot. In the real world, you should also descend and slow down (but maintain a tactical airspeed). You need to watch bandit maneuvers while maintaining the crank so as not to gimbal. Monitor missile time of flight (TOF), keep track of your bandit's WEZ, and assess spike status as required by the situation.

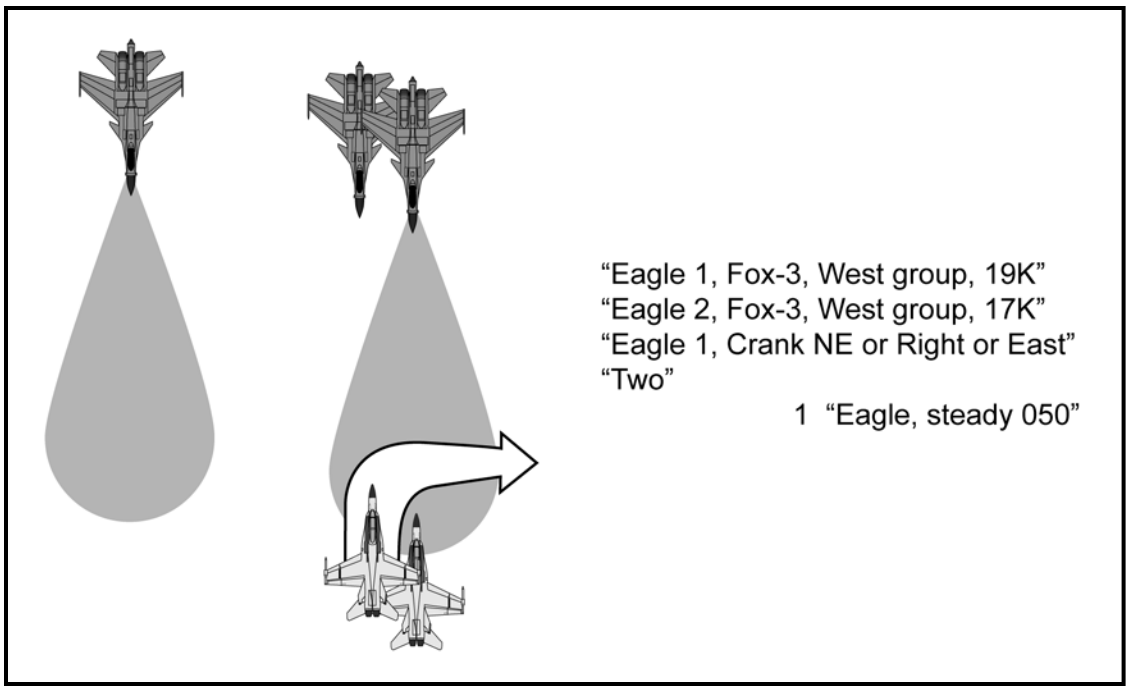


**Figure 19-2 Crank/Intercept Geometry**

The Fox-3 shot may not be successful (missile failure, break lock, jamming, chaff, etc.) In order to be prepared for this possibility in VT-86, you will follow your Fox-3 with an AIM-7 shot, stern conversion, and AIM-9. This last part of the intercept is very similar to what you have seen throughout the program, with two important additional considerations:

1. You may be forced to abort due to an unfavorable situation.

2. The bandit may force a merge.

**Visual Arena**

For most game plans, the goal is to shoot beyond visual range (BVR) and remain BVR. However, some conditions/scenarios may require a merge or stern conversion with an F-2.

**Separate**

At the end of the engagement, turn to the called/briefed egress heading, usually 180° out from your last intercept axis or 180° out from the follow on group. Regain the briefed formation and mutual support and conduct FARM checks. If you have not conducted proper FARM checks (i.e., radar in 5 NM AZ3 or you are stuck down at 11K), you are not ready to target and kill the next group! If you are not ready, then remain cold until you are. Once your flight is back together and ready to fight, be prepared to enter another engagement.

## 1902. BASICS BEYOND THE TIMELINE

### Types of Missions

The type of mission will determine the air-to-air tactics you employ as well as your risk level and weapons loadout. The two most common categories of missions flown are air interdiction (a subcategory of counter land) and counter air.

### Air Interdiction (AI)

The purpose of air interdiction missions is to destroy, neutralize, or delay enemy ground or naval forces before they can be brought to bear against friendly forces. The primary intent of these missions is to destroy targets on the ground. Therefore, air-to-air engagements usually only take place on a contingency basis.

### Counter Air

Counter air missions are offensive or defensive missions flown to achieve air superiority by destroying or neutralizing enemy air forces and facilities. Defensive counter air (DCA) actions are usually conducted over or near friendly airspace as a reaction to the enemy's initiative. Offensive counter air (OCA) operations are conducted throughout enemy territory to seek out and neutralize or destroy enemy aerospace forces and are essential to gaining air superiority.

### Defensive Counter Air (DCA)

DCA missions involve protecting a point or area on the ground or a high value airborne asset (HVAA) such as a tanker or AWACS. DCA missions usually involve holding in a combat air patrol (CAP) until committing on a bandit(s), and often require a larger air-to-air missile loadout, depending on the threat and the length of the vulnerability window.

### Offensive Counter Air (OCA)

There are several types of OCA missions, including air-to-surface attack, sweep, escort, and suppression of enemy air defenses (SEAD). OCA missions push out of a CAP/marshal area at their designated push time and engage enemy aerospace forces on the ground and in the air in order to achieve air superiority.

### Combat Air Patrol (CAP)

Most missions will have a combat air patrol (CAP) or marshalling phase. Marshalling is usually associated with an interdiction-type mission (AI, OCA, etc.), while a CAP is associated with DCA.

**Radar Setup**

Radar setup is one of the most important aspects of the intercept. It is extremely important to tailor your radar setup to the tactical and environmental situation you expect. The following key terms and concepts will give you a basis for your radar setup decisions.

**Scope Range**

Determine the minimum range necessary to detect the threat, analyze geometry and threat maneuvers, and still have room for the commit. Your scope range should be set to search beyond this minimum range.

**Azimuth Selection**

An azimuth sweep of 120° (AZF) is usually standard, but consider limiting azimuth selection to 60° (AZ3) when a single threat axis is available (lane assignment), when AIC/AWACS coverage will supplement your own radar coverage, or as SA dictates.

**Acquisition Symbol Range (ASR) / Curser Coordination Range (CCR)**

A prebriefed range must be specified to ensure that all flight members are using the same range to set the altitude coverage. If each flight member sets his acquisition symbols at a different range, gaps in the search coverage may occur. A rule of thumb is to use meld range (30 NM for VT-86) as the acquisition symbol range.

**Altitude Search Selection**

Altitude sanitization and division of elevation area of responsibility (AOR) are important factors in building a complete picture. Set up scope range at 80 NM with acquisition symbol range at briefed meld range. Divide the elevation coverage into high and low search to build a complete picture. Overlap radar coverage at least 2000 feet at meld range to avoid unintentional coverage holes. In VT-86, you are required to cover 8-24 K. Remember that your radar gives you 3.45° of vertical coverage. Multiply that by your meld range to calculate your altitude coverage (Coverage = 3.45 x 30 x 100 = 10,350'). Back up search increments w/SAD to set coverage. In VT-86, lead will search "high" 15-25 K and wing will search "low" 7-17 K.

**Intercept Progression Details**

The following section addresses each portion of the intercept in greater detail than above.

**Communication and Picture Building**

The ability to engage the enemy requires the use of clear, concise, accurate, SA-building communications ($C^3$ SA Comm). In short, effective communications can make or break the intercept. This does not mean talking excessively. And just as important, listen! The two most important factors in an efficient, effective comm plan are brevity and accuracy. Of these two,

accuracy is paramount. We always strive to communicate IAW USAF 3-1 or USN Top Gun standards, but there may be times when plain English is required to communicate accurately. Additional keys to effective communication are listening and pacing. You will not communicate well if you do not listen and build a picture based on what you hear. In addition, there is no communication if everyone is stepping on one another. Brief a comm flow (i.e., AIC, Eagle 1, Eagle 3) and then adhere to it. If your back is to the fight, AIC is the primary talker, followed by lead, then number two. If your radars are pointing down track, the fighters with the picture on the scope (either lead or wing) should talk with AIC filling in. A good flow of communication will set the stage for a fluid, error-free intercept. In most instances, B/E comm makes the most sense to the fighters as well as other blue air assets (F-15Cs, AWACS, AIC, etc.). To eliminate confusion, preface all calls with “BULLSEYE” or “BRAA” unless otherwise briefed.

**Calling the Picture and Labels - Fundamentals**

Group criteria will be 5 NM and 5K feet.

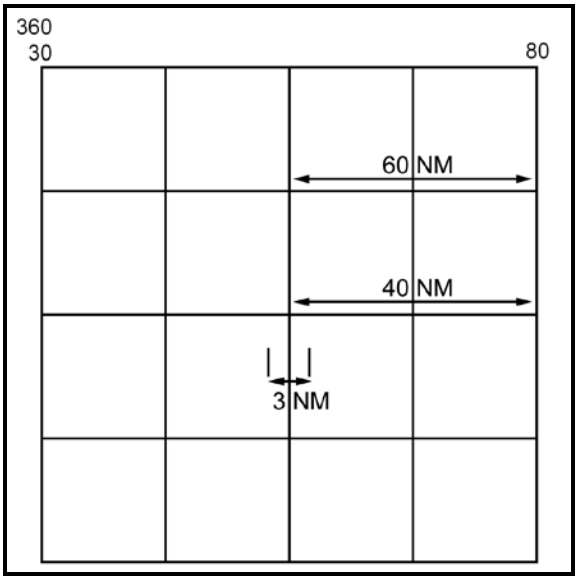


**Figure 19-3 Labeling the Picture**

A group is nothing more than a hit on your radar scope. A group may have one, two, or more contacts within it. For example, four MiG-29s flying in close formation would be a single group. If two MiG-29s were flying line abreast, 10 NM from one another, your radar scope presentation would be two groups. As the MiGs get closer, you may be able to determine that each group contains only one MiG (single contact). Remember that a group **assumes** two contacts; any more becomes a “heavy” group. “BULLSEYE” or “BRAA” will preface all calls to eliminate ambiguity. A full call sign will be associated with every radio transmission. Prior to the commit, always use the following core information:

1. Number of groups

2. Bullseye information

3. Altitude

Prior to the commit each group will be called "group," not "single group." In addition, when using core information to anchor the location of groups, AIC will not say, *"First group b/e 360/10, second group b/e 040/20."* No number is used. Also anchor the location. Example: "G*roup b/e 360/10, group b/e 040/20."*

For anchoring group location, the group closest to the fighters will be anchored off bullseye first, followed by the next closest and so on. If multiple groups are equal distances from the fighters, the group closest to the bullseye will be anchored first.

Labeling/naming the picture will help with fighter targeting and help the flight lead decide how to direct the actual intercept geometry and targeting. For example, a wide azimuth presentation may warrant a single-side offset type intercept while a pure range presentation may call for a hotter, pure intercept. Common sense and the tactical presentation should determine AIC labeling. Some general rules of thumb for when to label a picture follow.

1. Fighters have committed and the bogies/bandits have committed or are on a steady track.

2. The bandit formation fits a true picture that can be labeled.

Before reviewing the various picture labels, it is important to remember not to "force the picture." If one of the following picture labels does not apply to your particular presentation, it is better to simply call each group out one by one with respect to B/E than try to make a predefined picture label fit. Two major categories of labels are used to describe two groups: azimuth and range. If the groups are an azimuth relationship, name the groups using the four cardinal directions; i.e., "*north group*," "*south group*," etc. If the groups are in a pure range relationship, name the groups using "*lead group*" and "trail group." The use of "*side/side*" and "*near/far*" or "*northern/southern*" is reserved for inner-group relationships, like sorting.

A possible fill-in to a presentation is "*echelon.*" If the two echelon groups are wider than they are long, call, "*Two groups, Azimuth 10, echelon northwest, east group B/E.*" If the two echelon groups are longer than they are wide, call, "*two groups, range 10, echelon southwest, lead group b/e."*

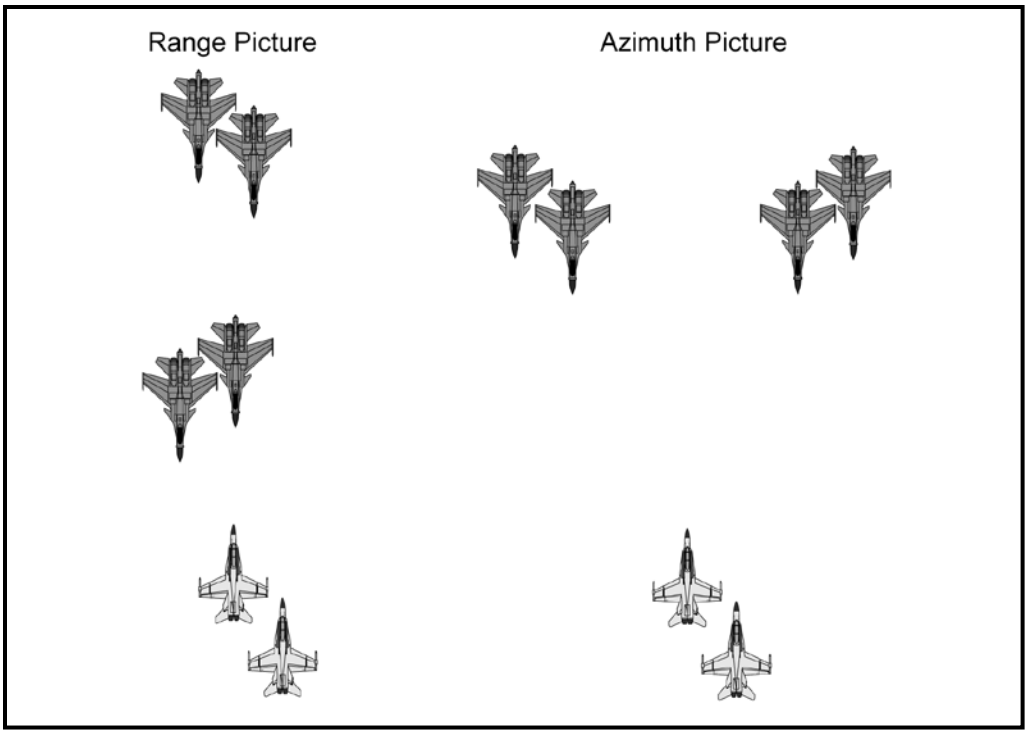


**Figure 19-4 Calling the picture**

*"Eagle, two groups range 20,*
*Lead group Bullseye 180/40 High, Hot,*
*Trail group, Medium, Hot"*

*"Eagle, two groups azimuth 20,*
*West group, Bullseye 200/30, High, Hot,*
*East group, Medium, Hot"*

The targeting plan is the meat of any good A/A game plan and brief. The targeting phase starts at the commit when the picture is labeled/named. In general, fighters target groups within a picture and sort contacts/bandits within a group. Fighter numbers and ordnance, bandit numbers and ordnance, and the planned fighter tactic will determine how the targeting will be accomplished. However, for VT-86, we will target the most threatening group. This could be the closest in range or azimuth, or possibly the highest group if the two are equally close. Aspect (hot or cold) must also be taken into account. If the targeting plan is well-briefed and well understood, the actual targeting should be obvious and should not require directive comm from lead. But the flight lead should make an informative targeting call and directive monitor call to AIC to ensure responsibility for killing that group is clearly understood by all. A clear cut situation that was well briefed and understood, will require almost no communications, with each flight member executing their briefed actions on its timeline, speaking only when necessary.

**Meld**

Meld range depends on desired weapons employment range, which is threat dependent. Minimal sort range should be 2-3 NM outside shot range, although this may be increased due to ID requirements. In order to ensure all flight members will see the threat picture, meld range must be an additional 5-10 NM outside lock range. Therefore, if you want to shoot NLT 20 NM, a 25

NM lock range and a 30 NM meld range might be appropriate. When melding radars it is important to put your radar in a position to find your sort.

The basic meld mechanics are:

1. 40 NM-mile scope

2. 60° sweep (AZ3) centered on the target position

3. Acq symbols leading 1-2 NM in front of the target

4. Elevation coverage centered on the target altitude

Meld mechanics occur after one frame of sanitization after the RESAN range call. If planning to sort, call the inner group picture (*"sort contract"* or radar-apparent picture, near/far, side/side, high/low) at the MELD range, expect the wingman to sort IAW the brief according to the radar-apparent picture; e.g., "*Eagle 2, meld BRAA 360/30, hits 22, side/side*."

**Lock/Sort Range**

Lock range is established to ensure first launch opportunity (FLO) against an adversary. If a valid sort can be accomplished, all players should lock at this predetermined range. If a valid sort cannot be accomplished, the *first-to-lock* should lock to ensure FLO. The second to lock should sanitize around the targeted group in order to detect group maneuvers. Generally, lock range is dependent on bandit altitude (WEZ).

The objective of sorting is to ensure all targets within a group are engaged to achieve maximum kills premerge. Radar-apparent geometry determines the sort, but not necessarily the formation the bandits are flying.

Possible radar-apparent formations are:

1. Near/far (range formation) – Distinct range breakout

2. Side/side (azimuth formation) – One side of acq symbols fits between returns

3. High/low (altitude stack) – May appear as one return but two separate altitudes

**NOTE**

Near/far is used for inner-group formation (sorting), while lead/trail is used when labeling groups in range (targeting/picture building).

The primary sort plan should match your formation. When sorting in range, leads take the closest bandit, wingmen the farthest. When sorting in azimuth, take the bandit that matches your position in the formation (your side). Due to simulator limitations and simplicity, a near-far sort,

lead will always sort near with –the wingman sorting far, and for a side-side sort, lead will always sort left with –the wingman sorting right, Lead will sort High and Wing will sort Low.

If a valid sort is accomplished, call your sort with the appropriate label; e.g., "*Eagle 2 sorted left, eighteen thousand*" If unsure that a valid sort is achieved, call "*locked*" with the altitude. In that case, the call for the first to lock sounds like "*Eagle 2, locked, twenty thousand*" You are only sorted after you have locked the bandit. However, "*sorted*" does not mean the same as "*locked.*" Nevertheless, once you are sorted, you have a contract to monitor and kill when in position to do so. Sort on the shortest-range scope you can. This gives the largest apparent breakout on the radar.

**First to Lock (FTL)**

One fighter will be designated as FTL. This will allow one fighter to lock and call "*sorted/locked.*" Then the other fighter can sort around that bandit, regardless of whether the FTL locked his assigned bandit. FTL will be the wingman here at VT-86.

Specific responsibilities are:

1. Locking the contact at the briefed range (after Meld)

2. Communicating sort responsibilities if required

**Second to Lock**

When sharing groups, the second to lock will sanitize and lock around the shared group, depending on the briefed game plan. If the plan is to sort the shared group, the second to lock sanitizes around the group and initiates the lock when a breakout occurs. The second to lock is responsible for sorting around the FTL so that both contacts are locked. Realize that all these are prebriefed responsibilities. Lead always has the hammer for directive targeting and sorting.

**Minimum Lock Range (MLR)**

When sharing a group, the second to lock sanitizes around the group and initiates a lock when the breakout occurs or at the MLR if a breakout is not available. MLR is the range when the second to lock will initiate a lock if a breakout of the formation is not available or FTL has not reported a "sorted" or "locked" call by that range. This lock will provide SA for the range and/or cranks, notches, and aborts**.**

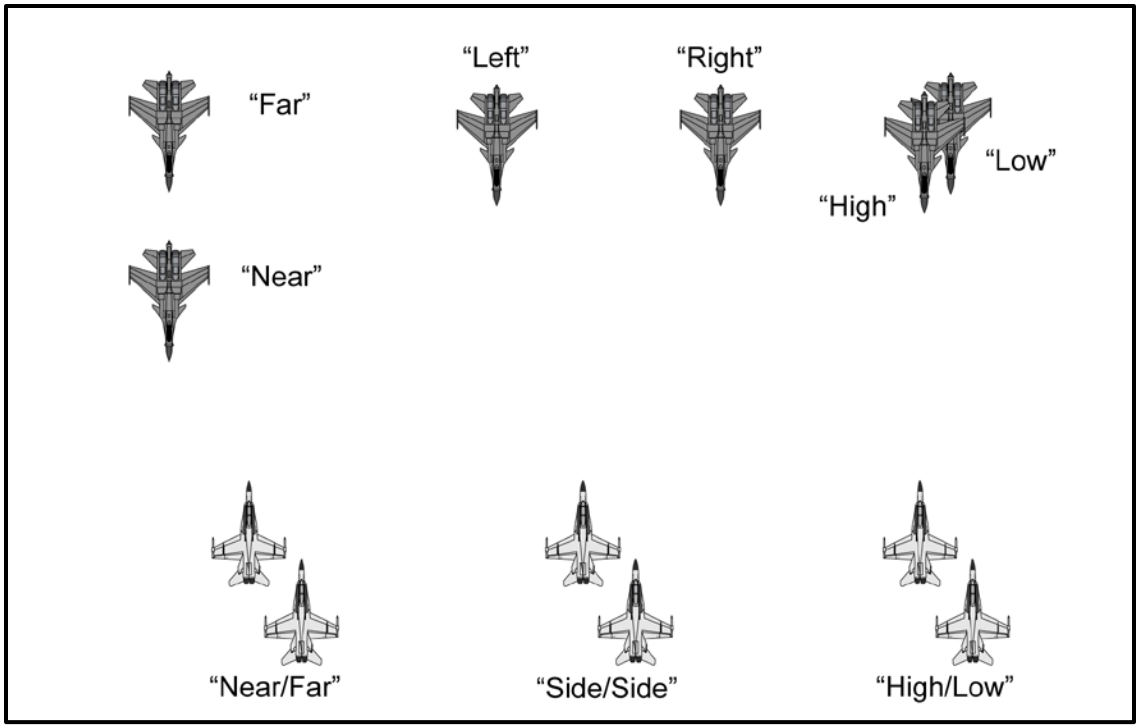


**Figure 19-5 Minimum Lock Range**

Shots are risk level, mission, weapons load, and altitude dependent. Weapons employment should be planned and briefed. Brief first to lock and second to lock, assuming that the first to lock will be the primary shooter (usually wing). This allows the wingman to have the simple task of locking, identifying the target, and shooting, while the more experienced flight lead has more time in search to analyze the bigger tactical picture and make the appropriate decisions. Modern radars are capable of telling you when your shots should hit their targets (time-out). In VT-86, you will need to keep track of your shot range and call your time-out on the radio at half of that range.

**Example:**

*"Eagle One, Fox-3 East Group, 18,000, crank West"*

*"Eagle One, time-out, East Group, 18,000"*

**Crank Execution**

A crank is a hard turn (4-5 Gs) executed as quickly as possible after the shot. You need to watch bandit maneuvers while maintaining the crank so as not to gimbal. In a flight situation, a crank in excess of 50° will cause the wingman (on the outside) to gimbal the targets unless the wingman flows to the inside. The objective of the crank is to decrease the bandit's WEZ and maximize your distance from the bandit when your missile hits.

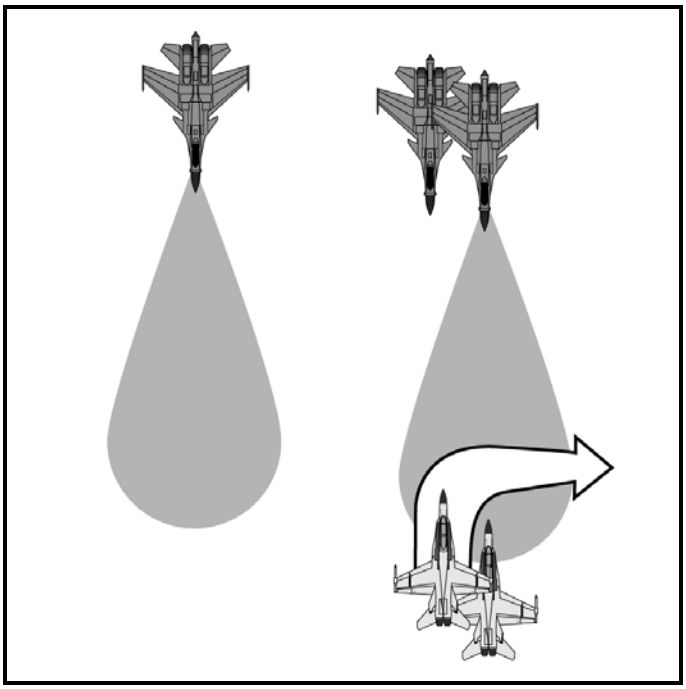

**Figure 19-6 Crank Execution**

Crank priorities are as follows.

1. Away from known threats (i.e., the other group, the next one you intend to target). If other threats are or may become a factor, crank away in order to isolate all the threats to one side, regardless of the TA of the group you are targeting (i.e., you may cross their nose).

2. Away from the nearest threat (i.e., the group you are targeting). Simply, turn 40 - 50° away from the vector stick or away from the TA displayed.

3. With the briefed flow/mutual support, large packages may have a briefed flow; therefore it would be in your best interest to follow it and not be shot by a trigger-happy striker. Otherwise, crank with your flight lead to maintain mutual support.

**Split**

This is guidance provided to the wingman. When the position/maneuvers of the target pulls a wingman away from their formation position, they must decide whether to leave formation or pass the target to AIC and maintain formation. Split criteria are generally briefed as a TA at a given range. Regardless, comm should be exchanged to increase all flight members' SA. The basic floating/split comm includes the following:

1. Floating - Target has reached 45° and you must turn to maintain radar SA.

2. Split - At the visual limits, request permission to leave formation to prosecute the attack.

Your flight lead should follow this with a "*press*" or "*negative*" call.

3. Crossing - Crossing lead's 6 o'clock to maintain radar SA/STT.

Bottom line: split to kill or split to live. Otherwise, stay together!

**Abort Decision**

Abort decision is based on the following criteria:

1. < 0/1/1 per fighter per contact

2. Untargeted contact within the targeted group

3. VID < 12 NM

4. Separation between groups ≤ 20 NM

5. Low SA

**Abort Execution**

The abort maneuver should be a maximum G, full A/B maneuver that results in a low altitude dash away from the threat. Maximum airspeed is mandatory in order to stay outside the threat's WEZ. The egress heading should be planned to enable you to get maximum separation from the threat while allowing you the opportunity to diverge from the threat's flight path. If the range and heading of the threat are available, you can quickly tell if the threat is following you or not. The crank and abort maneuvers should be considered jointly in that one can lead to the next and the performance during one affects the performance of the next one. Thus, your ability to survive an engagement in which you are spiked starts with your crank maneuver, followed by the notch maneuver and then the abort maneuver.

**Visual Arena**

For most game plans, the goal is to shoot and remain beyond visual range (BVR). However, some conditions/scenarios may require a merge. Denying the bandit a tally and acquiring your own tally is a huge advantage. Going blind or stripped is a possibility in this phase. Do not keep secrets. If you are "*blind*," call it. Call "*stripped*" if outside the briefed formation and are unable to tactically return to it.

**Merge**

At the merge, the possibility for Air Combat Maneuvering (ACM) engaged/supporting roles exists. Use proper comm to ensure a definite role for each fighter. If multiple bandits are alive, clearing your flight path and maintaining the visual tally of all players is imperative. It is important to keep the visual to avoid collisions with one another. A second consideration is the

flow to additional groups. Most likely, the supporting fighter is monitoring additional groups and will direct the flow to additional groups at the end of the engagement.

**Egress/Separation**

If a merge did take place, getting a quick separation is your number one priority when egressing a fight. Air-to-air engagements and fireballs tend to draw a crowd, especially in the large fighters such as the F-15E. You probably do not want to be there when more players arrive. The direction of the separation is secondary. Ideally, you would like to separate toward a friendly area, but that may not be feasible. So head "the same way, same day" and regroup. Always remember to change your altitude block when able. Then turn back to the friendly area as a flight. In case the flight separates, there needs to be a rendezvous plan. Also, consider your fuel and ordnance state when egressing a fight.

**Short Range Radar**

Anytime you clear a merge or come off target in an air-to-ground role, employ short-range radar mechanics to clear your flight path. Imagine building a bubble around your formation as you roll out on the new heading. Always work from near to far. In general, use ACM Slewable to your side of the formation, biased into your AOR. After you roll out, maintain your ACM Slewable in your AOR on your side of the formation for 10 seconds.

After 10 seconds, select a 40 mile scope, AZF, and acquisition symbols again at half your scope and sanitize in your AOR for 10 seconds.

Once the process has been completed, you can return to your briefed long-range search. If you are turning into a known threat, center your coverage on the threat's altitude. If you have good SA on a follow-on group (from AIC), then use the best radar setup to quickly acquire the follow-on after conducting SRR. Regardless, do not target the follow-on group until all FARM checks are complete.

## 1903. VT-86 PROCEDURES/SPECIFICS

Now that you have got a general familiarization of basic 2vX procedures, you are now ready for an overview of the flow and type of intercepts to expect at VT-86 and the specifics procedures we use. You are not required to develop your own game plan; we will provide one for you. You are free to make changes as you see fit to the brief/briefing guide/board/procedures etc.

**Intercept Overview**

2v2 and 2vX intercepts will begin with one student playing the role of the flight lead while the other student plays the role of the wingman. Lead responsibilities will be switched between runs. 2v2 intercepts will essentially be sorting exercises designed to practice the basic comm, pacing, and sorting skills. You will commit your section/2-ship against a group or groups consisting of two contacts. The intercept will begin at approximately 35-40 NM and allow you to commit, label, target, meld, sort/lock, shoot, crank, and time-out your shots. In most cases

(with good F-3/F-1 timeout calls), we will kill-remove one of the bandits, leaving one bandit alive for a merge or CT. The 2vX intercepts introduce an added level of complexity by presenting multiple groups. These intercepts will begin at approximately 40 NM, allowing the flight lead to make commit direction, lean/offset, and targeting decisions, as well as to manipulate the geometry and flow to the second group after killing the first group.

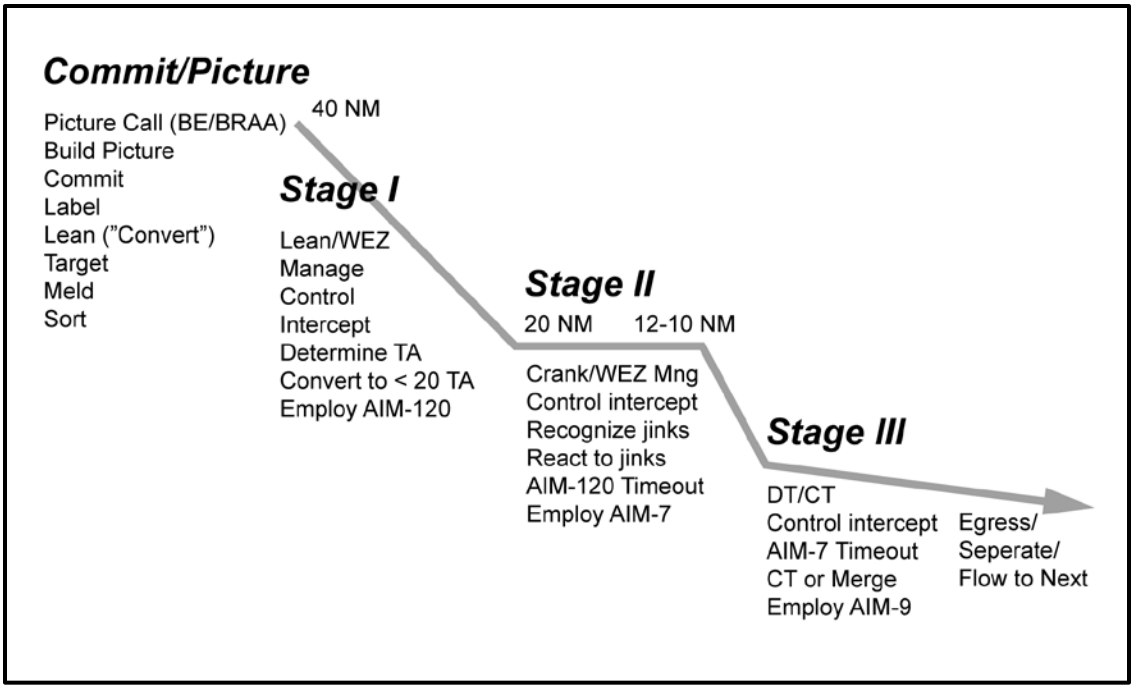


**Figure 19-7 Intercept Overview**

**Role**

Fighter assumes the Offensive Counter Air (OCA) role. Your role will not be Defensive Counter Air (DCA) or Interdiction! Your goal/mission is simply air superiority/dominance over a particular piece of airspace. You are not protecting a strike package, HVAA asset, or point on the ground.

**Threat**

All game plans must begin with an expected threat. All actions are based on the capabilities of this threat. To avoid classification issues, VT-86 does not use a real-world threat. Instead, all 2vX events assume a 10 NM Fox-1 equivalent shooter. This means that the enemy does not have an active missile.

**Mission/Training Objectives**

You will define the Mission/Training Objectives. There is a difference between the two. Mission objectives should be tactical objectives designed to meet your tactical goal of air

superiority. See examples below. Training objectives should include specific things that you personally (or as a team) want to improve or work on for this training mission. Start your first 2v2 simulator event with some basic comm, pacing, and radar objectives. Depending on how you improve, develop new training objectives for the next simulator. For instance, if you had 100% valid sorts for your first sim, but your mutual support broke down at the merge; tweak your training objectives for the next mission to focus on merge mechanics and lookout doctrine.

Mission Objectives: Should be measurable/realistic/fit mission scenario

1. Target all factor groups

2. No blue losses

Training Objectives: Should be what you are trying to learn/improve on

1. 100% good sorts

2. Excellent radar discipline/mechanics

3. 100% valid shots

4. No missed shot opportunities

5. Gameplan Execution

6. Clear/Correct/Concise/SA-building Comm ($C^3$ SA Comm)

**Recommended Radar Setup for VT-86**

Now that you have had a chance to review the thinking behind how you set-up your radar for 2vX employment, here are the recommended settings. Brief your planned set-up and be prepared to explain your reasoning.

Lead (1): Hi 15-25 K'
Wing (2): Lo 07-17 K'
Coverage = 3.45 x 30 x 100 = 10,350'
80 NM scope.
1 BR / MN / DB - ON / BLK - N
AZF as SA dictates possibly AZ3.
Peeking 25% of time searching is allowed (Not recommended, especially for the wingman since he has the low look, and that is the AOR that almost all pop-up threats will come from. Peeking is allowed, but should be avoided with good comm, pacing, and SA.)
Back up search increments w/ SAD to set coverage.
Do not lock immediately after BRAA call. Wait for meld call.
Place acquisition gates at Meld Range (30 NM) centered on BRAA call.

**Precommit Phase**

Your first priority prior to the commit is comm. Listen! GCI will begin by describing the picture using Broadcast Control Digital Bullseye (BE) Format. This means they will describe the picture in very general terms, not in relation to any flight of fighters in particular. You might also hear Tactical Control BE or BRAA.

BCDB: Broadcast Control Digital Bullseye (Re: all)
Prior to commit MAY include geographic labels

*"Sweep, Gritrock. Picture, group Vegas 200/20, low, maneuver. Group, Vegas 110/15, high, maneuver."*

TCDB: Tactical Control Digital Bullseye (Re: you)
Usually after commit. Should include geo or tactical labels

*"Sweep, Gritrock. Picture: 2 groups, azimuth 20, West group, Vegas 200/20, low, hot. East group, medium, flank southeast."*

TBRA: Tactical BRAA (Post commit BRAA)
Usually NLT meld. Includes geo or tact labels / MAY include Alt Est

*"Sweep, Gritrock. Picture: 2 groups, AZ 20, West group BRAA 350/40, hits 10, hot south East group BRAA 025/46, hits 22, flank southeast."*

Listen to what they are saying. Copy down the information, and accurately plot the picture on your BE Card (Spider Card - USN/USMC). This is extremely important, since it will determine the later stages of your intercept. Your commit direction (L or R) depends on accurately plotting the picture described. You will also make your lean/offset decision based on this, as well as your crank direction post-F-3.

**Post – Initial Picture Call**

AIC can include labels in their initial picture call or they may use a blanket BCDB. The first call you make should be the Commit Call, and the next should most likely be the Targeting Call. You can also use this initial call to start your initial lean or offset. Remember, you do not need the bogies on the scope to make these tactical decisions or comm calls. A sample call incorporating all of the information discussed might sound like:

*"Rage, Right HAP. Gritrock, Rage commit."*

*"Rage target West Group, Gritrock, Monitor East Group. Rage, steady 330."*

**Commit**

You will brief the criteria you will be using to commit. At VT-86 this is the same criteria from the 1v1 game plan. Regardless of how you define your commit criteria, it must be applied using

common sense. Keep in mind that your controller may recommend a commit, but the flight lead is the ultimate authority in deciding if your flight/section will commit against the threat. The commit call should sound like:

*"Rage 2, commit"*

**Picture Building**

After the commit decision, the picture will be built. Expect the fighter with the most SA on the contacts to build the picture. It is also possible that the controller will build the picture. Expect VT-86 pictures to be somewhat simplistic to allow for easier targeting decisions. The pictures will generally be either Azimuth or Range presentations; although you can expect some bandit maneuvers to develop into these (e.g., a single heavy group separates into 2 groups in range). Here is some sample comm:

*"Rage 1, two groups range 25. Lead group: Bullseye 180/35, Medium, Hot, Trial group, Low, Hot"*

**Targeting Game Plan**

You will brief a targeting game plan using the picture below to help describe the possibilities and your planned course of action for each. In general, the closest, hottest group is the one that should be targeted first. Another way to think of it is the group that can kill you first needs to be targeted first.

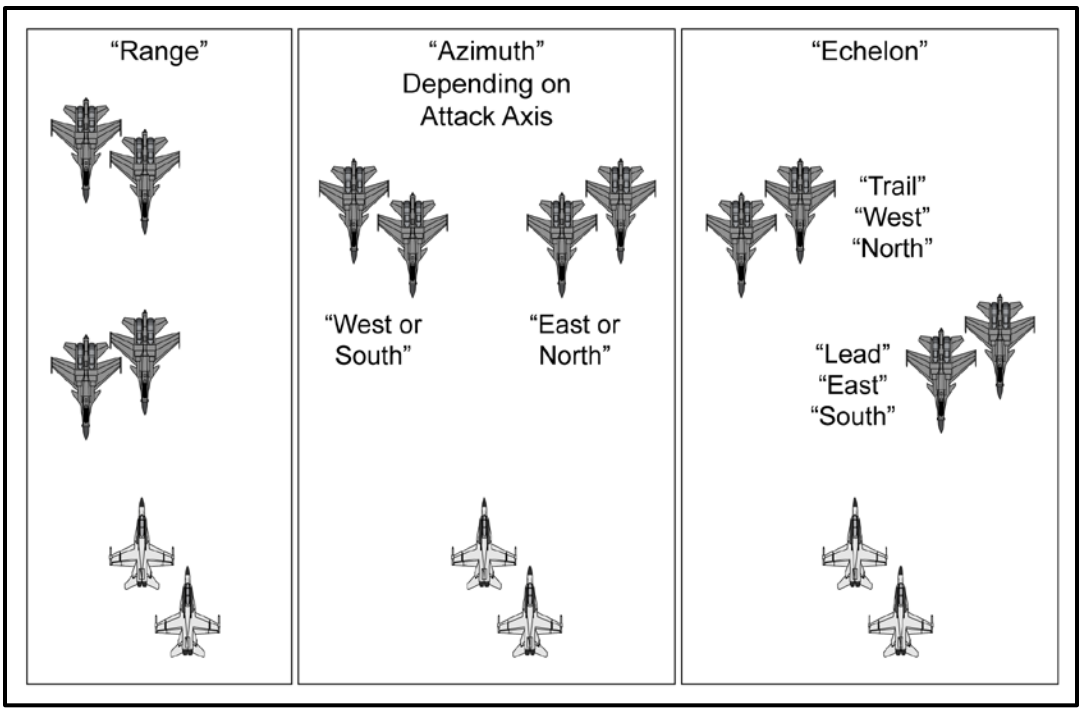


**Figure 19-8 Targeting Game Plan**

The flight will target the most threatening group first and pass the other group to GCI to monitor. After killing the first group, the fighters will decide if they can target the follow-on group. If the groups are equal in proximity, then the highest group might be the most threatening. If both groups are close in altitude, then the hottest group might be the most threatening. For example, fighters are at Bullseye 180/69.

*"Picture, group Bullseye 210/28 medium track south, group Bullseye 150/28 medium flank southeast."*

One group is hot south while the other is flanking southeast. In this case, both groups are the same in both range and azimuth, but one is pointed more directly at the fighters.

After committing and AIC labels and names the picture, the targeting call would sound like:

*"Rage target west group, Gritrock monitor east group."*

Each of the following examples introduces a similar type of threat to your safety. It is possible the second group can kill you while you're still prosecuting the first group. This threat is primarily a function of the distance between the two groups.

**Example 1:**

Two groups range 10 NM. There are two groups with 10 NM range between them. You can target the first group, fire your F-3s at 20 NM and expect to be at 10 NM from the first group and 20 NM from the second group when these F-3s time out. If these shots get trashed, you will be firing F-1s at approximately 10 NM. The second group will be approximately 20 NM away from you when you take these shots and only 10 NM away when you merge with the first group. This puts you at a disadvantage against the second group. This will cost you the F-3 shot. Also, it can cause you to shoot your F-1s later than the second groups of bandits shoot their radar missiles. This puts your flight in a bad position and is considered unacceptable.

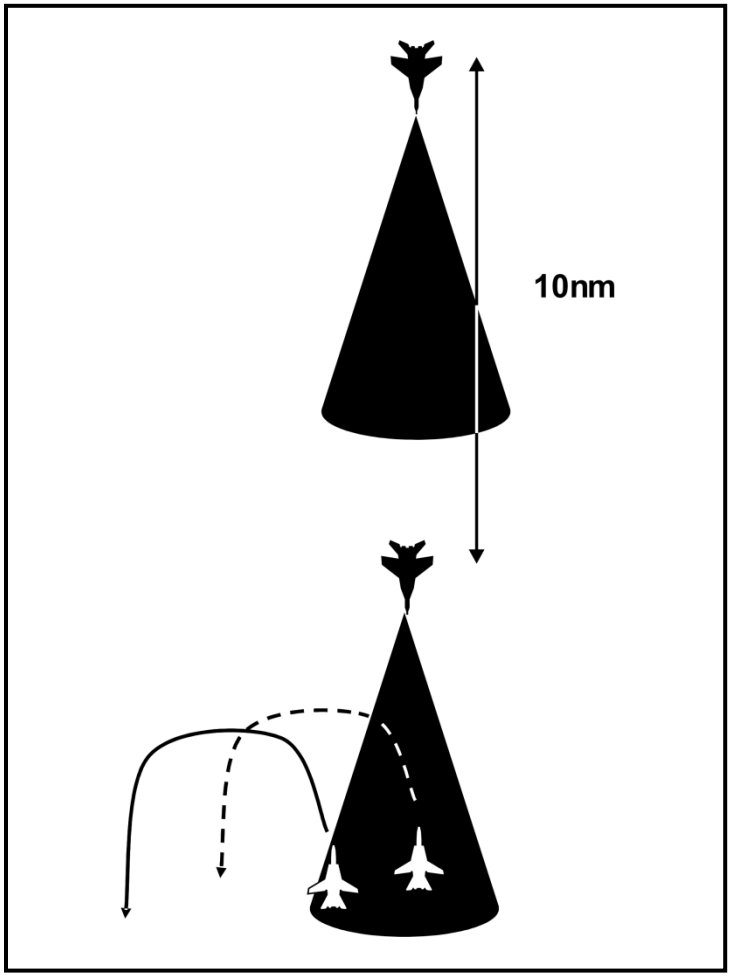


**Figure 19-9 Two Groups – Range 10 NM**

**Example 2:**

"Two groups range 20." There are two groups with 20 NM range between them. You can target the first group, fire your F-3s at 20 NM and expect to be at 10 NM from the first group when those shots time out. If these shots get trashed, you will be firing F-1s at approximately 10 NM. The second group will be approximately 30 NM away from you when you take these shots and 20 NM away when you merge with the first group. Assuming everything goes as planned and either your F-3s or F-1s are successful against the first group, you will still have an opportunity to fire F-3s at the second group at 20 NM.

This example is meant to help you understand the importance of First Launch Opportunity (FLO). You can assume that all missiles travel at the same speed and that the missile that is fired first will arrive first. Therefore, it is undesirable to go into a fight without FLO. As shown in Figure 19-9, in many cases FLO against the second group can be predicted based on the distance between the two groups at set-up.

In VT-86 you will use 20 NM as the minimum range between groups that is acceptable to continue the intercept (this concept is called Factor Bandit Range). If you have less than 20 NM between groups in range, you should consider it unacceptable due to flow problems (for your two-ship without multi-targeting capability) and abort.

**Echelon Presentation**

An echelon presentation is very similar in that you want to have at least 20 NM between groups to preserve FLO. An aggressive offset can help you convert it to a pure range problem and maximize the range between the two groups. This gives you more time to reset your radars and sort into the second group before F-3 range.

**Azimuth Presentations**

Azimuth presentations are the most difficult of the basic presentations that we will be addressing. The difficulty lies in determining the range of second group from you while you are targeting the first group. This is purely a function of geometry. If your section proceeds directly towards the azimuth presentation, you can expect them to be equidistant while you are targeting them. This inevitably results in a losing situation against one of the two groups.

The correct way to target groups in azimuth is to offset outside the closer of the two of them, maximizing your distance from the second group, while prosecuting the first. Essentially trying to turn your azimuth problem into a range presentation. This requires an early, aggressive offset and usually about 30 NM between the two groups. Anything less may put the second group in a position to threaten you before you are done with the first.

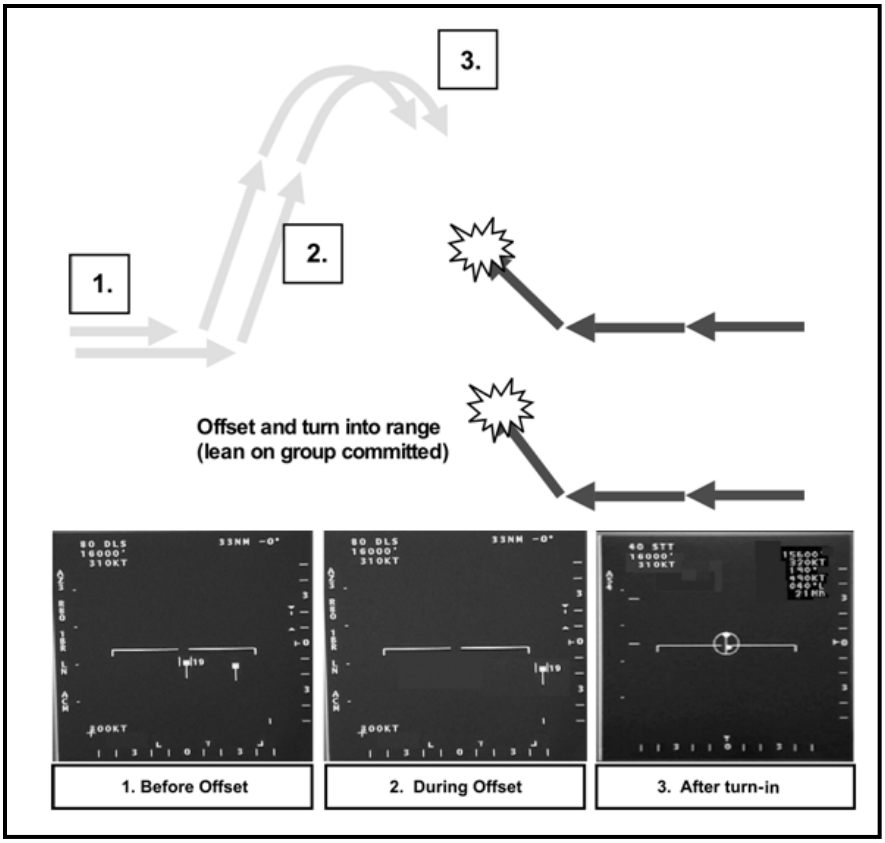


**Figure 19-10 Before Offset, During Offset and After Turn-in**

**Meld**

The Meld is simply putting both radars in the same piece of sky after a good sanitization of each AOR. Wingman may call meld if the picture falls in wing's AOR and they assume tactical control until sort. If the wingman does call the meld, they should expect to call the sort also unless lead quickly sees the picture and calls for the sort first. Regardless of who makes the call, priority is always execution on timeline.

**Meld Mechanics:** 40 NM scope, AZ3, ACQ gates 1 – 2 NM in front of called range, use the SAD to center the altitude coverage at the appropriate elevation.

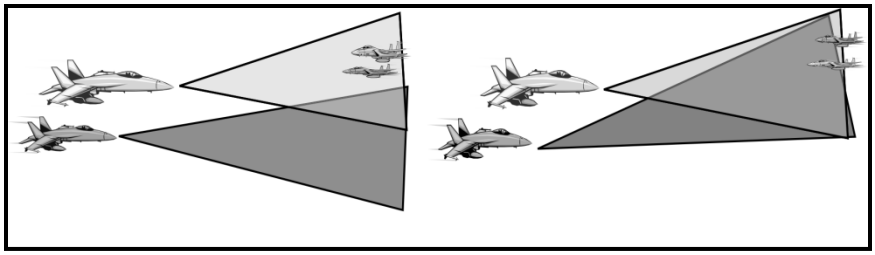

**Figure 19-11 Meld Mechanics**

**Meld Comm**

Directive meld comm with BRAA, Alt and sort contract

Example Meld Comm: *"Rage, meld, 350/30, hits 21, side/side"*

**Sorting Specifics**

The sort plan will be briefed. In general, for AF, you take the bandit that corresponds to your flight position. For example, wingman on the left takes the bandit on the left. Lead will take leaders or high, the wingman takes trailers or low. Navy and Marines tend to use a standard game plan. The flight lead will sort left, near, and high, leaving the wingman with right, far, and low. Either plan is fine as long as execution matches the brief. For VT-86 purposes (simplicity) and simulator limitations (no easy visual), use the following game plan: Lead sorts Near / Left / High; Wing sorts Right / Far / Low. Brief sort priorities according to which bandit may be the highest threat: 1) Near-Far, 2) Side-Side, 3) High-Low.

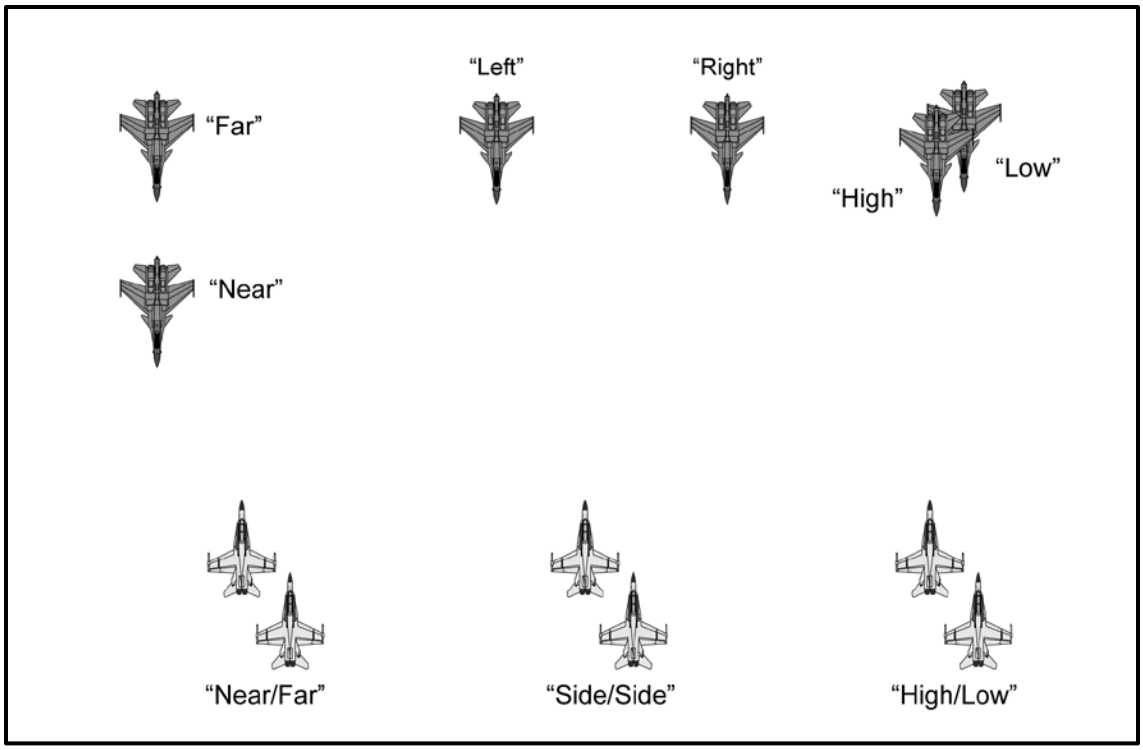


**Figure 19-12 Sorting**

Remember, you are not sorted until after you have a good lock! So you cannot make your sorted call before you lock your bandit. Also, as First-to-Lock (FTL) if you are not 100% sure which bandit you locked, call "*locked*" instead of "*sorted.*" Calling "*sorted*" implies you are 100% sure of who you locked.

**Example:**

*"Rage 2, sorted, right, eleven thousand"* If you are absolutely sure.
*"Rage 2, locked, eleven thousand"*

If you are not sure if you locked the right or left.

There is no such call as: "*Rage 2, locked, far eleven thousand*." It implies a sort was made. Using the term "*locked"* allows the Second-to-Lock fighter (should be flight lead) to sort around his wingman and achieve a good sort, regardless of the situation.

**No Sort**

A no sort situation exists only when there is one radar contact on scope after meld. Sometimes there may only be one radar contact that shows up at meld range. There are two reasons for this: first, there may only be one contact, second, there are two airplanes that are flying to close together and the radar can not break them out, so it just shows one contact. In either situation the meld call would be made just with an altitude and Rage 2 would need to call "Locked" with an altitude. Rage 1 would assume second to lock responsibilities and maintain a free radar (stay in search).

**Example**:

*"Rage meld BRAA 360/30, hits 18"*
*"Rage 2 Locked eighteen thousand"* at 25 NM
*"Rage 2 Fox 3 eighteen thousand"*

**Post-Sort / Shots**

The F-3 shot, crank, collision, F-1, and merge/CT will be very similar to what you have seen up to now in the advanced portion of the syllabus. Therefore, they will not be addressed in more detail here. However, comm brevity (LABELS!) may be used instead of full BRAA calls. Recommend using at least one discriminator (usually altitude, since bogies in VT-86 will usually be at different altitudes).

**Example:**

*"Rage 2, Fox 3, West Group, eleven thousand"*

is better/easier/faster than:

*"Rage 2, Fox 3, BRAA 350/22, eleven thousand"*

**Cranks**

As previously discussed, the crank is a WEZ denial maneuver. Therefore, an aggressive crank post F-3 is required until F-1 range. Use a crank to manage the WEZ on the targeted group and create desired flow for any follow-on groups. Call the crank with your shot call:

*"Rage 1, Fox-3, Lead Group, 18K, Crank West, Reference 310"*

Once you are steady, reference a heading. As wing, call Gimbals if you are about to lose the bogey off the scope. The wing's job is to maintain formation without losing radar contact. Do not let TA grow out of F-1 LAR! Go to collision if TA begins to approach 40.

**Kills / Lead Changes**

There is a possibility that one of the bandits may be killed by your all-powerful AMRAAM. If this is the case, you will hear "*fireball*" or see the contact disappear off the scope after your timeout call or at timeout range. It is important to determine what to do with the free radar once the kill has been made. Recommended priorities are:

1. Prosecute the closest, hottest threat (probably backing up your wingman)

2. Locate/monitor the next threat/group

In order to execute these priorities, you will need to know where your wingman's remaining live contact is. You will get this info from your wingman in one of two ways; either your wingman will hear your kill call and give you a BRAA call to his contact, or, if he fails to volunteer the info, you will need to request it directly. Following any kill call, the engaged fighter should strive to make an immediate engaged call with a BRAA to allow the free fighter to support them. If you determine that your priority is finding the next threat, request the information from the controller. If the flight lead kills his contact and the wingman's contact is still alive, the wingman will very likely need to take the tactical lead. This will allow him to maneuver appropriately in order to kill his bandit while the flight lead assumes the deconfliction for the element.

This lead change should be effected in following manner:

"*Rage 1, Kill, West Group, thirteen thousand*"
"*Rage 2, Engaged BRAA 345-9, 11K"*

or

*"Rage 2, Engaged ten right nine miles, 11K"*
*"Rage 1, Press."* (from Rage 1)

The engaged call tells the flight lead that Rage 2 cannot continue to support the flight lead (maintain formation position/deconfliction) *and* kill his bandit. The Press call from the flight

lead relieves Rage 2 of the wingman responsibilities and obligates Rage 1 to pick up a supporting role if possible. If Rage 1 is still prosecuting his bandit at this time, expect the formation to split and rejoin after the kills. Remember: split to kill, split to live. After the engagement is complete, while in VT-86 you will assume that Rage 1 is the flight lead again. Rage 1 can take back the lead at any time with a simple call: "*Rage 1 has the lead*."

**Abort Decisions**

There may be situations when it is not tactically smart to continue the fight, i.e., the fighters are in a "losing" situation or not in an advantageous position to kill and survive. These situations might include: less 20 NM separation between factor bandit groups, fighters are outnumbered or number of bandits is unknown, radar issues/heavy jamming (cannot employ ordnance), loss of SA, no sort, and/or no shots + spiked. This is a classic "losing" situation. The bottom line is: abort if you are unable to flow offensively from one group to the next group. As a rule, if there is not 20 NM between groups by Fox-1 range, then do not shoot your Fox 1 and do not attempt a CT. At 15 NM, ask GCI for "separation" to get the current range between groups. Between 15 and 10 NM from the nearest group, the fighter must assess the range between groups and decide to continue the current intercept and attempt to flow offensively to the follow-on group, or abort the current intercept to ensure survival. Make this decision by Fox-1 range to nearest group (12-10 NM) but no later than 10 NM! If you have shot your F-3, remember to make your F-3 timeout calls before the abort execution to possibly attrite one of the bandits. This will make your job easier at the recommit. VT-86: At Fox 1 range to original group, 20 NM to the next hot bogey allows fighter to employ (at a minimum) a Fox-1 into the follow-on group after radar acquisition and lock.

## 1904. DEBRIEF BASICS

You will be asked to debrief some of intercepts during your simulator events. There are some differences among the services. Cater to your audience or service specifics. Here are some basics. The rest will be covered in class and in your sims.

1. Start by recalling the initial picture given by Gritrock.

2. Cover all shots taken at the appropriate time including wingman's.

3. At the end of the debrief, cover each Mission and Training objective and summarize whether or not each one was met during the run.

## 1905. SIMULATOR SETUP

Ideally scheduled in twos (two instructors, two students, two sims) but can be done with a ghost wingman if necessary.

1. Select "Network" at the two stations (side by side best)

2. Host select "Master"

3. Linked select “Slave,” “Group X”

4. (X = Master Sim #)

5. Use Master to hotspot/control master and bogies

6. Start:

7. Select “Run OS” on slave

8. Select “Run” on master

9. Terminate/review – Normal operation from master sim.

10. Subsequent setups – Do not use randomize

11. Rewind, reposition, and “Run” on the master

12. Or “Exit” and setup again

13. Use visible yes/no on the target page to kill/remove bogey

**1906. COMM SETUP**

1. Hang-up all connections

2. All players select the same number (either master or slave sim number)

3. Do not select IOS/STS

**1907. COMM RECAP**

**GROUP:** A single contact or multiple contacts inside the VT-86 altitude and range constraints of 5 NM and 5000 feet.

**CONTACT:** A single aircraft inside a group.

**LEAD/TRAIL GROUP:** A descriptive term referring to a single group in a multi-group range or echelon presentation.

**NORTH/SOUTH/EAST/WEST GROUP:** A descriptive term referring to the location of a single group in a multi-group presentation.

**NEAR/FAR:** A descriptive term referring to 2 or more contacts inside a group separated by range when sorting.

**NORTHERN/SOUTHERN/EASTERN/WESTERN:** A descriptive term referring to the location of a contact inside a group when sorting

**HITS:** A descriptive term referring to the altitude where a group or contact is showing up in a search mode. Could be a specific altitude or an altitude block (i.e., Low, Medium, High)

**TARGET:** A directive call ordering a fighter to prosecute a specific group and to kill all contacts in the group.

**MELD:** A directive call ordering fighter in a section (two-ship) to bracket their radar altitude coverage around a specific altitude called by the flight lead.

**SORT:** A directive call ordering fighters to lock the appropriate contact inside of a group according to the sort contract

**MANEUVERING:** A descriptive AIC term letting the fighter know a bogey is changing heading or altitude. Further descriptive comm. (i.e., direction) should be provided as the picture develops.

**HOT:** A descriptive term refers to a group or contact maneuvering at a TA between 20 and 0 relative to the fighter.

**BEAMING:** A descriptive term refers to a group or contact maneuvering at a TA between 70 and 110 relative to the fighter.

**FLANKING:** A descriptive term refers to a group or contact maneuvering at a TA between 30 and 60 relative to the fighter.

**DRAGGING:** A descriptive term refers to a group or contact maneuvering at a TA between 120 and 180 relative to the fighter.

**CRANKING:** Fighter's maneuver in relation to the bogey 30-60 AO.

**NOTCHING:** Fighter's maneuver in relation to the bogey 70-110 AO.

**OUT:** Fighter's maneuver in relation to the bogey > 110 AO.

**COLD:** A descriptive term refers to a group or contact maneuvering at a TA between 160 and 180 relative to the fighter.

**LEAKERS:** A descriptive call used to inform AIC a contact is now outside of intercept parameters (i.e., a very cold counterturn ends up in a tail chase or a bandit blew past us at a merge).

**CLEAN:** A descriptive term to inform that radar area of responsibility is sanitized.

**GREEN:** A descriptive term refers to the direction the fighter must head in order to move away from threats.

## 1908. FINAL WORDS

Finally, 2vX events are challenging, but fun. There is a tremendous amount of material to absorb, but do not overthink this. There is new information, comm requirements, and procedures, but the vast majority of the new stuff is at range (> 25 NM). Once inside 25 NM, your job is to kill your assigned bandit.

There are four basic keys to success in 2vX intercepts.

1. Comm, Comm, Comm!
    a. New Communication/Calls/Terminology
    b. Cadence (AIC, -1, -2)
    c. Listening is just as important as talking!
2. Radar Mechanics and Discipline
    a. Search AOR
    b. Meld/Sort Mechanics
    c. Short Range Radar and ACM Usage
3. New Pacing and Timeline
    a. Pre-Meld Timeline
    b. 15NM Separation
    c. Abort Decision
4. Mutual Support
    a. Kill-Engaged-Press Calls
    b. Backing Up Comm
    c. Tactical Decision Making

Congratulations for making it to the end of Strike Fighter. This is the most difficult, most complicated, most tactical, most real world, most directly applicable, and by far the most fun portion of the Strike Fighter Syllabus. Your efforts to become fluent in these procedures and communications will directly affect how well prepared you are for your RAG/FTU. Show up for SS-1 with a copy of the 2vX briefing guide and ensure you have all of your questions about the brief, execution, and debrief answered before you leave. Good luck and FIGHT'S ON!!!

**This page reserved for Notes**

*"Rules are made for people who aren't willing to make up their own."*

General Chuck Yeager, USAF

*"And I have yet to find one single individual who has attained conspicuous success in bringing down enemy airplanes who can be said to be spoiled either by his successes or by the generous congratulations of his comrades. If he were capable of being spoiled he would not have had the character to have won continuous victories, for the smallest amount of vanity is fatal in airplane fighting. Self-distrust rather is the quality to which many a pilot owes his protracted existence."*

Captain Edward V. 'Eddie' Rickenbacker, USAS, 'Fighting the Flying Circus.'

*"There is a peculiar gratification on receiving congratulations from one's squadron for a victory in the air. It is worth more to a pilot than the applause of the whole outside world. It means that one has won the confidence of men who share the misgivings, the aspirations, the trials and the dangers of airplane fighting."*

Captain Edward V. 'Eddie' Rickenbacker, USAS.

*The important thing in airplanes is that they shall be speedy.*

Baron Manfred Von Richthofen

*"I started shooting when I was much too far away. That was merely a trick of mine. I did not mean so much as to hit him as to frighten him, and I succeeded in catching him. He began flying curves and this enabled me to draw near."*

Baron Manfred von Richthofen

# APPENDIX A
# GLOSSARY

**A100. N/A**

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# APPENDIX B
# ACRONYMS

## B100. ACRONYMS

| | |
|---|---|
| A/A | Air-to-Air |
| A/G | Air-to-Ground |
| AAA | Anti-Aircraft Artillery |
| AGL | Above Ground Level |
| AGM | Air-to-Ground Missile |
| AI | Air Interdiction/Air Intercept |
| AIC | Air Intercept Control |
| AIM | Air Intercept Missile |
| AM | Amplitude Modulation |
| AO | Angle Off |
| ARM | Anti-Radiation Missile |
| ATO | Air Tasking Order |
| AWACS | Airborne Warning and Control System |
| BRAA | Bearing, Range, Altitude, Aspect |
| BVR | Beyond Visual Range |
| C2 | Command and Control |
| CAP | Combat Air Patrol |
| EMCON | Emission Control |
| EO | Electro-Optical |
| FAC-(A) | Forward Air Controller-(Airborne) |
| FM | Frequency Modulation |
| GCI | Ground Controlled Intercept |
| HARM | High-Speed Anti-Radiation Missile |
| HF | High Frequency |
| HIGH-G | High Gravity |
| HPRF | High Pulse Repetition Frequency |
| ID | Identification |
| IFF | Identification, Friend or Foe |
| IR | Infrared |
| LOS | Line of Sight |
| MPRF | Medium Pulse Repetition Frequency |
| MSL | Mean Sea Level |
| NM | Nautical Mile |
| PRF | Pulse Repetition Frequency |
| ROE | Rules of Engagement |
| RWR | Radar Warning Receiver |
| S/A | Surface to Air |
| SAM | Surface-to-Air Missile |
| SEAD | Suppression of Enemy Air Defenses |
| VHF | Very High Frequency |

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# APPENDIX C
# MULTI-SERVICE TACTICAL BREVITY CODES

## C100. MULTI-SERVICE TACTICAL BREVITY CODES

| | |
|---|---|
| Abort(ing)(ed) | Directive/informative to cease action/attack/event/mission |
| Action | Directive to initiate a brief attack sequence or maneuver |
| Active | An emitter is radiating |
| Alpha Check | Request for/confirmation of ownship bearing and range to described point |
| Anchor(ed) | 1. Orbit about a specific point; reference point flown by tanker<br>2. Informative to indicate a turning engagement about a specific location |
| Angels | Altitude of friendly aircraft in thousands of feet MSL |
| Azimuth | Two or more groups separated laterally in bearing |
| Bandit | A positively identified enemy aircraft. The term is a function of identification and does not necessarily imply direction or authority to engage. |
| Beam(ing) | Target maneuvering stabilized within 70 to 110 degrees aspect; generally given with cardinal directions; east, west, north, or south |
| Bent | System indicated is inoperative |
| Bingo | Prebriefed fuel state which is needed for recovery using prebriefed parameters |
| Bird | Friendly surface-to-air missile (SAM) |
| Bittersweet | Notification of possible BLUE ON BLUE situation relative to a designated track or friendly aircraft |
| Blind | No visual contact with friendly aircraft/ground position. Opposite of Visual. |
| Blow Through | Directive/informative call that indicates aircraft will continue straight ahead at the merge and not turn with target/targets |
| Bogey | An unidentified air contact |

| | |
|---|---|
| Bogey Dope | Request for target information as requested or for the closest group in BRAA |
| BRAA | Format of tactical control providing target bearing, range, altitude, and aspect from fighter |
| Bracket | Indicates geometry where friendly aircraft will maneuver to a position on opposing sides, either laterally or vertically from the target |
| Break (direction) | Directive to perform an immediate maximum performance turn in the direction indicated. Assume a defensive situation. |
| Broke Lock | Loss of radar/IR lockon (advisory) |
| Buddy Lock | Locked to a known friendly aircraft |
| Bugout (direction) | Separation from that particular engagement/attack/operation; no intent to re-engage/return |
| Bullseye | An established point from which the position of an object can be referenced by bearing and range. |
| Buster | Directive call to fly a max continuous speed (military power) |
| CAP/Capping | 1. Directive call to establish an orbit at a specified location<br>2. An orbit at a specified location |
| Capture | Aircrew has identified and is able to track a specified A/G target with an onboard sensor |
| Cease Engagement | In air defense, break the engagement on the target specified and prepare to engage another target. Missiles in flight will continue to intercept. |
| Cease Fire | Do not open fire, or discontinue firing; missiles in flight are allowed to continue to intercept; continue to track |
| Chattermark | Begin using briefed radio procedures to counter communications jamming |
| Check (Left/Right) | Turn degrees left or right and maintain new heading |
| Cherubs | Altitude of a friendly aircraft in hundreds of feet above surface (usually refers to helicopter traffic) |
| Chicks | Admin term used to denote friendly aircraft |

| | |
|---|---|
| Clean | 1. No radar contacts on bandits, bogies or aircraft of interest<br>2. No visible battle damage |
| Cleared | Requested action is authorized (no engaged/support role are assumed) |
| Cleared Hot | Ordnance release is authorized |
| Closing | Decreasing in range/separation |
| Cold | 1. Attack geometry will result in a pass or roll out behind the target<br>2. On a leg of the CAP pointed away from the anticipated threats<br>3. Threat group heading away from fighters |
| Comeoff | (Left-Right/Low-High) Directive to maneuver as indicated to either might regain mutual support or to deconflict flight paths for an exchange of engaged and supporting roles. Implies both “visual” and “tally.” |
| Commit(ted) | Fighter intent to engage/intercept groups of interest |
| Cons/Conning | Unknown/non-friendly aircraft leaving contrails |
| Contact | 1. Sensor contact at the stated position<br>2. Acknowledges sighting of a specified reference point |
| Continue | Continue present maneuver, does not imply clearance to engage or expend ordnance |
| Crank | Maneuver to put target at gimbal limits to manage target weapons envelope |
| Cutoff | Request for, or directive to intercept using cutoff geometry |
| Dash(#) | Aircraft position within a flight. Use if specific callsign is unknown. |
| Deadeye | Informative call by the laser designator indicating the laser/IR system is inoperative |
| Declare | Inquiry as to the ID of a correlated group, a specific track, or target |
| Defensive | (Spiked/Missile/SAM/Mud/AAA) Aircraft is in a defensive position and maneuvering with reference to the stated condition and unable to ensure deconfliction of mutual support. |
| Divert | Proceed to alternate base |

| | |
|---|---|
| Drag(ing) | 1. (AF) Target maneuvering to 0-60 degree aspect<br>2. (NAVAL) Target maneuvering to 120-180 degree aspect |
| Drop(ing) | Directive/informative to stop monitoring a specified emitter/target and resume search responsibilities |
| Echelon | Fill-in to a picture label describing groups aligned behind and to the side of the closet group. |
| Engaged | Maneuvering with the intent to kill. If no additional information is provided (bearing, range, etc.) this implies visual/radar acquisition of target |
| Estimate | Estimate of size, range, height or other parameter of a specified contact; implies degradation |
| Extended | Short term maneuver to gain energy, distance or separation; normally with the intent of re-engaging |
| Eyeball | Fighter with primary visual identification responsibility |
| Faded | Radar contact is lost on unknown/non-friendly contact |
| Father | TACAN station |
| Feet Wet/Dry | Flying over water/land |
| Fence (In/Out) | Set cockpit switches as appropriate prior to entering/exiting the combat area |
| Fireball | Visual confirmation an air to air contact has been destroyed |
| Flank(ing) | 1. (USAF) Target with a stable AA of 120-150 degree<br>2. (NAVAL) Target with stable aspect of 30-60 degree |
| Flash | Temporarily torn on prebriefed IFF mode or system |
| Float | Directive/informative to expand the formation laterally within visual limits to maintain a radar contact or prepare for defensive response |
| Fox(number) | Simulated/actual launch of air-to-air weapons<br>ONE- semi-active radar-guided missile<br>TWO- Infrared-guided missile<br>THREE- active radar-guided missile |

| | |
|---|---|
| Friendly | A positively identified friendly contact |
| Furball | A turning fight involving multiple aircraft; non-friendly and friendly aircraft are in close proximity |
| Gadget | Radar or emitter equipment |
| Gimbal | Radar target is approaching azimuth or elevation limits |
| Gorilla | Large force of indeterminate numbers and formation |
| Green | A descriptive term referring to the direction the fighter must head in order to move away from threats |
| Group | Radar targets within 3 NM in azimuth and range of each other |
| Guns | An air-to-air or air-to-surface gunshot |
| Hard (Direction) | High-G, energy sustaining turn in direction called |
| Head/Head On | 1. (USAF) Target with an aspect of 160-180 degrees<br>2. (NAVAL) target with an aspect of 0-20 degrees |
| Heads Up | Alert of an activity of interest |
| Heavy | A group known to contain three or more contacts |
| Hit(s) | 1. (A/A) Radar return in search with altitude reference<br>2. (A/G) Weapons impact within lethal distance |
| Holding Hands | Aircraft in visual formation |
| Hold Fire | An emergency fire control order used to stop firing on a designated target, to include destruction of any missiles in flight |
| Home Plate | Home airfield or carrier |
| Hostile | A contact positively identified as enemy in accordance with theater rules of engagement and may be engaged with a clear field of fire |
| Hot | 1. Attack geometry will result in roll out in front of the target<br>2. On a leg of the CAP pointing towards the anticipated threats<br>3. Threat group heading towards fighters. Opposite of Cold Navy: 0 - 20 Aspect |

| | |
|---|---|
| | 4. Ordnance employment intended or completed<br>5. Defined area is expected to receive fire |
| Hotdog | Informative/directive call that an aircraft is approaching or at a specified stand-off distance from the sovereign airspace of a nation (as defined by national boundaries or territorial sea and airspace) (COLOR may indicate additional standoff distance) Follow briefed procedures |
| I.D. | 1. Directive to identify the target<br>2. I.D. accomplished followed by type |
| In | (Direction) Informative indication a turn to a hot aspect relative to a threat/target |
| India | Mode IV IFF |
| Jink | Unpredictable maneuvers to negate a gun tracking solution |
| Joker | Fuel state above Bingo at which separation/ bugout/event termination should begin |
| Judy | Aircrew has radar/visual contact on the correct target, has taken control of the intercept, and only requires situation awareness information Controller will minimize radio transmissions |
| Kill | 1. Clearance to fire<br>2. In training, a fighter call to indicate kill criteria have been fulfilled |
| Knock It Off | Directive to cease all phases of air combat maneuvers/attack/exercise activities |
| Ladder | Three or more groups/contacts in range |
| Laser On | Start/acknowledge laser designation |
| Lead/Trail | A descriptive term referring to a single **group** in a multi-group range or echelon presentation |
| Leaker(s) | Airborne threat has passed through a defensive layer. Call should include amplifying information. |
| Line Abreast | Two contacts within a group side-by-side |
| Locked | (BRAA/Direction) Final radar lock-on; sort is not assumed |
| Magnum | Launch of friendly antiradiation missile |

| | |
|---|---|
| Mapping | Multi-function radar in an A/G mode |
| Marking | Friendly aircraft leaving contrails |
| Marshal(ing) | Establish(ed) at a specific point |
| Merge(merged plot) | 1. Information that friendlies and targets arrived in the same visual arena<br>2. Call indication radar returns have come together and bearing and range information will be unavailable until aircraft separation is achieved |
| Monitor | Maintain radar awareness on or assume responsibility for specific group |
| Mother | Parent ship |
| New Picture | Used by controller or aircrew when tactical picture has changed. Supersedes all previous calls and reestablishes picture for all players |
| No Factor | Not a threat |
| No Joy | Aircrew does not have visual contact with the target/bandit/landmark Opposite of Tally |
| Off (Direction) | Informative call indication attack is terminated and maneuvering to the indicated direction |
| Offset | Informative call indicating maneuver in a specified direction with reference to the target |
| On Station | Informative unit/aircraft has reached assigned station |
| Opening | Increasing separation |
| Out | (Direction) Informative indicating a turn to a cold aspect relative to the threat. Opposite of In |
| Package | Geographically isolated collection of groups/contacts/formations |
| Padlocked | Informative call indicating aircrew cannot take eyes off an aircraft or surface position without risk of losing tally/visual |
| Parrot | IFF transponder |
| Picture | Request of provide air information pertinent to the mission in a digital bullseye format |

| | |
|---|---|
| Pig | JSOW launch |
| Pigeon | Magnetic bearing and range to Homeplate (or specified destination) |
| Pince/Pincer | Threat maneuvering for a bracket attack |
| Playmate | Cooperating aircraft |
| Playtime | Amount of time aircraft can remain on station |
| Pop | Starting climb for air-to-surface attack |
| Popeye | Flying into IMC (i.e., clouds or area of reduced visibility) |
| Popup | Informative that a contact has suddenly appeared inside a prebriefed range |
| Posit | Request for position; response in terms of a geographic landmark, or off a common reference point |
| Post Attack | Directive transmission to indicate direction after completion of intercept/engagement |
| Post Hole | Rapid descending spiral |
| Press | Directive to continue the attack; mutual support will be maintained Supportive role will be assumed |
| Pump | A briefed maneuver to low aspect to stop closure on the threat or geographical boundary with the intent to re-engage |
| Pure | Informative indicating pure pursuit is being used or directive to go pure pursuit |
| Push | (Channel) Go to designated frequency |
| Pushing | Departing designated point |
| Range | Two or more groups separated in range |
| Reference (Heading) | Directive to assume stated heading |
| Reset | Proceed to a prebriefed position or area of operation |
| Resume | Resume last formation/station/mission ordered |

| | |
|---|---|
| Rider | A bogey that is conforming with safe passage routing/airspeed/altitude procedures |
| Ripple | Two or more munitions released or fired in close succession |
| Rolex (Time +/-) | Timeline adjustment in minutes from preplanned mission execution time |
| SAM | Visual acquisition of a SAM or SAM launch, should include clock code position |
| Scram | Emergency directive to egress for defensive or survival reasons |
| Separate | Leave a specific engagement; may or may not reenter |
| Shackle | One WEAVE, a single crossing of flight paths; maneuver to adjust/regain formation parameters |
| Shooter | Aircraft/unit designated to employ weapons |
| Shotgun | Prebriefed weapons loadout at which separation/bugout should begin |
| Skate | Informative/directive to execute launch and leave tactics |
| Skip It | Veto of fighter commit, usually followed with further directions |
| Skosh | Aircraft is out of/or unable to employ active radar missiles |
| Snap | (Direction) An immediate vector to the group described |
| Sort | Directive to assign responsibility within a group; criteria can be met visually, electronically (radar) or both |
| Sorted | Sort responsibility has been met |
| Sour | 1. Equipment indicated is operating inefficiently<br>2. Invalid response to an administrative IFF check |
| Spitter | An aircraft that has departed from the engagement or is departing the engaged fighters targeting responsibility |
| Splash | 1. Air target destroyed<br>2. Weapons impact |
| Split | Request to leave formation to engage a threat; visual may not be maintained |

| | |
|---|---|
| Spoofing | Information that voice deception is being employed |
| Spot | Acquisition of laser designation |
| Squawk | Operate IFF as indicated or IFF is operating as indicated |
| Stack | Two or more groups/contacts/formation with high/low altitude separation in relation to each other |
| Status | Request for tactical situation/position |
| Steady | Directive to stop oscillation of IR pointer |
| Steer | Set magnetic heading indicated |
| Stern | Request for, or directive to, intercept using stern geometry |
| Stinger | Formation of two or more aircraft with a single aircraft in trail |
| Stop | Stop IR illumination of a target |
| Stranger | Unidentified traffic that is not associated with the action in progress |
| Strangle | Turn off equipment indicated, usually IFF |
| Stripped | Informative call from wingman/element indicating out of briefed formation/position |
| Sweet | 1. Equipment indicated is operating efficiently<br>2. Valid response to an administrative IFF check |
| Switch | Indicates an attacker is changing from one aircraft to another |
| Tactical | Request/directive to switch to tactical control |
| Tally | Sighting of a target/bandit/landmark opposite of No Joy |
| Target | Directive to assign group responsibility to aircraft in a flight |
| Targeted | Group responsibility has been met |
| Ten Seconds | Directive to terminal controller to standby for Laser On call in approximately 10 seconds |
| Terminate | 1. Stop laser illumination of a target<br>2. Cease local engagement without affecting the overall exercise |

## C-10 MULTI-SERVICE TACTICAL BREVITY CODES

| | |
|---|---|
| Threat | Untargeted HOSTILE/Bandit/Bogey within prebriefed range/aspect of a friendly |
| Tied | Positive radar contact with element/aircraft |
| Tiger | Enough fuel and ordnance to accept a commit |
| Tracking | 1. Stabilized gun solution<br>2. Continuous illumination of a target<br>3. Contact heading |
| Trashed | Informative call that missile has been defeated |
| Unable | Cannot comply as requested/directed |
| Uniform | UHF radio |
| Victor | VHF/AM radio |
| Visual | Sighting of a friendly, aircraft/ground position; opposite of Blind |
| Warning | (Color) Hostile attack is:<br><br>RED - imminent or in progress<br>YELLOW - probable<br>WHITE - improbable (all clear) |
| Weapons | (Fire only):<br><br>FREE - on a target not identified as friendly in accordance with current ROE<br>TIGHT - at target positively identified as hostile in accordance with current ROE<br>SAFE - in self defense or in response to a formal order |
| What Luck | Request for results of missions or tasks |
| What State | Report amount of fuel and missiles remaining. Ammunition and oxygen are reported only when specifically requested or critical<br><br>ACTIVE — number of active radar missiles remaining<br>RADAR — number of semi-active missiles remaining<br>HEAT — number of IR missiles remaining<br>FUEL — pounds of fuel or time remaining |
| Winchester | No ordnance remaining |

| | |
|---|---|
| Words | Mission-pertinent information |
| Yardstick | Directive to use A/A TACAN for ranging |

# APPENDIX D
# CONVERSION TECHNIQUES

## D100. CONVERSION TECHNIQUES

The following discussion illustrates a number of common VT-86 conversion techniques. These techniques are not a substitute for standard procedures as outlined in the FTI and squadron stan notes.

Write down the necessary information.

1. BH
2. BR
3. BB
4. Complete the “Iron Cross”
5. Steady Heading (SH), applying all caveats
6. Goal Bogey Bearing (GB)
7. AH
8. Lateral Separation Gates (If applicable)

**Example Initial Setup**:

*“Rage, Gritrock, your bogey is in a right hand turn to assigned heading 180, fighter left.”*

*“Rage left”*

*“Rage, Gritrock, your bogey bears 020, 30, medium.”*

*“Rage.”*

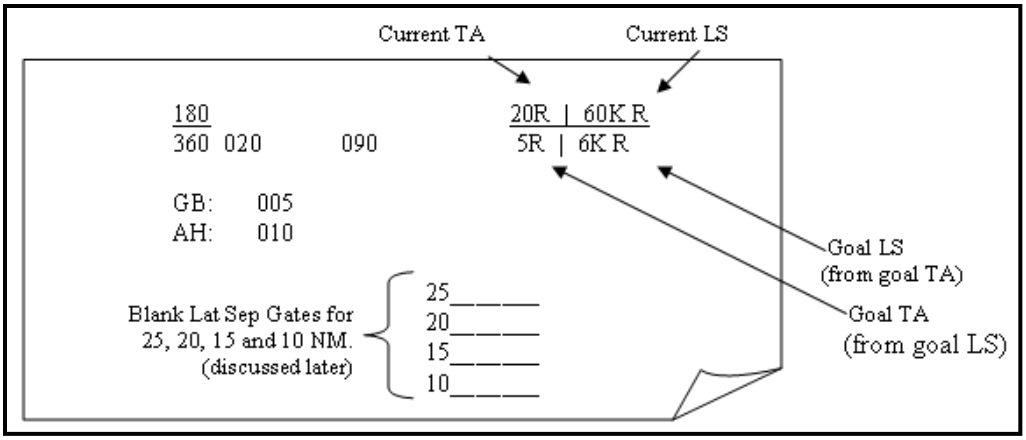


**Figure D-1 Example – Initial Setup**

To the instructor: *"I've got 20R TA and 60K on the right, what is my goal?"*

*"Your goal is 5R TA"* (Complete the Iron Cross and implement gameplan)

*"Ease to a standard, Steady 090. Buster, set speed point six."*

**Determining the Cut**

To calculate the proper cuts to meet the TA / LS goal, the following must be considered:

1. Area Identification
2. Game plan execution
3. Turn rates and lead points
4. Lateral separation calculations

**Area Identification**

Step one is to determine which one of the following four areas the fighter is in by comparing current TA / LS to the goal TA / LS.

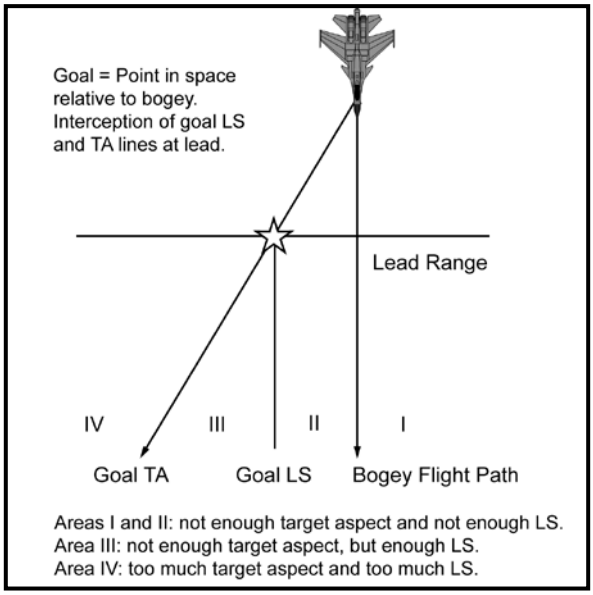


**Figure D-2 Area Identification**

A common technique to determine current area is the "Iron Cross" shown below.

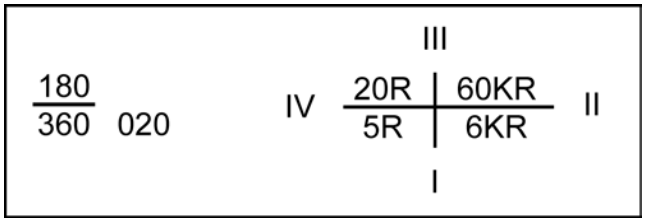


**Figure D-3 Iron Cross**

Start by writing the areas around the outside of the cross, starting with a I on the bottom and continuing counterclockwise to IV on the left. Here is how to use the outside numbers to determine which area the fighter is in:

**Area I**

Problems require a change in DOP and should be fairly obvious. *"I have 20 RIGHT TA, I need 5 LEFT"*

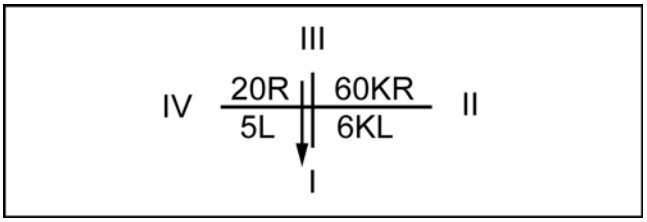


**Figure D-4 Area I**

**Area II**

If the numbers on bottom are bigger (TA compared to TA, LS compared to LS), go to the right - Area II.

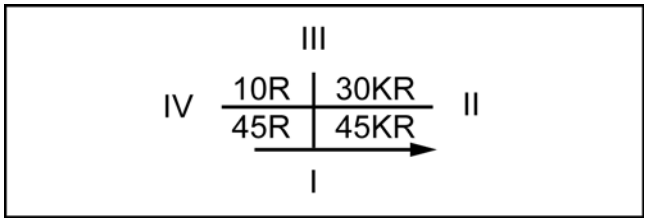


**Figure D-5 Area II**

**Area III**

If both bottom numbers fit between the top numbers then it is an Area III problem.

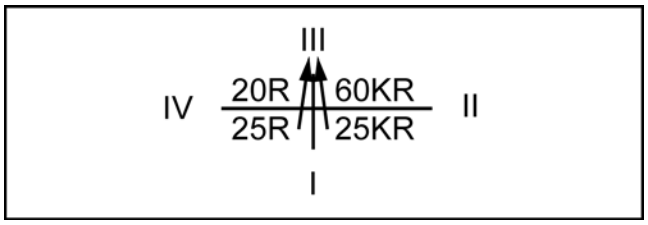


**Figure D-6 Area III**

**Area IV**

If the numbers on bottom are smaller, go to the left—Area IV.

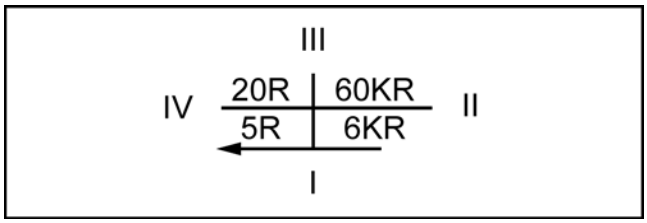


**Figure D-7 Area IV**

**Execute the Gameplan**

Each area requires a different cut which is a product of one's self-tailored game plan. This text is based on the common 90-60-0-90 game plan.

**AREA I** 90 cut into that becomes a cut away upon change in DOP

**AREA II** 60 cut away

**AREA III** 0 cut

**AREA IV** 90 cut into

This game plan has several caveats:

a. Converting more than 45K feet of lateral separation requires a buster. This usually only applies to 90 cuts.

b. Converting less than 24K feet of LS requires a 40 cut to minimize the potential for overshooting the goal. More aggressive game plans will only apply this caveat to area II problems, while a more conservative gameplan will apply it to areas I, II and IV.

c. If the current TA is initially within ±3 TA of the goal TA, turn directly to AH using a hard turn. Reconvert as necessary to achieve the goal TA.

d. If the goal TA is 15 or less on either side (area I or II) do not bother with lat sep calculations; simply lead the turn to AH.

A technique to visualize a cut into versus a cut away is to write down the SH next to the set-up information as it would appear on an EHSI (example: 330 to the left of 020). If the numbers are arranged like a normal reattack set-up, it is a cut into.

**Example: 90 Cut Into:**

| | | |
|---|---|---|
| 180 / 360 | 20 | 090 |
| | **BB** | **SH** |

**Figure D-8 Example 90 Cut Into**

If the SH is on the same side of the BH/reciprocal from the bearing, then you have a cut into

**Example: 60 Cut Away:**

| | | |
|---|---|---|
| | 180 / 360 | |
| 300 | | 020 |
| **SH** | | **BB** |

**Figure D-9 60 Cut Away**

If the SH is on the opposite side of the BH/reciprocal from the bearing, then you have a cut away.

**Vary the Initial Turn-in Rate**

Varying fighter turn in rate from a hard turn allows the fighter to begin converting TA ASAP. Remember, if the fighter is turning through BB to reach SH, increase to a hard as possible turn. If you will reach SH before BB, ease to a standard. Some students add an arrow indicating fighter turn in direction using the BH/reciprocal line.

Figure C-10 shows a left hand fighter turning:

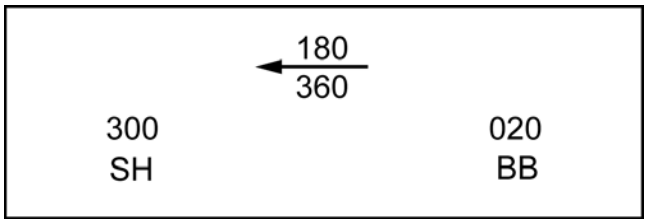


**Figure D-10 Varying Initial Turn-in Rate**

"*Bogey's right to 180, fighter left*"

After computing SH:

"*Increase to a hard as poss turn*."

**Lateral Separation Calculations**

To get the Fox 1 shot opportunity using a minimum of time and fuel, the fighter must know when the required lateral separation has been achieved in order to turn to a zero cut. There are a number of techniques to quickly calculate required lateral separation at set ranges, or "gates" using TA. The following example will use an area I setup:

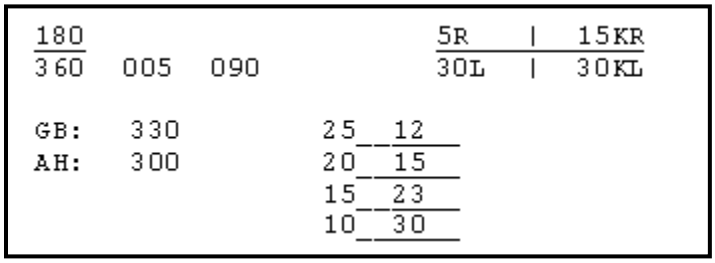


**Figure D-11 Lateral Separation Calculation 1**

For the 25 NM LS gate, one can use the "quarters technique": Convert the goal LS (30K) to the nearest fifty cents then calculate the number of quarters this dollar amount equals. The number of quarters is equal to required TA at 25 miles to ensure enough LS has been generated.

**Example**:

1. 30KL = $3.00 (round up to the nearest fifty cents if necessary.)

2. $3.00 = 12 quarters

3. 12 quarters = 12L TA at 25 NM or greater = LS gate met

If the fighter were to hear a BRAA call of "*348, 27, medium,*" a zero cut is now appropriate. This will preserve LS while TA continues to build. Turning to a zero cut instead of driving out to the goal TA line, then driving in to take the Fox 1 also saves fuel, gets the bogey on the radar sooner and decreases the amount of turn to AH/lead.

A technique to fill in the remaining gates quickly is to write the goal LS in the 10 NM gate, realizing this is now a TA. The 20 NM gate is simply half of the 10 NM gate and the remaining 15 NM gate splits the difference between 10 and 20 NM:

```
                                    5R   |  15KR
                                    30L  |  30KL
25__10__  (quarters technique)
20__15__  (half of 10 NM gate)
15__23__  (split the difference between 10 and 20 NM)
10__30__  (from goal of 30KL)
```

**Figure D-12 Lateral Separation Calculation 2**

Study the results of this technique. It shows us that the 15 NM gate of 23 TA = 34,500 feet, exceeding the required LS goal of 30K. This excess is acceptable in light that the technique is very fast and any errors occur on the side of having too much LS. See the overview example for an example using a 12 NM F1 shot. Notice a 10 NM gate is still used to allow for easily calculated 20 and 15 NM gates.

Another technique for 18 and 23 NM gates is the "plus two, minus three" technique. Calculate the 20 NM LS gate as shown above, then add two for the 18 NM gate and subtract three for the 23 NM gate.

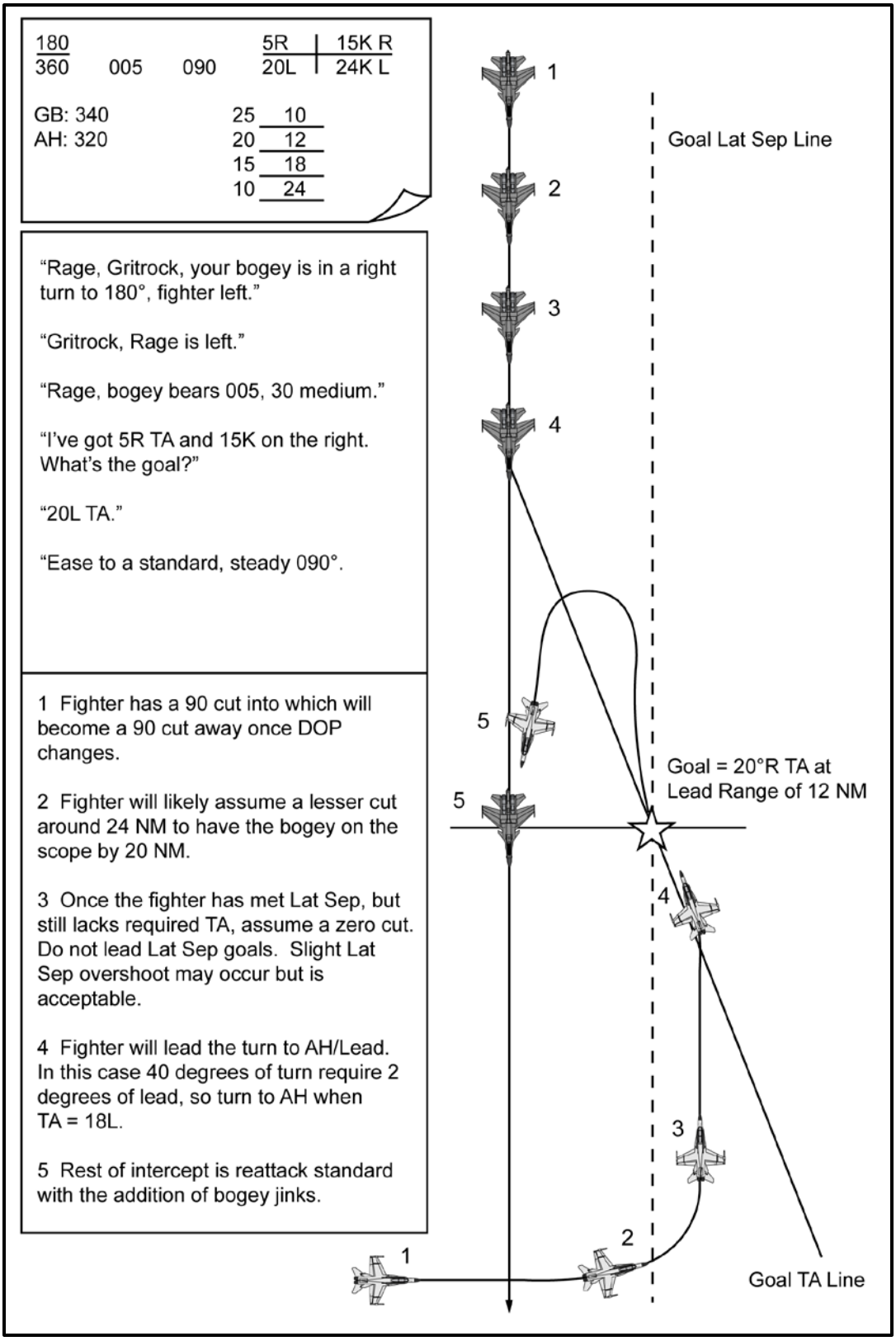


**Figure D-13 Overview Example**