



NAVAL AIR TRAINING COMMAND

NAS CORPUS CHRISTI, TEXAS

CNATRA P-1209 (Rev. 02-17)

FLIGHT TRAINING INSTRUCTION



STRIKE T-45 MPTS AND IUT

2017



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

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Subj: FLIGHT TRAINING INSTRUCTION, STRIKE, T-45 MULTI-SERVICE PILOT
TRAINING SYSTEM AND INSTRUCTOR UNDER TRAINING

Encl: (1) Change 2 Pages iv through xi, 3-16, 3-21, 3-22, 7-6, 7-20 through 7-24, 8-1, 8-14,
8-19, 11-5, A-2

1. Purpose. To publish Change 2 to the basic publication.
2. Action.
 - a. Remove pages iii through xi, 3-16, 3-21, 3-22, 7-6, 7-20 through 7-26, 8-1, 8-14, 8-19, 11-5, A-2 and replace with pages in enclosure 1.
 - b. Record Change 2 on the Summary of Changes page.
3. Future printing of this Flight Training Instruction will incorporate the change. CNATRA POC is LCDR Geoffrey Dick, N715, DSN 861-3895.

A handwritten signature in black ink, appearing to read "S. E. HNATT", is positioned above the typed name.

S. E. HNATT
By direction

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06 Feb 17

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1. CNATRA P-1209 (Rev. 02-17) PAT, "Flight Training Instruction, Strike, T-45 MPTS and IUT" is issued for information, standardization of instruction, and guidance for all flight instructors and student aviators within the Naval Air Training Command.
2. This publication shall be used as an explanatory aid to the T-45 Strike Pilot Training. It will be the authority for the execution of all flight procedures and maneuvers herein contained.
3. Recommendations for changes shall be submitted via the electronic TCR form located on the CNATRA website.
4. CNATRA P-1209 (Rev. 07-09) PAT is hereby cancelled and superseded.


M. B. TATSCH
By direction

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CHANGE 2

FLIGHT TRAINING INSTRUCTION

FOR

STRIKE

T-45 MPTS AND IUT

P-1209



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Dates of issue for original and changed pages are:

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Change Transmittal...2...23 Jul 20

TOTAL NUMBER OF PAGES IN THIS PUBLICATION IS 134 CONSISTING OF THE FOLLOWING:

Page No.	Change No.	Page No.	Change No.
COVER	0	7-9 – 7-15	0
CH LETTER	2	7-16	1
PROMU LETTER	0	7-17 – 7-19	0
iv – xi	2	7-20 – 7-23	2
xii	1	7-24 (blank)	2
1-1 – 1-14	0	8-1	2
2-1 – 2-4	0	8-2 – 8-10	0
3-1 – 3-5	0	8-11 – 8-13	1
3-6	1	8-14	2
3-7 – 3-15	0	8-15 – 8-16	0
3-16	2	8-17	1
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4-1	1	9-1 – 9-2	0
4-2 – 4-6	0	10-1 – 10-3	0
4-7	1	10-4 (blank)	0
4-8	0	11-1 – 11-3	0
5-1 – 5-2	0	11-4	1
6-1	0	11-5	2
6-2 (blank)	0	11-6 (blank)	0
7-1 – 7-2	0	A-1	0
7-3	1	A-2	2
7-4 – 7-5	0	A-3 – A-5	0
7-6	2	A-6 (blank)	0
7-7 – 7-8	1		

CHANGE 2

INTERIM CHANGE SUMMARY

The following changes have been previously incorporated in this manual:

CHANGE NUMBER	REMARKS/PURPOSE
1	Changes made per transmittal letter (15 Feb 18)
2	Changes made per transmittal letter (23 Jul 20)

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INTERIM CHANGE NUMBER	REMARKS/PURPOSE	ENTERED BY	DATE
1	Changes made per Promulgation Letter (29 Oct 08)		
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3	Changes made per Promulgation Letter (06 Feb 17)		

HOW TO USE THIS FTI

This Flight Training Instruction (FTI) is your textbook for the Strike stage and is the source document for all procedures related to Strike events. In addition, it includes suggested techniques for performing each maneuver and making corrections.

Use this FTI to prepare events and to review lessons learned afterward. Know all procedures in the assigned section(s), review the glossary, and be prepared to ask your instructor about anything that remains unclear. ***It is imperative that you review previously learned material as well as reference the current TACSOP and Standardization Notes for additional guidance while studying.***

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

CHANGE 2

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CHANGE 1

INTRODUCTION

GENERAL CONSIDERATIONS

Military aircraft are designed to destroy an enemy's potential to wage war. The primary means to accomplish this mission is by delivering various types of ordnance upon enemy personnel, equipment, and installations. Accurate delivery of ordnance on surface targets is one of the primary missions of Naval Aviation and is accomplished with a wide variety of ordnance. Deliveries also vary based upon type of ordnance as well as other mission planning factors and include roll-ins, pop up attacks, and level laydowns. To be a true professional, you - the Naval Aviator - must be thoroughly versed in air-to-surface employment.

OBJECTIVE

The primary objective of the Strike stage is to develop basic skills pertaining to ordnance delivery. Basic skills already learned, such as formation flying and instrument scan, will be helpful in the Strike stage. This publication emphasizes the fundamentals of ordnance delivery its application towards follow-on training. The procedures contained here, except those labeled "techniques," must be closely adhered to. For Training Command purposes, the most important aspect of ordnance delivery is developing consistent repeatable mechanics combined with consistent and effective target tracking. Tactical proficiency will come later once basic skills are developed and mastered.

GRADING

Accuracy is one component of bombing success and will be graded on all but the first flight. Accuracy is measured by determining the bomb's Circular Error Probability (CEP). The CEP is a statistical median and is theoretically the radius of a circle within which half the pilot's bombs could be expected to fall. Calculate CEP by arranging hits from best to worst; the CEP is the median of an odd number of drops or the mean of the middle two hits of an even number of drops. All scored hits will count toward the flight CEP, regardless of the pattern in which individual bombs were dropped. The grading of accuracy will be in accordance with the guidelines found in the applicable master curriculum guide (MCG).

This FTI also introduces the concept of *Air-to-Surface validation*. Validation is a set of allowable parameter errors during a delivery, and places well-defined limits on how tightly a delivery should be executed. Rough passes may still result in accurate hits but if they do not meet the training limitations they are technically "invalid." See Chapter 10 for a discussion of Air-to-Surface validation.

CHAPTER ONE ARMAMENT SYSTEM

100. INTRODUCTION

As a strike student, you are responsible for reading and familiarizing yourself with all information in NATOPS Chapter Twenty One “Armament System.” This chapter provides amplifying information on the T-45 armament system, suspension equipment, practice ordnance and preflight procedures.

101. ARMAMENT SYSTEM - GENERAL

The armament system provides for the carriage, jettison, and controlled release of external stores. Armament system controls include the jettison button, master armament switch (forward cockpit), master arm override switch/master arm light (aft cockpit), weapons release button and gun trigger, Data Entry Panel, MFD stores display, and the air-to-ground (A/G) T-45 mode button which provides both Manual (MAN) and Continuously Computed Impact Point (CCIP) delivery mode sighting for bombs, rockets and simulated guns. Weapons stations in the T-45C do not communicate quantity remaining with the armament system. As a result, the pilot must adjust weapon quantity to match aircraft loadout.

102. ARMAMENT SYSTEM CONTROLS AND INDICATORS

Emergency Jettison Button

When actuated, the emergency jettison button (Figure 1-1) releases stores from both wing stations simultaneously regardless of the selected weapon, master armament or master armament override switches. Emergency jettison requires aircraft weight off-wheels and either normal or battery power on the aircraft.

NOTE

Centerline external stores will not jettison.

Master Armament and Master Armament Override Switch/Master Arm Light

The **Master Armament switch** (Figure 1-1) is located in the front cockpit and will be referenced throughout this publication as the MASTER ARM. The MASTER ARM controls all armament circuits except for stores jettison. With the MASTER ARM switch in SAFE, the armament circuits are de-energized. With the MASTER ARM set to ARM, the armament circuits are energized and the MASTER ARM light (Figure 1-1) is illuminated in the aft cockpit.

The **Master Armament Override switch** (Figure 1-1) in the aft cockpit is a solenoid type toggle switch, which is energized when the front cockpit MASTER ARM switch is set to ARM. The Override switch has two positions: FORWARD and SAFE. With the front cockpit MASTER ARM set to ARM, placing the override switch in SAFE de-energizes armament circuits. When

the front cockpit MASTER ARM switch is set to SAFE, the Master Override Switch is de-energized, allowing the spring loaded override switch to return to the up or FORWARD position. The Master Armament Override Switch can also be manually switched back to the FORWARD position. When in the FORWARD position, the forward cockpit controls the armament system.

Weapons Release Button and Gun Trigger

The A/G weapon release button or “pickle button” (Figure 1-1) enables weapons release from the wing stations. With the MASTER ARM switch set to ARM and a wing station selected on the stores display, pressing the button releases a bomb or fires a rocket. With the MASTER ARM switch set to ARM and GUN selected on the stores display, squeezing the GUN trigger (Figure 1-1) simulates gun firing.

Data Entry Panel (DEP)

The DEP (Figure 1-1) enables adjustment of the MIL depression setting, selection of different HUD master modes, and the input of target height. The MIL depression setting of the depressed sight line adjusts with the SET DEP +/- rocker switch. HUD master modes (Navigation, Air-to-Air, Air-to-Ground) are selected with the MODE button. Target height is entered using the DEP buttons.

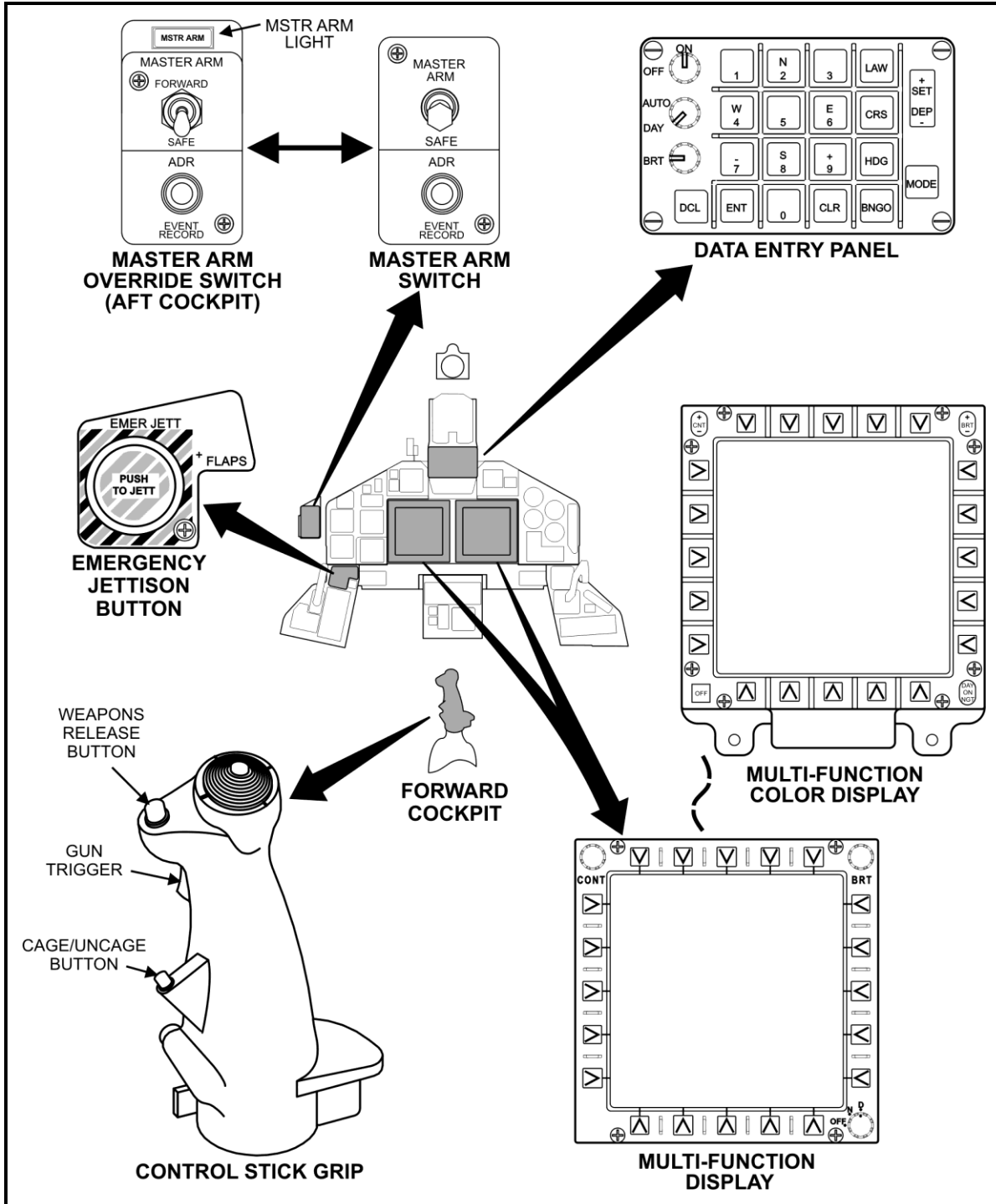


Figure 1-1 T-45C Armament Control and Indicators

MFD Air-To-Ground (A/G) Stores Display

The A/G stores display (Figure 1-2) options include delivery mode selection, weapon and station selection, weapon quantity selection, target height option selection, master armament status (SAFE or ARM), and rocket delivery options.

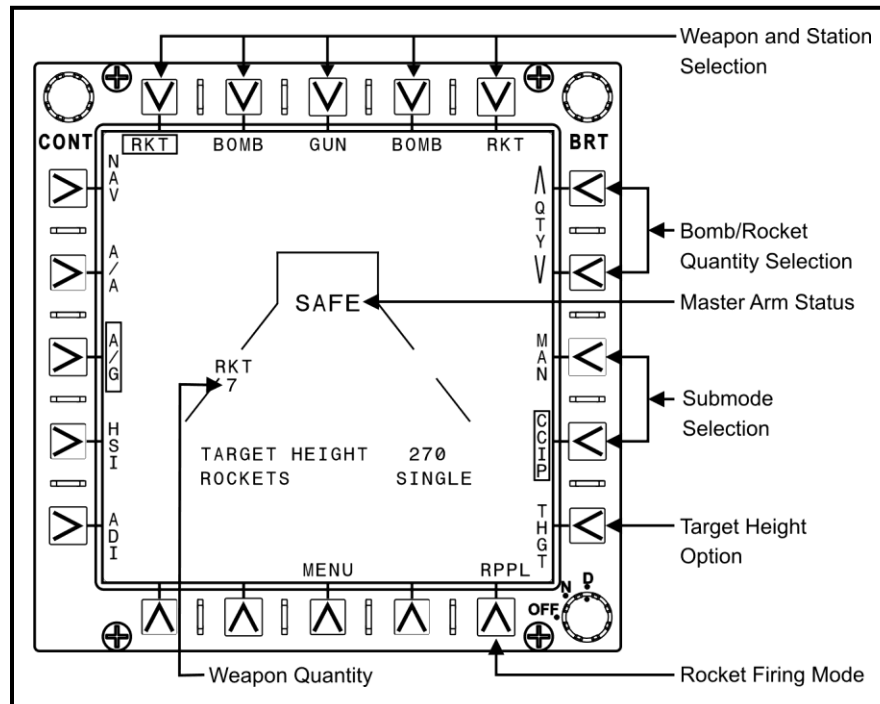


Figure 1-2 A/G Stores Display Controls and Indicators

1. **Weapons and Station Selection.** This function provides the ability to select respective weapons on certain stations. Only one weapon/station combination can be selected at any given time. The default setting is GUN.
2. **Bomb/Rocket Quantity Selection.** Weapon quantity can be adjusted to meet the current weapon quantity loaded on the aircraft after aircraft start-up.
3. **Delivery Mode Selection.** There are two modes of delivery: Manual (MAN) and Continuously Computed Impact Point (CCIP).
4. **Target Height Option.** In CCIP Mode, the target height solution is used in calculating a release solution for the CCIP cue when radar altitude is invalid. Selecting THGT will open up a scratchpad in the HUD and MFD for manual entry using the DEP.
5. **Rocket Firing Mode.** Indicates the selection of the rocket firing modes: SINGLE or RPPL (Ripple). Subsequent selection of the firing mode option will cycle between the two. Current firing mode status is shown below the aircraft load-out symbol as shown in Figure 1-2.

6. **Master Armament Status.** Indicates the MASTER ARM status: SAFE or ARM.
7. **Weapon Quantity Indication.** This serves as a counter only and has no interface between the BRU-38/A and the STORES page. The weapon quantity has default settings of RKT – 7; BOMB – 6; and GUN - has no counter and is unlimited. Inflight, with the armament system energized, each press of the weapon release button will cause the selected quantity to decrease by one.

103. T-45C AIR-TO-GROUND HUD SYMBOLOGY

The T-45C A/G mode may be entered by pressing the mode button on the DEP or by selecting A/G on the stores display. The T-45C A/G HUD is designed to display two types of weapon delivery modes: Manual (MAN) and Continuously Computed Impact Point (CCIP). These delivery modes are selectable through the MFD Stores Display. The Velocity Vector and pitch ladders in the A/G HUD default to uncaged.

T-45C A/G HUD Manual Delivery Mode Symbology

In Manual delivery mode, the HUD displays the following in addition to the normal gear up NAV symbology: MAN mode indication, selected weapon indication, MASTER ARM status, the Depressed Sight Line (DSL) aiming reticle, and DSL mil setting indication (Figure 1-3).

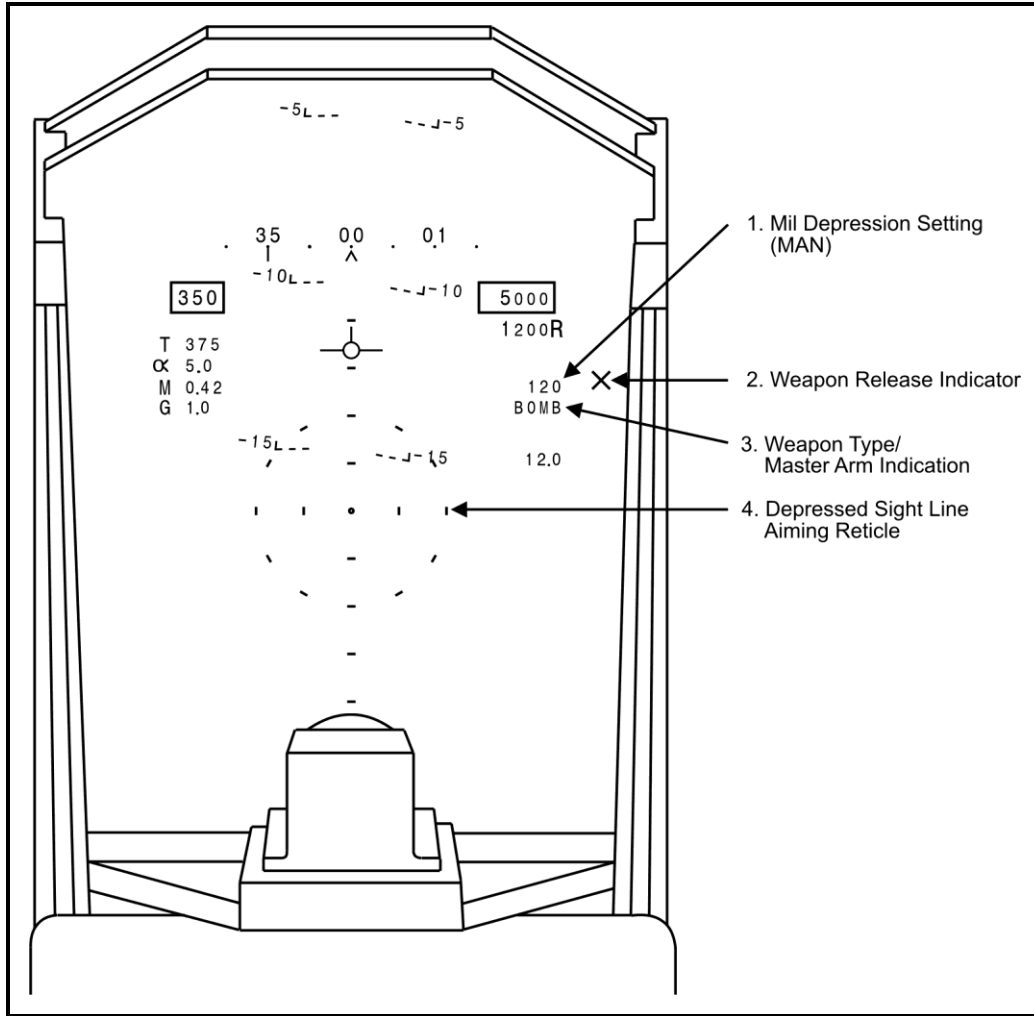


Figure 1-3 T-45C A/G HUD Manual Delivery Mode

1. **Mil Depression Setting (Manual mode).** Indicates the mil depression setting of the DSL reticle on the HUD. The system initializes at 12 mils for GUN, 140 mils for BOMB, and 30 mils for RKT. The sight can be adjusted from 0 to 270 mils, with 0 being coincident with the top of the altitude and airspeed boxes and 270 being towards the bottom of the HUD.
2. **Weapon Release Indicator.** This cue appears as a small X to the right of the selected weapon. It is displayed for 2 seconds when the pickle button or trigger is actuated.
3. **Weapon Type / Master Arm Indication.** Displays selected weapon type and armament status. With the MASTER ARM set to SAFE, an X will appear over the weapon legend in the HUD. With the MASTER ARM set to ARM, the X disappears from the weapon legend.
4. **Depressed Sight Line (DSL) Aiming Reticle.** This is a non-computing reticle which overlays the predicted impact point given a no-wind condition, weapon type, airspeed, altitude, optimum G and AOA. The reticle inner ring is 25 mils, and outer ring is 50 mils. Outside the rings are two (2) additional mil marks along the pitch ladder centerline: 75 and 100 mils (Figure 1-3).

T-45C A/G HUD CCIP Delivery Mode Symbolology

In CCIP mode, the HUD displays a continuously computed impact point based on current aircraft dive angle, bank angle, airspeed, altitude, and winds aloft (Figure 1-4). A Displayed Impact Line (DIL) is drawn from velocity vector to the CCIP cue and is sometimes referred to as Bomb Fall Line (BFL). The DIL is an azimuth reference between the CCIP cue and the Velocity Vector that indicates the calculated trajectory drop of the weapon. The Displayed Impact Line only appears with BOMBS selected.

If the HUD is caged, the DIL is displayed between the caged (solid) Velocity Vector and the CCIP cue not between the true (uncaged or ghost) Velocity Vector and CCIP cue. Correspondingly, the target *may not* track down the DIL. Employment of ordnance with the A/G HUD caged *is not recommended* in the T-45C.

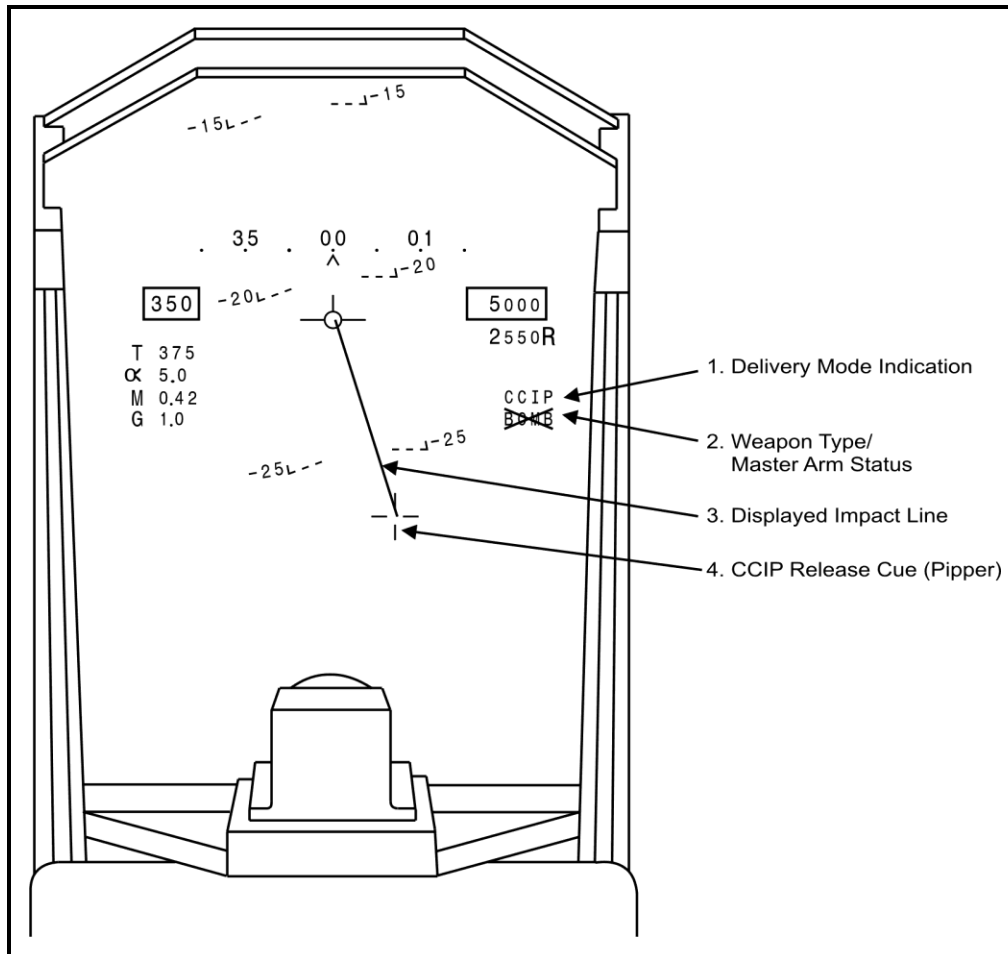


Figure 1-4 T-45C CCIP Delivery Mode – Bombs

1. **Delivery Mode Indication (CCIP).** Indicates the current mode of delivery. Shown here (Figure 1-4) is the CCIP mode.
2. **Weapon Type / Master Arm Status.** Same as in the manual HUD display.
3. **Displayed Impact Line.** Sometimes referred to as the Bomb Fall Line, appears only in the CCIP mode with bombs as the selected weapon. The DIL provides an azimuth steering reference.
4. **CCIP Release Cue.** This cue indicates the computed weapons impact point based upon current aircraft parameters and winds aloft.

T-45C Continuously Computed Impact Point (CCIP) Delivery Mode – Rockets / Gun

In addition to the normal NAV symbology in the HUD, the CCIP mode with Rockets or Gun selected provides: CCIP mode indicator, selected weapon, MASTER ARM status and a CCIP cue.

The CCIP cue represents the impact point of the rocket or gun shell given immediate employment. In CCIP ROCKETS and GUN, the CCIP marker will flash three times per second when the computed slant range exceeds 12,000 ft. for rockets or 8,000 ft. for gun. When inside those slant ranges, the CCIP cue remains steady.

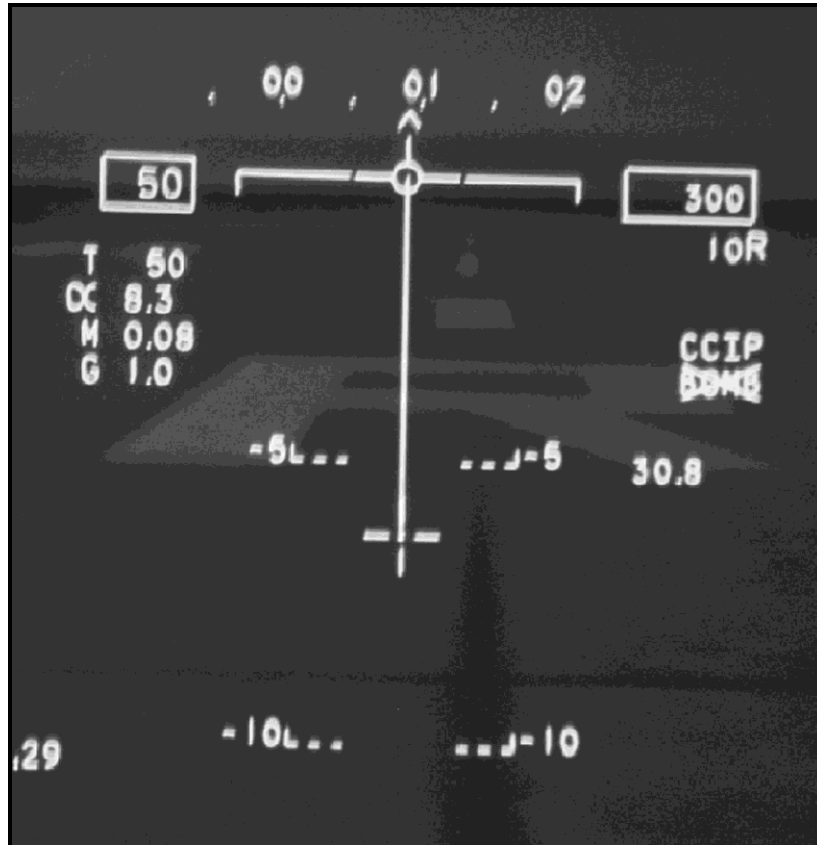


Figure 1-5 T-45C A/G HUD CCIP – Bombs

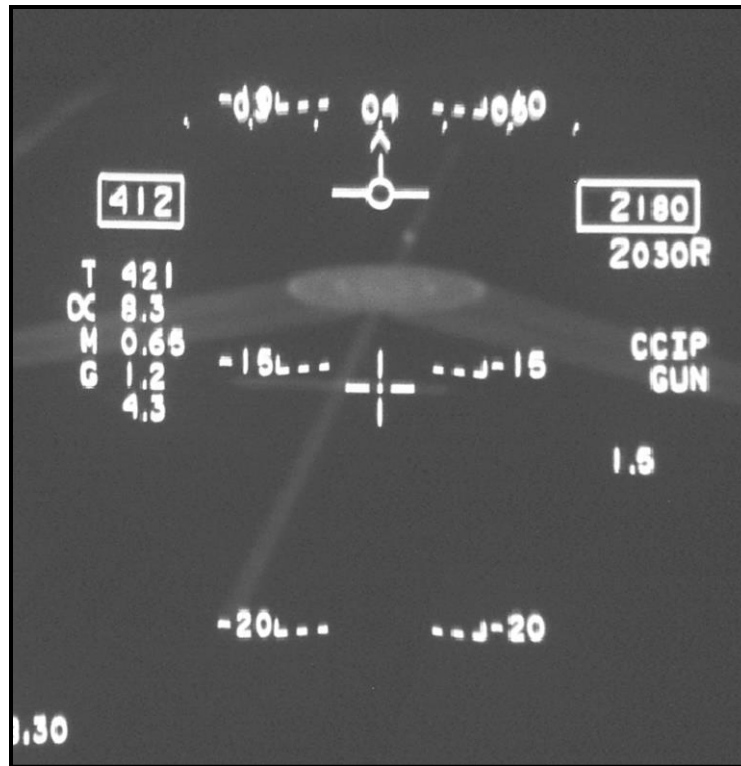


Figure 1-6 T-45C A/G HUD – Gun/RKTS

Target Height (TGHT) Entry for CCIP Mode

In CCIP mode when the RADALT information is invalid (e.g., when above 5,000' AGL, DEGD, or turned off), the system uses BARO altitude minus either the active/selected waypoint elevation or the entered TGHT for computation. Changing the active waypoint will change the target height. When using the CCIP mode, target elevation should be entered into the target waypoint and/or the stores page. This minimizes a “jump” in the CCIP release cue as the radar altimeter becomes active. During a bomb run in rugged terrain, the CCIP cue may jump around as the aircraft passes over obstacles. To force the system to use BARO altitude versus RADALT, the RADALT must be powered off. Turning off the RADALT in the T-45C considering our training environment *is prohibited per the SOP*.

INSTRUCTOR NOTE

The acceptable error tolerance between barometric altitude and the radar altimeter is +/-15%. This applies to all dive/bank angles less than 40 degrees when the RADALT is unmasked. Example: At 3000' AGL, the split between barometric and radar altitude can be as large as 450' and still be within acceptable tolerance. The following chart can be found in NATOPS under the FCF checklist.

ALTITUDE ABOVE MSL (LESS TERRAIN ELEVATION)	RADAR ALTIMETER
1,000 feet	1,000 ± 150 feet
3,000 feet	3,000 ± 450 feet
5,000 feet	5,000 ± 750 feet

Figure 1-7 RADALT Tolerances (ref. FCF A checklist)

104. T-45C AIR-TO-GROUND DATA ENTRY

MFD A/G Stores Display Data Entry

The DEU/mission computer does not monitor status of the simulated gun, bomb racks, rocket launchers, or weapons. Upon command to release a weapon (pickle button), the T-45C system counts down according to the number of times the release button is depressed. There is not a mechanical or electrical interface to wing stations; therefore, it is possible for the system to count down, even though a weapon has not been released or is “hung.”

Before strike sorties, ensure the STORES system has been programmed to support the mission (Figures 1-8 thru 1-10). Weapons programming and data entry is retained in the system memory for the duration of the flight.

To select the A/G Stores Display, select: MENU / STRS / A/G options on the MFD. Selecting the weapon / station combination next will call up the specific default displays. The system defaults to the manual (MAN) - GUN Delivery Mode.

MFD Air-To-Ground (A/G) Stores Display – (Manual Mode) Default Displays

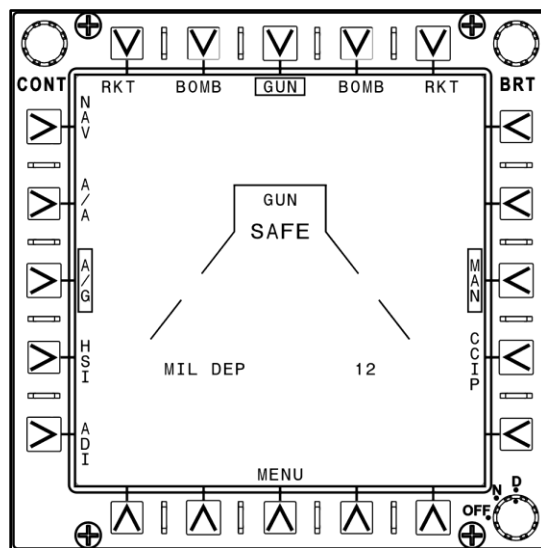


Figure 1-8 A/G Stores Display – Gun (Manual Mode) Default

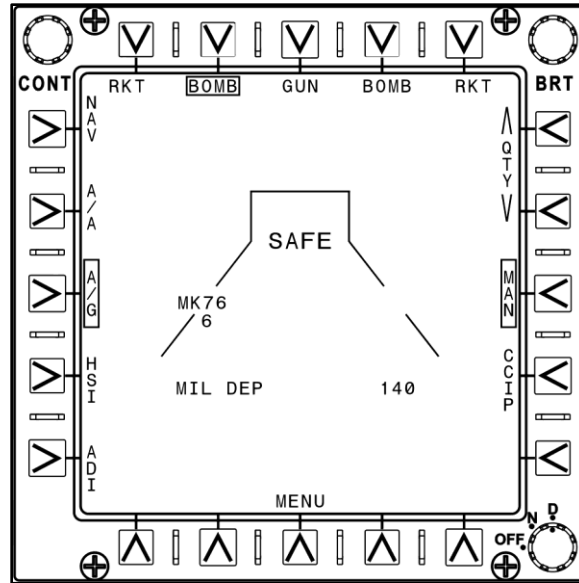


Figure 1-9 A/G Stores Display – Bomb (Manual Mode) Default

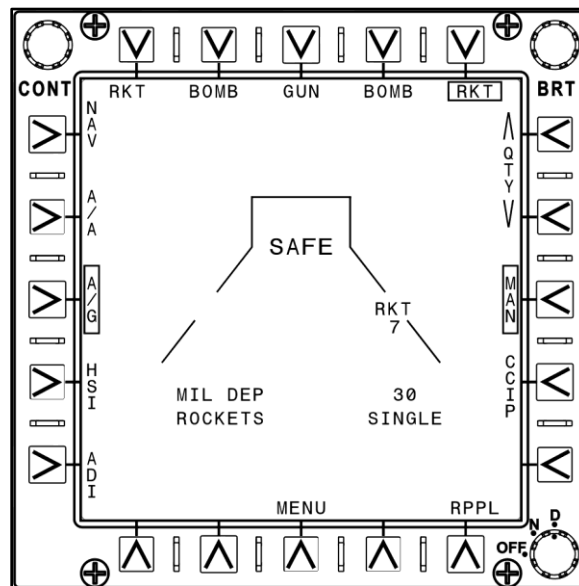


Figure 1-10 A/G Stores Display – Rocket (Manual Mode) Default

Waypoint and Offset Data. Waypoint offsets (0-359.9 degrees and 0-99.9 NM distance) are associated with an active waypoint; changing waypoint coordinates deletes offset data associated with that waypoint. Selecting a waypoint offset will replace previously entered target height with waypoint-offset elevation.

DECLUTTER

Declutter 1 or 2 (Figure 1-11) clears the left side of the HUD display of true airspeed, AOA, Mach, and G.

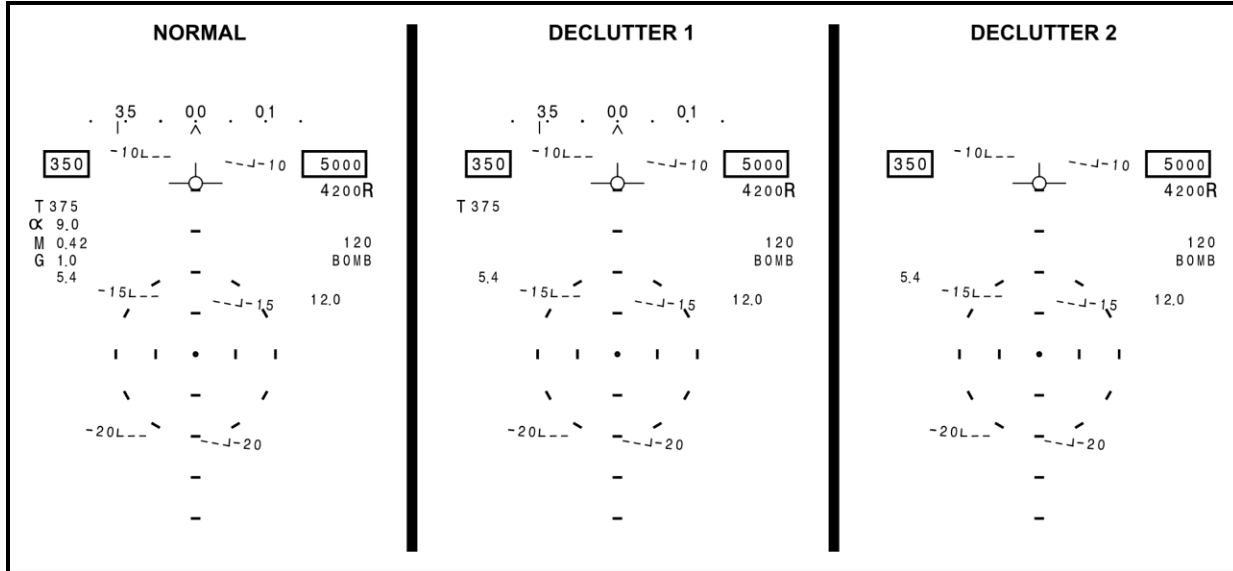


Figure 1-11 HUD Declutter Modes

BREAK X

A large flashing X appears in the center of the HUD when an immediate 4 G pull-up is required to achieve a ground clearance of 1,000 feet. The Break X does not appear at dive angles of less than 15 degrees.

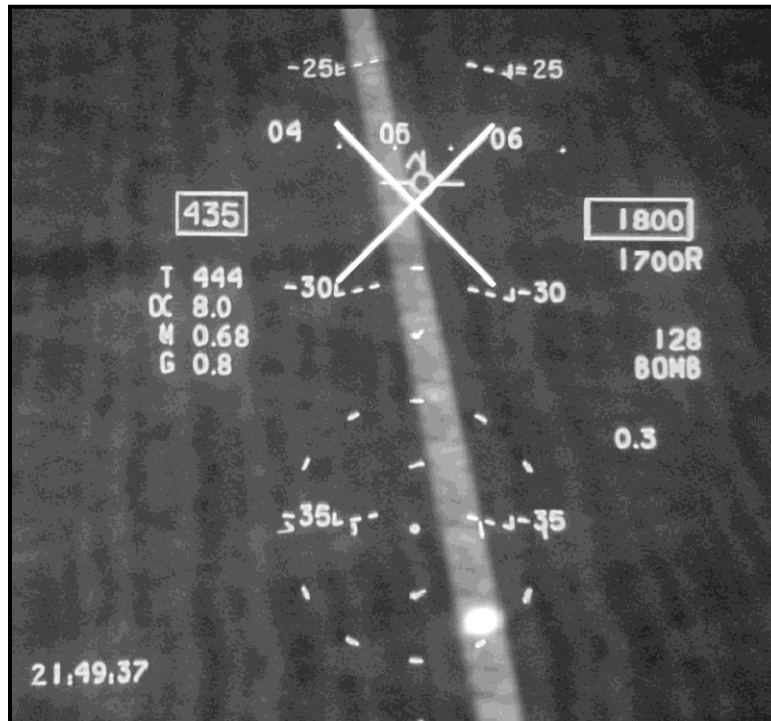


Figure 1-12 Break X

VIDEO CAMERA SYSTEM (VCS) AND VCR SETUP

The Video Camera System (VCS) is a tremendous asset in the strike stage. A HUD tape review (when feasible) following a training event promotes error recognition, analysis, and better overall understanding of strike delivery. If the aircraft is equipped with a working HUD camera, select "HUD" to be recorded. Tapes should be ON from FENCE in to FENCE out, or as dictated by local SOP. Reference NATOPS Chapter Two for further information regarding VCR operation.

VIDEO WITH DDS (After AFC-311)

Some of the aircraft you may fly will come equipped with the Digital Data Set Control Panel (located in the aft cockpit), which performs a similar function to the Mission Data Loader (MDL). In aircraft equipped with DDS, HUD video may be obtained by downloading recorded flight data to a USB memory device and viewed on the DDS loading computer. For further detail on DDS, reference NATOPS Chapter Two.

CHAPTER TWO T-45 PRACTICE ORDNANCE

200. INTRODUCTION

The Training Command primarily uses the Mark 76 (Mk 76) practice bomb. The BDU-33 is the Air Force variant of the Mark 76 and is unlikely to be used. Employment of 2.75" FFAR is also rare and will not be discussed here. The Mark 76 simulates the ballistics and delivery characteristics of the Mk 82 general-purpose 500 lb. bomb. For in-depth detail on ordnance and suspension equipment, refer to NATOPS Chapter Twenty-One.

201. MK 76

Refer to Figure 2-1 and 2-2 for details on the pre-flight inspection of the Mark 76.

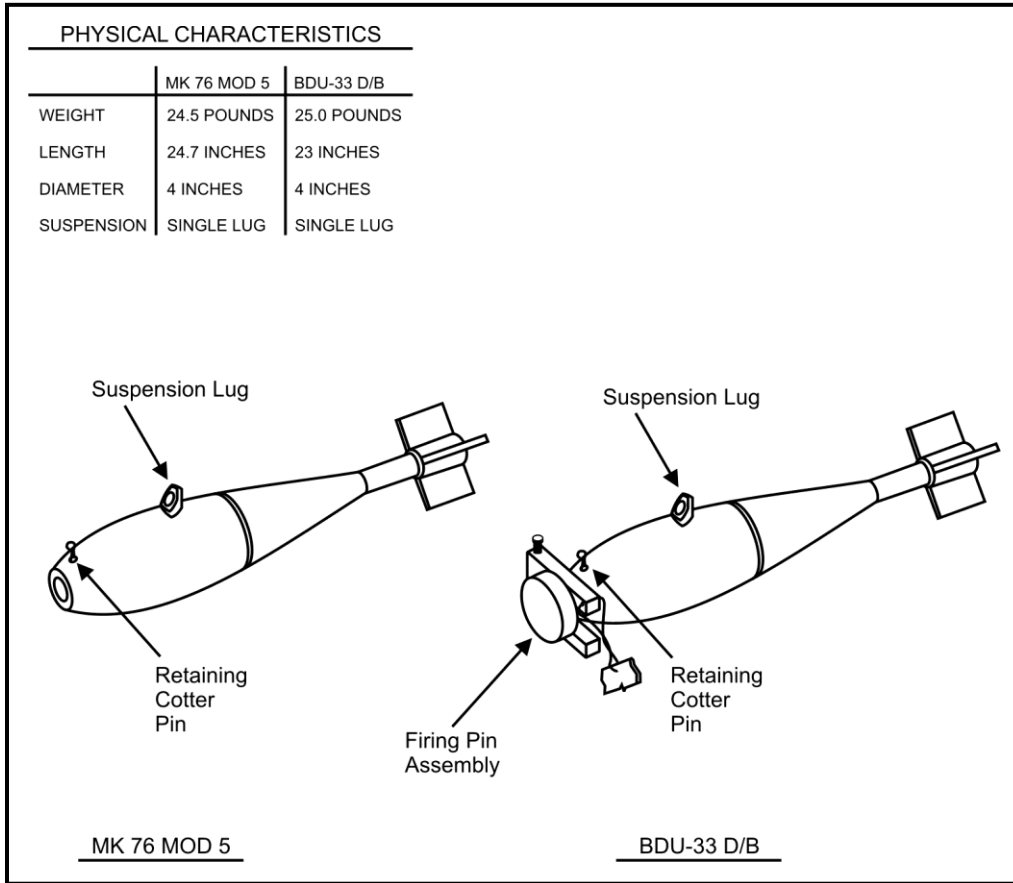


Figure 2-1 MK 76 / BDU-33 Practice Bomb Characteristics

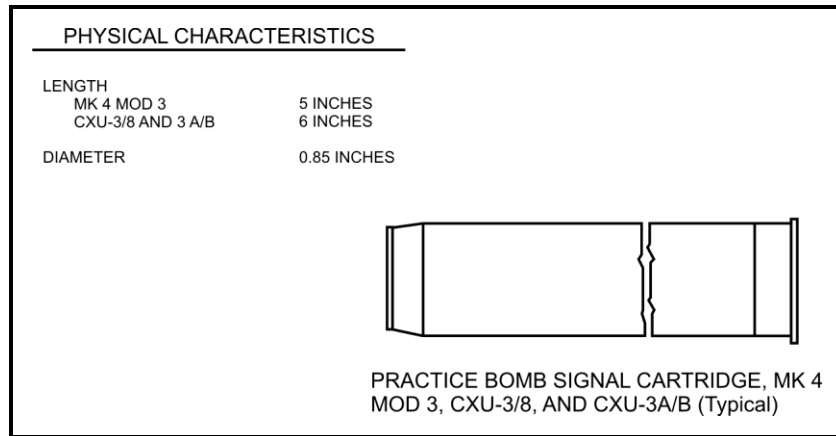


Figure 2-2 Smoke Charge

202. BRU-38A

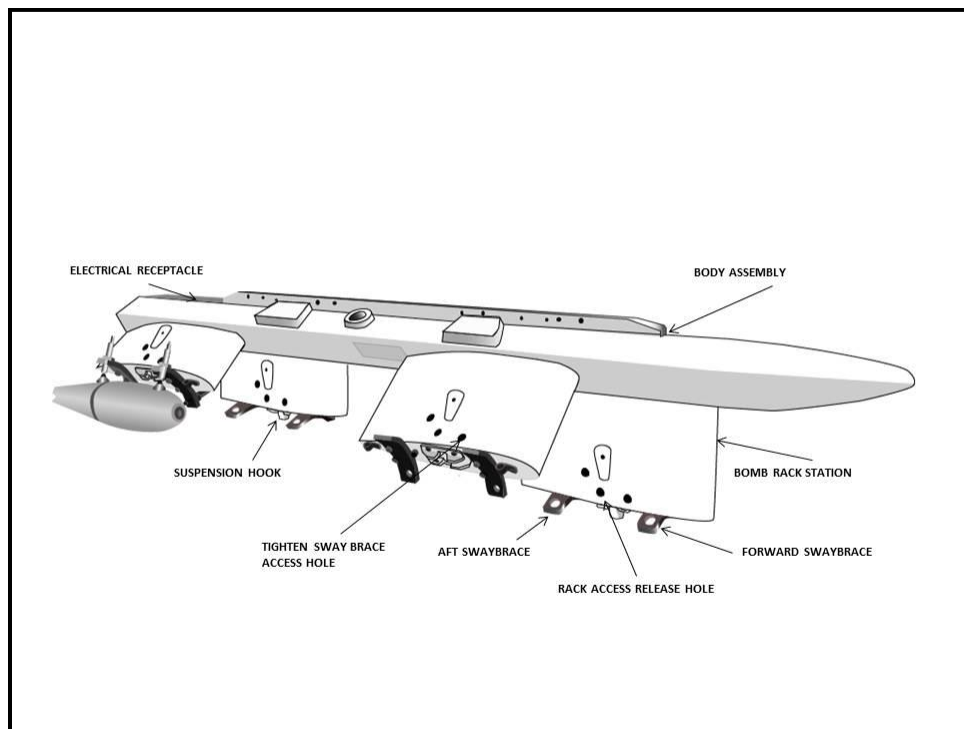


Figure 2-3 BRU-38

The BRU-38 is designed to carry up to six practice bombs. A typical strike sortie loadout will be four bombs per BRU-38 for a total of eight per aircraft. With this loadout, release order is as follows: center aft, center forward, left aft, and right aft (Figure 2-3).



Figure 2-4 Typical Bomb Load-out

203. PREFLIGHT INSPECTION OF ORDNANCE

Careful preflight inspection of ordnance will help to ensure a safe and successful flight. Use the following procedures for ordnance preflight (Reference NATOPS Chapter Twenty-One).

- BRU-38/Practice Bombs Preflight
 - a. All cockpit armament switches should be set to OFF, SAFE, or NORMAL
 - b. Check that the weight on wheels bypass switch lever is locked to WEIGHT ON WHEELS position (located in the nose wheel well).
 - c. Check security of PMBR/BRU-38 to station with safety pin installed from right-hand side (Figure 2-5).
 - d. Check electrical cable (pigtail) and cannon plug secure from pylon to PMBR/BRU-38 (Figure 2-5).
 - e. Check each bomb for security to the BRU-38. You may grasp each bomb by nose and tail and cautiously check for movement; slight movement should be evident. Too much play indicates improperly attached ordnance; a bomb with no movement at all may not drop when you release it at the target. If you are in doubt, call an ordnanceman. Do not attempt readjustment yourself.
 - f. At the rear of the BRU-38, check the station selector on SAFE (Figure 2-5).
 - g. Check the nose of each bomb for a smoke charge secured by a cotter pin (Figure 2-6).

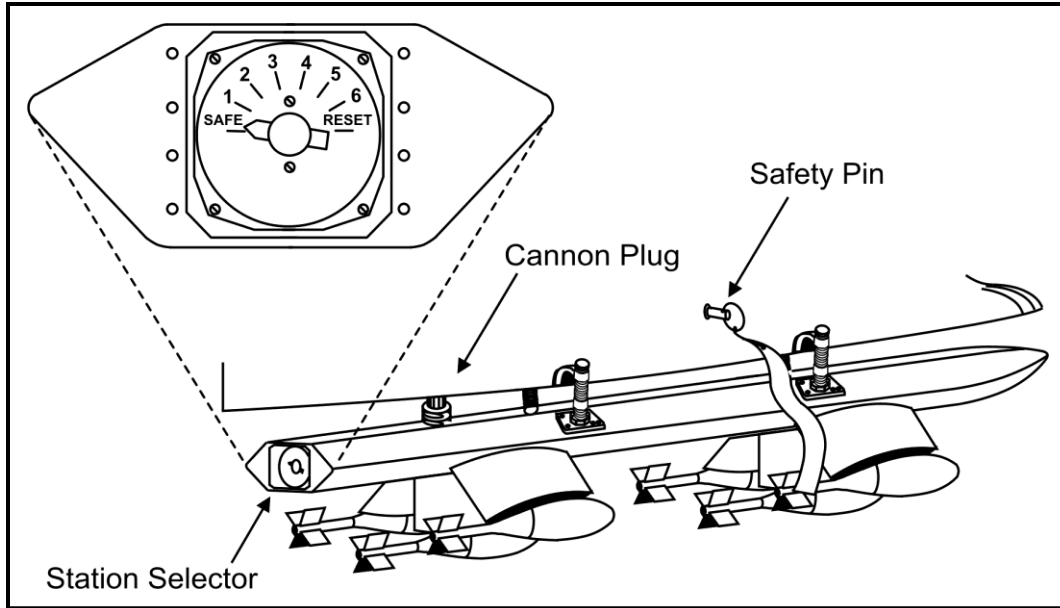


Figure 2-5 Station Selector on BRU-38

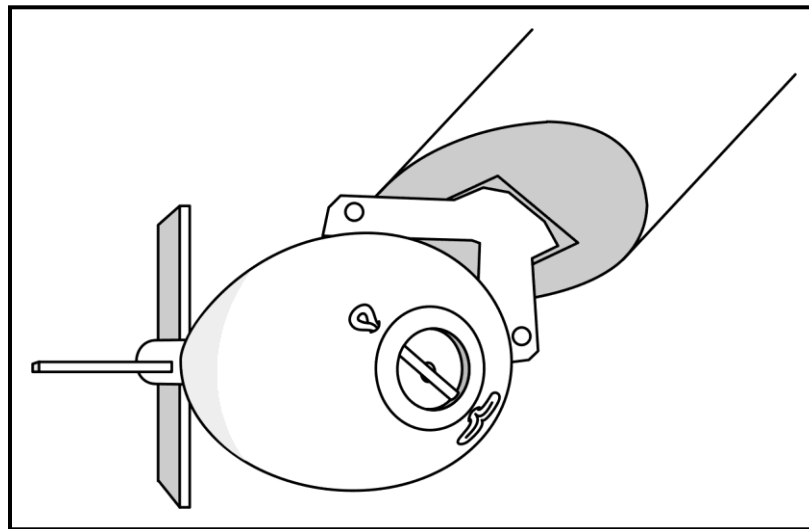


Figure 2-6 Secure Smoke Charge in nose of MK-76

CHAPTER THREE STRIKE DELIVERY THEORY AND PRINCIPLES

300. INTRODUCTION

This chapter will discuss general theory behind Air-to-Surface employment. Topics covered will be the bombing triangle and its components, factors affecting weapons trajectory, and Z-Diagram development / basic weaponeering.

301. THE BOMBING TRIANGLE

The bombing triangle is composed of *altitude*, *slant range* from the aircraft to the target, and the *down range travel* of the weapon.

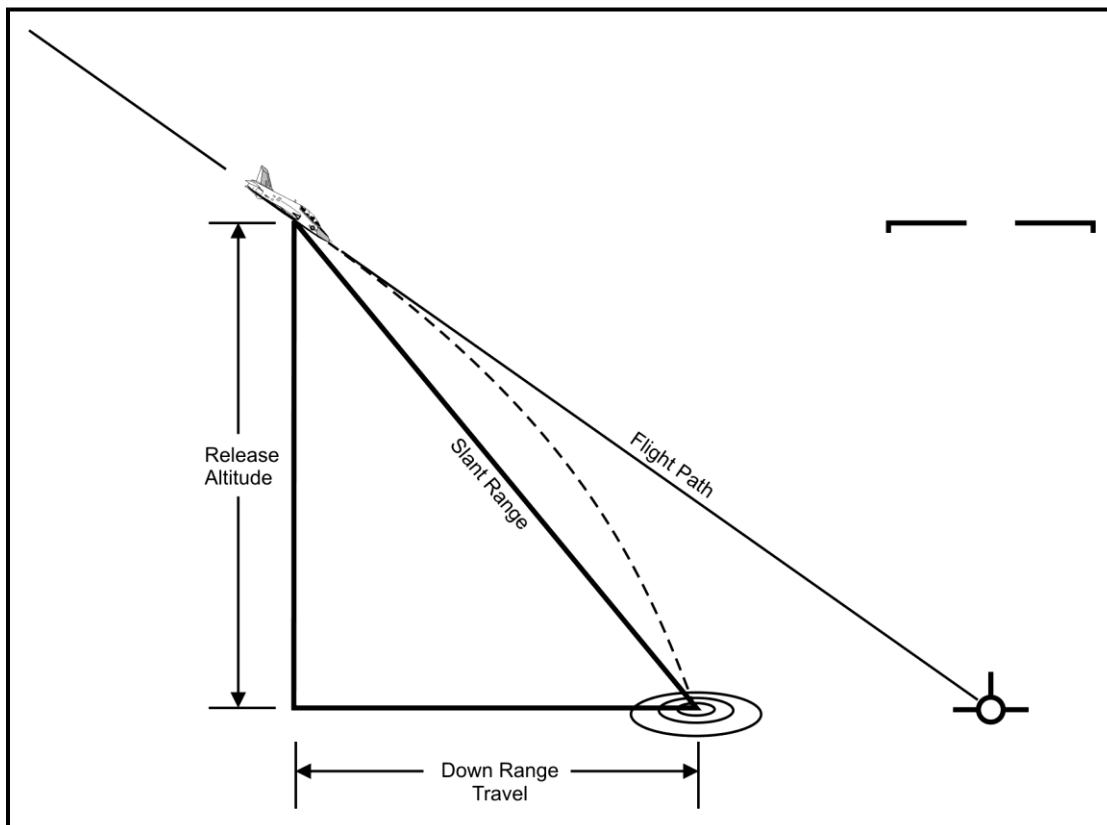


Figure 3-1 The Bombing Triangle

If we were to extend the flight path up to roll-in altitude, we can reference this line as being on, below, or above the bombing triangle. Aircraft flight path in the dive is also called the dive “wire.”

Definitions Relating to the Bombing Triangle

1. Flight Path. The path of the aircraft throughout the dive. The Velocity Vector in the HUD depicts aircraft Flight Path.
2. Flight Path Angle. The angle between the horizon and the Flight Path of the aircraft.
3. Dive Angle. The angle between the horizon and tangent line across the top of the airspeed and altitude boxes or waterline “W.”
4. Line of Sight. The line created by looking directly through the HUD to the target.

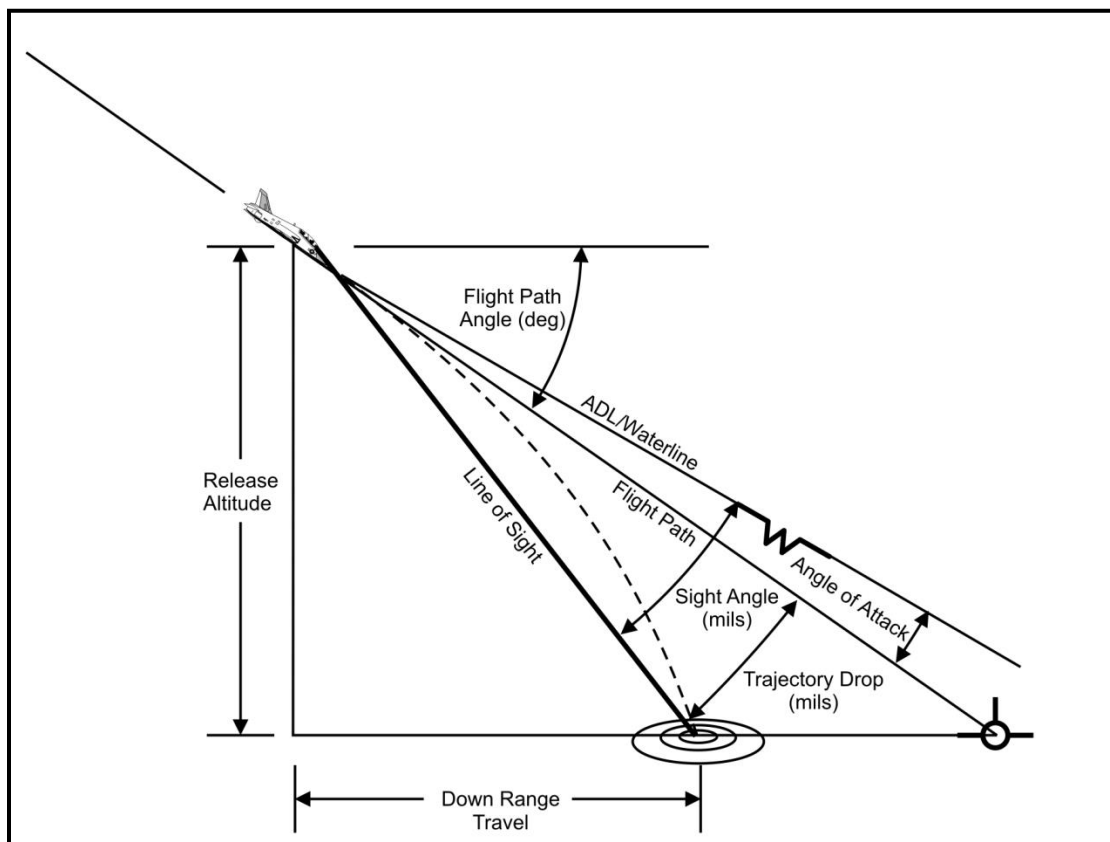


Figure 3-2 Bombing Triangle Definitions

5. Armament Datum Line (ADL). The fixed reference line through the longitudinal axis of the aircraft that parallels the flight path at planned release airspeed (450 KTAS). The ADL can be found in the HUD by drawing a straight line across the top of the airspeed and altitude boxes.
6. Sight Angle. Defined as the angle (in mils) below the ADL, this is the sum of the trajectory drop, angle of attack and parallax of a particular dive. The setting can be found on the delivery data table.

NOTE

At 450 KTAS, the Velocity Vector and ADL are equal in a zero headwind / tailwind condition. With a headwind, the ADL will be shallower than the Velocity Vector and with a tailwind; it will be steeper than the Velocity Vector.

7. Trajectory drop. The amount the weapon falls during its ballistic time of flight due to effects of gravity measured in mils. This can be found in the delivery data table.
8. Mil. A unit of angular measurement that subtends 1 foot at 1,000 feet. It is 1/6400 of a circle. 1 mil = 1 foot at 1,000'. There are 17.45 mils to every 1-degree.
9. Time of Fall. The time from weapons release to weapons impact.

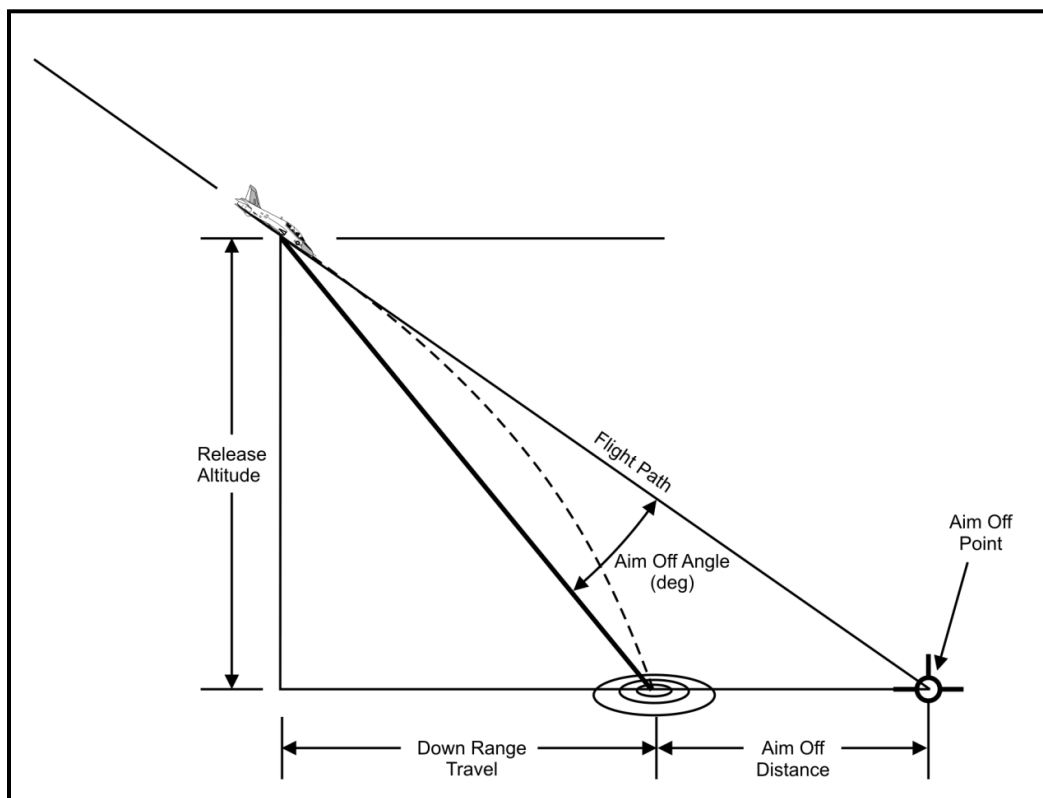


Figure 3-3 Aim-Off Distance/Point/Angle

10. Aim-Off Distance. The distance measured from the target to a point the flight path intersects the ground.
11. Aim-Off Point. A ground feature or point on the ground that represents the aim-off distance.
12. Aim-Off Angle. The angle created between the flight path angle and line of sight to the target.
13. Target Depression Angle. The angle created between the horizon and line of sight to the target. It is the number of degrees the target is depressed below the horizon, the sum of the flight path angle and aim-off angle.
14. Initial Sight Picture (ISP). The initial placement of the Velocity Vector above the target upon rollout at the beginning of the tracking run.
15. Attack Cone Distance (ACD). The optimal distance from the target (based upon the planned Z-Diagram) from which a roll-in is commenced. If the roll-in is accomplished on the planned roll-in altitude and distance, the aircraft should be established on the bombing triangle at the beginning of the tracking run. This point is synonymous with the ***Roll-In Point*** or “RIP.”

302. FACTORS AFFECTING TRAJECTORY (MANUAL MODE)

Yaw

A skid or sideslip can also affect the trajectory of the weapon by causing a false sight picture. This occurs when the balance ball is not centered. When a bomb is released, it travels along the same flight path over the ground as the aircraft represented by the uncaged Velocity Vector. Any yaw or sideslip will create lateral deviations in hits.

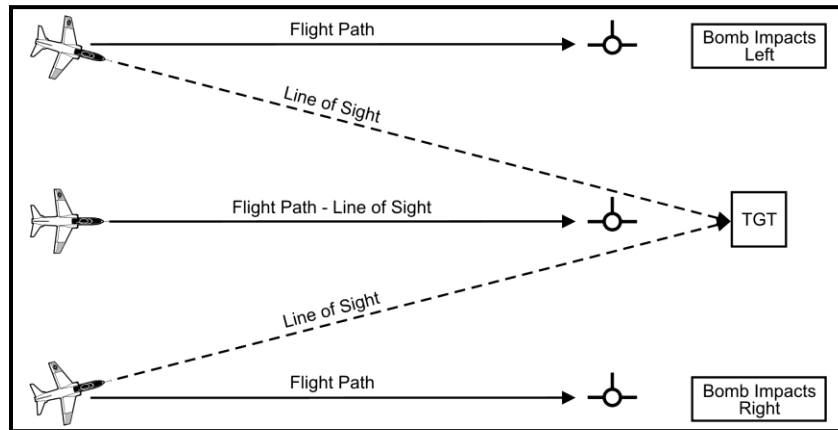


Figure 3-4 Yaw

Bank Angle

Any angle of bank at release will cause a false sight picture particularly in the manual mode of employment. This error is caused by the pendulum effect (Figure 3-5). If the aircraft is in a roll to the left, the reticle will appear to move to the right along the ground. If a bomb is released with the reticle on the target while the aircraft is in a right bank, the hit will be to the right and short.

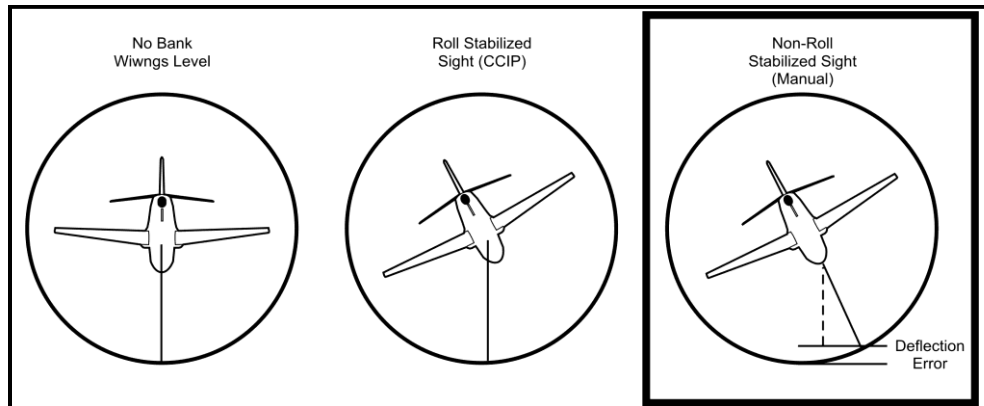


Figure 3-5 Bank Angle

G at Release

Proper G at release depends on dive angle. For a 30-degree delivery, approximately 0.87 G is required to maintain a consistent flight path. A 10-degree dive requires approximately 1 G. The mil setting for each type of delivery is valid given proper G at release. Incorrect G at release will change the angle of attack of the ADL and will invalidate aircraft mil setting by causing a false sight picture. Excessive G will cause an early sight picture. If excessive G is applied to obtain the proper sight picture with other parameters correct, the bomb will impact short of the target. Insufficient G will cause a long hit. Too much G will shallow the dive angle, and insufficient G will steepen it.

Maintaining the Velocity Vector on the appropriate dive angle will result in the proper G at release. A common error in early strike sorties is not being properly trimmed for release and allowing the Velocity Vector to “creep” up as the aircraft seeks 1 G flight.

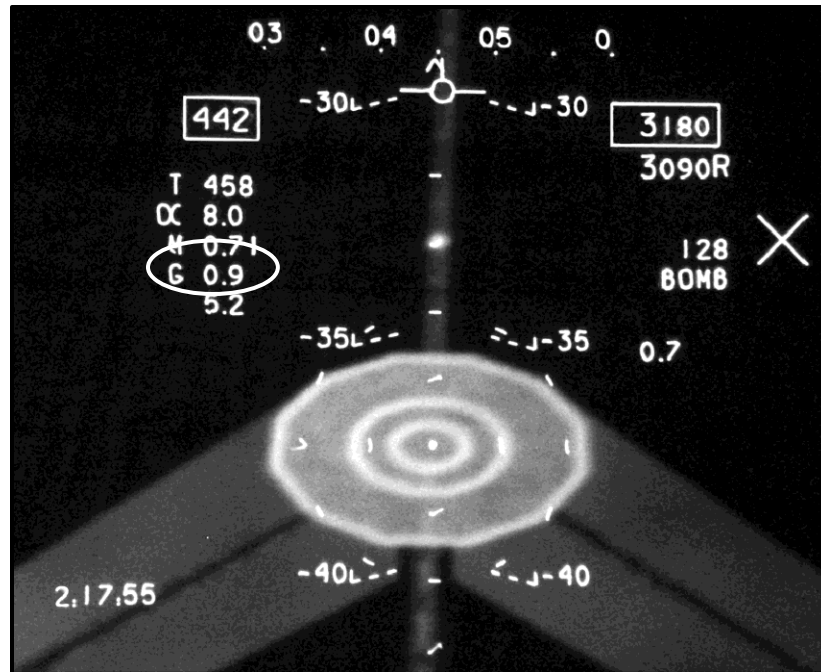


Figure 3-6 G at Release

The manual Z-diagrams contain a specific mil setting that accounts for the trajectory drop of the weapon. Each mil setting is calculated so that a bomb released on parameters (proper altitude with correct airspeed, dive angle, G, wings level, zero yaw, and reticle placement) will hit the target. A change in any of these parameters will affect the trajectory of the weapon. The following section explains the effects of dive angle, airspeed and altitude deviations on bomb trajectory.

Dive Angle

Deviations from planned dive angle will cause a false sight picture. A steep dive will cause a long hit and a shallow dive will cause a short hit. Consider a bomb released at a dive angle of 90 degrees. Given the effects of gravity, there is no trajectory drop relative to the reticle. Thus, a steeper planned dive angle requires a smaller mil setting. A bomb released from a steep sight picture will result in too large a mil setting, leading the bomb to strike beyond the target. A bomb that is released shallow will require a greater mil setting, otherwise it will hit short of the target (Figure 3-7).

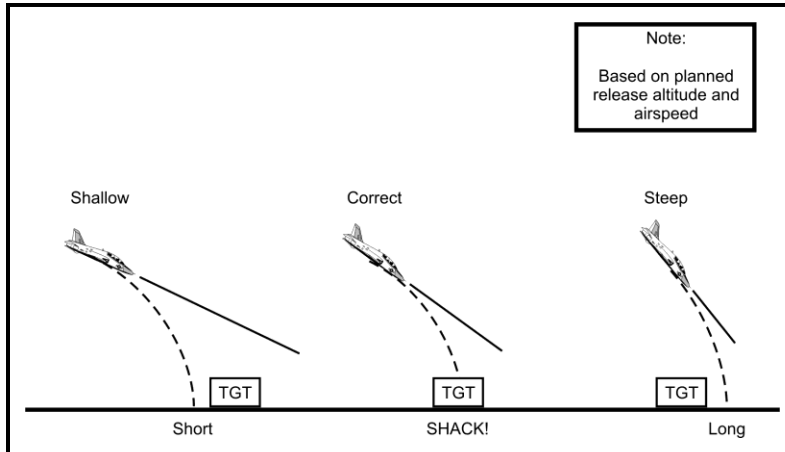


Figure 3-7 Dive Angle Error

Airspeed

Any deviation from planned release airspeed will also cause a false sight picture. Higher airspeed at planned release will decrease AOA and bring the reticle short of the impact point causing a long hit. Slower than planned airspeed at release will result in the reticle aimed long, causing a short hit. Airspeed also has an effect on weapon time of fall (Figure 3-8).

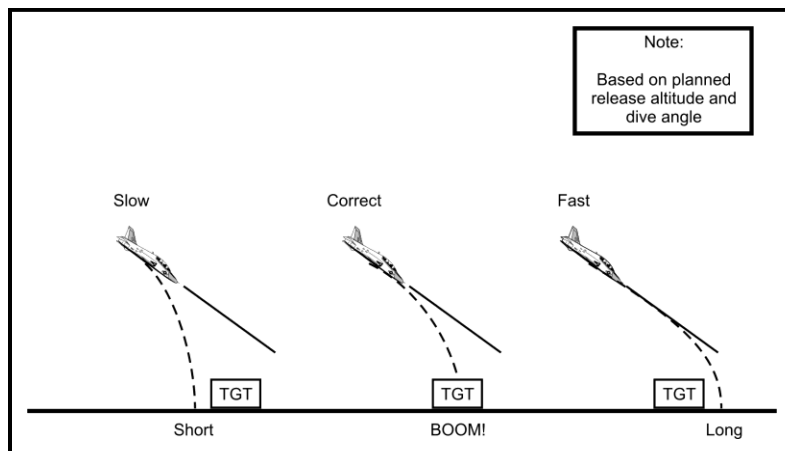


Figure 3-8 Airspeed Error

Altitude

Releasing high will increase the time of fall of the weapon, thus increasing the time during which gravity and drag can act to bend its trajectory. The horizontal distance to the target is also increased. A high release given all other parameters are correct will result in a short hit. Similarly, a low release given all other parameters are correct will result in a long hit (Figure 3-9).

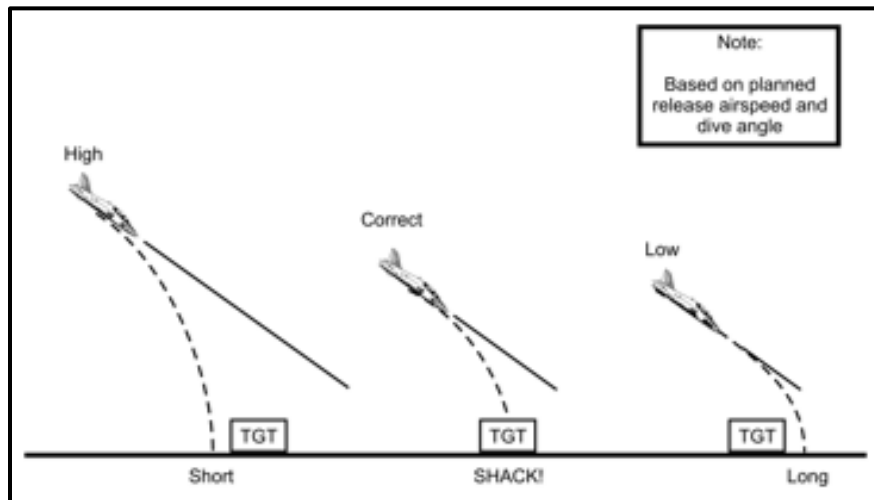


Figure 3-9 Altitude Error

Error Sensitivities

It is important to understand how errors will affect overall accuracy. Knowing how to compensate for deviations from planned parameters while understanding exactly how dive angle, airspeed, and altitude affect accuracy and how they relate to one another is crucial for achieving consistent results.

EXAMPLE: A 1-degree error in dive angle given a 30-degree delivery will cause a 50-foot deviation in hits, and a 10-knot airspeed error will have the same effect. Further discussion on error corrections can be found in Chapter Eight

	<u>Dive Angle</u>		<u>Release Airspeed</u>		<u>Release Altitude</u>	<u>Error</u>
10° Bombs	+/- 1°	=	+/- 10 kts.	=	+/- 100 ft.	= +80'
20° Bombs	+/- 1°	=	+/- 10 kts.	=	+/- 100 ft.	= +50'
30° Bombs	+/- 1°	=	+/- 10 kts.	=	+/- 100 ft.	= +50'

Figure 3-10 Error Sensitivities (for reference with Manual deliveries)

303. FACTORS AFFECTING TRAJECTORY (CCIP MODE)

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

Wires

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

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

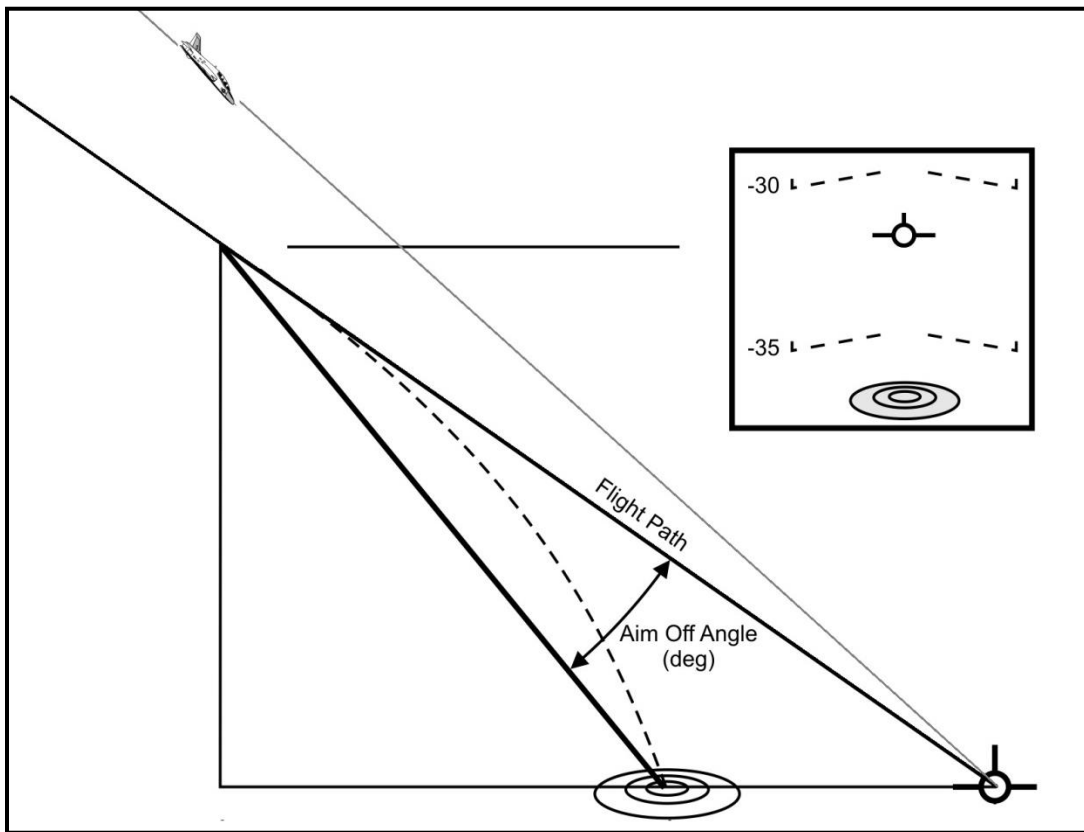


Figure 3-11 Steep Wire

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

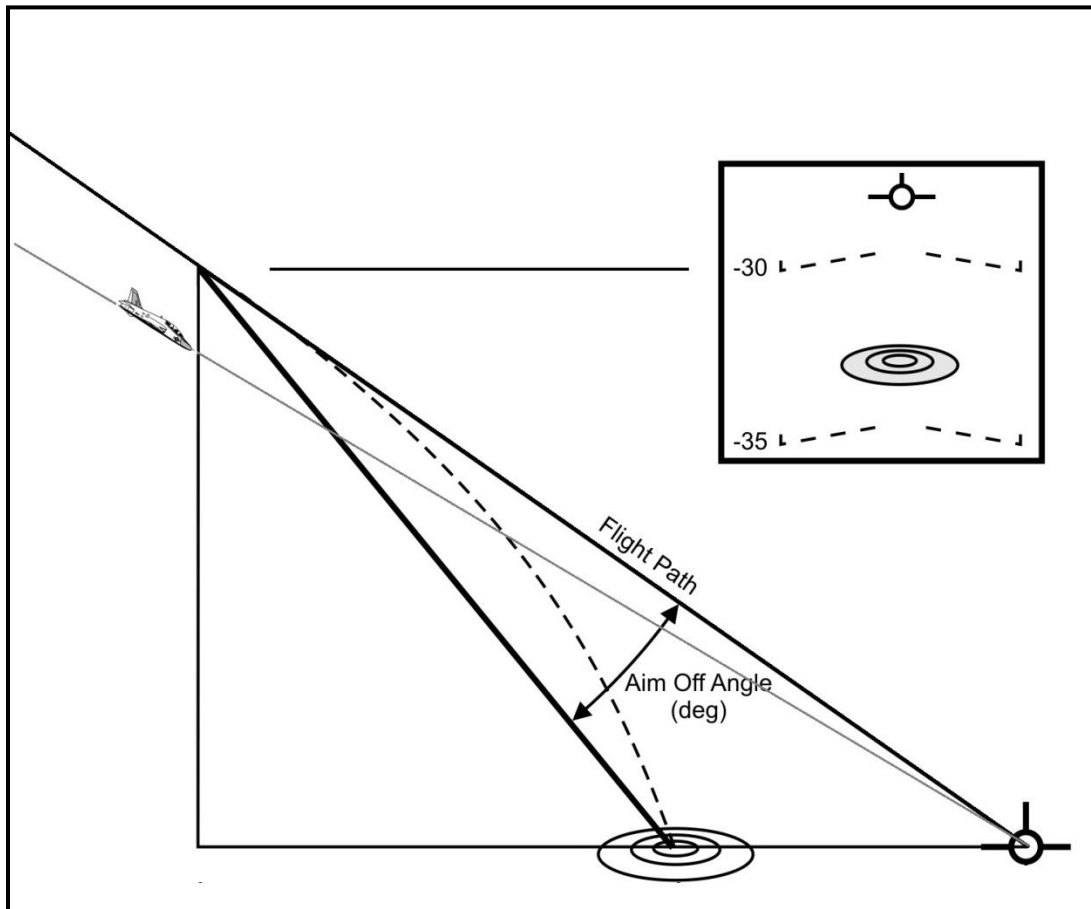


Figure 3-12 Shallow Wire

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

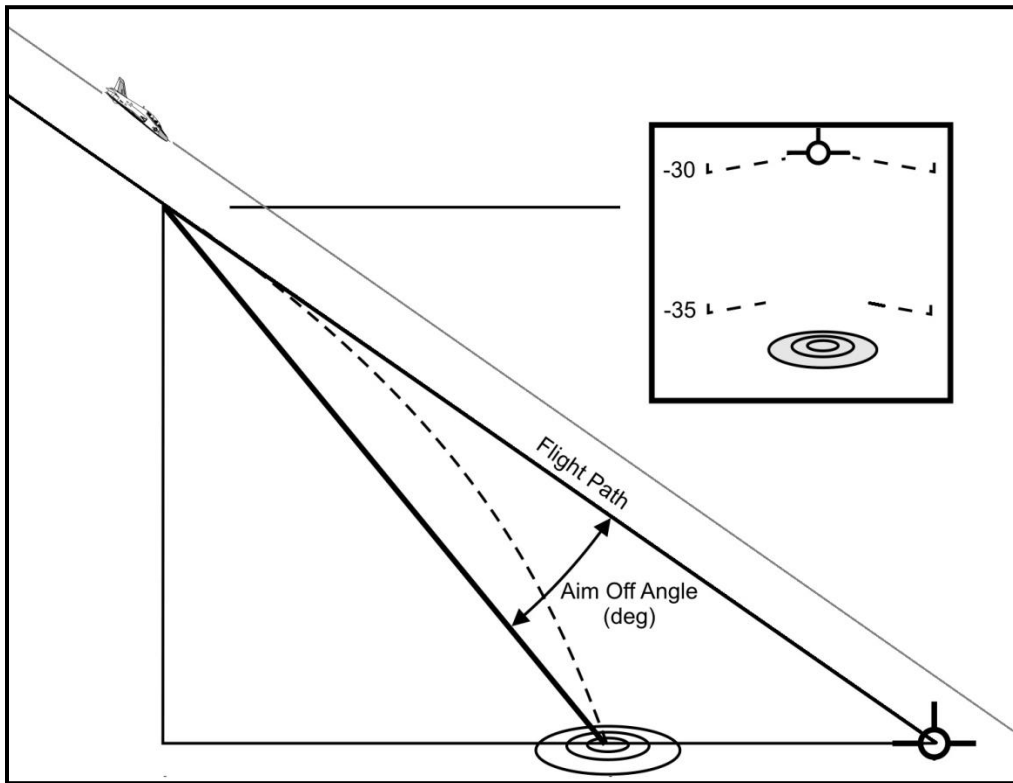


Figure 3-13 High Wire

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

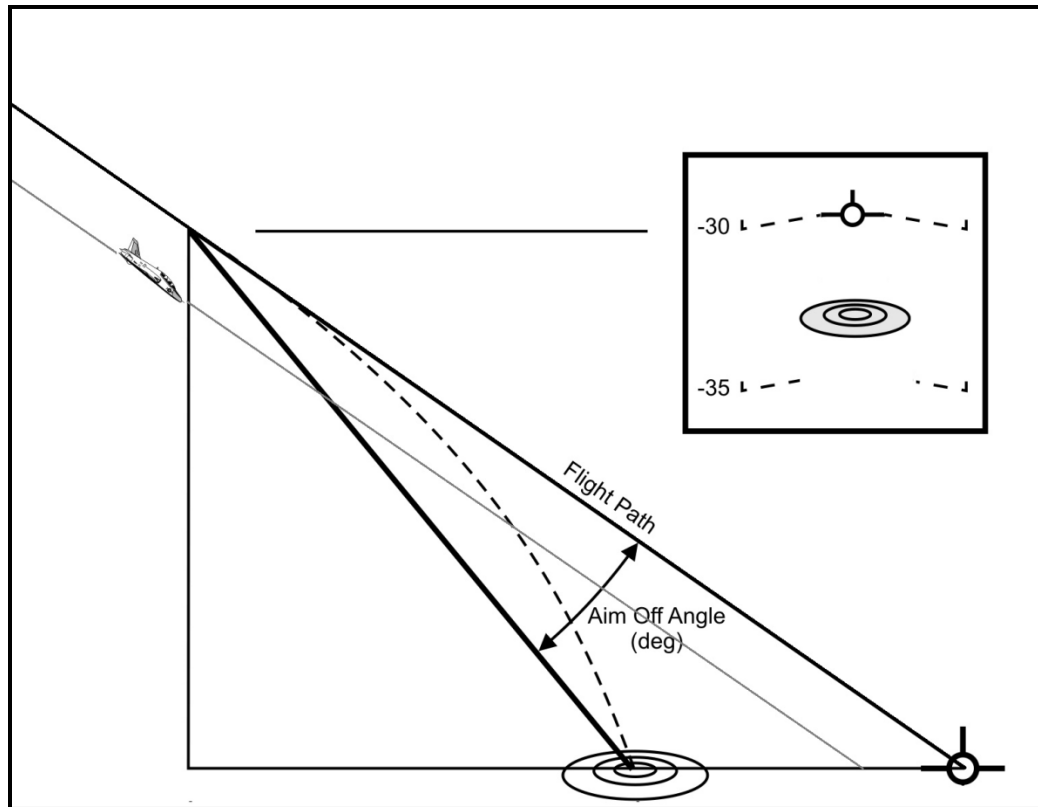


Figure 3-14 Low Wire

High or low wires result in large deviations in release altitude. In order to correct for a high wire, set the correct aim-off immediately once established in the dive, and accept a steep wire. In order to correct for a low wire, set the correct aim-off immediately once established in the dive, and accept a shallow wire. As long as the dive angle on the steep or shallow wire doesn't meet abort criteria, bomb release should occur close to Planned Release altitude. Abort and validation criteria on allowable dive angle and altitude deviation will be discussed in Chapter Ten.

Winds will also affect ability to adhere to planned Z-Diagrams. To correct for a headwind or tailwind, adjust the RIP according to the following rule-of-thumb: Add/subtract .1 NM from planned RIP distance for every 20kts of tailwind/headwind. (Ex. For a 30° CCIP dive delivery with a RIP of 2.2 NM, compensate for a 20kt headwind by adjusting the RIP to 2.1 NM, or for a tailwind by adjusting RIP to 2.3 NM.)

304. BASIC WEAPONING

The Z-Diagram

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

The first step in building a Z-Diagram is to determine the MINALT or Minimum Altitude. There are four factors that determine how low we can go and why we *do not* want to continue below the MINALT. They are: 1) Enemy Threat, 2) Weapon Fragmentation, 3) Weapon Arming Time (fusing time), and 4) Terrain. The most critical of these will drive our tactics and be the determining factor of calculating MINALT.

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

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

Weapon Arming Time (fusing). If release occurs too low, the time of fall of the weapon decreases and the fuse may not have time to arm causing the weapon to "dud." The MK 76 has an instantaneous type of fuse that causes the smoke charge to detonate upon impact.

Terrain. In the Training Command, since enemy threat on a raked range target is highly unlikely, the MK 76 does not explode (but may bounce or skip), and fusing is not a factor, hitting the ground with our aircraft becomes our number one threat and consideration.

Manual and Aim-Off (CCIP) Delivery diagrams differ slightly in depiction. Manual Z-Diagrams contain an additional "checkpoint" altitude during the dive that CCIP Aim-off diagrams lack.

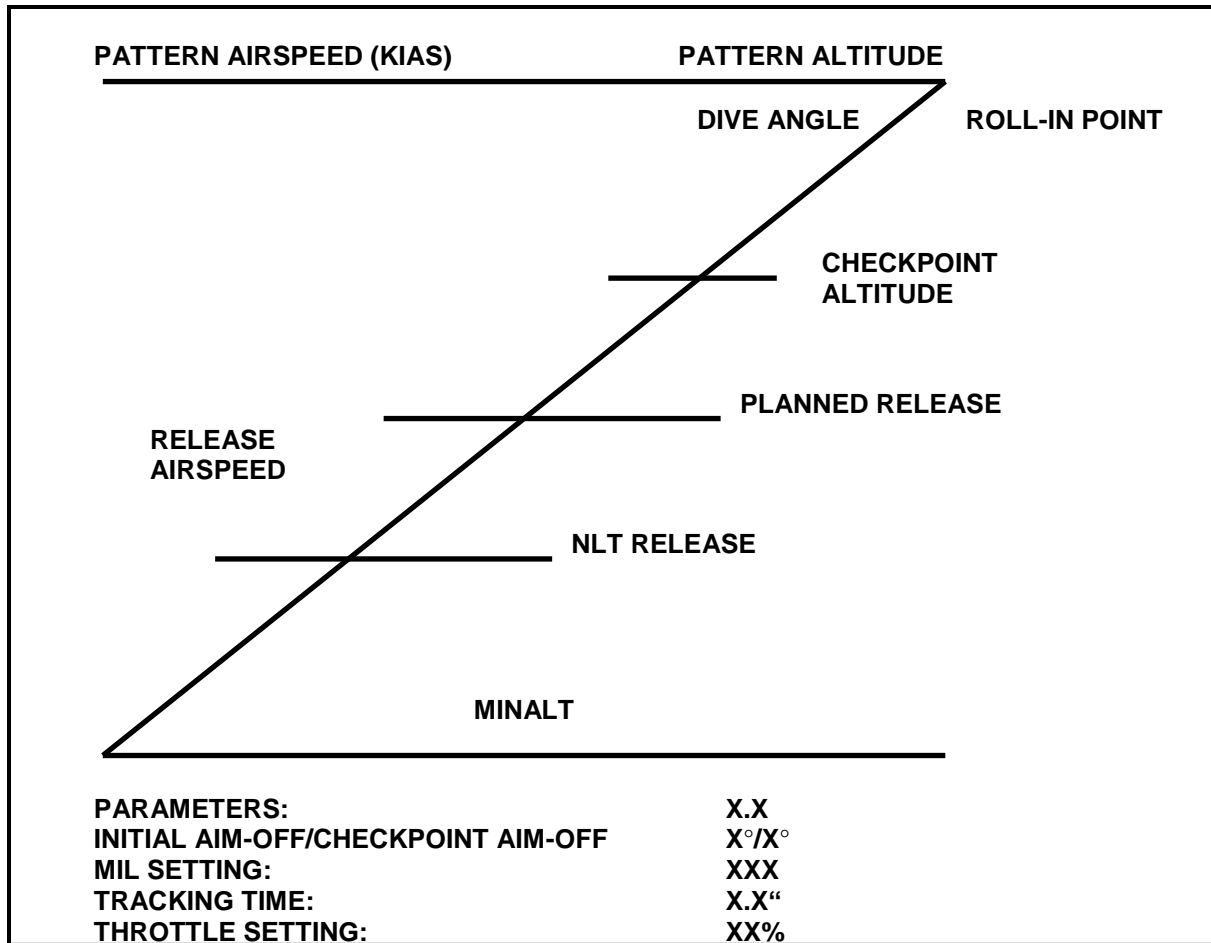


Figure 3-15 Manual Z-Diagram Components

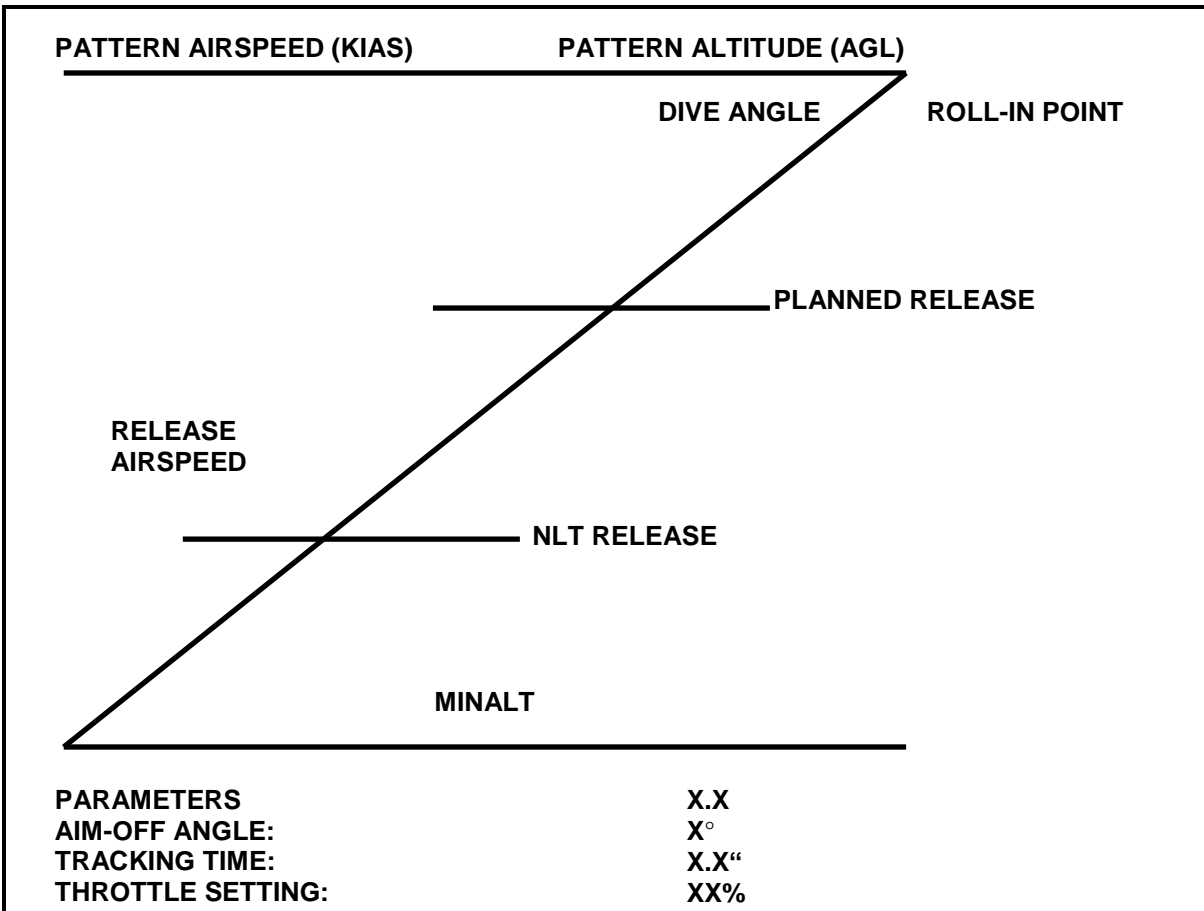


Figure 3-16 CCIP Z- Diagram Components

Planned Release altitude, or PR, is the altitude at which the release solution will occur given the aircraft is on planned dive angle and airspeed with the correct aim-off angle set. Releasing at PR also guarantees that the aircraft can be steep (up to 10° steep for high-angle, or 5° steep for low-angle bombing) and up to 50 knots fast and still recover above MINALT when a 4 G pull is initiated within 2.5 seconds. No Lower Than release altitude, or NLT release, is the lowest calculated safe release altitude. Release at this altitude guarantees the ability to recover above MINALT when on planned dive angle, and up to 50 knots fast. **Releasing below the NLT Altitude is not tolerated.** If upon reaching NLT release a valid solution has not been reached, ABORT. For the full list of abort criteria, refer to Chapter Eleven.

Aim-Off Angle is shown below the Z-Diagram. This is how far past the target the Velocity Vector needs to be in order to compensate for the trajectory drop of the weapon. All altitudes on the Z-Diagram are depicted in AGL. A space is allotted on the Z diagrams to add target elevation to the AGL altitudes thereby deriving the MSL altitudes flown in the aircraft. Release Power Setting is the power setting prior to roll-in that achieves planned release airspeed. Realize that these throttle settings are approximate and do not substitute for an effective airspeed scan.

Definitions Related to Z-Diagrams

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

Checkpoint Altitude: This altitude exists on manual Z-Diagrams. At this altitude, check the secondary checkpoint aim-off angle is set.

Dive Angle: The angle between the horizon and tangent line across the top of airspeed and altitude boxes or waterline "W."

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

MIL Setting: MIL setting is the sight depression in milliradians between the target at release, and the aircraft waterline. This is used for manual deliveries only.

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

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

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

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

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

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

Roll-In Point (RIP): The distance from the target at which the attacking aircraft intercepts the attack cone and should arrive 30-45 degrees off planned run-in heading.

Checkpoint Aim-off Angle/Target Placement Angle: Derived for the checkpoint altitude, the angle between the Velocity Vector and the line of sight to the target. Setting the proper angle at checkpoint ensures that the reticle arrives at the calculated aim point by planned release altitude.

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

305. DELIVERY DATA TABLES

DELIVERY DATA MK 76 MOD 5/BDU 33 PRACTICE BOMB										
RELEASE FLIGHT PATH (DEG)	RELEASE AIRSPEED (KTAS)	RELEASE ALTITUDE (FT)	RECOVERY ALTITUDE (FT)	TIME OF FALL (SEC)	DOWN RANGE TRAVEL (FT)	SLANT RANGE (FT)	SIGHT ANGLE (MIL)	TRAJECTORY DROP (MIL)	ANGLE OF ATTACK (MIL)	PARALLAX (MIL)
-10	400	1000	738	5.2	3252	3402	142	124	15	3
		1100	838	5.6	3471	3641	151	132	15	3
		1200	938	5.9	3681	3871	159	141	16	3
	425	1000	716	5.1	3365	3511	129	114	12	3
		1100	816	5.4	3595	3760	137	122	12	3
		1200	916	5.8	3816	4000	145	130	12	3
	450	1000	694	5.0	3472	3613	117	106	9	3
		1100	794	5.3	3712	3872	125	114	9	3
		1200	894	5.7	3943	4121	132	121	9	2
-20	400	2000	1311	6.4	3754	4253	158	140	15	2
	425	2000	1254	6.2	3858	4346	143	129	12	2
	450	2000	1196	6.0	3954	4431	130	119	8	2
-30	400	3000	1725	7.1	3833	4868	156	140	13	2
	425	3000	1596	6.9	3925	4940	141	129	10	2
	450	3000	1468	6.7	4008	5006	128	119	7	2

Figure 3-17 Delivery Data Tables

The data delivery tables for the T-45C can be found in Chapter Twenty-One of NATOPS. There are multiple tables at the end of the chapter; always check the headings first to ensure you're looking at the correct one. Shown here is the table for the MK 76 Practice bomb.

These tables depict sight angle settings, recovery altitudes and weapon time of fall that are of particular significance in Manual bombing.

To use this chart, find the delivery parameters for the briefed dive angle. For example, a 30-degree dive, 450 KTAS, and a 3,000' AGL release altitude. Follow that line across for the information you need. In manual deliveries, we will reference *Time of Fall (TOF)* and *Sight Angle (SA)*.

EXAMPLE: TOF is 6.7 and SA is 128.

TOF is used in determining offset aim point and will be discussed later.

The Sight Angle setting is the value used for adjusting the reticle in manual deliveries. Notice, the sight angle is the sum of the trajectory drop, AOA, and Parallax in mils.

306. DIVE RECOVERY CALCULATIONS

The recovery altitudes in the delivery data tables indicate aircraft “bottom out” altitudes and are based on a straight path dive release with the following assumptions (NATOPS Chapter Twenty-One):

1. Aircraft gross weight: 13,875 lbs.
2. Straight flight path release.
3. 1.0 second pilot/aircraft response delay after weapon release.
4. Wings level, G build-up to 4 G’s within 1.25 seconds.
5. Fifteen degrees flight path run-out angle.
6. Constant throttle setting during release and recovery.
7. Single weapon release.
8. Sea level target.
9. Standard day as given in U.S. Standard Atmosphere, 1962.

Recovery Altitudes (MK 76 Deliveries)			
RELEASE FLIGHT PATH (DEG)	RELEASE AIRSPEED (KTAS)	RELEASE ALTITUDE (FT)	RECOVERY ALTITUDE (FT)
-10	400	1000	738
		1100	838
		1200	938
	425	1000	716
		1100	816
		1200	916
	450	1000	694
		1100	794
		1200	894
-20	400	2000	1311
	425	2000	1254
	450	2000	1196
-30	400	3000	1725
	425	3000	1596
	450	3000	1468

Figure 3-18 Recovery Altitudes (MK 76 Deliveries)

Z-Diagram release altitudes, RADALT settings, and Break X computations are based upon the above information. Further information on altitude lost in the dive recovery can be interpolated from charts in Chapter Thirty-Three of NATOPS.

307. STANDARDIZED Z-DIAGRAMS

The standardized Z-Diagrams for both CCIP and Manual dive deliveries include 30, 20 (Manual Only), 15 (CCIP Only), and 10-degree dives. The standardized 15 and 10 degree Pop-Up Z-Diagrams are covered in Chapter Seven. All Z-Diagrams have been calculated and tested using the Dive Delivery tables in NATOPS as well as the previously discussed assumptions regarding Planned Release and NLT Release.

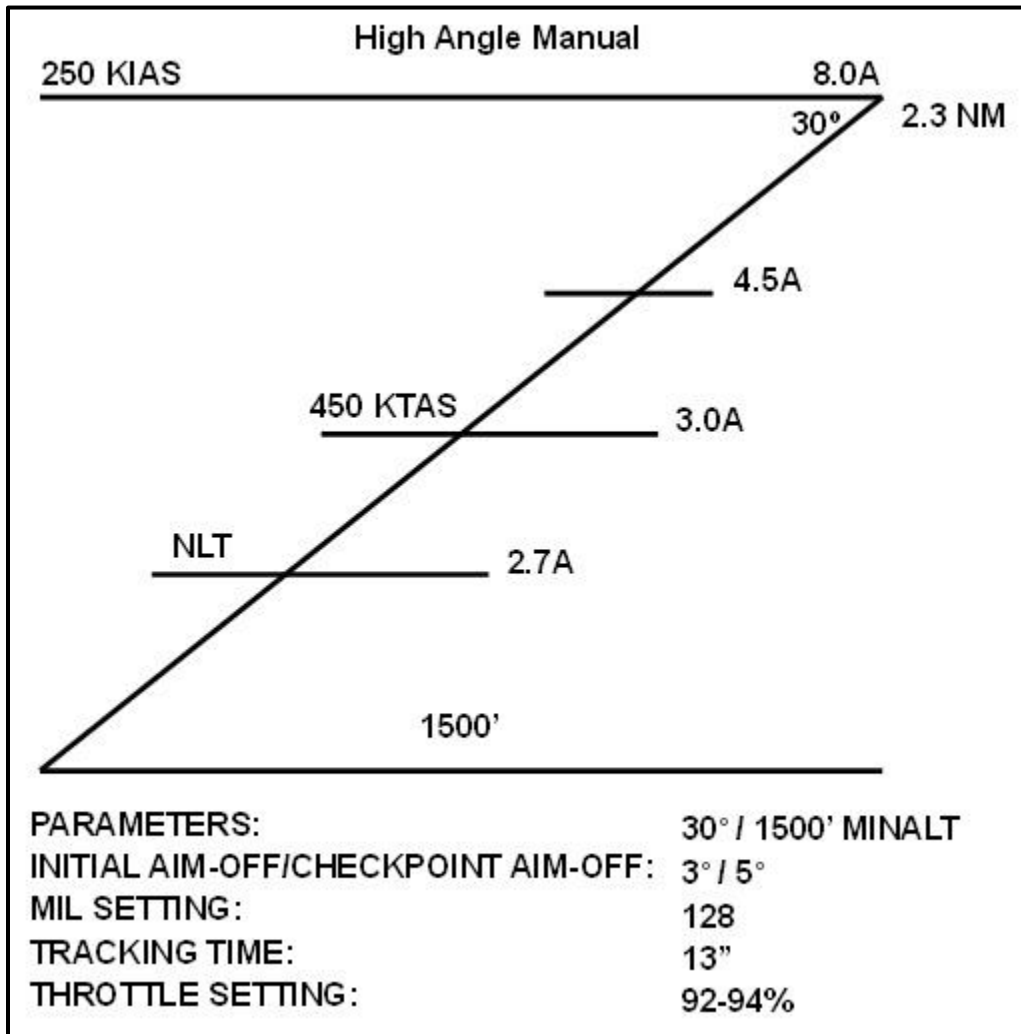


Figure 3-19 High Angle (30°) Manual Z-Diagram

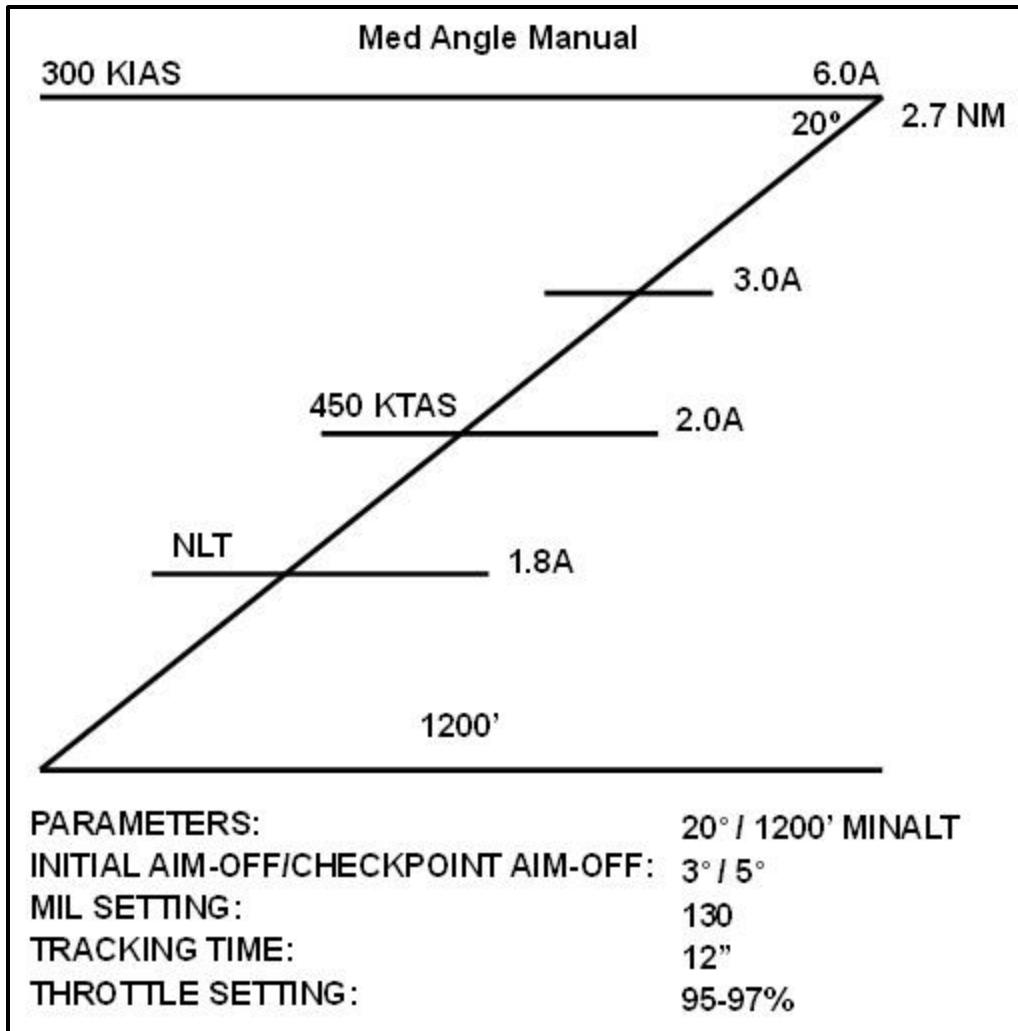


Figure 3-20 Medium Angle (20°) Manual Z-Diagram

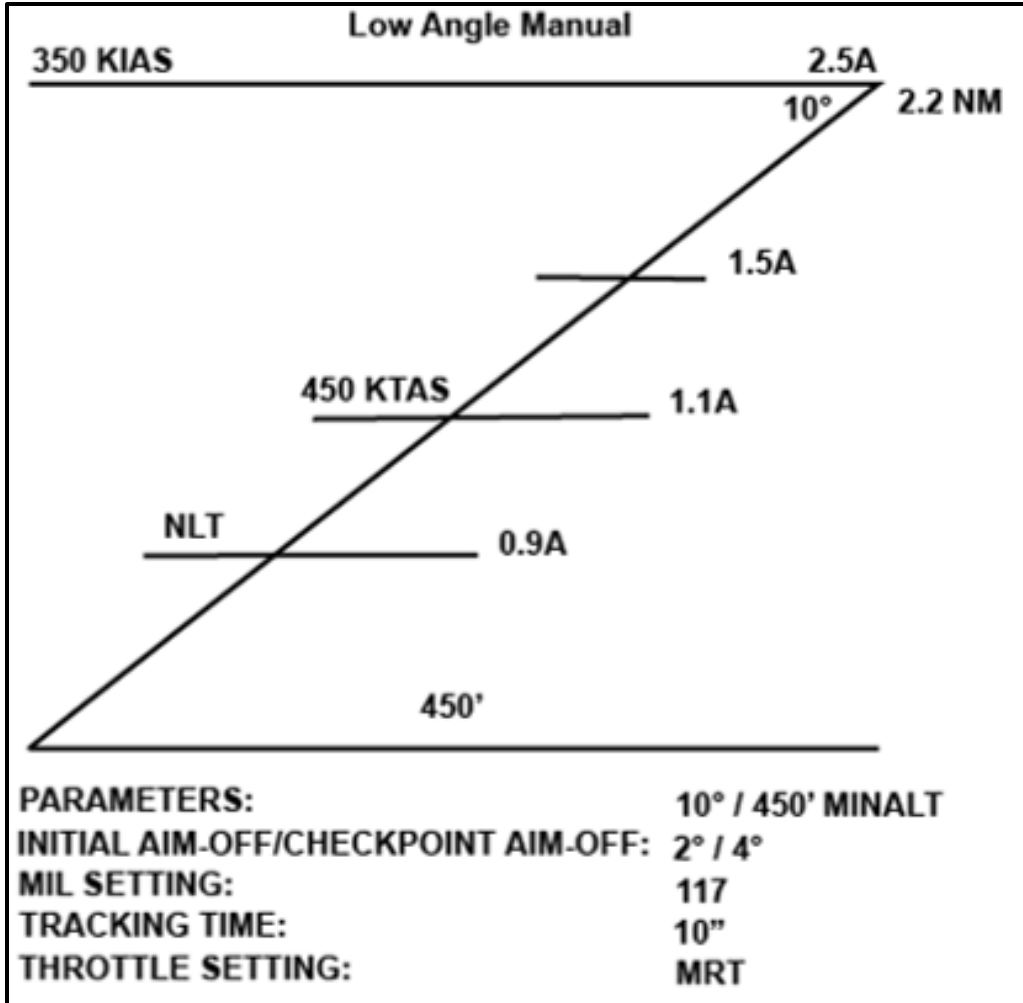


Figure 3-21 Low Angle (10°) Manual Z-Diagram

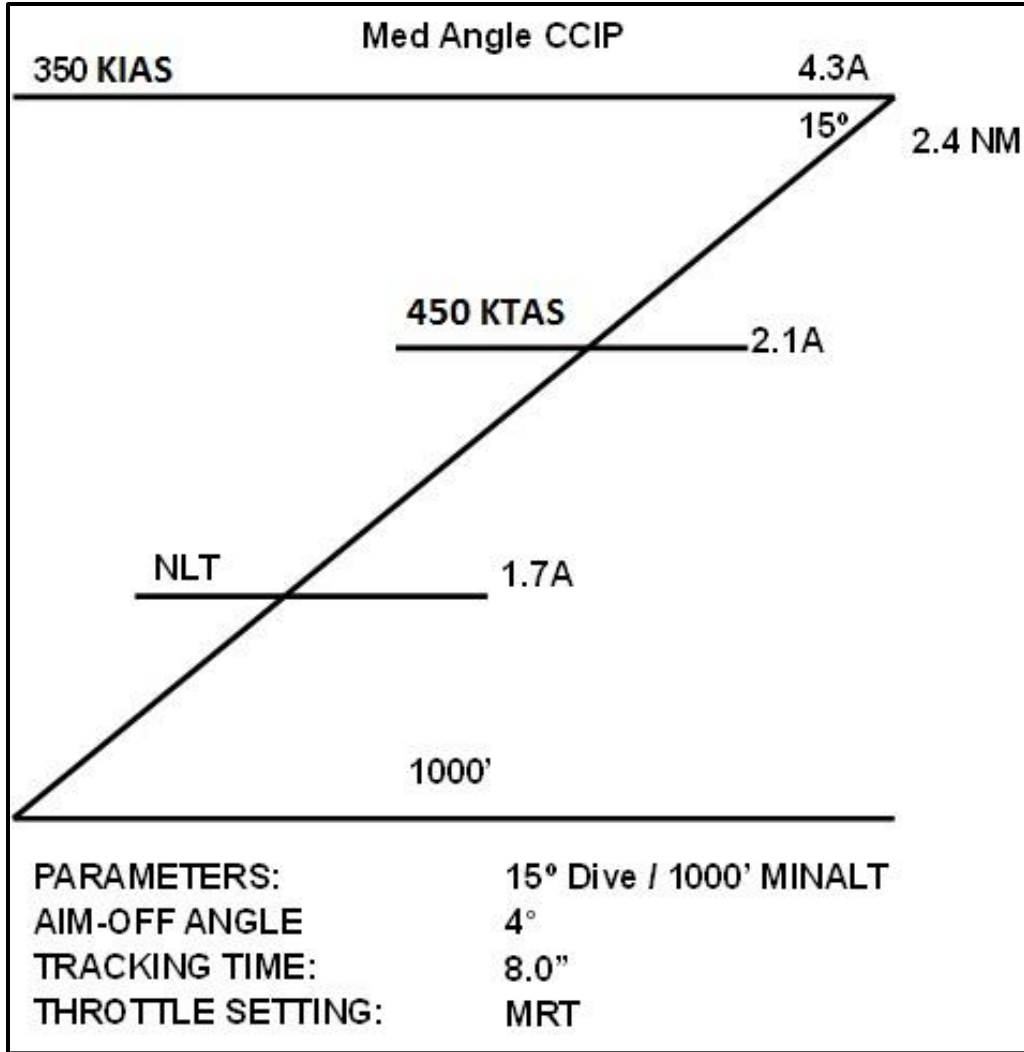


Figure 3-23 Medium Angle (15°) CCIP Z-Diagram

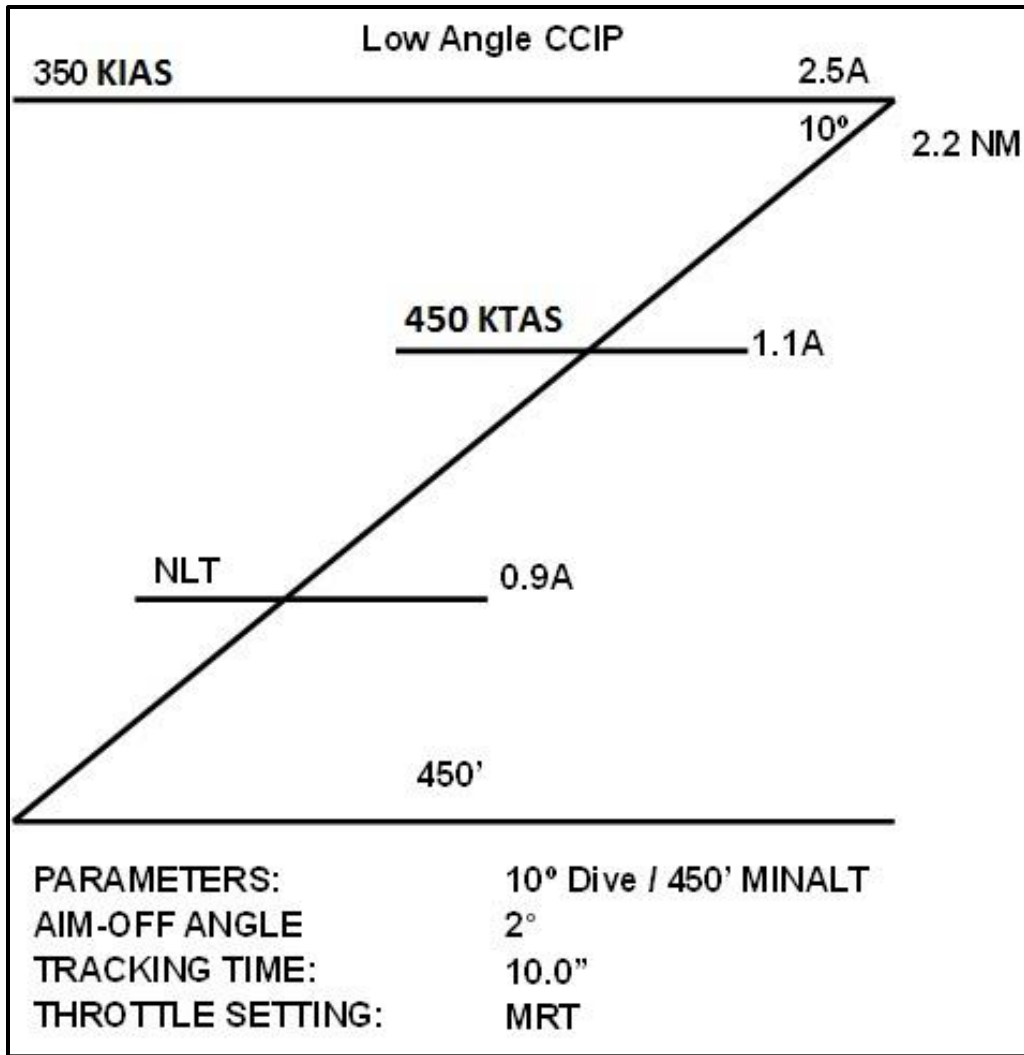


Figure 3-24 Low Angle (10°) CCIP Z-Diagram

CHAPTER FOUR PREFLIGHT PREPARATION

400. INTRODUCTION

This chapter covers strike kneeboard cards and briefing board setup in order to be properly prepared for strike flights in the Training Command.

401. THE STRIKE KNEEBOARD CARD

This is an example of a Strike Flight Kneeboard card. Refer to local standardized kneeboard cards for the current card in use.

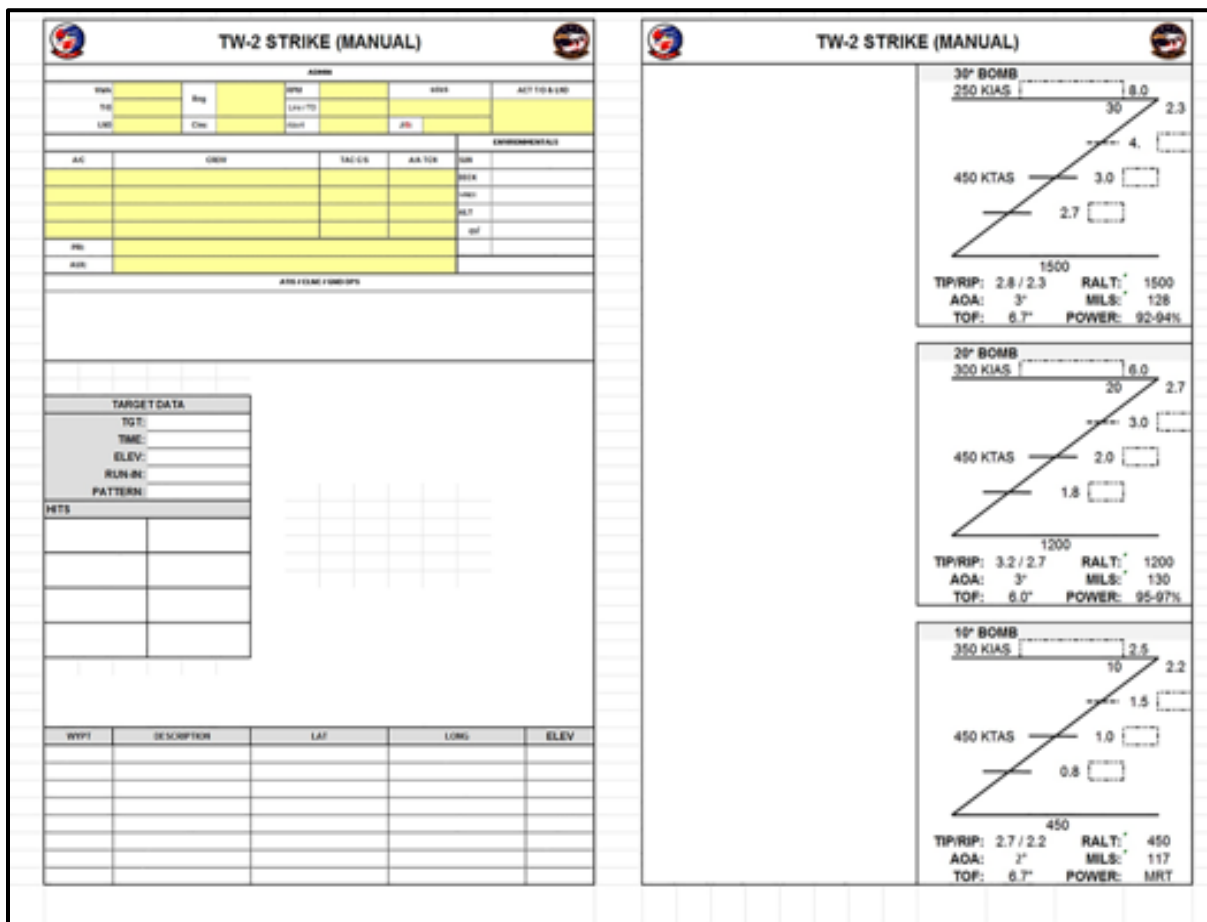


Figure 4-1 The Strike Kneeboard Card (Manual example)

The Strike kneeboard card is filled out specific to each flight. Information on the card should include but is not limited to:

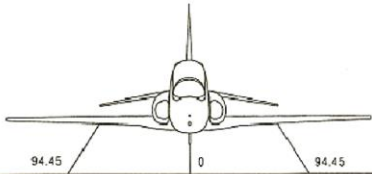
1. A/C lineup, call sign, syllabus event

2. Target Data
3. Target waypoint number, latitude, longitude and elevation
4. Admin timelines
5. Off Target Rendezvous altitudes
6. Planned Z-Diagrams to be flown with space for the addition of calculated MSL altitudes.
7. Any other pertinent specific data the lead briefs

402. LIMITATIONS

Weapons Limitations

Knowledge of NATOPS carriage and release limitations is critical to safely employing ordnance in the T-45C. Figure 4-2 describes T-45 external stores limitations (reference NATOPS Chapter Four).



LBA - LIMIT BASIC AIRCRAFT







STORE	DISTANCE FROM AIRCRAFT CENTERLINE-INCHES			AIRSPEED - MAXIMUM AIRSPEED OR MACH WHICHEVER IS LESS			ACCELERATION - G				MAXIMUM DIVE ANGLE (DEGREES)	ANGLE OF ATTACK LIMITS (UNITS)	CG LIMITS % MAC	CONFIGURATION WEIGHTS (LBS)	APPLICABLE NOTES
	STATION LOADING AND SUSPENSION			CARRIAGE (KAS)	JETTISON (KAS)	RELEASE (KAS)	CARRIAGE		JETTISON						
	RIGHT	CENTER	LEFT				SYM	UNSYM	JETTISON	RELEASE					
Pylon	□		□	525/ 0.80	—	—	LBA	LBA	—	—	LBA	LBA	LBA	Wing/77	1, 2, 3
PMBR/BRU-38A with 0 to 6 Mk-76 or BDU-33 Bombs				525/ 0.80	290 MIN 310 MAX	500/ 0.80	LBA	LBA	1.0	0.5 TO 1.5	45	LBA	LBA	PMBR/87 BRU-38A/98 MK76/25 or BDU33/25 each	7
LAU-68 with 0 to 7 2.75" FFAR				525/ 0.80	200 TO 350	500/ 0.80 MIN A/S 350 MAX ALT 10,000 FT MSL	LBA	LBA	1.0	0.5 TO 1.5	45	LBA	LBA	LAU-68/85 FFAR/21 each	
MIXED LOAD LAU-68 with 0 to 7 2.75" FFAR and PMBR/BRU-38A with 0 to 6 Mk-76 or BDU-33 Bombs				525/ 0.80	290 MIN 310 MAX	500/ 0.80 FFAR MIN A/S 350 MAX ALT 10,000 FT MSL	LBA	LBA	1.0	0.5 TO 1.5	45	LBA	LBA	PMBR/87 BRU-38A/98 MK76/25 or BDU33/25 each LAU-68/85 FFAR/23 each	1, 2, 3, 7

Figure 4-2 External Stores Limitations

LBA stands for Limit of Basic Aircraft. Only authorized station loading and configurations are shown.

The primary aircraft loadout will be 2 pylons, 2 BRU-38's and 8 x MK 76 bombs (4 on each wing station).

Carriage. The airspeed limit on how fast external stores can be carried on the aircraft.

Jettison. The minimum and maximum airspeed envelope to jettison the BRU-38 from the wing stations by selecting (pushing) the emergency jettison button.

Release. The maximum airspeed limitation for weapons release.

Acceleration. The G limits associated with symmetrical/unsymmetrical maneuvers, BRU-38 jettison and normal weapons release.

Maximum Dive Angle. The maximum dive attitude for normal weapons release.

Configuration Weight. Indicates the weight of each item. Example: a normal weapons loadout for a strike flight is:

BRU-38: 87 lbs. X 2 = 174 lbs.

Pylon: 77 lbs. X 2 = 154 lbs.

MK 76: 25 lbs. X 8 = 200 lbs.

264 lbs. per wing station. 528 lbs. addition to the basic aircraft weight. Verify takeoff performance numbers reflect the additional weight.

Aircraft Limitations

The aircraft will have other limitations associated with carrying external stores; landings and G limits.

Landings with External Stores

Refer to Chapter Four NATOPS Limitations. Landing with the BRU-38A (with 1 or more bombs) shall not exceed 600 fpm.

G Limitations

Overstress. Given a decently flown pattern, the most amount of G expected at any given time should be approximately 4.2 to 4.8 G. *You must know the G limitations of the aircraft!* At 450 KTAS, the aircraft becomes noticeably more sensitive to aft stick inputs. Additionally, once over 410 KIAS, the aircraft is above corner airspeed. It is extremely important to be *smooth* with the pull off target.

Symmetrical Maneuvering

Limits for symmetrical maneuvering are +6.5 G to -3.0 G below 5,000' MSL. All pulls off target should be wings-level and symmetrical. That is, when pulling G, pull straight back and avoid any large lateral control inputs.

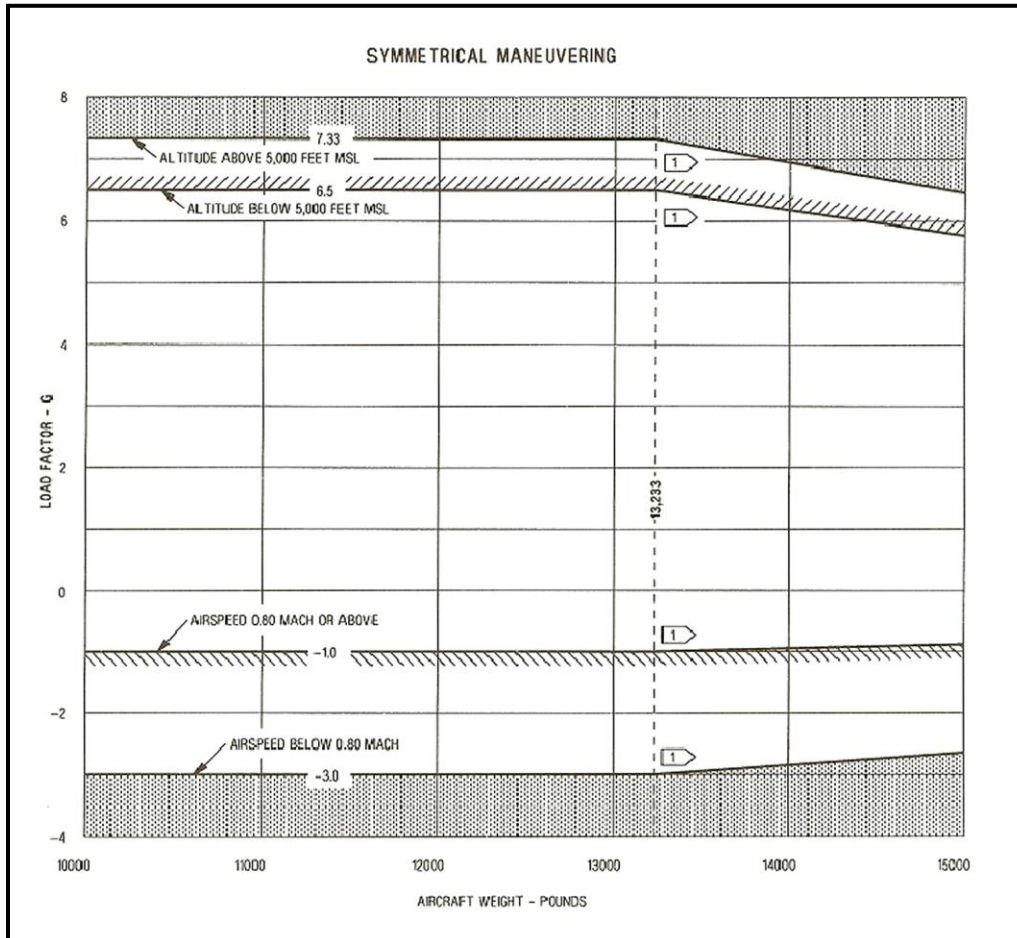


Figure 4-3 Symmetrical Maneuvering

Unsymmetrical Maneuvering

Unsymmetrical limits (rolling pullouts) are reduced to +5.0 G to -0.2 G. This is a big factor in the turn to the abeam, as well as rolling-in to the target in the 10 degree pattern. Remember, before turning the aircraft, relax your pull, roll, then smoothly reapply G.

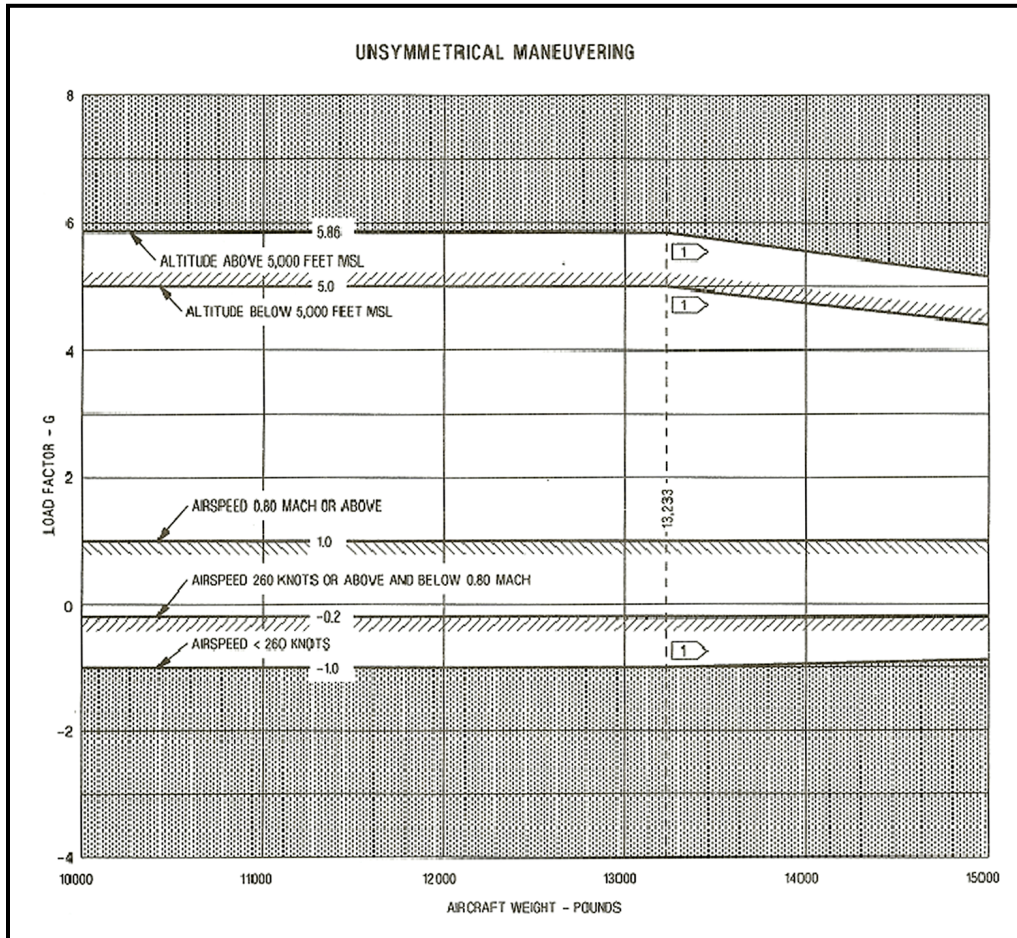


Figure 4-4 Unsymmetrical Maneuvering

403. MINIMUM EJECTION ALTITUDES

This chart can be found in Chapter Seventeen of NATOPS and should be considered boldface. *Always* review the notes at the bottom of the chart.

<u>Dive Angle</u>	<u>Minimum Ejection Altitude (AGL)</u>
30	650'
20	450'
15	350'
10	200'

These are based on initiation of the ejection seat system; pilot reaction time is not included.

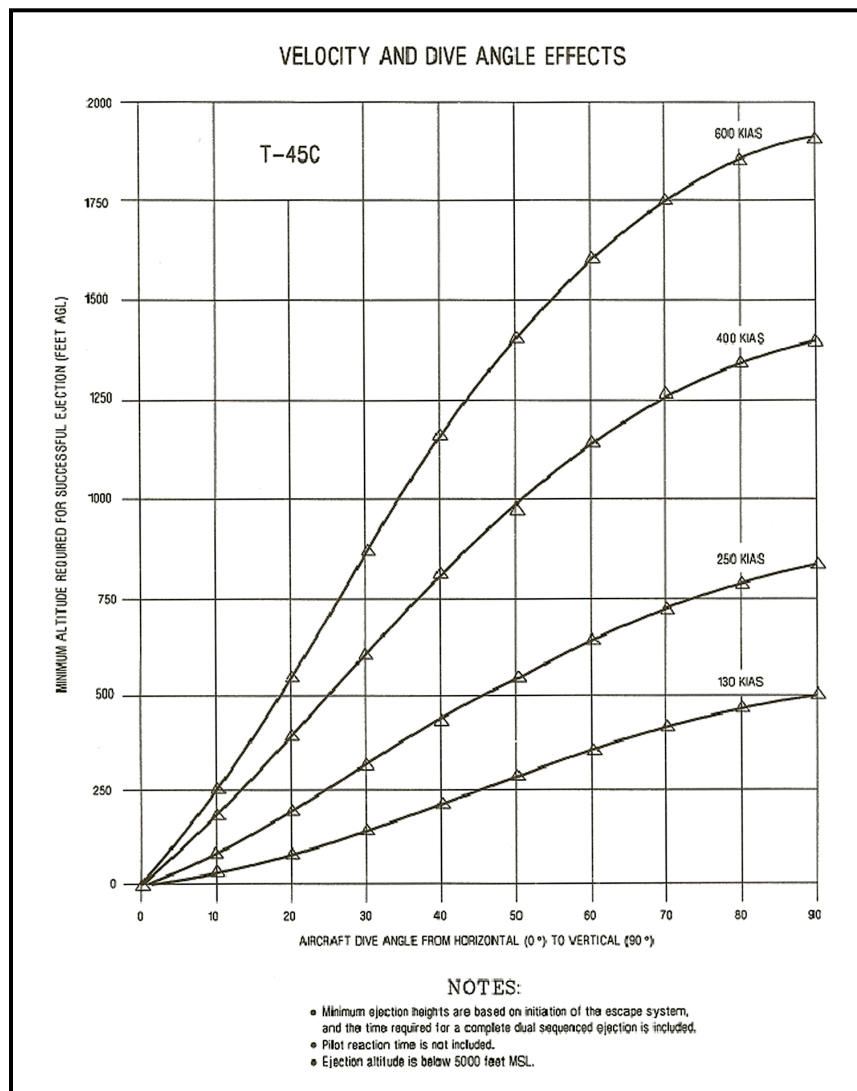


Figure 4-5 Minimum Ejection Altitudes

404. STRIKE BRIEFING BOARD

Below is an example of a detachment Strike Briefing Board. Refer to the local standardization notes for updates. Strike events local to NQI or NMM can plan on using respective training wing e-briefs. It is your responsibility to ensure all information on this board is accurate and up to date. Do not rely on previous flight boards for their accuracy.

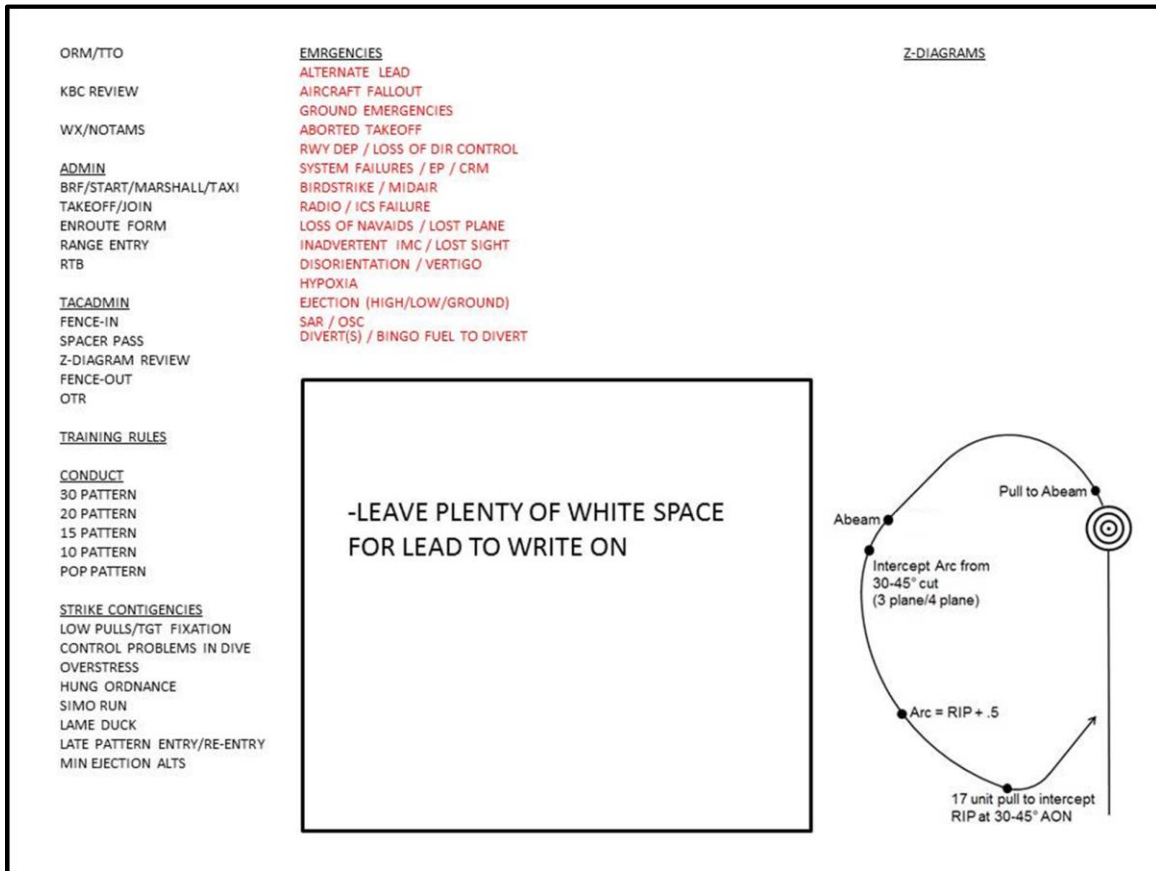


Figure 4-6 Strike Detachment Briefing Board

Strike Flight Preparation Procedures - Summary

The following will cover what you are responsible for regarding the strike brief. Show up to the brief with the Strike briefing board filled out with A/C assignments, tactical frequency, WX to include target winds, NOTAMS, and kneeboard cards filled out for the entire flight.

The Brief

The strike lead normally conducts the coordination brief for the flight. MCG requirements for each SNA will also be covered. Each SNA will cover strike specifics to include techniques and inter-cockpit emergencies with their respective trunk instructors (flight lead for student solos). For the first few strike flights, accuracy is less important than basic pattern mechanics. Early flights should emphasize good basic formation, the strike pattern, communications, and the Off

Target Rendezvous. Good hits on target will come after mastery of these skills. *Be brilliant at the basics.*

Flight Admin

ORM/TTO issues.

Formation Composition. Call signs, aircraft, lineup, mission/syllabus requirements, weapon load-out, fallout/spares/alternate lead, and bump plan should be discussed.

Target. Target name, coordinates, elevation, run-in, pattern direction and primary and secondary frequencies.

Timing: Brief, walk, marshal/taxi, T/O, target times, and Go/No-Go criteria.

Weather. Forecast weather for the target area to include winds at release altitude and on deck, weather at divert fields, and weather requirements (Weather No-Go).

Fuel Plan. Joker and Bingo.

COMM: Admin and Tactical Frequencies, single radio plan, “Get Well” frequency and channelization.

Waypoint/Nav Plan. Waypoints, O/S, elevations, course lines, TACAN. See strike supplement/In-Flight Guide for local and detachment detailed information.

Conduct/Sequence of Events: Post brief tasks – answer unresolved questions, ensure tapes are re-wound, update of the weather.

Emergencies/Contingencies. Refer to Chapter Eleven.

Review Limitations. Carriage, release, jettison, overstress, minimum ejection altitudes.

Establish the Bets. Worst pays the best: 1st hit/overall hit/CEP.

CHAPTER FIVE GROUND OPERATIONS

500. INTRODUCTION

Ground operations in the Strike stage will be similar to what was learned in the Division Formation stage with the addition of ordnance preflight, STORES page set-up, and arming procedures.

Ordnance Preflight

Refer to Chapter Two, NATOPS Chapter Twenty-One, and local directives for detailed instructions on ordnance preflight.

A/G STORES Page Setup

Refer to Chapter One for instructions on STORES page set-up. A/G STORES page setup should be completed in the line following engine start prior to Plane Captain checks. Following the A/G STORES page set-up, ensure NAV master mode is selected prior to signaling to the Plane Captain that you are ready for the Plane Captain checks.

To perform the A/G STORES page set-up:

1. MFD - Select MENU/STRS / A/G
2. Select either wing station /weapon combination, (e.g., left wing station/BOMB).
3. Adjust QTY to match BRU-38/A load-out
4. Select the other wing station/weapon combination (e.g., right wing station/BOMB)
5. Adjust QTY to match BRU-38/A load-out
6. DEP – Adjust MIL setting (set for the initial briefed pattern).
7. MFD – Select CCIP
8. TGHT – Verify/Adjust as required (Entry of a “+” or “-” required before elevation entry)
9. A/G Delivery Mode – Select first intended mode (e.g., MAN or CCIP)
10. NAV master mode – Select

Arming Procedures

Refer to local directives for all arming procedures.

This is an example of a typical arming sequence:

1. A lead ordnanceman will position themselves in front of the aircraft and signal for you to place your hands up.
2. Place your hands up above the canopy rail to be completely in view during weapons arming. Hands should remain there unless a safety/emergency situation dictates.
3. The lead then signals to additional ordnancemen under each wing to remove the safety pins from each BRU-38/A.
4. The ordnancemen under the wings remove the BRU-38/A safety pins and place the station selectors to "1." They then show you the pin(s) removed.
5. The ordnancemen then hand the pins to the lead ordnanceman standing in front of the aircraft.
6. The lead ordnanceman will indicate he has the two pins, secure them in a pouch, then pass you off to the Plane Captain for taxi instructions.

Marshaling/Taxi/Takeoff/Rendezvous Procedures

In accordance with the flight coordination brief. Further detail on the initial rendezvous is provided in Chapter Six.

CHAPTER SIX ENROUTE PROCEDURES

600. INTRODUCTION

The enroute procedures during the strike stage are similar to procedures learned in Division Formation. This chapter covers the initial join-up, cruise position and considerations while transiting from the departure airfield to the target area complex.

The Initial Rendezvous

The initial rendezvous will be as briefed by the flight lead. It could be a CV rendezvous, a running rendezvous, or a combination of the two. All procedures learned to date will still apply. Most students have a significant gap between Division Formation and the Strike phase. A long gap in training is not an excuse for poor formation procedures. From this point forward, formation will get you *to* the mission, instead of formation *being* the mission. You are expected to perform as such and will be held to a high standard.

There is a difference in aircraft performance on the initial rendezvous. This corresponds to the amount of drag on the aircraft due to bomb racks and weapons. Climb performance will be reduced, and any large power off corrections will result in noticeable loss of airspeed. Pay attention to stagnation on the rendezvous. Your instructors will provide you with techniques to compensate. Be expeditious, but most importantly – **BE SAFE**.

Once the division has joined, complete an *integrity check* on the aircraft in front of you to ensure there are no loose panels and all weapons remain onboard. Once *everyone* is in parade position, Lead will signal the flight to take the admin cruise position.

The Admin Cruise Position

While in the admin cruise position during the Strike stage, you can expect all communications regarding range check-in and checkout to be standard from previous experiences.

Being placed in cruise gives Lead multiple sets of eyes to scan for traffic enroute. Be in position; keep scanning for VFR traffic, skydivers, and/or birds.

Remain in NAV master mode until the flight lead calls “*Fence in.*”

On your first few trips to the range, take the opportunity to look around to build your SA. For example: divert airfields, landmarks, and VFR reporting points (applicable on detachment in El Centro). Take notice to any smoke on the ground. This may provide visual reference to wind direction and speed on the deck.

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CHAPTER SEVEN TARGET AREA PROCEDURES

700. INTRODUCTION

This chapter will cover basic procedures in the target area. It begins with the “*Fence in*” call and ends with the “*Fenced out*” call. The Spacer Pass, break into the pattern, pattern positions, pattern communications, pattern transitions, and Off Target Rendezvous are covered.

Fence In

Once the flight lead directs the flight to “*Fence in*,” select A/G master mode, verify the stores page is setup as per the brief, and select TAPES to ON. Echo the flight lead’s call in order, calling out any abnormalities (e.g., system degrades) that may affect your ability to employ ordnance.

Target Area Check-In

Approaching the target area, the flight lead will switch the flight to the target frequency. The flight lead will then check-in with the target after ensuring a positive check-in by all wingmen.

EXAMPLE: Admin C/S: CD11-14 Tactical C/S: HAMMER 11-14 Target: Loom Lobby

HAMMER 11: AUX: “*Hammer, standby, check-in, Pri.*”

HAMMER 11-14: PRI: “*Hammer One One*”, “*Hammer One Two*”, “*Hammer One Three*”, “*Hammer One Four.*”

HAMMER 11: PRI: “*Loom Lobby, CD One One, flight of 4 T-45s, 8 x MK76 a piece, to work the main bull for the next 0+40.*”

LOOM LOBBY: PRI: “*CD One One, Loom Lobby, you are cleared into the target area, cleared hot at flight lead discretion, lead assumes range safety.*”

The Spacer Pass

The primary objective of the Spacer Pass is to over-fly the target at release altitude and airspeed ensuring that the aircraft is properly trimmed.

Approaching the target area, the flight lead will call out the target location and set up for the spacer pass. With about 45 to 90 degrees of turn to go before the run-in heading, the flight assumes right or left echelon depending on the direction of the pattern (ex. right echelon for a left pattern). Echelon should be set on parade bearing line with double the normal cruise interval.

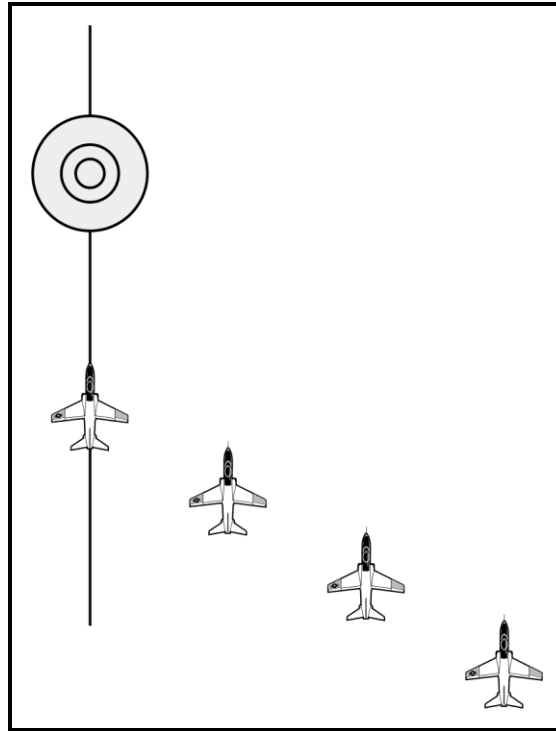


Figure 7-1 The Spacer Pass

When trimming the aircraft, first trim out the balance ball (*trim the rudder*), then aileron, and finally pitch. If you trim while in the pattern (*not* recommended), excessive nose down stick pressure will be required to maintain proper release G and sight picture.

On the Spacer Pass, scan release altitude winds on the HSI. This provides a reference for bomb drift post release.

The flight lead will call out the True Airspeed, Barometric Altitude, and wind readout from their HSI. Verify that the flight lead's information roughly matches the indications in your cockpit. If you are more than 200' or 20 knots off, call it out. A third aircraft will break the tie.

Passing over the target, everyone should take a moment and visually clear the target, ensuring there are no unwanted visitors in the target area. *Everyone is a Range Safety Officer*. If you see something that does not look right, speak up.

The Break into the Pattern

Slightly before the target, the flight lead will call out "*Hammer One One, breaking, (hi/mid/low) pattern.*" Pattern break interval will be 8 seconds, regardless of number of A/C in flight.

Once the last aircraft in the flight has broken into the pattern, the flight lead will make their position call with fuel state. Dash 2 and Dash 3 will call out their position and fuel state in order. Dash 4 will hold their position call until the flight lead calls "*Hammer One One, off safe,*" then the normal comm cadence begins.

7-2 TARGET AREA PROCEDURES

Example: Admin C/S: CD 11-14 Tactical C/S: HAMMER 11-14

HAMMER 11-14: PRI: *“Hammer (c/s), breaking, (type) pattern.”*

HAMMER 11-13: PRI: *“Hammer (c/s), (pattern position), (fuel state).”*

HAMMER 11: PRI: *“Hammer One One, in heading one four three.”*
PRI: *“Hammer One One, off safe.”*

HAMMER 14: PRI: *“Hammer One Four, (pattern position), (fuel state).”*

HAMMER 12: PRI: *“Hammer One Two, in heading one four three.”*

LOOM LOBBY: PRI: *“Copy One Two, One One your hit 60’ at 6.”*

After making your “breaking” call into the pattern, roll the aircraft roughly 45 degrees AOB smoothly apply approximately 3-4 G, set MRT and fly the jet to the Abeam position. A good technique is to pull up to the pattern the same number of degrees as your planned dive. For example, if flying a 30-degree pattern, pull the nose up no greater than 30 degrees. If flying a 10-degree pattern, pull the nose up no greater than 10 degrees. The initial 90° of turn typically requires 3-4 G, with the second 90° of turn being a gradual reduction from 3 G to 1 G. 1000 feet prior to reaching pattern altitude, reduce power and relax back-stick pressure to allow the aircraft’s nose to reach level flight.

Pattern Objectives

1. To arrive at the Roll-in Point with the target 30-45 degrees off the nose at the appropriate distance/visual sight picture.
2. To build consistent in the Roll-in mechanics leading to repeatable predictable results.
3. To reduce the risk of mid-air collision and to increase safety. When all aircraft in the flight execute consistent pattern mechanics the risk of a mid-air collision is minimized

Pattern Action Points

Pattern consistency is the primary focus of early simulator and strike events. Hits and target tracking are secondary. Developing consistency in the pattern will improve your ability to reach a consistent and accurate roll-in sight picture. With practice, pattern mechanics will become second nature allowing for full concentration on refining tracking techniques, and error corrections.

NOTE

Do not just fly the HUD around the pattern. The HUD and target waypoint distance are instruments referenced while flying the aircraft around the visual strike pattern.

Pattern action points are:

1. Abeam
3. Approach Turn Arc
4. Approaching or Power-up Point
5. Roll-In Point (RIP)
6. Target Tracking
7. Safe Escape
8. Pull to the Abeam.

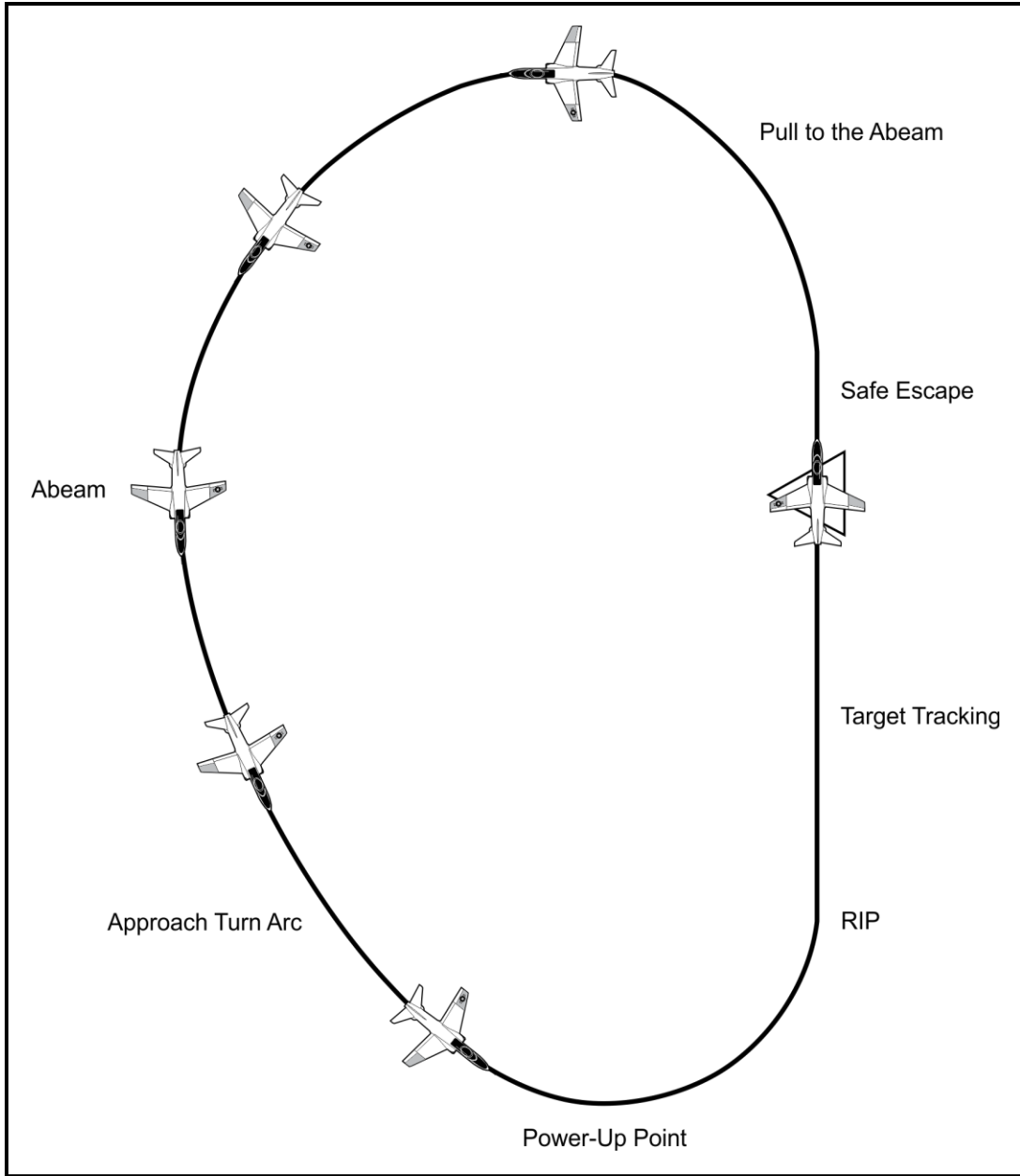


Figure 7-2 The Strike Pattern

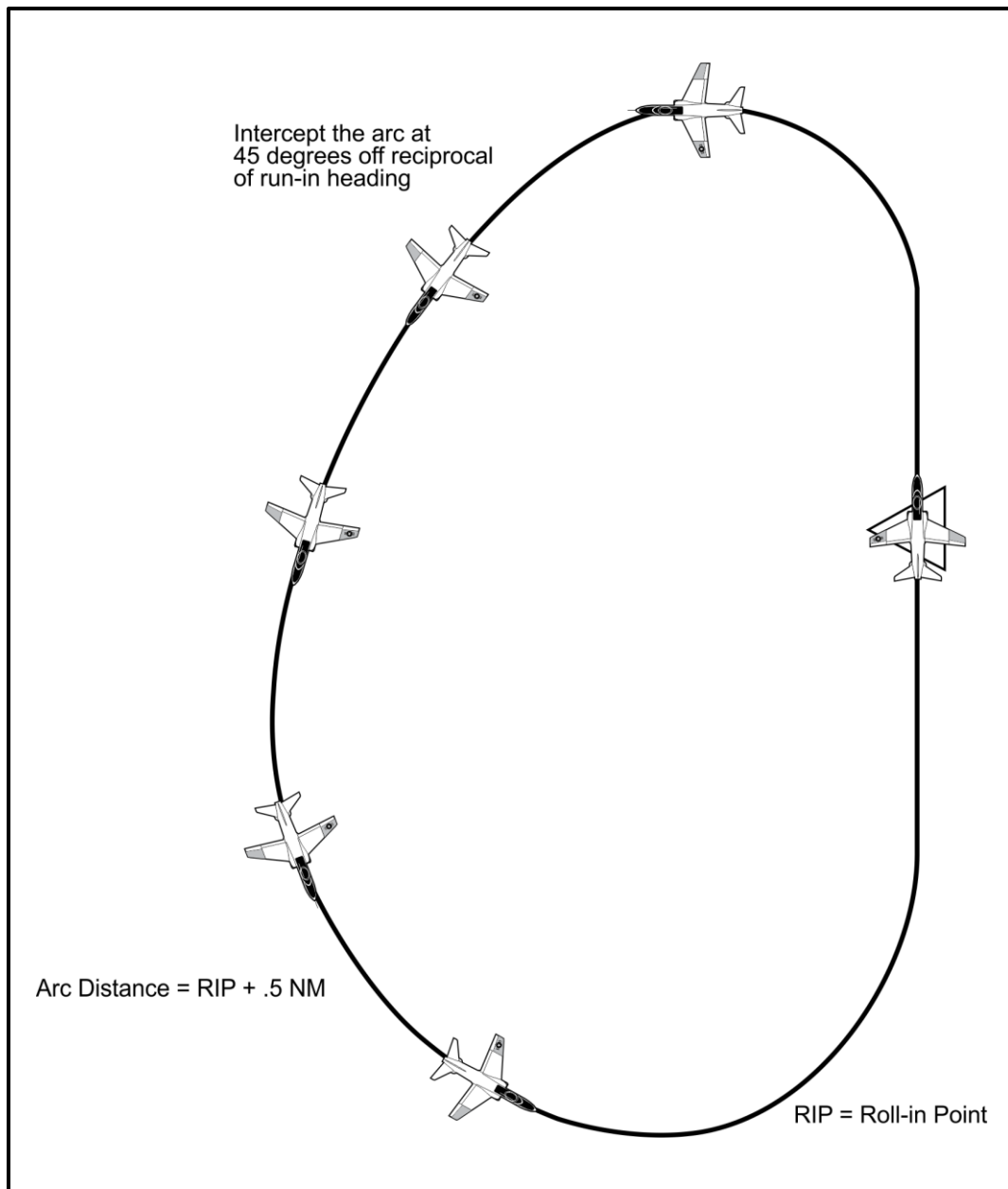


Figure 7-3 Pattern Procedures

701. PATTERN ACTION POINTS AND PROCEDURES

Pull to the Abeam

After completing the safe escape, use the same procedures described for the break into the pattern to arrive at the proper abeam position. Pulling too hard will result in a tight abeam position, which will reduce arcing distance prior to the roll-in and make proper roll-in mechanics more difficult. Locate your interval and ensure de-confliction. Procedures in the event you cannot locate your interval are described under “Chapter 11, Emergencies and Contingencies.”

7-6 TARGET AREA PROCEDURES

The Abeam

Upon rolling reaching the abeam, the target should appear just above the canopy rail. In the aircraft, the BRU-38 (or middle of the wing) should bisect the target. Stop the aircraft on an outbound heading 45 degrees (30 degrees for a 3 ship) off the reciprocal of the run-in. (Ex. if the run in heading is 143, the reciprocal is 323, and a left hand pattern, then outbound heading should be 323+45 or 008 degrees.) Hold this heading until intercepting arc distance of RIP + .5 nautical miles. The use of the Ground Track Marker on the HSI for heading reference assists in creating a wind corrected track while keeping the pattern consistent over the ground. The only time a 45° turn away at the Abeam would be required would be following the initial break into the pattern or following an off-target extension.

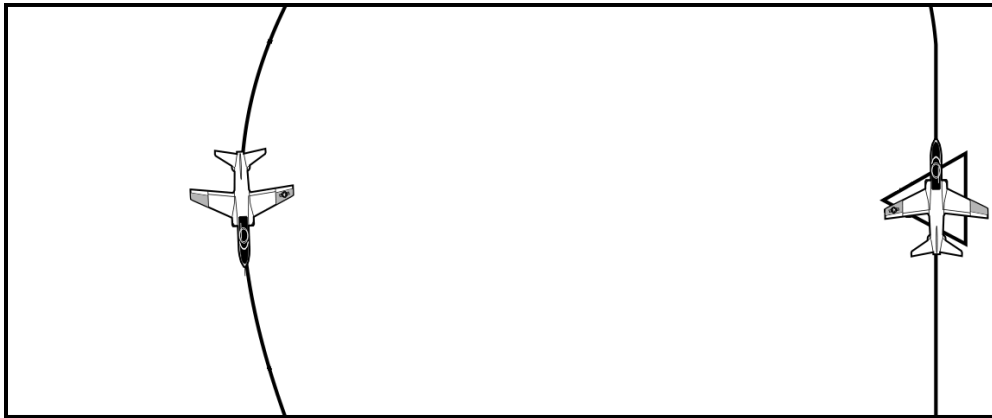


Figure 7-4 The Abeam Position

At the abeam, take note of any pertinent ground features. Examples include T-shaped intersections of roads, small dunes, ponds, mountainous terrain, or open areas. Locating ground features when pulling to the abeam will assist in developing motor skills required to build consistency on later flights.

The Abeam to the Arc

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

The Arc

The Arc is 0.5 nautical miles outside of the planned Roll-in distance. Vary the angle of bank in order to stay on the arc. Common errors are to over-bank resulting in a "tight" arc position or not over-bank enough resulting in a "deep" arc position.

Strive to make this a visual turn, placing the target on your inside shoulder and *reference* the HUD/HSI waypoint distance. Ground gouge for the roll-in point will aid in developing a consistent approach turn.

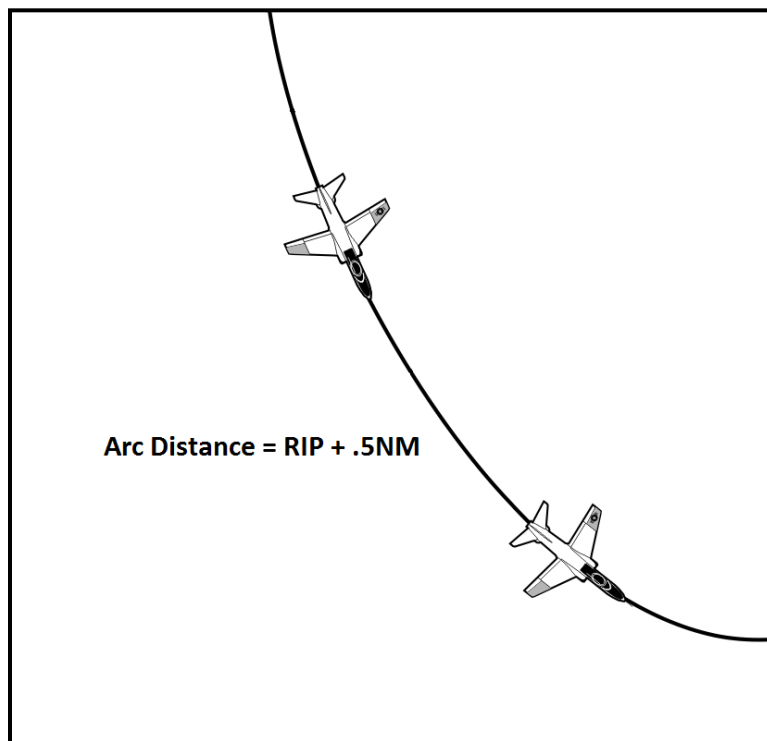


Figure 7-5 The Arc

Approaching Turn Corrections

Strive to achieve a consistent Approach Turn. If you find the approach turn to be off planned numbers, make adjustments. To adjust for pattern deviations:

1. If the approach turn is too tight: Ease your pull, place the target aft of the 9 o'clock position in order to build abeam distance. Re-establish the target at the 9 o'clock position once back on RIP + .5 NM. If excessively tight and approaching the roll-in point, drive wings level away from the target and then execute a hard pull to the run-in line/roll-in point.
2. If the approach turn is too deep: Increase the pull to put the target just forward of the 9 o'clock position. If excessively deep and approaching the roll-in, pull hard towards the roll-in point initially, then drive wings level to run-in line/roll-in point.

Remember, the overall pattern objective is to arrive at the Roll-in Point roughly 45° off the run-in heading at the appropriate distance. Anything more or less than 45°, you will be hurting yourself by either losing sight of the target initially (roll-ahead) or lose tracking time (bringing your nose to the target), rolling out lower in the dive.

The Approaching Turn – Adjustment for Strong Winds

Winds at altitude will affect the pattern. In order to correct for a headwind or tailwind, adjust the RIP according to the following rule-of-thumb: add/subtract 0.1 NM from the RIP distance for every 20 kts. of tailwind/headwind.

The Approaching/Power-up Point

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



Figure 7-6 Target from the Approaching/Power-Up Point

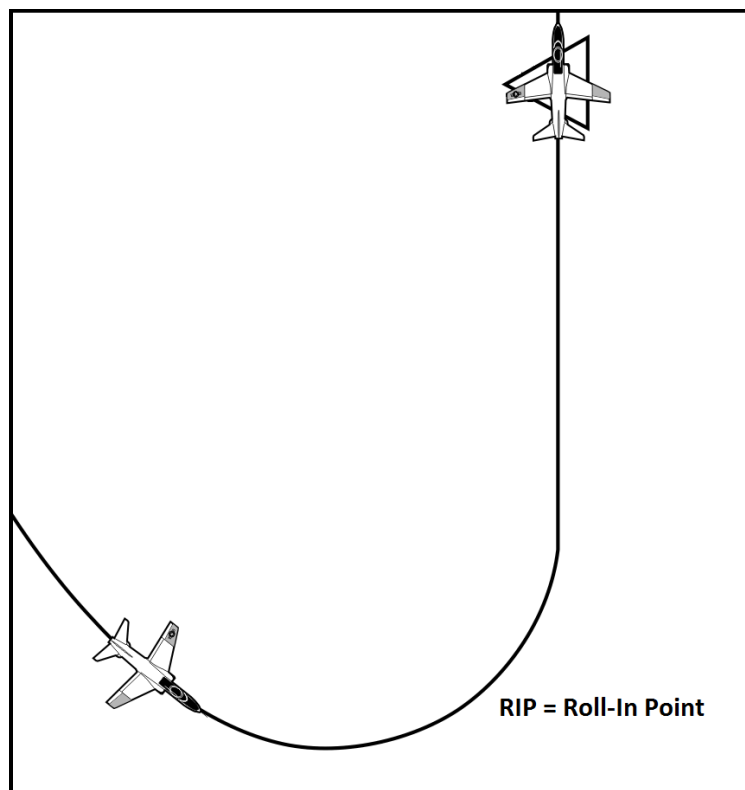


Figure 7-7 Pull to RIP

Set planned release power setting when the nose of the aircraft is perpendicular to the run-in line, (e.g., 90° off planned run-in heading). A good scan of the target, run-in line and roll-in point will enable you to better evaluate the pull required to get the aircraft to the roll-in point.

As a technique for setting the power: Power-up by “feel” first, then fine tune power setting by checking the N2 gauge while pulling the nose around. This will allow for RPM spool-up time.

Strive to be as close to pattern airspeed as possible. In the event you have deviated from the pattern airspeed, set power based on current airspeed.

For example, in the High Angle (30°) pattern: Use 94% as the base release power setting for 250 KIAS, and adjust +/- 1% for every 10 KIAS off of 250.

250 KIAS – 94%

260 KIAS – 93%

240 KIAS – 96%

Be consistent with the power-up point. Set the release power setting at the same place in the pattern every time to have some type of basis for power setting.

Note the airspeed at release – adjust as necessary on follow-on passes (1% for every 10 knots off 450 KTAS).

The Approaching to the Roll-in Point

After setting the power, set MASTER ARM to ARM and start a hard pull (15-17 units AOA). Extend the run-in line out visually and adjust the pull to arrive at the roll-in point 30-45° off planned run-in heading. Visually, 30-45° off run-in heading equates to the outside target ring (300' ring) touching the base of canopy bow. It is critical to maintain a good inside/outside scan approaching the roll-in. **Do not** fly the aircraft exclusively referencing the instruments without referencing the target!

Maintain a level turn across horizon. A common error is to let the Velocity Vector sag in the approach turn – losing altitude, resulting in a shallow Initial Sight Picture.

If the RIP distance is reached prior to this point (nose more than 45° off), the approaching position was too tight. You will need to commence the roll-in immediately or the result will be a steep Initial Sight Picture. This also results in greater altitude loss during the roll-in, which equates to the loss of tracking time in the dive.

Once the target is 30-45° off the nose, relax the pull and drive wings level until arriving at planned RIP distance. Arriving at a consistent RIP sight picture is crucial in getting to a correct and consistent release sight picture. These mechanics will carry over in follow on training.

The Roll-In Point (RIP)

The Roll-In Point (RIP) is defined by the sight picture described above and where the aircraft starts down from pattern altitude to begin the tracking run established on the bombing triangle/planned dive wire. Figures 7-8 and 7-9 show the visual and HSI sight pictures at the RIP for a high angle delivery. Take note of where the target appears in relation to the dash and the canopy bow. Provided DME to the target is available, plan on executing the RIP once reaching the appropriate DME.



Figure 7-8 The Target from the RIP



Figure 7-9 HSI at the RIP

The Roll-In

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

The Lift Vector extends from top of the canopy bow. One technique for proper lift vector placement is to use the Standby Compass light switch located on the canopy bow just above the HUD. Over-bank, line up the standby compass with the target, and smoothly pull to set the appropriate aim-off.

When attacking the target, be aggressive but smooth. If you encounter “pitch-buck,” you’re pulling too hard and stalling the stabilizer. If you are trying to be too smooth, you may float the pull, causing excessive altitude loss in the maneuver. This results in loss of valuable tracking time.

If the lift vector is placed below the target, the aircraft will end up below the bombing triangle (below the wire) causing a low sight picture. ***The ultimate focus of the Strike Stage is to develop consistent roll-in mechanics, leading to consistent results,*** which requires a good initial sight picture. The initial simulator events and aircraft flights will concentrate on developing that sight picture and consistent roll-in.

The Rollout

As part of the Roll-in procedure, the Rollout onto the target begins the tracking run. As the aircraft waterline (airspeed and altitude boxes in the HUD) approach the appropriate Aim-off Point/Distance, smoothly neutralize the stick, roll the aircraft upright, and immediately set the planned Aim-off Angle. In both manual and CCIP deliveries, the target should be lined up beneath the standby compass and the center of the uncaged HUD pitch ladders. Centering the target between the pitch ladders and below the uncaged Velocity Vector will solve for most lateral error.

If the Velocity Vector travels below the target prior to rollout this is caused by too much overbank (lift vector below the target), or excessive G at the rollout causing the aircraft to “J-hook.” If the Velocity Vector stops at greater than planned aim-off angle, there either was not enough overbank or not enough G/AOA (e.g., the pull was floated).

Detailed corrections for lateral error (e.g., lineup) will be discussed in Chapter Eight.

The Safe Escape

Pickle, pause a half a second to allow the bomb to clear the aircraft, then ***smoothly recover in accordance with Safe Escape Criteria.*** The Training Command Safe Escape is defined as a 4 G pull within 2.5 seconds until a 10° climb Flight Path Angle is reached (indicated by the Velocity Vector reaching the 10° pitch ladder). Do not ease the G until this criteria is met. Once

completing the safe escape, place the MASTER ARM Switch to SAFE and make your “(c/s), *off safe*” call.

702. PATTERN COMMUNICATIONS

Proper communications while in the pattern are essential to safety during strike flights. Realize that communications are difficult to accurately portray in simulator events. Effective communication lies in practice (e.g., chair-fly the comms with other students).

This section discusses pattern communication positions, comm cadence, comm sequence (who says what and when), additional calls not part of the normal comm flow, and pattern transitions.

Concentrate on the basics during the first few aircraft flights (comm, pattern, form, and OTR). Get with other students, walk around the living room, ride bikes in a parking lot, or whatever it takes. **Practice** the comm before your first flight in the aircraft!

On days with low ceilings and visibility, clear and concise communication becomes even more important. Initially, you will be blind coming off target and comm will help you regain sight and/or SA. When the comm breaks down, so does the SA.

Position Calls

Position calls are the most often missed calls on early aircraft flights. The best way to prevent a missed call is to both listen and anticipate the comm while pulling to the “abeam” position. Once the aircraft behind you has called “*off, safe,*” respond in a timely fashion with your position call and fuel state.

The position call references the location of your aircraft in the pattern at the time the call is made. The positions in order are: Crosswind, Prior, Abeam, Past, and Approaching. Prior or Past are referenced from the Abeam position.

If in between two positions, the safe bet is to call the previous position. For example: If you find yourself between Prior and Abeam, call “*Prior.*”

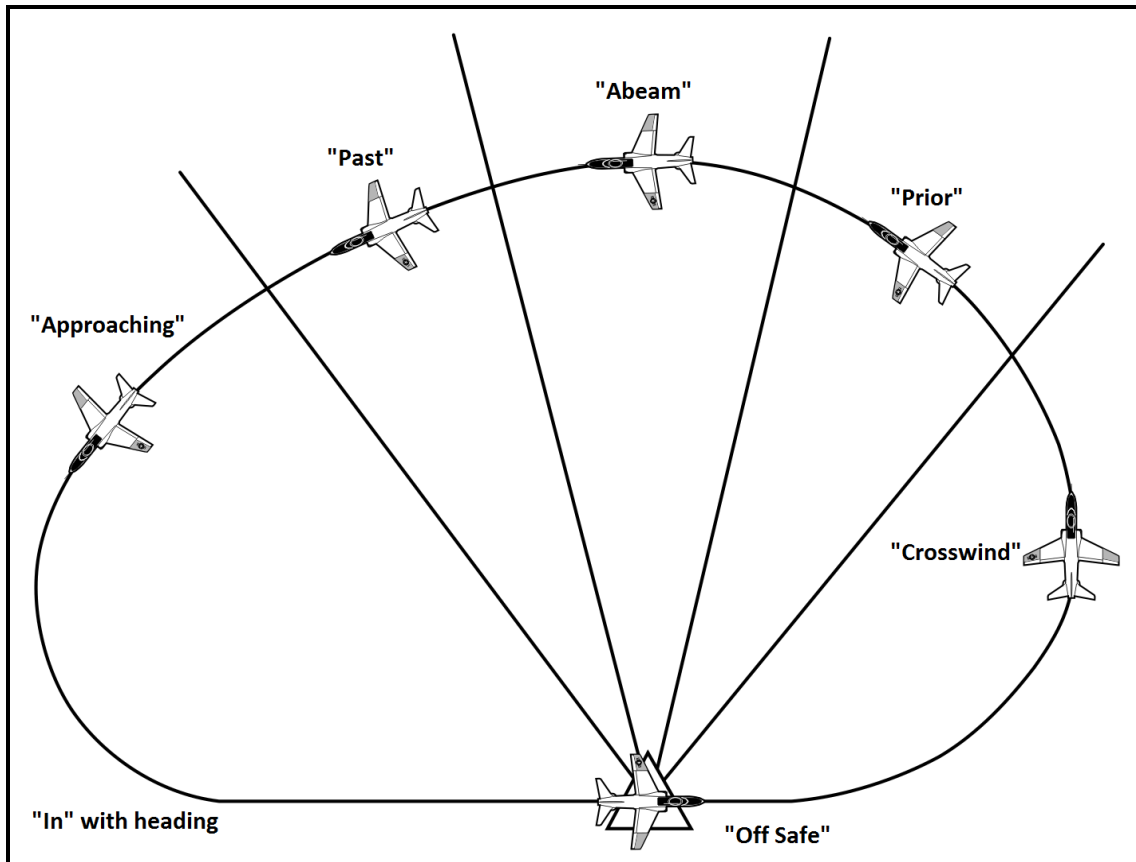


Figure 7-10 Position Calls

The Comm Cadence

There is a specific order as to who says what and when, which results in a steady cadence when all aircraft are flying the pattern well and keeping SA to their preceding interval. Listen carefully! Wait for your time to speak and only speak when it is your time to talk.

The one who initiates the comm sequence is the one calling “*off, safe.*”

Example Comm Flow/Sequence:

HAMMER 14: “*Hammer One Four, off safe.*”

HAMMER 13: “*Hammer One Three, abeam, one point eight.*”

HAMMER 11: “*Hammer One One, in, heading one four three.*”

LOOM LOBBY: “*Roger One-One, One Four, your hit, One Five Zero at three-thirty.*”

With four aircraft, there will always be one aircraft that remains quiet: the aircraft between the position call aircraft and the “IN” aircraft. With three aircraft, there will be a natural pause

between the position call and the “IN” call. In this case, the “IN” aircraft will hold its call until it is just about to roll-in.

Other Standard Comm Calls

Some of the other standard comm calls that can be expected while in the pattern are as follows:

“In (Heading)”

Given after the position call and includes the heading the aircraft is tracking after rolling in. This should normally correspond to run-in heading $\pm 15^\circ$ “*Hammer One Two, in, heading one four three.*”

“In, (Heading), Dry”

Given when there is no intention of dropping on that pass, but the aircraft has ordnance remaining.

“Off Safe”

Given after recovering from the target attack.

“Winchester”

This call is added to the “off safe” call after the final bomb has been released.

“No Drop”

This call is added to the “off safe” call when the aircraft did not drop but has ordnance remaining. Ex. “*Hammer Three Four, off safe, no drop.*”

“Crosswind” and “Extending”

When making your “off, safe” call if your interval makes the call “*Hammer One Two, Crosswind, one point five,*” immediately call “*Hammer One Three, extending.*” This also applies if visual of your interval coming off target and you assess their position to be crosswind.

“Say Pos”

If still blind on your interval by upon reaching the abeam, call “*(interval’s c/s), say pos*” and remain at the lost interval altitude. If interval responds with *(c/s), approaching,* there is sufficient de-confliction to climb back up to pattern altitude. If interval responds with “*Abeam*” or “*Prior,*” remain at the lost interval altitude sanctuary **1000’ below pattern altitude** and start scanning in front, high and side-to-side for your interval.

“Abort, Abort, Abort”

If you hear “*abort, abort, abort*” with aircraft nose pointed at the target, immediately recover the aircraft until a positive rate of climb is established. Set the MASTER ARM to SAFE and call “*(c/s), aborting.*” Reduce power as required to slow to pattern airspeed and continue to overfly the target following the pattern track over the ground. Once over the target make your “*off, safe, (no drop if applicable)*” call, find your interval, and work to re-establish the appropriate abeam position.

“Joker”

This call is made anytime an aircraft reaches briefed Joker fuel state, ex. *“Hammer One Two, Joker.”* If this occurs about the same time as the abeam call, add it to the end (ex. *“Hammer One Two, Abeam, Joker”*).

There is no need to wait for the BINGO to flash to report *“Joker.”* As a technique, if you are within 100 lb. of JOKER, call *“(c/s), Joker.”* This will prevent the BINGO bug from going off in the dive, preventing an aborted run.

“Bingo”

If you hit *“Bingo”* while still in the pattern, call *“(c/s), Bingo.”* ***There is no need to call out “Bingo” while executing the Off Target Rendezvous.*** If you find yourself in a situation where you ***need*** to put the needle on the nose to execute an immediate BINGO profile, do so then make the appropriate call.

“Simo Run, Simo Run”

A *Simo Run* is a condition when two aircraft occupy the same piece of sky (at the RIP or during the dive) without being aware of each other. Simo runs greatly increase the likelihood of a mid-air collision. Clear the aircraft flight path left, right, and above and smoothly recover following abort procedures.

703. PATTERN TRANSITIONS

For the majority of the syllabus, ordnance will be delivered from the highest available pattern. There may be times when weather will make delivery from the “High” pattern unworkable. The “Medium” or “Low” patterns will be substitutes in these cases. Expect to practice the transition from the “High” to “Low” patterns on every flight unless otherwise briefed.

Transition Communications

When transitioning from one pattern to another, additional comm calls are added to *“IN”* and *“OFF, SAFE.”* The flight lead will repeat pattern transition comm twice and all wingmen will repeat pattern transition comm once.

Example:

HAMMER 11: *“Hammer One One, in heading one four three, high to low, high to low.”*

HAMMER 11: *“Hammer One One, off safe, low pattern.”*

HAMMER 14: *“Hammer One Four, abeam, one point one.”*

HAMMER 12-14: *“(c/s), in heading one four three, high to low.”*

HAMMER 12-14: *“(c/s), off safe, low pattern.”*

Procedures

Once the Safe Escape is complete, relax, roll, start the turn, reduce power and climb/descend to the next briefed pattern altitude. Realize that the safe escape may put the aircraft above pattern altitude when in the “medium” or “low” patterns. Listen carefully for your interval’s position and adjust accordingly. *Avoid making descending turns to the max extent possible.*

NOTE

Watch out for rolling pulls in the low pattern. This is where overstresses easily occur. Always stop the roll *prior* to applying G on the aircraft.

“ARMS” Checks

Complete these checks after transitioning between patterns:

1. **Altitude/Airspeed – set for current pattern.**
2. **RADALT – Check/Reset.**
3. **MIL setting – Check/Reset.**
4. **Stores – Check racks/loadout (if bombs remaining).**

As a technique, it is useful to verify checks complete in between each run (particularly with regards to the STORES page).

704. ADDITIONAL PATTERN PROCEDURES

When the pattern is flowing properly with four aircraft, one aircraft is calling off the target, another is “abeam,” the following aircraft is calling “in” and the remaining aircraft (silent) is between the “abeam” aircraft and the “in” aircraft.

If your interval calls “*Past*” or “*Approaching*,” start your turn to abeam early to narrow the gap between the two of you. If your interval calls “*Prior*” or “*Crosswind*,” slightly delay your turn to abeam and or ease your pull to generate appropriate spacing.

Bottom Line, if you are not maintaining proper interval in the pattern, fix it.

The Off Target Rendezvous (OTR)

During the final run, the flight lead will call: “*Hammer One One, in, heading one four three, last pass, last pass.*” After executing their safe escape, the flight lead will call: “*Hammer One One, off safe, off target rendezvous.*” The flight lead will climb to the pre-briefed rendezvous

altitude and slow to 250 KIAS. Other flight members will repeat the call as they come off target, adding to the call the **total number of aircraft** they have in sight.

An example of this call from Dash 3's standpoint would be: "*Hammer One Three, off safe, off target rendezvous, two in sight.*" If blind, say "*(c/s), off safe, off target rendezvous, blind.*"

Upon regaining sight, update the number in sight accordingly until you are visual of all preceding aircraft (ex. "*Hammer One Four, three in sight.*")

After hearing Dash 2 call: "*Off safe,*" the flight lead will begin a 30-degree AOB turn in the pre-briefed direction (usually in the same direction as the pattern). Knowing where to look will help you efficiently gain sight. As Dash 2 comes off target, the flight lead should be at the 11 o'clock to 12 o'clock position. As Dash 3 comes off target, the flight lead should be close to the "prior" or 10 o'clock position. As Dash 4 comes off target, the flight lead should be close to the "abeam" or 9 o'clock position.

Regardless of the number of aircraft in sight, each member of the flight climbs to their **sanctuary altitude** (500 ft. below the preceding aircraft) and performs a CV rendezvous. Stay 500 ft. below the preceding aircraft until fuselage alignment, bearing, and closure are under control. **Never** climb above your interval during the rendezvous. Once the preceding aircraft vacates its altitude sanctuary, the following aircraft may step up to the preceding aircraft's old altitude sanctuary. It is not required to wait until the preceding aircraft is fully joined before leaving your altitude sanctuary.

EXAMPLE: During the OTR, Dash 2 has gained fuselage alignment and is approaching bearing line. Dash 2 now can vacate their altitude sanctuary and climb to be co-altitude with the flight lead. Once Dash 2 vacates its altitude, Dash 3 can step up to Dash 2's previous altitude and Dash 4 can step up to Dash 3's previous altitude.

If blind after coming off target, climb to your sanctuary altitude and begin a 250-knot, 30-degree AOB turn in the direction of the flight while scanning for your preceding interval. The flight lead will give their position relative to pattern positions used earlier (prior, abeam, past, etc.) or relative to the target waypoint. **Do not** delay the climb or turn while looking for your interval.

Hung Ordnance Check / "Fence Out" Call

Once all flight members are visual, the flight lead will call: "*Hammer, fence out.*" The flight will typically join into an echelon turn away as previously learned in Division Formation. For hung ordnance checks Dash 2 will check the flight lead on the cross-under; Dash 3 will check Dash 2, Dash 4 will check Dash 3 and the flight lead will check Dash 4 prior Dash 4 crossing under. The flight lead then places the flight in admin cruise. The flight lead will initiate the "Fenced Out" comm and wingmen will echo the call as follows: "*(c/s) fenced out, (fuel state), good g (unless overstressed).*" Dash 4 adds: "*flight's clean*" to the end of their call. If any aircraft are still carrying ordnance, Dash 4 will replace the "clean" call with position and number of bombs remaining. The aircraft with ordnance remaining will then communicate to lead whether the ordnance remaining is hung or unexpended.

If due to extenuating circumstances the flight joins via an alternate rendezvous game plan, it will be the responsibility of Dash 4 to check the flight for hung/unexpended ordnance.

705. POP-UP ATTACK PATTERN

Attacks from the arc are only one method of delivering ordnance on a target. Higher threat environments might necessitate a strike from a pop-up attack following a low altitude ingress. A pop attack is designed to quickly elevate the aircraft from ingress altitude to roll-in altitude. The methods and techniques for getting to the roll-in point after the pop include offset and oblique pops as described below (also referred to “Navy” and “Marine” methods).

Pop Attack Pattern

Unlike the standard weapons pattern, the pop-up pattern is a long racetrack pattern. The pattern is flown at no lower than 500' AGL as allowed by range space and 350 KIAS. When initially entering the pattern, aircraft will perform a level break at 15-second intervals to provide extra spacing. The abeam position will be slightly wider at 2 miles. At the abeam, track outbound and descend to pattern altitude on the reciprocal of the run-in heading or as required by range limitations. At 4.5 to 5.0 NM, initiate the turn in by adding power to MRT and executing a 3-4 G level until 90 degrees off of run-in heading. Nearing the run-in line, execute a 3-4 G level turn inbound to arrive nose onto the target with the target approximately 4.5 NM off the nose - see figure 7-11. An alternative method at 4.5 NM to 5.0 NM downwind is to add power to MRT and execute a level, 12 unit pull to arrive nose on to the target.

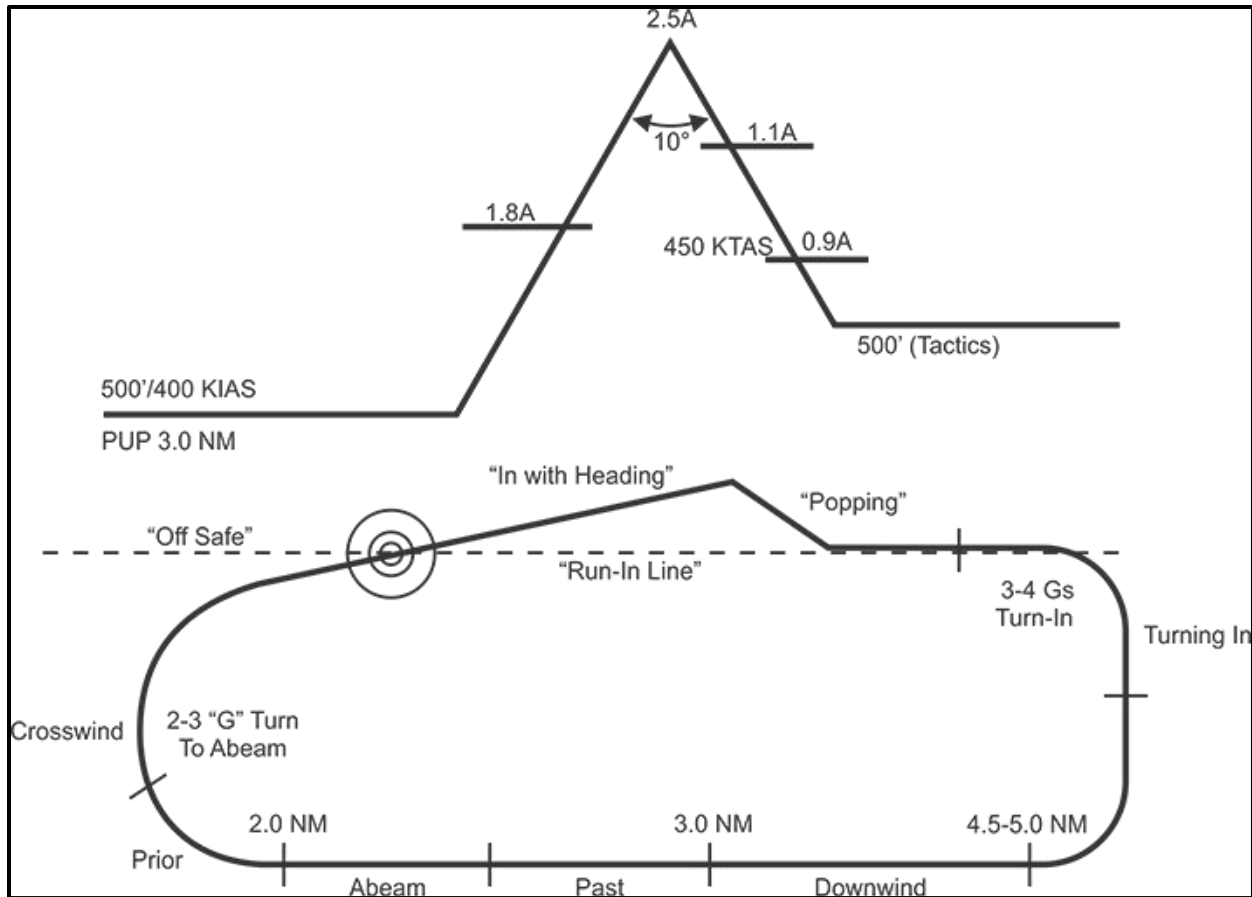


Figure 7-11 Low Angle Oblique Pop Z-Diagram and Pattern

Oblique Pop Mechanics

Once established on the ingress towards the target at 500' AGL, continue to accelerate to 400 KIAS. At the pull-up point, set the power to MRT (if not already set), simultaneously roll 30 AOB away from the pattern and pull the nose to 30 degrees flight path angle using smooth 4 G pull. This will generate approximately 30 degrees of heading change. Reaching 30 degrees nose up, roll wings level in the climb and quickly reacquire the target. Passing reversal altitude, roll to put the lift vector on the target and execute a smooth pull (~15 units) to establish the appropriate aim-off angle. The amount of time between rolling wings level in the climb and initiating the pull down to the target is only a few seconds. If done correctly, the aircraft should be established on the planned dive angle towards the target.

Offset Pop Mechanics

The advantage of an offset pop is the ability to keep the target area in sight throughout the entire maneuver. Once established on the ingress to the target level at 500' AGL, continue accelerate to 400 KIAS. At the appropriate action point, set the power to MRT (if not already set), perform a level 20° turn away from the pattern and roll wings level. Once reaching the appropriate pull up point distance, pull the nose wings-level up to 30 degrees flight path angle using a smooth 4 G pull. Similar to the oblique pop, the amount of wings level time in the climb is only a few seconds. Passing reversal altitude, roll to put the lift vector on the target and execute a smooth pull to set the appropriate aim-off angle. If performed correctly, the aircraft should be established on the planned dive angle towards the target.

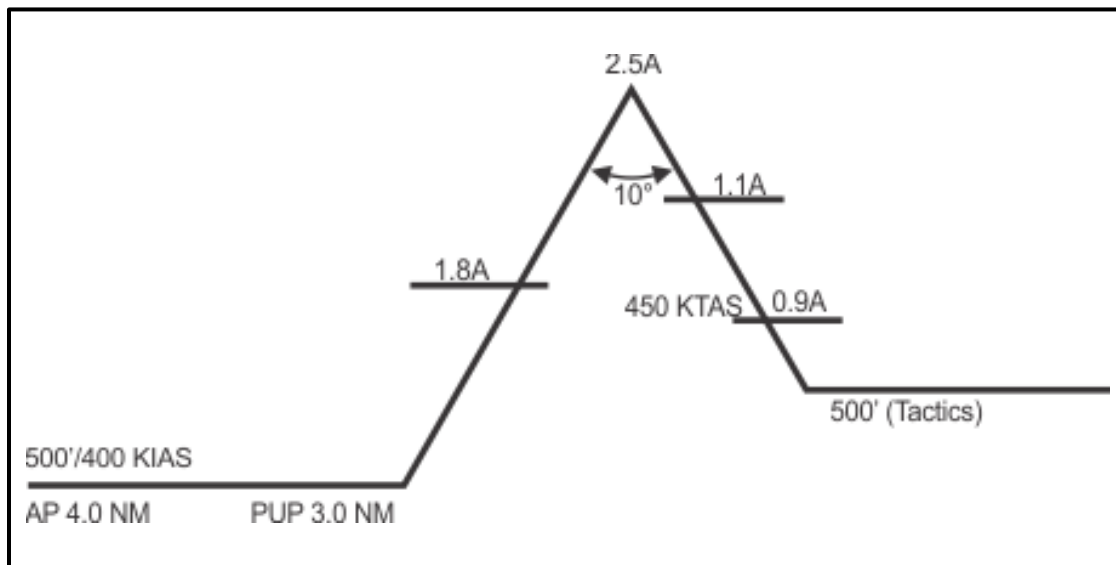


Figure 7-12 Low Angle Offset Pop Z-Diagram

Off-Target

After release, execute the safe escape (smooth 4 G pull within 2.5 seconds up to 10 degrees FPA). Once recovered, set the MASTER ARM to SAFE, call “off safe,” and begin a LEVEL pull to the abeam. Adjust for gaps in the pattern by “cutting the corner” during the turn to the abeam or extending slightly if too close to your interval. Executing the safe escape will initially place the aircraft above pattern altitude (~1000-1500' in the low angle and ~2,000-2,500' in the medium angle). Descend back to pattern altitude once established on the downwind with high SA or preceding interval in sight. **Do not** make descending turns below 1,000' AGL.

706. COMMS

In the pop-up pattern, the same calls made in the standard weapons pattern are utilized with the addition of the “downwind,” “turning in,” and “popping” position calls. The aircraft coming off-target initiates the sequence with their “off, safe” call, and their interval follows with their “Abeam” call. Due to the extended spacing in the pop patterns, your interval will normally be

past the abeam or downwind. The aircraft about to hit the base leg will call “*turning in,*” and the aircraft approaching their attack will call “*popping,*” and “*in (heading)*” as appropriate. Especially in a 4 ship, the “turning in” call is optional and not to interfere with the other required calls, unless for safety of flight.

Example Comm Flow:

HAMMER 11: “*Hammer One One, in, heading zero one zero.*”

TARGET: “*Copy One One, One Four, your hit 65’ at twelve-thirty.*”

HAMMER 11: “*Hammer One One, off safe.*”

HAMMER 14: “*Hammer One Four, downwind, two point one.*”

HAMMER 13: “*Hammer One Three, turning in (@ distance as appropriate).*”

HAMMER 12: “*Hammer One Two, popping.*”

HAMMER 12: “*Hammer One Two, in heading zero one zero.*”

De-Confliction/Lost Interval/Lame Duck

Due to the low altitude of the patterns and the extended interval between aircraft, de-confliction is primarily via comm. If your interval calls “*Prior*” or “*Crosswind,*” extend off-target to increase separation. If you don’t have sight of your interval during the turn to the abeam, *stay* LEVEL and *do not* descend below 1,500’ AGL. Rolling out abeam, if your interval is still not in sight, ask for their position. Once regaining sight/SA, descend wings level back down to pattern altitude. As in the low strike pattern, the lame duck pattern is 1,000’ above the briefed off-target rendezvous altitude.

Off-Target Rendezvous

Procedures for the off-target rendezvous are identical to those on previous strike sorties. Expect to have to work off a lot more angles during the off target rendezvous from the pop pattern because the flight lead will be further around the turn circle than usual.

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CHAPTER EIGHT DELIVERY PROCEDURES AND TRACKING TECHNIQUES

800. INTRODUCTION

This chapter discusses aim-off angles the roll-in point, target depression angles, initial sight pictures, error recognition/corrections, and basic target tracking techniques. Realize that there are a few differences between tracking techniques in manual versus CCIP deliveries that will be covered in depth. For discussion purposes, both Manual and CCIP techniques will reference the high angle patterns. The concepts remain the same for medium and low angle patterns.

801. MANUAL DELIVERIES AND TRACKING TECHNIQUES

For many years, Naval aircraft had to rely on manual iron sights and unguided ordnance to strike targets. In manual or “fixed reticle” mode, the reticle is bore-sighted to the waterline of the aircraft, and will not correct for deviations in dive angle, release altitude, airspeed, G, or wind. Because of this, there are a few more corrections, such as offset aim point, that are required during dive deliveries. Reference Chapter Three for a review of the manual Z-Diagrams in use.

On a perfect high angle manual delivery, the Velocity Vector is set 3 degrees above the target once rolling out. The target should be 33 degrees depressed from the horizon (around the 33 degree position relative to the pitch ladders). By maintaining the resultant Flight Path Angle achieved at roll-in, the target eventually becomes 5 degrees depressed below the Velocity Vector (35 degrees) at checkpoint altitude. At release, the target should appear 37 degrees depressed below the horizon (approximately 7 degrees below the Velocity Vector if established on a perfect 30 degree dive). By maintaining the Velocity Vector above the target, target depression will continue to increase as the aircraft gets closer to release altitude.

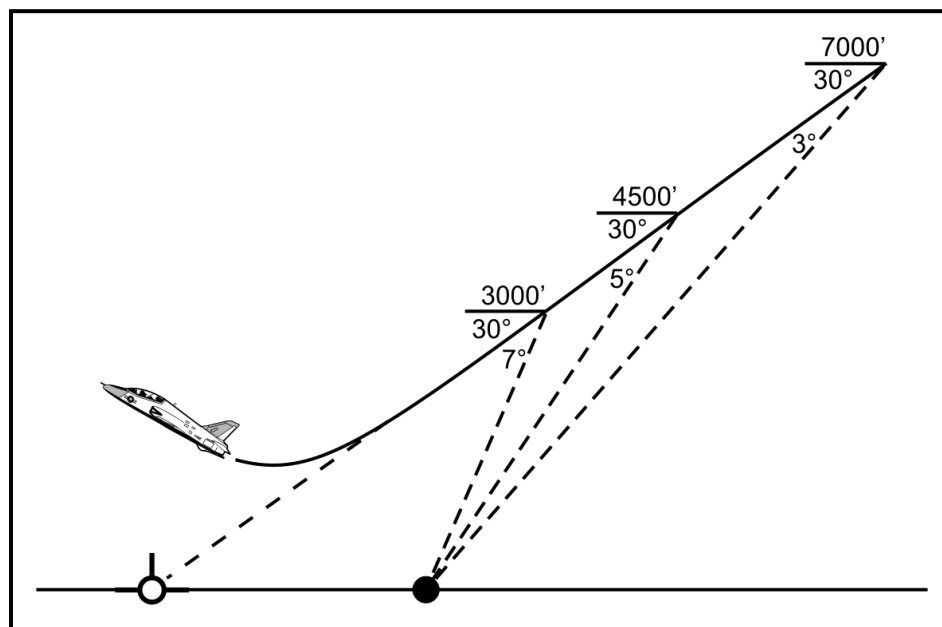


Figure 8-1 Target Depression Angles

A Good Initial Sight Picture

The high angle manual delivery roll-in altitude is 8,000' AGL. By performing roll-in mechanics perfectly, there should only be approximately 1,000' to 1,200' of altitude loss with the aircraft rolling out wings level on the appropriate aim-off at approximately 7,000' AGL. Anything below this altitude, valuable tracking time is being lost. Realize that the 3-degree aim-off is **ONLY VALID** at 7,000' AGL. Setting the initial aim-off angle immediately is critical.

Line-Up Corrections in Manual Mode

In order to correct for lateral deviations, align the target directly between the uncaged pitch ladders and directly below the Velocity Vector as displayed in Figure 8-2. The bomb will fall on an imaginary line below the Velocity Vector. The mil setting (128 mils for the 30-degree pattern) represents the *Trajectory Drop* of the weapon when released on planned parameters.



Figure 8-2 T-45C Uncaged HUD

Notice how the Velocity Vector is placed close to the 12:00 position *relative to the target as viewed from the pilot*, not relative to the run-in line on the ground. Strive to fly the jet in a manner that places the TARGET directly in between the inner tick marks of the 35-degree pitch ladder (or the respective 5 degree pitch ladder below planned dive angle). The reticle only represents where the offset aimpoint is located given current aircraft parameters and winds at release. Using the uncaged Velocity Vector and pitch ladders largely solves for lateral error given all other parameters are consistent. All hits should thus fall on the 12:00 to 6:00 line relative to the target.

8-2 DELIVERY PROCEDURES AND TRACKING TECHNIQUES

NOTE

As shown in Figure 8-2, the aircraft is lined up to the RIGHT of the target referencing the Velocity Vector and uncaged pitch ladders. An early correction to the left should solve for line-up in this example.

Manual Aim-Off Angle

In the manual 30° Z-diagram initial aim-off angle after rolling out is 3 degrees. Immediately after setting aim-off, assess if the aircraft is shallow, steep or on the planned dive wire.

Target Movement and Velocity Vector Placement

In order to drive the target to the proper location on the pitch ladders during the run, it is important to understand the relationship between the Velocity Vector placement and target movement.

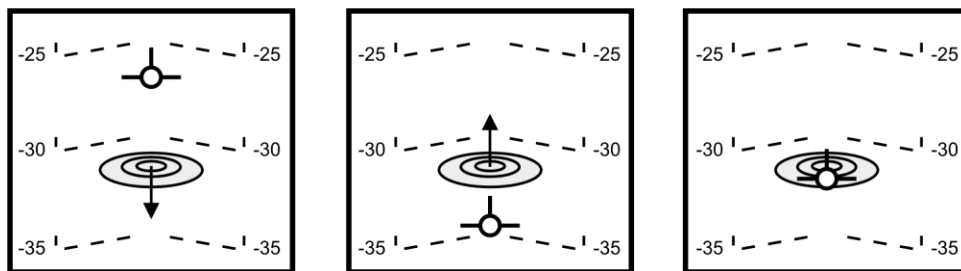


Figure 8-3 Target Movements and Velocity Vector Placement

By placing the Velocity Vector above the target, the target will appear to move down in the HUD as the aircraft gets closer to release. By placing the Velocity Vector below the target, the target will appear to move up. By placing the Velocity Vector on the target, the target remains stationary. The farther away the Velocity Vector is placed from the target the faster the target will appear to move. The closer you place the Velocity Vector to the target, the slower it will move.

Corrections for Steep/Shallow in Manual Mode

A shallow dive wire will result in a late sight picture and/or a *low* release. Correct by setting an even shallower dive angle, then reset aim-off at checkpoint altitude and assess.

A steep dive wire will result in an early picture and/or *high* release. Correct by setting an even steeper dive angle, then reset aim-off at checkpoint altitude and assess. By driving steeper towards checkpoint altitude, you will arrive at checkpoint altitude sooner and may exceed dive angle limitations for release. So long as you are able to make this correction quickly and safely, dive angle limitations shouldn't be a factor once resetting at checkpoint altitude.

Assessing the causes of a steep or a shallow remain the same as previously discussed in CCIP. Strive to keep altitude, roll-in mechanics, and RIP distance consistent throughout all runs.

The Checkpoint Altitude

Checkpoint altitude is an intermediate point at which final corrections to aim-off and dive angle are made. It is also the point where our last second corrections need to be applied if we have errors to the *planned* dive parameters. Ensure the Velocity Vector is set to a 5-degree aim-off above the target. This will ensure that the reticle arrives at the offset aimpoint close to planned release altitude. Figure 8-4 displays what an appropriate 5-degree aim-off looks like at checkpoint altitude.



Figure 8-4 Checkpoint Altitude – Slightly Shallow Dive

The Checkpoint aim-off is set at the checkpoint altitude, not after.

It is extremely important to set appropriate aim-off at checkpoint altitude and not just planned dive angle. If off of the planned dive angle by one degree or less, hold the resultant dive and release based upon reticle placement and parameters. A one-degree or less error in dive angle will result a release sight picture that occurs 100' high or low. At the rate and speeds of descent on the run, seeing 100' high or low at release may be difficult to determine. The exact release altitude will be apparent during HUD tape review or during simulator events where the “freeze on release” function is utilized. The importance of recognizing that a *shallow equates to a late sight picture/low release* cannot be emphasized enough. **Do not** press the run below NLT release altitude for any reason. If setting appropriate aim-off at checkpoint results between one and three degrees steep or shallow, make the appropriate error corrections. If the dive angle exceeds +/- 5 degrees, abort the run. Look to make appropriate corrections on the next pass.

8-4 DELIVERY PROCEDURES AND TRACKING TECHNIQUES

Use the pitch ladders in the HUD to aid in setting aim-off at checkpoint. Since there are exactly 5 degrees between the pitch ladders, wherever the target lies in relation to the 35-degree pitch ladder, place the Velocity Vector the same in relation to the 30-degree pitch ladder. If the target lies slightly above the 35-degree pitch ladder, place the Velocity Vector slightly above the 30-degree pitch ladder (shallow). If the target lies slightly below the 35-degree pitch ladder, place the Velocity Vector slightly below the 30-degree pitch ladder (steep). **Do not** set the dive angle without regard to checkpoint aim-off angle.

Straight Path Tracking

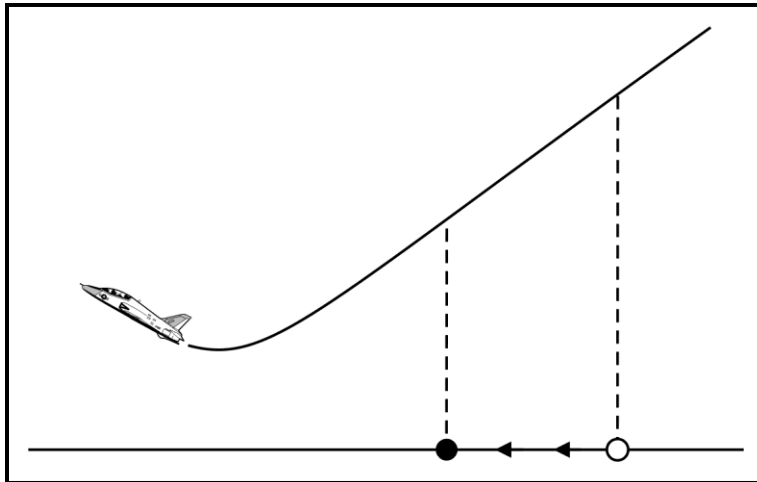


Figure 8-5 Straight Path Tracking

Straight Path. A tracking technique where a specific Flight Path Angle is maintained from rollout to release. Straight Path tracking is achieved by placing the Velocity Vector a set number of degrees above the target after roll-out and holding the resultant Flight Path Angle to release altitude. The aircraft is taking one straight flight path throughout the entire dive. This is the most common type of tracking utilized in the T-45C. Figure 8-5 displays a straight path dive.

Straight Path Tracking Procedures – MANUAL Delivery Mode

At initial roll-out (Refer to Figure 8-6):

1. Evaluate the Initial Sight Picture:
 - a. Good roll-in distance.
 - b. Good ISP.
2. Set the Initial Aim-Off:
 - a. Place the VV 2 ½ degrees to 3 degrees above target (high angle pattern).

- b. Results in approximately a 30 degree FPA.



Figure 8-6 Straight Path Tracking Procedures – MANUAL Delivery Mode

3. Maintain the *resultant* Flight Path Angle (FPA) to checkpoint altitude.
 - 30 degree FPA shown – right on planned dive.



Figure 8-7 Straight Path Tracking – MANUAL Delivery Mode

4. Between rollout and checkpoint, correct left or right for lineup – have the target track vertically between pitch ladders and below the Velocity Vector.

8-6 DELIVERY PROCEDURES AND TRACKING TECHNIQUES

5. Maintain the Flight Path Angle (FPA) to checkpoint altitude.



Figure 8-8 Straight Path Lineup Corrections – MANUAL Delivery Mode

Checkpoint altitude:

1. Set the checkpoint Aim-Off Angle (5 degrees for a 30-degree dive).
2. Note the airspeed.
 - a. 30 deg: ~410 – 420 KTAS
 - b. 10 deg: ~425 – 430 KTAS
3. Check Line-up.
4. Apply error corrections as required.
5. Maintain the resultant Flight Path Angle (FPA) to release.

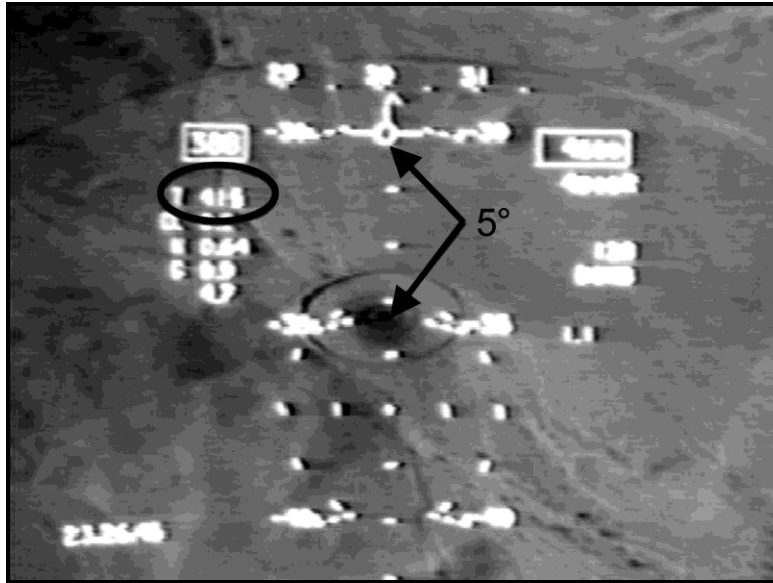


Figure 8-9 Checkpoint Altitude Sight Picture

Checkpoint to Release:

1. Maintain the resultant FPA to release.
 - Resist VV “creep”; maintain a slight bunt.
2. Scan airspeed, altitude, line-up, and reticle placement.

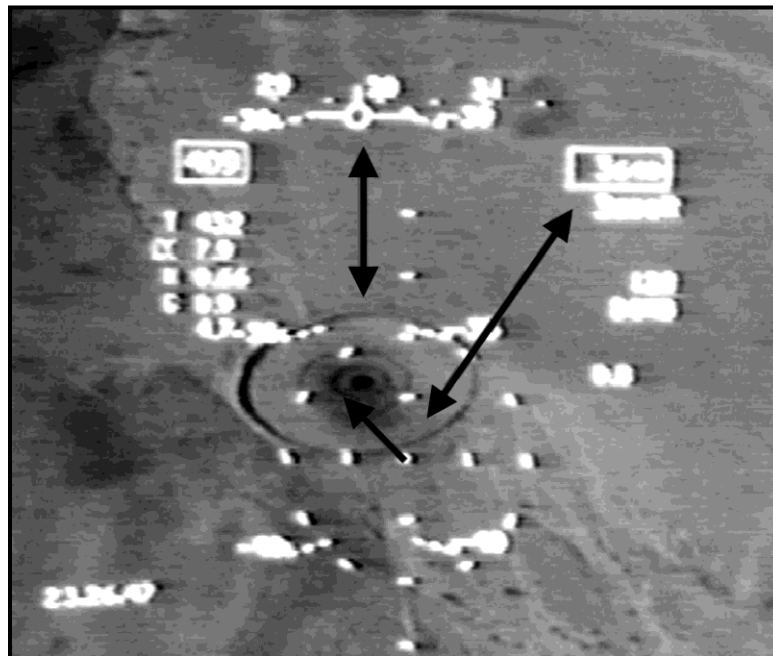


Figure 8-10 Checkpoint to Release

Release Altitude:

1. Pickle when approaching release parameters (the reticle should be superimposed over the offset aimpoint).
2. Pause, and execute the safe escape-4 G pull within 2.5 seconds up to 10 degrees FPA.



Figure 8-11 Release Altitude Sight Picture

Manual Correction Techniques - Review

This section explains and reviews techniques for correcting deviations from planned parameters. How well you are able to recognize errors and correct for them during each run and on subsequent runs will factor into your overall grades and the accuracy of your hits.

Corrections for Dive Angle (MANUAL deliveries only)

Dive angle is referenced from the Velocity Vector. Based upon roll-in mechanics, roll-in distance, and winds aloft, dive angle corrections may have to be made in order to arrive at the appropriate checkpoint sight picture. Corrections for dive angle should be made *prior* to reaching checkpoint altitude.

1. Correcting for a Steep. If upon roll out the dive angle is steeper than planned, drive slightly steeper and reset to 5-degree checkpoint aim-off at checkpoint altitude. If the resultant checkpoint sight picture is still steep, avoid losing valuable tracking time by maintaining the resultant dive angle provided the aircraft is still within dive angle limits. This will cause an early/high release sight picture.

Example: Dive angle in the HUD indicates 32 degrees after setting aim-off at checkpoint altitude. Compensate by pickling 200 feet high. If the proper aim-off was set at checkpoint altitude, *the reticle will arrive at the offset aimpoint earlier, resulting in a release altitude 100' high for every degree steep.*

Understand what caused the steep and make the proper adjustments on follow on runs.

2. Correcting for a Shallow. There are two options for correcting a shallow dive angle:
- a. Add power to increase airspeed (10 KTAS / 1 degree shallow)
 - Example: Dive angle in the HUD indicates 28 degrees approaching release altitude. Compensate by increasing power approximately 4% rpm, allowing the aircraft to accelerate to 470 KTAS while pickling at release altitude.
 - b. Prior to release, adjust the nose slightly to have the reticle track past the aimpoint 50' long (30-degree pattern) or 80' long (10-degree pattern) and release on altitude. **Do not** press the target past NLT release altitude!
 - i. Be careful not to release with excessive G. Excessive G may cause a false sight picture and could invalidate the delivery.
 - ii. Understand what caused the shallow and make the proper adjustments on follow on runs.

Corrections for Airspeed

Maintain awareness of airspeed during the final portion of the run; strive to be as close to release airspeed as possible approaching the planned release altitude. Adjust power accordingly so as to stay within acceptable parameters (not to exceed 500 KTAS at release). Additional corrections for airspeed are similar to corrections for dive angle. For example, if the aircraft is 20 knots fast approaching release altitude compensate either by pickling 200' high or by pickling at release altitude with the reticle set 100' short of the target. If the aircraft is 20 knots slow approaching release altitude, allow the reticle to drift 100' past the target at release altitude. **Be careful to honor NLT release altitude when making last minute reticle adjustments.**

Corrections for Reticle Placement

Realize that the reticle is only accurate based upon planned release parameters. Provided we release while on planned altitude, airspeed, dive angle, etc. (no wind), the weapon will impact where the reticle superimposes the target at release. If the reticle was 300 feet past the target (again given no wind), then this is where the bomb will impact, even if all other parameters are in check.

Corrections for an Early Sight Picture

If the reticle arrives at the aimpoint before reaching planned release altitude, this is an “early sight picture.” Two factors can cause an early sight picture:

1. Excessive aim-off set at the checkpoint altitude (e.g., more than 5 degrees between the Velocity Vector and the target), and/or;
2. Excessive G at release (Velocity Vector creeping up).

An early sight picture/high release can be corrected by adjusting aimpoint to beyond the target, or by increasing airspeed. Apply appropriate corrections on subsequent runs.

Corrections for a Late Sight Picture

If approaching planned release altitude the reticle has not reached the offset aimpoint then we’ve arrived a late sight picture. Causes of a late sight picture include:

1. Insufficient aim-off set at checkpoint altitude (e.g., less than 5 degrees between the Velocity Vector and the target).
2. Being shallow/slow after setting proper aim-off at checkpoint altitude.

If corrections haven’t been made by NLT release altitude, abort the run.

Corrections for Deflection

With bombs, there is no last-minute correction for deflection. Kicking in rudder to move the reticle to the desired aimpoint will result in significant yaw, causing your hit to be inaccurate. Rolling into an angle of bank at the last moment will not be effective either due to the pendulum effect. Recognize lineup, dive angle and airspeed errors early in the run in order to avoid making any last minute “plays” for the target.

802. CCIP DELIVERIES AND TRACKING TECHNIQUES

CCIP flights will build upon previously learned skills in the strike stage. Key differences in transitioning from Manual to CCIP deliveries include slight changes in error corrections and tracking time. The concept of aim-off angle bombing will be reinforced here as well as an increased emphasis on achieving consistent “valid” training parameters.

The Roll-in Point (RIP)

The Roll-In Point (RIP) is the distance at which a smooth 15-17 unit AOA pull with the lift vector placed on the target will result in the aircraft reaching the planned dive wire. The three variables on our roll-in are altitude, RIP distance, and roll-in mechanics. By keeping two of the three variables constant, the remaining variable can be adjusted to achieve a good initial sight picture. By being *on* planned pattern altitude and keeping roll-in mechanics consistent, all that remains is to arrive at a consistent RIP distance from the target suitable to environmental conditions (e.g., wind).

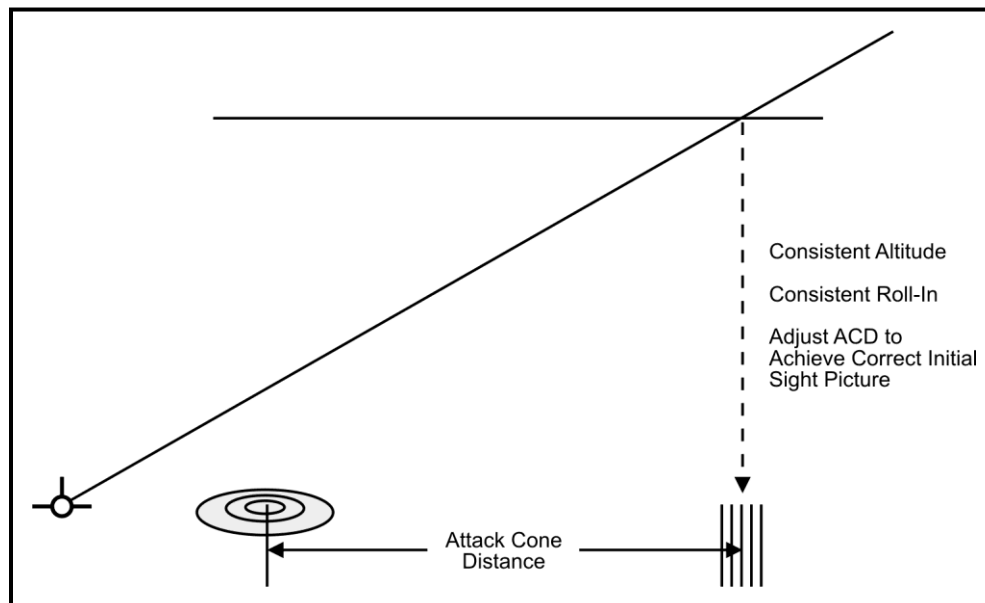


Figure 8-12 Roll-In Components

Aim-Off Angle on the Tracking Run

Remember from Manual deliveries that the *Aim-Off Angle* is the angle between the velocity vector and the Line of Sight to the target. Setting initial aim-off angle becomes even more critical during CCIP deliveries due to reduced tracking time and a greater emphasis on parameter scan.

Notice in Figure 8-12, the Velocity Vector is initially placed 4 degrees above the target immediately upon rolling wings-level at the beginning of the tracking run. The *resultant* flight path angle created is subsequently maintained for the rest of the tracking run until release. The

target will gradually become more depressed below the Velocity Vector as the aircraft proceed towards Planned Release altitude.

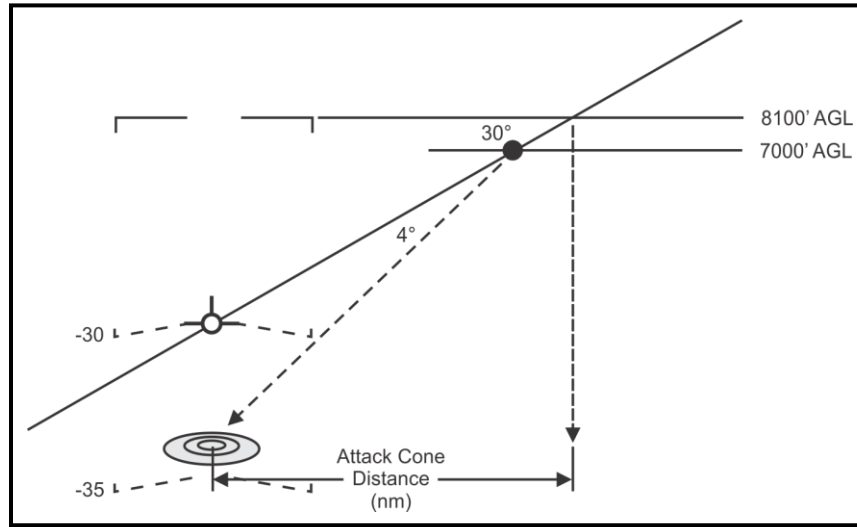


Figure 8-13 Initial Sight Picture

Figure 8-13 displays what a good initial sight picture should look like. Placing the Velocity Vector 4 degrees above the target at the roll out (approximately 7,000' AGL) should result in the planned flight path angle of 30 degrees. Notice the target is 34 degrees depressed in the HUD.

Initial Sight Pictures

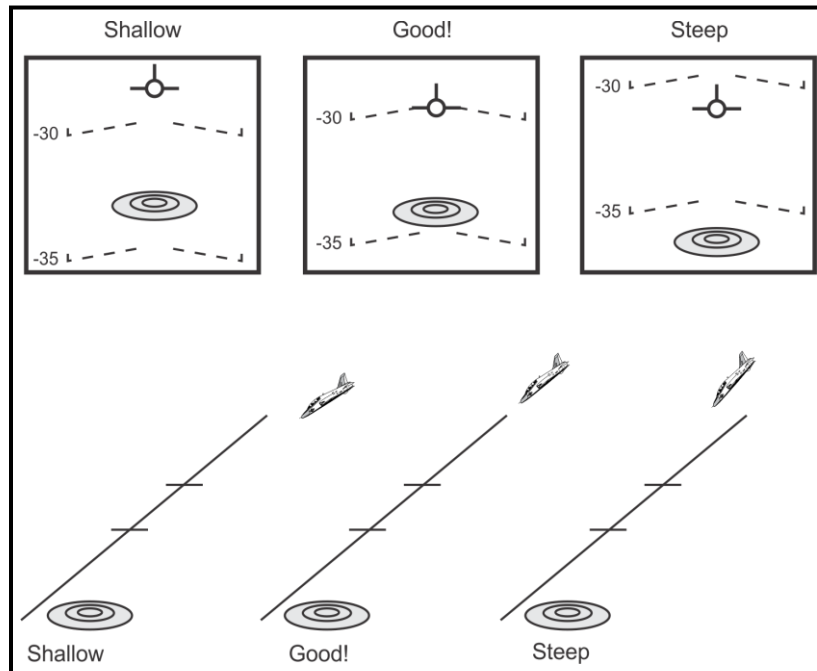


Figure 8-14 Shallow/Good/Steep Initial Sight Pictures

Look at the target in relation to the pitch ladders in Figure 8-14. Notice how the picture on the left shows the target only 32° depressed, but the correct aim-off angle of 4 degrees has been set, leading to a dive angle of only 28°. This is a *Shallow Initial Sight Picture*. The picture in the middle shows the target exactly 34 degrees down (4 degrees aim-off set resulting in the planned 30° degree dive angle). This is a *Good Initial Sight Picture*. Finally, the picture on the right displays the target at 37°, leading to a dive angle of 33°. This is a *Steep Initial Sight Picture*.

Notice that in all of these cases, the sight pictures can be determined by simply placing the Velocity Vector 4 degrees above the target and the resultant flight path angle determines whether the aircraft is shallow, good, or steep in relation to the planned dive angle.

The *goal* of the roll-in is to get to a *Good Initial Sight Picture*.

If the Initial Sight Picture (ISP) is other than *good*, it is critical to understand what caused a Steep or Shallow ISP and make adjustments on subsequent runs.

By keeping pattern altitude and roll-in mechanics consistent, moving the RIP (Roll-In Point) closer or farther from the will get the aircraft to a *good* Initial Sight Picture. The following section discusses the causes of Steep or Shallow ISP's.

Causes of a Steep or Shallow ISP

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

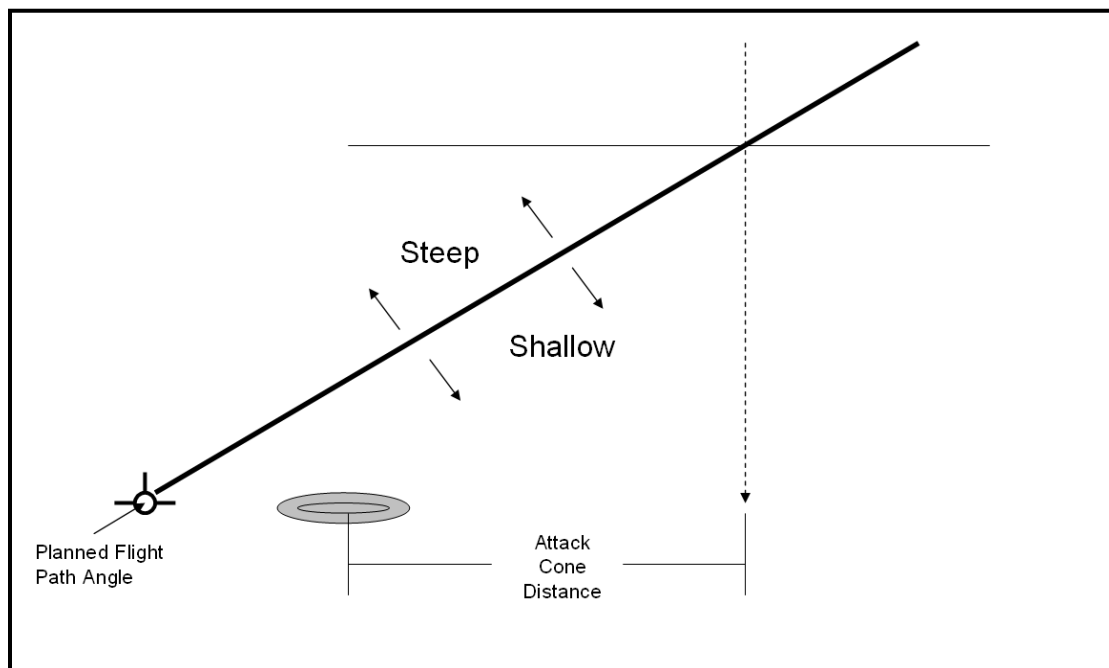


Figure 8-15 Causes of a Steep or Shallow

Any deviations from these variables that cause the aircraft to be **above** the planned wire will result in a *Steep Initial Sight Picture*. Any deviations that cause the aircraft to be **below** the “wire” will result in a *Shallow Initial Sight Picture*.

Causes of a Shallow Initial Sight Picture

Altitude. Beginning the roll-in at the appropriate RIP distance but below pattern altitude will result in the aircraft arriving below the “wire” on the tracking run. Altitude loss will typically occur approaching the roll-in if the Velocity Vector is allowed to “sag” in the approach turn. For example: instead of rolling in at 8,100’ AGL, the roll-in occurs at 7,700’ AGL. This is one cause of a *Shallow ISP*. Strive to have at least a few seconds of wings level time when driving in to the RIP sight picture.

Roll-in Mechanics. If the aircraft is over-banked too far, placing the lift vector well below the target and/or if the pull is too aggressive, the aircraft will arrive below the “wire” on the tracking run. It is crucial to execute the roll-in smoothly, over-bank, place the standby compass on the target and pull. Resist the tendency of allowing the Velocity Vector to go below the target upon initial rollout causing a “J-hook.”

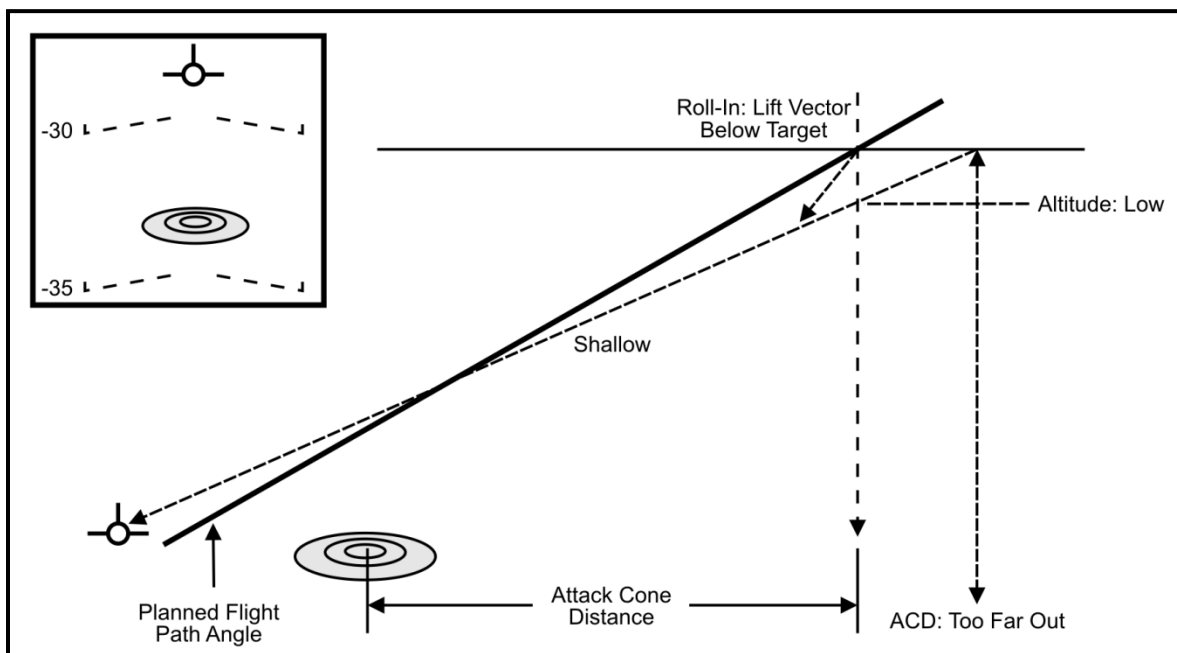


Figure 8-16 Causes of a Shallow ISP

RIP distance. Rolling in at greater distance than planned RIP will result in a shallow ISP.

Try to understand what caused the shallow in the first place. Just like in the landing pattern, flying consistently to “low starts” is unacceptable, and requires fixing during follow-on passes. By keeping the pattern altitude and roll-in mechanics consistent, the only remaining fix is to *roll-in closer* to the target.

Effects & Corrections for a Shallow

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

Causes of a Steep Initial Sight Picture

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

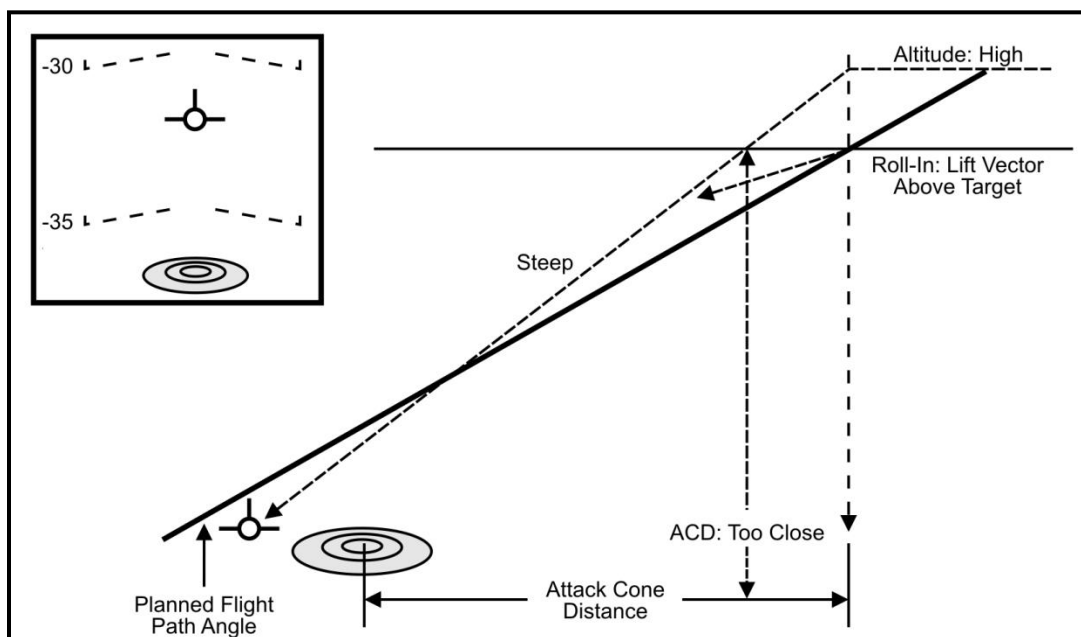


Figure 8-17 Causes of a Steep ISP

Altitude. Beginning the roll-in at the appropriate RIP distance but above pattern altitude will result in the aircraft arriving above the “wire” on the tracking run. Common errors include climbing too high coming off target and climbing during the approach turn while looking for the target/run-in line. Instead of rolling in at 8,100’ AGL, the roll-in occurs at 8,500’ AGL resulting in a steep ISP. Look out the window at the target during the approach turn, but continue to scan altitude. Keep the Velocity Vector level “on the horizon.”

Roll-in Mechanics. If the aircraft is not over-banked enough, placing the lift vector well above the target and/or if the pull is too weak, the aircraft will arrive above the “wire” on the tracking run. Once again execute the roll-in smoothly; over-bank, place the standby compass on the target and pull. Strive to rollout with the Velocity Vector set to the appropriate aim-off.

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

Try to understand what caused the steep in the first place. Just like in the landing pattern, flying consistently to “high starts” is unacceptable, and requires fixing during follow-on passes. By keeping the pattern altitude and roll-in mechanics consistent, the only remaining fix is to *roll-in further away* from the target.

Effects/Corrections Regarding a Steep

A steep dive will result in an early weapons release solution that may be above Planned Release altitude. Throttle back to control airspeed in order to arrive at a solution close to PR altitude and accept a slightly high release. As long as the release solution comes no higher than 500’ above PR altitude, the release will still be considered valid. For a full discussion of Air-to-Surface delivery validation, see Chapter Ten.

Effects of Wind on RIP Distance

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

The Initial Sight Picture - Review

The Initial Sight Picture is only used to evaluate how well the roll-in was executed. Strive to analyze and understand what errors caused a steep or shallow ISP. Keep altitude, roll-in mechanics, and RIP distance as consistent as possible in order to arrive at a good ISP each pass.

A good ISP in the high angle CCIP pattern results in a 4-degree aim-off where the target is depressed 4 degrees from planned dive angle (34 degrees depressed in the HUD). A good ISP in the medium angle CCIP pattern results in a 4-degree aim-off where the target is depressed 4 degrees from planned dive angle (19 degrees depressed in the HUD).

Comparing the FCLP pattern to the strike pattern, getting to a good start is analogous to getting to a good ISP. The fewer corrections needed at the start of the tracking run, the easier it will be to the scan altitude, airspeed, line-up, and release cue. This results in both greater precision and greater accuracy.

Remember, the ISP is only valid upon initial rollout with minimal loss of altitude during the maneuver.

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

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

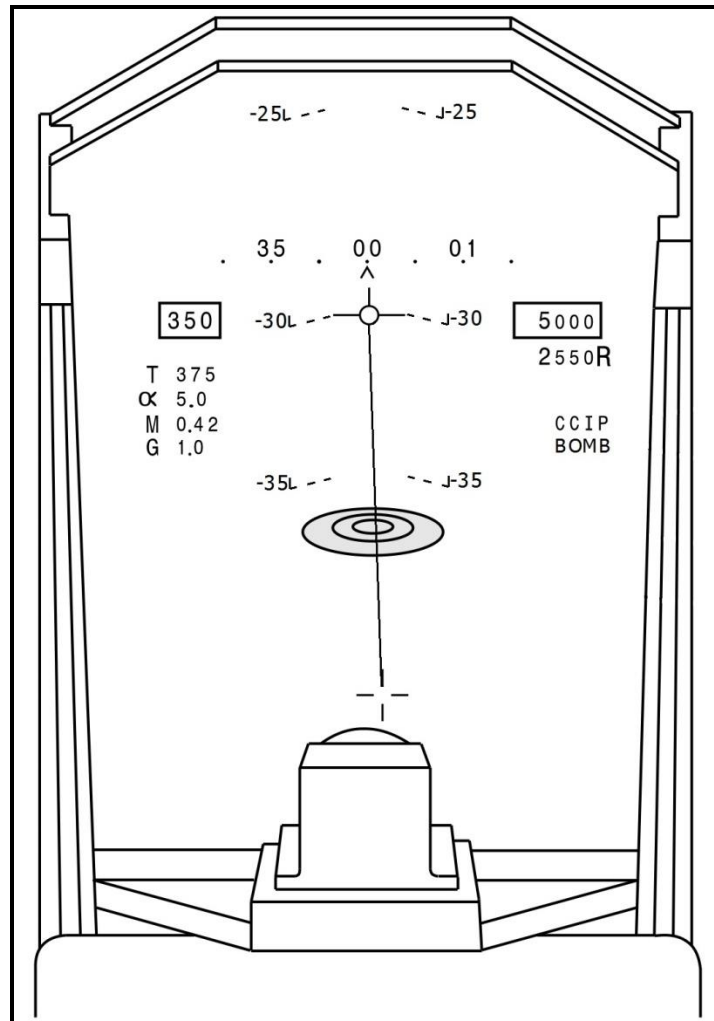


Figure 8-18 Displayed Impact Line and CCIP cue

Figure 8-18 shows that Velocity Vector is placed close to the 12:00 position, *relative to the target*, not relative to the run-in line on the ground.

Tracking Time and References

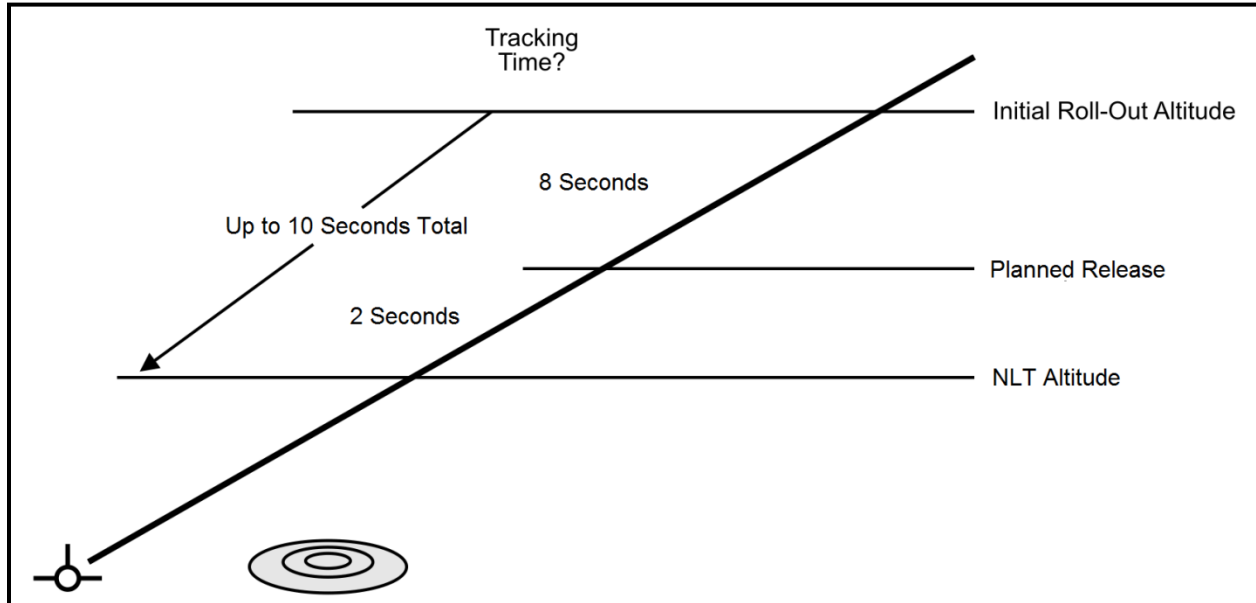


Figure 8-19 Tracking Time / References (CCIP Deliveries)

Normal tracking time is usually between 8 to 10 seconds, depending on airspeed and dive angle. Since the planned release airspeed is still at 450 KTAS, you will need a higher power setting in the 30 Degree CCIP delivery to compensate for less tracking time. During early simulator events and flights, your scan will naturally be slow. You'll struggle initially with the roll-in, line-up control, and dive angle. Knowing what to scan and when to scan it is crucial. As time and experience progresses tracking time will become more manageable.

Immediately after rolling upright in the dive, set the appropriate aim-off angle and hold the resultant FPA (dive angle). Next, correct laterally in order to superimpose the DIL through the center of the target. Finally, *always* keep altitude in your scan and *never* stare at the target. This is known as *target fixation*. In order to achieve valid deliveries, it is critical develop an effective scan.

Release Sight Picture

From the roll-in to release altitude, the resultant FPA (dive angle) obtained after setting appropriate aim-off must be maintained. A common error is to not trim for 450 KTAS resulting in the Velocity Vector "creeping" up as airspeed increases. When the Velocity Vector "creeps up" it causes the release cue to track towards the target faster, leading to a high release solution. To fight this "creep," hold the Velocity Vector on the resultant FPA. This will also result in will a slightly "light in the seat" feel. Optimum G for a 30° dive is approximately 0.8 G and optimum G for a 15° dive is 0.9-1.0 G. Paying attention to G during the dive is normally done by recognizing the "light in the seat" feel and can also be determined in the debrief from watching HUD video. Figure 8-20 is a view of the release sight picture on a perfect delivery. Notice how the CCIP cue superimposes the target at Planned Release altitude.



Figure 8-20 Release Sight Picture

Dive Delivery Example

The following example shows all previously discussed concepts put together. Reference the Initial Sight Picture in Figure 8-21.

At initial roll-out:

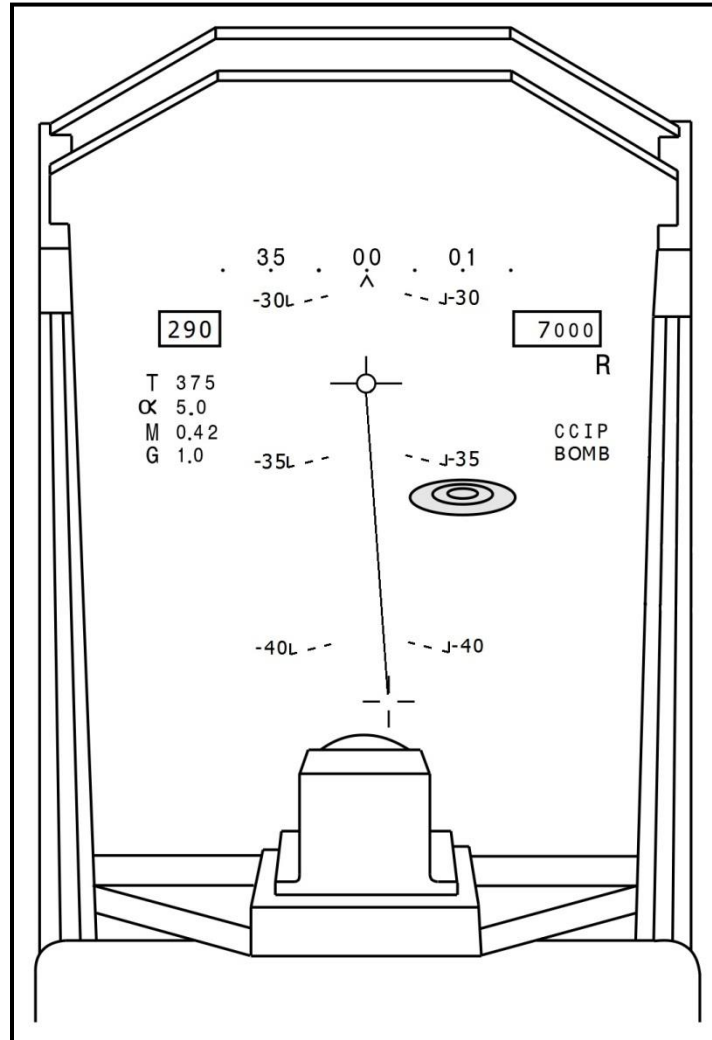


Figure 8-21 Straight Path Tracking – CCIP Delivery Mode

1. Evaluate the Initial Sight Picture.
 - a. Low Wire (not enough aim-off angle set)
 - b. Lined up left of the target

2. Set the Initial Target Placement (ITP):
 - a. Place the VV 4 degrees above target (30 degree delivery).
 - b. Results in 31 degree FPA shown in Figure 8-22.
3. Maintain the *resultant* Flight Path Angle (FPA) to release altitude.

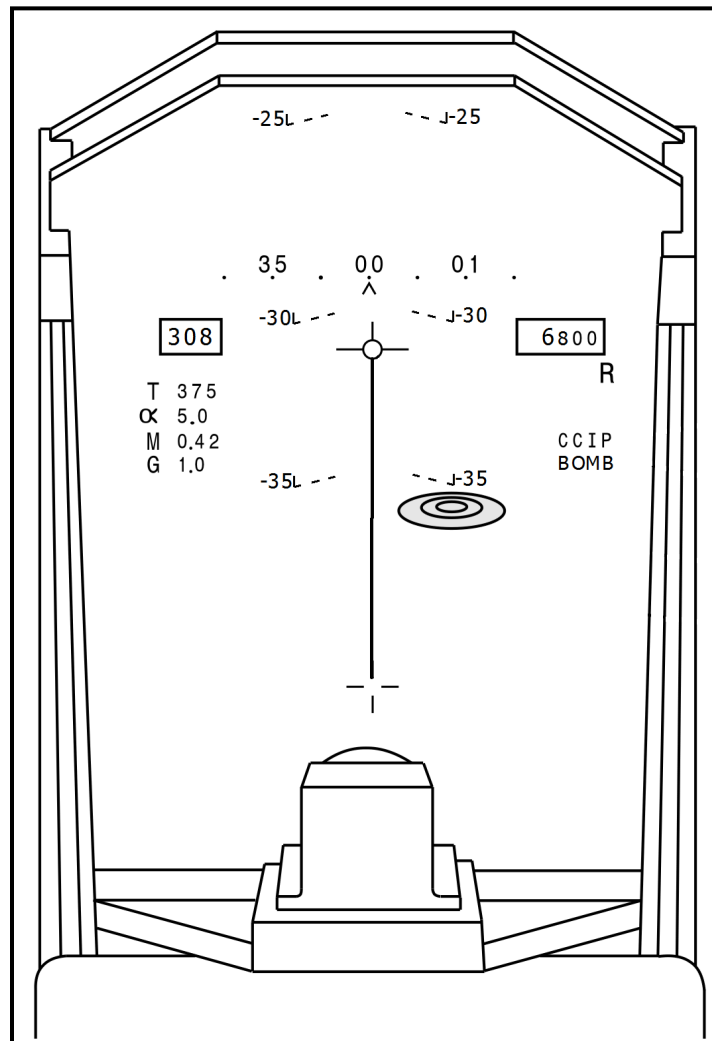


Figure 8-22 Aim-off set

4. Once the aim-off angle is set, maintain the 31-degree FPA and correct laterally in order to superimpose the DIL through the target.

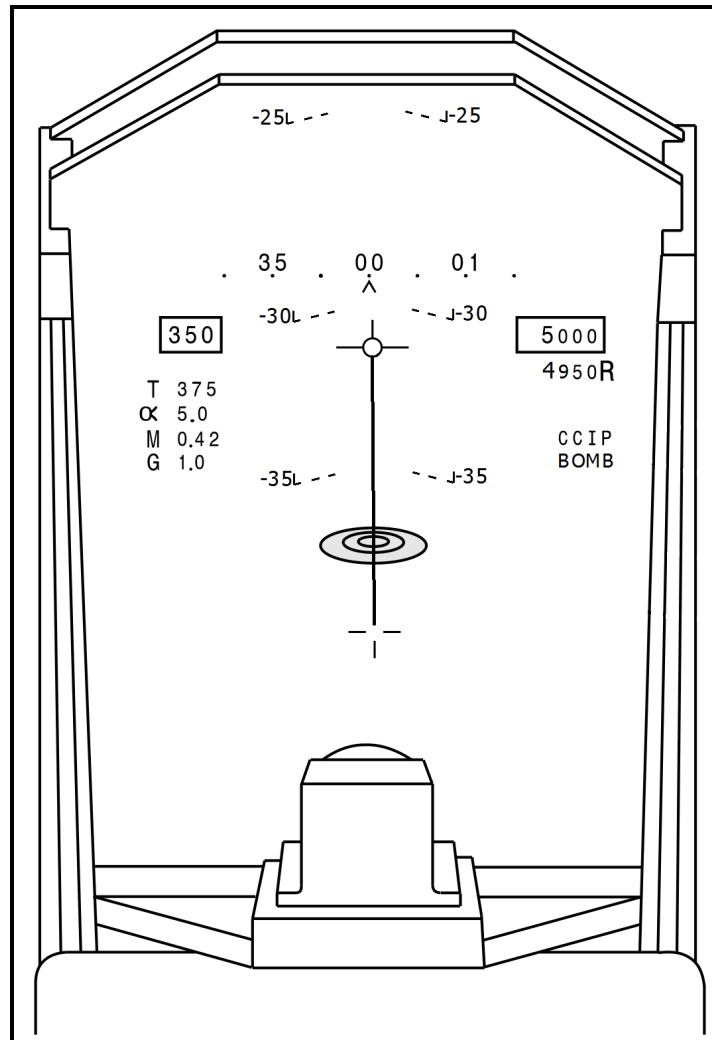


Figure 8-23 Target Tracking

Tracking to Release:

1. Maintain the resultant FPA to release.
 - Resist VV “creep”; slight unload to maintain FPA.
2. Monitor altitude, airspeed, line-up, and CCIP cue.

Release Altitude:

1. Pickle when CCIP cue superimposes intended aimpoint.
2. At release, note CCIP cue placement, airspeed, and altitude.

In Figure 8-24, TAS is 447, G is 0.9, and altitude is 3,530' AGL with the CCIP cue superimposing the one o'clock position on the target.



Figure 8-24 Release Sight Picture

CCIP Error Sensitivities

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

Therefore, if the aircraft is *steeper or faster than planned*, the CCIP cue will display a *high* release solution to compensate. If the aircraft is *shallow or slow*, the CCIP cue will display a *low* release solution relative to planned parameters. Error sensitivities for each dive angle are displayed below:

<u>Correction</u>	<u>Dive Angle</u>	<u>Airspeed</u>	<u>Altitude</u>	<u>Reticle</u>
30 degree:	+/- 1 deg	= +/- 10 kts.	= +/- 100 ft.	= 50' error
15 degree:	+/- 1 deg	= +/- 10 kts.	= +/- 70 ft.	= 80' error

8-24 DELIVERY PROCEDURES AND TRACKING TECHNIQUES

If you are 1° steep or 10 KTAS fast in a 30° dive, CCIP will provide a release solution 100' higher for every one of those deviations. Likewise, if you are 1° shallow or 10 KTAS slow, CCIP will give you a 100' low solution for every one of those deviations.

If you are 1° steep or 10 KTAS fast in a 15° dive, CCIP will give you a release solution 70' higher for every one of those deviations. Likewise, if you are 1° shallow or 10 KTAS slow, CCIP will give you a 70' low solution for every one of those deviations.

The length of the CCIP Displayed Impact Line (DIL) or “stick” increases or decreases based on the trajectory drop of the weapon (i.e., how far the bomb will fall below the Velocity Vector). Notice with the combination of the aircraft accelerating in the dive and getting closer to the ground, the CCIP cue moves up toward the Velocity Vector while the DIL decreases in length.

CCIP is a backup mode in most fleet aircraft but can still be used to illustrate the critical concepts of aim-off angle bombing. While the computer will correct for deviations in dive angle and airspeed (which Manual mode will not) your hits will be significantly better if corrections are smooth and the jet is stable prior to release.

Common Mistakes in CCIP during Raked Range Sorties

1. Getting lazy in the pattern and at roll-in, thinking the system will do all the work, resulting in poor release parameters potentially invalidating a release or a “no-drop.”
2. Setting an insufficient amount of power at roll-in leading to slow release airspeed resulting in a low release; Setting too much power at roll-in causing *excessive* airspeed, resulting in a high release or an unsafe run.
3. Not having the proper aim-off angle set or failing to hold the resultant FPA, causing either a late sight picture (low release) or an early sight picture (high release).
4. Not tracking the target through the DIL resulting in not having the CCIP cue on the target at release.
5. Forgetting to press the pickle with the CCIP cue on the target or pressing the pickle too early. Any “itchy trigger fingers” or delay in pressing the pickle button will cause inaccurate hits.
6. Bombing with the HUD “caged” making it difficult to correct for lateral error to release.

803. ADAPTIVE ROLL-INS

Up until this point, the emphasis of the roll-in was to keep altitude and roll-in mechanics consistent while varying the roll-in distance based upon head/tailwinds to achieve the proper initial sight picture. In real world scenarios, you may find yourself off the planned attack altitude, or at a less than optimal roll-in distance/sight picture. All is not lost. This is where an *Adaptive Roll-In* can help salvage what could have been a bad start and turn it in to one that is manageable. An Adaptive Roll-in is a maneuver in which lift vector placement varies in order to get the aircraft back to the bombing triangle or dive “wire.”

1. Adapting for a high or close:

If we had a situation at the roll-in which would normally cause us to be steep at the start, such as rolling in closer to the target or rolling in at a higher altitude, we could over-bank and place the lift vector *below* the target and/or aggressively pull down. This can help us fly the aircraft down, closer to the planned dive “wire” at rollout. Another correction for being high is to simply roll-in farther away from the planned roll-in point (increase the ACD).

2. Adapting for a low or wide (far):

If the situation presented itself which would normally cause us to be shallow at the start, such as rolling in farther out from the target and/or rolling in at a lower than planned altitude, we could place the lift vector *above* the target and/or float the pull down. This will help us fly the aircraft up to the planned dive “wire” at rollout. Another correction for being low is to simply roll-in closer to the target (decrease the ACD).

Conclusion

Your instructors will provide you with many personal techniques as well as other keys to success that will aid in developing effective bombing mechanics. Incorporate techniques that work for you only after fully understanding the concepts described thus far. With time and consistency throughout the flights, you will develop the skills necessary to move to the next level.

CHAPTER NINE RETURNING FROM THE TARGET

900. INTRODUCTION

RTB Procedures

Following the “fenced out” check and/or exiting the target area, the flight will set-up for the break, a hung ordnance approach, or a combination of the two. Overstressed aircraft and/or aircraft with ordnance remaining will perform a straight-in or hung ordnance approach, as directed by the flight lead.

The Break

The break will be as briefed by the flight lead and executed in accordance with Division Formation procedures, SOP, and local course rules.

The Hung Ordnance Approach

The hung ordnance approach is flown anytime an aircraft has ordnance remaining. It is designed to avoid populated areas and normally consists of a straight in or a modified base leg to final. If flown as a division, the flight lead will separate each aircraft individually as to have the lead aircraft fully configured no later than 3 NM from the runway and established on a 3° glideslope. A technique used by the flight lead is to detach each aircraft approximately 20 seconds apart to generate the appropriate spacing.

When cleared by the flight lead to detach: Throttle-IDLE, speed brakes-EXTEND, landing gear handle-DOWN (below 200 knots), flaps-HALF, slow to 150 knots and retract the speed brakes. It is important to follow the flight lead’s path over the ground without cutting corners. This is to ensure appropriate separation between all aircraft. Do not descend below your preceding interval’s altitude. Maintain 150 knots until 3 NM. Once you are 3 NM from the runway: Flaps-FULL, speed brakes-EXTEND, complete the landing checklist, slow to on-speed while reporting gear down and locked to the tower.

Landing rollout will be on centerline per the SOP. **Do not** exceed 600’ per minute rate of descent as described in NATOPS. If a go-around/wave-off is performed, enter the landing pattern as to avoid buildings, houses and other populated areas.

If only one aircraft has hung ordnance, the flight lead will arrange the flight as to detach the hung aircraft prior to the initial, allowing sufficient time and distance for the detaching aircraft to fly the appropriate hung ordnance approach behind the rest of the division. If there are more than two aircraft with hung ordnance (and/or the flight lead has hung ordnance), the entire flight flies the hung ordnance approach. Hung ordnance is most likely to fall from the aircraft either in the transition to landing configuration or upon touchdown. ***Exercise extreme caution at all times.***

Taxi to the Line

If taxiing with ordnance remaining, advise maintenance and/or base with status (hung or unexpended) and comply with local de-arming procedures. The term “hung” indicates there was an attempt to release while “unexpended” indicates there was no attempt to release.

Shutdown / Post-Flight Procedures

Aircraft parking and shutdown procedures are in accordance with the SOP and NATOPS. Pay special attention to any aircraft damage due to frag or bomb-to-aircraft collisions. Specific areas of inspection include: access panels, underside of the wing, flaps, empennage, and the horizontal and vertical stabilizers.

CHAPTER TEN STRIKE DELIVERY VALIDATION

1000. INTRODUCTION

In the early 1990s with the introduction of AUTO and CCIP mode unguided bomb deliveries in the F/A-18 Hornet, the fleet noticed an alarming trend of pilots releasing low in order to get a bomb on target. After determining sloppy roll-in mechanics as the cause, the fleet introduced Air-to-Surface validation criteria in order to remedy the situation. This introduced a series of defined parameters in order to determine if a roll-in was executed per the Z-Diagram, and a way to ensure that new pilots were trained with proper habit patterns.

1001. VALIDATION CRITERIA

Properly weaponized Z-Diagrams have very specific safety margins built in to the calculations. In order to ensure that dive deliveries are properly performed and executed within acceptable parameters, each bombing run is evaluated according to four categories: System, Parameters, Aimpoint, and Safety. For a bombing run to be “valid,” it must meet specific criteria in each category. That is, if a run meets all the criteria for System, Parameters, and Aimpoint, but fails to meet a specific Safety wicket, the entire run is “invalid.” If any criteria cannot be determined, either by an IP in real-time or by tape debrief, that run is considered “un-assessable.”

Validation Criteria:

1. System
2. Aimpoint
3. Parameters
4. Safety

System Validation

The purpose of system validation is to ensure that the T-45C weapons systems are set up properly for each run. For a bombing run to be considered “valid for system,” the pilot must roll-in with:

1. MASTER ARM set to ARM
2. Proper employment mode for the briefed flight (Manual vs. CCIP)
3. A rack selected on the STORES page with bombs remaining

The instructor pilot should be able to determine in flight that the MASTER ARM and STORES page were set up correctly. If a bomb is successfully released, the run may be considered “valid

for system.” If the student rolls-in with the MASTER ARM in SAFE, or an empty rack selected with ordnance remaining on the other, the resulting no-drop will be considered “invalid for system.” *Once all ordnance has been delivered, the first two criteria are sufficient to fulfill validation requirements (e.g., simulated runs).*

Parameters Validation

In order to validate the parameters of a bombing run, an instructor pilot must evaluate the following parameters at bomb release: dive angle, airspeed, altitude, and G. For a run to be “valid for parameters” each must be within a specific tolerance:

1. Dive angle within 3° of planned Z-Diagram in use.
2. Airspeed within 20 knots of planned release airspeed.
3. Altitude from NLT to PR + 500’ per the Z-Diagram in use.
4. Release G from 0.6-1.2 G

For example, if a bomb was released in the high angle (30°) CCIP pattern at 3500’ AGL, 0.9 G but 477 KTAS, the entire run would be “invalid for parameters” because of the high airspeed. However, a bomb released at 3200’ AGL, 445 KTAS, 33°-dive angle and 1.0 G would be considered “valid for parameters” because each parameter is within allowable tolerance.

Aimpoint Validation

A bomb release is “valid for aimpoint” if:

1. The intended target is within ½ width of the CCIP cue length of cross-center at release.
2. For manual deliveries, the target is lined up between the pitch ladders with the reticle within 25 mils of the offset aimpoint. *(IP Note: Due to the difficulties real time with assessing offset aimpoint, consideration can be given to call aimpoint “valid” based upon CEP guidelines if all other criteria are valid.)*



Figure 10-1 Valid Aimpoint at Release

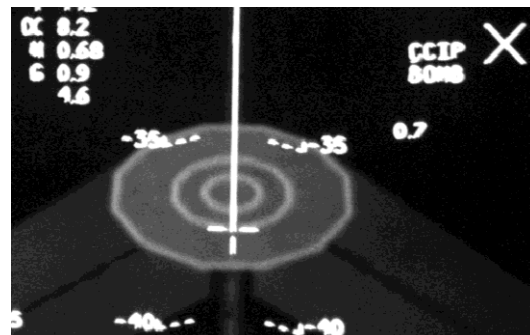


Figure 10-2 Invalid Aimpoint at Release

Safety Validation

Immediately after pickle, the pilot must *smoothly* initiate a 4 G pull within 2.5 seconds, and hold 4 G until the Velocity Vector is 10° above the horizon. Only once the aircraft is established in a 10° FPA climb should the pilot call “*off safe*” and begin the pull to the abeam. Consequently the bombing run will be considered “valid for safety” if:

1. A 4 G pull is established within 2.5 seconds and held until a 10° FPA climb is reached.
2. MINALT is not broken.

The run will be “invalid for safety” if the pilot relaxes below 4 G before the Velocity Vector is 10° above the horizon, or if the pilot presses the target low and fast and busts MINALT as a result. Note that the safety criteria allows for an adequate time post release in order for the pilot to reach 4 G. **Do not** snatch aft stick input in order to maintain valid safety parameters. Smoothly establish a 4 G-pull post release in order to avoid the T-45C symmetrical G limit of +6.5 G below 5000’ MSL.

1002. VALIDATION PROGRAM

The entire purpose of strike validation is to place training focus on the process rather than results. A student that can perform 12 completely valid drops in a row has solid roll-in mechanics, and is well on his way to proficiency in the tactical air-to-surface environment, even if his CEP is larger than his peers. Conversely, a student that achieves a tight CEP, but cannot consistently produce valid runs has sloppy mechanics, and their hits are the result of a healthy dose of luck. Focus on proper, valid, roll-in mechanics and the hits will follow.

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CHAPTER ELEVEN
TRAINING RULES / CONTINGENCIES / EMERGENCIES

1100. AIR-TO-SURFACE TRAINING RULES

Weather Requirements

Use local altimeter setting

WX Requirements IAW CNATRINST 1542.167 Series (T-45 MPTS)

Radar Altimeter Procedures

DIVE deliveries – the RADALT shall be set to the minimum altitude for the pattern being flown.

POP deliveries-the RADALT shall normally be set to 10% below the final run-in altitude.

Ordnance Considerations

No release of ordnance unless:

The target is positively identified and cleared by the Range Safety Officer (normally assumed by the flight lead).

Carriage & Release limitations shall be briefed per NATOPS Ch. 4.

MASTER ARM may be placed to ARM under the following conditions:

1. Free-fall ordnance “CCIP” or “MANUAL” dive deliveries: approaching roll-in.
2. Free-fall ordnance “POP” deliveries: once established in the dive.

Termination of Strike Maneuvering

Tactical Abort Criteria:

1. The preplanned dive angle, once established in the run, is exceeded by $\pm 5^\circ$.
2. Outside of briefed attack geometry (final attack heading $\pm 15^\circ$).
3. Airspeed exceeds 500 KTAS at release altitude.
4. Passing No Lower Than Release altitude / minimum altitude.
5. Break “X” in the HUD.

6. LAWS Tone goes off.
7. “KIO,” “Terminate,” or “Abort” is called by any aircrew.
8. Any aircraft NORDO.
9. Bingo fuel state is reached.
10. Interloper in the target area.
11. Inadvertent IMC or weather deteriorates below minimums.
12. Any aircrew experiences or suspects G-LOC.
13. Crossing the border of the authorized training area.
14. Overstress or malfunction with aircraft.
15. Any doubt concerning any element of information related to safety of flight.

1101. EMERGENCIES AND CONTINGENCIES

Midair Collisions

If the proper interval is established and maintained throughout the individual patterns, the danger of a midair collision is greatly reduced. However, it is mandatory that each pilot exercise extreme caution and take particular care not to cut the aircraft ahead out of the pattern. One of the most likely places for this to occur is where the pilot pulls off target and looks for his interval to commence his turn to the abeam. If the pilot ahead has extended off target farther than normal and the pilot behind picks up the wrong aircraft as his interval and commences his turn, an extremely dangerous situation exists. There are now two pilots using the same aircraft as their interval. A similar danger can also arise near the roll-in point. A simultaneous run (Simo-run) is a short interval at the roll-in, usually resulting from an early or deep roll-in on the part of one pilot. In order to help avoid dangerous situations, these rules must be followed:

1. Maintain proper pattern airspeed and altitude.
2. Use proper voice procedures.
3. When turning to the abeam position after a run, if you do not see your interval and you have not heard him call his position, do not climb to pattern altitude. Remain 1,000 feet below the pattern altitude, and ask your interval for his “posit.”
4. If you find you are too close to the aircraft ahead of you, make your pattern corrections when coming off target.

5. Do not hesitate to sacrifice radio discipline when safety is involved. If at any time you are not sure where your interval is, or you are not sure that the aircraft you have in sight ahead is really your interval, do not hesitate to make a radio transmission. Always call a “Simo run” if you see it.
6. If you are in a run when someone calls “*Simo run*,” follow these procedures:
 - a. Report the abort and gradually displace the aircraft laterally from the run-in line and fly to clear airspace.
 - b. Regain sight of all other aircraft.
 - c. Reestablish flight sequence at flight lead's discretion.

Low Pullout

Going below the release altitude during the pullout from the dive can be the result of any one, or a combination, of the following situations. Recall the breakaway cross on your head-up display. If you see it, pull up immediately. Do not depend on the cross as a cue; recover when you are supposed to.

Excessive Airspeed at Release

Failure to monitor power settings, roll-in airspeeds, and dive angles can easily result in excessive airspeeds at release altitude. Disregarding any of these variables not only creates a dangerous situation because of a resultant low pullout, it also detracts considerably from the pilot's ability to bomb effectively. Strive to keep an effective scan in order to make runs safer and more predictable.

Dive Angles Steeper than Optimum

Not only does a steeper dive angle result in a lower than normal pullout, but it usually causes excessive airspeed and loss of tracking time. Learn to recognize steeper than optimum dive angles early in the run with the help of the HUD.

Correcting by Releasing Low

There is another reason not to go low, a reason connected with the combat job you are learning. That reason is fuse-arming delay, which involves a time delay set into the fuse to allow safe separation of the bomb from the aircraft. A bomb with a timed fuse must fall for a set length of time before the fuse is armed. Consequently, going low for release may not give sufficient time for your weapon to arm and you are in the position of trying to drop scrap iron on somebody instead of high explosive. With live ordnance, you will also have a fragmentation pattern to avoid. ***Do not go low.*** **Pitot-Static Malfunctions**

You have two altitude readings on your HUD, barometric and radar. If the radar altimeter readout does not appear below 5,000' AGL, something is wrong. You may simply not have the radar altimeter turned on. If the barometric altitude does not display, then there is a failure of some sort, either in the HUD or in its inputs. If only the HUD or one of its transducers has failed, you have the option of continuing with the flight using your cockpit altitude readout or standby altimeter. A failure may affect more than just the HUD; if you have reason to suspect that something is wrong with the pitot static system itself, investigate at a safe altitude.

If your instruments indicate greater than +/- 200' or +/- 20 knots from other aircraft on the Spacer Pass, take it to the lame duck.

Exceeding G Limits

Overstressing the aircraft in the weapons pattern is usually the result of snapping on G, instead of applying it smoothly when beginning the pullout after release. You do not need to use more than 4 to 4.5 G to make a normal pullout. If you do happen to apply too much G, you must be able to determine whether it is an overstress. See the NATOPS manual for limitations. If you overstress your aircraft, discontinue your runs, notify the flight lead, and go to the lame duck pattern (discussed under lost communications). The instructor will brief the student on the lame duck pattern for a non-NORDO scenario.

Rolling Pullouts (Unsymmetrical Pulls)

Ensure that there is no rolling moment on all pullouts. A rolling pullout not only decreases the G that may be safely applied, but also sharply lowers the bottom-out altitude reached during the pullout. To avoid this, recover from a dive with a level pull-up, stop the pull, roll, stop the roll, *and then* pull again.

Inadvertent Weapons Release

There have been many cases where short circuits or faulty switches have caused inadvertent firing or ordnance drop. The danger is especially grave when you are carrying forward-firing ordnance, because it can shoot well out of the restricted area. Adhering to switchology rules already given can minimize the danger of inadvertent release. Do not arm your MASTER ARM switch in a forward-firing ordnance run until you are wings level *in the dive* and your interval has called off the target.

Lost Communication

In the event that you lose your radio in the bombing pattern and have no other problems, enter the lame duck pattern. The lame duck pattern is 2,000 ft above the high *and medium patterns* or 1,000 ft above the off target rendezvous pattern *for the low patterns*, depending on which pattern the flight is using. Orbit in the direction of the pattern. Should the weather not permit orbiting above the pattern, maintain your interval and fly the pattern normally except for the roll-in; stay at altitude. When you arrive at the roll-in, rock your wings and stay at pattern altitude. When

the rest of the flight has finished bombing, a rendezvous will be executed. Normally the NORDO aircraft joins last, inside lead's turn, and will be positioned as Dash 2 for the return.

1. If you have a serious problem with your aircraft while you are NORDO, return to base or emergency airfield as briefed. A wingman will be dispatched to assist you.
2. If you have aircraft problems that do not require immediate action but do require assistance, enter the lame duck pattern, orbit opposite the direction of the flight and an instructor will join you. Use standard HEFOE signals to inform the instructor of your difficulties.

Late Pattern Entry

The flight lead may permit an aircraft in the flight to enter the pattern late due to maintenance problems. The late aircraft must contact the lead for a clearance into the target area and should enter the pattern at the briefed altitude, between the abeam and the roll-in position.

Target Fixation

Target fixation remains a major concern. Continue to work your scan while in the dive to ensure you are remaining within parameters. Make sure you thoroughly review and adhere to your planned Z-Diagram. Continue to scan altitude in the dive. If you reach your NLT release altitude without a valid releases sight picture, *abort*.

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APPENDIX A GLOSSARY

A

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

Aim-Off Distance: The distance past the target where the planned flight path intercepts the ground.

Aim-Off Point: The ground feature or point on the ground representing the Aim-Off Distance.

Aimpoint: The point on the ground that the reticle superimposes at planned release. See also final aimpoint and initial aimpoint.

Armament Control System (ACS): The electromechanical system that releases the selected weapon upon the pilot's command.

Attack Cone Distance (ACD): The distance from the target at which a normal roll-in from pattern altitude would result in being established on the planned dive wire or bombing triangle. See also Roll-in Point.

B

Breakaway Cross or Break X: A cross displayed on the HUD indicating that an immediate 4-G pull-up is required for a safe ground clearance of 1,000 feet when the dive angle is greater than 15 degrees.

C

Circular Error Probability (CEP): The median of total hits, calculated in feet.

Continuously Computed Impact Point (CCIP): A HUD air-to-ground delivery mode that provides an aiming reticle showing where the ordnance would hit if released at any given moment.

Curvilinear/Straight-Path Tracking: A weapons delivery technique, which uses curvilinear tracking until reaching a predetermined checkpoint, then straight-path tracking to release.

D

Deflection: The distance to one side of the target of the reticle or impact point.

Depressed Sight Line (DSL): A HUD air-to-ground delivery mode that provides a non-computing aiming reticle for use in a manual weapons delivery. See also Iron Sight.

Dive Angle: The angle between the horizon and tangent line across the top of the airspeed and altitude boxes or waterline “W.”

Dive Recovery: See Safe Escape.

E

Early Sight Picture: The reticle arrives at the final aimpoint before the aircraft arrives at release altitude. Will usually result in a short hit.

F

Final Aimpoint: The point on the ground where the reticle should be at release in order to hit the target; the final aimpoint is corrected for wind. See also Initial Aimpoint.

H

Hung Ordnance: Bombs or rockets still attached to aircraft after an attempt to release has been made. Unexpended ordnance (no attempt at release) will be treated as hung in the Training Command.

I

“In” Call: Indicates the pilot has intent to release ordnance and that the MASTER ARM switch is set to ARM.

“In Cold“: Indicates that the pilot has no intent to release ordnance and the MASTER ARM switch is SAFE.

Initial Aimpoint: A point on the ground chosen as a reference for initial reticle placement at the beginning of the run. See also Final Aimpoint.

Interval: The aircraft ahead of you in the pattern; also the distance between you and the aircraft ahead of you.

Iron Sight: A fixed gun-, rocket-, or bombsight; no computer is used to aid the pilot in aiming. See also Manual Delivery.

L

Lame Duck Pattern: The pattern flown by a pilot who for some reason cannot finish his flight but does not have a serious emergency.

Late Sight Picture: The aircraft arrives at release altitude before the reticle arrives at the final aimpoint. Will usually result in a long hit.

LAU 68: The rocket launcher used for 2.75” practice rockets; also called “rocket pod.”

Line of Flight: The aircraft path through the air.

Line of Sight: A line from the pilot's eye through the reticle.

M

Manual Delivery: Weapons delivery unaided by computer; see also Iron Sight.

Mil: 1/6400 of a circle; 17.45 mils = 1 degree. 1 mil subtends 1 unit at 1,000 units (1 mil covers 1 foot at 1,000 feet).

Mil Setting: See Sight Depression Angle.

MINALT: The minimum altitude of the Z-Diagram based on terrain, fusing, threat or frag. In order to achieve a valid delivery, the aircraft must never break MINALT.

N

NLT: No Lower Than release altitude. DO NOT drop ordnance below the NLT altitude. Release at this altitude guarantees that an aircraft that is on planned dive angle and up to 50kts fast will still remain above MINALT if a 4 G pull is established within 2.5 seconds.

NORDO: No Radio. Refers to a pilot who is unable to receive voice communications. He will still broadcast in the blind until established in the lame duck pattern.

O

Offset Aimpoint: An aimpoint displaced from the center of the target to compensate for wind at release altitude. Calculated by using the following formula: $D=1.7 \times T \times W$ (offset) = 1.7 x (time of flight) x (wind)

P

Pendulum Effect: Caused by the depressed sight line. With one wing down, the reticle will move in a direction opposite the bank; the line of sight swings through the air below the aircraft like a pendulum.

Pickle: (noun) The weapons release button; releases bombs or rockets on the T-45C. (verb) To release a weapon; usually used with reference to bombs.

Pigtail: The electrical connection between the pylon and the bomb rack or rocket launcher.

PR: Planned Release altitude. Releasing at this altitude guarantees that an aircraft can be steep (up to 10° for high-angle bombing, or 5° for low-angle) and up to 50 kts. fast and still remain above MINALT if a 4 G pull is established within 2.5 seconds.

R

Reticle: A pattern of lines, dots, cross hairs, etc. used in a sighting device (HUD, gun sight).

Roll-in: The method of getting from level flight into a dive at a sharp angle to the original flight path.

Rollout: Rolling the wings level and upright to complete the roll-in and establish the dive.

Rolling Pullout: Recovering from the dive with wings not level; applying a roll input during dive recovery may cause overstress.

Run-in Line: A line that represents the aircraft ground track or anticipated ground track in a dive. An established run-in track on a practice target range.

S

Safe: Master armament switch is off.

Sight Angle: See Sight Depression Angle.

Sight Depression Angle: The degree to which the line of sight is below the line of flight; measured in mils.

Sight Picture: The reticle and the target as they appear together, superimposed.

Simo Run: Simultaneous run; two (or more) aircraft in the roll-in or dive at the same time.

Slant Range: The distance from the aircraft to the target measured in a straight line.

Straight-path Tracking: The portion of the dive where the aircraft path through the air is a straight line, with the reticle moving continuously toward the target.

Switchology: Managing the positions of the various armament control switches to release the desired ordnance.

T

Target Depression Angle: The angle between the horizon and the line of sight to the target.

Target Fixation: The act of looking at the target only, paying no attention to flight instruments or proximity to the ground.

Time of Fall: The time a weapon spends in the air from release to impact.

Time of Flight: See Time of Fall.

Trajectory: The path the weapon follows from release to the ground.

Trigger: The switch on the front of the control stick; only operates the simulated gun on the T-45C.

W

Winchester: Voice-call that indicates all ordnance is expended.

Wind-Corrected Tracking: Adjusting the tracking run to compensate for wind so that the reticle superimposes the offset aimpoint at release altitude.

Z

Zero Sight Line: The line from the pilot's eye through the sight with a sight depression angle of zero mils.

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