NAVAL AIR TRAINING COMMAND

NAS CORPUS CHRISTI, TEXAS **CNATRA P-1209 (Rev. 07-09)**

FLIGHT TRAINING INSTRUCTION

T-45 WEAPONS/STRIKE

2009

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Subj: FLIGHT TRAINING INSTRUCTION, T-45 WEAPONS/STRIKE

1. CNATRA P-1209 (Rev. 07-09) PAT, "Flight Training Instruction, Weapons/Strike" is issued for information, standardization of instruction, and guidance for all flight instructors and student aviators within the Naval Air Training Command.

2. This publication shall be used as an explanatory aid to the T-45 Weapons/Strike Jet 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 CNATRA TCR form CNATRA 1550/19 in accordance with CNATRAINST 1550.6E.

4. CNATRA P-1209 (Rev. 10-08) PAT is hereby cancelled and superseded.

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Chief of Staff

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FLIGHT TRAINING INSTRUCTION

FOR

T-45 WEAPONS/STRIKE

JET PILOT TRAINING

P-1209

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LIST OF EFFECTIVE PAGES

Dates of issue for original and changed pages are:
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Page No.	Change No.	Page No.	Change No.
COVER	0	6-1 – 6-3	0
LETTER	0	6-4 (blank)	0
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4-18 (blank)	0		
5-1 – 5-4	0		

INTERIM CHANGE SUMMARY

The following changes have been previously incorporated in this manual:

CHANGE NUMBER	REMARKS/PURPOSE

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

INTERIM CHANGE NUMBER	REMARKS/PURPOSE	ENTERED BY	DATE

SAFETY/HAZARD AWARENESS NOTICE

This course does not require any special safety precautions other than those normally found on the flight lines.

HOW TO USE THIS FTI

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

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

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

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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 special and conventional weapons. Delivery techniques vary as widely as the weapons themselves, and vary from conventional dives of all angles to computer-integrated loft maneuvers. To be a true professional, you - the Naval Aviator - must be thoroughly versed in air-to-ground delivery.

OBJECTIVE

The primary objective of the Weapons stage is to develop your basic skills of weapons delivery. The most important of these skills involves developing consistency in two concepts - rolling in and tracking. You will find that the basic skills you already learned, such as formation flying and instrument scan, will be helpful in the weapons delivery stage. The ultimate objective is to teach you how to make the ordnance hit the target. This publication will emphasize the fundamentals of weapons delivery and their application to various types of practice ordnance. The procedures contained here, except those labeled "techniques," must be closely followed. For Training Command purposes, the most important aspect of weapons delivery is consistency in roll-in and tracking. Diversification can come later, after building basic skills.

GRADING

Because accuracy of delivery is the goal of weapons training, it will be graded on all but the first few flights. You will determine accuracy by figuring the 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. Figure your CEP by arranging your hits from best to worst; the CEP is the middle hit of an odd number of drops or the average of the middle two hits of an even number of drops. Count off-target hits of unknown distance as 500 feet. Four drops are required to compute a CEP and complete a flight. All scored hits will count toward the flight CEP, regardless of the pattern in which the individual bombs were dropped. Accuracy will be graded in accordance with the guidelines found in the applicable master curriculum guide (MCG).

NOTES

CHAPTER ONE
T-45 ARMAMENT CONTROLS AND INDICATORS

T-45C WEAPONS SYSTEM

100. T-45C WEAPONS SYSTEM INTRODUCTION

101. T-45C ARMAMENT SYSTEM - GENERAL

The armament system provides for the carriage, jettison, sighting, gun firing simulation, and controlled release of external stores. Armament system controls consist of 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. There is no data interface between the weapons station and the A/G stores display. Weapon quantity and rocket firing mode must be set in by the pilot to match the weapons load.

102. T-45C ARMAMENT SYSTEM CONTROLS AND INDICATORS

Emergency Jettison Button

The jettison button (Figure 1-1) in the forward and aft cockpit when pushed will jettison stores on the wing pylons simultaneously with weight off wheels. Stores jettison occurs regardless of the selected weapon or master armament switch position. 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. All armament circuits, except for jettison, are controlled by the master armament switch. With the master armament switch in SAFE, the armament circuits are de-energized. In MASTER 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 Armament Switch is selected to ARM. The Override switch has two positions: FORWARD and SAFE. This is a safety switch that can disable the armament system when placed in the SAFE (down) position, preventing an undesirable weapons release. When the front cockpit Master Arm Switch is placed 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) is used to release weapons from the wing stations. With the master arm switch in ARM and a wing station selected on the stores display, pressing the button releases a bomb or fires a rocket. The GUN trigger (Figure 1-1) is used to fire the simulated gun. With the master arm switch in ARM and GUN selected on the stores display, squeezing the trigger simulates gun firing.

Data Entry Panel (DEP)

The DEP (Figure 1-1) is used to adjust the MIL depression setting, select the HUD master mode, and enter target height. The MIL depression setting of the depressed sight line is adjusted with the SET DEP +/- rocker switch, HUD master modes - navigation, air-to-air, and air-to-ground - are selected with the MODE button and target height is entered with the DEP buttons.

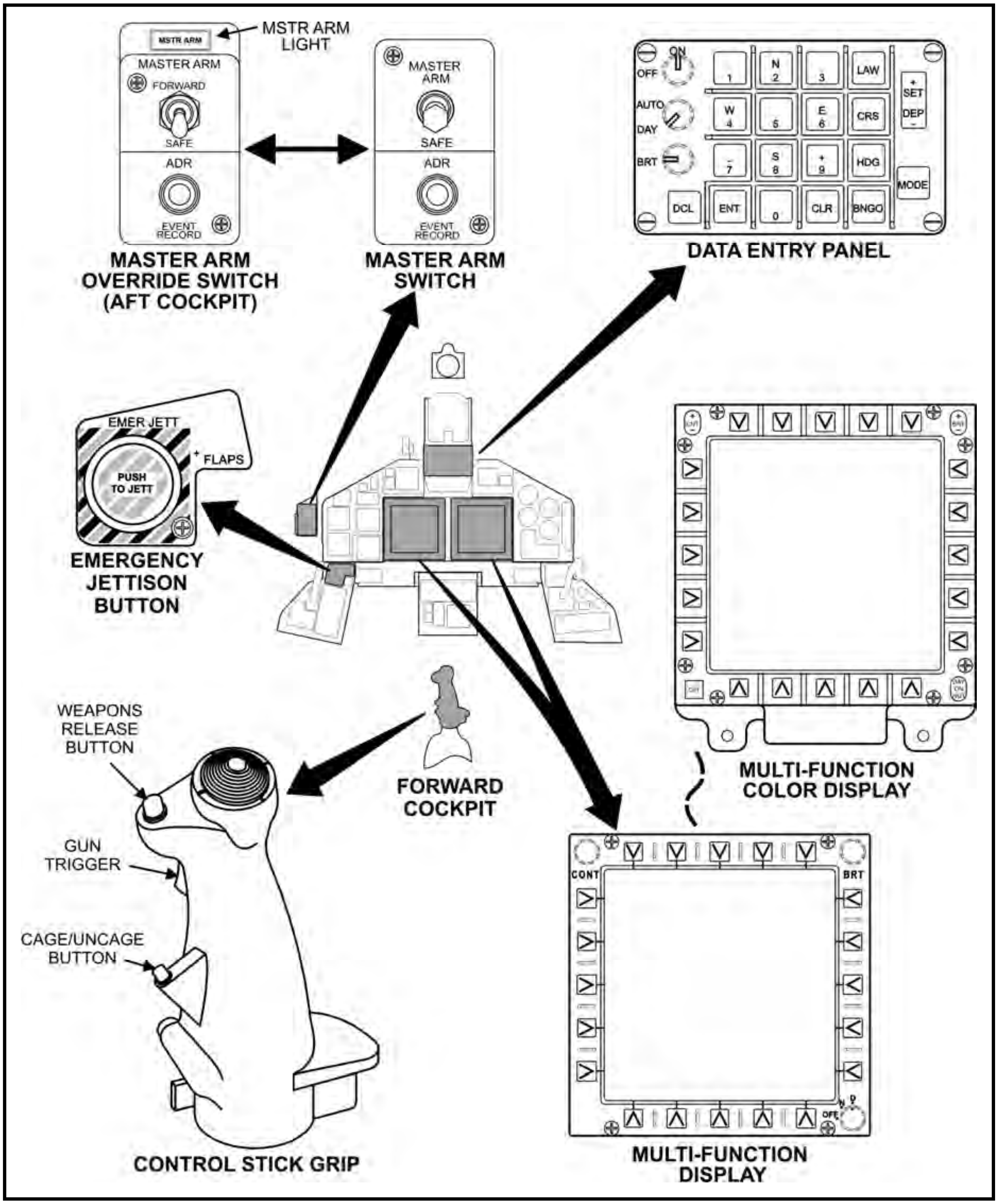

Figure 1-1 T-45C Armament Control and Indicators

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, weapon quantity, target height option selection, master armament status (SAFE or ARM), and rocket delivery options.

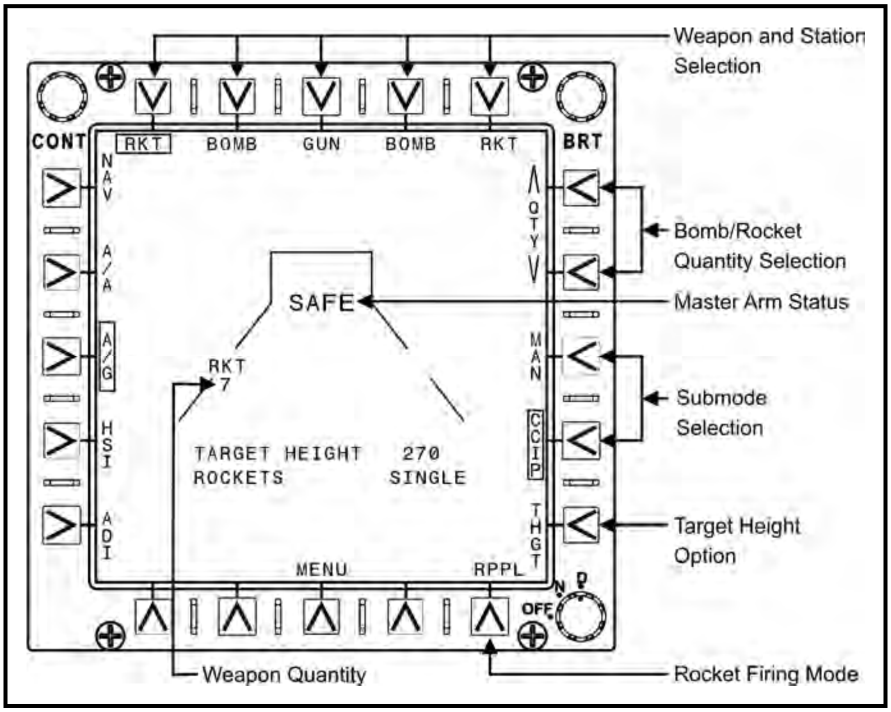

Figure 1-2 A/G Stores Display Controls and Indicators

1. **Weapon and Station Selection.** Selects the respective weapon to the selective station. Only one weapon/station combination may 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.** Weapon delivery mode selection is the Mode of Delivery for the selected weapon. There are two modes of delivery: Manual (MAN) and Continuously Computed Impact Point (CCIP). The default setting is the MAN mode.

4. **Target Height Option.** Available in the CCIP delivery mode only. When selected, will show current active waypoint elevation or last manually entered target height (whichever occurred last). 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 and 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 as selected via the Master Arm Panel.

7. **Weapon Quantity Indication.** This serves as a counter only and has no interface between the PMBR and the STORES page. The weapon quantity has default settings of RKT – 7; BOMB – 6; and GUN - has no counter and is unlimited. It is important to select the correct bomb/rocket quantity to match the actual load on the aircraft. 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 A/G HUD can be used in either caged or uncaged mode. The system defaults to uncaged and is the normal and recommended mode.

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

The Manual delivery mode HUD symbology, in addition to the normal gear up NAV symbology, provides: MAN mode indication, selected weapon indication, MASTER ARM status, the Depressed Sight Line (DSL) aiming reticle and DSL mil setting indication, as shown in Figure 1-3. The MAN mode provides a fixed impact point based on the planned parameters (e.g. dive angle, airspeed and altitude) of weapon delivery.

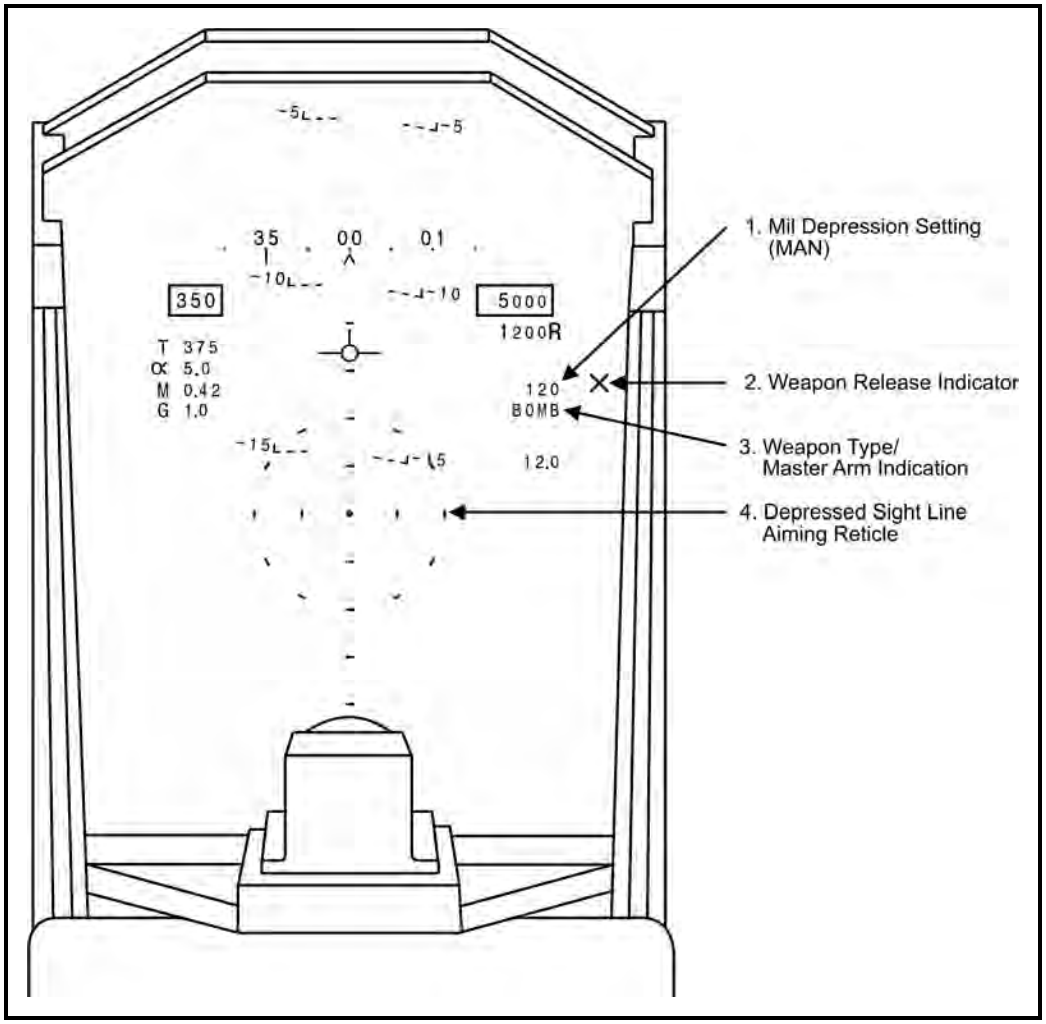

Figure 1-3 T-45C A/G HUD Manual Delivery Mode

1. **Mil Depression Setting (Manual mode).** Indicates the mil depression setting of the DSL reticle on the HUD and is shown in the MAN mode only. The setting is adjusted by using the SET DEP rocker switch on the DEP. The system initializes at 12 for GUN, 140 mils for BOMB, and 30 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 (waterline or Armament Data Line (ADL)) and 270 being toward 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.** The selectable weapons are: GUN, RKTS, and BOMB. Master arm SAFE status is indicated with an X through the weapon legend. Armed status is indicated by the absence of the X.

4. **Depressed Sight Line (DSL) Aiming Reticle.** This cue is a non-computing reticle which overlays the point a weapon would impact in a no-wind condition, given the weapon type, airspeed, altitude, optimum G and AOA. This reticle can be adjusted up/down on the HUD using the SET DEP rocker switch on the DEP. 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 Manual Delivery Mode - Objective

The objective of the manual delivery is to fly the aircraft in a manner as to arrive at or close to the planned release parameters (altitude, airspeed and dive angle) with the DSL aiming reticle close to the intended aiming point. When the aiming reticle is about to overlay the target / aimpoint, the pickle button / trigger should be actuated to initiate weapons release / firing. In the Manual delivery mode, the pilot needs to manually compute error corrections required if deviations occur from the planned release parameters as well as adjust for release wind direction and velocity. <u>Detailed instruction on techniques of Manual weapons delivery will be discussed in later chapters.</u>

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

In the CCIP mode, the HUD displays the same flight parameters as in MAN mode (compare Figures 1-3 and 1-4) with the exception of the aiming sight. CCIP compensates a weapon release solution based on current aircraft dive angle, bank angle, airspeed, altitude, and release altitude wind to display a continuously computed impact point for a selected weapon.

In CCIP mode the HUD displays a continuously predicted impact point under the pipper, a cruciform symbol. A Displayed Impact Line (DIL) is drawn from velocity vector to the pipper, sometimes called a Bomb Fall Line (BFL). It is only available in A/G BOMB mode, not in RKTS or GUN. The bomb fall line is an azimuth reference between the pipper and the velocity vector that indicates wind and speed effects on the weapon. When the target and CCIP pipper are coincident, you will command bomb release.

Should you occasion to employ the HUD in caged mode, be aware that the bomb fall line is displayed between the caged (solid) velocity vector and the pipper; not between the true (uncaged ghost) velocity vector and pipper. Correspondingly, your target may not track down the bomb fall line, as during uncaged mode of operation. Therefore, employment of the **A/G HUD in the caged mode is not recommended** and is highly discouraged.

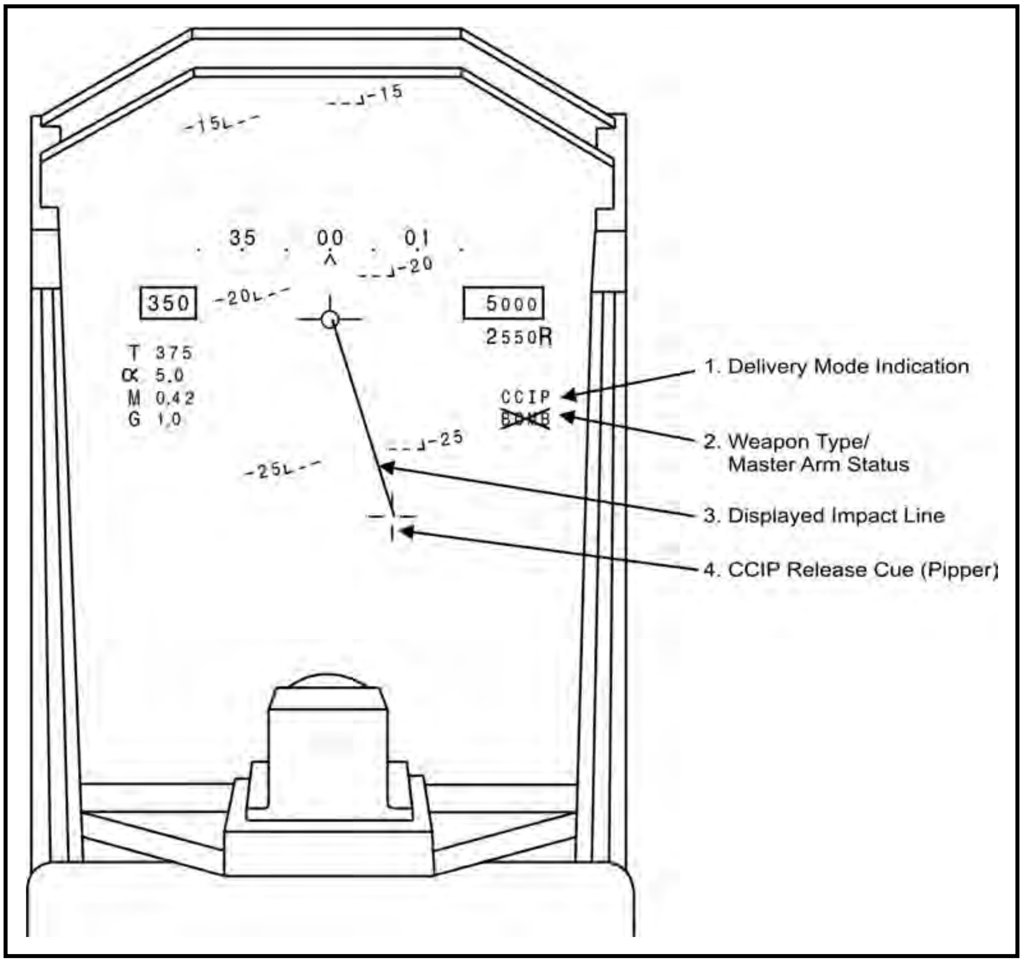

Figure 1-4 T-45C CCIP Delivery Mode – Bombs

1. **Delivery Mode Indication (CCIP).** Indicates the current mode of delivery. In the Manual mode, it shows the mil depression setting. Shown here (Figure 1-4) is the CCIP mode.

2. **Weapon Type / Master Arm Status.** Same as in the manual HUD display. Shows weapon selection and Master Arm status. The selectable weapons are: GUN, RKTS, and BOMB. Master arm SAFE status is indicated with an X through the weapon legend. Armed status is indicated by the absence of the X.

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 for instantaneous weapon release.

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

In addition to the normal NAV symbology on the HUD, the CCIP mode with Rockets or Gun selected provides: CCIP mode indicator, selected weapon, master arm status and a CCIP release cue.

The CCIP release cue represents the impact point of the rocket or gun shell if the weapon is fired immediately. 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 illuminated steady.

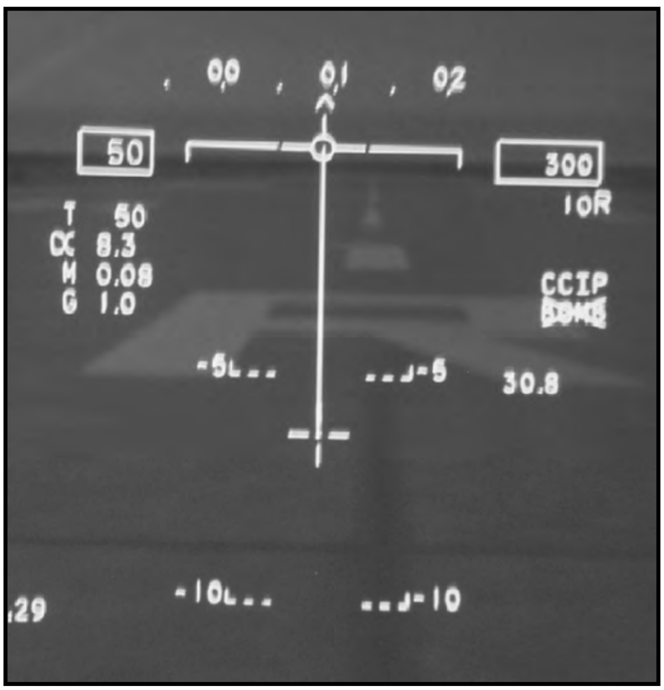

Figure 1-5 T-45C A/G HUD CCIP – Bombs

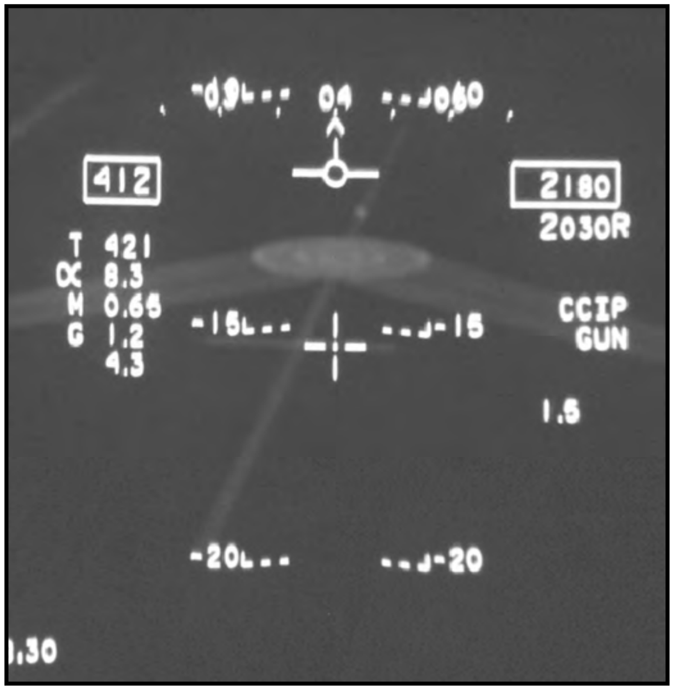

Figure 1-6 T-45C A/G HUD – Gun/RKTS

T-45C CCIP Delivery Mode – Objective

The objective of a CCIP delivery is to fly the aircraft in a manner to arrive at or close to the planned release parameters (altitude, airspeed and dive angle) with the CCIP cue close to the intended aiming point. When the CCIP cue superimposes the target, the pickle button / trigger should be actuated to initiate weapons release / firing. In the CCIP delivery mode, the DEU / weapons computer computes error corrections required if deviations occur from the planned release parameters as well as adjust for release wind direction and velocity. Remember, the CCIP mode is not magical. The computed impact point relies on the data entered and a <u>smooth</u> tracking run to solve the bombing triangle equation. <u>Detailed instruction on the techniques and procedures of CCIP weapons delivery, getting the aircraft to arrive at or close to the planned release parameters, will be discussed in later chapters.</u>

Target Height (TGHT) Entry for the CCIP Mode

The CCIP delivery mode uses the radar altimeter for it's height above target (HAT) computation. When the radar altimeter is off (e.g. when above 5,000' agl, becomes invalid, or turned off), the system uses BARO altitude minus either the active/selected waypoint elevation or the entered TGHT, whichever was selected or entered last, for the HAT computation. When using the CCIP mode, target elevation should be entered into the system. This prevents a "jump" in the CCIP release cue when descending through 5,000' agl as the radar altimeter redisplays. During a bomb run in rugged terrain, the pipper may jump around as the aircraft passes over terrain of varying heights. To force the system to use BARO altitude, versus radar altitude, the radar altimeter must be turned off. However, turning off the radar altimeter in the T-45C, considering our training environment is very rare.

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

MFD A/G Stores Display Data Entry

The T-45C is capable of carrying MK 76 bombs and/ or 2.75 FFARs. The gun is "always available" and is simulated on the centerline station. It is presumed to have unlimited ammo; therefore, no ammo countdown is provided.

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 is not released or is "hung."

The T-45C navigation and weapons delivery system defaults to various displays. Before air-to-ground sorties, you must assure that the STORES system is programmed to support your mission plan (Figures 1-7 thru 1-9). Weapons programming and data entry will be retained in the system memory for application in 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

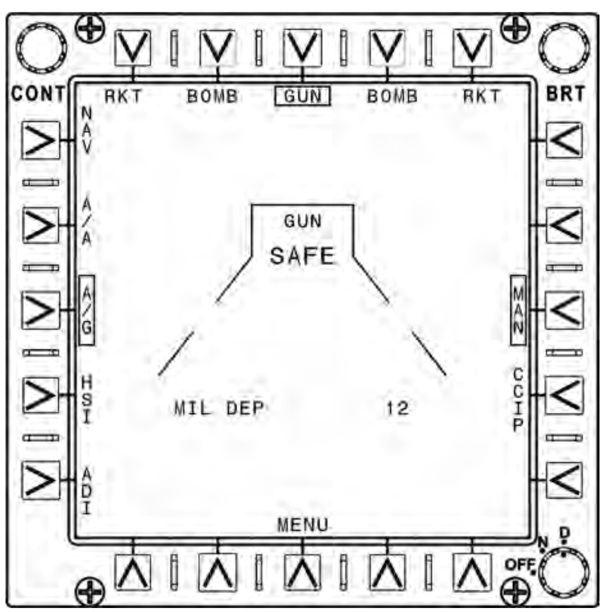

Figure 1-7 A/G Stores Display – Gun (Manual Mode) Default

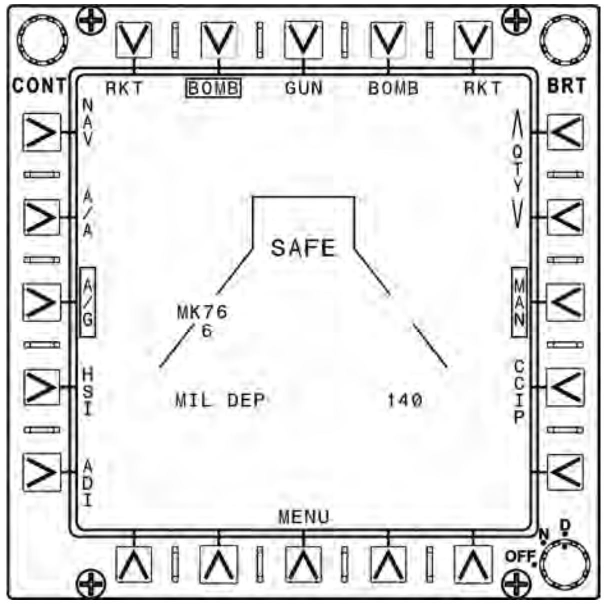

Figure 1-8 A/G Stores Display – Bomb (Manual Mode) Default

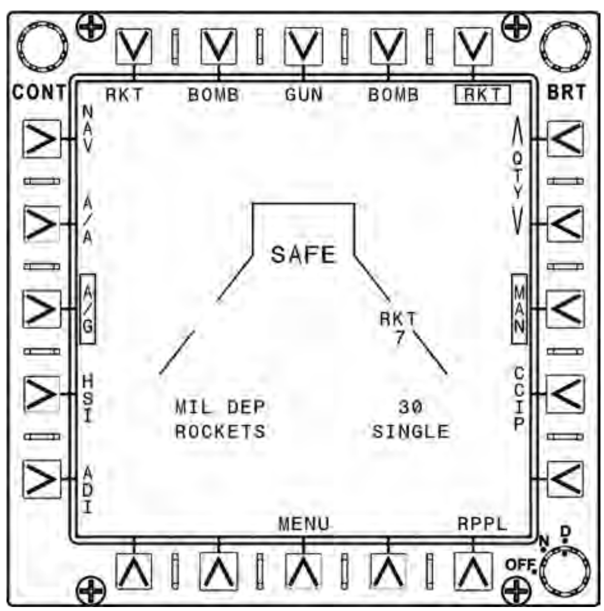

Figure 1-9 A/G Stores Display – Rocket (Manual Mode) Default

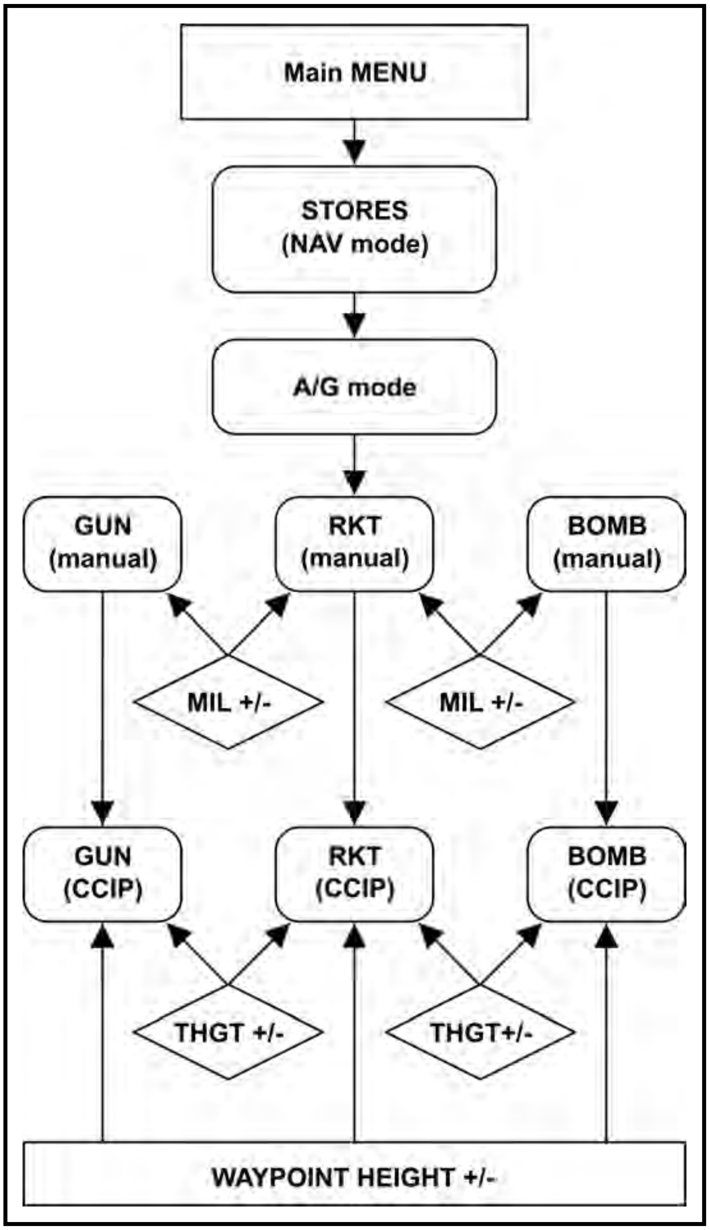

Figure 1-10 Weapons Data Entry Sequence Flow Chart

Waypoint and Offset Data. Mission profiles determine in what manner you may employ waypoints and offsets. Remember that each offset (0-359.9 degrees and 0-99.9 nm distance) is associated with an active waypoint; changing waypoint coordinates deletes offset data associated with that waypoint. Also, when selecting a waypoint, an offset causes replacement of CCIP target height with that height.

DECLUTTER

The declutter function works the same in the air-to-ground mode as in the navigation mode. Declutter 1 or 2 (Figure 1-11) clears the left side of the HUD display of true airspeed, AOA, Mach, and g. Since true airspeed is referenced for release and g is referenced for recovery, declutter functions will not be used in the air-to-ground mode.

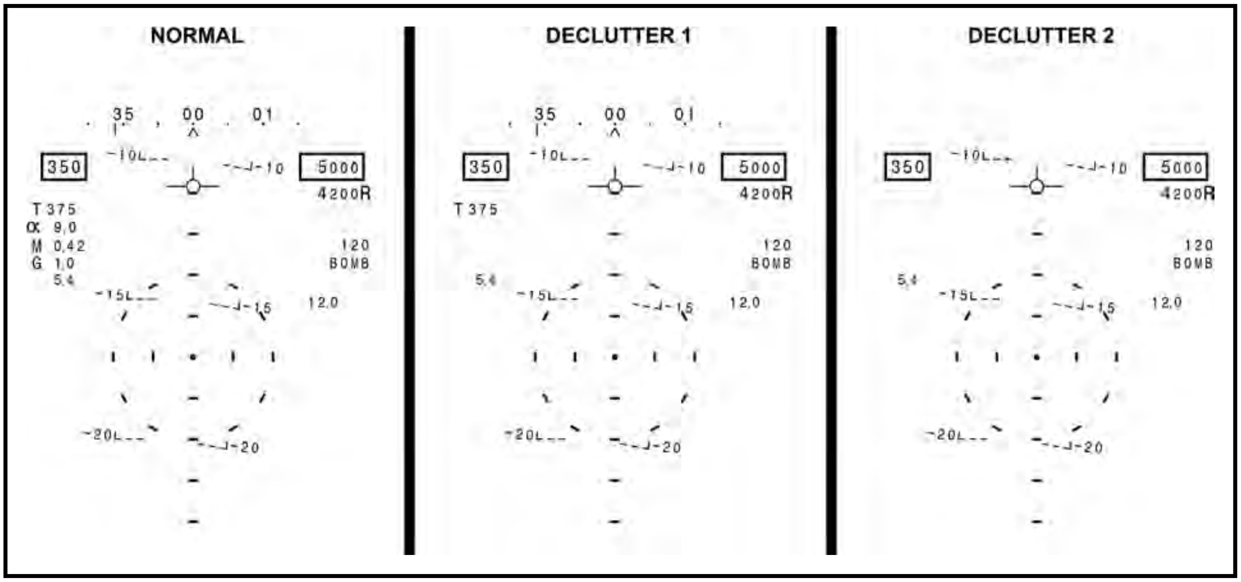

Figure 1-11 HUD Declutter Modes

BREAKAWAY CROSS (BREAK X)

A large X appears in the center of the HUD when an immediate 4g 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°.

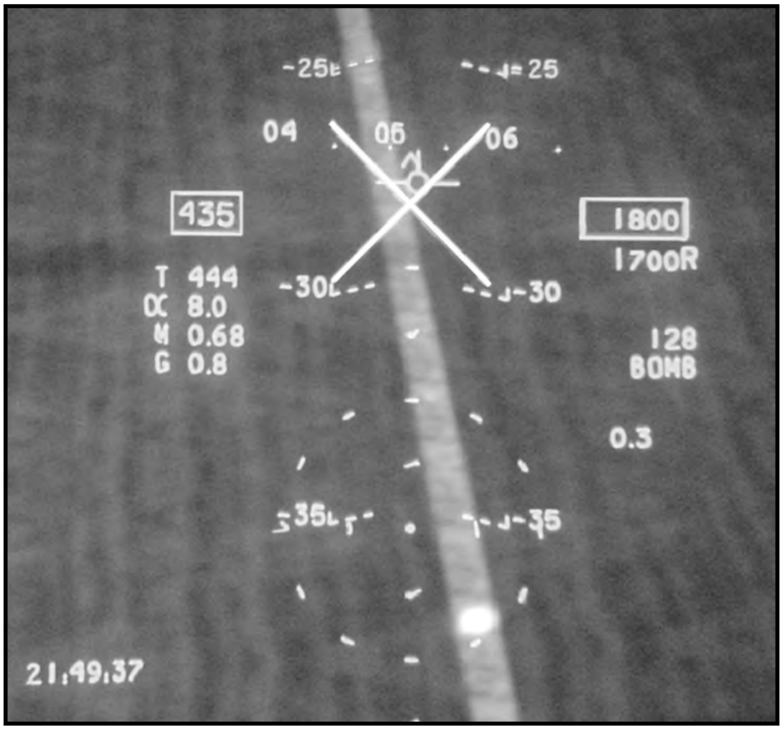

Figure 1-12 The Break X

VIDEO CAMERA SYSTEM (VCS) AND VCR SETUP

The Video Camera System (VCS) is a tremendous asset to the learning environment in the weapons stage. The HUD tape review following a training event promotes error recognition, analysis, and better overall understanding of the task at hand. It is strongly recommended the tapes are ON from takeoff to after landing, as per the S.O.P. For details on VCS care and setup, please refer to the current NATOPS manual.

NOTES

T-45A WEAPONS SYSTEM

105. T-45A WEAPONS SYSTEMS

Accurate weapons delivery requires that you correctly analyze and adjust for the effects of altitude, airspeed, dive angle, and pipper to target to ensure ordnance release within prescribed parameters. You must be able to perform essential calculations and adjustments during the tracking run. The HUD will assist you in performing these functions by permitting you to scan flight instruments and aiming displays without scanning inside the cockpit.

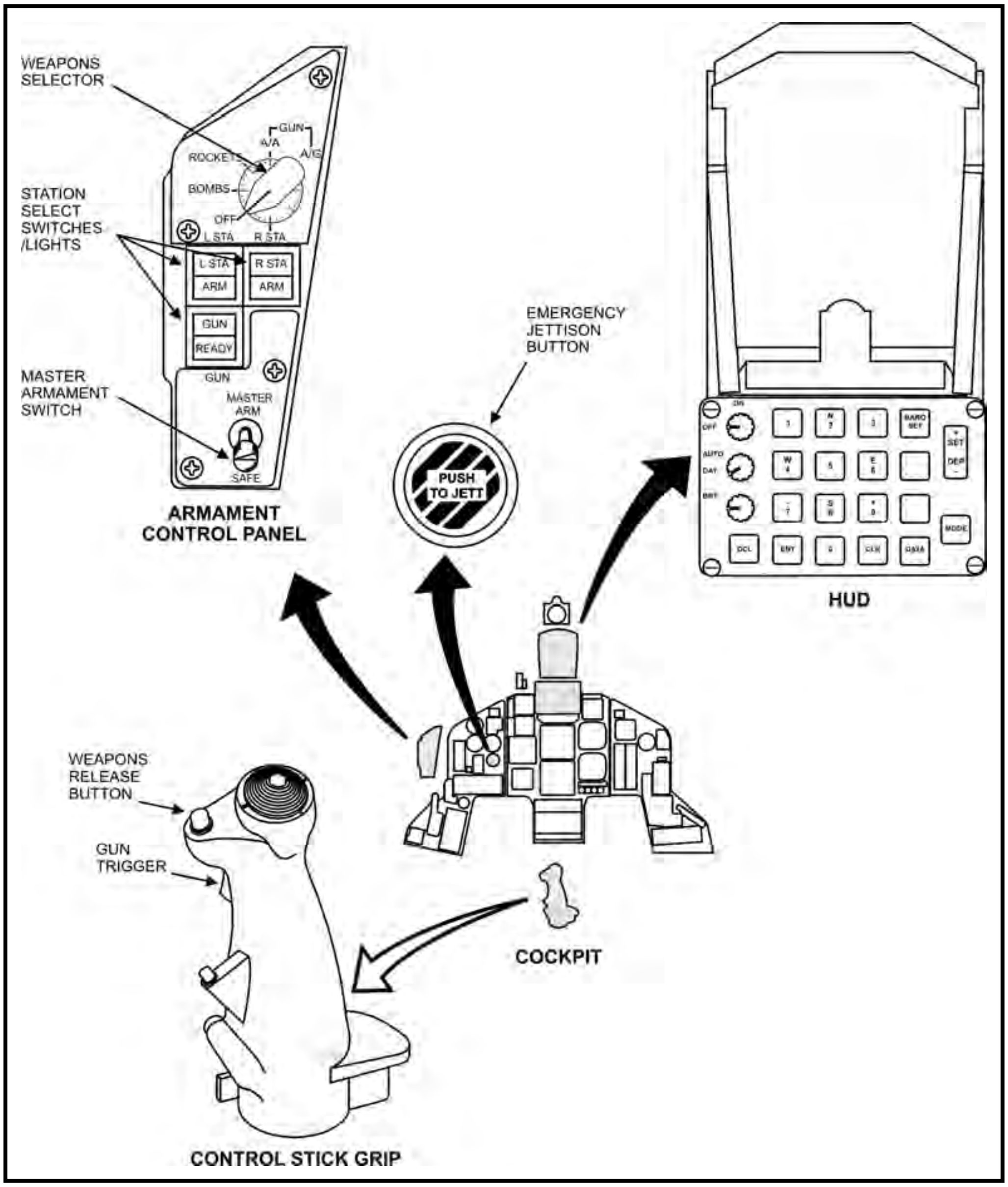

Figure 1-13 T-45A Armament Controls and Indicators

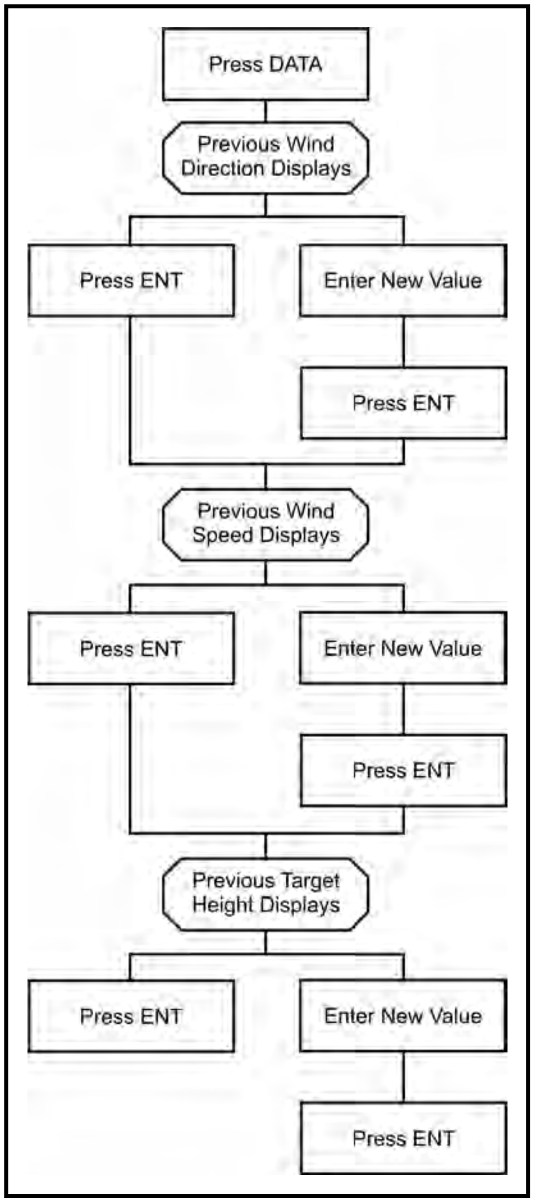

Figure 1-14 Weapons Data Entry Sequence

106. T-45A AIR-TO-GROUND DATA ENTRY

After completing the interactive BIT and entering the altimeter and field height, you're ready to enter target data into the HUD (Figure 1-13). First, press DATA on the data entry panel (DEP).

The scratch pad displays wind direction (WD) and the last entered wind-direction value. Enter the forecast wind direction for the release altitude at the target and press ENT. The scratch pad then displays wind speed (WS) and the current wind-speed value. Enter the forecast wind speed for the release altitude at the target and press ENT. The scratch pad displays target height (TH) and the current target height value. Enter the height of the target and press ENT.

Second, set the sight depression angle in mils. Set the weapons selector to BOMBS to get the air-to-ground depressed sight line (DSL) submode for bombs. Just below the radar altitude, BOMBS covered by an “X” and “140” will be displayed. BOMBS indicates that you are in the DSL submode, X indicates that the master armament switch is set to SAFE, and 140 represents the default mil setting for bombs. You can increase the displayed mil setting by pressing the top “+” of the SET DEP key or decrease the mil setting by pressing the bottom “-” of the SET DEP key. Selecting ROCKETS or GUN A/G on the weapons selector will switch the display to the default mil setting for rockets or guns. Their mil settings can be changed with the SET DEP key.

To set the continuously computed impact point (CCIP), press the MODE key after selecting one of the air-to-ground modes on the weapons selector. Pressing the MODE key again will return the display to the DSL submode. After entering air-to-ground data, set the weapons selector to OFF to return the HUD to the navigation master mode.

The target data, submode (DSL or CCIP), and the mil settings will be retained in the HUD’s memory even if the HUD is switched to another master mode or turned off in flight. In the target area, place the weapons selector to BOMBS, ROCKETS, or GUN A/G and press the station or gun select switch as appropriate for the weapon you are going to use. Also set the VCR switch to ON or AUTO as briefed. You can update target data and change mil settings in flight by following the same procedures listed above.

T-45A HUD AIR-TO-GROUND SYMBOLOGY

In air-to-ground mode the aircraft symbol is displayed on the waterline, and bank angle indicators are <u>not</u> displayed. Because you are maneuvering in relation to the target, your specific bank angle is not important; the pitch bars will still be displayed, and you can use them as a wings level reference in the tracking run.

The “X” over BOMBS, indicating that the master armament switch on the weapons selector panel is set to SAFE, is removed when the master armament switch is set to ARM . The DSL A/G aiming reticle consists of two concentric dashed rings around the pipper. The inner ring has a radius of 25 mils and the outer ring has a radius of 50 mils. Below the outer ring are two reference marks at 75 and 100 mils (Figure 3-10).

A breakaway cross appears in the middle of the PDU to indicate that you must initiate your dive recovery immediately. The breakaway cross is removed when the aircraft begins to climb. The breakaway cross is displayed only when the HUD determines that, with normal pilot reaction time and a normal 4g recovery, the aircraft would bottom out with 1,000 ft or less of ground clearance. The breakaway cross function is disabled for a dive angle of less than 15 degrees.

T-45A CONTINUOUSLY COMPUTED IMPACT POINT (CCIP)

The CCIP submode (bombs, rockets, gun) compensates for dive angle, airspeed, altitude, and target wind to display a continuously computed impact point for the selected weapon. The CCIP submode display provides a cruciform symbol with a pipper in the middle which depicts where the weapon will strike if released immediately. In CCIP BOMBS only, an aiming line is projected above the CCIP marker to provide azimuth steering guidance (Figure 3-11). When the pipper of the CCIP marker is over the target, press the weapons release button. Remember, the CCIP mode is not magical. The computed impact point relies on the data entered and a smooth tracking run to solve the bombing triangle equation.

In CCIP ROCKETS and GUN, the CCIP marker will flash when the computed slant range exceeds 12,000 ft for rockets or 8,000 ft for gun. The technique for using CCIP begins with a normal roll-in. For CCIP BOMBS, place the aiming line over the target and allow the CCIP marker to move up to the target. For CCIP ROCKETS or GUN, place the CCIP marker on the target and hold it there. Even though the computer compensates for all release parameters, except for pipper placement, releasing near your normal parameters will improve the system's accuracy. You may have to adjust your release aimpoint because the actual target winds may differ from the forecast winds you entered into the HUD.

T-45A DECLUTTER

The declutter function works the same in the air-to-ground mode as in the navigation mode. Declutter 1 or 2 clears the left side of the HUD display of true airspeed, AOA, Mach, and g. Since true airspeed is referenced for release and g is referenced for recovery, declutter functions will not be used in the air-to-ground mode.

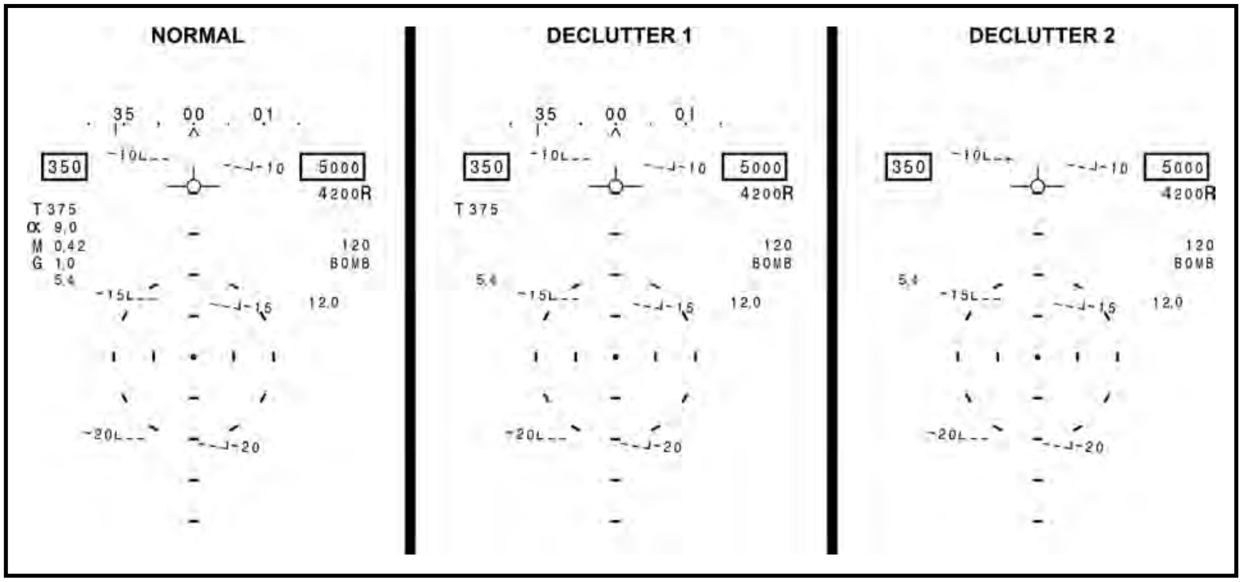

Figure 1-15 Declutter Modes

T-45A VIDEO CAMERA SYSTEM (VCS)

The video camera system (VCS) records the view through the HUD. The sealed video module is placed in the video interface module located in the aft cockpit, right console, and is secured by placing the locking bar in the LOCKED position. In the RECORD position, the VCR begins recording shortly after power is applied to the aircraft. With the aft cockpit VCR switch in STBY or OFF, the forward cockpit VCR switch controls VCR operation. The forward cockpit VCR switch has three positions:

1. ON, VCR starts recording;

2. OFF, VCR operation is controlled by the aft cockpit;

3. AUTO, VCR starts recording when the master armament switch is set to ARM.

T-45A VCR SETUP

1. Place the entire sealed video module in the video interface module (VIM) located in the aft cockpit, right console, and secure it with the locking bar. Then place the aft cockpit VCR switch in STBY or OFF as briefed.

2. Check that the forward cockpit VCR switch is set according to instructions: ON, VCR starts recording; OFF, VCR operation is controlled by the aft cockpit; AUTO, VCR starts recording when the master armament switch is set to ARM.

NOTES

CHAPTER TWO
T-45 PRACTICE ORDNANCE

200. INTRODUCTION

Types of Ordnance. In the Training Command, you will use two types of practice ordnance: the Mark 76 (Mk 76) / BDU-33 practice bomb and, if available, the 2.75" FFAR. Practice ordnance consists of water-sand fills that simulate the ballistics of general-purpose bombs. Practice ordnance possesses the same delivery characteristics as more sophisticated weapons. Training Command ordnance simulates combat ordnance and is more than adequate to prepare you for advanced ordnance and delivery methods. The Mk 76 simulates an Mk 82 (500 lb.) bomb, and 2.75" rockets have been used in combat with a variety of warheads. For in depth detail on ordnance and suspension equipment, refer to the NATOPS Chapter 22.

201. MK 76 / BDU-33

The primary practice bomb carried in the training command is the MK 76. The BDU-33 is the Air Force designation for the MK 76 and may be used on rare occasions. They are almost identical and have the exact same ballistics as each other. For our intention purposes, we will focus mainly on the MK 76.

PHYSICAL CHARACTERISTICS

	MK 76 MOD 5	BDU-33 D/B
WEIGHT	24.5 POUNDS	25.0 POUNDS
LENGTH	24.7 INCHES	23 INCHES
DIAMETER	4 INCHES	4 INCHES
SUSPENSION	SINGLE LUG	SINGLE LUG

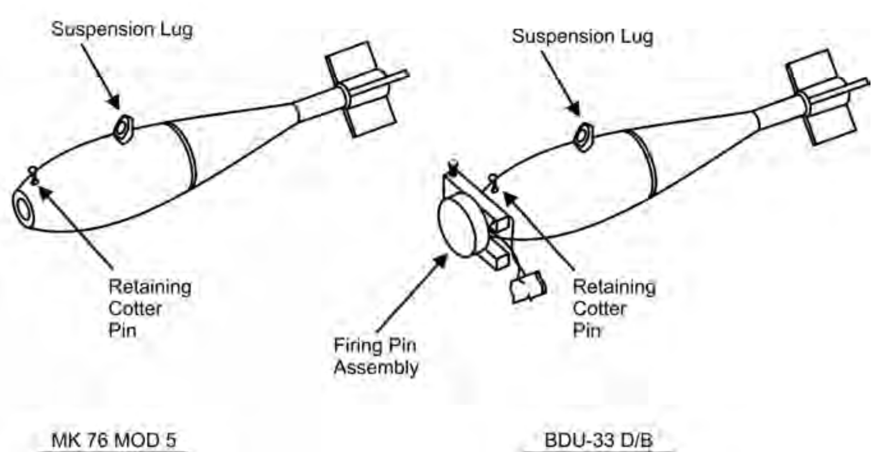

Figure 2-1 MK 76 / BDU-33 Practice Bomb Characteristics

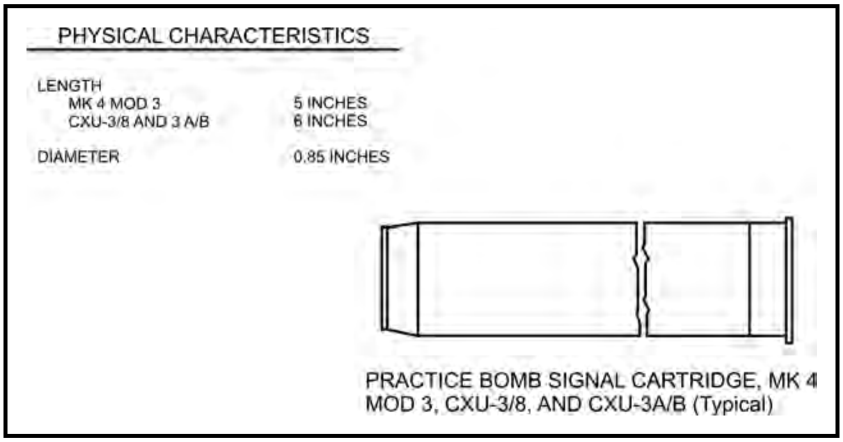

Figure 2-2 Smoke Charge

202. PRACTICE MULTIPLE BOMB RACK (PMBR)/BRU-38A

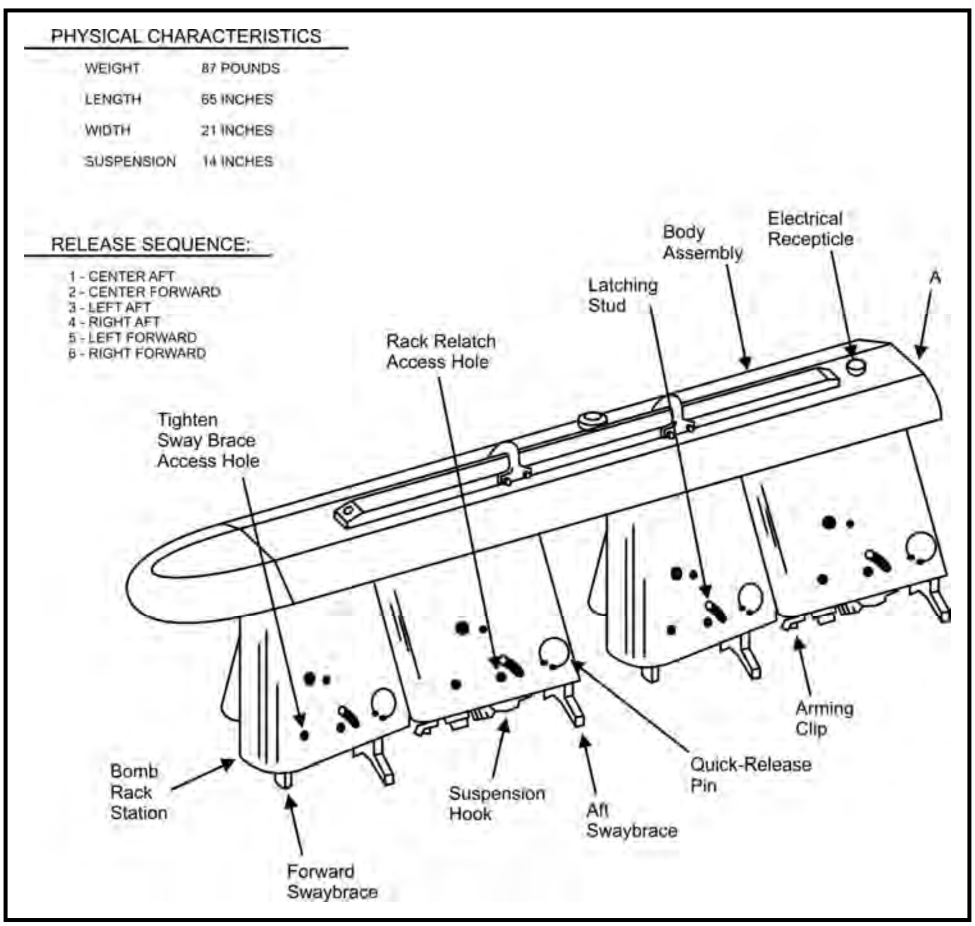

Figure 2-3 PMBR

The Practice Multiple Bomb Rack (PMBR) is designed to carry from one to six practice bombs. Ordnance load-out will vary as per the MCG, however, on a typical weapons sortie the load-out will be four bombs per PMBR, for a total of eight per aircraft. The normal bomb load-out per PMBR will be in order of release: 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 your ordnance load will help to ensure a safe and successful flight. Use the following procedures to preflight each type of ordnance you carry in the Training Command.

1. BOMBS

   a. All cockpit armament switches – OFF, SAFE or Normal

      i. T-45C - Check Master Armament - SAFE

      ii. T-45A - Check Master Armament – SAFE, and;
      - Weapons Selector - OFF

   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 the practice multiple bomb rack (PMBR) 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 (Figure 2-5).

e. Check each bomb for security to PMBR. 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 PMBR, 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).

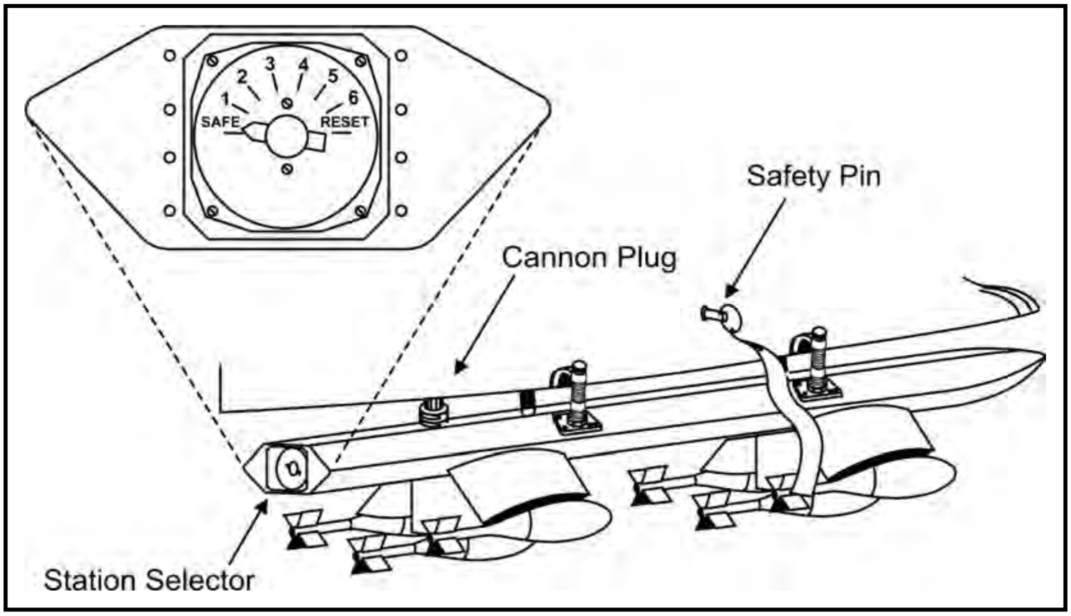

Figure 2-5 Station Selector on PMBR

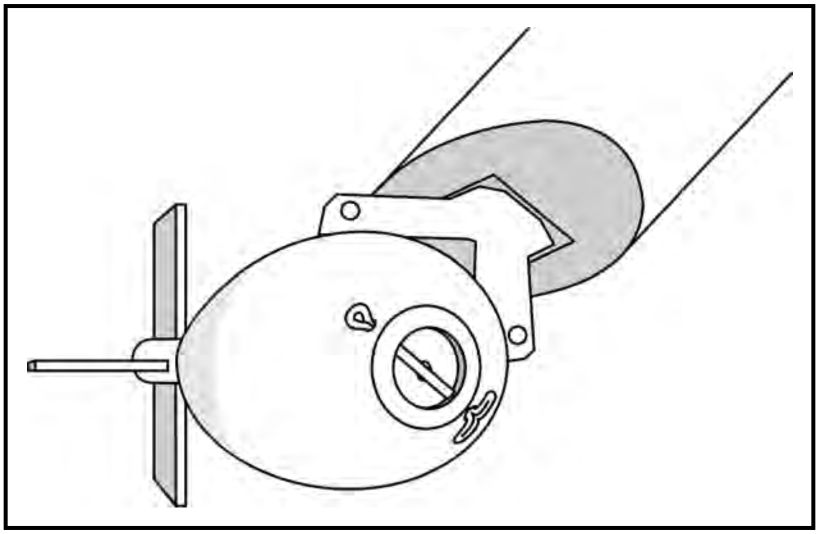

Figure 2-6 Secure Smoke Charge

2. ROCKETS

a. Check Master Armament switch SAFE (Figure 1-1).

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 LAU 68 launcher to station with safety pin installed from right-hand side.

d. Check the pigtail from the parent rack to the launcher; the cannon plug should be disconnected.

e. Check that the shorting pin is installed.

f. Check that the intervalometer is on L (for "load"), and the mode selector switch is on SINGLE (Figure 2-5).

g. Check that you have the correct number of rockets according to maintenance control.

h. Check that the foil RADHAZ shield is in place on back of pod.

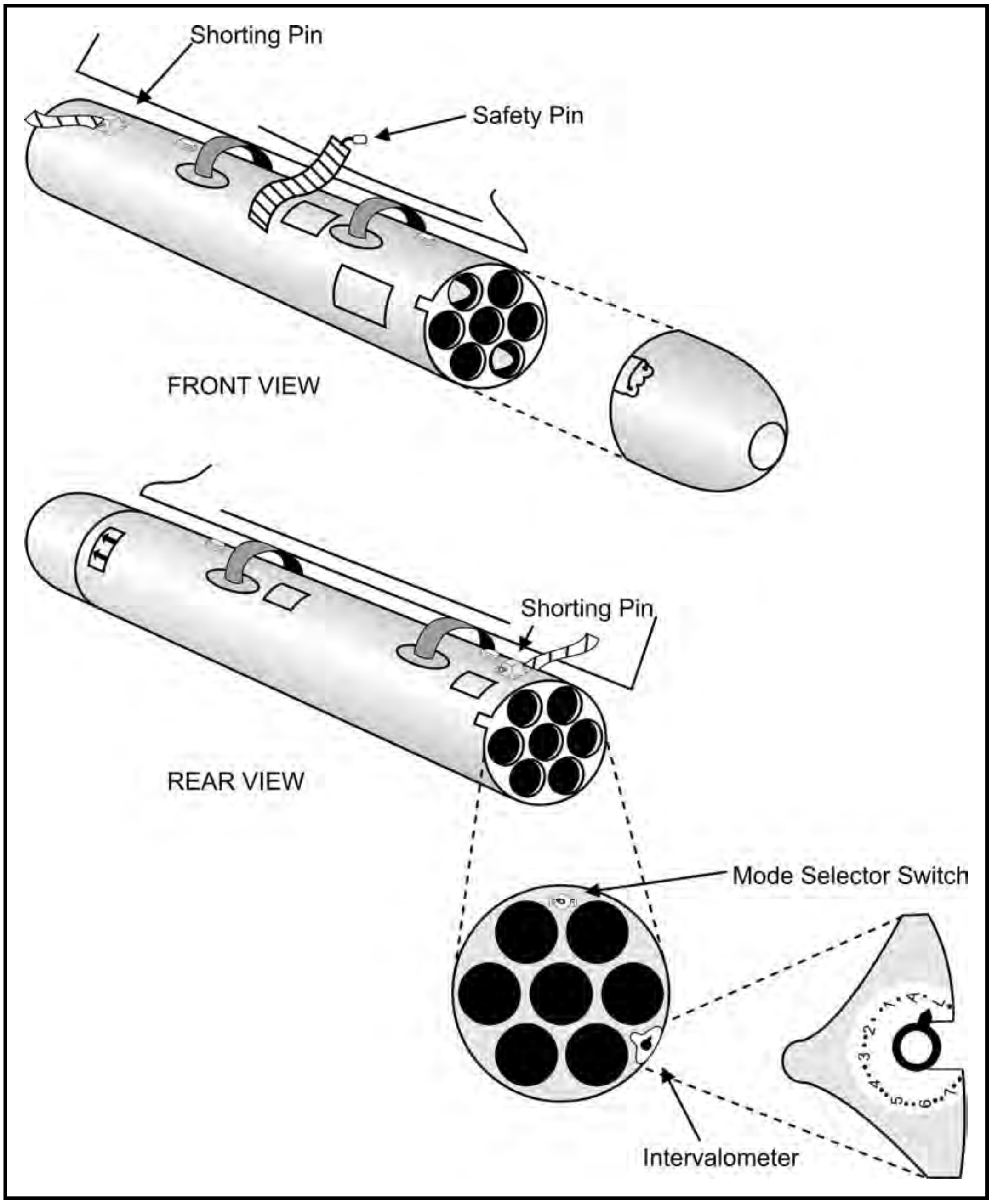

Figure 2-7 Intervalometer and Mode Selector Switch on Rocket Launcher

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CHAPTER THREE
WEAPONS DELIVERY THEORY AND PRINCIPLES

300. INTRODUCTION

Basic Weapons Delivery Theory

This chapter will discuss the theory behind Air-to-Ground weapons delivery. Flying the aircraft to the planned release parameters increases the likelihood of success. Some of the topics covered will be the bombing triangle and it's definitions, the difference between Dive Angle and Flight Path Angle, the factors affecting trajectory, error sensitivities and finish up with Z Diagram development and basic weaponeering.

The Bombing Triangle

The bombing triangle is created at weapons release. It is composed of ***altitude***, ***slant range*** from the aircraft to the target, and the ***down range travel*** of the weapon. In the Training Command, we reference the bombing triangle which is created with release altitude, the flight path of the aircraft, and the distance over the ground from the aircraft to the point on the ground where the flight path intersects.

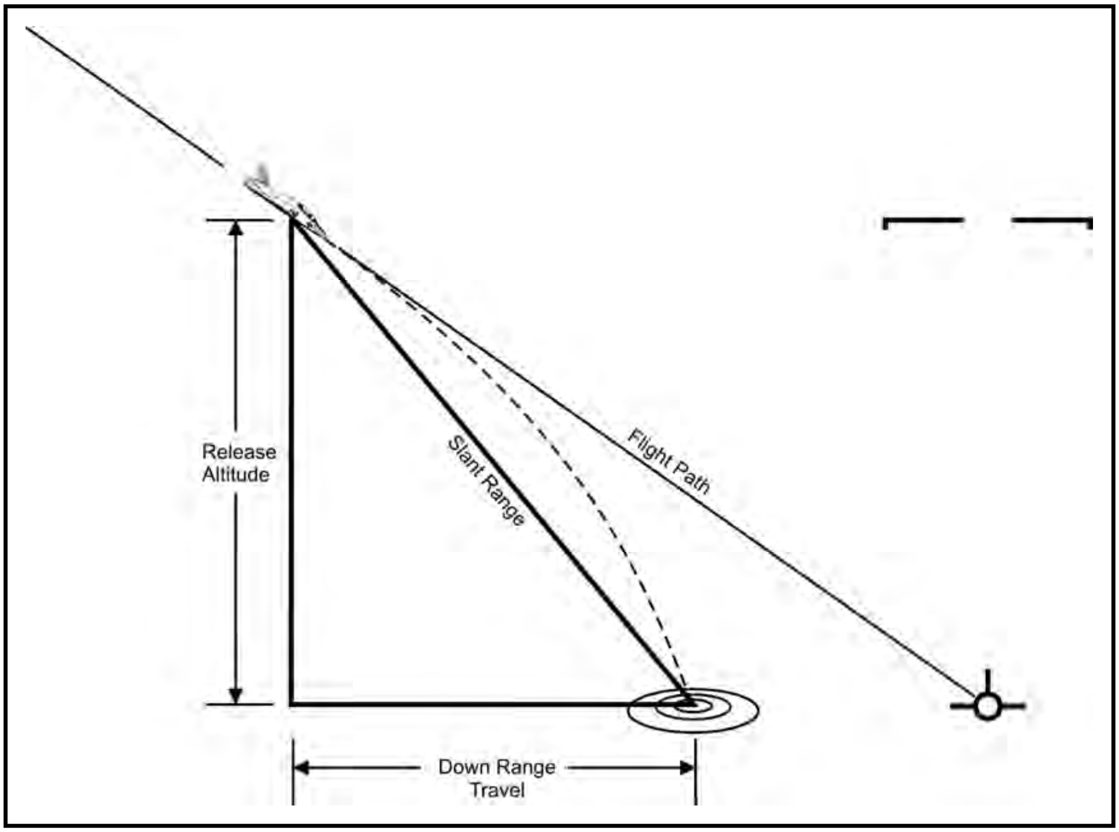

Figure 3-1 The Bombing Triangle

If we extend the flight path up to roll-in altitude, we can reference this line as being on, below, or above the bombing triangle. Some refer to this planned flight path as being “the wire”.

Definitions

Now let’s define a few terms associated with the bombing principles.

1. Flight Path. This is the path of the aircraft. It is also defined by the Velocity Vector in the HUD.

2. Flight Path Angle. This is the angle between the horizon and the Flight Path of the aircraft.

3. Dive Angle. This is 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.

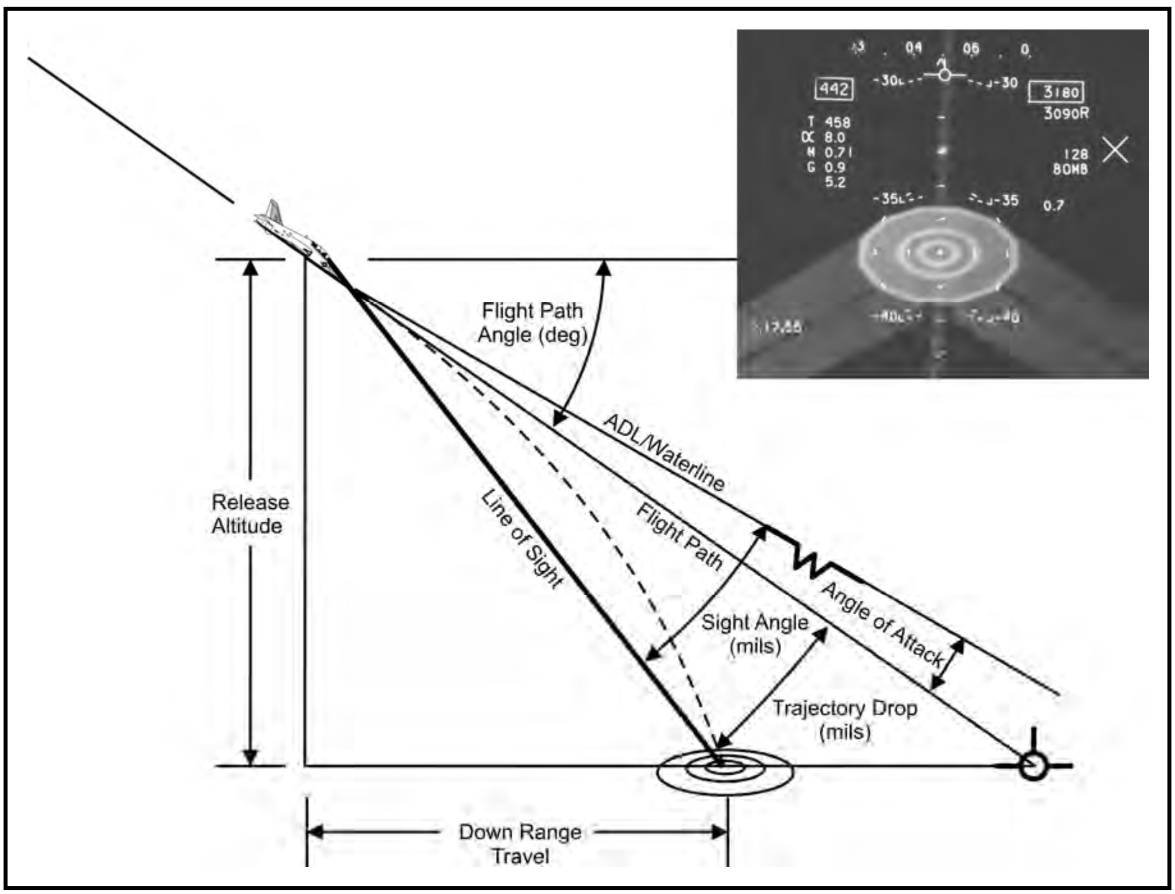

Figure 3-2 Bombing Triangle Definitions

5. Armament Datum Line (ADL). The origination of the sight angle, it is a fixed reference line through the longitudinal axis of the aircraft that parallels the flight path at 450 KTAS. The ADL can be found in the HUD by drawing a straight line across the top of the airspeed and altitude boxes.

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, “crabbing” the aircraft, in a vertical plane, to maintain the aircraft’s vertical flight path (flight path angle).

6. Sight Angle. The angle (in mils) below the ADL which 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.

7. Trajectory drop. The amount the weapon falls during its ballistic time of flight due to gravity effect, measured in mils. This can be found in the delivery data table.

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 release to impact.

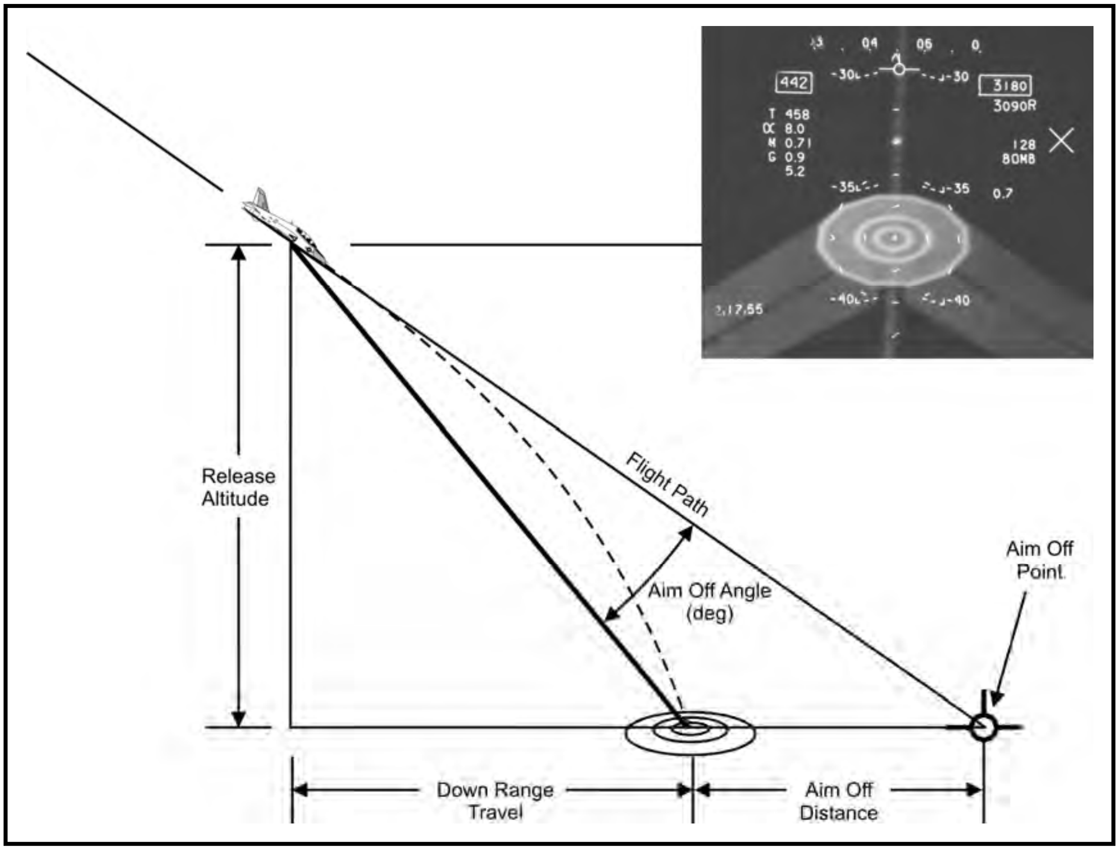

Figure 3-3 Aim Off Distance / Point / Angle

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 target placement angle.

14. Target Placement Angle (TPA). The angle between the flight path and the line of sight to the target derived for checkpoint altitude. Ensuring the TPA is set at checkpoint altitude will provide a reasonable weapons solution very close to planned release altitude. If the aircraft is on the bombing triangle, setting the TPA results in the Velocity Vector overlaying the Aim-Off Point.

15. Initial Target Placement (ITP). The initial placement of the Velocity Vector above the target upon roll-out at the beginning of the tracking run.

16. Attack Cone Distance (ACD). The optimal distance (planned Z diagram) from the target from which the roll-in maneuver is commenced. If the roll-in is accomplished on the planned roll-in altitude, the aircraft should be established on the bombing triangle at the beginning of the tracking run. This point is sometimes referred to as the **Roll-In Point** or “RIP”.

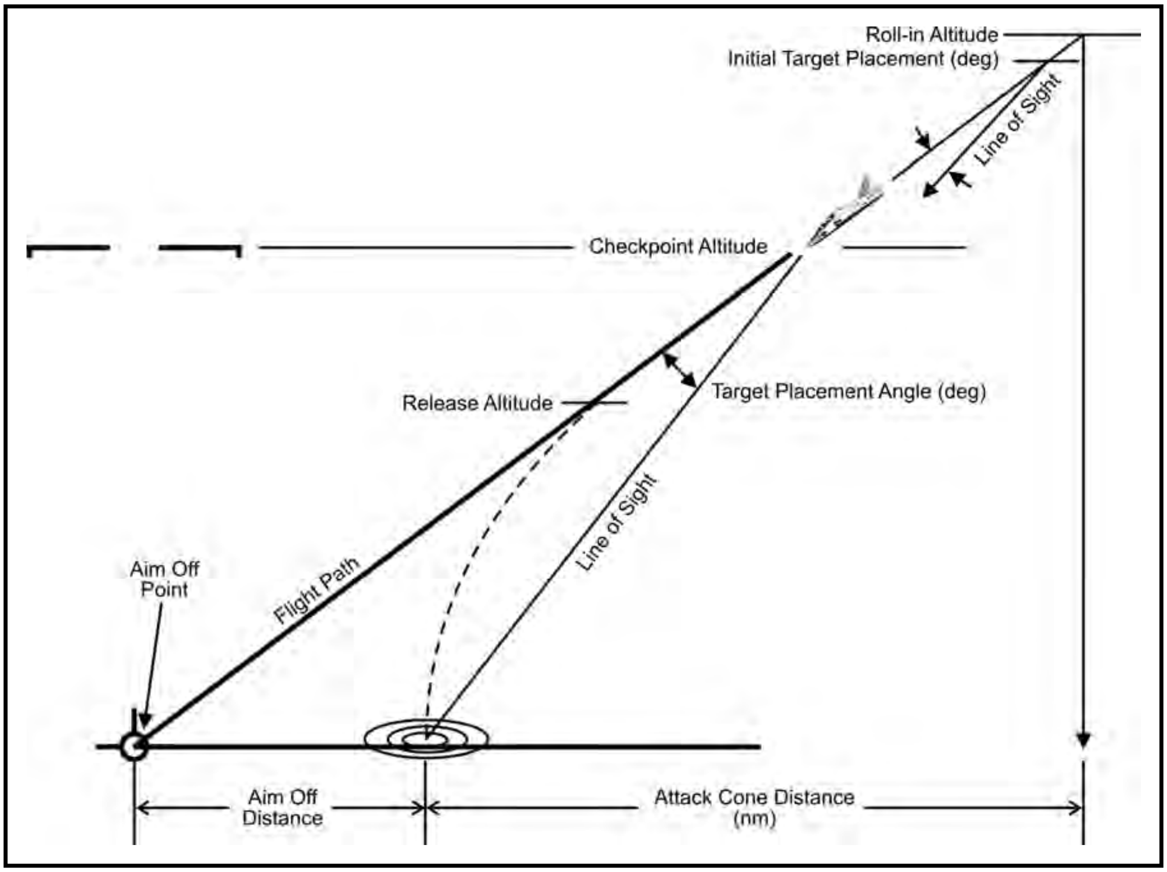

Figure 3-4 Target Placement Angle

Dive Angle vs. Flight Path Angle

For the most part, when we talk dive angle we reference the Velocity Vector for our dive angle. If we are targeting a 30 degree delivery, we are looking at the Velocity Vector to be on the 30 degree pitch ladder. But, there is a difference between Flight Path and Dive Angle.

The aircraft attitude or waterline “W” is the top of the altitude and airspeed boxes in the HUD. This is the same as the aircraft’s Armament Datum Line (ADL). At 450 KTAS the Velocity Vector is equal to the waterline.

When the aircraft is traveling in a vertical plane, a headwind or tailwind component will cause the Dive Angle to be slightly different to the Velocity Vector.

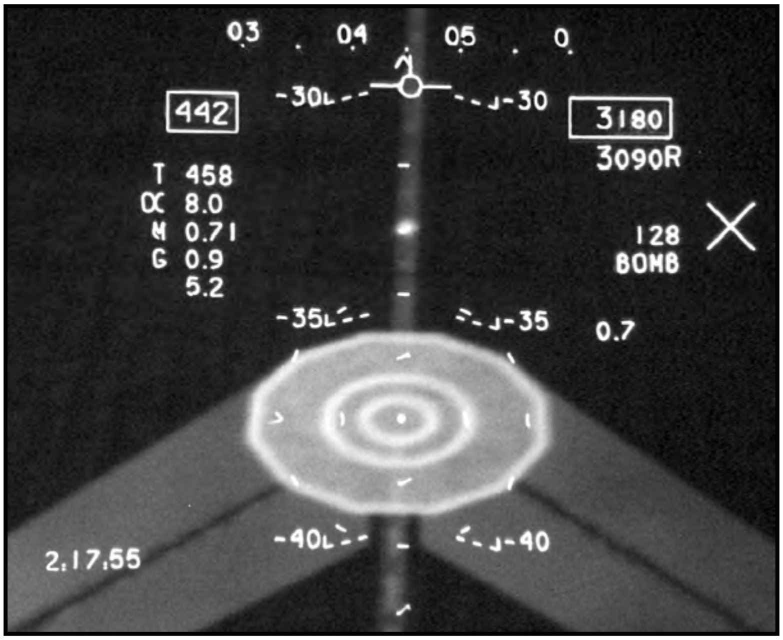

Figure 3-5 Calm Wind

With a <u>headwind</u> component in a dive, the aircraft will crab vertically (up) into the wind creating slightly more of a <u>shallow</u> dive than what the Velocity Vector is indicating.

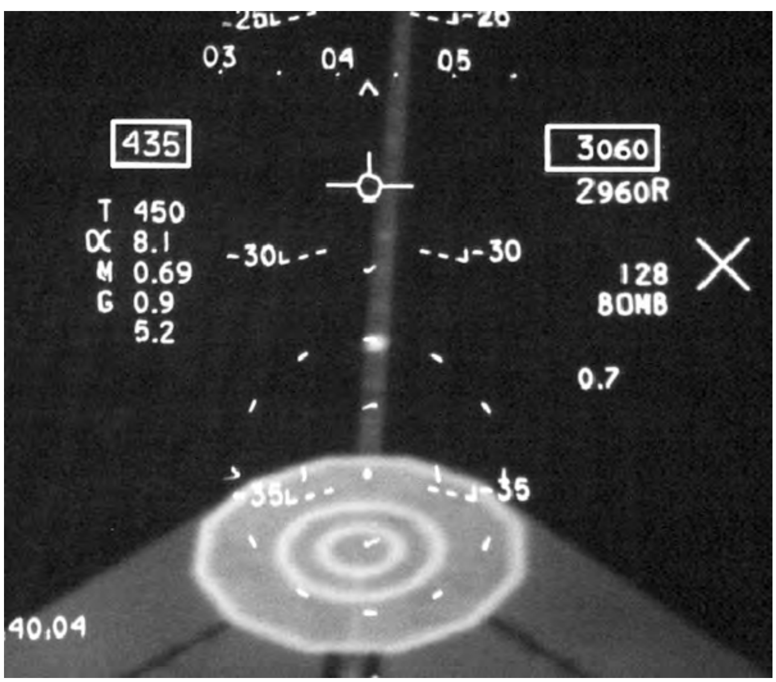

Figure 3-6 Headwind Component

With a tailwind component, the aircraft will crab vertically (down) into the wind, creating slightly more of a steep dive than what the Velocity Vector is indicating.

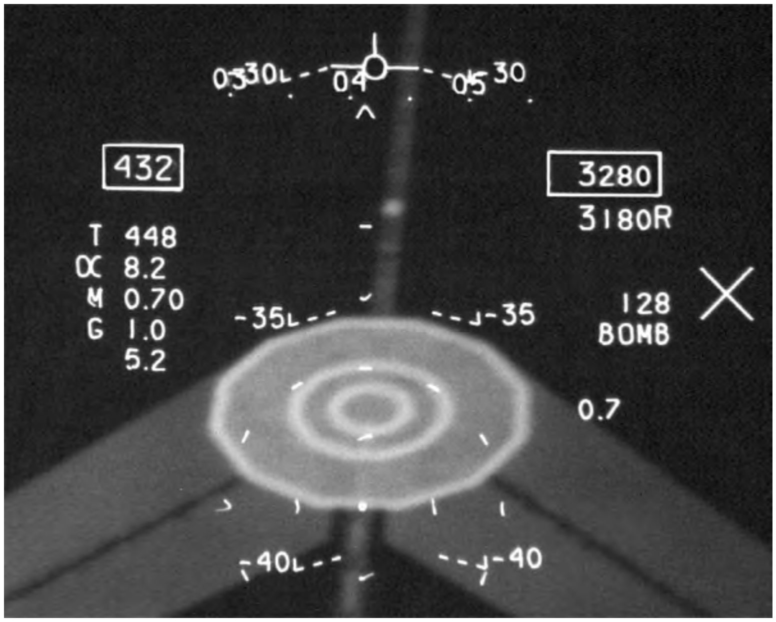

Figure 3-7 Tailwind Component

This is one reason why a headwind causes a shallow and a tailwind causes a steep. The pipper seeks the Offset Aim Point in all cases.

Yaw

A skid or sideslip can also affect the trajectory of the weapon by causing a false sight picture. Unless the ball is centered (balanced flight), the aircraft will not be moving in the direction the pipper is looking. So, if the ball is out to the right (the aircraft yawing to the left) when you release a bomb with the pipper on the target, your hit will be to the right of the target. Remember, when we release the bomb from our aircraft, we are imparting the Velocity Vector to the bomb. Minus some negligible winds between release altitude and the target, the bomb will travel where the Velocity Vector is pointed, just that it falls below it due to drag/gravity (i.e. trajectory drop). In contrast to bombs, which depend on the aircraft for their velocity, forward-firing ordnance tends to travel initially in the direction it was fired, even in unbalanced flight. How this principle can be applied for correction with rockets will be discussed later in this section.

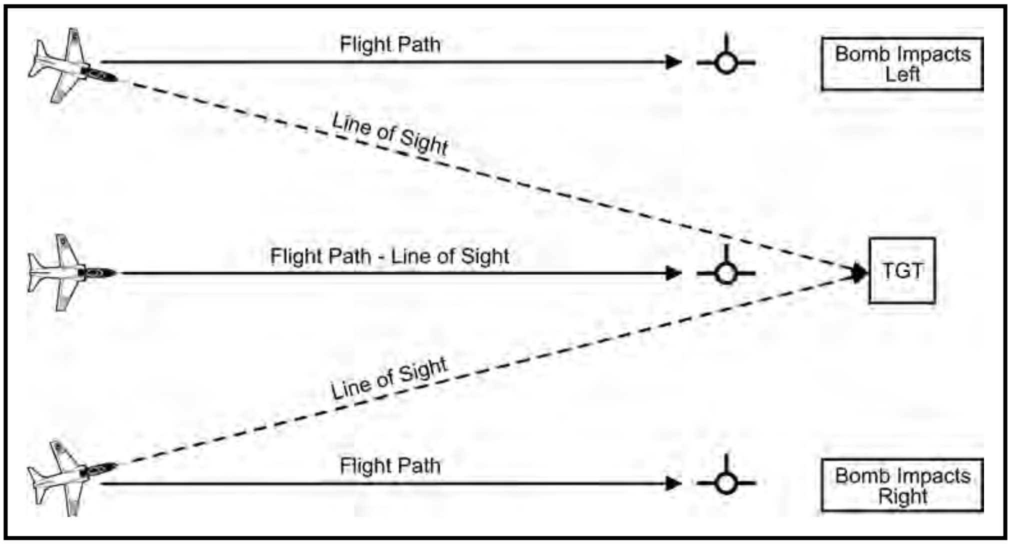

Figure 3-8 Yaw

Bank Angle

Because of the depression of the sight line below the line of flight, any bank will cause a false sight picture. This error is caused by the pendulum effect (Figure 3-9), so that if you roll to the left, your pipper will appear to move to the right along the ground. Thus, if you release with the pipper on target while you are in a right bank, your hit will be to the right and short.

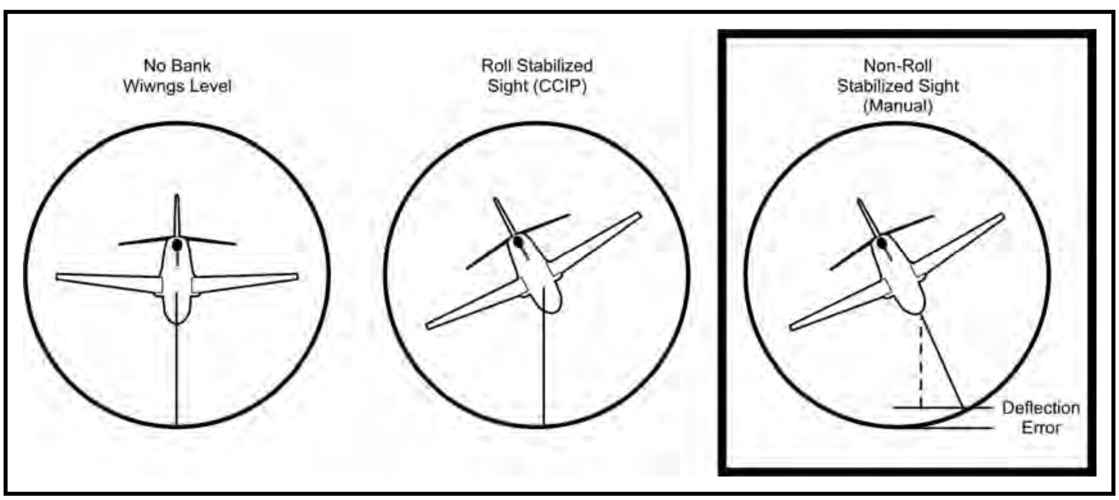

Figure 3-9 Bank Angle

G at Release

Proper g at release depends on dive angle. For a 30-degree delivery, about 0.87 g is required to maintain a straight flight path. A 10-degree dive requires almost 1 g. A 60-degree dive (not used in the training command) would require only 0.5 g. The mil setting for each type of delivery is valid only at the proper g. Incorrect g at release will change the angle of attack of the ADL and will invalidate your mil setting by causing **a false sight picture**. Excessive g will cause an early sight picture. So, if you apply excessive g to obtain the proper sight picture and have all other parameters correct, your hit will be short. Insufficient g will cause a long hit. In addition, incorrect g will have another undesirable effect—changing your dive angle. Proper g results in a straight flight path and a constant dive angle. Too much g will shallow the dive angle, and insufficient g will steepen it.

By simply maintaining the Velocity Vector on a specific angle will result in the proper g at release. Common error in weapons delivery is not being properly trimmed for release and allowing the Velocity Vector to “creep” up as the aircraft seeks 1.0g flight.

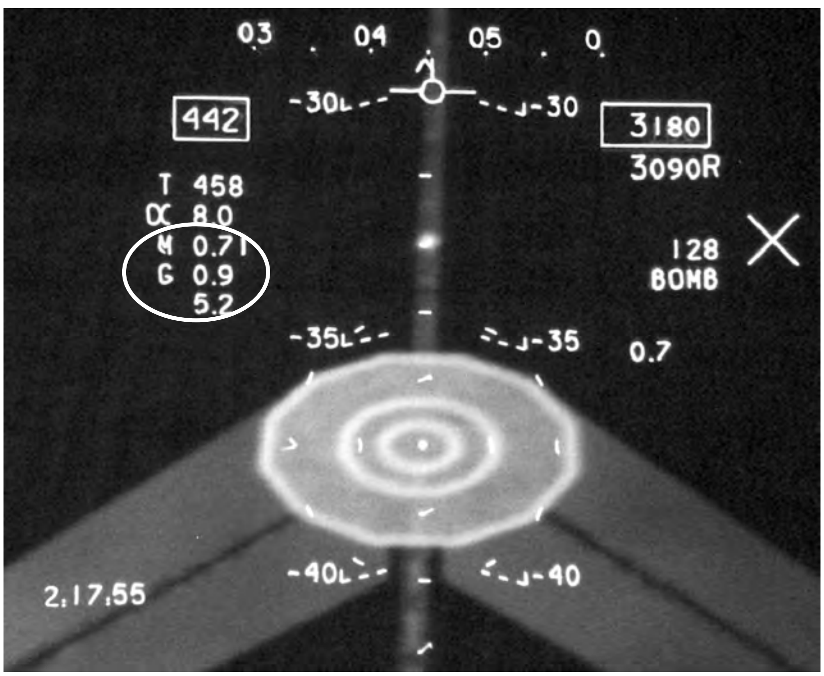

Figure 3-10 G at Release

Factors Affecting Trajectory

For each type of weapons run you make, you will have a mil setting, which will compensate for the extent to which a weapon will drop below your aircraft flight path. Each mil setting is calculated so that if you release your weapon at the proper altitude, with correct airspeed, dive angle, and g, with wings level, zero yaw, and the pipper on the target, the weapon will hit the target, assuming no wind. However, a change in any of these parameters will affect the trajectory of the weapon. The effect of changing each parameter will now be considered. The following factors are discussed from a perspective of using a Depressed Sight Line (DSL) pipper in the T-45C manual (MAN) bombing mode.

Dive Angle

Deviations from planned dive angle will also cause a false sight picture. A steep dive will cause a long hit and a shallow dive a short one. Changing the dive angle will change the extent to which gravity will bend the weapon trajectory below the line of flight. Suppose you release a weapon at a dive angle of 90 degrees. Since gravity works straight down, there will be no effect on the trajectory. You can see that a steeper angle requires a smaller mil setting; if you release steep, your mil setting is too large and the bomb will strike beyond the target. If you are shallow, you need a greater mil setting, just as you do for a shallow pattern, and your hit will be short. (Figure 3-11)

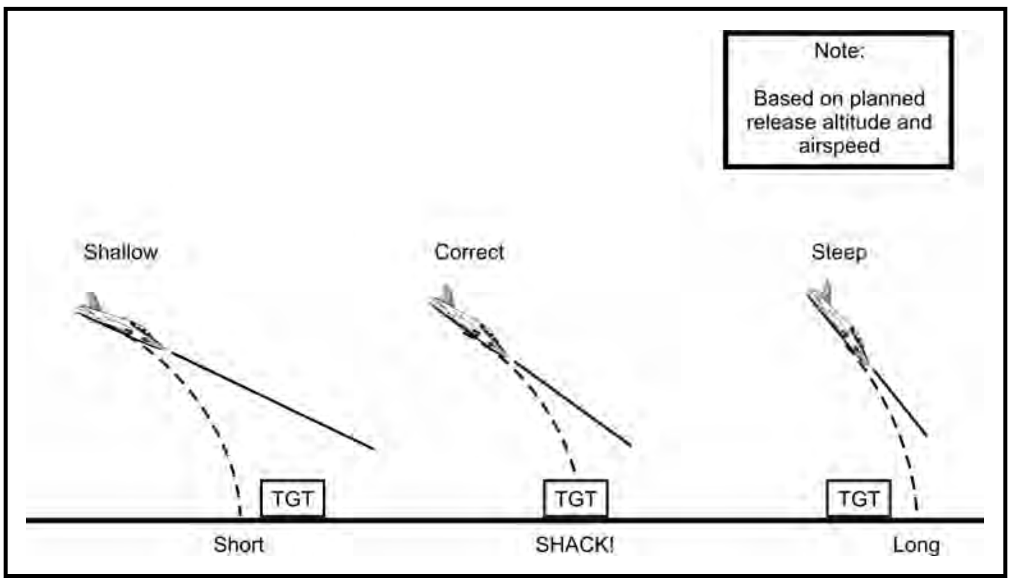

Figure 3-11 Dive Angle Error

Airspeed

Any deviation from planned release airspeed will cause a false sight picture. For example, a fast release will decrease your AOA and bring the pipper short of the impact point causing a long hit. A slow release will show the pipper long and cause a short hit. Airspeed also has an effect on the weapon time of fall. (Figure 3-12)

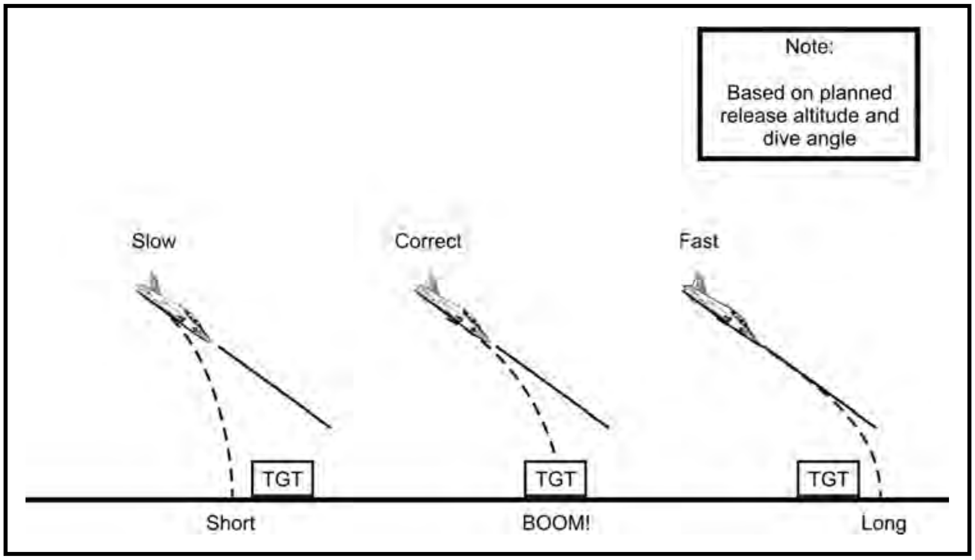

Figure 3-12 Airspeed Error

Altitude

Releasing high will increase the time of fall of the weapon, and so will increase the time during which gravity can act to bend its trajectory. You are also releasing a greater distance from the target. Therefore, if you release high, with all other parameters correct, the weapon will hit short. Similarly, if you release low, the hit will be long. (Figure 3-13)

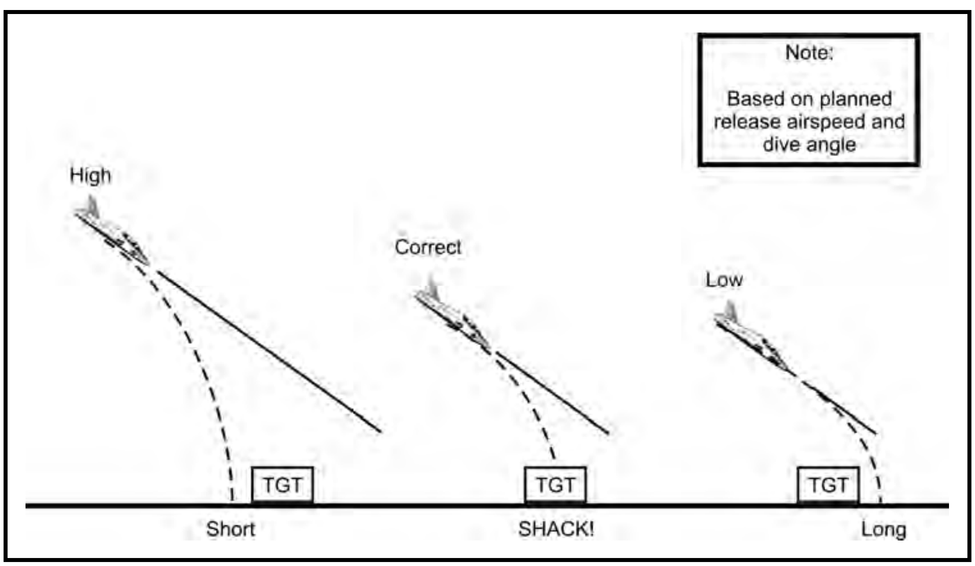

Figure 3-13 Altitude Error

Error Sensitivities

In order to make proper corrections, you must know how much each error will affect your accuracy. We have already discussed in general terms the effects of deviating from each of the various parameters such as airspeed, dive angle and altitude. For example, we showed that a dive angle steeper than planned will cause a long hit, so releasing high can compensate for a steep dive angle.

However, in order to actually make such a correction, you must know how high to release to compensate for each degree you are steep. In other words, for each type of run, you must know exactly how dive angle, airspeed, and altitude affect accuracy, and how they relate to one another. The table (Figure 3-14) summarizes this information and should be memorized.

This table shows, for example, that a 1-degree error in dive angle in a 30-degree bomb run will cause your hit to be 50 feet long or short, and that a 10-knot airspeed error will have the same effect. How these relationships can be used in a run will be discussed in the Target Tracking / Error Corrections section.

TABLE OF ERROR SENSITIVITIES

	Dive Angle		Airspeed		Release Alt		Error
10° bombs	+/-1°	=	+/-10 kt	=	-/+70 ft	=	+80 ft
10° strafe	+/-1°	=	+/-10 kt	=	-/+100 ft	=	+30 ft
20° bombs	+/-1°	=	+/-10 kt	=	-/+100 ft	=	+50 ft
20° rockets	+/-1°	=	+/-10 kt	=	-/+100 ft	=	+20 ft
30° bombs	+/-1°	=	+/-10 kt	=	-/+100 ft	=	+50 ft
30° rockets	+/-1°	=	+/-10 kt	=	-/+100 ft	=	+20 ft

Figure 3-14 Error Sensitivities

Wind

You correct for wind effects by varying your bank angle as you fly around the pattern. During the tracking phase you will need to make adjustments in your roll-in point and initial aimpoint. Wind effect on the bomb after release is corrected by the offset aimpoint you calculate. An offset aimpoint (OAP) is a point referenced from the target where the manual pipper is placed at release to counter the effect release altitude wind has on bomb drift during the Time of Fall. The offset aimpoint is only referenced during manual mode deliveries. The calculation of the OAP will be discussed in a later chapter.

The "Z" Diagram and Basic Weaponeering

"Z" Diagrams are presentations of pattern and weaponeering information included on briefing boards and kneeboard cards. In the Fleet, you will be responsible for developing your own "Z" diagram tailored to the specifics of your mission. In the Training Command, these "Z" diagrams are prepared for you. It is important for you to understand the concepts of weaponeering and the basic components of the "Z" diagram so you can apply those concepts to your follow-on fleet aircraft training. The "Z" diagrams and terminology used in Fleet aircraft will vary slightly from fleet to fleet and fleet to service based on training and tactics employed. The concepts, however, are all the same.

Weapons delivery planning always begins with the target we plan to attack. The target type will drive the type of ordnance we bring to the fight. In Basic Conventional Weapons Delivery (BCWD), in order to give ourselves the best opportunity to deliver that ordnance as accurately on the target as possible, we would want to drop as close to the target as we possibly can. The steeper the planned dive, the more accurate the hits will be due to error sensitivities.

Threat is the next item to be considered. The threat will drive our tactics. How low can we go? There are four reasons which determine how low we can go and why we DO NOT want to release lower than our minimum release altitude. 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 our release altitude.

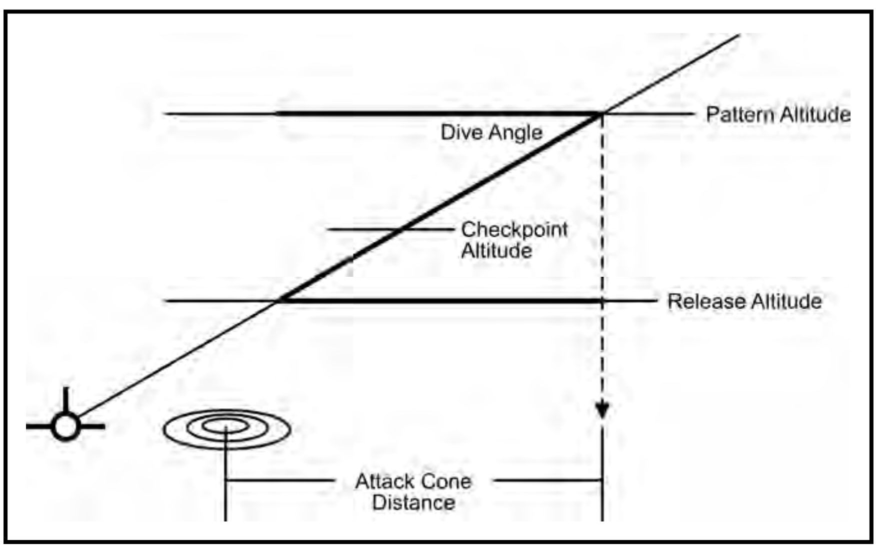

Figure 3-15 "Z" Diagram

First, let's discuss *Enemy Threat*. As previously stated, the closer we can get to the target, the more accurate we can be. However, just as we would not like to be fired upon while attacking the enemy, the enemy does not want to be fired upon in the first place. He will set up his defenses to prevent us from attacking, creating a threat envelope. Our job is to get as close to that threat envelope as possible, deliver our weapons, and get ourselves back to our altitude sanctuary. Our target attack planning should craft a solution to avoid or minimize our time spent in this threat envelope, thereby increasing our chances of survivability while decreasing his.

Weapon fragmentation from the weapon exploding can reach up and damage our aircraft. We want to plan our release as to recover the aircraft above this “frag pattern”. *Weapon Arming Time (fusing)* is a safety practice to reduce the possibility of our aircraft flying into the fragments of the weapon we just delivered. Each weapon will have some type of fusing. A time delay is set on our fuses, allowing us to time to maneuver the aircraft safely away from the detonation. If we release too low, the time of fall of the weapon is decreased, the fuse doesn’t have time to arm, therefore causing the weapon to “dud”. The Mk 76 has an instantaneous type of fuse which will cause the smoke charge to detonate upon impact.

The last threat, and most importantly to us in the Training Command, is *terrain*. 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. We need to plan our release as to recover the aircraft at some safe altitude without impacting the ground.

There needs to be a fine balance between how low, how fast, and how steep our aircraft is when defining our release point. If we release steeper and/or faster than our planned release parameters we will be increasing the altitude lost on our recovery/pull-out from the dive, driving us closer to the threat.

The components of the T-45C “Z” Diagram are shown in Figure 3-16. The bottom line represents the release altitude, the diagonal line represents the flight path, and the top line represents the pattern altitude. The dive angle/Flight Path Angle is shown as well as an intermediate point during the tracking run called a “Checkpoint”. The checkpoint altitude is calculated to be 1.5 times the release altitude and is a “how-goes-it” point.

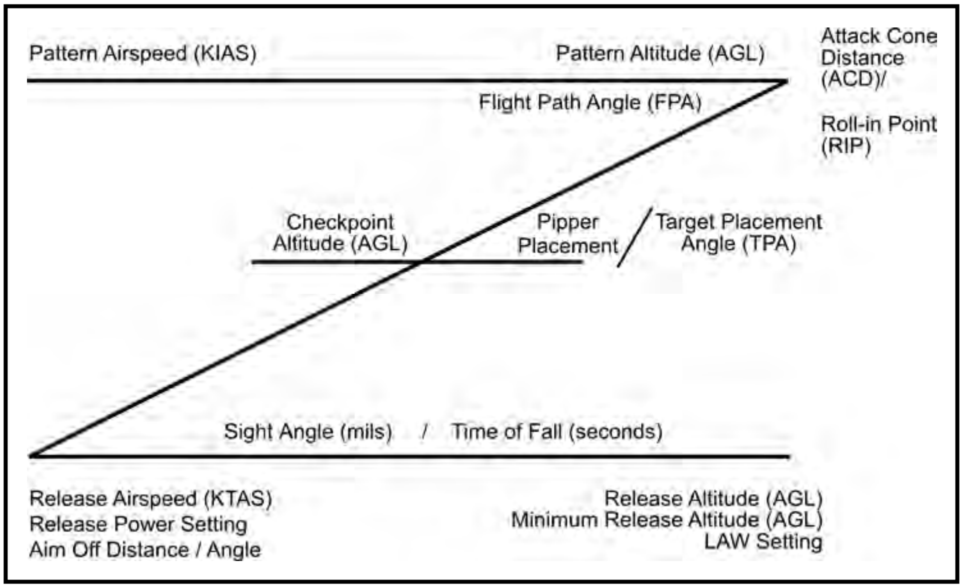

Figure 3-16 T-45C "Z" Diagram Components

Release Altitude is the planned release altitude, were as the Minimum Release Altitude, or "Zmin" Altitude, is the "No Lower Than" release altitude. We will strive to release with the pipper arriving at our aimpoint as close to the ***planned*** release altitude as possible. The minimum release altitude is just that – the absolute minimum. Releasing below the Zmin altitude WILL NOT BE TOLERATED. Consistently releasing well below the planned release altitude will be reflected in your grades. You need to recognize a developing late sight picture, understand what caused it and make the appropriate adjustments on subsequent runs. **Releasing below the Minimum Release Altitude is considered to be unsafe.** The causes of late sight pictures will be discussed in detail in the Target Tracking Section of this text.

Release Power Setting is the power setting prior to roll-in to achieve the planned release airspeed. Aim Off Distance (AOD) and Aim Off Angle are shown below the Power Setting. This is how far past the target our Velocity Vector needs to be to compensate for the trajectory drop of the weapon. All altitudes are shown 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. ACD stands for Attack Cone Distance which is the distance from the target where the roll-in from pattern altitude begins. This is also referred to as the Roll-In Point or "RIP".

Figure 3-17 shows the T-45C "Z" diagrams used for Mk 76 bomb deliveries.

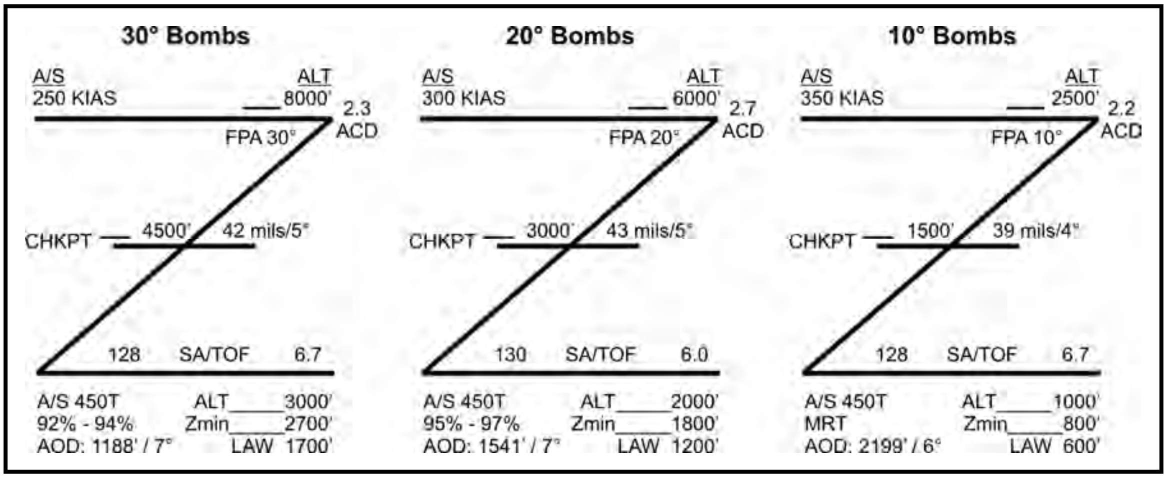

Figure 3-17 Mk 76 "Z" Diagrams

All of the Z diagrams used in the training command are already supplied to you, the Data Delivery Tables and their use in developing our Training Command Z diagrams will be covered next in the Preflight Preparation chapter.

NOTES

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CHAPTER FOUR
PREFLIGHT PREPARATION

400. INTRODUCTION

It would be nice to just show up at walk time, sign for the aircraft, head out and go drop bombs. Unfortunately, to be a professional Naval Aviator and to give yourself the best chance of mission success, the majority of your time will be spent on preflight preparation and mission planning.

The Marine Corps has a saying "The more you sweat in peacetime, the less you bleed in war". This holds true to many aspects in life, but it especially holds true to our aviation profession. Being prepared for the flight will not only make you more proficient but it will make you a safer pilot. Knowing the "why's" behind what we do manifests a learning environment. Understanding our limitations breeds safety and leads us to that well known Latin-LSO saying "rectus non bustus". So let's take a little closer look at some of the preflight preparation expected of you during your Weapons stage of training.

In this chapter we will discuss: the Delivery Data tables; Weapons Kneeboard cards; Offset Aimpoint calculation and determination; Safety of flight issues such as aircraft and weapons limitations, minimum ejection altitudes, and external stores considerations; Briefing board setup and the normal flow of the Weapons preflight brief and what you can expect.

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 4-1 Delivery Data Tables

The data delivery tables for the T-45C can be found in the end of Chapter 22 of the NATOPS. There are a few tables at the end of the chapter so 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.

In these tables you will find sight angle settings, recovery altitudes and weapon time of fall.

The numbers in the tables are dive angle, airspeed, and release altitude specific.

For example, let's take a closer look at the data delivery table for the MK 76. This is the primary weapon you'll be dropping in the aircraft.

To use this chart, first, check to ensure you're looking at the right chart. Notice at the top it is labeled MK 76 MOD 5/BDU 33 PRACTICE BOMB.

Second, find the delivery parameters we will be releasing the weapon. We have already determined that we will be dropping in a 30 degree dive, 450 KTAS, at 3,000'. You now follow that line across for the information you need.

The info you'll become most familiar with is *Time of Fall (TOF)* and *Sight Angle (SA)*.

For our example, TOF is 6.7 and SA is 128.

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

The Sight Angle setting is the value we use when we set our mil setting for the manual delivery mode pipper. Notice, the sight angle is the sum of the trajectory drop, AOA, and Parallax in mils.

This information is displayed above our release altitude line on or Z diagrams as shown below:

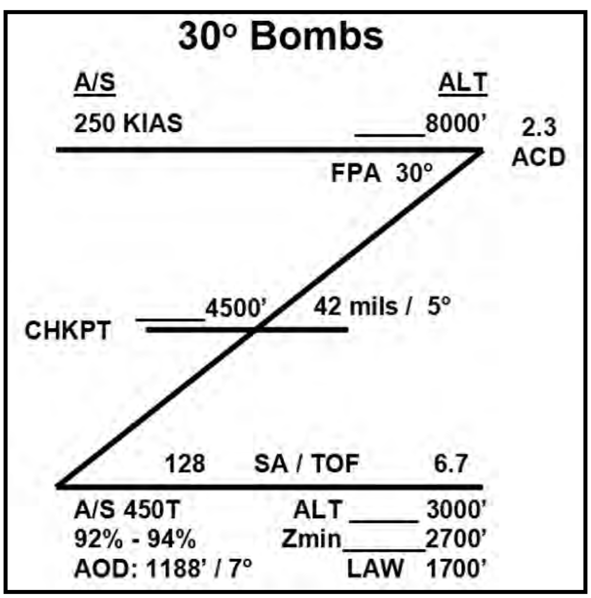

Figure 4-2 Information for Z Diagram

Altitude Loss in the Recovery

The recovery altitudes in the delivery data tables indicate the “bottom out” altitudes and are based on a straight path dive release with the following assumptions:

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 in 1.25 seconds.

5. 15 degree flight path run-out.

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.

DELI
MK 76 MOD 5/BD

RELEASE FLIGHT PATH (DEG)	RELEASE AIRSPEED (KTAS)	RELEASE ALTITUDE (FT)	RECOVERY ALTITUDE (FT)	TIME OF FALL (SEC)
-10	400	1000	738	5.2
		1100	838	5.6
		1200	938	5.9
	425	1000	716	5.1
		1100	816	5.4
		1200	916	5.8
	450	1000	694	5.0
		1100	794	5.3
		1200	894	5.7
-20	400	2000	1311	6.4
	425	2000	1254	6.2
	450	2000	1196	6.0
-30	400	3000	1725	7.1
	425	3000	1596	6.9
	450	3000	1468	6.7

Figure 4-3 Altitude Loss in the Recovery

These assumptions are slightly generous in that we normally operate at a gross weight less than 13,875 lbs and our response and G build up times are slightly less than that assumed. Our Z diagram release altitudes, pattern LAW settings and Break X computations are based upon the above information.

To find the altitude lost in the recovery, simply subtract the recovery altitude from the release altitude. For example, in a 30 degree dive, 450 KTAS, 3000’ release: 3000 – 1468 = 1532’ lost.

Valid Break X Determination

With the above information, we could determine our expected valid Break X indication. As we previously discussed, the Break X in the HUD indicates an immediate recovery (based on above assumptions) to have the aircraft “bottom out” at 1000’ AGL. By adding altitude lost on recovery (1532’) to 1000’ we get 2532’AGL. With the addition of the target elevation, we can determine the MSL altitude we could expect the Break X to first illuminate. Weapon release should **NEVER** be accomplished with a valid Break X and is one of our tactical abort criteria. If you see a valid Break X appear, you are fixating on the target and “pressing the target”. Keep altitude in your scan. Altitude progression is first your planned altitude, followed by your minimum release altitude, then comes the Break X indication, followed by the LAW tone. If the LAW tone sounds before recovery initiation, you need to immediately and aggressively abort your run as it will have the aircraft bottom out between 200’ and 400’ AGL.

Offset Aim Point

The pipper of the T-45C manual delivery mode reflects where the weapon will impact the ground on a no-wind day, at our precise release parameters. VERY rarely, will you bomb on a no-wind or calm wind day. During your first few simulator events, you will have the conditions of no-wind so you can concentrate on aiming and releasing “pipper-to-bull”. In the aircraft and on late simulator events, you will be introduced to winds.

With wind, if we aimed at the target, the wind will cause the bomb to drift away from the intended impact point. To counter this effect, we need to place our pipper in a position into the wind and let mother nature take its course. There is a formula that can be applied to find the distance we need to offset our aim point. Here’s where knowing the Time of Fall (TOF) of our weapon from the delivery data table comes into play.

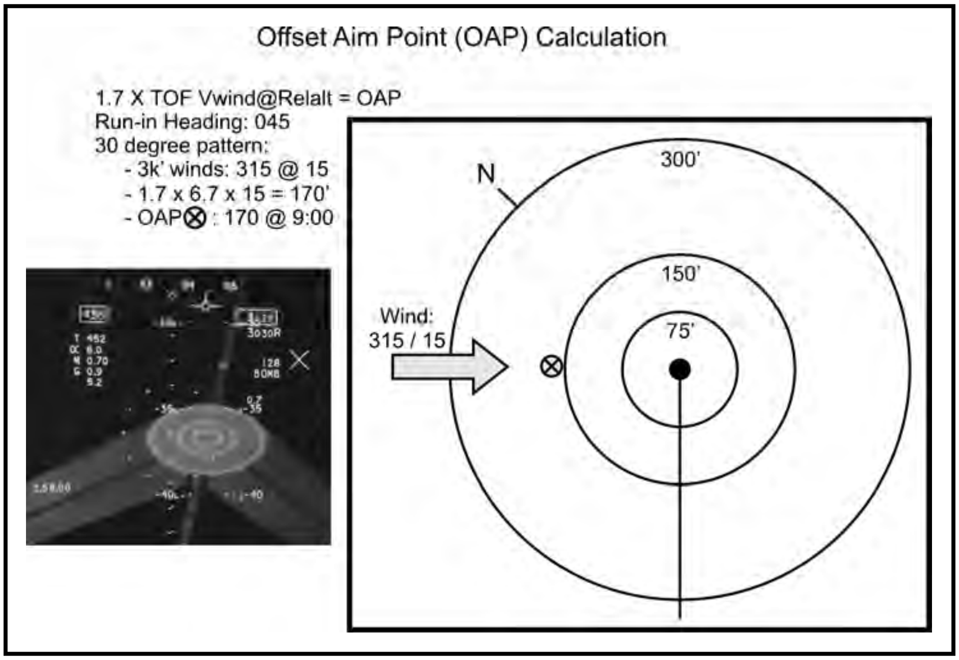

Figure 4-4 Offset Aim Point (OAP) Calculation

To find the Offset Aim Point (OAP) we apply the following formula:

1.7 x Weapon Time of Fall (TOF) x wind velocity at release altitude (Vwind@Relalt)

For example: The run-in heading for the target is 045 degrees. The winds at our 30 degree release altitude (3,000') are 315/15.

$$1.7 \times 6.7 \times 15 = 170'$$

Applying the above formula we derive that the aim off distance is 170'. We move 170' in the direction INTO the wind from the target and we find our OAP. As shown here. It is important to point out this OAP is the *planned* OAP. Release altitude wind will change over time and may not be the same as computed during your preflight preparation. Mentally update the OAP calculation in flight during the Mach Run by referencing the wind on your HSI. Following your first run, evaluate where the pipper was at release, note where the bomb hit, evaluate any errors and adjust the OAP to make the bomb go where you want it to go – that is to HIT THE TARGET!

The Weps Briefing Card

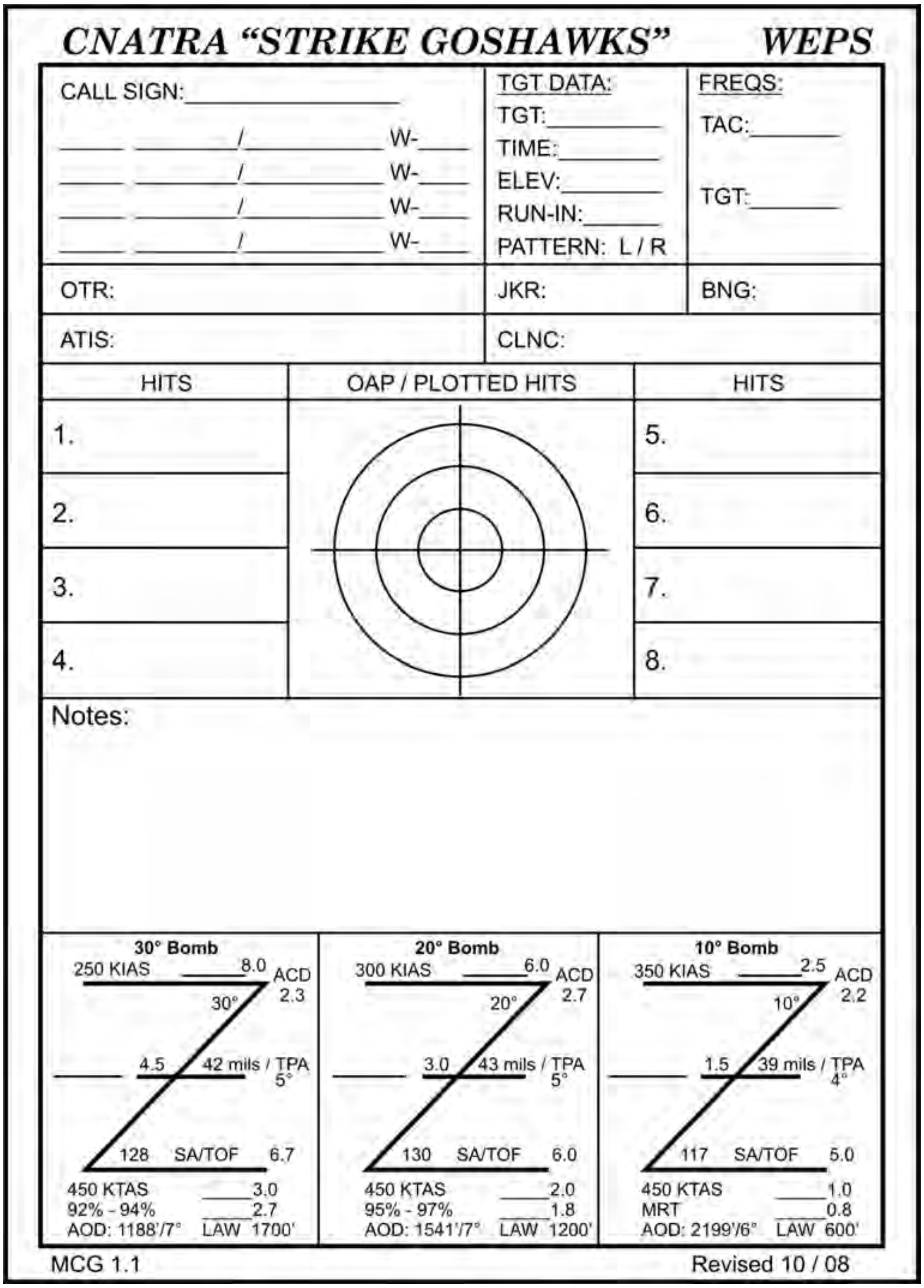

Figure 4-5 The Weps Briefing Card

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

The Weps kneeboard card is made out for each Weps flight and should contain the following:

1. A/C lineup, callsign, Weps syllabus event.

2. Target Data

3. Other pertinent admin data

4. Plot the planned Offset Aim Point based on forecasted release altitude winds

5. Off Target Rendezvous altitudes

6. The Z diagrams have spaces to add MSL altitudes

7. Any other pertinent specific data lead briefs.

Weapons Limitations

"Dirty Harry" Callahan once said: "A man's got to know his limitations". Anytime you change an aircraft configuration, it almost always changes the associated limitations to that aircraft. Knowing the limits before flight and operating within those limitations will keep you safe and is paramount. Here are the configurations and limitations associated with T-45C Weapons training.

LBA - LIMIT BASIC AIRCRAFT

STORE	DISTANCE FROM AIRCRAFT CENTERLINE-INCHES / STATION LOADING AND SUSPENSION: RIGHT	CENTER	LEFT	AIRSPEED - MAXIMUM AIRSPEED OR MACH WHICHEVER IS LESS: CARRIAGE (KIAS)	JETTISON (KIAS)	RELEASE (KTAS)	ACCELERATION - G: CARRIAGE: SYM	UNSYM	JETTISON: JETTISON	RELEASE	MAXIMUM DIVE ANGLE (DEGREES)	ANGLE OF ATTACK LIMITS (UNITS)	CG LIMITS % MAC	CONFIGURATION WEIGHTS (LBS)	APPLICABLE NOTES
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/95 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/95 MK76/25 or BDU33/25 each LAU-68/85 FFAR/23 each	1, 2, 3, 7

Figure 4-6 Weapons Limitations

Limitations associated with certain configurations are obtained from this chart: airspeeds, dive angle, release G and configuration notes. LBA stands for Limit of Basic Aircraft. Only authorized station loading and configurations are shown. Refer to the T-45 NATOPS Limitations section for further detail.

The primary aircraft loadout will be a pylon, PMBR and 4 Mk 76 bombs on each wing station.

Carriage. The limit on how fast you can you can carry the nomenclature on the aircraft.

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

Release. The maximum airspeed limit to release the weapon.

Acceleration G. The G limits associated with symmetrical/unsymmetrical pulls, PMBR jettison and normal weapon release.

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

Configuration Weights. Indicates the weight of each nomenclature. Example: a normal weapons loadout for an aircraft flight is:

PMBR:	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. Ensure your preflight 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 the NATOPS Limitation section. Landing with LAU-68 rocket pod (empty or full) or PMBR/BRU-38A (with 1 or more bombs) shall not exceed 600 fpm.

4.16 EXTERNAL STORES LIMITATIONS

1. Only the external stores shown in the External Stoers Limitations chart, figure 4-7, are permitted for carriage. LBA refers to the limits of the basic aircraft.

WARNING

Only WTU-1/B and MK 67 warheads are authorized.

2. Carrier operations with other than clean loading prohibited.

3. Landings with LAU-68 rocket pod (empty or full) or PMBR/BRU-38A (with 1 or more bombs) shall not exceed 600 fpm.

Figure 4-7 External Stores Limitations

G Limitations

Overstresses. With limited assets available and with limited human resources on the line and in the shop, we need to preserve those assets to the best of our ability. If you fly a good pattern, the most amount of g you should pull at any one time should be between 4.2 to 4.8 g’s. You should “target” 4.0 g’s on the recovery, just as in performing a loop in FAMs. This is the first time you are pointing your nose at the ground, hurling yourself towards earth at 450 KTAS and 3000’. You need to know the g limits of the aircraft.

Realize, when you are traveling at this airspeed, mostly all of the overstresses derive from quick application of back stick or “snatching” on the g. Be SMOOOOOOOOTH with your pulls.

The g limits in the T-45C are broken down into two maneuvering envelopes, symmetrical (wings level) and unsymmetrical (rolling pull).

Symmetrical Maneuvering

The limits for the symmetrical maneuvering are +6.5 and -3.0 below 5,000’ MSL, which is the regime we spend all of our time pulling our g’s.

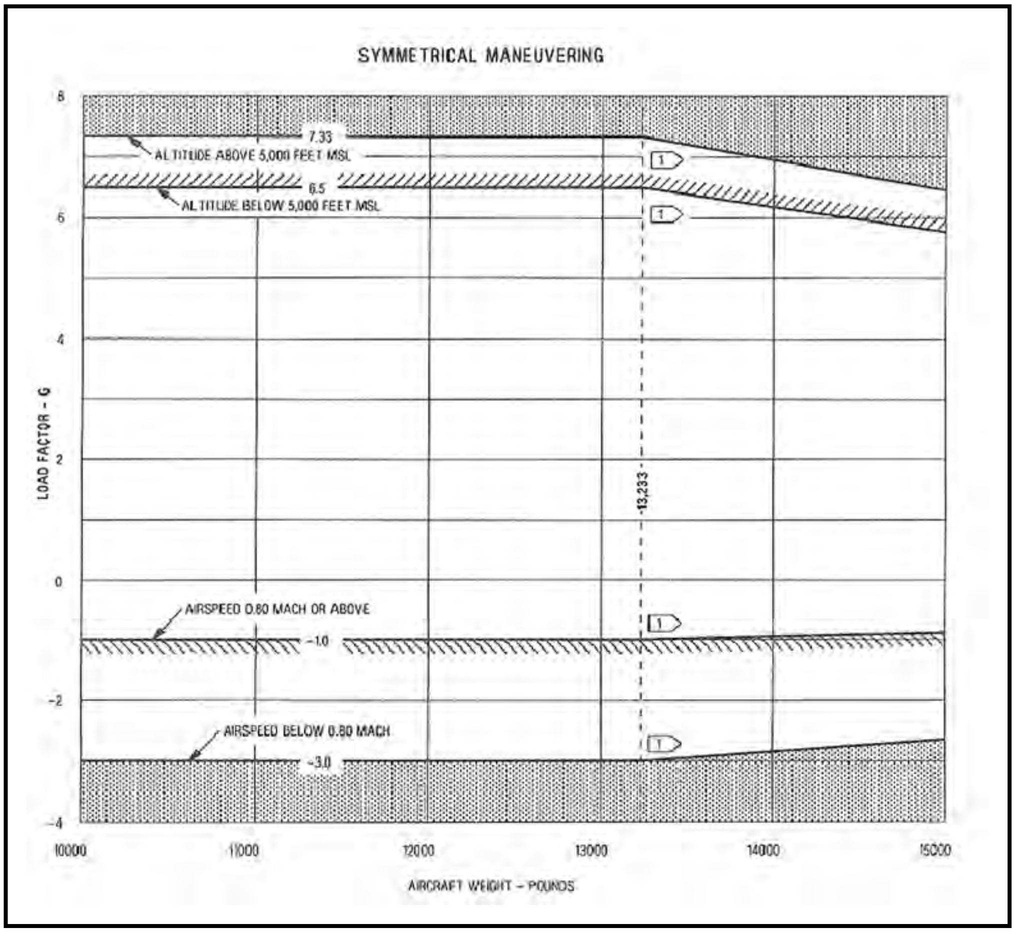

Figure 4-8 Symmetrical Maneuvering

Unsymmetrical Maneuvering

For unsymmetrical limits, or rolling pullouts, the limits are reduced to +5.0 and -0.2 g's. This is a big factor in your turn to the abeam in all patterns, as well as your turn while rolling-in to the target in the low pattern. Remember, before turning the aircraft, relax your pull, roll, then smoothly reapply the g.

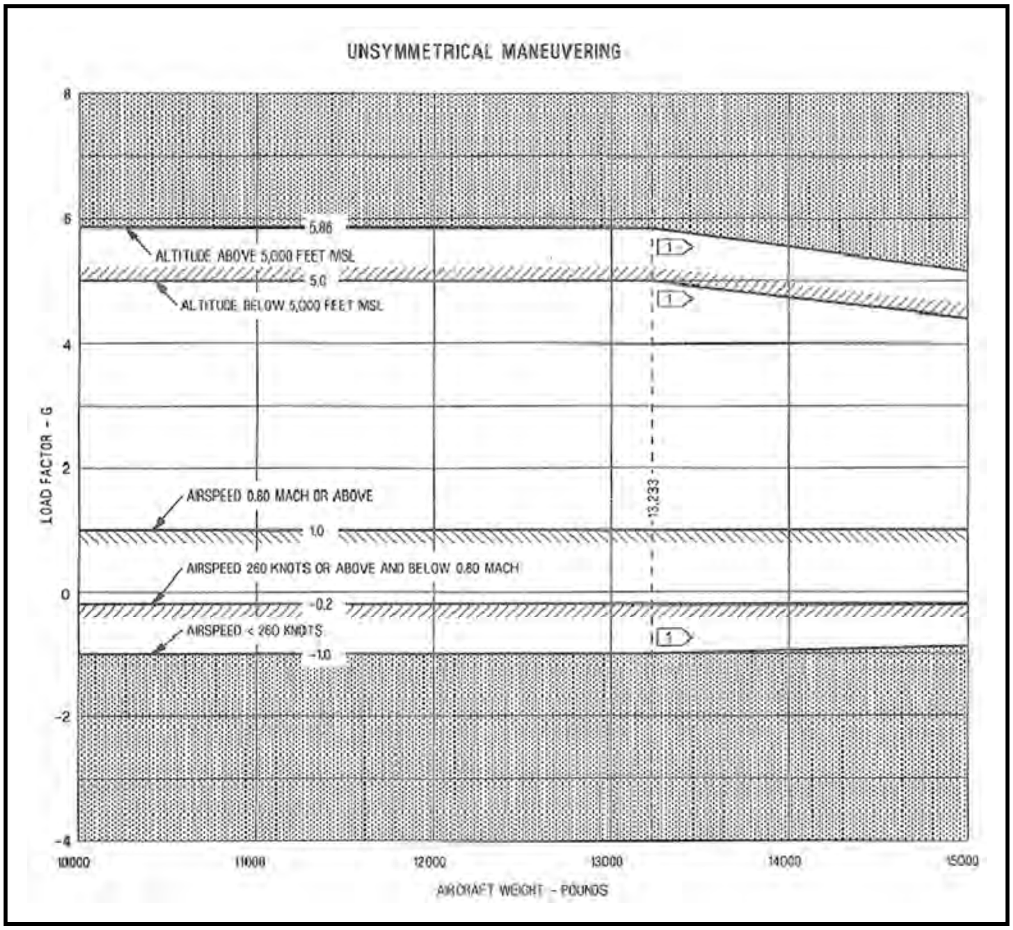

Figure 4-9 Unsymmetrical Maneuvering

Minimum Ejection Altitudes

This chart is found in the NATOPS and should be reviewed and understood.

Always review the notes at the bottom of the chart.

For a 30 degree dive, the minimum ejection altitude is 650’ AGL.

For a 20 degree dive, the minimum ejection altitude is 450’ AGL.

For a 10 degree dive, the minimum ejection altitude is 200’ AGL.

These are AGL altitudes and need to be converted to MSL altitudes for target elevation.

As the notes say, these are based on initiation of the ejection system, pilot reaction time is not included.

Know them cold.

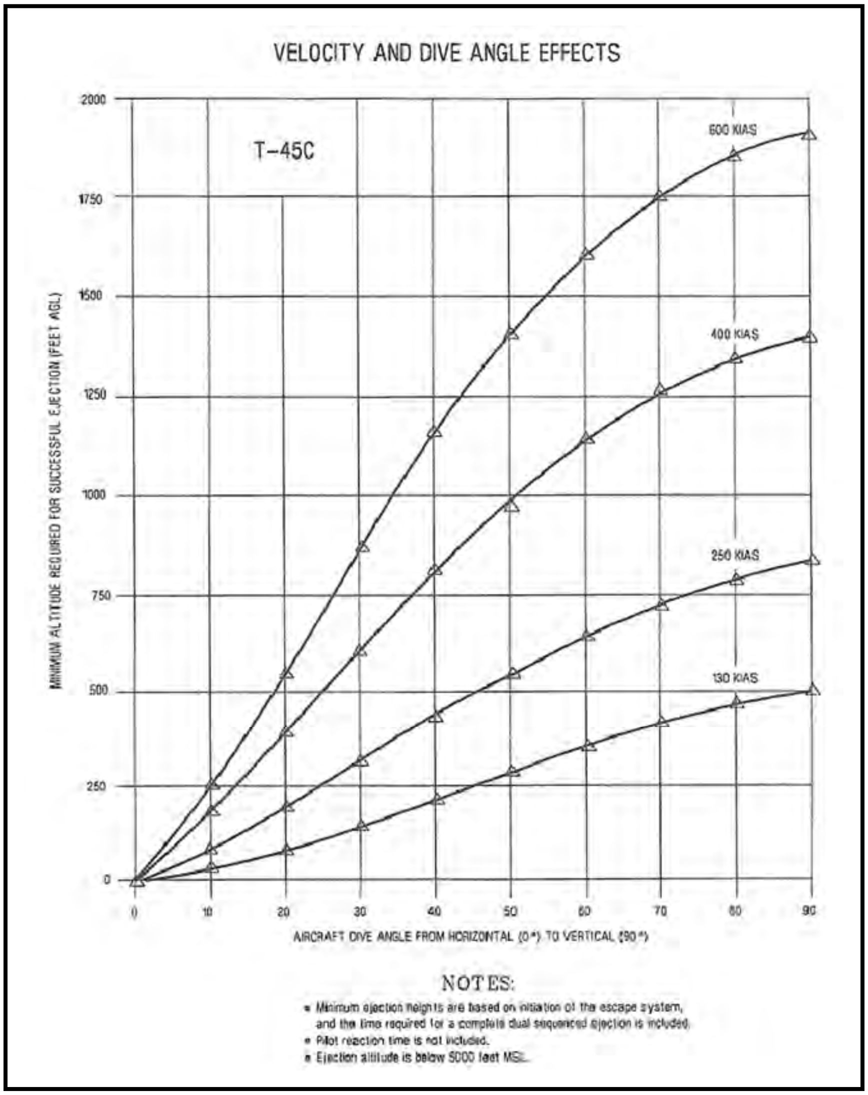

Figure 4-10 Minimum Ejection Altitudes

Weps Briefing Board

The standard flight briefing will be from the standardized e-brief in the squadron spaces. When on detachment or when the e-brief system is not available, you will have to construct a briefing board the old fashion way. Below is an example of the items required for the Weps Briefing Board. 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.

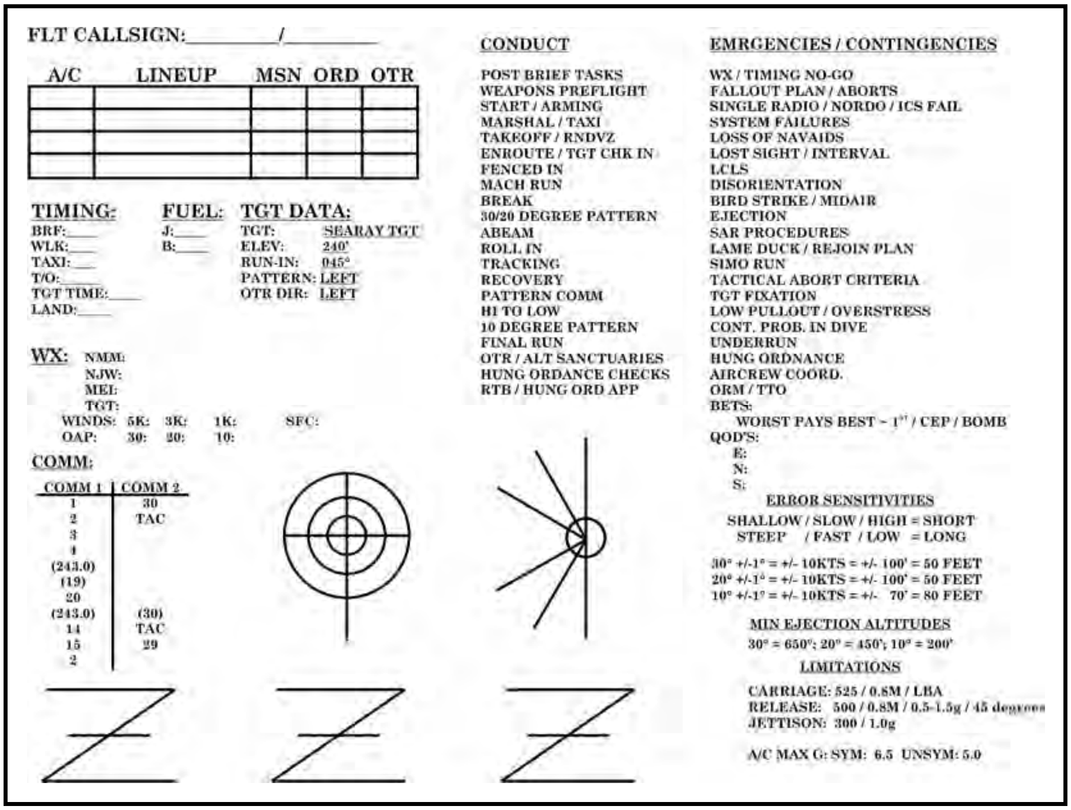

Figure 4-11 Weps Briefing Board

The Weapons Flight Preparation Procedures - Summary

The following will cover what you can expect on how the Weapons brief will take place.

Thoroughly familiarize yourself with all preceding information.

You should show up to the brief with the weapons briefing board filled out (either electronically or manually) with the line-up, A/C assignments, de-conflicted Tac Freq, and weather to include target winds at 5k, 3k, 2k, and 1k. You should compute the offset aimpoint for the patterns you intend to fly that day. The briefing board should have the target drawn with the respective rings (to include run-in line and heading), OAP plotted, error sensitivities for the patterns to be flown, and pattern diagram with position calls. Kneeboard cards will be filled out for the entire flight.

The Brief

The Weps lead conducts the brief for the flight. MCG requirements for each SNA will be discussed. Flight Leads should target 45 minutes for their brief. Once the flight lead brief is complete, each SNA will cover weapons techniques and inter-cockpit emergencies with their respective IP's.

Accuracy is nominal on WEP-08, as long as the comm is smooth, the pattern is tight, and the SNA actually sees all other aircraft in the pattern. Early flights should emphasize good basic formation, the Weps pattern, Communication, and the Off Target Rendezvous. Good hits on target will come after the basics are mastered.

To do well in Weps, you need to break down the flight into four separate flights wrapped up into one: Division Form, Weps, Division Form, and FCLPs.

Flight Admin

The Flight Lead will cover the following admin:

<u>Resolve ORM/TTO issues.</u>

<u>Formation Composition.</u> Callsigns, aircraft, lineup, mission/syllabus requirements, Weapons load-out, back-ups available, succession of lead, and bump plan should be discussed. See Weps supplement for local and detachment detailed information.

<u>Target.</u> Target name, coordinates, elevation, run-in, pattern direction and primary and secondary frequencies.

<u>Timing.</u> Brief, walk, marshal/taxi, T/O, target times, and target No-Go.

<u>Weather.</u> Forecast weather for the target area to include winds at release altitude and on deck. The OAP should be calculated for all flights. Quick Rule of Thumb, 11 ft per knot of wind in the 30 degree pattern, 10 ft per knot in the 20 degree pattern, and 9 ft per knot in the 10 degree pattern.

Weather at divert fields.

Weather requirements (Weather No-Go): 30 degree – 10,500/5; 20 degree – 8500/5; 10 degree – 4000/5.

<u>Fuel Plan.</u> Joker and Bingo.

<u>COMM:</u> Positive check-ins only. Volume control, COMM 1 T/R, COMM 2 T/R&G, tactical Frequency, single radio plan, "Get Well" frequency and channelization.

Waypoint/Nav Plan. Waypoints, O/Ss, elevations, course lines, TACAN. See Weps supplement 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 and resolve confliction of target use.

Sequence of events are covered in the remainder of this text.

Emergencies/Contingencies. Refer to Emergency/Contingency chapter of this text.

Review Limitations. Carriage, release, jettison, overstress and error sensitivities.

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

NOTES

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CHAPTER FIVE
GROUND OPERATIONS

500. INTRODUCTION

The Ground Operations in the Weapons stage will be, for the most part, exactly what you learned in the Division Formation stage with the addition of ordnance preflight, setting up the A/G STORES page after engine start, and arming procedures.

Ordnance Preflight

Refer to Chapter Two – T-45 Practice Ordnance, current NATOPS, and local directives for detailed instructions on ordnance preflight.

A/G STORES Page Setup

Refer to Chapter One – T-45 Armament Controls and Indicators for instructions on STORES page set-up. Generally speaking, the A/G STORES page setup is *usually* completed in the line following engine start and sometime between waypoint programming and the Plane Captain checks. Following the A/G STORES page set-up, ensure the NAV mode is selected prior to signaling to the Plane Captain you are ready for the Plane Captain checks.

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

1. MFD - Select MENU / STRS / A/G (defaults to MAN/GUN)

2. Select either wing station / weapon combination, (i.e. left wing station / BOMB).

3. Adjust QTY to match PMBR/BRU-38/A load-out

4. Select the other wing station / weapon combination (i.e. right wing station / BOMB)

5. Adjust QTY to match PMBR/BRU-38/A load-out

6. DEP – Adjust MIL setting for first intended pattern to be flown

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 (i.e. MAN or CCIP)

10. NAV HUD master mode – Select

The system is now set for your first run on the target. All that remains for weapons delivery setup is to select A/G HUD master mode on the “Fenced In” call and place Master Arm Switch to ARM on the roll in.

Arming Procedures

Refer to local directives for all arming procedures.

The typical sequence of the Mk 76 Arming procedures:

1. A Lead Ordnanceman will position himself 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 be idle unless a safety/emergency situation dictates.

3. The Lead then signals to an ordnanceman under the wing to remove the Safety Pin from the PMBR/BRU-38/A.

4. The Ordnanceman under the wing removes the PMBR/BRU-38/A Safety Pin and places the Station Selector to “1”. He then shows you the pin(s) he removed.

5. The Ordnanceman then hands 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.

Rocket arming will be accomplished as per local / airfield directives.

Marshalling / Taxi Procedures

Marshalling, Comm check-in, and Taxi procedures are accomplished as in Division Formation.

For special procedures/Detachment operations, refer to local course rules and directives.

Takeoff Procedures

Division Interval Takeoff procedures are the standard takeoff plan. Weather may dictate deviations to the standard and will be accomplished as briefed by the Weapons Flight Lead.

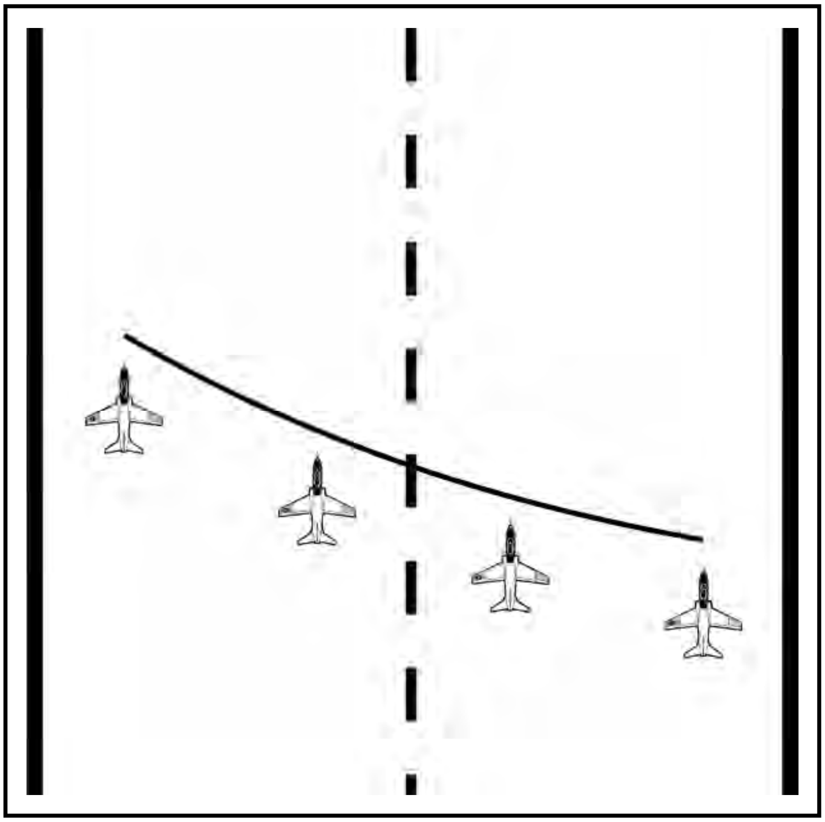

Figure 5-1 Takeoff Procedures

NOTES

CHAPTER SIX
ENROUTE PROCEDURES

600. INTRODUCTION

The enroute procedures during the Weapons stage will be, for the most part, the same as what you learned in Division Formation with a few exceptions. This chapter will briefly cover the general scope of the initial join-up, cruise positioning and considerations while transiting from the departure airfield to the target area complex.

The Initial Join-up

The initial join-up will be as briefed by Lead. It could be a CV Rendezvous, a Running Rendezvous or a combination of the two. All procedures which you have learned to date will still apply. For many of you, the Division Formation stage was completed a good time ago. Now is the time to "shake off the rust" and compartmentalize. When you are flying formation, concentrate on formation flying. From this point forward, formation will get you TO the mission, instead of formation BEING the mission. You will be expected to perform as such and will be held to a higher standard.

You will find a slight difference in aircraft performance on the join-up. This corresponds to the amount of drag the aircraft has due to the bomb racks and weapons being carried. The aircraft will slow down a little easier, especially in the climb. So, pay attention to stagnation on the join-up, but at the same time, don't be overly aggressive. Be expeditious, but most importantly - Be Safe!

Regardless of the join-up Lead briefs, they all will end up with everyone joining in parade position. Take this opportunity to complete an *Integrity Check* on the aircraft in front of you to ensure there are no loose panels and all weapons remain onboard. Once EVERONE is in parade position, Lead will signal the flight to take the cruise position.

The Cruise Position

The Advanced Stage Division Cruise position keeping varies slightly from what you've experienced in Basic Division Form Cruise in that you will be expected to remain on your respective side during maneuvering flight. All comm check-in and check-out procedures should be standard from previous experiences.

Once placed in the cruise position, this can be used a reminder to reset your LAW setting. Being placed in cruise gives Lead a few more sets of eyes to scan for traffic conflicts enroute. Be in position; however, keep the eyes scanning for VFR traffic, skydivers, and/or birds!

Now is not the time to be an over-achiever and select the A/G Master Mode prior to Lead calling for the "Fenced In" check. This will be discussed in detail in the following chapter. This includes setting your MFD to the STORES display. At this point you should have the ADI on the left MFD and the HSI on the right. You can take this time ensure your HSI is properly displayed and set to the proper range scale as well as noting the wind at altitude. This may be of some use as it applies to flying the pattern.

On your first few trips to the range, take the opportunity to see what's around you to build your SA. For example: Divert airfields, landmarks/reporting points for Tower (such as being on Detachment). Take notice to any smoke on the ground, this could give you a visual reference to the direction of the wind on the deck.

NOTES

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CHAPTER SEVEN
TARGET AREA PROCEDURES

700. INTRODUCTION

This chapter will cover the basic procedures in the target area. It begins with the "Fenced In" call and ends with the "Fenced Out" call. In between, we'll cover the Mach Run, the break into the pattern, the three different patterns with or without target waypoint distance, pattern action points, pattern positions, pattern communications, pattern transitions, and the Off Target Rendezvous. We'll also discuss the Pop-to-Attack pattern.

The "Fenced In" Call

Approaching the target area and <u>over sparsely populated terrain</u>, Lead will "Fence In" the flight. This typically occurs after checking in with range control and /or the target controller. The "Fenced In" call is a signal to the flight that your system is properly set-up and you are ready to attack the target, i.e. your "combat checks". Most of your combat checks should have been completed on the ground with the only items remaining are to select A/G Master Mode, configure your MFDs as desired, and place your Master Arm switch to ARM.

When Lead is ready to fence the flight "In", typically Lead will do so over Tactical frequency, but is not limited. A typical fence-in call is: *"(Call sign) Flight, On Tac. One Fenced-In, good Gs, (fuel state)"*. When Lead makes the call, the flight members should select the A/G Master Mode at that time (typically by pressing the HUD Mode button on the DEP twice). When Dash 2 is ready, Dash 2 calls*: "Two Fenced-in, good Gs, (fuel state)."* The rest of the flight will call "fenced-in" in order. The A/G Master Mode may also be entered via the MFD by selecting MENU / STRS / A/G. The recommended MFD set-up is: Left MFD – ADI or STORES page; Right MFD – HSI.

CAUTION

> Do not select A/G Master Mode prior to Lead making the "Fenced In" call. There have been instances in the past when the selection of the A/G mode caused a Mk 76 to fall from the aircraft. It's not supposed to happen, but it did. For that reason, DO NOT select the A/G Master Mode until Lead calls for it. Realize, by selecting A/G on the STORES page, you enter into the A/G Master Mode.

The weather in the target area may dictate a change to the pattern initially planned. If an audible is called, ensure you have the correct LAW setting and Mils (MAN delivery) for the pattern to be flown.

The Mach Run

The primary objective of the Mach Run is for Lead to over-fly the target at release altitude and airspeed and for you to trim the aircraft for release airspeed of 450 knots true.

Approaching the target area, Lead calls out the target location and advises “setting up for the Mach Run”. With about 45 to 90 degrees of turn to go onto the run-in heading, the flight assumes echelon for the break.

The flight takes a double the interval cruise position. When trimming the aircraft, first trim out the standby ball first (rudders), then aileron, and finally pitch. Once established in the pattern, resist the urge to trim for pattern airspeed. If you do, as the aircraft accelerates to release airspeed in the dive, it will naturally seek the trimmed pattern airspeed causing the nose / Velocity Vector to rise, resulting in the pipper tracking faster than optimum, thereby causing an early sight picture or high release - ultimately resulting in a short hit. Fight the urge to trim while in the pattern and let the nose seek 450 KTAS on the dive.

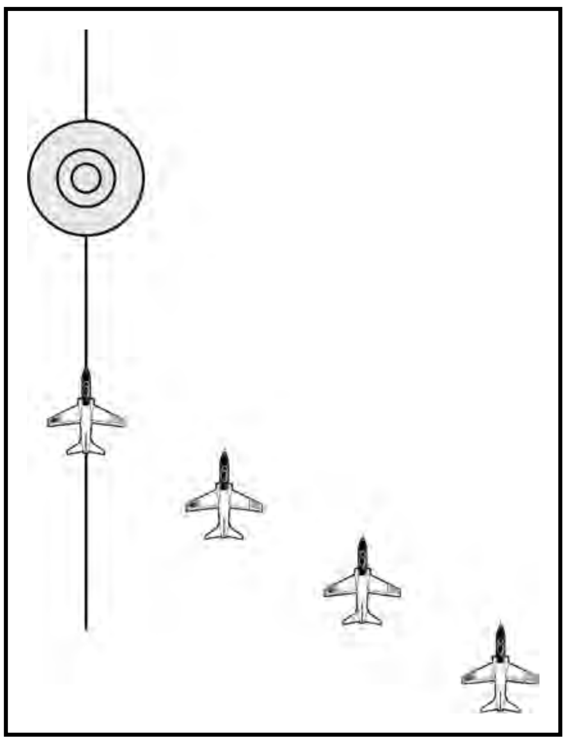


Figure 7-1 The Mach Run

On the Mach Run, scan the release altitude wind. This will give you a better indication on where the offset aimpoint truly is, rather than just going with the OAP derived in the brief.

Recommended technique (if able) is to set the Heading Bug to the wind direction. Multiply the wind speed by 11 for a rough distance from the target for the 30-degree pattern; multiply by 10 for the 20-degree pattern, and; multiply by 9 for the 10-degree pattern. The displayed HDG Bug will show the direction of the Offset Aimpoint and the wind speed determines the distance from the target. Worst case, go with the briefed OAP and adjust on subsequent runs.

Approaching the target, Lead will call out the True Airspeed, Barometric Altitude, and wind readout from his HSI. At this time, verify 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 should chime in and be the tie breaker. Otherwise, silence is consent and Lead will continue with the Breaking Maneuver.

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

The Break into the Pattern

Slightly before the target, Lead will call out "One breaking, High (Mid/Low) Pattern". Dash Two maintains altitude and heading and breaks at an eight second interval for a four plane. The break interval for a three plane is ten seconds. When it's your time to break, call out what Lead said on his break into the pattern. For example: "Two breaking, High (Mid/Low) Pattern."

Once the last aircraft in the flight has called "breaking", Lead will make his position call with fuel state. When Two arrives at the abeam, Two will make his position call, "Two Abeam, 2.4" (for example). When Three arrives at the abeam, Three makes it's position call, unless the flight is a three plane. The last aircraft in the flight will hold the position call until Lead calls "Off", then the normal comm cadence begins. Pattern communications will be discussed in detail later on in this chapter.

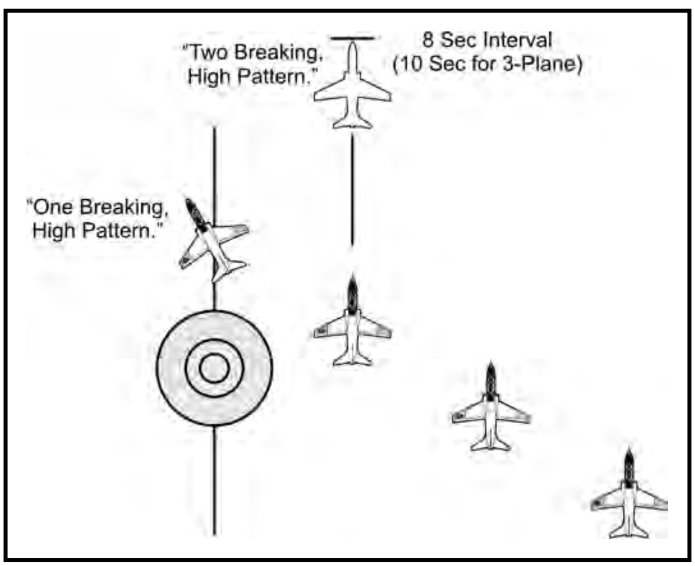


Figure 7-2 The Break into the Pattern

The mechanics of breaking into the pattern is similar to the breakup and rendezvous as in Division Form except that you'll be selecting MRT and climbing up to the pattern as well as timing 8 to 10 seconds between aircraft. The procedure is to roll the aircraft about 45 degrees AOB away from the echelon, then smoothly apply up to 4 g's, simultaneously select MRT and fly the jet to the Abeam position. A good rule of thumb (technique) is to pull up to the pattern the same number of degrees you will be going down. For example, if flying a 30 degree pattern, nose up no greater than 30 degrees; 20 degree pattern, climb out at 20 degrees; 10 degree pattern, no greater than 10 degrees to pattern altitude. Angle of bank and g force as required getting to a good Abeam position. Typically, the initial 90° of turn requires 3 – 4 g's, with the second 90° of turn being a gradual reduction from 3 g's to 1 g. Around 1000' prior to the pattern altitude, reduce the power (around mid range) and relax the back-stick pressure to allow the aircraft's nose to fall to level flight. Trade excess airspeed for altitude and fine tune basic airwork to fly the jet to the proper pattern altitude, airspeed, and position.

The Pattern Objectives

The overall pattern objectives and the reason we fly the pattern is to:

1. Arrive at the Roll-in Point *roughly* 30 degrees off the run-in heading.

2. Build consistency in the Roll-in Technique leading to consistent results.

3. Last, but above all, Safety of Flight. There are several reasons why we roll-in on a particular run-in line, which are too many to mention at this juncture. For our administrative purposes, we will all reference the same run-in line.

These basic objectives should be remembered when you are flying the weapons pattern.

The T-45C Weapons Raked Range Pattern

Breaking down the pattern into action points, we can better dissect the procedures in the pattern. The PRIMARY objective on early simulator and aircraft events is *pattern consistency*. Hits and target tracking are not the primary concern. Developing consistency in the pattern will lead to getting good starts to the tracking run. Over time with practice, the basic airwork of flying the pattern will become second nature, allowing for full concentration on refining your tracking techniques, error corrections and pipper placement. It has been proven time and time again, the students who master the pattern early in training end up being the best bombers overall. Take the time to master the pattern from the beginning.

IMPORTANT NOTE

Fly the *aircraft* while in the pattern. 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* weapons pattern.

The pattern is broken down into the:

1. Abeam,
2. Turn Point,
3. Approach Turn Arc,
4. Approaching or Power-up Point,
5. Attack Cone Distance (ACD) or Roll-In Point (RIP),
6. Tracking Time,
7. Recovery, and
8. Pull to the Abeam.

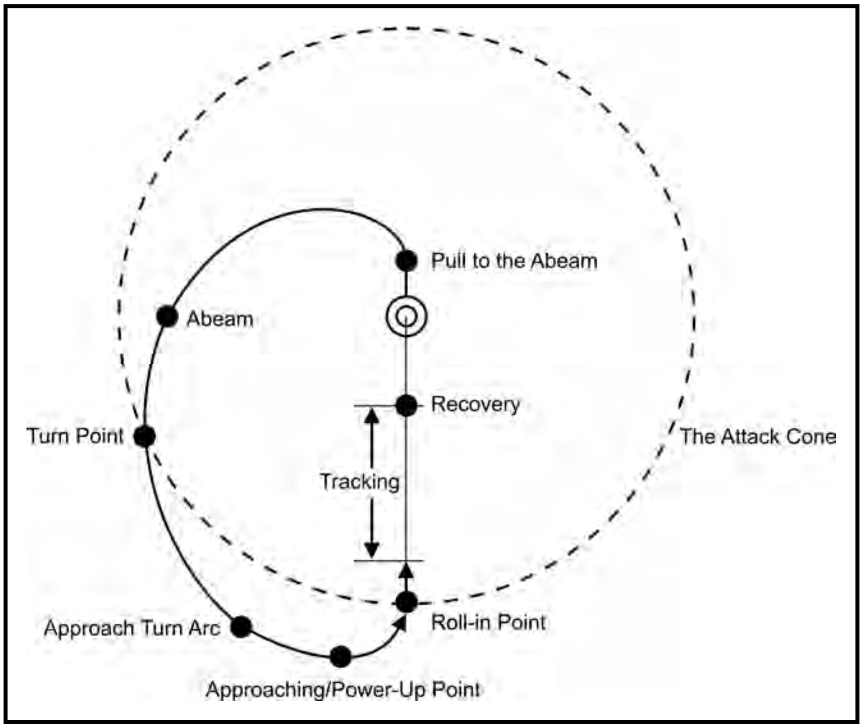


Figure 7-3 The T-45C Weapons Raked Range Pattern

Let's take a look at the patterns we will be exposed to in the Training Command.

There are three patterns flown in the Training Command. They are: the High Pattern, the Mid Pattern and the Low Pattern. After defining each of these patterns, we'll break down the respective action points associated with the pattern.

The "High" Pattern: 30-Degree

Pattern Altitude/Airspeed: 8,000'/250 KIAS

Abeam: 1.7 – 1.8

Turn Point: 2.3

Approach Turn Arc: 2.7 – 2.8

Attack Cone Distance (ACD): 2.3

Approaching power setting: 92% - 94%

Initial Sight Picture (ISP) and Target Placement Angle (TPA): 3° and 5° respectively

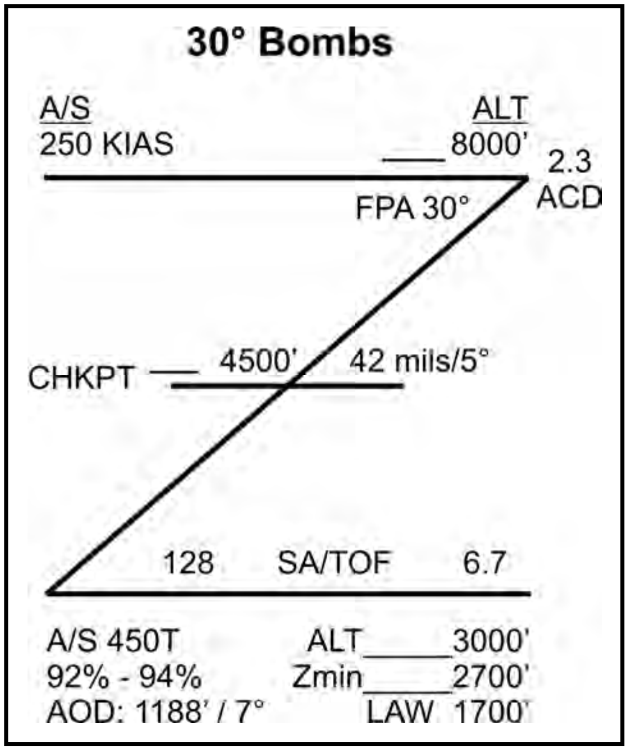


Figure 7-4 The "High" Pattern: 30-Degree

MIL Setting: 128

Release Altitude/Airspeed: 3,000'/450 KTAS

Aim Off Distance: 1188 ft. / Aim Off Angle: 7 degrees

Weather requirements: 10,500/5

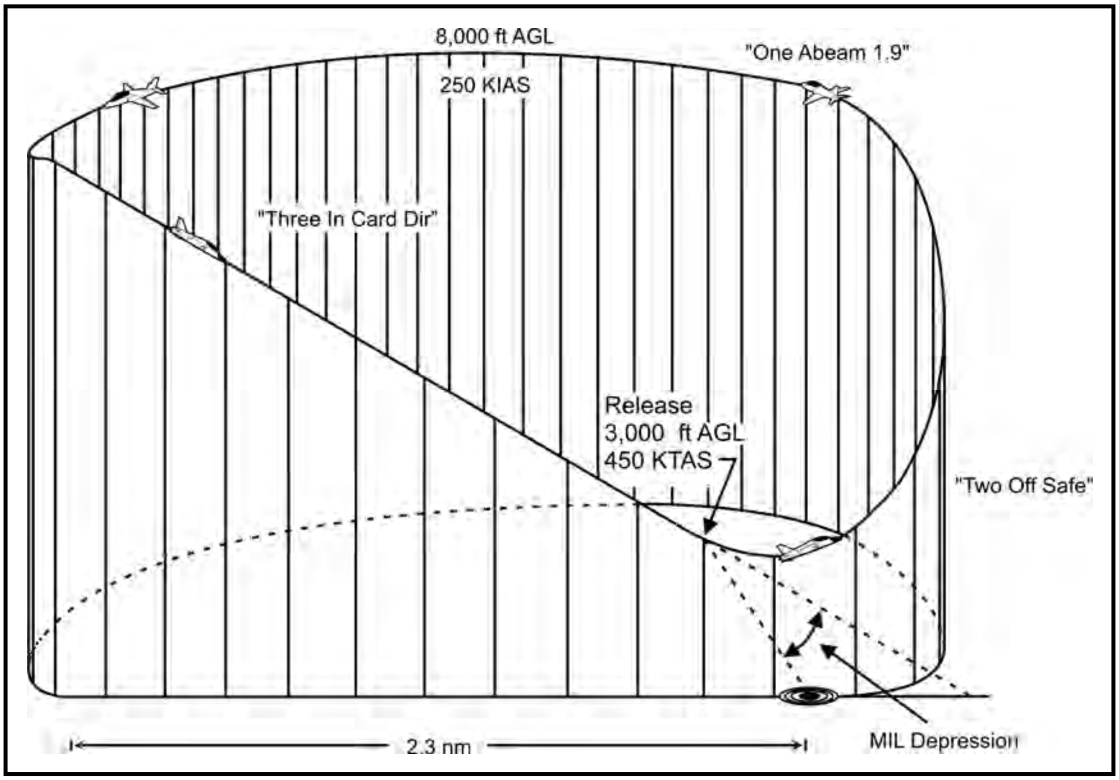


Figure 7-5 The "High" Pattern: 30-Degree

30-Degree Pattern and Z Diagrams

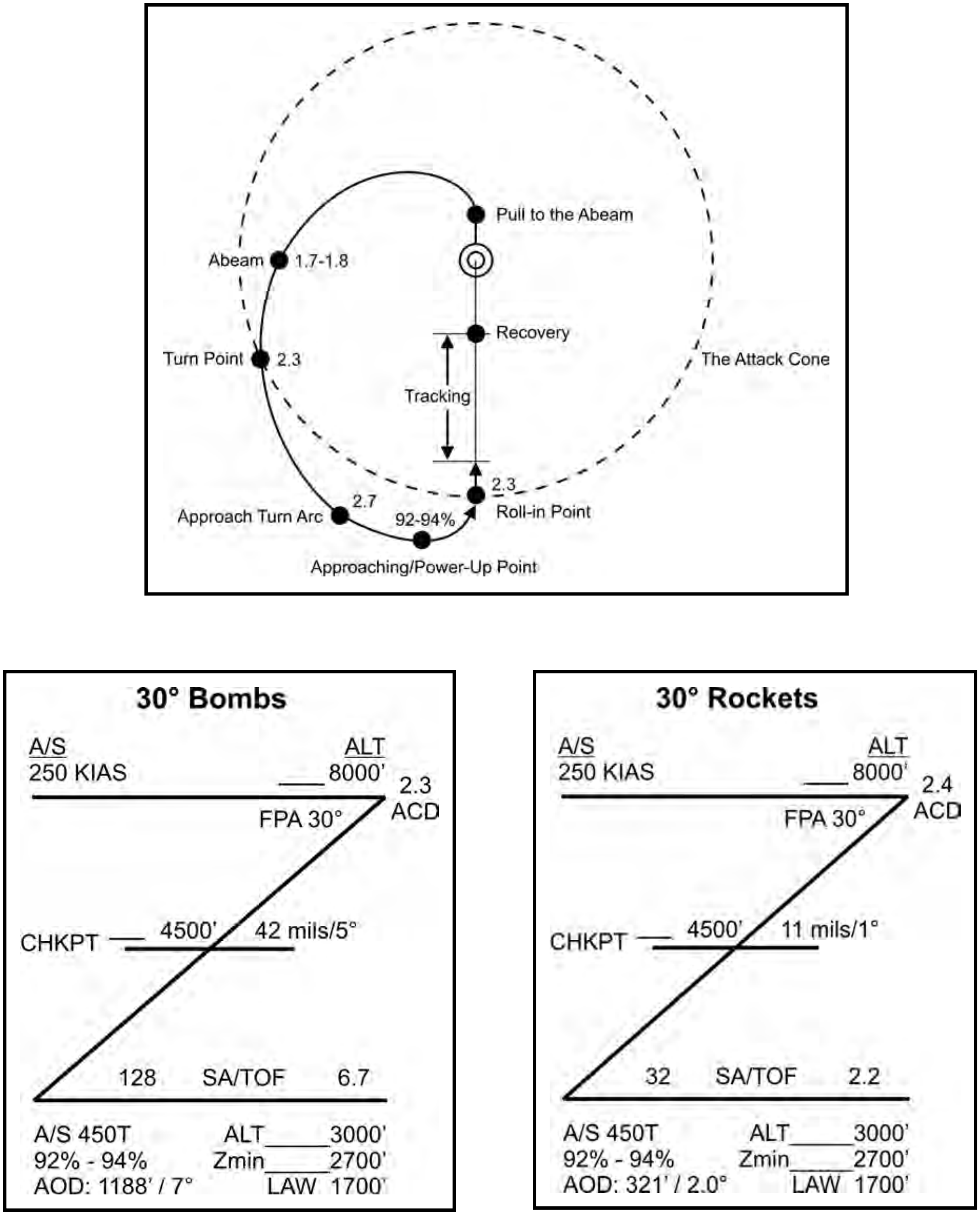


Figure 7-6 30-Degree Pattern and Z Diagrams

The "Mid" Pattern: 20-Degree

The 20-degree pattern substitutes for the 30-degree pattern when the ceiling is unsuitable for 30-degree deliveries.

Pattern Altitude/Airspeed: 6,000'/300 KIAS

Abeam: 2.0 – 2.1

Turn Point: 2.7

Approaching: 3.0 – 3.1

Attack Cone Distance (ACD): 2.7

Approaching power setting: 95% - 97%

Initial sight picture and TPA: 3^o and 5^o respectively

MIL setting: 130 mils

Release Altitude/Airspeed: 2,000'/450 KTAS

Aim Off Distance: 1541 ft. / Aim Off Angle: 7 degrees

Weather requirements: 8,500/5

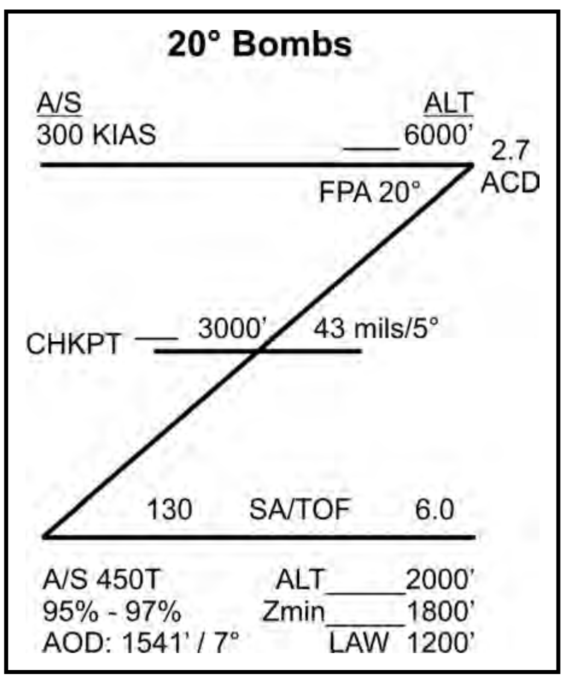


Figure 7-7 The "Mid" Pattern: 20-Degree

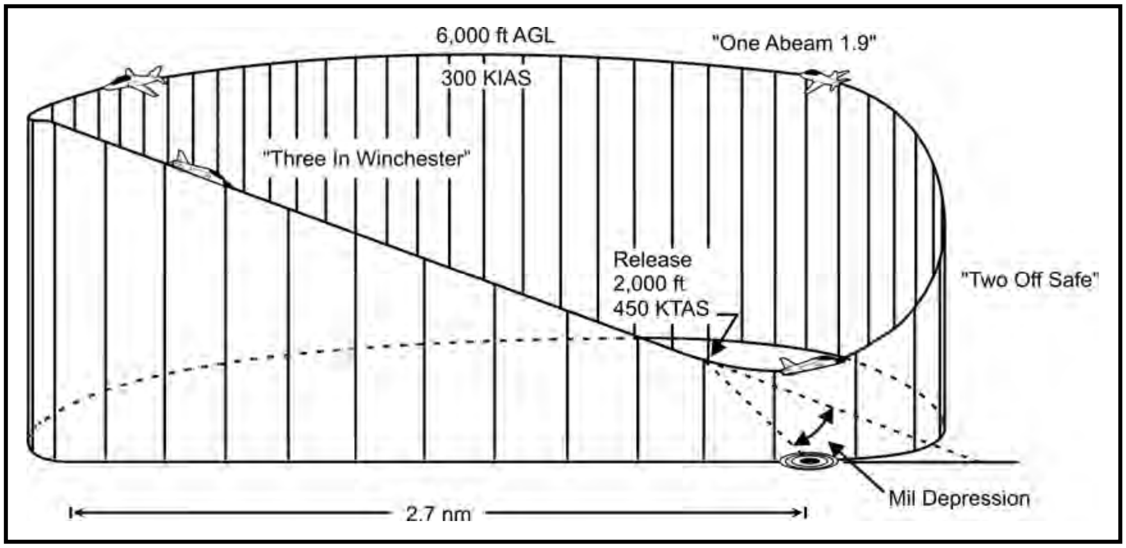
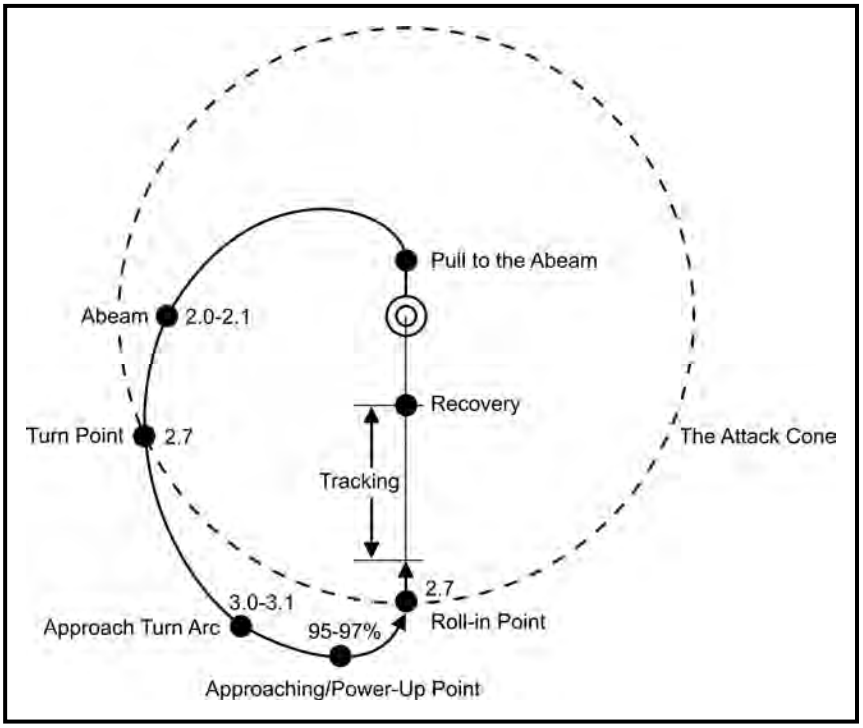
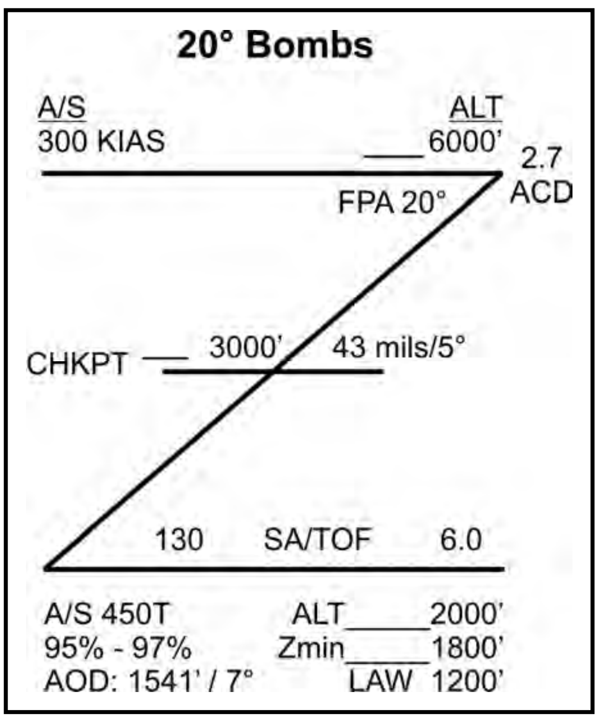


Figure 7-8 The "Mid" Pattern: 20-Degree

20-Degree Pattern and Z Diagrams





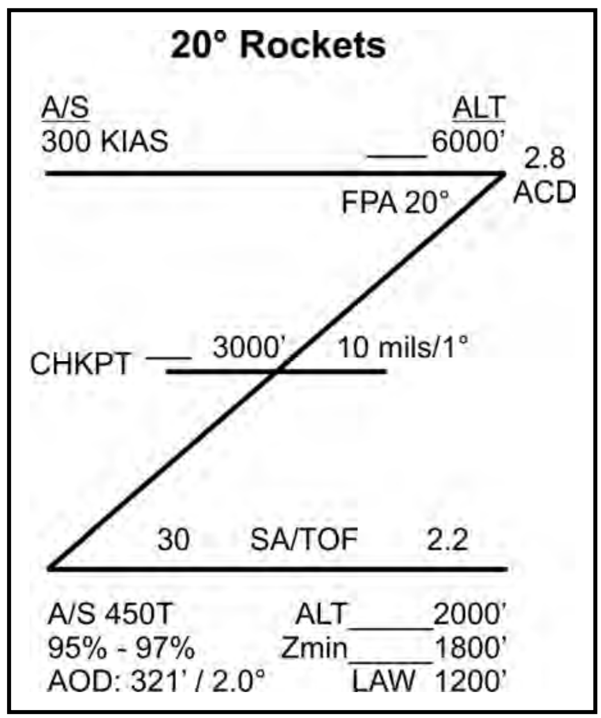


Figure 7-9 20-Degree Pattern and Z Diagrams

The "Low" Pattern: 10-Degree

The 10-degree pattern simulates high drag or forward firing ordnance deliveries. Because of the higher pattern airspeed, somewhat more g and AOB will be maintained in the pattern.

Pattern Altitude/Airspeed: 2,500'/350 KIAS

Abeam: 1.8 – 2.0

Turn Point: 2.3

Approaching: 2.7 – 2.8

Attack Cone Distance (ACD): 2.2

Approaching power setting: MRT (Just prior to roll-in)

Initial Sight Picture and TPA: 2^o and 4^o respectively

Release rpm: MRT

MIL setting: 117 mils Bombs / 47 Strafe / 26 RKTS

Release Altitude/Airspeed: 1,000'/450KTAS (Bombs)
1,300 – 1,000 (Strafe)

Aim Off Distance: 2199 ft. / Aim Off Angle: 6 degrees

Weather requirements: 4,000/5

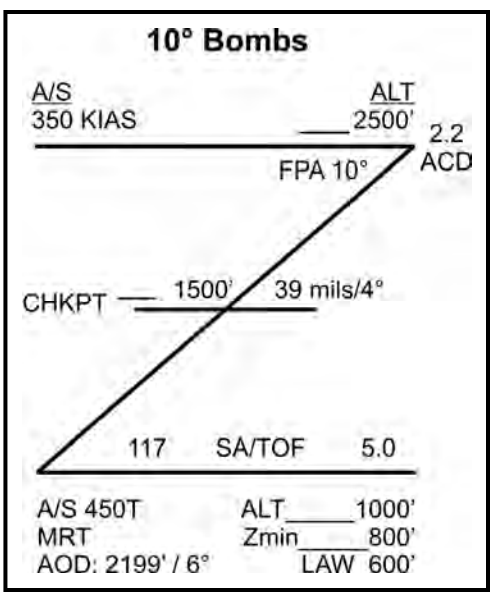


Figure 7-10 The "Low" Pattern: 10-Degree

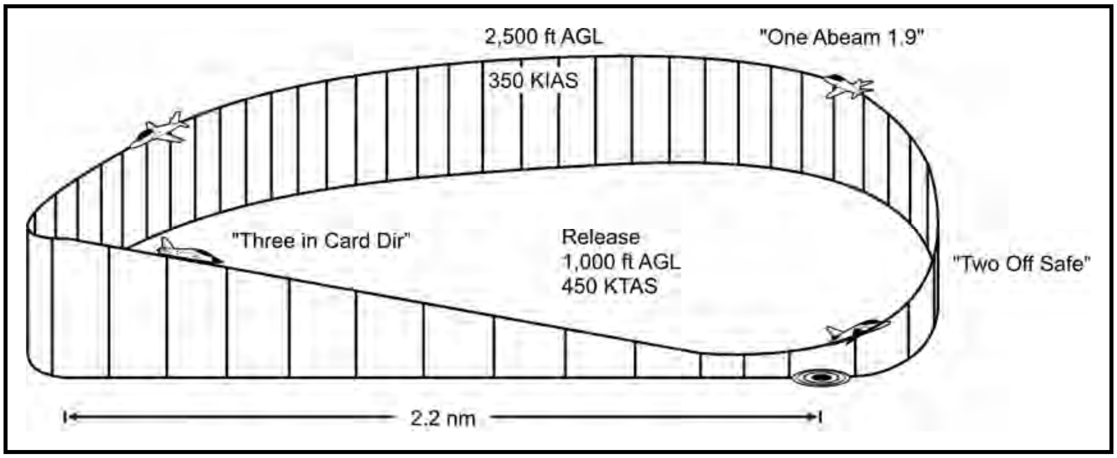


Figure 7-11 The "Low" Pattern: 10-Degree

10-Degree Pattern and Z Diagrams

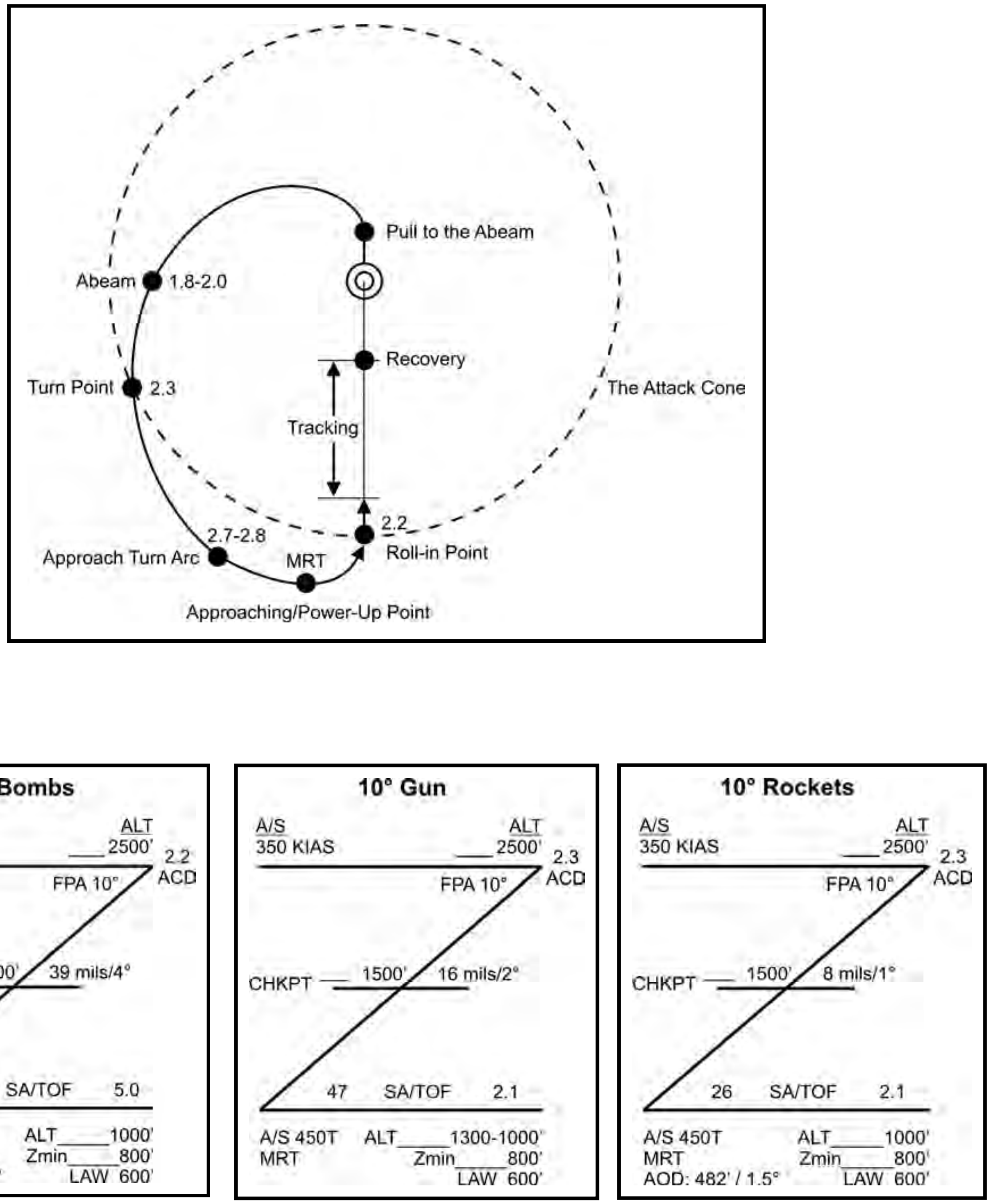


Figure 7-12 10-Degree Pattern and Z Diagrams

701. THE PATTERN ACTION POINTS – PROCEDURES (WITH TARGET WAYPOINT DISTANCE)

Now let's look at the positions in the pattern and discuss the procedures of flying the pattern as well as introduce some techniques to help you fly a more precise pattern.

The Abeam Position

Upon rolling wings-level at the abeam, the target should appear just above the canopy rail. In the aircraft, the PMBR/BRU (or middle of wing) should bisect the target.

The Abeam position is slightly inside Attack Cone and varies depending on the specific pattern flown, typically between 1.8 and 2.1 nm from the target. Just as in the landing pattern, remember, this is a visual pattern, flown by looking out the window. The T-45C has tools at its disposal which will enhance the visual pattern; we will use those tools to our advantage. Once established in the pattern, upon arriving at the Abeam, we should have about a 15 degree ground track differential from the reciprocal of the run-in line (Run-in reciprocal + 15). Arriving at the Abeam, roll wings-level and track the reciprocal run-in heading +15 degrees to the Turn Point. The use of the Ground Track Marker on the HSI for your heading reference will give you the desired pattern track, creating a wind corrected track, keeping the pattern consistent over the ground. The only time a 15° turn away at the Abeam would be required would be following the initial break or an off-target extension.

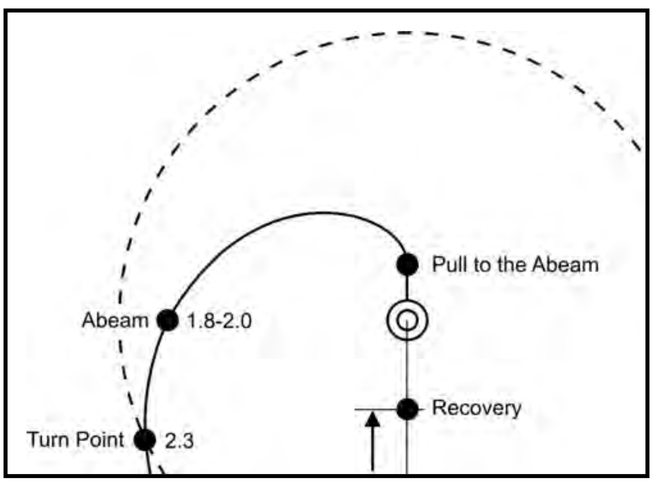


Figure 7-13 The Abeam Position

Ground gouge, when available, should be used to aid in pattern consistency. When arriving at the abeam for the first time, take notice of the land feature directly below the aircraft. It could be a T-shaped intersection of roads, small dune mounds, a pond, mountainous terrain, or just an open area. Locating this ground feature when pulling to the abeam will help you develop the motor skills required to build consistency on later flights.

Upon arriving at the abeam, take notice to the target position as it relates to the wing, then cross-reference the target waypoint distance in the HUD/HSI to build an “eyeball cal” for the proper abeam distance. Normal abeam position for the 30-degree pattern, for example, is to have the target bisect the wing at the PMBR/BRU. If the target appears to be too far out or too close in, cross-check the target waypoint distance to verify. Eventually, you will gain visual reference knowledge of what a good abeam position looks like with or without a target waypoint.

The Abeam to the Turn Point

From the Abeam position, a wings-level period to the turn point is maintained. If the proper Abeam distance is achieved at the Abeam, the standard 15 degree ground track is maintained. This ground track can be adjusted slightly based on the abeam distance achieved at the Abeam as to arrive at the proper Turn Point over the ground.

The wings-level period lasts for about 8 – 10 seconds. During this time, the target will disappear under the wing. With target waypoint distance available, the turn to the Approach Turn Arc is commenced based on distance from the target. Typically, it corresponds to the same distance as the Attack Cone Distance for the pattern flown. The distances of the Turn Point are 2.3 nm for the 30-degree and 10-degree patterns and 2.7 nm for the 20-degree pattern.

The Turn Point

The turn to intercept the Approach Turn Arc is commenced at the Turn Point. Upon rolling into an angle of bank, the target will once again reappear. At this time, locate the target and place it abeam your inside shoulder. Angle of bank is not referenced in the turn; however, around 60° AOB – calm wind – can be used as initial guidance to fly the aircraft to the Approach Turn Arc. Again, this is a VISUAL turn accomplished by referencing the <u>target</u> - complimented with quick cross-checks of target waypoint distance - to verify the accuracy of the turn. As with the Abeam distance, an “eyeball cal” of the Approach Turn Arc distance should be developed as to gain knowledge of what a proper approach turn looks like visually, with or without waypoint target distance.

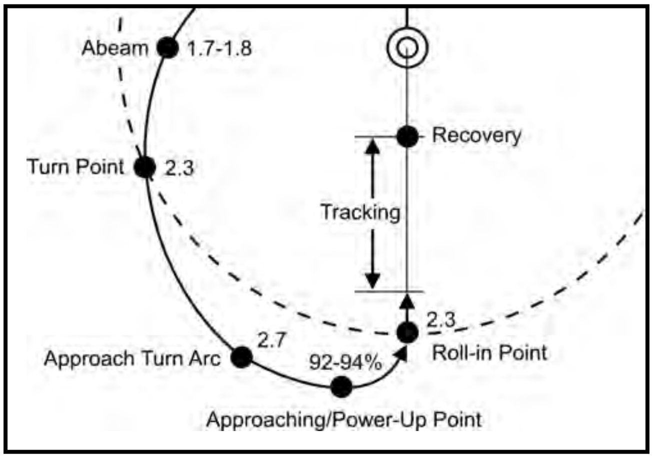


Figure 7-14 The Turn Point

The Approach Turn Arc

The Approach Turn Arc is 0.4 – 0.5 nm outside of the Attack Cone Distance or Roll-in Point. The angle of bank will need to be varied in order to maintain the proper approach turn arc distance. For the 30-degree and 10-degree patterns, this would equate to 2.7 – 2.8 nm from the target. The 20-degree pattern is 3.0 – 3.1 nm. Common errors are to over-bank too much resulting in a "tight" approaching position or not over-bank enough resulting in a "deep" approaching position.

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

The Approaching Turn Corrections

You should strive to achieve a good, consistent Approach Turn. If you find the approach turn to be off the planned numbers due to pilot error, the Approach Turn needs to be adjusted. To adjust for a pattern deviation:

1. If the approach turn is too tight (2.5 – 2.6 nm): Wings level away from the target, drive out, then hard pull to the run-in line/roll-in point.

2. If the approach turn is too deep (2.9 – 3.1): Hard pull towards the roll-in point initially, drive wings level to run-in line/roll-in point.

Remember, the overall pattern objective is to arrive at the run-in line roughly 30° off the run-in heading at the Attack Cone / Roll-in Point. Anything more or less than roughly 30°, 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

Wind at altitude will affect your pattern. You will need to adjust your pattern for strong winds. Anything less than 20 knots at altitude are considered minimal. When you start to see 30 to 40 knots or greater at altitude, minor adjustments will be required. It's very similar to the approach turn in the landing pattern.

A Headwind will cause you to be shallow. Move your approaching turn arc in slightly and roll-in slightly closer to target.

A Tailwind will cause you to be steep. Move your approaching turn arc out slightly and roll-in slightly farther away from target.

Remember, the overall pattern objective:

1. Arrive at the Run-in line *roughly* 30° off the run-in heading at the Attack Cone / Roll-in Point.

The "Approaching" Position – The Power-up Point

When a good pattern is flown 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.

Here is where you set your release power setting and place the Master Arm switch to "ARM" (with the exception of forward firing ordnance; in that case, DO NOT select Master Arm to ARM until the nose is pointed at the target).

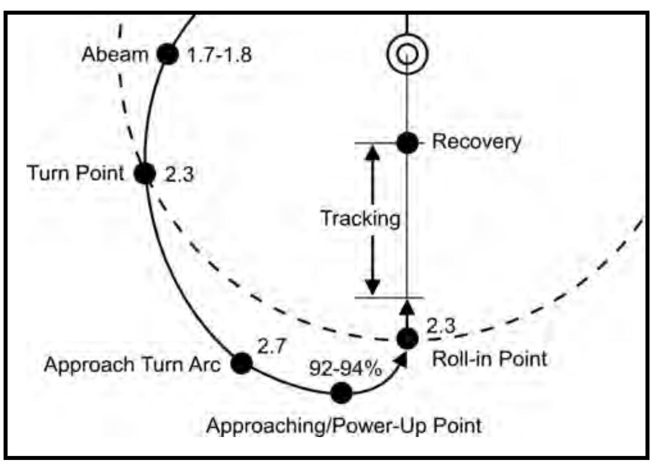


Figure 7-15 The "Approaching" Position – The Power-up Point

Powering-up at the Approaching Position – The Gouge

Set the release power setting when the nose of the aircraft is perpendicular to the run-in line, i.e. the 90° approaching position. Refrain from using the HDG bug on the HSI as a crutch to indicate the 90° position. This only promotes head's down/instrument flying. A good scan combination of the target, run-in line and roll-in point will enable you to better evaluate the pull required for you to get the aircraft to the roll-in point. Scanning the HSI / CRS Line would only be required in the event the target does not have a displayed Run-in Line on the ground.

As a Technique for setting the power: Power-up by "feel" first, place Master Arm Switch – ARM, then fine tune power setting by checking N2 gauge. This will allow for RPM spool-up time.

You should 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 30° pattern: Use 94% as the base release power setting for 250 KIAS, and adjust +/- 1% for every 10 KIAS off of 250. The Z diagram calls for 92 – 94%.

250 KIAS – 94% (simulator use 93% as the base)
260 KIAS – 93%
240 KIAS – 95%

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 450T).

One of the reasons for inaccuracy of hits is due to slow scan development of airspeed at release. Most common error is to be too fast, causing long hits, especially in the Low Pattern.

The Approaching to the Roll-in Point

Never in the pattern can this be more emphasized to be an outside/inside scan. *DO NOT* fly the aircraft exclusively referencing the instruments without referencing the target!

Extend the run-in line out visually and vary your pull to arrive at the roll-in point roughly 30° off run-in heading. Visually, 30° off equates to the outside target ring (300' ring) touching the base of canopy bow.

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

If the Attack Cone Distance (ACD) is reached prior to this point (nose more than 30° off), the approaching position was too tight. You will need to commence the roll-in at the ACD 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.

If the ACD is not reached at this point (nose less than 30° off), the approaching position was too deep. Do not continue the turn past the run-in heading / the target. The choices are to either relax the pull and slightly overshoot the run-in line or to pull to the target, roll wings level, drive to ACD and perform roll-ahead. The setback of performing a roll-ahead maneuver is losing sight of the target prior to commencing the roll-in.

The Roll-In Point (RIP) or Attack Cone Distance (ACD).

The *Roll-In Point* (RIP) or *Attack Cone Distance* (ACD) is the point at which the aircraft should start down from pattern altitude, begin the tracking run as to have the aircraft established on the bombing triangle or planned dive wire. Arriving at this point in space is the focus of flying the pattern.

The Roll-In Point or Attack Cone Distance Sight Pictures

Here are two views of the same Roll-In. The picture on the left is what we see if we were looking out the window and the picture on the right is what we see in the HUD. Notice, the nose is about 45° off the run-in heading of 045°. We have hit our ACD (2.3), so we must commit our nose low and roll-in onto the target.

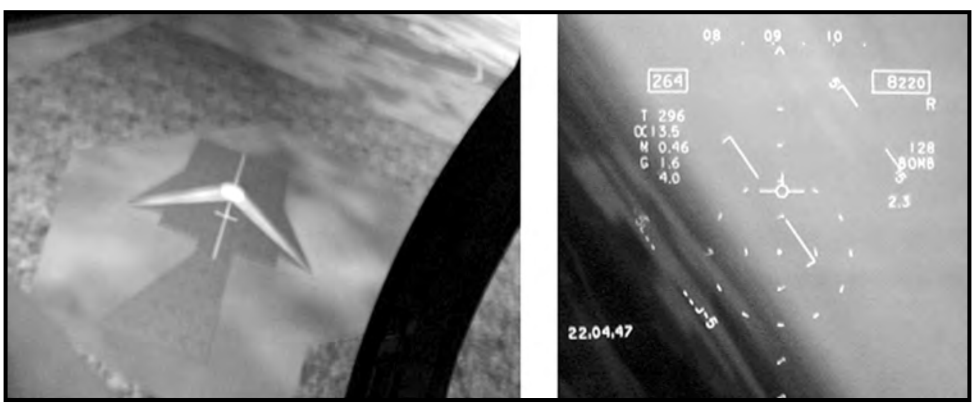


Figure 7-16 The Roll-In Point or Attack Cone Distance Sight Pictures

The Roll-In

At the Roll-In Point or Attack Cone Distance we begin our pull down to the target. This is accomplished simply by over-banking the aircraft, placing the lift vector on the target and pulling 15 to 17 units AOA, pulling the target through the standby compass, through the center of the HUD (between the Airspeed and Altitude boxes).

The Lift Vector is the top of the canopy bow. A 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, as shown here.

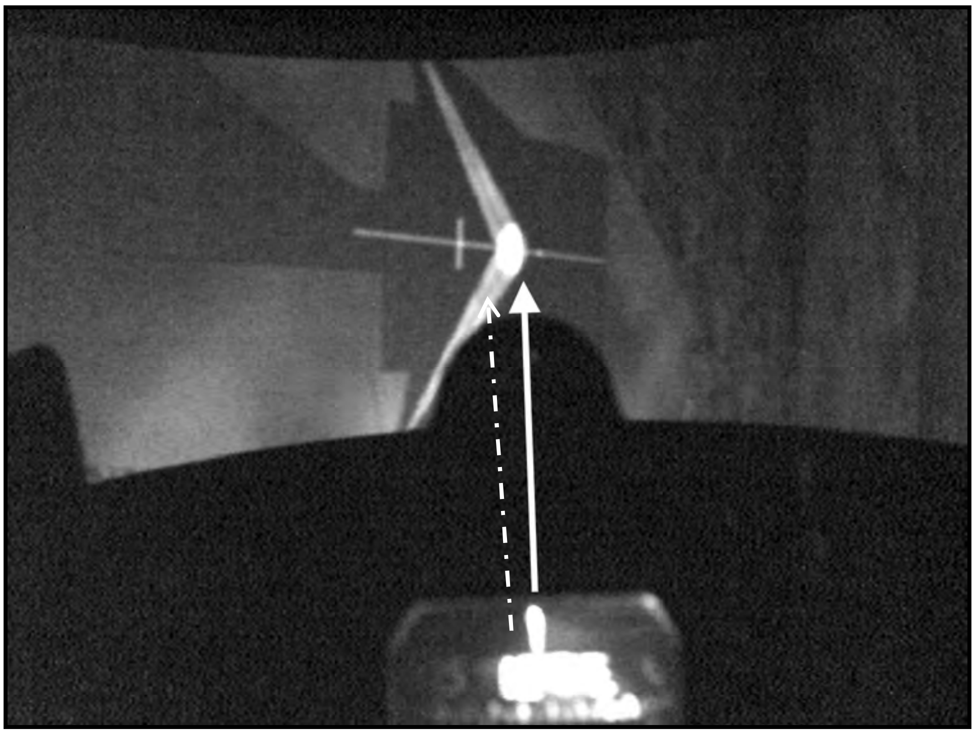


Figure 7-17 The Roll-In

It is important to develop consistency in the roll-in maneuver. When attacking the target, be smoothly aggressive. After placing the lift vector on the target, pull 15 to 17 units AOA, just under the nibble of buffet. If you encounter “pitch-buck”, you’re pulling too hard and stalling the stabilizer. If trying to be too smooth, you’ll float the pull, causing excessive altitude loss in the maneuver, resulting in loss of tracking time.

If upon roll-in the lift vector is placed above the target, the result will have the aircraft above the bombing triangle (above the wire) causing a steep Initial Sight Picture (ISP).

If upon roll-in the lift vector is placed below the target, the result will have the aircraft below the bombing triangle (below the wire) causing a shallow ISP.

An *Adaptive Roll-In* technique can be used to correct for errors at the roll-in point and will be discussed in detail in a follow-on chapter. **However, the ultimate focus of the T-45C Weapons Stage is to develop a consistent roll-in maneuver, leading to consistent results –** that being – a good initial sight picture. The initial simulator events and aircraft flights will concentrate on developing a consistent roll-in. Once consistency is proven, the *adaptive roll-in* technique can be introduced and utilized.

The Roll-out

As part of the Roll-in procedure, the Roll-out onto the target begins the tracking run. By placing the lift vector on the target on roll-in, the target will be lined up with the standby compass and the vertical center of the HUD combiner glass. It is important to keep your eyes on the target as you pull the nose of the aircraft to the target and not just focus totally on the HUD symbology. Remember, the HUD is an instrument we look *through*, not *at*.

As you pull the target into the HUD combiner, the target should travel between the airspeed and altitude boxes. Once the target is in between the boxes, briefly relax the pull and crisply roll wings level. This should line up the pipper with the target on a no-crosswind day.

With a crosswind, the above technique may not achieve the ultimate results you desire. The ultimate goal of the Roll-out is to roll wings level with the Velocity Vector directly above the target (2 ½ - 3 degrees above for straight path tracking) as well as have the target centered vertically in between the pitch ladders (as shown here). Simply “flying the Velocity Vector” above the target seems to work for most. At no time should the Velocity Vector travel below the target on the initial roll-out.

If you find the Velocity Vector traveled below the target, the cause was due to overbanking too much on the roll-in (lift vector below the target). If the Velocity Vector ends up greater than 3 degrees above, you didn’t overbank enough.

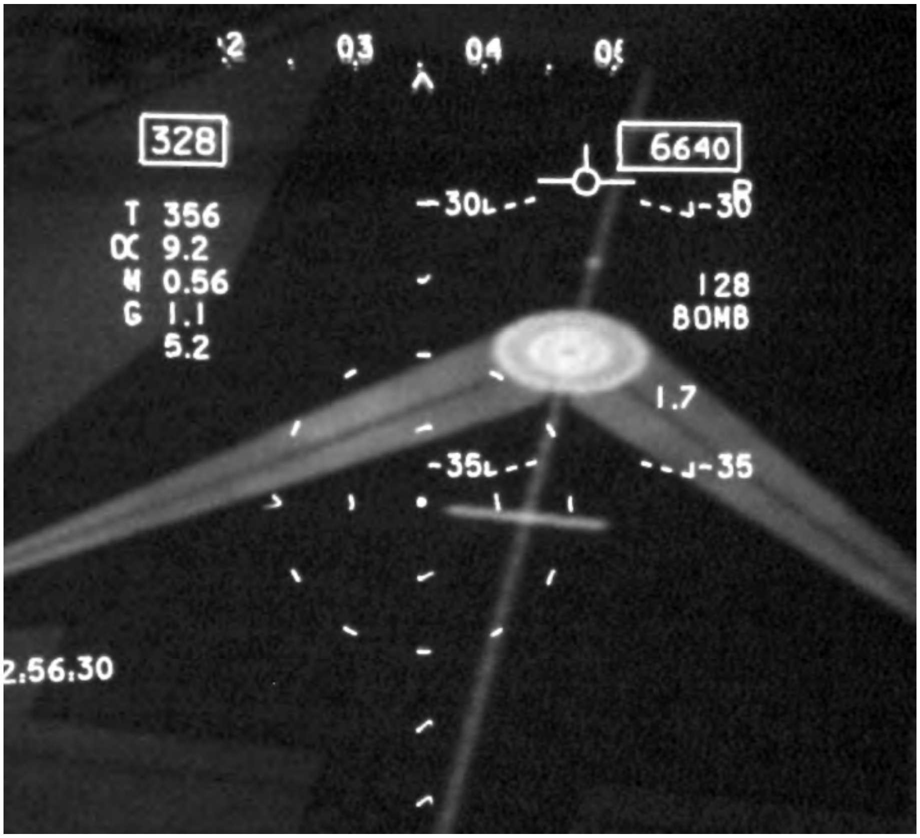


Figure 7-18 The Roll-out

For a left hand pattern, if the Velocity Vector and pitch ladders are left of the target upon initial roll-out, you rolled out too late or too slow. If the Velocity Vector and pitch ladders are lined up right of the target, you rolled out too soon or too quick.

Discussion on line-up control will be covered in detail in the following chapter.

The Tracking

Target Tracking Techniques will be discussed in detail in the following chapter.

The Recovery

Pickle, Pause, Pull, then Power. Press the weapons release button until the release tone is heard, pause, then begin the recovery. Release should be with 0 AOB and no lower than Z min for the delivery being used. Pause a half a second to allow the bomb to clear the aircraft, then smoothly apply **4 g's** wings level, with a 2-3 second gradual onset. Once the nose is established in the recovery, place the Master Arm Switch to SAFE. Once the velocity vector climbs above the horizon, apply MRT.

NOTE

In some Fleet aircraft, you will be told to add power prior to the "pull" on the recovery. The T-45C does not support this technique as it will result in excessive altitude loss during the recovery. To minimize the altitude loss, recover at the release power setting then apply MRT once the nose is above the horizon.

The Pull to the Abeam

After recovery, at a pitch attitude of 10 degrees above the horizon, ensure MRT, relax g, roll to approx. 60 degrees AOB, and initially apply 4 g's to reach the abeam position slightly inside the cone. During the turn, you will have to locate your interval (the aircraft immediately preceding you in the pattern). Procedures in the event you cannot locate your interval are given later, under "Safety." After 90 degrees of turn, maintain 2-3 g's and begin to reduce power to arrive at the abeam position on pattern altitude and airspeed. Approaching the abeam position, the g required should be reduced to approx. 1.5 - 2 g's. Use this g application as a reference for your turn, to help you understand a constant g is not maintained from off target to the abeam. The proper procedure is to fly the aircraft to the abeam position based upon the visual reference to the target, backed up with target waypoint distance (if available). The use of abeam distance ground gouge will aid in the development of the muscle skills involved in pulling to the abeam by simply flying the aircraft over a spot on the ground which equates to the proper pattern abeam distance.

702. PATTERN COMMUNICATIONS (PATTERN COMM)

This portion of the chapter will discuss pattern communications. This will be the first time, for those who have yet to fly Tac Form, which you will fly in a dynamic environment and talk at the same time. Pattern Comm is one of the four basic items your instructor will be primarily grading you on your first three flights in the aircraft. Communications while in the pattern is crucial to the safety of a Weapons flight. The old adage, "as the comms go, so goes the flight" could not be more emphasized in this stage. To become a successful Naval Aviator you must be able to talk and fly at the same time. Patten Comm is one of those items which can be extremely difficult to reproduce while in the simulator and usually a suffering point on early aircraft flights.

During this section, we will discuss the pattern comm positions, the comm cadence and sequence (who says what when), other standardized calls which are not part of the normal comm flow, and lastly, the pattern transitions.

Pattern Comm: General

Pattern Comm is extremely important on early flights. You want to be concentrating on the basics on your first few aircraft flights; Comm, Pattern, Form and OTR. Pattern Comm is tough to duplicate in Sim due to IP constraints. Get with your buddies, walk around your living room, ride bikes in a parking lot, or whatever it takes, but PRACTICE the comm prior to your first flight in the aircraft!

In Weps, there are no bonus points for proper English. Drop the S's. Example "THREE" vice "THREE'S".

On low visibility days (i.e. 5-6 sm), it can't be overemphasized how extremely important comm becomes. You will be blind almost every time coming off target on your interval and Lead needs to hear the proper callsigns of the aircraft rolling in on the target. Proper position calls accompanied by the correct aircraft callsign enhances situational awareness (SA). When the comm breaks down, so does the SA.

It's not a contest on how fast you can say it, it's how ***timely*** it is said. If you speak too fast, no one will understand a word you said. Speak calmly and clearly.

Position Calls

The position call is the most often missed call on the early aircraft flights. In the simulator, you'll call Abeam when you're at the Abeam and no other aircraft are in the pattern. Some Sim IP's will do their best to simulate the comm, but it is usually difficult to simulate other aircraft communication and instruct you at the same time. The best way to not miss a call is to anticipate your call when you are pulling to the Abeam. To assist you in knowing when the aircraft behind you is calling off, try and locate the aircraft in the dive, this will enhance your overall situational awareness in the pattern. Obviously, you need to find your interval first or take the precautions to avoid running into your interval by executing the lost interval procedures if blind.

The position call is based on your position in the pattern. It is associated with the location of your aircraft in the "piece of the pie" at the time you make the call. The positions in order of flying the pattern are: Crosswind, Prior, Abeam, Past, and Approaching. Prior is sometimes confused with Approaching. Prior or Past are references to the Abeam position.

If you find yourself in between two positions, the safe bet is to call the previous position, such as: if you find yourself between Prior and Abeam, call *"PRIOR"*.

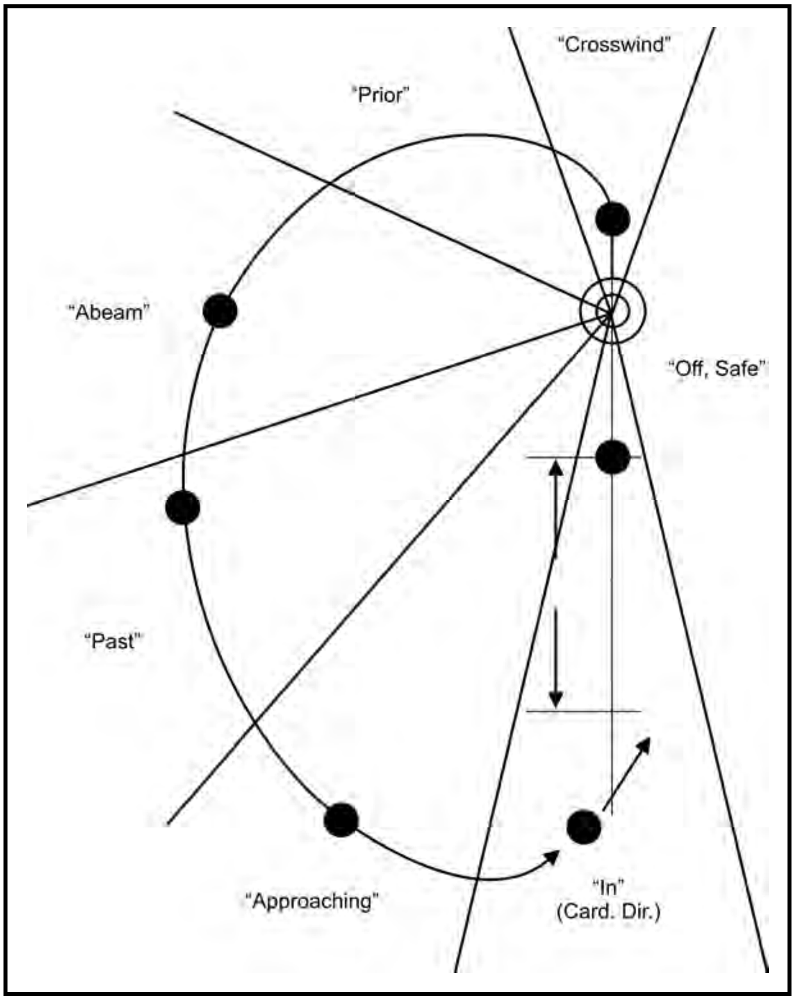


Figure 7-19 Position Calls

The Comm Cadence

There is a specific order in who says what, when they say it in the pattern. It has a cadence to it when the pattern is flowing well. Listen up! Wait for your time to speak and only speak when it's your time to talk.

The one who initiates the comm sequence is the one calling "OFF, SAFE". The "OFF, SAFE" call is immediately followed by the aircraft ahead of the "OFF" aircraft. The aircraft ahead of the "OFF" aircraft calls its current position relative to the target with its fuel state. Then the "IN" call, with the direction the aircraft is rolling in from (such as N, NE, E, SE, S, SW, W, and NW), can be given. If there is someone scoring the hits, whether it's Lead, other IP's, or the scorer on a scored range, the score usually follows the "IN" call.

Sample Comm Flow/Sequence:

FOUR: *"Four off safe."*
THREE: *"Three abeam, one point eight."*
LEAD: *"One in West."*

TARGET: *"Roger, one."*
TARGET: *"Four, your hit: one five zero at three thirty."*

If the flight is a four plane, there will always be one aircraft that remains quiet. It is the aircraft between the position call aircraft and the "IN" aircraft. In a three plane, 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 you will hear or possibly make while in the pattern are as follows:

"IN" Call.

Given after the position call and includes the direction from which the aircraft is rolling in from. It is the reciprocal direction of the run-in heading. *"IN, (Card. Dir.), COLD"* means you have no intention of dropping on that pass.

"WINCHESTER"

The *"WINCHESTER"* call is made on the *"IN"* call on the run following your last bomb expended. This call lets Lead or the scorer know you have no more bombs remaining. In doing so, the scorer knows not to look for anymore impacts from your aircraft. Lead usually marks you off in some form and it helps Lead in his planning for pattern transitions and/or Off Target Rendezvous.

"OFF, SAFE, NO DROP"

The *"OFF, SAFE, NO DROP"* is a good call on to make on your *"OFF"* call if you did not drop on that pass. This way the scorer does not have to waist time expanding his search looking for an impact outside the immediate target area.

"CROSSWIND" and *"EXTENDING"*

If at anytime the aircraft which calls *"CROSSWIND"* as it's position call, the *"OFF"* aircraft will immediately follow the "CROSSWIND" call with *"(callsign), EXTENDING"*, then the *"IN"* call can take place.

When extending off target, continue your nose up pull until your Flight Path Vector reaches 20 degrees, pause about 2 seconds, then continue with your pull to the Abeam. Normally, by the time you call *"EXTENDING"* you can almost start your turn to the Abeam. You DO NOT need to wait until your interval is abeam you before you begin your pull to the Abeam.

"SAY POS"

If you are pulling to the Abeam and you have lost sight of your interval, normal procedure is to continue flying the pattern. DO NOT EXTEND! Continue to fly the pattern with the exception of altitude. Remain 2,000' below the High and Mid patterns and 1,000' below the Low pattern until at the Abeam position. If you are still blind on your interval, call *"(your interval's callsign) SAY POS"*. If your interval responds with *"(callsign) APPROACHING"*, you are now de-conflicted by position, therefore, you can now climb up to pattern altitude. In doing so, you will then acquire sight of your interval. If your interval responds with *"ABEAM"* or *"PRIOR"* remain in your altitude sanctuary for lost interval, get your head on a swivel, look all around, fly your aircraft to get established in a better position.

"ABORT, ABORT, ABORT"

If you hear *"ABORT, ABORT, ABORT"* and your nose is pointed at the target. Place the MASTER ARM switch to the SAFE position while simultaneously, begin your off target recovery. Have situational awareness of where you are. If someone calls "ABORT" as you are just rolling wings level in the dive, you might not need to be overly aggressive on your recovery. If, however, someone sees your aircraft pressing the target and your LAW tone is going off, get the pull on.

This leads to the proper procedure for aborting the run. If someone calls "Abort" and it is you who needs to abort. Immediately recover the aircraft from diving nose low to either level flight or to a slightly climbing attitude. Call *"(callsign), ABORTING"* Reduce power as required to slow to pattern airspeed, continue to fly over the target flying the pattern track over the ground, once over the target, make your *"OFF, SAFE, (NO DROP if applicable)"* call and continue with the pattern.

"ABORT" calls are made by aircraft other than the one in the dive. It is almost always for a safety of flight issue. Some things that come to mind are interlopers that compromise safety. We have seen other aircraft (civilian) wander into the target area as

well as people wander into the target area (motorcycles, ATV's). If you abort a run due to one of the mandatory abort criteria, there is no need to call *"ABORTING"* to everyone. Keep flying the aircraft within safe parameters, safe up the system, call *"OFF"* when it is time to and continue to fly the pattern.

"JOKER" and *"BINGO"*

The *"JOKER"* call is made in conjunction with your position call. Lead will acknowledge the call and have the entire flight "*RESET BINGO"*. Once one aircraft calls JOKER, there should be no others calling it. One call is good for the entire flight since the flight can only fly as long as the aircraft with lowest fuel state.

If you hit *"BINGO"* while still in the pattern, call it out at anytime. There is no need to call out *"BINGO"* when executing the Off Target Rendezvous. You are on your way home at that point. However, if you find yourself in a situation where you NEED to put the needle on the nose to execute an immediate BINGO profile, call it out and do it.

Instructor Note: Have students to reset BINGO setting when they are within 100 lb of JOKER. They should know that 1.2 for example equals "JOKER". When they get to the position call with 1.2, they call "JOKER" not 1.2. You do not need to wait for the BINGO to flash to report "JOKER". If they get to the position call with less than "JOKER" and "JOKER" has yet to be called, then they will report "JOKER MINUS ONE (as applicable)" Also, this will prevent the BINGO from going off on the first run in the 10 degree pattern and prevent an aborted run.

"IN, (Card. Dir.), CCIP"

The *"IN, (Card. Dir.), CCIP"* is a call to let Lead know you are dropping in the CCIP mode. CCIP hits are not counted in your overall CEP. Some of our aircraft are not properly boresighted and drop long, so unless you want bad hits in your CEP, it'd be wise to state that you are dropping in the CCIP delivery mode.

"SIMO RUN, SIMO RUN"

A *Simo run* is a condition when you have two aircraft occupying the same piece of sky not knowing that the other aircraft is there. The name results from two aircraft simultaneously running on the same target or attacking the target at the same time. Aircraft collision would be immanent. Although a Simo Run can take place at any point in the Weps pattern, there are two places in the pattern in particular which it is more likely to occur; those being the Abeam and the Roll-in.

A Simo Run at the Abeam occurs when the "OFF" aircraft sees an aircraft at the Abeam, thinks it's his interval and pulls to the Abeam referencing that aircraft when in fact his interval is actually Prior or Crosswind. This is also where calling the proper position on your position call is crucial to Situational Awareness.

The other place a Simo Run is likely to occur is at the Roll-in. When one aircraft flies a deep pattern or goes deep to avoid a cloud at the approaching, the following aircraft either flies a tight pattern or cuts inside that same cloud, the flowing aircraft is “belly up” to the first aircraft and the first aircraft is looking at the target.

If you hear “SIMO RUN” while in the pattern, first step is to clear the airspace around you. If you are in a nose low attitude, level your wings and smoothly pull to a clear piece of sky above you. Look all around and whoever called it can direct the two aircraft involved.

703. PATTERN TRANSITIONS

The T-45C Weapons syllabus is designed to introduce to you the basic procedures and techniques of delivering practice ordnance from a “high” dive and a “low” dive. For the majority of the syllabus, you will be required to deliver your ordnance from the highest available pattern. There may be times when the weather will preclude you from delivering from the “High” pattern; therefore, the “Mid” or “Low” pattern may substitute. For this reason, and when the weather is favorable, we practice the transition to the lower pattern on every flight. As specified by the MCG, a typical flight will start out in the “High” pattern and transition to the “Low” pattern.

Pattern Transitions – The Comm

There are calls made going “IN” and coming “OFF” during the pattern transition. Bottom line, say what ONE says going in, say what ONE says coming off. Normally, to initiate the transition of patterns from the High Pattern to the Low Pattern, lead will say “*ONE, IN, (CARD. DIR.), HIGH TO LOW, HIGH TO LOW*” followed by: *“ONE, OFF SAFE, LOW PATTERN”*. Substitute *“MID”* in place of “LOW” if transitioning from the High to the Mid pattern.

Pattern Transitions – The Procedures

You may be *“WINCHESTER”* on the transition. If so, call it.

Normal recovery altitude from the 30 degree pattern is around 2,000’ agl. Your new pattern altitude is only 2,500’ agl; you only have 500’ or so to climb. Once the Velocity Vector is slightly above the horizon (about 2 to 4 degrees), relax, roll, start the turn, reduce power and begin a slight climb to the 10 degree pattern altitude. Once established in the pattern, a nose high attitude of 10 degrees nose up will suffice when pulling to the abeam; i.e. the same going up as is the same going down.

If transitioning from the High to the Mid patterns, pull to the abeam as if in the High pattern with the exception of only 20 degrees nose up vice 30 degrees; the same as the pattern transitioning to going down.

WATCH FOR ROLLING PULLS in the Low pattern!!!! This is where you can easily overstress the aircraft with rolling pulls. Always stop your roll prior to applying g on the aircraft.

“RAM” Checks

Three major things to do when transitioning patterns:

1. **Don’t climb above the new pattern altitude**

2. **Reset the LAW (Radalt) And**

3. **Reset the Mils/sight angle.**

After making your position call, verify the “RAM” checks have been completed. This also is a good time (if not previously done) to update the BINGO setting to prevent the Bingo “caution” from illuminating during the first run, causing you to abort.

704. OTHER PATTERN PROCEDURES

Fixing the Pattern Interval

To some extent as in the landing pattern, the pattern interval is adjusted during the off target pull to the abeam. When the pattern is flowing properly with four aircraft, one aircraft is calling off the target, his interval is “abeam” and the following aircraft is calling “in” and the remaining aircraft (silent) is between the “abeam” aircraft and the “in” aircraft. If coming off target your interval is other than “abeam”, you will need to adjust your pull to the abeam accordingly.

Normally, you will recover from the dive, come off target until your nose reaches 10° nose up, relax, roll, pull to the abeam. If your interval calls, “Past” or “Approaching” you will need to start the turn to the abeam sooner, cutting down the distance or close the gap between you and your interval. If your interval calls “Prior” or “Crosswind”, you will need to delay the turn to the abeam to generate a bigger gap as well as prevent the two of you from meeting at the abeam at the same time, which as previously mentioned, is also known as a *Simo Run* at the abeam.

A common technique to help you understand this concept is to use the pitch ladders as a reference for your turn. Upon calling “off safe”, listen for the position call from your interval. If the interval calls “past”, stop the initial off target pull at 5° nose up, relax, roll, and pull; “Abeam” - 10° nose up; “Prior” - 15° nose up; and “Crosswind” - 20° nose up, pause, call “Extending” and start the turn.

Bottom line, if there is a large gap between you and your interval, you need to start the turn to the abeam sooner. To increase the gap if you are tight on your interval, extend and turn later.

The Off Target Rendezvous (OTR)

During the final run, the flight lead will call *“One In cold (Card. Dir), last pass, last pass.”* Coming off target, the lead will call *“One off safe, off-target rendezvous,”* and will normally continue straight ahead while climbing to the pre-briefed rendezvous altitude and slowing to 250 KIAS. Other flight members repeat the call as they come off target, adding to the call the total number of aircraft they have in sight. A typical call would be, *"Three off safe, off-target rendezvous, two in sight."* If blind on everyone, say *"(#) off safe, off target rendezvous, Blind."* Once sight is gained, update your status to lead until you have the required number of aircraft preceding you in sight. Example: *"Four has three in sight."*

When -2 calls off, lead will begin a 250 knot, 30-degree AOB turn in a pre-briefed direction, usually in the same direction as the pattern. Finding the lead can be a daunting task, but knowing where to look will help you efficiently gain sight. As -2 comes off target, lead should be at the 12 o'clock to 11 o'clock position. As -3 comes off, lead should normally be about the "prior" or 10 o'clock position. As -4 comes off, lead should normally be at 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, which is 500 ft below the preceding aircraft, and performs a standard CV rendezvous on lead. 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, until everyone has joined. It is not required or is it desired to wait until the preceding aircraft is fully joined before leaving your altitude sanctuary.

For example: During the OTR, -2 has gained fuselage alignment and relatively on bearing, -2 now can vacate its altitude sanctuary and climb to lead's OTR altitude. Once -2 vacates its altitude, -3 can now step up to -2's old altitude and -4 to -3's old altitude, and so on, until all aircraft have either joined or are established on bearing and altitude.

If you come off target and do not have your interval in sight, climb to your sanctuary altitude and begin a 250 knot, 30-degree AOB turn in the direction of the flight until you regain sight. Lead should give his position relative to target positions (prior, abeam, past, etc.) or will give it relative to the target waypoint ("2.3, SW"). DO NOT delay your climb while looking for your interval.

At the rendezvous, you should have expended all your ordnance. If you have not done so, plan on performing a Hung (unexpended) Ordnance Approach. Rockets must be released prior to the last run as you must not fire forward into the rendezvous – the last rocket run is always cold.

Hung Ordnance Check / "Fenced Out" Call

The hung ordnance check is made during the off-target rendezvous. On the join-up, the flight typically joins crossing under to Parade Turn Echelon Away, as in Division Form B&R's. In this case, -2 will checkout lead on the cross-under; -3 checks out -2; lead checks out -4 prior to the cross-under; and, -4 checks out -3 on the cross-under. The flight lead places the flight in cruise at which time -2 balances the formation. Upon lead's command, the flight members check in and report *"(#) Fenced Out, (Highest g pulled), (fuel state)"*; -4 adds *"Flight's Clean"* or states which aircraft have ordnance remaining. The aircraft with ordnance remaining will then communicate to lead whether or not the ordnance remaining is actually hung or unexpended. This information is helpful to lead's flight path planning, to Tower/Ground and to Maintenance Control. Either way, in the event of ordnance on board, plan on executing a HOA/straight-in approach.

If for some reason the OTR precludes the flight from joining in parade turn away, such as joining in a running rendezvous, it will be the responsibility of -4 to check the flight for ordnance.

It is also important to mention, the purpose of the Hung Ordnance Check is not only for checking each aircraft for ordnance remaining. This check is sometimes referred to as an *Integrity Check*. When checking over an aircraft, you are checking for all items such as loose panels (gear pin door, refueling panel, access panels), frag damage, and / or bird strike damage, just to name a few.

705. POP-UP ATTACK PATTERN

There are times in combat when you will arc around the attack cone prior to rolling in, usually while providing cover to your wingman while he is attacking. Most times, however, you will intercept the attack cone from an ingress heading and just pass briefly through it. Your first look at this will come in the pop-up pattern, where we practice ingressing from low altitude and popping up to the attack cone. The methods and patterns of getting to the roll-in point vary slightly between the two “Styles” as described below. The objectives, dive parameters and off target procedures all remain the same.

“Navy Style” 30/30 Pop-to-Attack Pattern

Unlike the standard weapons pattern, the pop-up pattern is a long racetrack pattern. The pattern is 1,000 AGL. When initially entering the pattern, wingmen will perform a level break at a15-second interval to provide extra spacing in the pattern. The abeam position will be slightly wider than the standard 2 miles. At the beam, track outbound on the reciprocal of the run-in heading for 35-40 seconds. Perform a level 90-degree turn towards the run-in line and roll out. Approaching the run-in line, add power to MRT and execute a 15-17 unit level turn inbound to arrive over the run-in line with the target approximately 4 miles off the nose. Adjust altitude to ingress toward the target at 700-1,000 AGL. Do not arm the Master Arm switch until your nose is pointed at the target!

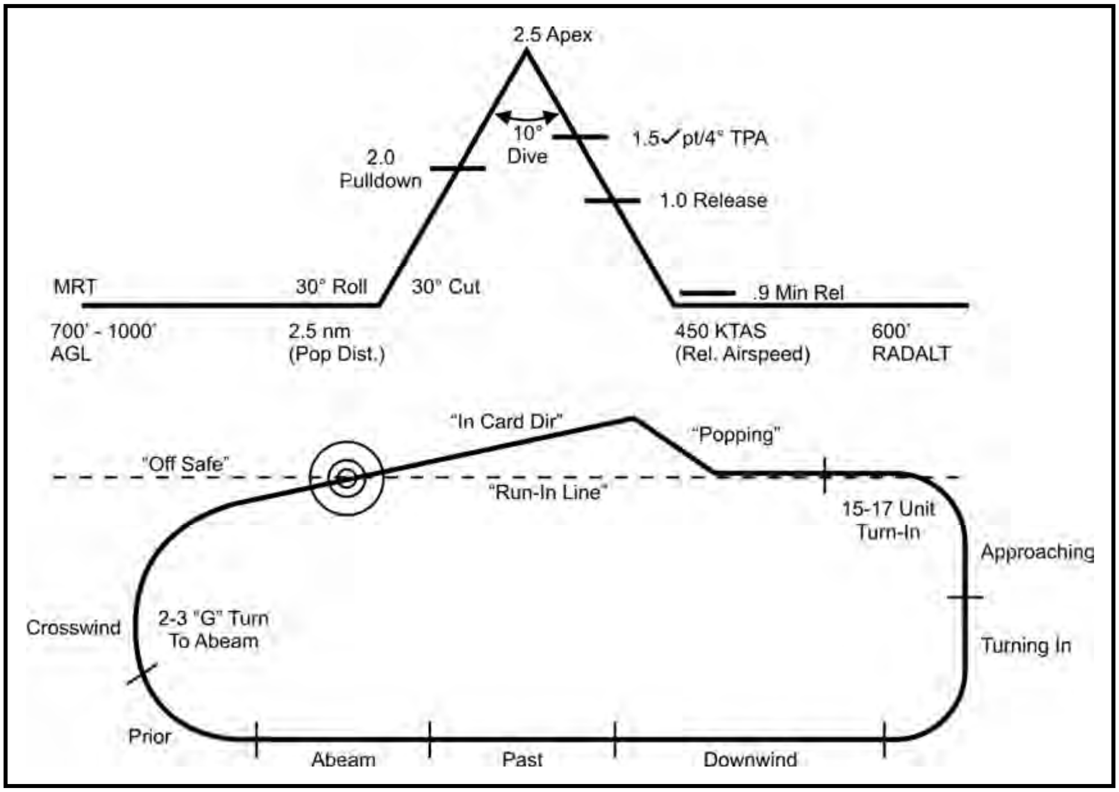


Figure 7-20 "Navy Style" 30/30 Pop-to-Attack Pattern

"Navy Style" Pop Mechanics

The pop is designed to quickly elevate you from ingress altitude to roll-in altitude. The pop is offset to one side so that you can keep the target in sight while climbing. To perform the pop, ingress to the target level at 700-1,000 AGL. At approximately 2.5 nm, the target will be about 5 degrees down in your HUD. With the power still at MRT, roll 30 AOB away from the pattern and pull the nose 30 degrees up using a17-unit 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 2,000 AGL, roll to put your lift vector on the target and pull down to establish the aircraft in a 10-degree dive. The amount of time between rolling wings level in the climb and initiating your pull down into the target is only a few seconds. This maneuver should put you in a standard 10-degree dive toward the target over the run-in line.

"Marine Style" 30/30 Pop-to-Attack Pattern

The "Marine Style" Pop Pattern differs slightly than the "Navy Style" Pop Pattern in that the Final Attack Heading to the target will attempt to be as close to the Run-In Line as possible, vice beginning the run on the Run-In Line and popping/offsetting off it.

The “Marine Style” Pop Pattern somewhat resembles the standard weapons pattern, with the exception the pop-up pattern has a longer downwind leg from the abeam. The pattern altitude is 1,000 AGL. When initially entering the pattern, wingmen will perform a level break at a 15-second interval to provide extra spacing in the pattern. Initially out of the break, parallel the run-in line until at the abeam. The abeam position will be close to the standard abeam distance of the 10 degree pattern - around 2 nm. At the abeam, track outbound on the reciprocal of the run-in heading plus 15 degrees (rounded to the nearest 5 degrees), utilizing the Ground Track Marker to provide a wind corrected ground track. Continue this ground track to 4.0 nm from the target (without target waypoint distance timing is required for 35-40 seconds from the abeam). Perform a 12 unit AOA level 90-degree turn towards the run-in line and roll out for about 2 seconds to clear the turn. Add power to MRT and execute a 12 unit AOA level turn inbound to place the target on the nose approximately 4 nm. Adjust altitude to ingress toward the target at 700-1,000 AGL. Do not arm the Master Arm switch until your nose is pointed at the target!

“Marine Style” Pop Mechanics

The pop is designed to quickly elevate you from ingress altitude to roll-in altitude. The advantage of the “Marine Style” pop is the ability to keep the target area in sight throughout the entire maneuver. To perform the pop, ingress to the target level at 700-1,000 AGL. At approximately 3.3 nm, with the power still at MRT, perform a level 30° turn away from the pattern, roll wings level, *briefly* pause and pull the nose up (smoothly, but aggressively) to 30 degrees using a **4 g / 17 unit** pull. Reaching 30 degrees nose up, cross-check the target and run-in line. Passing 1,900 AGL, roll to put your lift vector on the target and pull down to establish the aircraft in a 10-degree dive. The amount of time between the climb and initiating your pull down into the target is only a few seconds. This maneuver should put you in a standard 10-degree dive toward the target over the run-in line. Adjust the pop distance as required on subsequent runs to get as close to the planned release flight path angle of 10 degrees.

“Marine Style” Pop-to-Attack Z Diagram and Pattern

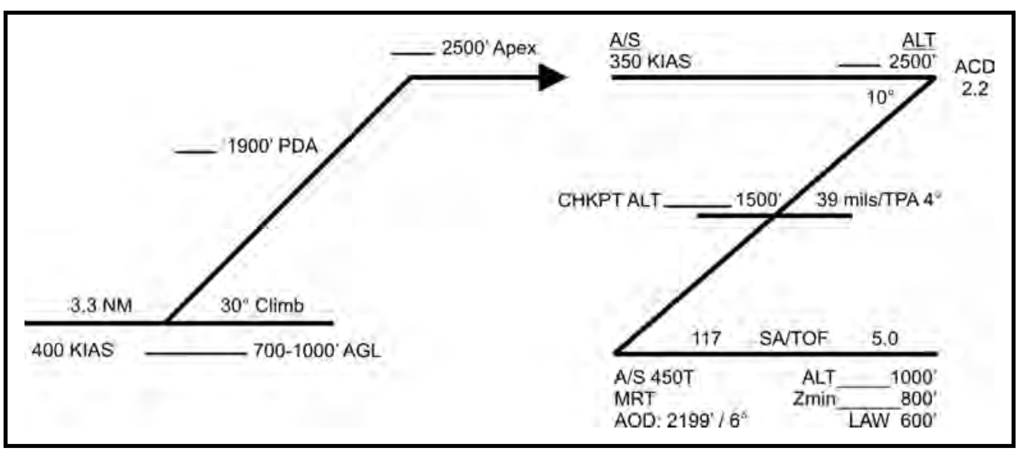


Figure 7-21 “Marine Style” Pop-to-Attack Z Diagram and Pattern

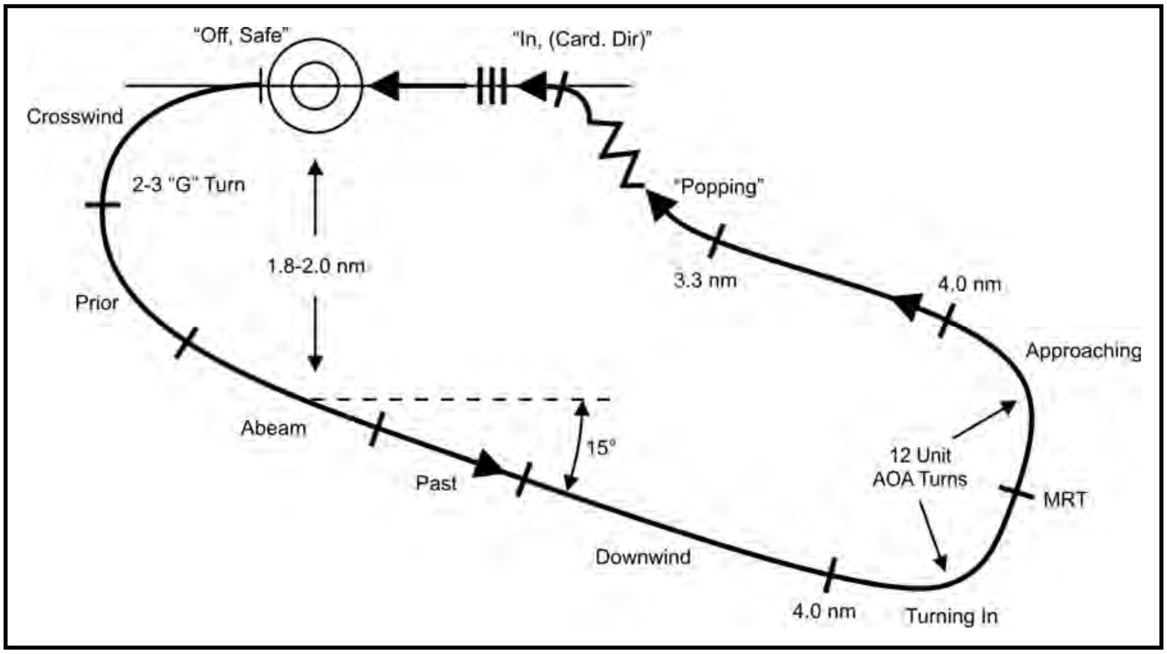


Figure 7-22 "Marine Style" Pop-to-Attack Z Diagram and Pattern

Contingency "Marine Style" Pop-to-Attack Z Diagrams

There may come a time when you are range-space limited and cannot achieve a 450 KTAS at release. Here are some additional Z diagrams for the use for your target attack planning purposes:

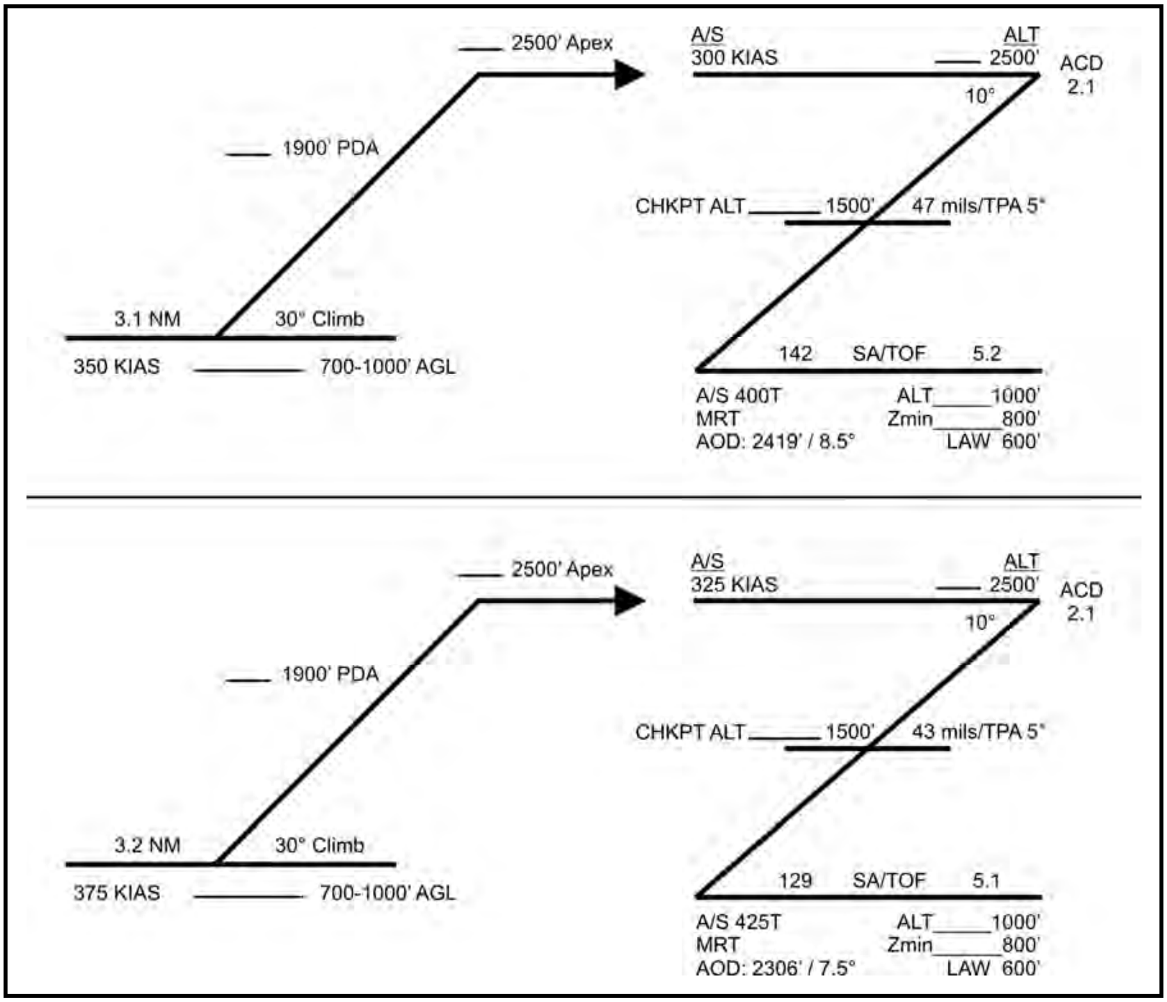


Figure 7-23 Contingency "Marine Style" Pop-to-Attack Z Diagrams

Target Tracking

The rest of the run is conducted exactly like your low pattern run-ins, except that during your pop-up sorties you will be bombing using CCIP mode. In CCIP, the computer will help you correct for any deviations in dive angle, airspeed, and release altitude; however, the closer you are to the planned parameters, and the smoother you fly, the better hits you will get. Do not just "slime it in there" and hope that the computer will do all the work for you or your hits will suffer. Any significant longitudinal stick inputs during the final seconds of the tracking run are likely to cause large deviations in your hits. Fuel can be critical on these events so make every run count.

Off-Target

After release, recover straight ahead to 1,000 AGL, make your off call, and perform a level 2-3 g turn to the abeam at 1,000 AGL. Adjust for gaps in the pattern by “cutting the corner” during the turn to the abeam or extending slightly if you are too close to your interval.

706. COMMS

In the pop-up pattern you will use the same calls you made in the standard weapons pattern but with the addition of the “downwind,” “turning in,” and “popping” positions. The aircraft coming off-target initiates the sequence with his *“off”* call, and the interval follows with his *“abeam”* call. Due to the extended spacing in the pop-up pattern, the interval will normally be past abeam or downwind. The aircraft coming in will call *“turning in,” “popping,”* or *“in Card Dir”* as appropriate.

Example Pop-Up COMM

THREE: *“Three off safe”*
TWO: *“Two downwind, 1.6”*
FOUR: *“4, Popping”*
FOUR: *“4 in Card Dir.”*
TARGET: *“Roger 4, three your hit one two two at nine”*

De-Confliction/Lost Interval/Lame Duck

Due to the low altitude of the pattern and the extended interval between aircraft, de-confliction in the pop-up pattern is done primarily via comm. If your interval is prior to the abeam when you call off, you should extend off-target to increase your separation. If you don’t have sight of your interval during the turn to the abeam, climb above 1,500 AGL. Rolling out abeam, if you still don’t have your interval in sight, ask for his posit. Once sight/SA is regained, descend wings level back down to pattern altitude. Do not descend in a turn. As in the low weapons pattern, the lame duck pattern will be flown 1,000 ft above the briefed off-target rendezvous altitude.

Off-Target Rendezvous

Procedures for the off-target rendezvous are identical to those for your previous weapons sorties. You should realize, however, that due to the increased interval in the pop-up pattern, you can expect to have to work off a lot more angles during the rendezvous because lead will be further around the turn circle than usual.

NOTES

CHAPTER EIGHT
DELIVERY PROCEDURES AND TRACKING TECHNIQUES

800. INTRODUCTION

In this section we'll cover the Attack Cone and Attack Cone Distance or Roll-In Point, review the Z Diagram, and introduce target depression angles, initial sight pictures, setting the target placement angle and basic target tracking techniques.

The Attack Cone Distance (ACD) or Roll-in Point (RIP)

Depending on the community you go to or the background of your instructor, you will hear these terms used synonymously. The Attack Cone is the shape which is created based on the aircraft's altitude and distance from the target which at any given point on the cone, the aircraft can roll in and establish the planned dive angle. In a low threat environment, one, two, three or four aircraft can literally arc around the target on this cone and could take turns rolling in and delivering ordnance onto a target. The only time this can be performed is in a low threat type of environment as well as in a training type of environment. This is almost never used in any type of tactical scenario.

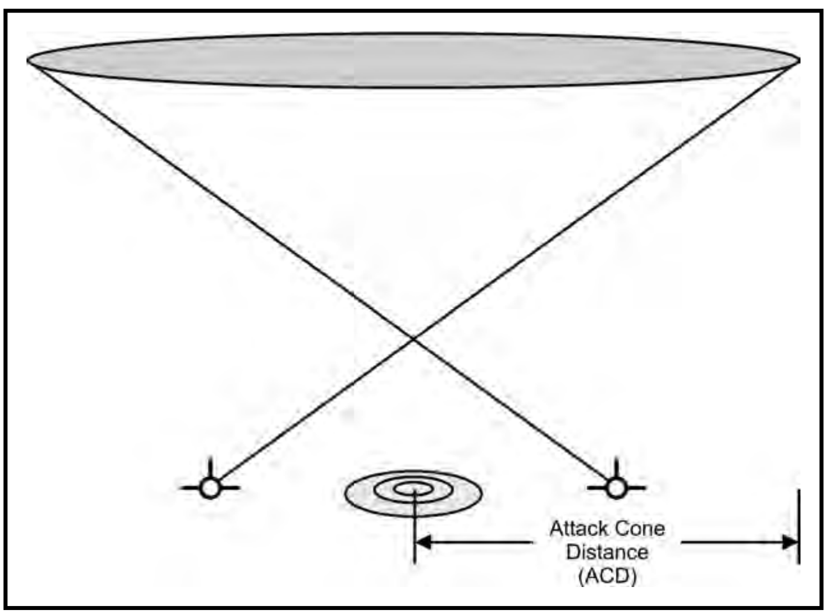


Figure 8-1 The Attack Cone and Attack Cone Distance

The distance from the target if a roll-in is commenced at the planned roll-in altitude resulting in the planned dive angle is called the Attack Cone Distance (ACD). The AV-8B community still references the Attack Cone and Attack Cone Distance as does our training and Z diagrams.

In the F/A-18 community, the Attack Cone Distance is referred to as the Roll-In Point or “RIP”. The Roll-In Point is what it sounds like, the point at which you roll in on the target based on your altitude, the distance from the target, resulting in being on the planned dive angle. Attack Cone Distance and Roll-in Point are terms which can be used interchangeably.

The Z Diagram Review

As previously discussed in Weapons Theory, the Z diagram represents our “plan of attack” on the target. It is comprised of: the pattern altitude on the top, the PLANNED dive angle, the checkpoint altitude (which is 1.5 times your release altitude), and your planned release altitude.

Here is the 30 degree pattern Z diagram and associated parameters.

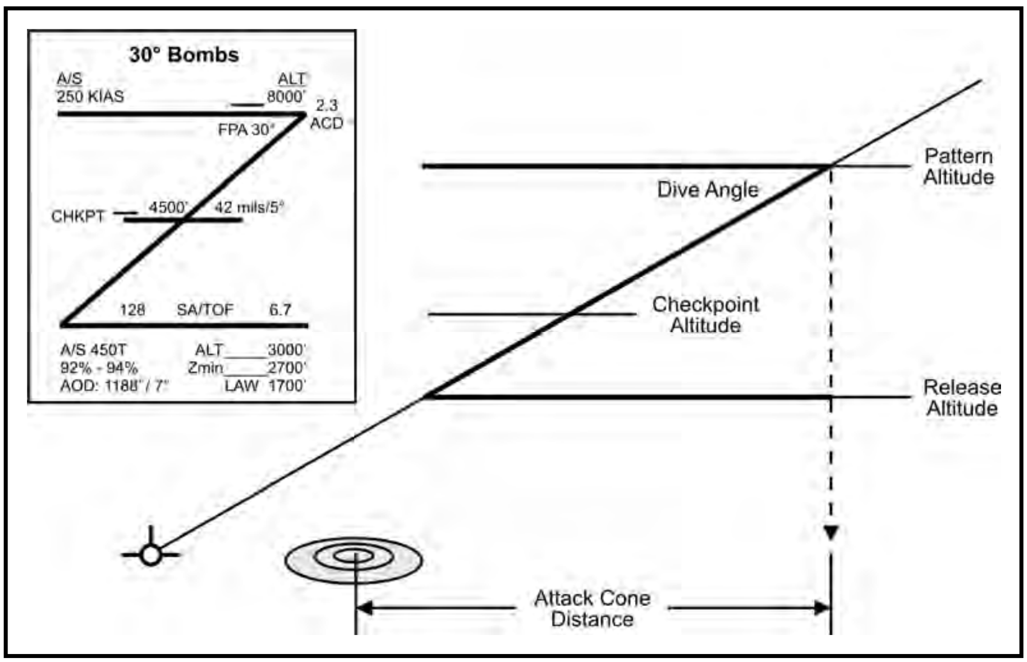


Figure 8-2 Z Diagram Review

The Pattern Objective: Consistency

One of the primary objectives for your Weapons training is to build a consistent Roll-In leading to consistent results of a good initial sight picture. To excel in the Weps stage of training, being consistent in the pattern is a crucial element to your early success. There are three basic variables to the roll-in which results in a good start to your tracking run. Just like flying the ball and in the landing pattern, if you have three variables, by keeping two of them consistent and adjusting the third will get you the results you desire. Our GOAL on our roll-in is to get to a good Initial Sight Picture (ISP).

The three variables on our roll-in are:

1. Altitude,

2. The roll-in maneuver, and

3. The roll-in distance (or Attack Cone Distance (ACD)).

By keeping two of the three variables constant, we can adjust the remaining one to achieve our goal of a good initial sight picture. Being ON the planned pattern altitude, keep our roll-in maneuver the same, then all that remains is to adjust the roll-in distance at which we commit our nose to the target.

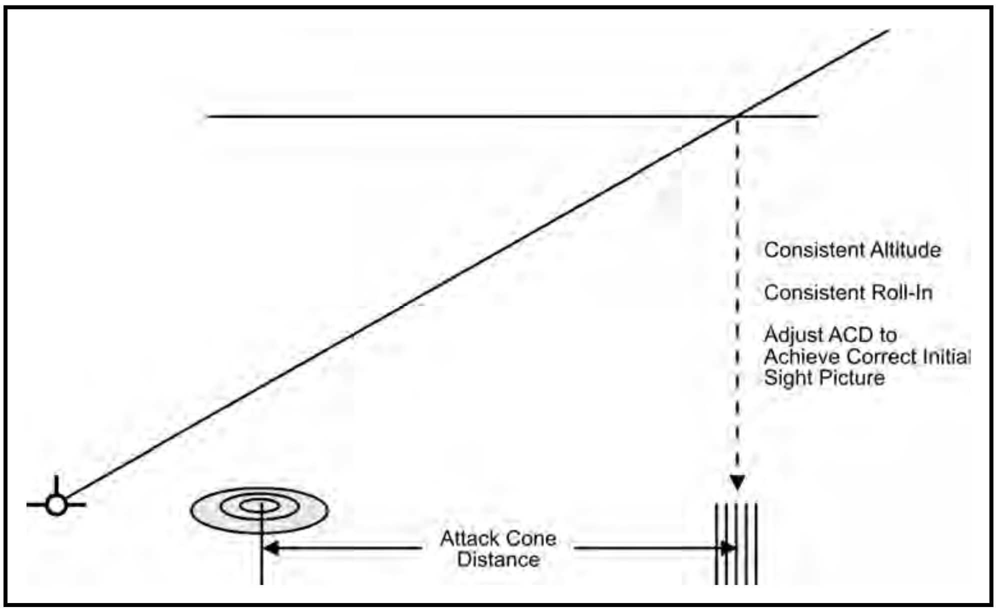


Figure 8-3 Roll-In Components

Target Depression on the Tracking Run

Before getting into what a good Initial Sight Picture is, we must first discuss the Target Depression Angle and understand the target will move down the pitch ladders as we progress from the roll-in altitude through the checkpoint and to the release altitude. The *Target Depression Angle* is the angle between the horizon and the Line of Sight to the target. Simply stated, it is the location of the target as it appears on the pitch ladders looking through the HUD. To further explain this, Figure 8-4 is an example of what is called the *straight path target tracking* technique, the most basic of all tracking techniques and the one most often used in fleet aircraft.

Notice in Figure 8-4, the Velocity Vector is initially placed 2 ½ to 3 degrees above the target immediately upon rolling wings-level at the beginning of the tracking run. The ***<u>RESULTANT</u>*** flight path angle which is created by doing so is then maintained for the rest of the tracking run until release altitude. The target will gradually become more depressed below the Velocity Vector as you proceed to the checkpoint altitude. At the checkpoint altitude (4,500’ in this case), with no headwind or tailwind component, the target will be 5 degrees depressed below the Velocity Vector. Continuing on to release, the target ends up being 7 degrees depressed. In the T-45C, the important angles we are concerned with are the initial target placement (ITP) and the checkpoint (TPA) angles, the 3 and the 5 in this case respectively. The angle at release, called the *Aim Off Angle* is the least important due to the fact your concentration at that point should be on the pipper overlaying the aimpoint.

The most crucial point during this entire run is the *Target Placement Angle* at the checkpoint.

As shown in Figure 8-4, if by placing our Velocity Vector 3 degrees above the target at 7,000’ agl resulted in the Velocity Vector being on the 30 degree pitch ladder, the target would be 33 degrees depressed from the horizon; around the 33 degree location on the pitch ladders. By maintaining the resultant Flight Path Angle achieved at the roll-in, the target becomes 5 degrees depressed below the Velocity Vector; the target will be 35 degrees depressed at the checkpoint altitude. At release, it becomes 37 degrees depressed below the horizon. By maintaining the Velocity Vector above the target, the target will continue to depress as you get closer to the ground.

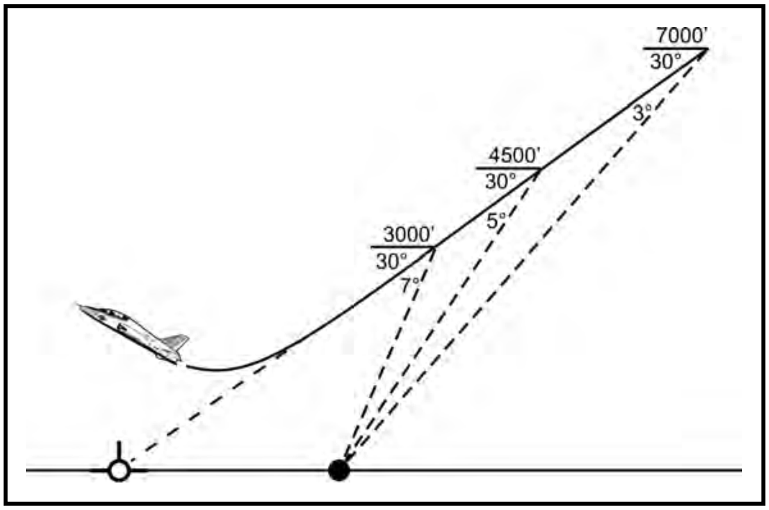


Figure 8-4 Target Depression Angles

Now with that said, let's look at what a good Initial Sight Picture (ISP) looks like in your HUD at the initial roll-out at the beginning of the dive bombing run.

The Roll-in Objective: A Good Initial Sight Picture

Using the 30 degree bombing pattern, the pattern altitude is 8,000' agl. If performed correctly, you should only lose about 1,000' to 1,200' on your roll-in maneuver. You should be rolling out wings level on the target around 7,000' agl. If you are seeing more along the lines of 6,500 to 6,000 consistently, then you are hurting yourself because you are losing valuable tracking time, AND, the 3 degrees depressed is ONLY VALID at 7,000' agl, not 5,000' agl.

The purpose of the Initial Sight Picture is to determine how well you accomplished the roll-in. Just like when flying the pattern your GOAL was to get to a good roll-in position; your GOAL on your roll-in is to get to a GOOD Initial Sight Picture.

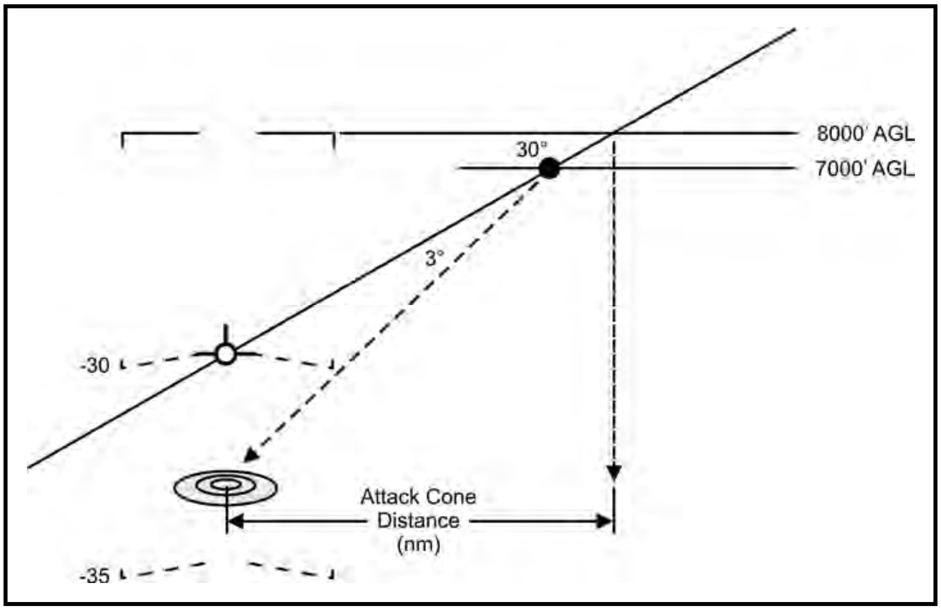


Figure 8-5 Initial Sight Picture

Here is what a good initial sight picture looks like. Notice by placing the Velocity Vector 3 degrees above the target at 7,000' msl, it results in the planned flight path angle of 30 degrees. Notice the target is 33 degrees depressed.

Initial Sight Pictures

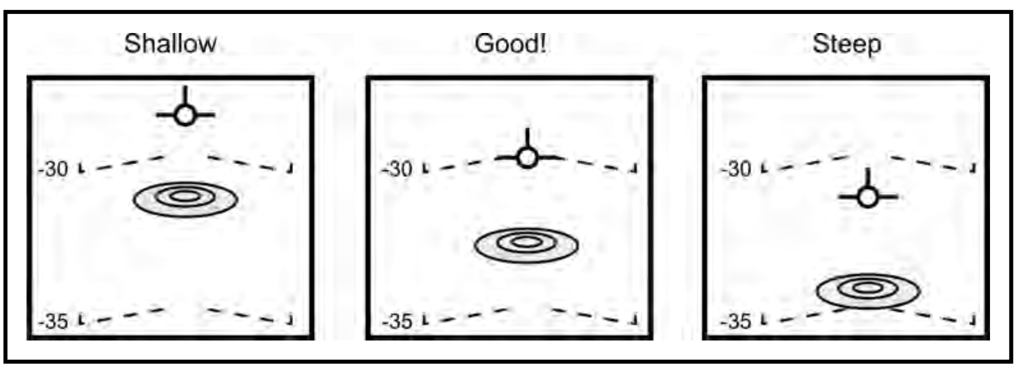


Figure 8-6 Shallow/Good/Steep Initial Sight Pictures

There are three types of Initial Sight Pictures. They are either: Shallow, Good, or Steep. Just looking at the target in relation to the pitch ladders, notice the figure on the left shows the target laying closer to the 30 degree pitch ladder or less than 3 degrees depressed from the planned dive angle. This is called a ***Shallow Initial Sight Picture***. The figure in the middle shows the target pretty much half way between the 30 and 35-degree pitch ladder or 2 ½ to 3 degrees depressed from the 30-degree (planned) dive angle. This is called a ***Good Initial Sight Picture.*** Finally, the figure on the right displays the target lying closer to the 35 degree pitch ladder or more than 3 degrees depressed from the planned dive angle. This is called a ***Steep Initial Sight Picture***.

Note that in all of these cases, the sight pictures can be determined by simply placing the Velocity Vector 3 degrees above the target and the resultant flight path angle determines if you are shallow, good, or steep referenced to the planned dive angle.

Initial Sight Picture – The Goal

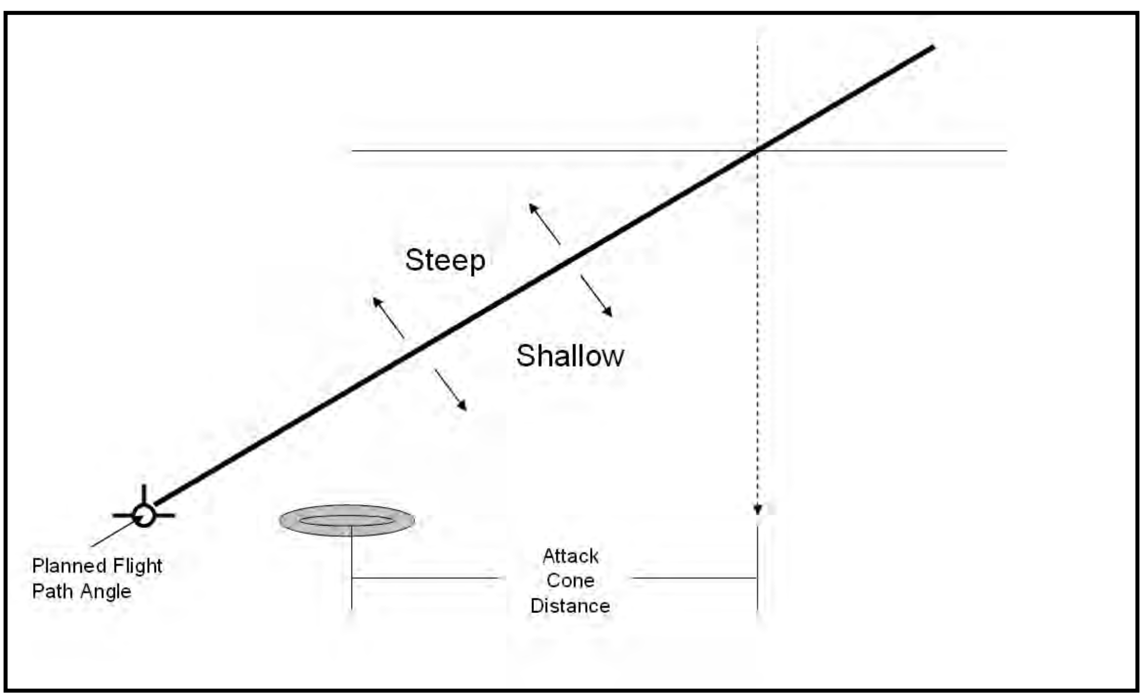
As previously stated, **the GOAL of your roll-in is to get to a GOOD Initial Sight Picture**.

If the Initial Sight Picture (ISP) is other than GOOD, you need to understand what caused a Steep or Shallow ISP and make adjustments on subsequent runs.

By keeping your pattern altitude and roll-in technique consistent, moving the ACD (Roll-In Point) in or out will get you to that GOOD Initial Sight Picture. Now let's take a look at the causes of Steep or Shallow ISP.

Causes of a Steep or Shallow ISP

As previously discussed, there are 3 variables in the roll-in: Altitude, Roll-in Technique, and the Attack Cone Distance (Roll-in Point). As shown here, if we rolled in at our planned roll-in altitude, committed our nose down to the target (rolled IN on the target) by over-banking, placing the lift vector on the target, pulling 15 to 17 units AOA, and rolled in at the planned distance from the target (ACD / RIP), we should be on our planned Flight Path Angle. This is also referred to as being "on the bombing triangle" or "on the wire".



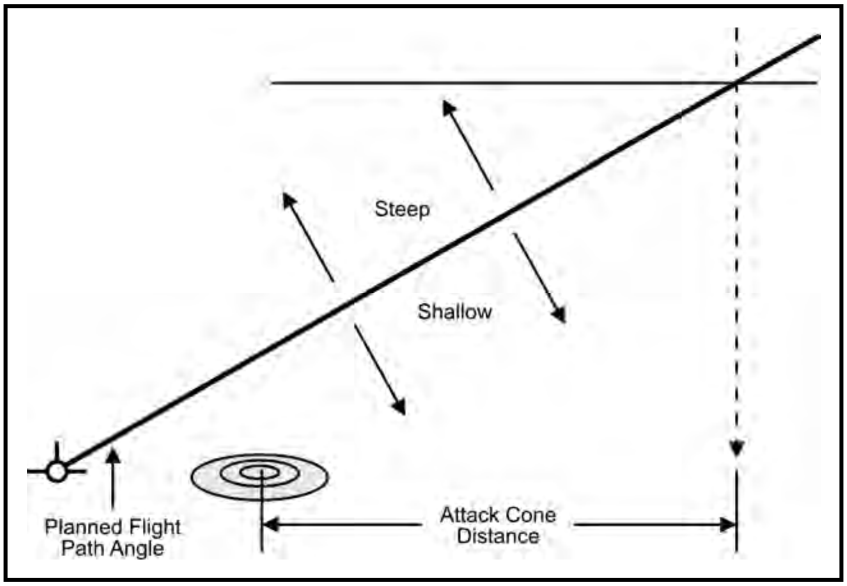


Figure 8-7 Causes of a Steep or Shallow (2 graphics)

Any deviations from those variables which cause your aircraft to be **above** the planned “wire” will cause you to obtain a STEEP Initial Sight Picture. Likewise, any deviation which causes you to be **below** the “wire” will cause you to obtain a SHALLOW Initial Sight Picture. Let’s look at the causes of a Shallow.

Causes of a Shallow Initial Sight Picture

First variable is Altitude. If you begin your roll-in below your planned roll-in altitude, at the correct ACD, this puts you below the “wire”. This is common early on in the Sims and first few flights in the jet. Usually it happens just prior to the roll-in, if you allow the Velocity Vector to “sag” in the approach turn. Instead of rolling in at 8,000’ agl, you roll in at 7,700’ agl. This will lead you to a shallow.

Second is the Roll-in Technique. If you over-bank too far, placing the lift vector well below the target, you are pulling the aircraft below the “wire”, leading to a shallow. 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 roll-out.

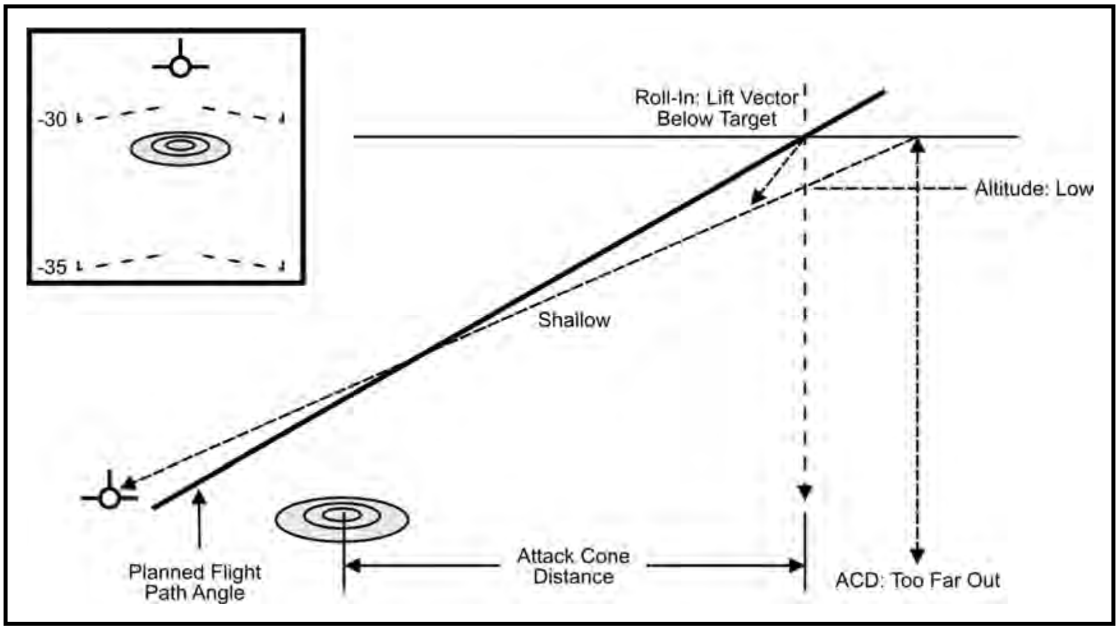


Figure 8-8 Causes of a Shallow ISP

And finally we have the Attack Cone Distance (ACD). This is the distance (nm) from the target at which we over-bank and commit our nose low to the target. If we roll-in too far away from the target, it will result in a Shallow ISP.

To best way to fix the Shallow ISP is understand what caused the Shallow in the first place. Just like in the landing pattern, we don't want to fly the whole hop getting "low ball starts". You NEED to fix it on follow-on passes. If we keep our pattern altitude consistent and our roll-in consistent, then the only other variable which remains is to **roll-in closer** to the target. This will get you to the good ISP.

Effect of a Shallow and Corrections for a Shallow

The effects of a shallow dive will lead you to a late sight picture or **LOW** release. The correction is either to add power and go faster, releasing on altitude; or just prior to release altitude, smoothly adjust the pipper past the aimpoint (50' per degree past the aimpoint for the 30 and 20 degree patterns; 80' past for the 10 degree pattern) and pickle on altitude. In the 10 degree pattern, correcting by going faster is not an option, since our power setting is already set to MRT. The options available are either aim past your aimpoint or abort your run. See the error sensitivities for details.

HOWEVER, TAKE NOTE!!! RELEASING LOW TO CORRECT FOR A SHALLOW IS NOT ACCEPTABLE!!! Releasing with a valid Break X could constitute an unsatisfactory grade.

Abort Criteria for a Shallow Initial Sight Picture

If the ISP shows the target above the 30 degree pitch line or your Velocity Vector is shallower than 28 degrees (27 or less). Do not attempt to release on that pass. Just realized that if you are 3 degrees shallow, it will cause you to get a late release solution (pipper arrives at the aimpoint) 100’ low for every degree shallow. In this case, 300’ low. You will get a Break X appearing very close to that. DO NOT fixate on the target and release low. Shallows lead to a late sight picture/late weapons release solution and will cause you to release low. Understand what caused you to be that far shallow and **<u>FIX IT</u>** on the next run.

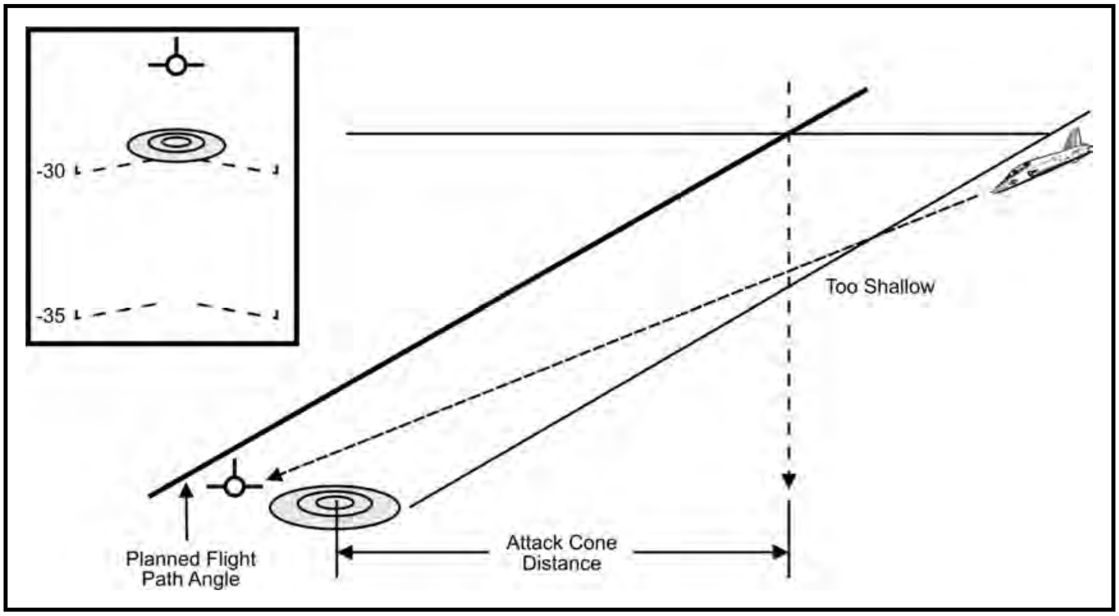


Figure 8-9 Too Shallow – Abort

Causes of a Steep Initial Sight Picture

Now let’s look at the causes of a steep initial sight picture. Reviewing the three variables of the roll-in which are Altitude, Roll-in Technique, and Attack Cone Distance (or Roll-in Point), just the opposite of a shallow is true for a steep.

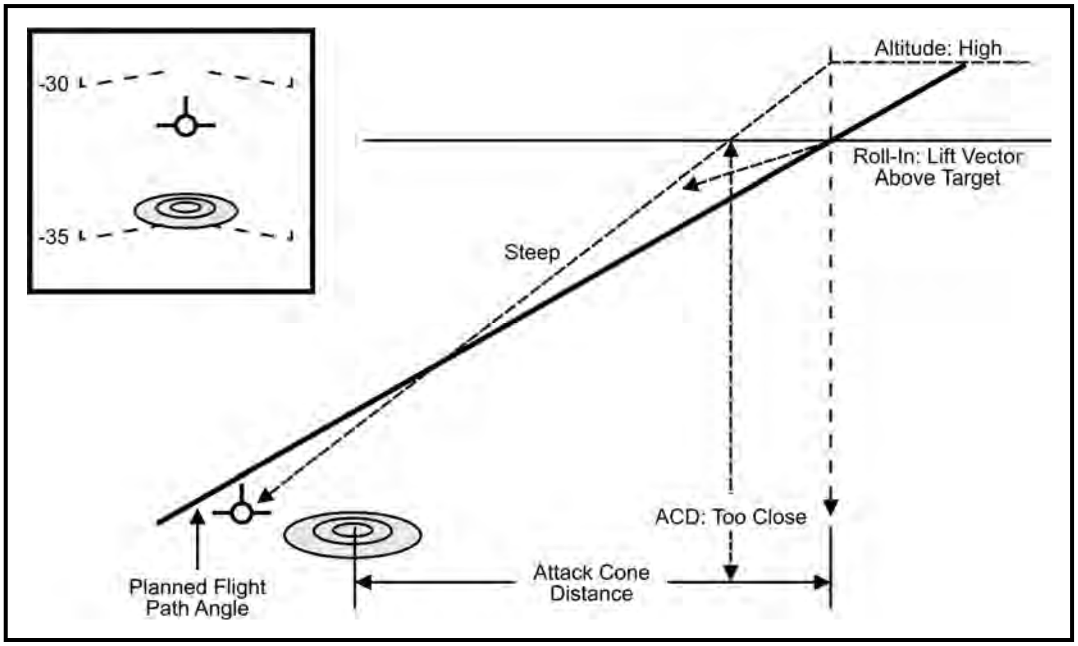


Figure 8-10 Causes of a Steep ISP

Again, the first variable we'll address is Altitude. If you begin your roll-in above your planned roll-in altitude, at the correct ACD, this puts you above the "wire". This is common early on in the Sims and it occurs due to poor basic airwork in the pattern. Most common error of altitude is in the approach turn while looking at the target/run-in line and pulling to the Attack Cone, the aircraft begins to climb. Instead of rolling in at 8,000' agl, the roll-in occurs at 8,200' agl. This will lead you to a steep. You NEED to be looking out the window at the target in the approach turn, but you also need to be referencing your altitude while in the turn. Be on altitude and keep the Velocity Vector level "on the horizon" in the turn.

Second is the Roll-in Technique. If you don't over-bank enough, place the lift vector well above the target, or float the pull-down (not enough AOA), you are pulling the aircraft above the "wire", leading to a steep. Over-bank; place the standby compass on the target and pull. Avoid letting the Velocity Vector go more than 5 degrees above the target upon initial roll-out. You should strive to roll-out with the Velocity Vector 3 degrees above the target.

And finally we have the Attack Cone Distance (ACD). If we are on our altitude and our roll-in maneuver performed correctly, rolling-in too close to the target it will result in a steep ISP.

To best way to fix the steep ISP is understand what caused the steep in the first place. Just like in the landing pattern, we don't want to fly the whole hop getting "high ball starts". You NEED to fix it on follow-on passes. If we keep our pattern altitude consistent and our roll-in consistent, then the only other variable which remains is to **roll-in farther away** from the target. This will get you to the good ISP on the next pass.

Effect of a Steep and Corrections for a Steep

A steep dive will result in an early weapons release solution or high release. The correction is to release when the pipper arrives at the aimpoint, which will be 100’ high for every degree steep. See the bomb error sensitivities below, slight difference for the 10 degree pattern versus the 20 and 30 degree patterns. In the 10 degree pattern, the pipper will arrive at the aimpoint 70’ high for every degree steep.

Since a steep will cause you to release high, this is better than releasing low. So if you were to error, error to being on the steep side. Releasing high will increase your foot/mil dispersion, thereby decreasing your accuracy and chances in getting a “Bullseye”. Strive to achieve being on the planned dive angle which will lead you to being closer to your planned release altitude.

T-45C / Mk 76 Error Sensitivities:

	Dive Angle		Airspeed		Altitude		Impact Error/ Pipper Correction
30 degree:	+/- 1 deg	=	+/- 10 kts	=	+/- 100 ft	=	50’ error
20 degree:	+/- 1 deg	=	+/- 10 kts	=	+/- 100 ft	=	50’ error
10 degree:	+/- 1 deg	=	+/- 10 kts	=	+/- 70 ft	=	80’ error

Abort Criteria for a Steep Initial Sight Picture

If there is a time when the ISP shows the target below the 35 degree pitch line or your Velocity Vector is steeper than 32 degrees. Do not attempt to release on that pass. Just realized that if you are steep, it will cause you to get an early release solution (pipper arrives at the aimpoint)

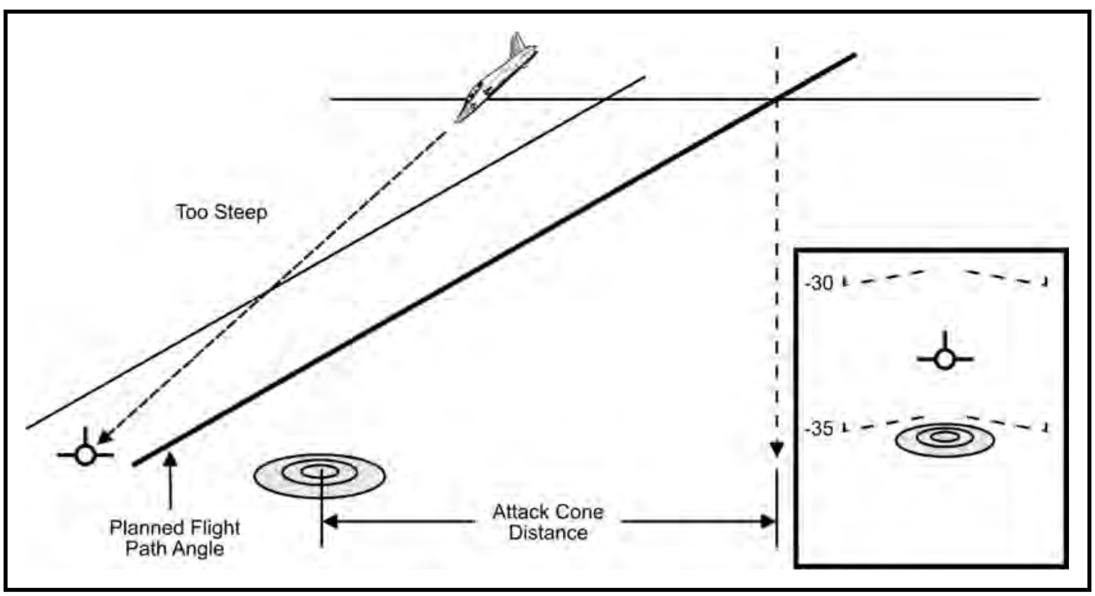


Figure 8-11 Too Steep - Abort

100' high for every degree steep. In this case, 300' high. Although deemed to be safe in releasing high, your accuracy will be slightly degraded. Steeps lead to an early sight picture/early weapons release solution and will cause you to release high. Understand what caused you to be that far steep and **FIX IT** on the next run.

Wind Effect on the Roll-in ACD

Remember, the Z diagram and pattern distances are based on a no wind condition, with the exception to the Abeam distance. A tailwind at altitude will cause the aircraft to be blown towards the target faster, therefore requiring you to roll-in slightly farther out than planned. The opposite is true for a headwind; you will need to roll-in slightly closer to the target. The approaching arc distance also needs to be adjusted to compensate for the approach turn. Typically, adjust the pattern numbers 0.1 nm for headwind/tailwind component above 25 knots.

This is one of the reasons a tailwind causes a steep and a headwind causes a shallow. The effect wind has on your dive will be discussed in more detail later in this chapter.

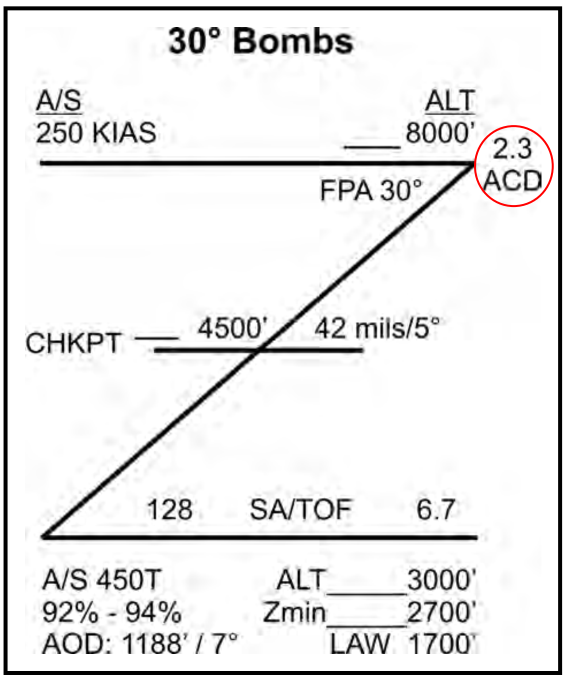


Figure 8-12 Z Diagram

The Initial Sight Picture - Review

The Initial Sight Picture is only used to evaluate how well you accomplished the roll-in. If your ISP is anything other than good, you need to understand what caused you to be either steep or shallow. By keeping your altitude and roll-in technique consistent, you can then adjust your ACD or Roll-in Point to get you to that good ISP you are seeking.

A good ISP for the 30 and 20 degree patterns is 2 ½ to 3 degrees depressed from your planned dive angle (32 ½ to 33 and 22 ½ to 23 degrees respectively). For the 10 degree pattern it is closer to 2 to 2 ½ degrees depressed (12 to 12 ½ degrees).

Just like in the landing pattern, a good start equals a good tracking run which in turn equals good hits. The fewer corrections you need to make in the dive the more you can scan altitude, airspeed, line-up, Target Placement Angle at the checkpoint, and pipper placement at release. This will lead to your hits being grouped closer to the intended impact point.

Finally, the ISP is only valid upon initial roll-out onto the target with minimal loss of altitude in the roll-in.

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

When selecting the A/G HUD Mode, the HUD initializes to the UNCAGED mode. THIS IS A GOOD THING! In the uncaged HUD mode, the Velocity Vector and pitch ladders show where the aircraft is actually going. The Pipper, Altitude and Airspeed boxes are fixed locations on the HUD.

When we release the bomb by pressing the "pickle" button, we are essentially taking the Velocity Vector and placing it on the bomb. Due to the fact the bomb does not have a Rolls Royce engine strapped to it set at 94%, it will fall below the Velocity Vector a certain number of mils (128 mils in our case) due to *Trajectory Drop*. This is the distinct advantage we have in the T-45C which is not in the T-45A. We use this for our line-up guidance.

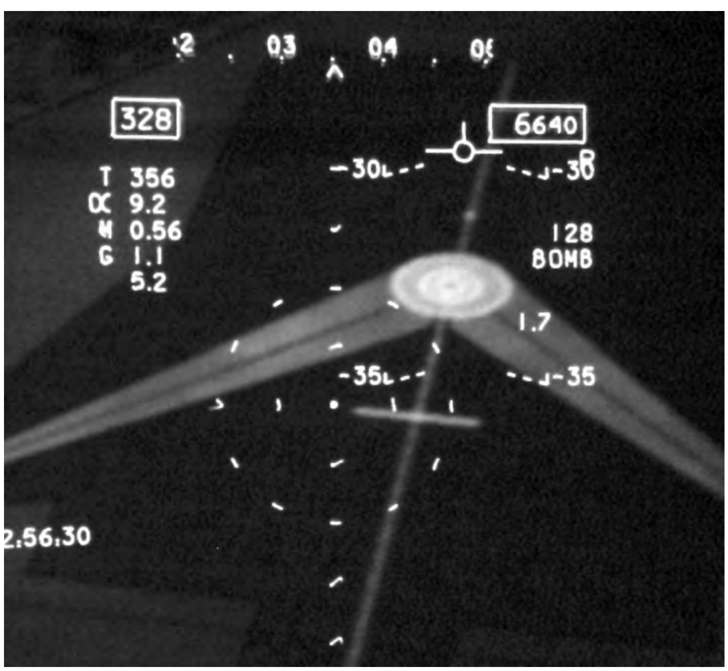


Figure 8-13 T-45C Uncaged HUD

On this tracking run you will see the Velocity Vector is placed close to the 12:00 position, ***relative to the target as you are seeing it***, not relative to the run-in line on the ground. Here, the run-in line was slightly overshot. By placing the Velocity Vector above the target as it is seen will ensure the bomb falling on an imaginary plumb line which falls directly below the Velocity Vector and in between the inner tick marks of the pitch ladders. This line will be visible in the CCIP delivery mode and is called the Bomb Fall Line or BFL and is used in determining line-up in the CCIP mode. In the MANUAL delivery mode, you should strive to fly the jet in a manner that places the TARGET (the Bullseye) directly in between the inner tick marks of the 35 degree pitch ladder (or the respective 5 degree pitch ladder below your intended planned dive angle). This will lead to your pipper seeking the proper aimpoint (offset aimpoint with winds) at release. By using the Velocity Vector in the uncaged mode for line-up, we solve for the 3:00 – 9:00 portion of our hits.

NOTE

> As shown in Figure 8-15, there is no need to correct back to the run-in line if you are within the Abort Criteria of plus or minus 15 degrees of the run-in heading. Run-in Line 045 degrees.

Use the pitch ladders and Velocity Vector for your line-up guidance, not the pipper mil rings. This will become VERY apparent on high crosswind days and will help you better in placing your bombs on target. All of your hits should be on the 12:00 to 6:00 line.

Now let's talk about setting the Target Placement Angle and Checkpoint Altitude.

Target Placement Angle (TPA)

Target Placement Angle or TPA, is defined as the Angle between the Velocity Vector and the target.

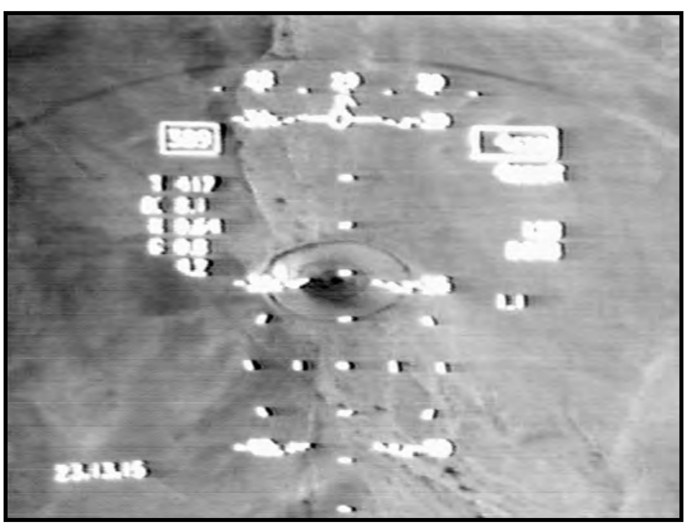


Figure 8-14 TPA – On Planned Dive

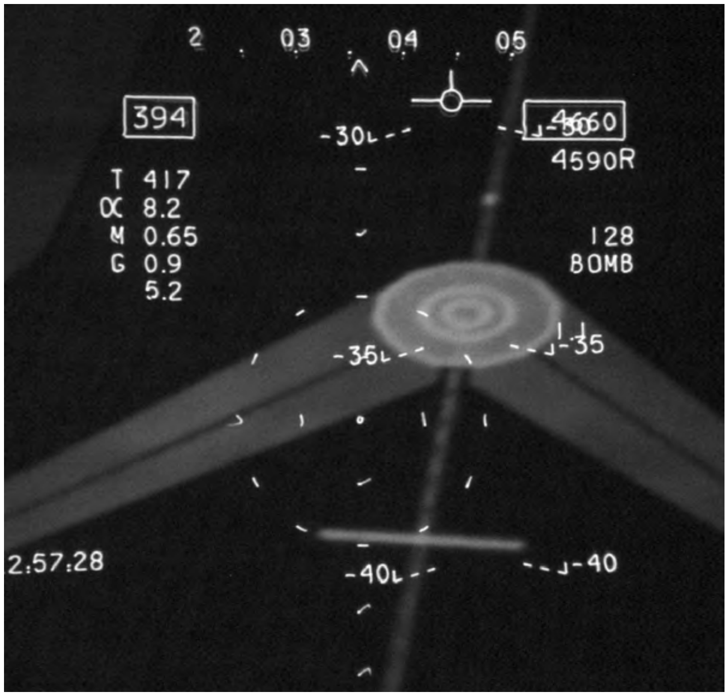


Figure 8-15 TPA – Slightly Shallow Dive

TPA for the T-45C is 5^o for 30^o and 20^o pattern; 4^o for 10^o pattern.

The Velocity Vector placed 5 degrees above the *TARGET.* Not the offset aimpoint.

Resultant FPA is then maintained to release.

The Checkpoint Altitude: Setting the Target Placement Angle

The Checkpoint Altitude is a "how goes it" and a correction altitude. This is the point in the dive we ensure our Velocity Vector is placed a certain number of degrees above the target so that our pipper arrives at the aimpoint close to our planned release altitude. It is also the point where our last second corrections need to be applied if we have errors to the *PLANNED* dive parameters.

The Target Placement Angle (TPA) is set ***at*** the checkpoint altitude, not after. As previously stated, the TPA is the angle (measured in degrees) between the Velocity Vector and the target. The TPA for the 30 and 20 degree dives is 5 degrees and for the 10 degree dive, it is 4 degrees.

IT IS EXTREMELY IMPORTANT to set the TPA at checkpoint and not just the planned dive angle. No ATTEMPT should be made to set the planned dive angle without first respect of the TPA. Set the TPA and accept the resultant FPA which it gives you. If you are off the planned dive by one degree or less, hold what you have and release on pipper placement. Being off your planned dive angle by one degree or less will cause you to get less than 100' high or low release sight picture in the 30 and 20 degree patterns and 70’ high or low in the 10 degree pattern. 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, however, where the “freeze on release” function is utilized. The importance of recognizing a <u>shallow will equate to a late sight picture/low release</u> cannot be over emphasized. Do NOT press the run below 100’ in any case. If setting the TPA at checkpoint yields between one degree and 3 degrees steep or shallow, make the appropriate error corrections. More than 3 degrees off, do not drop, abort the run. But FIX IT on the next pass.

This is an example of what a good TPA looks like at the checkpoint. Results in about ½ degree shallow.

A good technique in determining 5 degrees above the target is to use the pitch ladders. 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 relation to the 30 degree pitch ladder. For example: If the target lies slightly above the 35 degree pitch ladder, place the Velocity Vector slightly above the 30 (shallow). If the target lies slightly below the 35, place the Velocity Vector slightly below the 30 (steep).

Once again, NO ATTEMPT should be made to just set the planned dive angle without respect to the TPA!

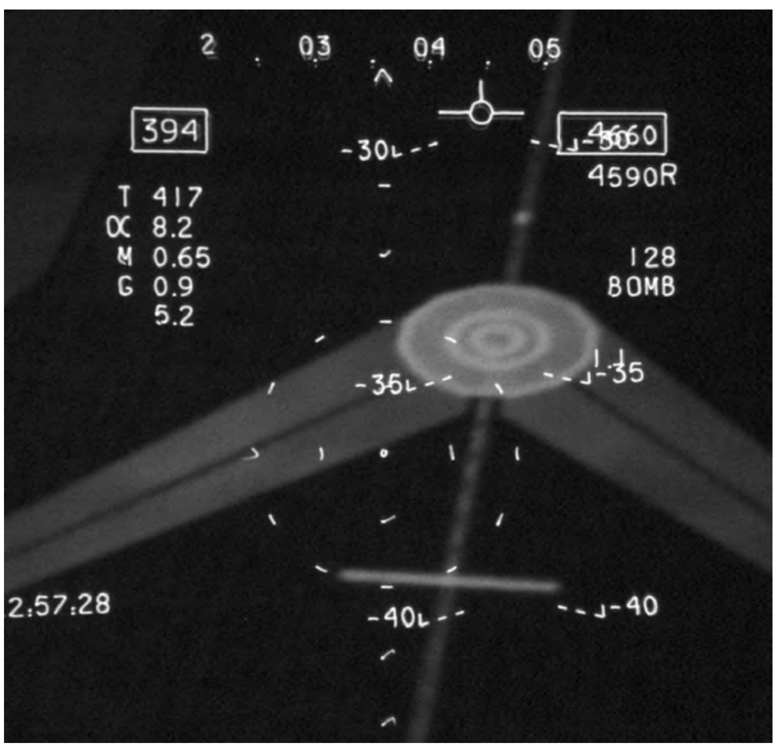


Figure 8-16 Checkpoint - TPA

Release Sight Picture

From checkpoint altitude to release altitude, the resultant FPA obtained at the checkpoint is maintained. Common error is to be not trimmed for 450 KTAS resulting in the Velocity Vector "creeping" up. When the Velocity Vector "creeps up" it causes the pipper to track to the aimpoint faster, causing the pipper to reach the aimpoint earlier than desired. To fight this "creep", you need to freeze the Velocity Vector, or hold it, on the FPA. Realize in doing so, you will feel slightly "lighter in the seat" because you will be at the optimum g for the dive.

INSTRUCTOR NOTE

Optimum G for any dive is the cosine of the dive angle. G is NOT scanned on the dive run, but is reviewed on the HUD tape debriefs to determine pipper validity. Optimum G on the HUD debriefs are: 30 degree, 0.8-0.9; 20 degree, 0.9; and 10 degree, 1.0.

A very common error for the students early on is allowing the VV to rise above the resultant FPA approaching release. This is partly due to the fact the simulator does not replicate g forces, aircraft not being trimmed for 450 KTAS, and eyes transitioning from scanning the VV to the target initially, then to scanning pipper to the aimpoint at the end. This common error will occur in both MANUAL and CCIP mode deliveries.

The pipper will naturally track to the aimpoint as the target continues to move down the pitch ladders.

Release Sight Picture

Here is a blow up view of the release sight picture. The pipper seeks the Offset Aimpoint. Release altitude wind was 315 / 15 for and OAP of 170' at 09:00. The target is 128 mils below the Velocity Vector. At the moment the pickle button is pressed, the scan is to: 1) know where the pipper was when you pressed the button; and 2) quickly note the airspeed and altitude. Pulling to the abeam, record the hit and evaluate. If the hit went long, correct the pipper placement (aimpoint) on the next run by releasing short of this aimpoint by the same amount of feet you were long. This hit was actually 26' at 5:30.

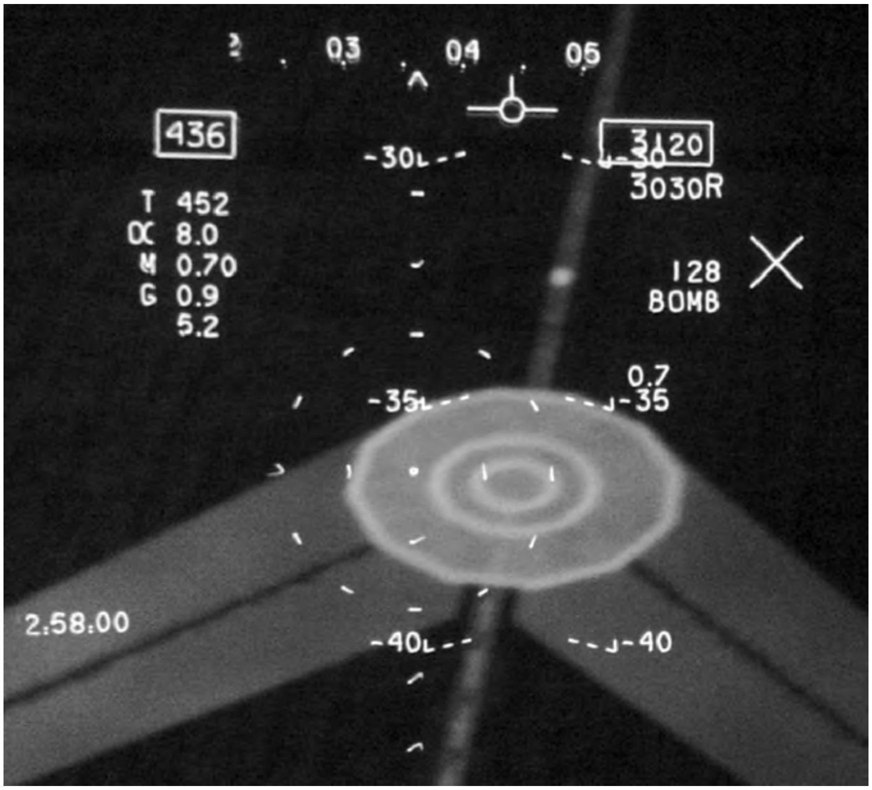


Figure 8-17 Release Sight Picture

801. TARGET TRACKING

Tracking Time and References

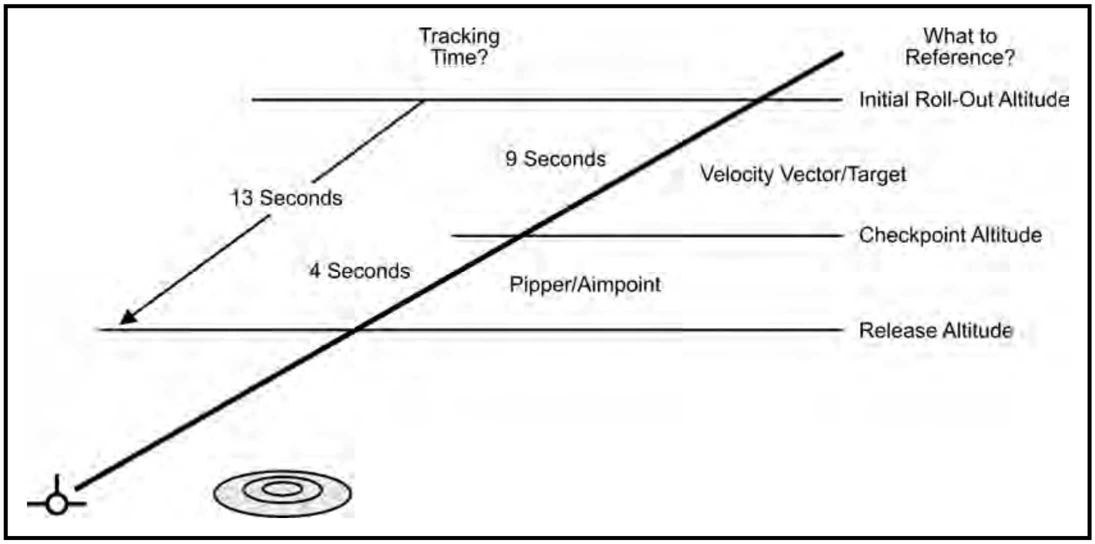


Figure 8-18 Tracking Time / References

Normal tracking time is usually between 12 and 14 seconds, depending on wind. Nine seconds from roll-out to checkpoint, four seconds from checkpoint to release. When you first begin pointing your nose at the ground early in the syllabus, your scan will naturally be slow. You'll struggle initially with the roll-in, line-up control, etc. Knowing what to scan, when to scan it, is crucial to your HUD scan development. Initially, the total time spent in the run will seem like it is four to five seconds at most, but over time as your scan improves, it will appear to be more than adequate.

Let's take a moment to focus on what is referenced during the tracking run to promote standardization throughout your training and to aid in your HUD scan development. From roll-in to the checkpoint, we reference the Velocity Vector to the target. From checkpoint to release, we switch to the pipper to the aimpoint. Referencing the Velocity Vector to the target during the first part of the run standardizes the scan and references in ALL modes of delivery, both Manual and CCIP. Referencing the pipper to the aimpoint at release is essential as to best evaluate your Offset Aimpoint and parameters. We ALWAYS keep our altitude in our scan and NEVER just look at the target. That's called *target fixation*. At the same time, we never just release exclusively on altitude, there has to be a good mix between the two.

Tracking Techniques

Tracking techniques are like opinions and you know what they say about opinions. Everyone's got one. There are many different ways you can get to release altitude, on parameters, release the weapon and have it impact the target.

By definition, a *tracking technique* is a means by which an aircraft obtains a weapons release solution at the planned release altitude; or, more simply, how we get from roll-in to weapons release.

Take trust in the fact there are MANY types and variants of tracking techniques used throughout the world today. They will vary between Service and Fleet, Service to Service, and Country to Country. We will introduce to you one basic technique for you to master, then, possibly, expose you to some advanced techniques to put into your "bag of tricks" so you can use them when the situation warrants their use. In the aircraft, we teach the most widely used technique which is *straight path tracking*. However, once again, you *may be* exposed to two or three in the sim.

The first technique, which is arguably the easiest technique of all, is called the Straight Path technique. The second technique is Curvilinear to Straight Path technique. There is a third technique, which is an advanced technique, called "Harp Angle Bombing" which combines the use of both Straight Path and Curvilinear to Straight Path techniques. You need to understand you must walk before you run so we'll concentrate on the first two basic techniques.

<u>*Straight Path*</u> tracking is maintaining a specific Flight Path Angle from roll-out to release. In the T-45C, upon initial roll-out on the target, the Velocity Vector placed a number of degrees above the target and the resultant Flight Path Angle is maintained all the way to release. In theory, if you roll-in with minimal altitude loss, setting the correct measurement above the target initially will lead to the target being accurately depressed at checkpoint and the pipper on the aimpoint at release altitude. The aircraft is taking one <u>straight</u> flight <u>path</u> all the way down the dive.

<u>*Curvilinear to Straight Path*</u> tracking is where the checkpoint Target Placement Angle is set upon initial roll-out, a constant slight bunt is maintained to keep the TPA sight picture constant from roll-out to checkpoint. At the checkpoint, the bunting stops and the resultant Flight Path Angle is then maintained from checkpoint to release. This is called a compound technique because it calls for two types of maneuvers during the run. It has validity for use.

The only Fleet which still teaches Curvilinear to Straight Path is the AV-8B Harrier, and they only use it on undesignated deliveries. The rest of the time, everyone utilizes a straight path variation. For that reason, we concentrate on Straight Path Tracking in the T-45C.

Straight Path Tracking

This is the foundation of most techniques out there and is the easiest of all the methods to initially grasp and develop your HUD scan.

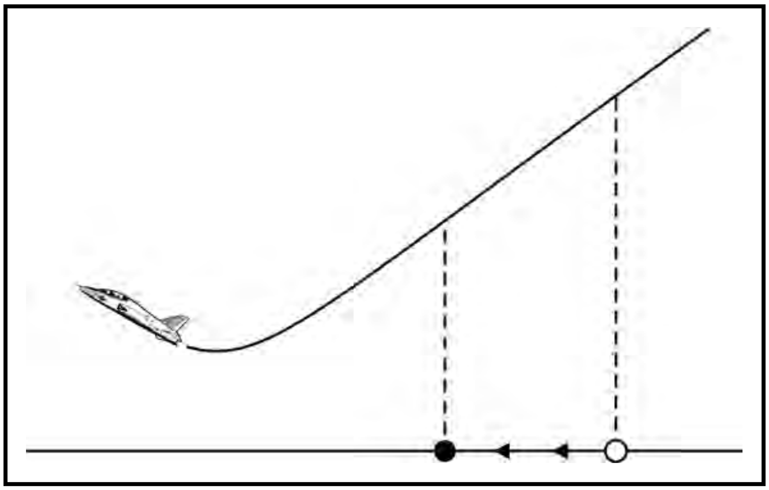


Figure 8-19 Straight Path Tracking

After roll-in, the Velocity Vector is placed a certain number of degrees above the target and the resultant flight path angle is maintained until pipper crosses target or OAP

While maintaining a constant dive angle, the pipper will continuously track up towards the target.

Straight Path tracking can be performed in either MANUAL or CCIP delivery modes.

Straight Path Tracking Procedures – MANUAL Delivery Mode

At initial roll-out (Refer to Figure 8-20)**:**

1. Evaluate the Initial Sight Picture.

   - Good roll-in distance.

   - Good ISP shown here.

2. Set the Initial Target Placement Angle:

   - Place the VV 2 ½ degrees to 3 degrees above target. (30/20 deg pattern)

   - Results in 30 degree FPA shown here.

   - 10 degree pattern: 2 – 2 ½ deg.

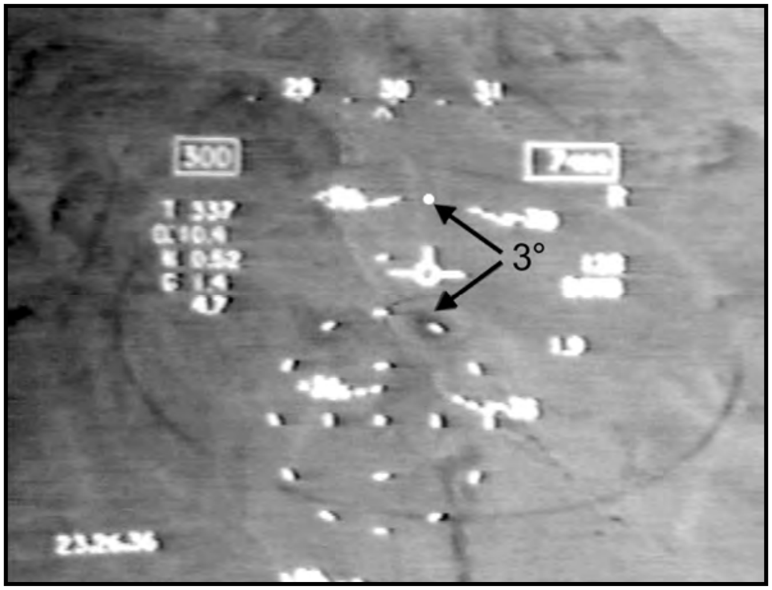


Figure 8-20 Straight Path Tracking Procedures – MANUAL Delivery Mode

3. Maintain the *RESULTANT* Flight Path Angle (FPA) to checkpoint altitude.

   - Shown here results in 30 degree FPA – right on our planned dive!

Figure 8-21 Straight Path Tracking Procedures – MANUAL Delivery Mode

4. Between roll-out and checkpoint, correct left or right for lineup – have target track vertically between pitch ladders, below the VV.

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

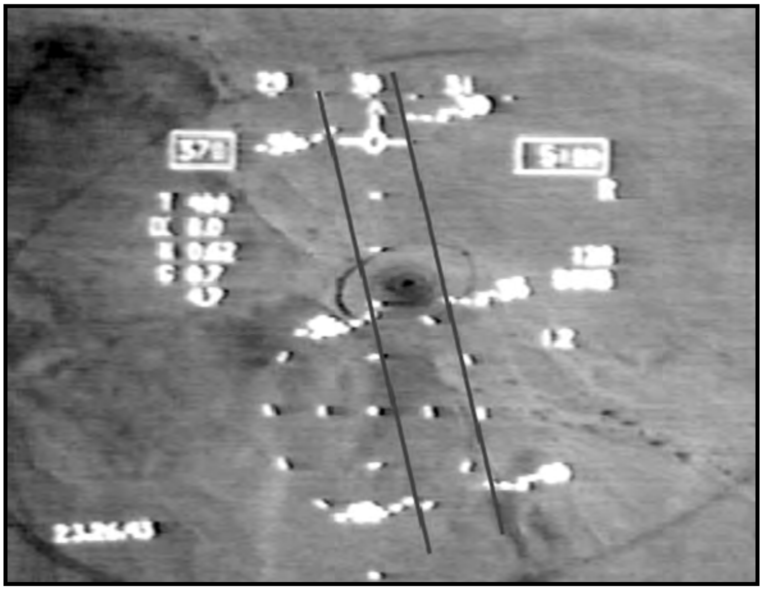


Figure 8-22 Straight Path Tracking Procedures – MANUAL Delivery Mode

Checkpoint altitude:

1. Set the Target Placement Angle (TPA).

2. Note the airspeed.

   - 30 deg: 410 – 420 KTAS

   - 20 deg: 415 – 420 KTAS

   - 10 deg: 425 – 430 KTAS

3. Check Line-up.

4. Apply error corrections, if required.

5. Maintain the resultant Flight Path Angle (FPA) to release.

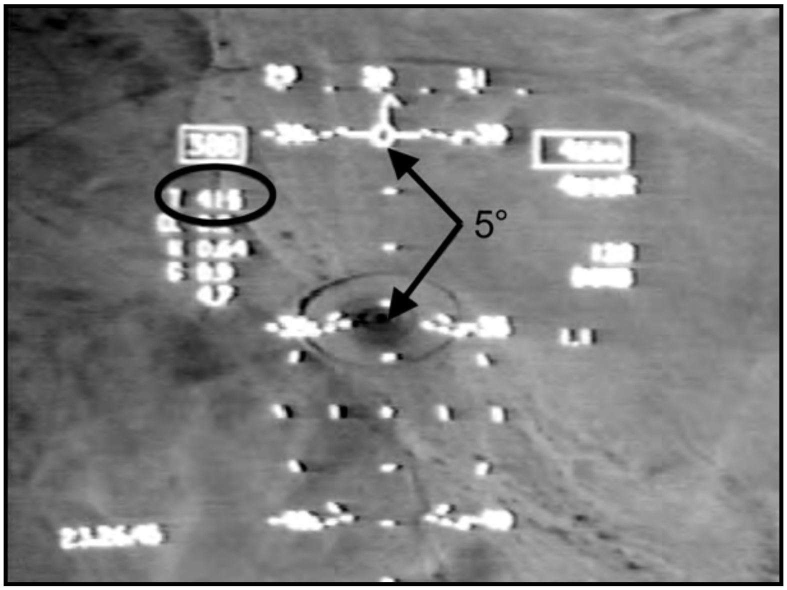


Figure 8-23 Checkpoint Altitude

Checkpoint to Release:

1. Maintain the resultant FPA to release.

   -resist allowing VV to creep up.

2. Monitor altitude, line-up and pipper tracking.

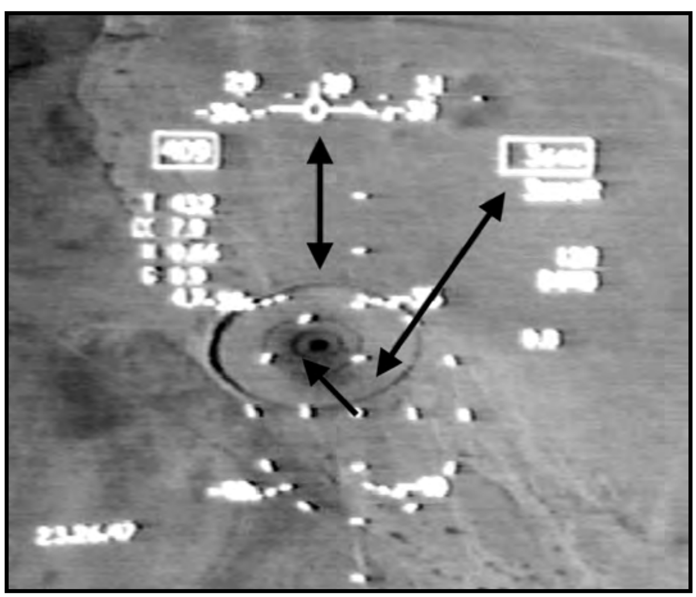


Figure 8-24 Checkpoint to Release

Release Altitude:

1. Pickle when pipper is on the Aim Point

   - OAP: 75’ at 8:00 shown here.

2. At release, note pipper placement, airspeed and altitude.

   Hit resulted in a score of 33’ at 3:30.

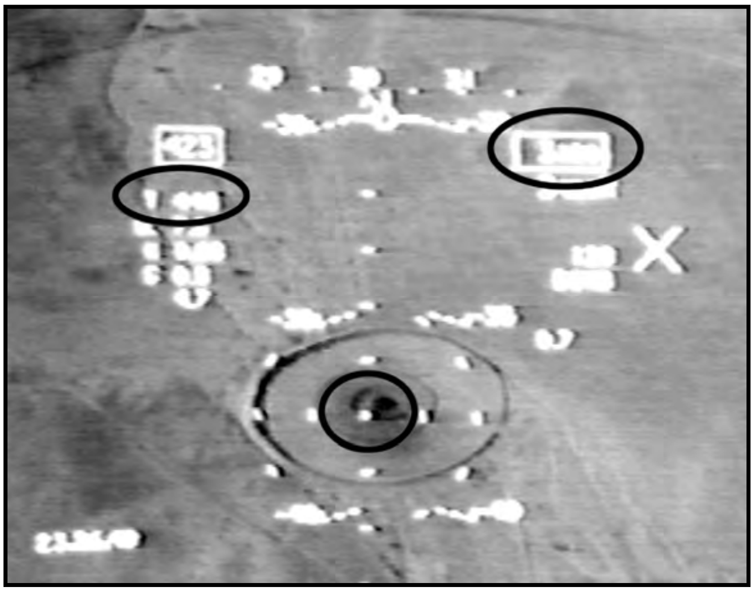


Figure 8-25 Release Altitude

Curvilinear to Straight Path Tracking

Preferred Basic Conventional Weapons Delivery (BCWD) method of manual bombing taught by the Navy and Marine Corps for years.

It is the technique which is still being taught at VMAT-203 (Harrier FRS) for undesignated deliveries in the CCIP mode.

This technique is not taught in the F/A-18 Hornet FRS or Fleet aircraft.

On Curvilinear to Straight Path Tracking, the aircraft flies a curvilinear profile from roll-out to checkpoint, then Straight Path from checkpoint to release.

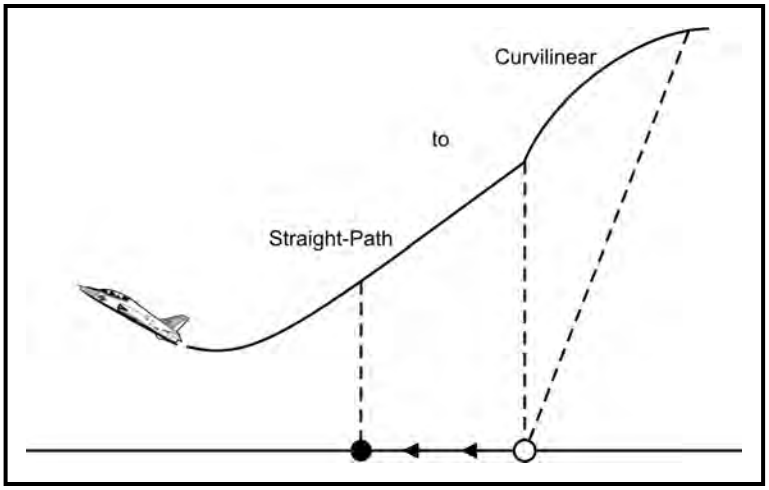


Figure 8-26 Curvilinear to Straight Path Tracking

This technique can be performed in either MANUAL or CCIP modes.

Curvilinear to Straight Path Tracking technique is a compound tracking technique. It involves two types of techniques to get you to the release point.

To perform this technique, a constant TPA is maintained from roll-out to checkpoint, then the resultant FPA is maintained and straight path tracking is commenced from checkpoint to release.

Curvilinear to Straight Path Tracking Procedures – MANUAL Delivery Mode

At Initial Roll-out:

1. Evaluate the Initial Sight Picture

   - Tough to read altitude, but it reads 6800’ (slightly shallow ISP)

2. Set the Target Placement Angle (TPA):

   - Place VV 5 degrees above target for 30 / 20 degree patterns after rolling out on target.

   - 4 degrees above in the 10 degree pattern

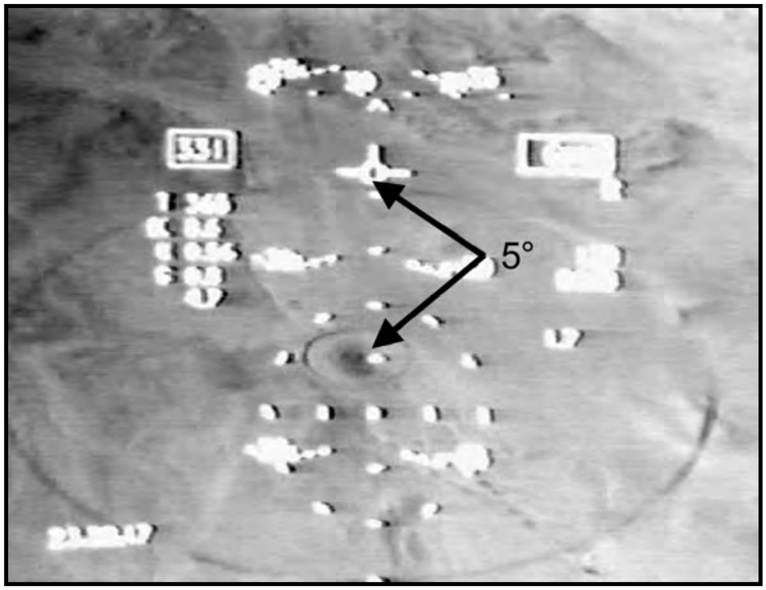


Figure 8-27 Curvilinear to Straight Path Tracking Procedures – MANUAL Delivery Mode

3. Slight bunt to keep TPA constant.

   - requires about .7g vice .9g in straight path tracking

4. Keep monitoring line-up to track target vertically between pitch ladders.

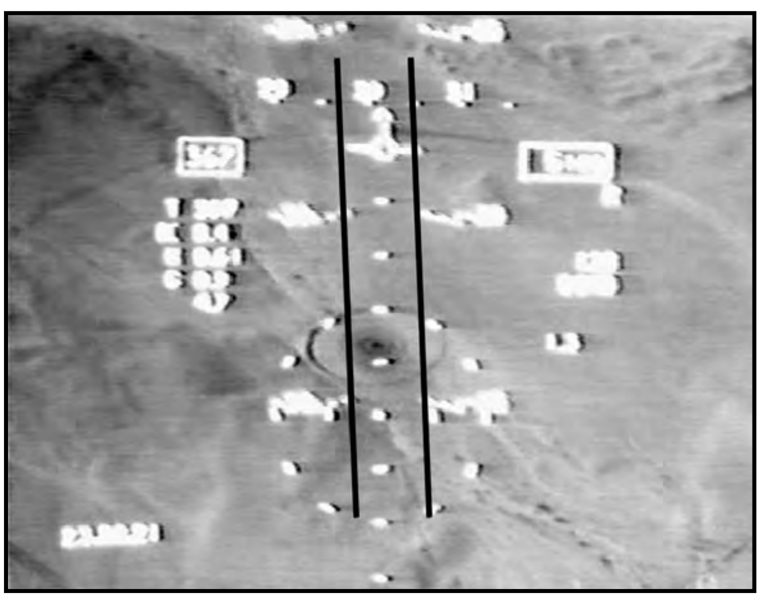


Figure 8-28 Curvilinear to Straight Path Tracking Procedures – MANUAL Delivery Mode

At Checkpoint altitude:

1. Stop bunting and maintain the RESULTANT FPA

2. Note the airspeed:

   - 30 deg: 410 – 420 KTAS

   - 20 deg: 415 – 420 KTAS

   - 10 deg: 425 – 430 KTAS

3. Continue Straight Path to release.

4. Monitor altitude, line-up and pipper tracking

5. Make appropriate error corrections

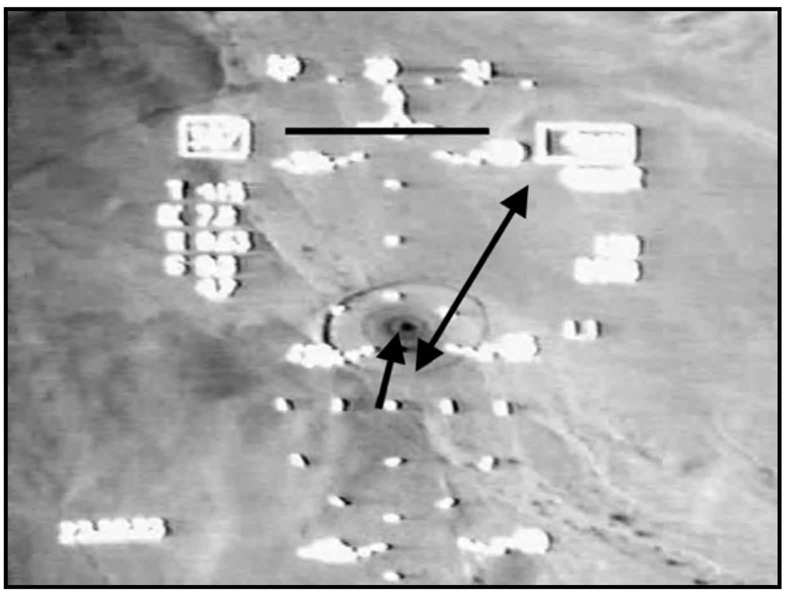


Figure 8-29 At Checkpoint Altitude

At Release:

1. Note airspeed, altitude and pipper placement.

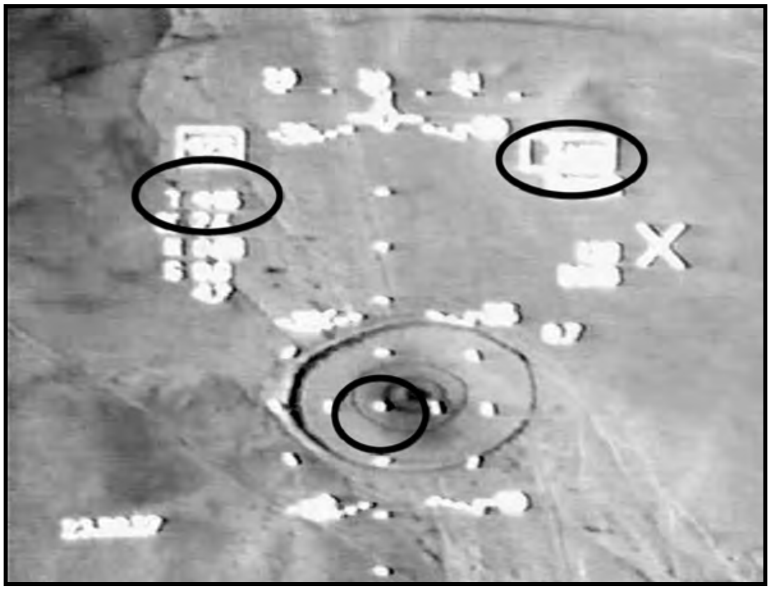


Figure 8-30 At Release

Now let's take a detailed look at what we reference for line-up corrections.

Line-Up Corrections

In the old iron sight days of the TA-4J and T-45A, we were taught to roll-in with the manual pipper lined up on the aimpoint (offset or bull). During the run, it was necessary to make constant lateral corrections into the wind to keep the pipper over the aimpoint to correct for the aircraft's lateral drift. We were taught to use the pipper for our line-up control. We still could do that today with the T-45C, but it wouldn't make much sense to teach a method that is no longer in use or even practiced EVER in a fleet airframe. The older-style fleet aircraft, the MANUAL delivery mode was the back-up mode in case your system went down in-flight and you still needed to get ordnance on-target when Marines were dying on the ground. In today's fleet aircraft, CCIP is that back-up mode, "manual" mode is not addressed in training. In the T-45C, we teach you the proper procedures of computed deliveries in both our delivery modes (MAN or CCIP) by referencing the Velocity Vector and pitch ladders.

The T-45C has the advantage of having an uncaged HUD and Velocity Vector (VV). In the uncaged mode, the Velocity Vector and Pitch Ladders are tied together in that the VV will always be in the center of the pitch ladders. Together, the pitch ladders and VV show where the aircraft is going. When we command weapon release, the bomb continues on that same path of the VV (one of those Newton Laws of motion) essentially imparting the VV to the front of the bomb. We will use this to help us solving for our 3 – 9 line correction. Lateral corrections will still be required to correct for lateral drift, however, those required corrections can be smoother (compared to the ratcheting of iron sight bombing) and less pronounced. In essence, we really are bombing in CCIP, but utilizing the Manual Sight Angle (pipper) to emphasize the importance of parameters at weapon release.

First, well look at a no crosswind component HUD picture, then we'll look at a tracking run with a direct crosswind.

No Crosswind Component

Here is an example of a no crosswind component tracking run. The wind is calm. You can see in this situation the pipper and Velocity Vector / pitch ladders all line up.

If you drew an imaginary plumb line below the Velocity Vector (as shown), you will see they all line up. Also, you will see the target ever so slightly left of the imaginary plumb line. We need to smoothly fly the aircraft slightly to the left to have the target directly below the Velocity Vector.

If we just continued this run, our hits will fall somewhere along the plumb line. How short or how long along this line will be determined by airspeed, altitude, and pipper placement.

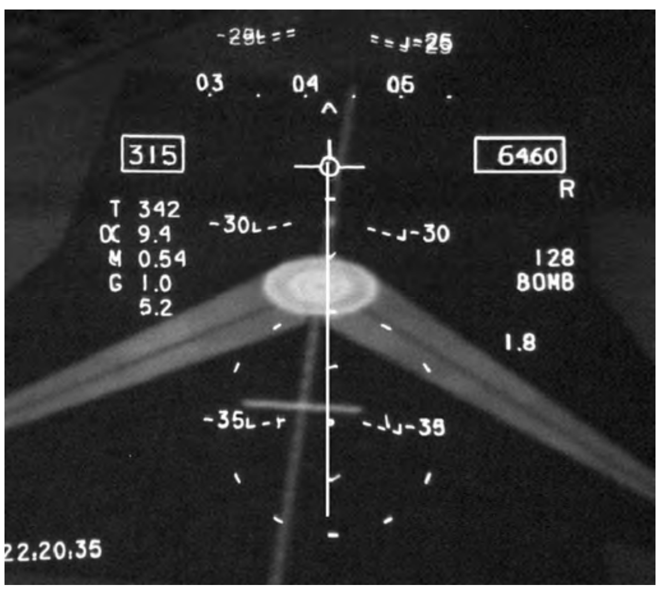


Figure 8-31 No Crosswind Component

With Crosswind Component (OAP: 170' @ 9:00)

Here is an example of what a direct crosswind looks like. The wind is 90 degrees off, left to right, at 15 knots. Our Offset Aim Point is calculated to be 170 feet at 9 o'clock.

Notice, in order to fly the flight path, the aircraft is pointed left of the target. With an uncaged HUD, the Velocity Vector and Pitch Ladders indicate where the aircraft is actually going, everything else displayed in the HUD is stationary and indicate where the aircraft is actually pointing. As our aircraft accelerates, this crab angle will decrease slightly.

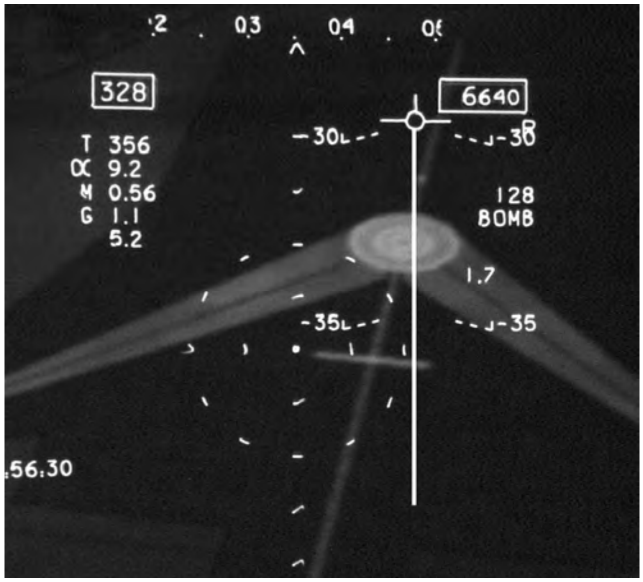


Figure 8-32 With Crosswind Component (OAP: 170' @ 9:00)

Looking at the bullseye, we can see the target is closer to the left side of the pitch ladders than it is to the right, so we need to come slightly left for lineup. To emphasize this, we can draw an imaginary plumb line below the Velocity Vector down in between the inner tick marks of the 35 degree pitch ladder (as shown). Notice how the target is ever-so-slightly left of the line.

In doing so, the pipper will naturally see the Offset Aim Point (OAP) at release.

With Crosswind (Checkpoint Altitude)

Arriving at Checkpoint Altitude, notice the lineup now appears to look good with the bullseye directly in between the pitch ladders.

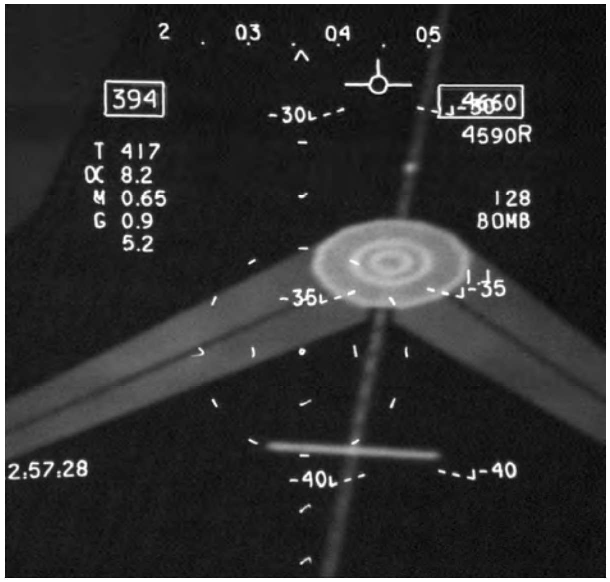


Figure 8-33 With Crosswind (Checkpoint Altitude)

If we hold this lineup, the pipper will seek the aim point.

With Crosswind (Release Altitude)

Arriving at Release Altitude, the pipper arrives at the OAP of 170' @ 9:00 relative to the run-in line. Again, if we drew an imaginary plumb line down below the Velocity Vector it will indicate where the bomb will fall.

When we press the Weapon Release Button or "Pickle Button", you are telling the bomb to take on the flight path of your Velocity Vector. Due to *trajectory drop*, it will fall below the Velocity Vector.

Shown here, we are slightly shallow, but slightly low, the airspeed is good. This would have resulted in a hit within 40 feet of the target.

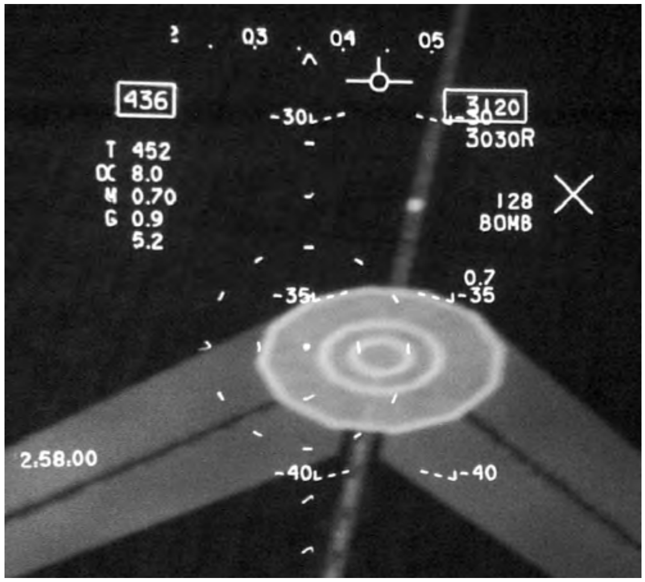


Figure 8-34 With Crosswind (Release Altitude)

The Importance of Setting the Correct TPA

The T-45C MANUAL delivery mode offers us the capability to better understand the importance of setting the proper Target Placement Angle at the checkpoint altitude. To help us better understand this concept, we revert to the Manual Pipper Tracking "Rules of Thumb" used exclusively in the iron sights of aircraft past.

The Manual Pipper "Rules of Thumb" of Straight Path Tracking state:

1. At 3 times the release altitude, the pipper should be 2/3 of the sight angle short of the aimpoint.

2. At 2 times the release altitude, the pipper should be 1/2 of the sight angle short of the aimpoint.

3. At 1.5 times the release altitude, the pipper should be 1/3 of the sight angle short of the aimpoint.

Our checkpoint altitudes on our Z Diagrams are based on Rule #3. Now let's look at the checkpoint altitude sight picture for our 30 degree dive, for example.

1.5 times our release altitude is 4,500' agl. 1/3 of our sight angle (128) is 42 mils.

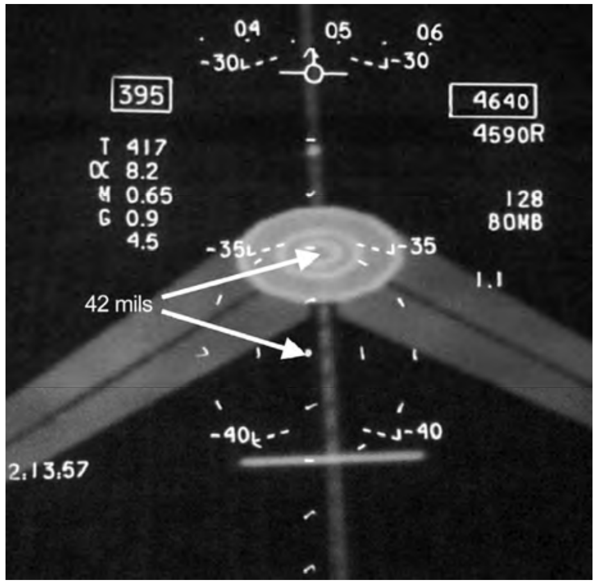


Figure 8-35 Setting the Correct TPA

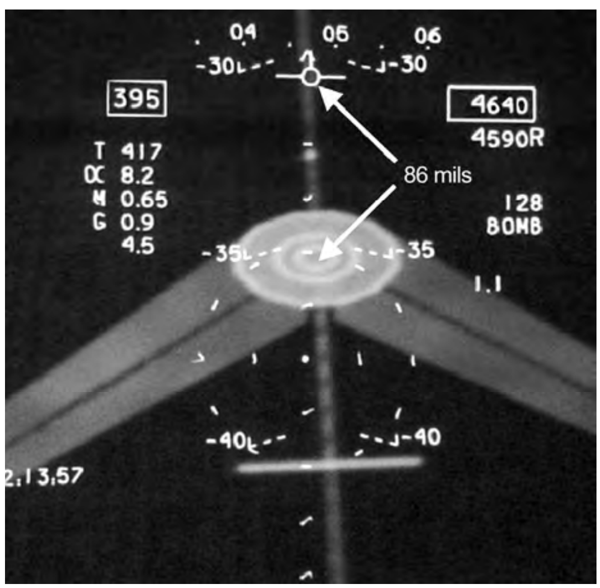


Figure 8-36 Setting the Correct TPA

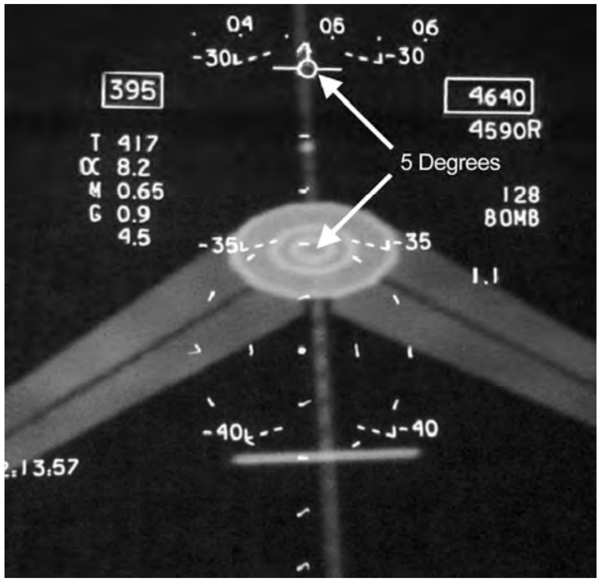


Figure 8-37 Setting the Correct TPA

In our example above, the Sight Angle is 128 mils. With the pipper being 42 mils <u>below</u> the target results in 86 mils <u>above</u> the target.

There are 17.45 mils per degree. 86 mils / 17.45 = 4.9 or 5 degrees. So then, by placing the Velocity Vector 5 degrees above the target results in the pipper 42 mils below the aimpoint.

If we set **more than 5 degrees (>TPA)** above the target, it will result in the pipper being less than 42 mils from the aimpoint, causing the pipper to arrive at the aimpoint earlier than planned (i.e. less tracking time, **early sight picture**) or higher than planned.

If we set **less than 5 degrees (<TPA)** above the target, it will result in the pipper being more than 42 mils below the target, causing the pipper to arrive at the aimpoint later (longer tracking time, **late sight picture**) or lower than planned.

When we employ the T-45C in the MANUAL delivery mode, we have the ability to reference the mil settings associated with the MANUAL sight. When employing in CCIP, we don't have the ability to read mils. We must convert mils to degrees. We ultimately are training you the proper techniques associated with computed deliveries, hence the reason we focus on setting the Velocity Vector a certain number of degrees above the target on all deliveries.

A technique in determining 5 degrees above the target for 30 and 20 degree dives has been to use the pitch ladders (inner tick marks) as a 5 degree ruler. By matching the position of the target as it relates to the 35 degree pitch ladder, placing the Velocity Vector on the same location relative to the 30 degree pitch ladder results in exactly 5 degrees. As shown in the above figure, the target is ever so slightly below the 35 degree pitch ladder and the Velocity Vector is ever so slightly below the 30 degree pitch ladder. The same technique can be used for the 20 degree pattern, referencing the 25 and 20 degree pitch ladders. The 10 degree TPA is 4 degrees and requires a bit more of an eyeball calibration to see 4 degrees.

802. CONTINUOUSLY COMPUTED IMPACT POINT (CCIP) DELIVERY MODE

The CCIP delivery mode is a computed mode which features a continuously computed impact point for the release cue. The pilot is required to fly the aircraft in a manner which places the CCIP release cue (CCIP pipper) over the target and manually press the weapon release button or Gun trigger. To aid the pilot in CCIP pipper tracking during bomb delivery, a vertical line, called a Bomb Fall Line (BFL) extends below the Velocity Vector to the CCIP pipper. In the uncaged HUD mode, this line represents the trajectory of the bomb as it falls from the aircraft to the CCIP pipper. The CCIP pipper should indicate the location the bomb will impact the ground based on the existing aircraft parameters.

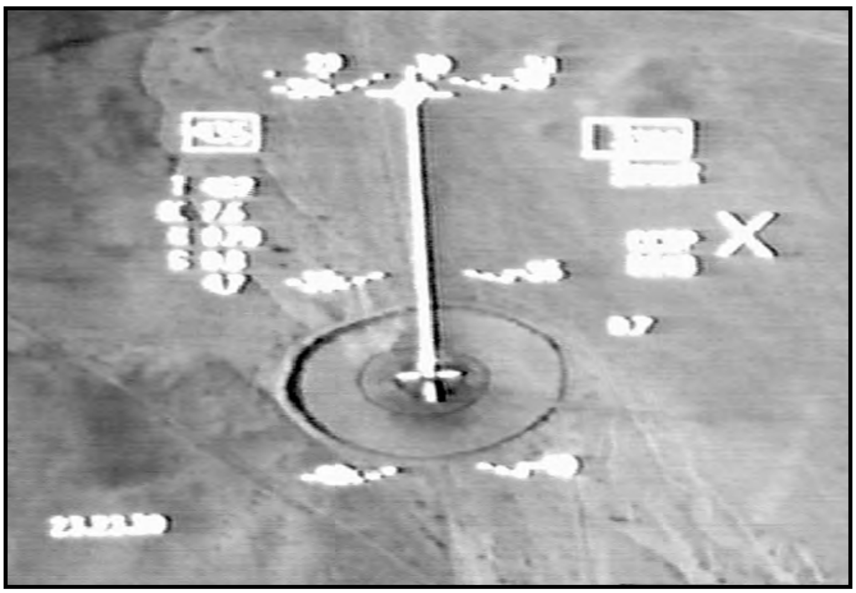


Figure 8-38 Continuously Computed Impact Point (CCIP)

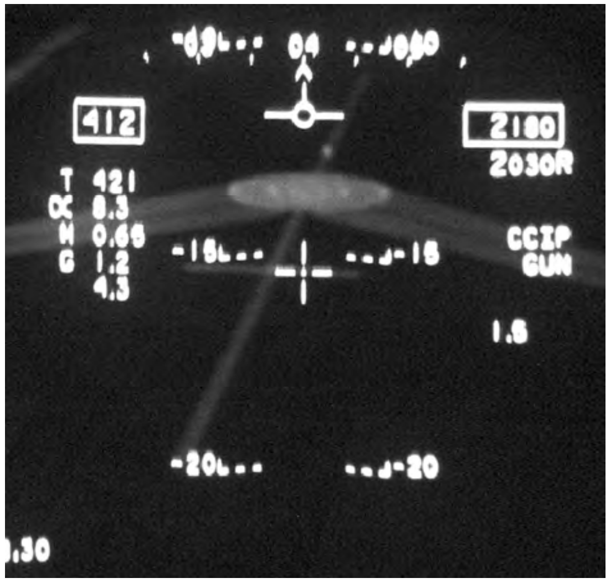


Figure 8-39 Continuously Computed Impact Point (CCIP)

The T-45C mission computer uses the radar altimeter for it’s height above target computations. Absence of the radar altimeter (above 5000’ agl for example or if the RALT is turned off), the mission computer uses barometric altitude minus entered target height to determine the height above target. A noticeable “jump” in the CCIP release cue is common passing 5000’ agl as the CCIP sight transitions from using barometric altitude to radar altitude.

To smooth this transition, the entry of Target Height (TGHT) into the system is recommended.

INSTRUCTOR NOTE

> The acceptable error tolerance for the T-45C radar altimeter is 10% of the actual radar altitude. So at 3000’ agl, it can be off by 300’ and still remain within acceptable tolerance.

The procedures for using the CCIP delivery mode are no different than those taught in the MANUAL delivery mode. We still employ the same techniques of straight path tracking and curvilinear to straight path tracking, with the exception, CCIP bomb delivery mode produces a Bomb Fall Line (BFL) to enhance our line-up guidance and a release cue to indicate the proper time to command weapon release. In the MANUAL mode, you had to determine when to release based on our current conditions, whereas in CCIP, it tells you when to release. WE ARE STILL REQUIRED to maneuver the aircraft to the “same piece of sky” for the weapon to fall and impact the intended target. There is no “magic” involved, but it does take out some of the mental gymnastics.

Most CCIP bombing sights require some amount of steady state tracking time to allow the weapons computer enough time to calculate an accurate release solution. Any last minute BOLD adjustments will degrade the accuracy of the CCIP pipper. Be smooth when flying in CCIP.

Straight Path Tracking – CCIP Delivery Mode

At initial roll-out (Refer to Figure 8-40)**:**

1. Evaluate the Initial Sight Picture.

   - Slightly far roll-in distance.

   - Slightly shallow ISP shown here.

   - Notice altitude is 6600' vice 7000'.

2. Set the Initial Target Placement (ITP):

   - Place the VV 2 ½ degrees to 3 degrees above target. (30/20 deg pattern)

   - Results in 29 ½ degree FPA shown here.

   - 10 degree pattern: 2 – 2 ½ deg.

3. Maintain the *RESULTANT* Flight Path Angle (FPA) to checkpoint altitude.

4. Between roll-out and checkpoint, correct left or right for lineup – have target track vertically along the Bomb Fall Line.

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

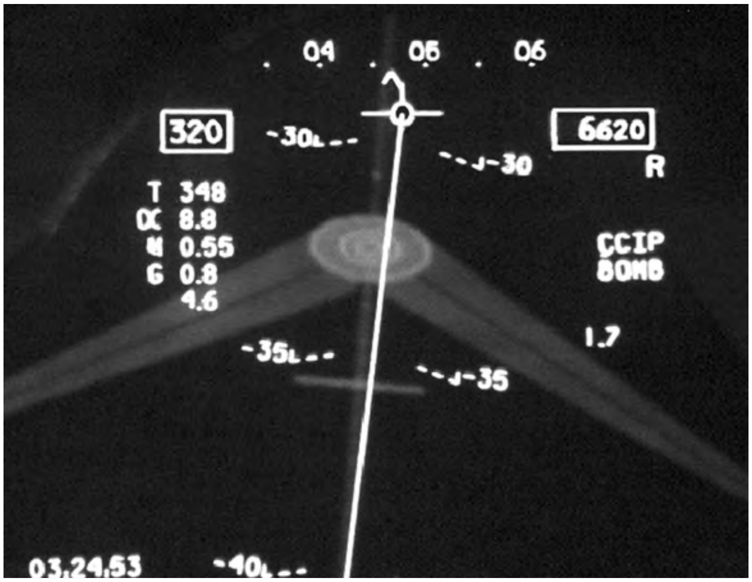


Figure 8-40 Straight Path Tracking – CCIP Delivery Mode

Checkpoint altitude:

1. Set the Target Placement Angle (TPA).

2. Note the airspeed: (404, a little slow)

   - 30 deg: 410 – 420 KTAS

   - 20 deg: 415 – 420 KTAS

   - 10 deg: 425 – 430 KTAS

3. Check Line-up.

4. Apply error corrections, if required:

   - Shallow / slow cause low releases – late release solution.

   - Steep / fast cause high releases – early release solution

5. Maintain resultant Flight Path Angle (FPA) to release.

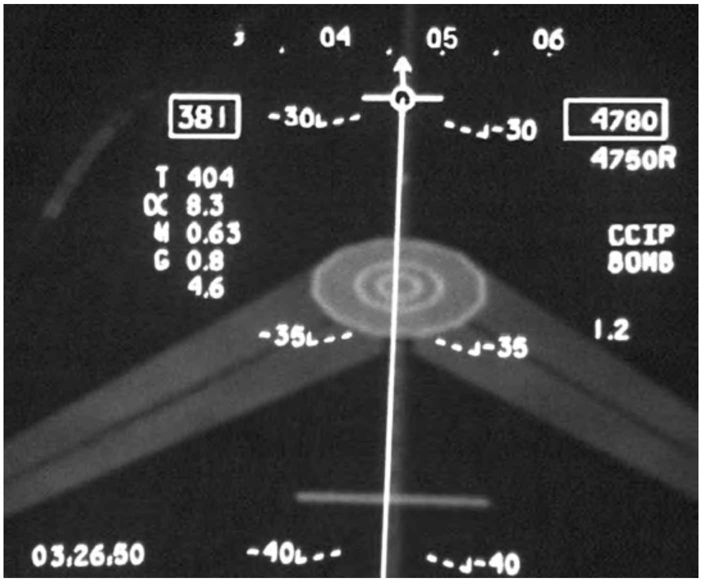


Figure 8-41 Checkpoint Altitude

Checkpoint to Release:

1. Maintain the resultant FPA to release.

   -resist VV creep.

2. Monitor altitude, line-up and pipper tracking.

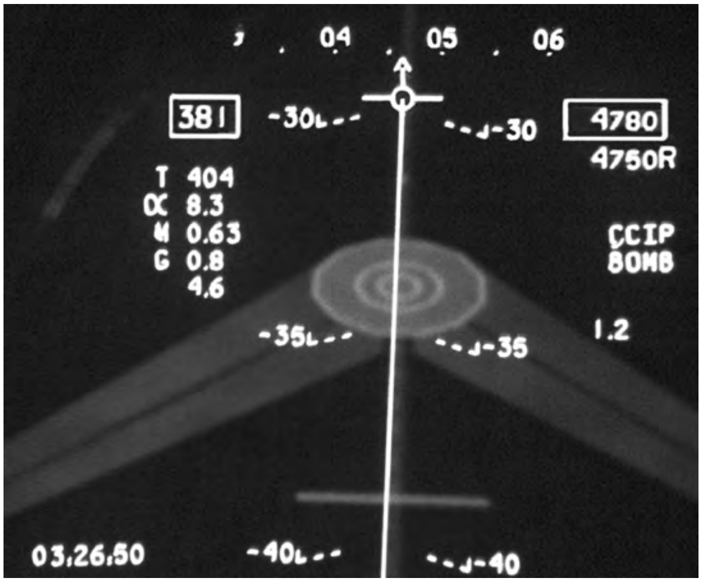


Figure 8-42 Checkpoint to Release

Release Altitude:

1. Pickle when CCIP pipper is on the Aim Point.

   - Normally, the CCIP cross would be over the target at release. Shown here, this particular simulator CCIP sight drops 150’ long, so we needed to aim 150’ short of the target to get the bomb to impact our intended point.

2. At release, note pipper placement, airspeed and altitude.

   - Since we are 8 knots slow and slightly shallow, CCIP corrects for these errors and gives us a release solution slightly lower than planned.

This hit resulted in a score of 12’ at 6:00.

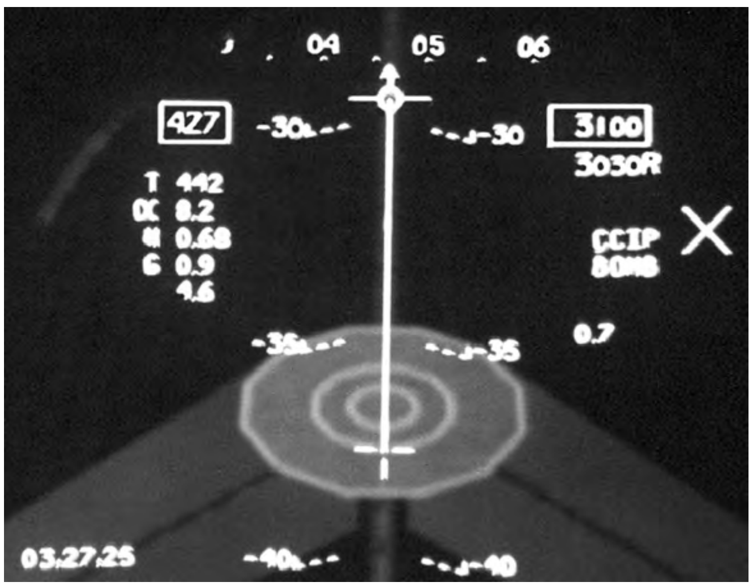


Figure 8-43 Release Altitude

Curvilinear to Straight Path Tracking – CCIP Delivery Mode

At initial roll-out:

1. Evaluate the Initial Sight Picture.

   - Good roll-in distance.

   - Good ISP shown here.

2. Set the Target Placement Angle (TPA):

- Place the VV 5 degrees to above target. (30/20 deg pattern)

- Results in 27 ½ degree FPA shown here.

- 10 degree pattern: 4 deg. above

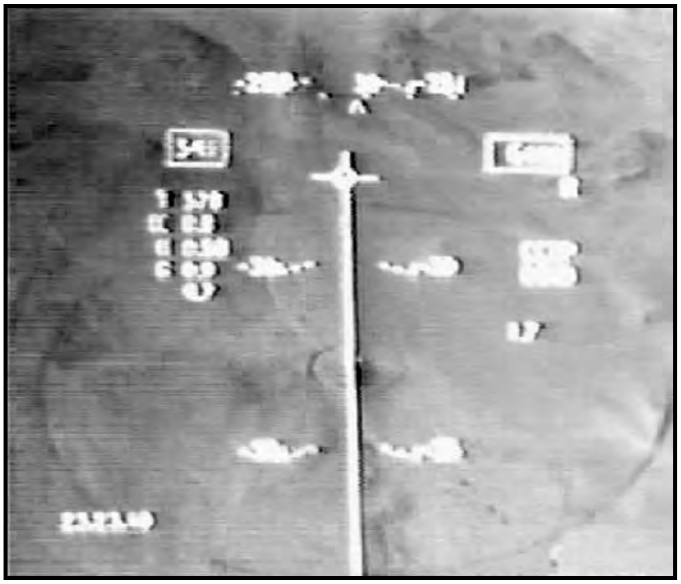


Figure 8-44 Curvilinear to Straight Path Tracking – CCIP Delivery Mode

3. Slight bunt to keep TPA constant.

   - requires about .7g vice .9g in straight path tracking.

4. Between roll-out and checkpoint, correct left or right for lineup – have target track vertically along the Bomb Fall Line.

5. Maintain constant Target Placement Angle (TPA) to checkpoint altitude.

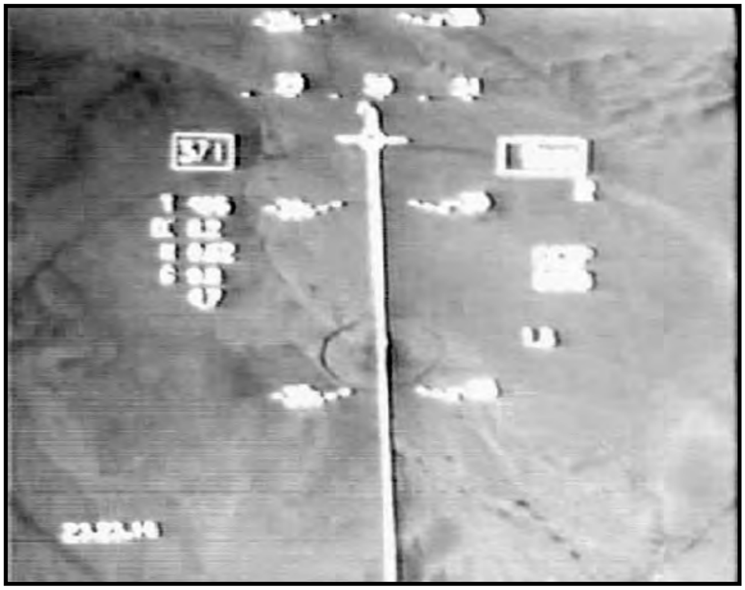


Figure 8-45 Curvilinear to Straight Path Tracking – CCIP Delivery Mode

Checkpoint altitude:

1. Stop bunting and maintain resultant Flight Path Angle (straight path).

2. Note the airspeed:

   - 30 deg: 410 – 420 KTAS

   - 20 deg: 415 – 420 KTAS

   - 10 deg: 425 – 430 KTAS

3. Check Line-up.

4. Apply error corrections, if required:

   - Shallow / slow cause low releases – late release solution.

   - Steep / fast cause high releases – early release solution

5. Maintain the resultant Flight Path Angle (FPA) to release.

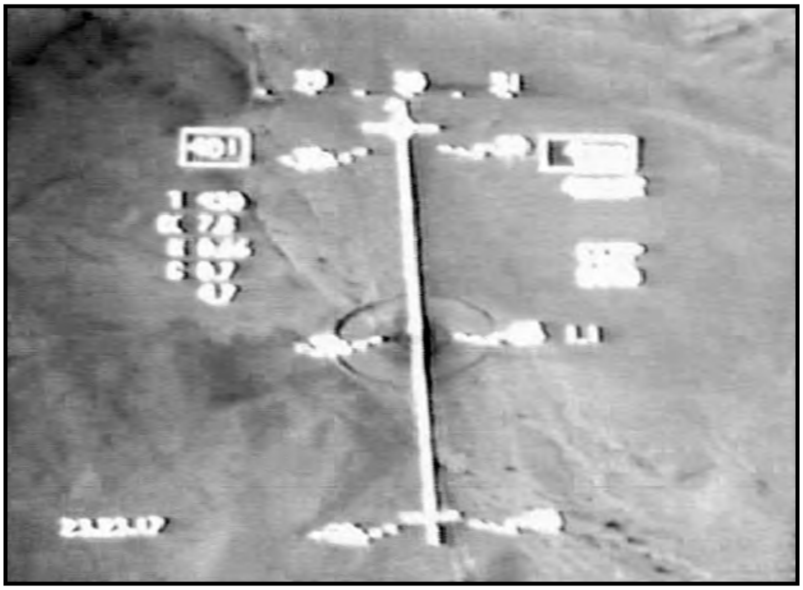


Figure 8-46 Checkpoint Altitude

Checkpoint to Release:

1. Maintain the resultant FPA to release.

   -resist VV creep.

2. Monitor altitude, line-up and pipper tracking.

Release Altitude:

1. Pickle when CCIP pipper is on the Aim Point.

2. At release, note pipper placement, airspeed and altitude.

   - A little fast and a little steep causes a little high release solution.

Hit resulted in a score of 4’ at 1:00.

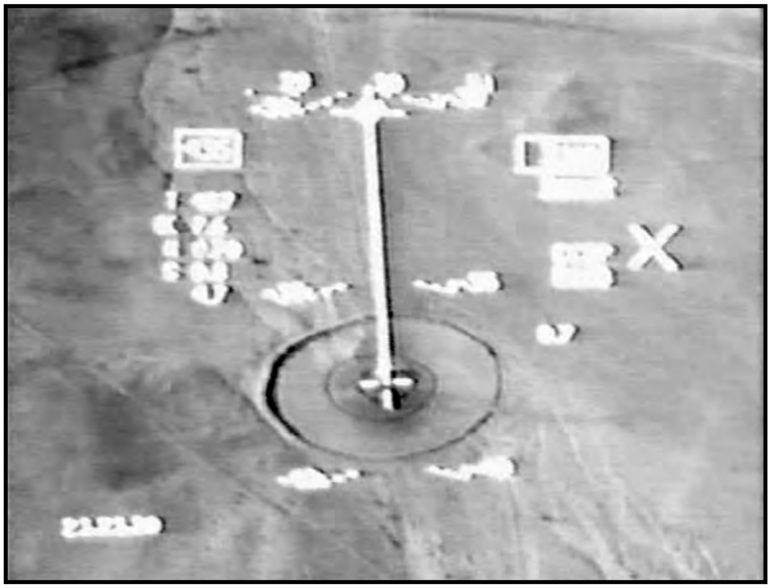


Figure 8-47 Release Altitude

Once again, the key to CCIP bombing is to be smooth during the last part of the tracking run. This allows the mission computer to give you the best, most accurate weapons release solution. Any last minute BOLD adjustments in pitch (g application) or left / right corrections will degrade the accuracy of the system.

CCIP Error Sensitivities

As in MANUAL delivery mode, the error sensitivities remain the same, with the beautiful exception in that the aircraft computes the error computations and corrections needed for you. Some may think of this technology as “magic” but when it comes right down to it, the weapon you are delivering (Mk 76) is basically a smooth rock with fins and falls through the air the same whether or not you release in a MANUAL or a computed mode. Recalling the errors from the weapons theory chapter for a MANUAL delivery, a steep, fast, or low release will cause a long hit and a shallow, slow, or high release will cause a short hit. In MANUAL, it was up to you to determine the correction needed to compensate for the error. For example, if you were steep (long) or fast (long), you would have had to release high (short) to compensate. In CCIP, the weapons computer will provide you with the proper release altitude based on your aircraft’s parameters. In essence, it will give you a release solution high or low to compensate for your deviations. The computer cannot control the dive angle or speed of your aircraft, it can only provide you with an altitude solution based on the other two.

So, if your aircraft is **STEEPER or FASTER than planned** <u>with the correct TPA set at checkpoint</u> altitude, CCIP will give you a **HIGH** release solution to compensate for the long error.

If your aircraft is **SHALLOW or SLOW** <u>with the correct TPA set at checkpoint altitude</u>, CCIP will give you a **LOW** release solution to compensate for the short error.

Recalling the error sensitivities for the 30° and 20° pattern, they are:

+/- 1° = +/-10 KTAS = +/-100’

If you are 1° steep or 10 KTAS fast, CCIP will give you 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. Based on the proper TPA being set at the checkpoint.

Recalling the error sensitivities for the 10° pattern:

+/- 1° = +/-10 KTAS = +/-70’

If you are 1° steep or 10 KTAS fast, 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. Based on the proper TPA being set at the checkpoint.

Some Last Words on Computed Deliveries

One last note regarding the CCIP sight. The length of the CCIP Bomb Fall Line (BFL) or “stick” increases or decreases based on the trajectory drop of the weapon (or how far the bomb will fall below the Velocity Vector). You will notice with the combination of your aircraft accelerating in the dive and your aircraft getting closer to the ground, the CCIP cross or “pipper” moves up toward the Velocity Vector, the BFL decreasing in length. This is all based on trajectory drop.

If you notice, the tracking techniques taught here in CCIP should be VERY similar to those techniques taught in our MANUAL deliveries. This is the reason we referenced the Velocity Vector to the target, set proper Target Placement Angles, and lineup using the Velocity Vector and Pitch Ladders in the MANUAL mode. If you learned the techniques and procedures properly in MANUAL, the transition to the CCIP mode will be smooth and SAFE. The MANUAL mode taught us the basics and importance of parameters, CCIP mode will refine those basics and increase accuracy while reducing pilot workload.

CCIP remains a valid delivery mode for missions such as Close Air Support (CAS) and at times when you are called upon to get bombs on target without having time for system management. CCIP tracking **IS NOT** just rolling in, placing the Velocity Vector on your preplanned dive angle and waiting for the CCIP pipper to cross the target. There’s more to it than that. There’s a right way and a wrong way to bomb in CCIP.

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 parameters at release or not getting a solution at all due to poor parameters at planned weapon release.

2. Setting an insufficient amount of power at roll-in causing a slow release airspeed resulting in a low release.

3. Setting too much power at roll-in causing EXCESSIVE airspeed, resulting in a high release or an unsafe run.

4. Not having the proper TPA set at checkpoint altitude, causing either a late sight picture (low release) or an early sight picture (high release). Less than optimum TPA at checkpoint altitude causes a late solution (low release). More than optimum TPA causes an early solution (high release).

5. Setting the planned dive angle without respect to the TPA, resulting in late or early sight pictures which lead to low or high releases.

6. Not "freezing" the Velocity Vector after checkpoint altitude and allowing it to creep up, maintaining more than optimum g, inducing errors to the system. The optimum g for the dive angle is found by taking the cosine of the dive angle. For example, cosine of 30 is 0.87 g. By simply "freezing the Velocity Vector" on the dive angle will result in proper g.

7. Not tracking the target down the BFL, therefore not having the CCIP pipper on the target at release point, causing the bomb to miss the target.

8. Not pressing the bomb pickle button with the CCIP pipper on the target. Any "itchy trigger fingers" or delay in pressing the pickle button will cause inaccurate hits.

9. Bombing in the "caged" mode making it difficult to track the target down the BFL to release.

803. ERROR CORRECTION TECHNIQUES – REVIEW (ALL MODES)

This section explains/reviews the proper techniques for deviations from the planned release parameters, referred to as error corrections. These corrections apply to either MANUAL or CCIP Delivery Modes. The checkpoint altitude is designed to give you a last opportunity to correct for these errors. You will be graded on how well you apply these corrections.

Corrections for Dive Angle

You can read your dive angle directly from the pitch scale on your HUD. Depending on tracking technique, your dive may steepen or shallow slightly during the run and should indicate the proper dive angle at release. Corrections for dive angle should be applied after the TPA is properly set at the Checkpoint altitude.

1. Correcting for a Steep. In a 30-degree run, for example, the HUD should indicate 30 degrees at the checkpoint. If you find that your dive angle is too steep, to avoid losing valuable tracking time, maintain your dive angle and adjust your release altitude accordingly. If you know your error sensitivities, this is a simple correction to make. For example, if in a 30-degree bomb run, your HUD indicates 32 degrees after setting the TPA at checkpoint. You can compensate by pickling 200 feet high. If the proper TPA was set at the checkpoint, the pipper will naturally arrive at the aimpoint 100’ high for every degree steep. You can pickle when the pipper reaches the aimpoint.

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

2. Correcting for a Shallow. To correct for a shallow dive angle, you have two options:

   a. Add power to increase your airspeed (10 KTAS / 1 degree shallow)

      For example, if in a 30-degree bomb run you find that your HUD is indicating 28 degrees as you approach release altitude, you can compensate by increasing power by about 4% rpm, allowing the aircraft to accelerate to 470 kts and pickling at the planned altitude.

   b. Prior to release, adjust the nose slightly to have the pipper track past the aimpoint 50’ long (30/20 deg pattern) or 80’ long (10 deg pattern) and release on altitude. This may be your only option in the 10-degree pattern due to the fact you have MRT set and you can not possibly correct by going faster.

      You must also be careful not to release with excessive g, because, as has already been explained, this can cause a false sight picture. Also, keep in mind, the maximum g at release (limitations) is 1.5 g.

      A shallow will lead you to a late sight picture if no error correction is applied. Never press the run below normal release altitude to correct for a dive parameter or for any other reason.

   Understand what caused you to be shallow and make the proper adjustments on follow on runs.

Corrections for Airspeed

Experience will help you to anticipate large errors early in the run and to make appropriate power corrections. Maintain awareness of airspeed during the final portion of the run to be sure you are at release airspeed when you reach release altitude. Last-minute corrections for airspeed errors are similar to those for dive angle errors. For example, if in a 30-degree bomb run you find that you are 20 knots fast at the checkpoint, you can compensate either by pickling 200 feet high or by pickling at normal altitude with the pipper 100 feet short of the target. If you are 20 knots slow, you can allow the pipper to drift 100 feet past the target by release altitude. Never release below normal release altitude to correct for a dive parameter, or for any other reason.

Correction for Pipper Position

The position of your pipper at release is probably the most important single factor in determining where your weapon will hit. If you release with the correct altitude, airspeed, dive angle, etc. (no wind), the weapon will impact where the pipper was positioned at release. If the pipper was 300 feet past the target, that is where your hit will be, even though you did everything else right. Experience will help you recognize early in the run that the pipper is not going to arrive at the final aimpoint by release altitude, and to make early corrections. Sometimes it is an improper roll-in that leads to improper pipper position. For example, if you start a straight-path tracking run with the proper dive angle, but you find that you have to shallow your run to make the pipper reach the target by release altitude, then the problem could be that you have rolled in too far from the target, or that you have allowed your nose to drop during the initial part of the roll-in. Sometimes, however, even though you may have the proper dive angle and airspeed, you will find that the pipper is not where you want it to be as you approach your release point. The pipper may be reaching the aimpoint too early or too late, or it may be deflected to one side or the other.

Corrections for Early Sight Picture

If your pipper arrives at the aimpoint before you reach the normal release altitude, then you have an "early sight picture." There are two causes which result in an early sight picture:

1. Too much TPA is set at the checkpoint (i.e. more than 5 degrees between the Velocity Vector and the target), and/or;

2. Too much g at release (Velocity Vector creeping up).

In such a case, assuming all parameters correct and no wind, if you were to pickle with the early sight picture, your hit would be short because of your altitude error. On the other hand, if you were to pickle at normal release altitude, your hit would be long because the pipper would be past the target. If you were to try to hold the pipper on the target until release altitude, your dive angle would increase and you would release with insufficient g.

The proper correction is to notice the altitude at which you get the early sight picture and to split the difference between that altitude and release altitude. For example, suppose that in a 30-degree bomb run, your pipper arrived at the aimpoint at 3,400 ft AGL. With proper airspeed, dive angle, etc., you could compensate by continuing to hold your 30-degree dive and pickling at 3200 ft AGL. However, improper pipper position can often be traced to an improper roll-in. If you find that you are consistently getting an early sight picture, and your dive angles are correct at release, then the problem may be that you are rolling in too close to the target or have too much nose up trim. In contrast to an early sight picture, a late sight picture cannot be corrected at release.

Resist the urge to hold the pipper on the aimpoint until release altitude. You are only giving yourself a false sense of security, for your bomb will go long, due to an invalid pipper (less than optimum g).

Corrections for Late Sight Picture

If you reach release altitude and the pipper has not reached the aimpoint (late sight picture), you must either release at normal altitude and take the short hit, or you must abort the run. Never release below normal release altitude to correct for a late sight picture or for any other reason. The causes of a late sight picture are a few:

1. Not enough TPA set at checkpoint (i.e. less than 5 degrees between the Velocity Vector and the target);

2. Being shallow after setting the proper TPA at checkpoint

3. Bunting the stick after checkpoint (insufficient g), and/or;

4. In CCIP, being slow.

If you recognize during the run that you are going to have a late sight picture, you can correct by using very slight back pressure on the stick to make the pipper track faster, or you can use slight back pressure to change pipper placement and then resume proper g. You should be aware, however, that this technique will shallow your dive angle and may necessitate another correction. In any case, you should try to analyze the reason for the late sight picture. It could have occurred because you rolled in too far from the target, or because you did not maintain altitude during the initial part of the roll-in, or because you pulled your nose down too far during the final part of the roll-in.

Corrections for Deflection

If your pipper is offset to one side of the desired initial aimpoint, the correction you can make for this deflection error depends on the type of ordnance being used. With bombs, there is no last-minute correction for deflection. Kicking in rudder to move the pipper to the desired aimpoint will not appreciably affect the trajectory of the bomb, and your hit will not be improved. Rolling into an angle of bank at the last moment will not be effective either, because the pendulum effect will cause a false sight picture. You must recognize the problem early in the run, make a correction using small amounts of bank, and be sure that your wings are level at release.

Conversely, with forward-firing ordnance, it is possible to use your rudder to make a last-minute correction for pipper deflection. Unlike bombs, forward-firing ordnance will initially travel in the direction it is fired, even in unbalanced flight where the firing direction is not the same as the aircraft direction of flight. The ordnance will then curve as it aligns itself with the relative wind. Because of this realigning tendency, you cannot simply move the pipper over to the desired aimpoint. You must make a larger correction. With rockets, your correction should be four times the deflection error. For example, suppose that your pipper is 10 mils left of the aimpoint. Use your rudder to move the pipper a total of 40 mils to the right, so that it will be 30 mils to the right of the aimpoint. With guns, because the bullets have a higher initial velocity and have fewer tendencies to align themselves with the relative wind, a smaller correction is needed. Your correction should be 1.25 times the deflection error. For example, if your pipper is 20 mils to the left of the desired aimpoint, use your rudder to move it a total of 25 mils to the right, so that it will be 5 mils to the right of the aimpoint.

Corrections for Multiple Errors

In each of the foregoing discussions of error correction techniques, it was assumed that only one dive parameter was in error, and that the rest were correct. For example, when we say that a 2-degree error in dive angle will cause a 100-foot miss, we are assuming that the weapon is released at the proper airspeed and altitude, wings level, and with correct g and the pipper on the aimpoint. However, you will frequently find that one or more of your dive parameters is in error as you approach release. In such a case, the errors may be additive, or they may tend to cancel each other. For instance, suppose that in a 30-degree bomb run, you notice that your dive angle is 1 degree shallow and that your airspeed is 10 knots slow. If you have learned your error sensitivities properly, you know that each of these errors will cause your hit to be 50 feet short, for a total of 100 feet, and that you could correct by allowing the pipper to drift 100 feet past the target by release altitude. On the other hand, if you happen to be 1 degree shallow and 10 knots fast, you know that these errors cancel each other and no correction is needed. You can probably see, however, that trying to mentally compute corrections for multiple errors during the few seconds before release could become excessively complicated. Imagine trying to figure a correction for steep dive angle, fast airspeed, and early sight picture. For now you are in a training environment, and you have the option of aborting your run at any time. If you find yourself in a run that is really fouled up, don't drop.

CCIP Gun Strafe Procedures

The T-45C Gun Strafe will be normally performed in the 10 degree (low) pattern. A normal 10 degree pattern is flown. The Attack Cone Distance is moved out slightly to 2.3 nm.

With any type of forward firing ordnance, safety is always a concern. Even though the T-45C does not employ a real gun, we will teach you the habit patterns as if it did. One of the biggest differences is the Master Arming procedure. DO NOT place the Master Arm Switch to ARM until the nose is pointed at the target in the dive **and** the aircraft in front of you has called off. Ensure the Master Arm Switch is placed to SAFE when off target.

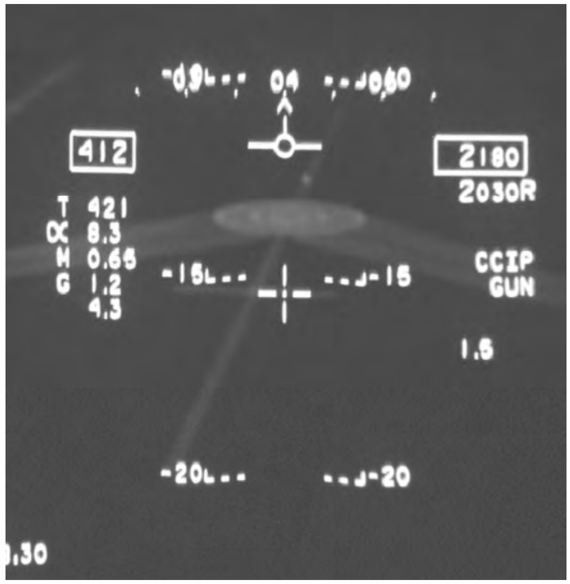


Figure 8-48 CCIP Gun Strafe Procedures

Upon rolling in on the target, place the Velocity Vector about 1° above the target. Or simply, place the target in between the Velocity Vector and the CCIP cross. The CCIP cross initially flashes indicating it is out of firing range and turns steady when within firing range. Allow the CCIP cross to naturally track up to the target, as it approaches the target begin firing by squeezing the Gun Firing Trigger in the control stick. As the CCIP cross begins to cross over the target, smoothly begin a slight forward bunt to help concentrate the main portion of the rounds on the target. Prior to reaching the minimum firing altitude, release the gun trigger and begin the *Guns Jink Maneuver*. The firing window is between 1,300’ and 1,000’. The time in this window is about one second.

The Guns Jink Maneuver

For strafe recovery, a level jink will be practiced. As the nose of the aircraft comes through the horizon, roll to 70 degrees AOB and smoothly apply 4 g’s. After 20 degrees of heading change, relax g, reset AOB, and pull to the abeam.

NOTES

CHAPTER NINE
RETURNING FROM THE TARGET

900. INTRODUCTION

RTB Procedures

Following the "Fenced out" check and/or exiting the Target Area, the flight will either set-up for the Break, perform a Hung Ordnance Approach, or separate the flight for a combination of the two. With all systems normal, the Break is the primary method of airfield entry. Overstressed aircraft will perform a straight-in or the hung ordnance approach, as directed by Lead.

The Break

The Break is the preferred landing pattern entry procedure. The Break will be preformed as briefed by Lead and will be in accordance with Division Form procedures and local directives.

The Hung Ordnance Approach Procedure

If Lead is hung or if two or more aircraft are hung, then the entire flight will fly the Hung Ordnance Approach. If one aircraft is hung, 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 published straight-in or appropriate Hung Ordnance Approach route. Extreme caution should be taken as not to over-fly populated terrain with hung ordnance. The most inclined times hung ordnance inadvertently falls from the aircraft are when transitioning to the landing configuration and upon touchdown. Caution should be taken at all times, however, due to the uncertainty of the ordnance remaining with the aircraft.

The Hung Ordnance Approach path is flown as to avoid populated areas and in accordance with local directives. If flown as a division, Lead will separate each aircraft individually as to have the Lead aircraft fully configured by three miles from the runway and established on a 3° glideslope. A technique used by Lead is to detach each aircraft in 2 nm intervals or 20 seconds apart.

When cleared by Lead to detach, the procedure is to select IDLE, speed brakes OUT, slow below 200 knots, select landing gear DOWN, flaps to HALF, slow to 150 knots and place the speed breaks back IN. It is important to follow Lead's flight path over the ground without cutting corners. This will keep you over the appropriate ground track as well as maintain the proper interval between aircraft. Each aircraft maintains 150 knots to 3 nm. At 3 nm from the runway, select flaps to FULL, speed breaks OUT, complete the landing checklist, slow to on-speed and report the "gear down" and locked with the Tower.

Lead will pick an appropriate side of the runway on which to land. Each aircraft will plan to land on alternate sides of the centerline in relation to the proceeding aircraft. The rate of descent on touchdown with ordnance needs to be monitored as to not exceed 600' per minute, as limited by NATOPS.

If a go-around/wave-off is performed, enter the landing pattern as to avoid buildings, houses and other populated areas.

Landing Roll-out and Taxi to the Line

If aircraft land from the same approach while alternating sides of the runway, remain on your respective side while slowing the aircraft to taxi speed. Normal deceleration rates as per local S.O.P. apply. Be considerate of the aircraft landing behind you as to avoid overly aggressive braking, unless safety dictates otherwise. Once the deceleration rate is acceptable, your aircraft is under control and it is safe to do so, you may clear the aircraft to cross in front of you by stating over Tactical frequency “cleared to cross”.

If Lead dictates the flight will taxi back together, the taxi back will be in accordance with Division Formation taxi procedures, complying with local directives. Dash Two sets the interval and Three and Four make the flight look good.

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 NATOPS and local procedures. Normal post-flight inspection is accomplished with special attention to aircraft damage due to frag or bomb-to-aircraft collisions. Specific areas of inspection include: access panels, underside of the wing, flaps, empennage, horizontal and vertical stabilizers.

NOTES

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CHAPTER TEN
ADDITIONAL WEAPONS MANEUVERS / TARGET TRACKING

1000. INTRODUCTION

Up to this point, you have been introduced to the basic skills of putting steel on target. The emphasis early in training was on building consistency; consistency in the pattern, basic airwork, the roll-in, HUD scan development and basic tracking techniques. The objective of the Air-to-Ground stage is to teach you those basic skill sets. If all you do during your time spent in this stage is master the basics of what has been previously discussed, you'll leave the Training Command with a solid foundation of which the FRS will build upon. Keep it simple and execute it to perfection.

This chapter will discuss some of the additional techniques, which if properly employed, can enhance the overall learning experience and give you some corporate knowledge for use in your follow-on training. The techniques discussed in this chapter should be attempted only after the basic skill sets previously discussed have been mastered. We will introduce Adaptive Roll-ins, the Harp Angle Bombing Technique, and Target Attacks without Target Waypoint Distance.

1001. ADAPTIVE ROLL-INS

Up until this point, the emphasis of our roll-in was to keep our altitude and roll-in maneuver consistent, then vary our roll-in distance to achieve the proper initial sight picture. There may be times due to weather or distractions, you might find yourself off of the planned altitude, or you may find yourself closer in or farther away from the target as you optimally would like when it comes time to roll-in on the target. All is not lost. Here is where you can apply an *Adaptive Roll-In* to help you salvage what could have been a bad start and turn it in to one that is at least, manageable. An Adaptive Roll-in is a maneuver in which you vary the lift vector placement 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 roll-out. Another correction for being high is to simply roll-in farther away from the planned roll-in point (increase the ACD) and execute a normal roll-in maneuver.

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 roll-out. Another correction for being low is to simply roll-in closer to the target (decrease the ACD) and execute a normal roll-in maneuver.

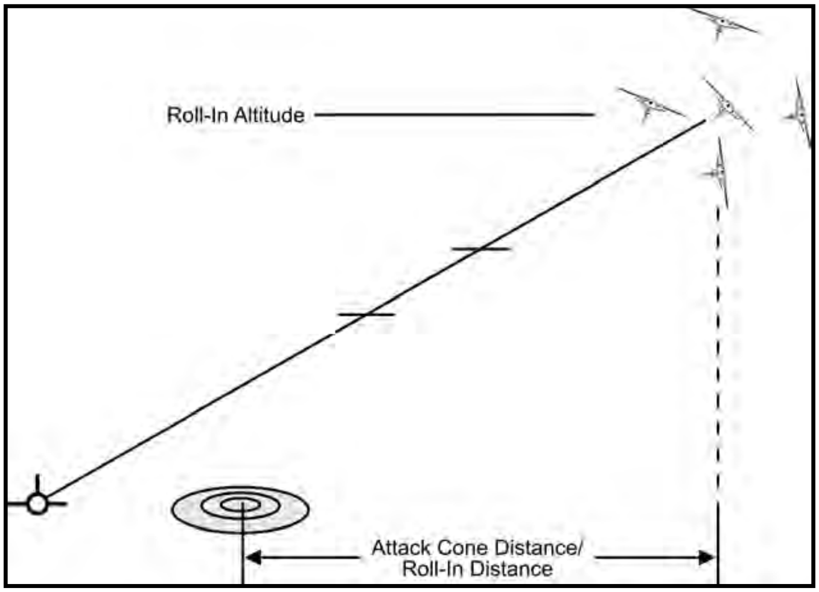

Figure 10-1 The Adaptive Roll-In Technique

1002. HARP ANGLE BOMBING TECHNIQUE / FLYING THE WIRE / STRAIGHT PATH – STRAIGHT PATH

The Harp Angle Bombing Technique is a way to fly the aircraft in a manner which places the target on a pre-determined depression angle at the checkpoint altitude, whereas by setting the Target Placement Angle (TPA) results in being on the planned flight path angle. The *Harp Angle* is the angle between the horizon and the line of sight to the target.

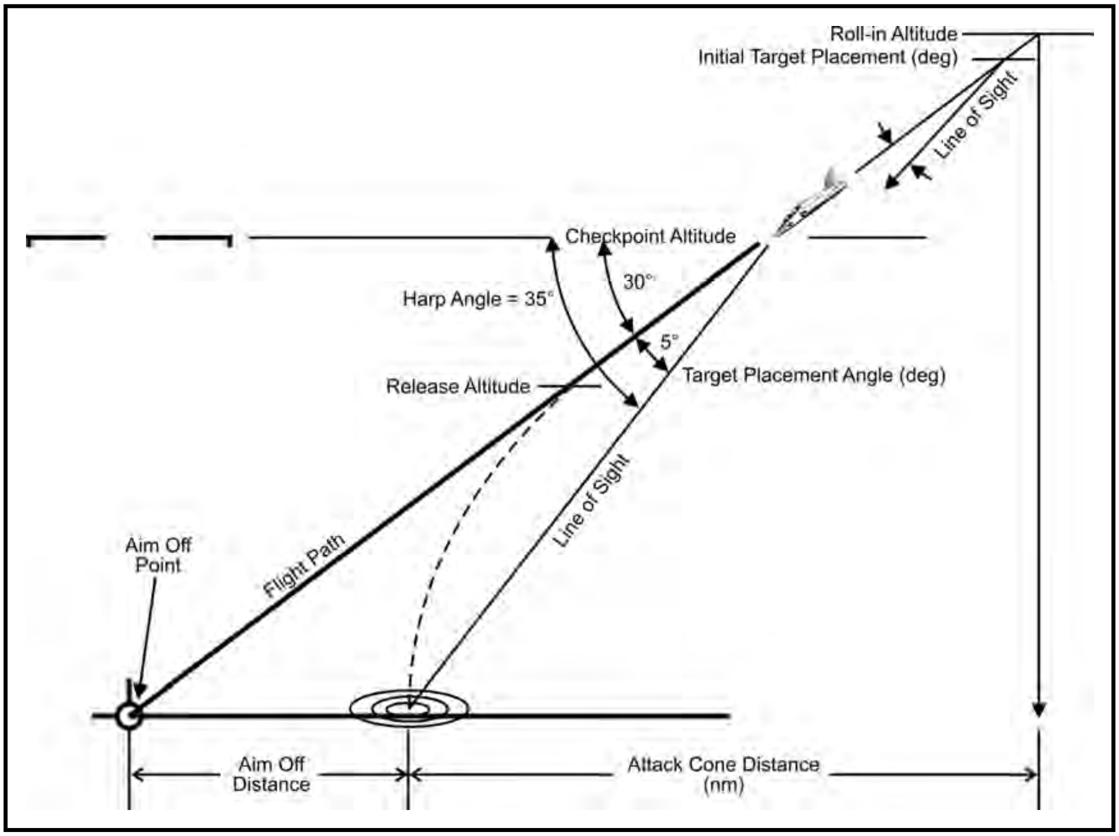

Figure 10-2 The Harp Angle

As discussed in the adaptive roll-in section, we used a building block approach to develop the basics of the roll-in. The same holds true for the tracking techniques. The two tracking techniques previously discussed are the basic techniques of any fleet aircraft. To consider Harp Angle Bombing, you first must develop a good HUD scan and have an understanding of target depression angles in the dive. It is not a technique intended to be introduced on early simulator events. However, if the concepts can be understood and when properly employed, it is a technique which will be available for you to try during the syllabus. After all efforts of obtaining a good initial sight pictures have failed, it can help you to correct for a steep or shallow initial sight picture and turn it into a good sight picture at the checkpoint altitude; that is, being established on the dive wire or on the bombing triangle.

The advantage of this method is it allows the pilot to achieve a weapons release solution close to the planned release parameters. It also can be beneficial to correct for a shallow in the 10 degree pattern where going faster to correct is not an option. If not employed properly, however, valuable tracking time may be wasted trying to gain the exact dive angles when there is little need for it. Either way, at checkpoint altitude, the corrections back to the dive angle cease; the procedure of setting the TPA at the checkpoint is still required and the resultant flight path angle must then be maintained to weapons release. Error corrections will still be required if all efforts of getting back to the bombing triangle have been exhausted. Now let's take a look.

The Goal of Harp Angle Bombing

First of all, the goal of Harp Angle Bombing should be to get to a good start. You want to exhaust all efforts in obtaining a good initial sight picture at the beginning of the tracking run; thereby minimizing the need to correct at all. Most of your attention could be focused on lineup control and target tracking progression and minor adjustments, if any, as you ensure the TPA is properly set at the checkpoint. The less time you spend correcting for dive angle, the more time spent scanning the other variables.

If you find yourself with something other than a good initial sight picture, the goal for your corrections between the Initial Target Placement (rollout) to the checkpoint is to drive the target to the Harp Angle at the checkpoint. In order to achieve that goal, we should review the Target Depression Angles.

Target Depression Angles

For the 30-degree and 20-degree dives, if you are on the bombing triangle, the target will be **3** degrees depressed below the planned flight path angle at the beginning of the tracking run. At checkpoint altitude, the target becomes **5** degrees depressed. At release, the target becomes **7** degrees depressed.

We could even determine the target to be 4 degrees depressed at 6,000’ in this case.

For the 10 degree dive, the target initially will be **2** degrees, then **4** degrees at checkpoint, then **6** degrees at release.

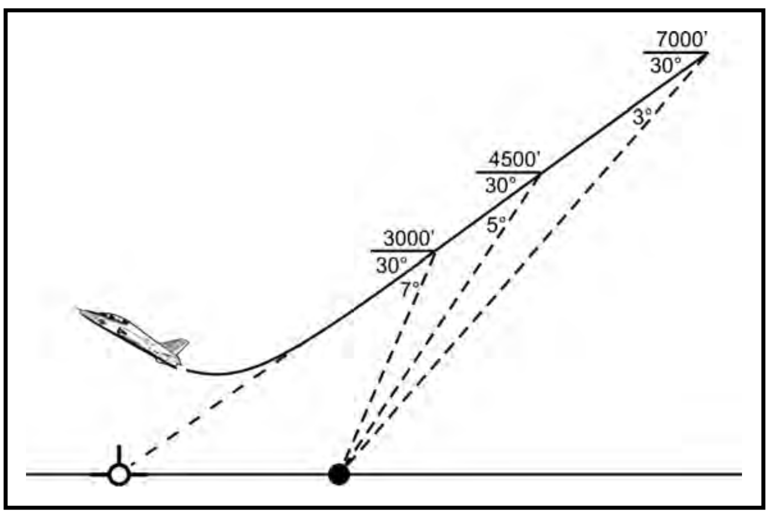

Figure 10-3 Target Depression Angles

If you were established on the 30-degree bombing triangle, the target should be 33 degrees depressed from the horizon at initial roll-out, 34 degrees at 6,000’, 35 degrees at 4,500’ and 37 degrees at release.

Initial Sight Picture Review

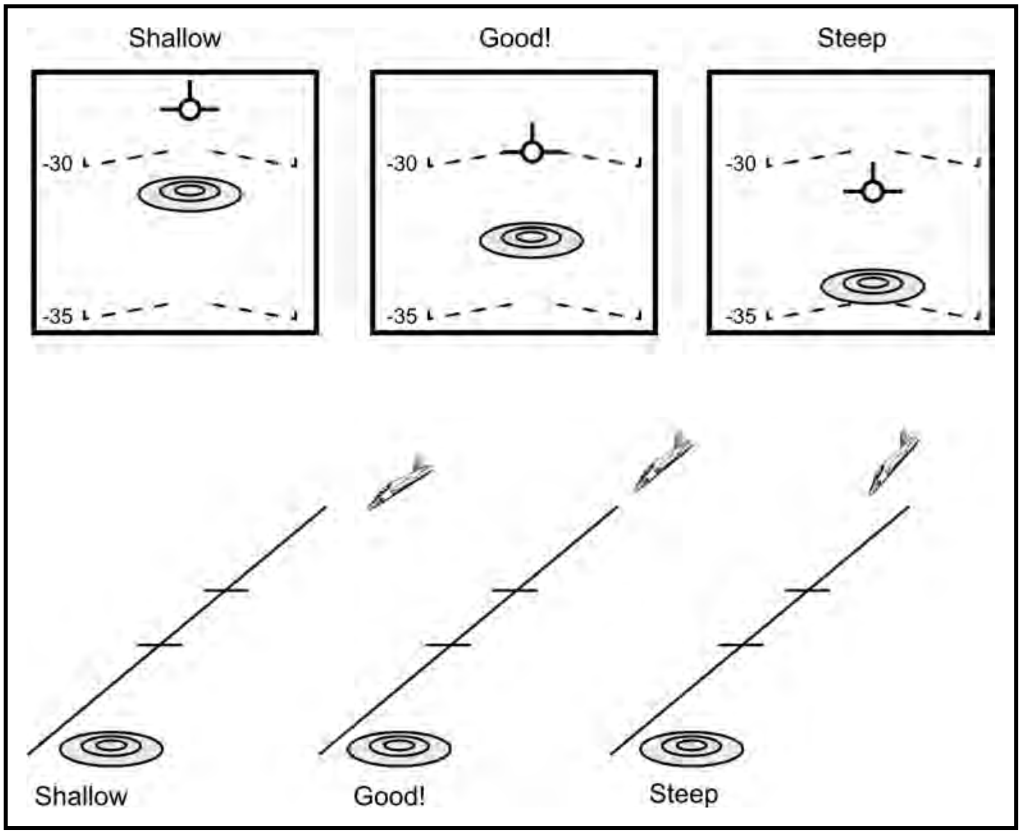

Figure 10-4 Initial Sight Picture Review

As you can see, a **shallow initial sight picture** puts the aircraft below the “wire” or below the bombing triangle. This equates to the target being less than 3 degrees depressed below the planned dive angle. The target appears to be around 31 to 31½ degrees.

A **good initial sight picture** puts the aircraft on the “wire” or on the bombing triangle. This equates to the target being 3 degrees depressed below the planned dive. The target appears to be 33 degrees.

A **steep initial sight picture** puts the aircraft above the “wire” or above the bombing triangle. This equates to the target being more than 3 degrees depressed below the planned dive. The target appears to be around 34 to 34 ½ degrees.

Target Movement and Velocity Vector Placement

In order to drive the target to the location on the pitch ladders during the run, we also must understand the relationship between the Velocity Vector Placement and target movement.

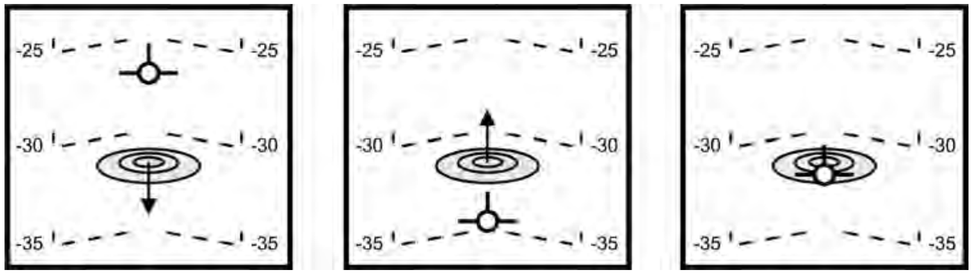

Figure 10-5 Target Movement and Velocity Vector Placement

By placing the Velocity Vector above the target, the target will move down. By placing the Velocity Vector below the target, the target will move up. By placing the Velocity Vector on the target, the target remains stationary.

The farther away you place the Velocity Vector from the target, the faster it will move. The closer you place the Velocity Vector to the target, the slower it will move. Farther = Faster; Closer = Slower.

Correcting for a Shallow Initial Sight Picture

For a little shallow (target lies 31 to 32 degrees):

If you find yourself with a shallow sight picture, in order to correct back to the wire, you need to fly shallower than the planned dive. Typically speaking, if the target is around 31 to 32 degrees, place the Velocity Vector 4 to 5 degrees above the target and hold that Flight Path Angle. In doing so, the target will begin to move down. If at 6,000' the target is 34 degrees depressed, you are back on the wire; reset the Velocity Vector to the planned dive (30 degrees) and continue tracking to the Checkpoint. If the target still has some angles to travel, continue holding the initial FPA to keep the target tracking down. Approaching checkpoint, you will need to start evaluating the Target Placement Angle and begin a smooth bunt to set the TPA.

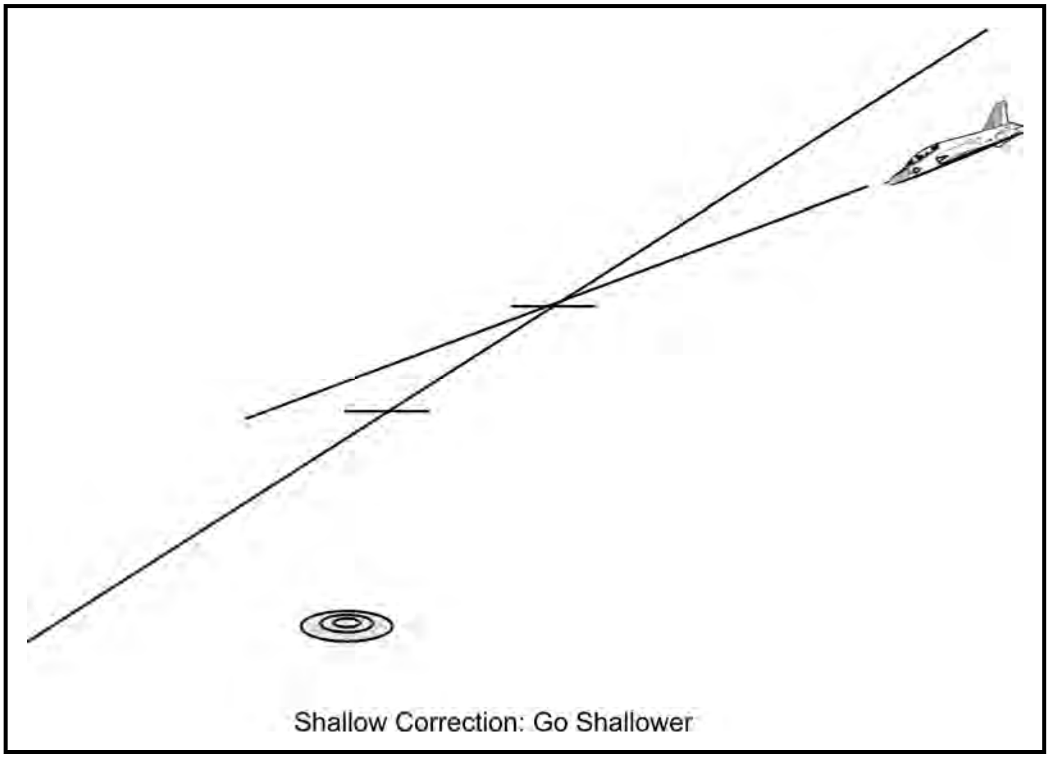

Figure 10-6 Correcting for a Shallow Initial Sight Picture

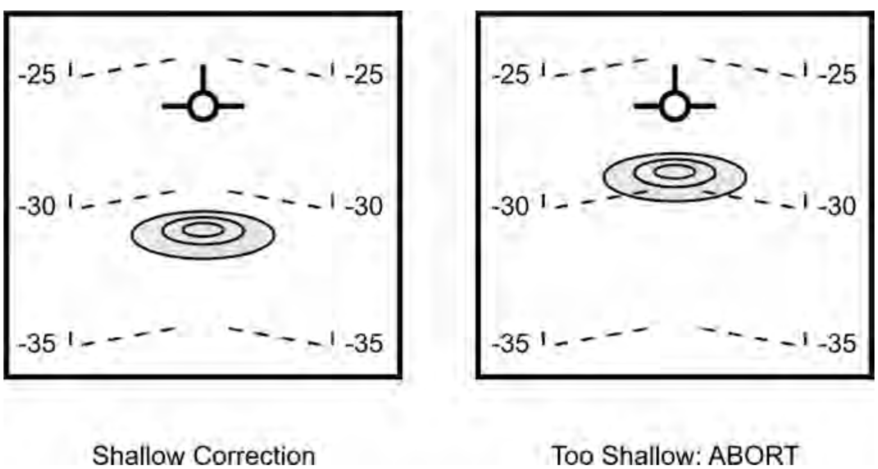

Figure 10-7 Correcting for a Shallow Initial Sight Picture

At checkpoint altitude, set the Target Placement Angle. Hopefully, the target will be at 35 degrees. If it is not, set the TPA, accept the resultant FPA and make the appropriate corrections.

At this point if you are not on the wire, you will be +/- 1 degree, which is minimal. If you find yourself greater than 1 degree shallow, you need to make the appropriate corrections.

DO NOT JUST SET THE PLANNED DIVE ANGLE WITHOUT RESPECT FOR THE TPA!

<u>For a big shallow correction (target lies close to 30 degrees):</u>

Place the Velocity Vector 5 degrees above the target (around the 25 degrees) and hold it until 6,000’ and evaluate, you most likely will end up being shallow so accept it and begin a smooth bunt to set 5 degrees above the target at the checkpoint, setting the TPA. Evaluate and make the appropriate corrections.

<u>For a WAY shallow (target lies less than 30 degrees):</u> Safe up the system. Do not attempt to drop. You still can go though the procedures of correcting, but abort your run by release altitude. FIX IT on the next pass!

Correcting for a Steep Initial Sight Picture

<u>For a little steep (target lies around 33 ½ to 34 degrees):</u>

If you find yourself with a steep initial sight picture, in order to get back to the wire, you will need to fly steeper than the planned dive. For a little steep, a little steeper correction is needed. In this case, most will place the Velocity Vector 1 degree above the target (33 degrees) and hold that Flight Path Angle to checkpoint. Some will place the Velocity Vector on the target until 6,000’ at which time you will be back on the wire, set the planned dive. In either case, set and evaluate the TPA at checkpoint; make the appropriate corrections if needed (should be minimal). The target should lie close to 35 degrees.

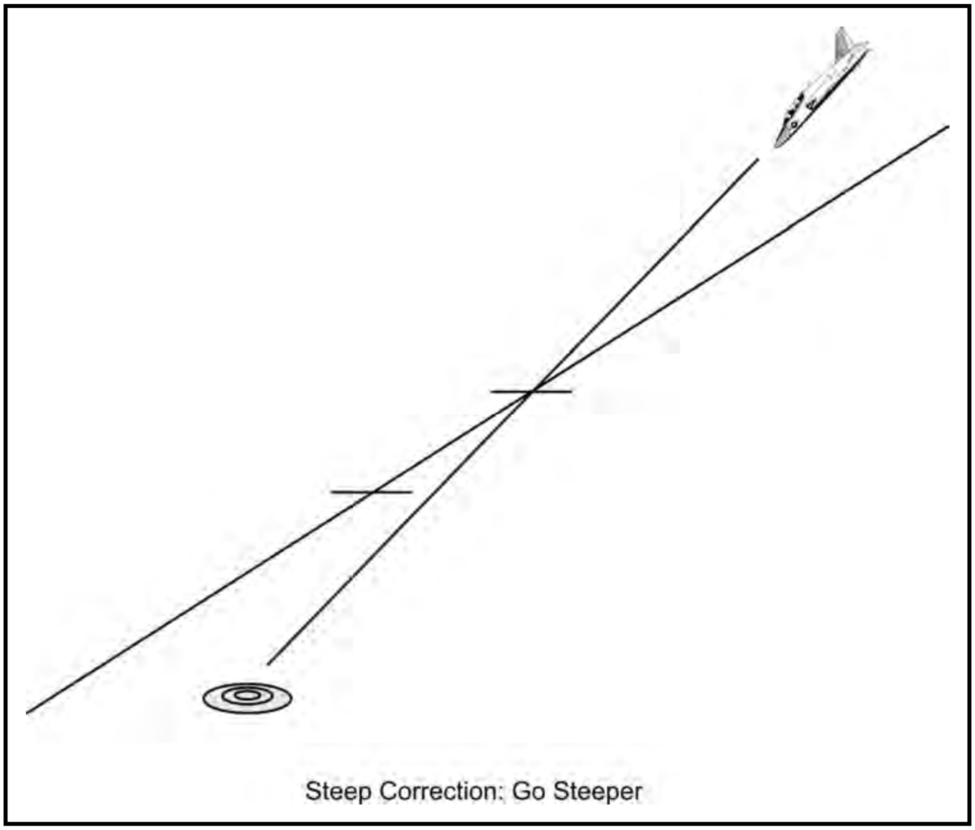

Figure 10-8 Correcting for a Steep Initial Sight Picture

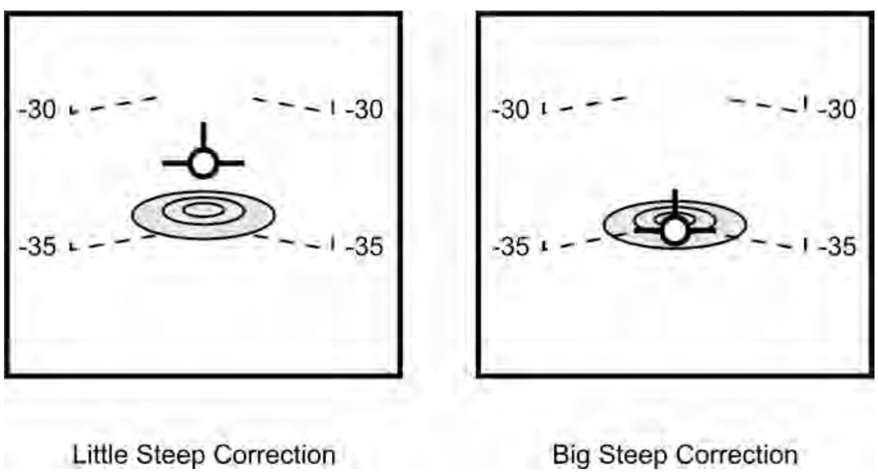

Figure 10-9 Correcting for a Steep Initial Sight Picture

For a big steep (target lies 35 degrees):

For a big steep initial sight picture, a big correction is required. If the target lies on the 35 degree pitch ladder, place the Velocity Vector on the target. This will keep the target from moving up or down. Approaching checkpoint altitude (about 200' above), smoothly set the Target Placement Angle, which may end up being just a little steep by the time the TPA is set. You should be within 1 degree of the planned dive angle. Make the appropriate corrections, if needed (should be minimal).

DO NOT JUST SET THE PLANNED DIVE ANGLE WITHOUT RESPECT TO THE TPA!

For a WAY steep (target lies greater than 35 degrees):

Safe up the system. Do not attempt to drop. You may go through the procedures of correcting, but don't allow the Velocity Vector below the target to try and drive the target up. If anything, place the Velocity Vector on the target, approaching the checkpoint, set the TPA and evaluate. Make the corrections in your mind and abort the run prior to release altitude.

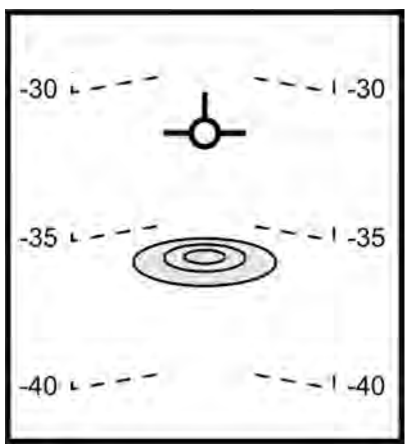

Figure 10-10 Way Steep: ABORT

Checkpoint Altitude to Release

The procedures from checkpoint altitude to release are exactly the same as all other tracking techniques. Straight path tracking to release. Pickle referencing the aimpoint and altitude, not solely referencing the altitude or pipper/aimpoint.

If the initial sight picture was other than optimum, evaluate what caused it and fix it on the next run. Evaluate the speed at checkpoint and release – adjust to make it what you want.
And, probably most importantly, where was my pipper placement and where did my hit go? Move the pipper placement to put the bombs where you want them to go.

Corrections for the 20 and 10-degree patterns

The 20-degree pattern corrections are identical to the 30-degree pattern, except for being 10 degrees shallower on the run.

The 10-degree pattern, you are looking for 2 – 2 ½ degrees depressed initially and 4 degrees depressed (14 degrees) at the checkpoint. Again, set the TPA of 4 degrees at checkpoint and track the resulting Flight Path Angle to release.

1003. TARGET ATTACKS WITHOUT TARGET WAYPOINT DISTANCE

1004. INTRODUCTION

The T-45A and all training aircraft of years gone by have all flown the weapons pattern without a target waypoint. If you have developed the proper look-out procedures in the T-45C pattern, flying without a target waypoint should not be any different. The approach turn, roll-in technique and pull to the abeam are all the same. The big difference in this pattern is the roll-in without a definitive distance from the target. Ground gouge for the roll-in distance will help, however, the eyeball calibration development of “that looks about right”, or “T-LAR”, on target distance is the objective of this pattern.

This type of situation can be encountered in the real world if you were called upon to cover an immediate Close Air Support mission such as a scenario where Marines are pinned down and cannot construct the target coordinates for you. It would be up to you to deliver some support to the Ground Combat Element without it. So gaining the knowledge of T-LAR is an important skill set to have.

Turn to Abeam

After recovery, at a pitch attitude of 10 degrees above the horizon, apply MRT, relax g, roll to 60 degrees AOB, and initially apply 4 g to reach the abeam position slightly inside the cone. During the turn, you will have to locate your interval (the aircraft immediately preceding you in the pattern). Procedures in the event you cannot locate your interval are given later, under "Safety." After 90 degrees of turn, maintain 2-3 g and begin to reduce power to arrive at the abeam on altitude and airspeed.

Abeam Position

The abeam position is a point slightly inside the cone and abeam the target; your heading is 180 degrees from the run-in line. The abeam distance is slightly less than two nautical miles. At the abeam, begin a slight AOB turn of about 10 – 15 degrees (wind dependent).

Abeam to Roll-In

Between the abeam position and the roll-in, the aircraft follows a circular arc, moving from slightly inside to slightly outside the cone. Pattern altitude must be maintained from the abeam to the roll-in. Passing the abeam, fly a 12-14 unit level turn maintaining pattern airspeed. About 90 degrees from the run-in heading, set power to the weapon release rpm and increase the pull to 15-17 units, maintaining pattern altitude.

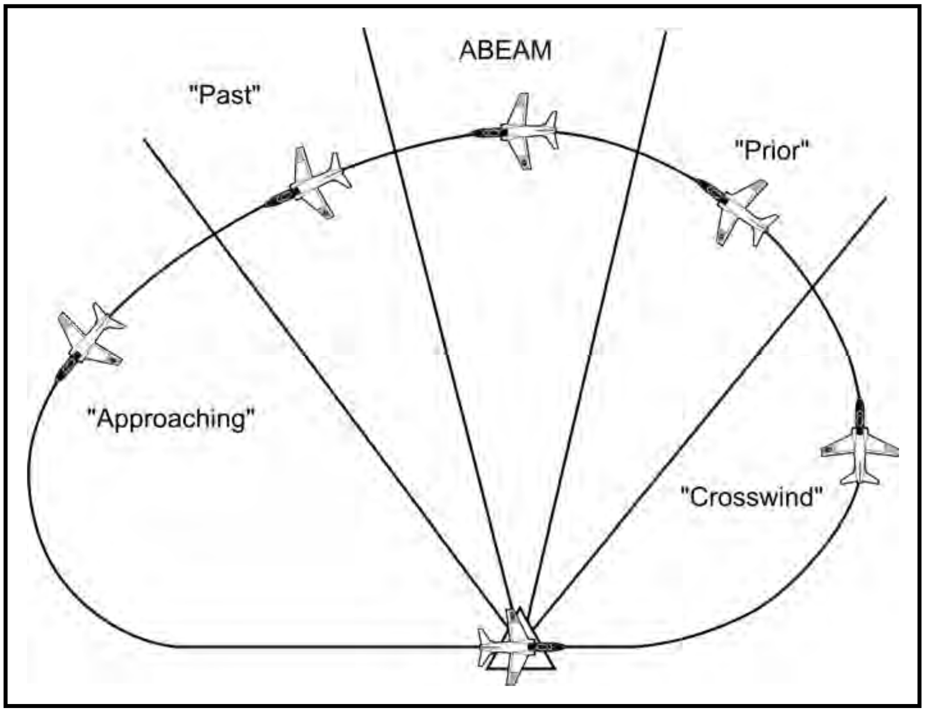

Figure 10-11 Abeam to Roll-In

The Roll-In

The roll-in begins about 30 degrees of heading prior to the run-in heading. Because the HUD only displays heading 15 degrees either side of the heading marker, you will have to estimate this 30- degree lead point. At this point, relax back stick and roll the aircraft to place the lift vector on the target, and smoothly pull the aircraft down so that it is aligned with the run-in line. (You can accept a variance of less than 15 degrees from the target run-in line.). Over time, you'll gain knowledge for the roll-in distance sight picture and will apply the adaptive roll-in technique as it applies to the situation.

Tracking Methods

All tracking methods and techniques mentioned are available for employment.

CHAPTER ELEVEN
SAFETY PRECAUTIONS

1100. INTRODUCTION

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 2,000 feet below the high (20-degree and 30-degree) pattern or 1,000 feet below the low (10-degree) pattern, 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 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 a 1.5-second reaction time followed by a 1 g/second pull to a sustained 4 g's would allow your aircraft below 1,000 feet AGL, you will get a large "X" in the center of your display. If you see it, pull up immediately. Do not depend on the cross as a cue; pull off when you are supposed to. The cross is not generated in dives of less than 15 degrees.

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, but detracts considerably from the pilot's ability to bomb effectively. Be a professional and strive to arrive at the release point on airspeed. Not only will your runs be safer, but your hits will be more accurate.

Dive Angles Steeper than Optimum

Not only does a steeper dive angle result in a lower than normal pullout, but it usually causes a faster run. The pilot thus introduces two variables into the bombing solution merely by being steep. Learn to recognize steeper than optimum dive angles early in the run with the help of your HUD, and make the appropriate correction when it won't cost you too much valuable tracking time.

Target Fixation

Every pilot would like to get a bull's eye on every run, but unfortunately, some have become so engrossed in achieving hits that they have flown into the ground by fixating on the target and disregarding their release altitude. This is especially a problem with forward firing ordnance where it is easy to "follow" the projectiles' flight path. Last-second corrections usually result in both a false sight picture and a loss of altitude. Ensure the proper Target Placement Angle is set at the checkpoint, not just the planned dive angle. This will aid in acquiring a release solution close to the planned release altitude. Adhere to your mandatory abort criteria for being Steep or Shallow.

Bottom line. If the run is that bad, abort and go around to try again. Continually scan the altimeter; don't become another statistic.

Correcting by Releasing Low

We have told you several times not to correct for errors by releasing low. The primary reason is safety. But 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 ft 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 Mach Run, 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 4-1/2 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 pullup, stop the pull, roll, stop the roll, 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. The danger of inadvertent release can be minimized by adhering to switchology rules already given. Do not arm your Master Armament 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 pattern or 1,000 ft above the off target rendezvous pattern, 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 effected; normally the NORDO aircraft joins last, inside lead's turn, and will be positioned as #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 1,000 ft above pattern altitude and between the abeam and the roll-in position.

NOTES

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CHAPTER TWELVE
SELF TEST

1200. INTRODUCTION - GRADING

1. If you have four hits at 150 ft, 60 ft, 200 ft, and 20 ft, and a hit in the next county 3/4 mi away, what is your CEP?

ANSWER: 150 ft

Preparation – Determining Delivery Data

2. What is the sight depression angle for a 30-degree delivery of bombs with a release altitude of 3,000 ft AGL and a release airspeed of 450 KTAS?

ANSWER: 128

3. What is the weapon time of fall (TOF) if you drop a Mk 76 bomb in a 10-degree dive, release altitude 1,000 ft AGL and release airspeed 450 KTAS?

ANSWER: 5.0

Preparation – Computing Offset Aimpoint

4. Where is your offset aimpoint if you have a 10-kt wind at release altitude and a 7-sec time of fall?

ANSWER: 119 ft from the bull

Practice Ordnance – Preflight Inspection of Ordnance

5. Bombs should show no movement at all if shaken. True or false?

ANSWER: False. Bombs should show slight movement if shaken.

6. Should the pigtail (cannon plug) to the PMBR be connected or disconnected at preflight?

ANSWER: Connected. It should be disconnected from the rocket launcher.

7. Where is the EMER JETT button located?

ANSWER: On the LH instrument panel (forward and aft cockpit)

Enroute Procedures

8. All flight members acknowledge the range controller's information. True or false?

ANSWER: False. Only Lead acknowledges.

Target Pattern Procedures – Breakup

9. The flight continues over the target on its course from base. True or false?

ANSWER: False. The flight flies over the target on the run-in heading.

Target Pattern Procedures – The 30-Degree Pattern

10. What are the weather minimums for the 30-degree pattern?

ANSWER: 10,500/5

Target Pattern Procedures – Flying the Pattern

11. How does a shallower than usual AOB or less g affect the distance to abeam?

ANSWER: Lengthens, increases, makes it greater, etc.

Target Pattern Procedures – Voice Procedures

12. Who makes the call to initiate position calls in the pattern?

ANSWER: The pilot coming off target makes the call.

13. List, in the order of occurrence, the three positions in the weapons delivery pattern where radio position calls are required.

ANSWER:

a. Off target

b. Abeam (or interval position), with fuel stated

c. Roll-in

14. Make a sample transmission of a required radio position call for each of the weapons pattern positions in the order they would occur around the weapons delivery pattern.

ANSWER:

a. (off target) "One off, safe."

b. (interval position, with fuel state) "Four crosswind/prior/abeam/past/approaching, 1.6."

c. (roll-in) "Two in (card dir)/cold/Winchester."

Returning from the Target – Hung Ordnance Approach

15. In a formation hung ordnance approach, each aircraft flies its own course to the field. True or false?

ANSWER: False. All aircraft follow lead's flight path.

Returning from the Target – Dearming

16. During dearming, you may keep your hands in the cockpit. True or false?

ANSWER: False. Let the ground crew see them just as during arming activities.

Safety Precautions

17. List three reasons to abort a run.

ANSWER:

Any three of the following:

a. Poor roll-in

b. Off dive parameters

c. Unsafe conditions in flight (simo run, instrument error, unauthorized aircraft in target area)

d. Unsafe conditions on ground

e. Directed by RSO

f. Close interval (simo run)

g. Suspected instrument error

h. Valid Beak X

Safety Precautions – Midair Collisions

18. Who should call a simultaneous (simo) run?

ANSWER: Anybody who sees it.

19. If you lose sight of your interval in the pattern, should you go to the lame duck pattern?

ANSWER: No. Stay 2000’ below the High and Mid patterns. 1000’ below the Low pattern.

Safety Procedures – Lost Communications

20. How many feet above the high pattern is the lame duck pattern flown?

ANSWER: 2,000 ft

Limitations

21. What is the maximum speed and Mach number to release a Mk 76 practice bomb?

ANSWER: 500 KCAS/0.80 mach

22. What is the maximum and minimum g limits when releasing a Mk 76 practice bomb?

ANSWER: 0.5 to 1.5

23. What is the maximum rate of descent on landing with ordnance remaining on the PMBR/BRU?

ANSWER: 600’ per minute

24. What is the symmetrical g limit of the T-45C below 5,000’?

ANSWER: 6.5 g’s

25. What is the unsymmetrical (rolling pull) g limit of the T-45C below 5,000’?

ANSWER: 5.0 g’s

Armament Controls and Indicators

26. What does the illumination of the Break X mean?

ANSWER: A normal, 4 g recovery is immediately required in order for the aircraft to bottom out at 1,000’ AGL.

27. During preflight weapons arming of the PMBR’s/BRU’s, it is permissible to set-up the STORES page for the flight. True or False?

ANSWER: False. During Arming procedures, hands MUST remain up for the ground crew to see.

28. Selecting the A/G STORES page on the MFD DOES NOT place the T-45C in A/G Master Mode. True or False?

ANSWER: False. The A/G Master Mode may be entered by either selecting the A/G STORES page or by pressing the MODE button on the DEP.

29. When is the proper time to select the A/G Master Mode in-flight?

ANSWER: When directed by Lead (Fenced In call), over sparsely populated terrain.

BONUS QUESTION

30. During the Hung Ordnance check following the OTR, you notice an aircraft has one Mk 76 remaining on the center aft station of one of his PMBR's. The pilot in command of that aircraft confirms he tried to release on every pass and thinks it's a hung bomb because he didn't get a spot on his last attempt to release on that rack. The BOMB QTY on the STORES page indicates 0's on both wing stations.

a) Is the bomb hung or is it unexpended?
b) What is the normal release sequence of a PMBR?

ANSWER: Figure it out on your own!

Hint: What would happen if during arming, the ordnanceman placed the station selector accidently from SAFE to "2" vice SAFE to "1"?

NOTES

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 pipper should cover at release. See also final aimpoint and initial aimpoint.

Angle of Attack of the Armament Datum Line: The angle between the line of flight and the ADL; not the AOA read from the AOA indicator.

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

Armament Datum Line (ADL): A fixed longitudinal reference line on the aircraft; it will be parallel to the flight path at 450 knots provided that fuel load and aircraft configuration are as calculated.

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.

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 Tracking: The aircraft following a curved path during tracking rather than a straight path; the aircraft ground track is a straight line with the curve (convex) in the vertical plane.

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 pipper 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 flight path and the ground.

Dive Recovery: See Pullout.

E

Early Sight Picture: The pipper 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 pipper should be at release in order to hit the target; the final aimpoint is corrected for wind. See also Initial Aimpoint.

H

Harp Angle: Derived for the checkpoint altitude, it is the planned depression angle of the target if the aircraft is established on the planned dive wire or bombing triangle. It is equal to the planned Dive Angle plus the Target Placement Angle at checkpoint altitude.

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 Card Direction": Indicates the pilot has intent to release ordnance and that the Master Armament switch is set to ARM.

"In Cold/Winchester": Indicates that the pilot has no intent to release ordnance and the Master Armament switch is SAFE.

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

Initial Sight Picture (ISP):

Initial Target Placement (ITP):

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 pipper 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 pipper.

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.

N

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=1.7xTxW (offset) = 1.7 x (time of flight) x (wind)

P

Pendulum Effect: Caused by the depressed sight line. With one wing down, the pipper 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.

Pipper: The sighting device (usually a dot) in the center of the aiming reticle.

Pipper-to-Bull Tracking: A method of target tracking that ignores wind and places the pipper directly on the center of the target, or bull.

PMBR: Practice Multiple Bomb Rack.

Pullout: Recovery from a dive.

R

RadHaz: Radiation Hazard; some older rockets require a metallic shield on the aft end of the launcher to protect the ignition mechanism from electromagnetic radiation that might cause accidental firing.

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

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

Roll-out: 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 pipper 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.

Target Placement Angle (TPA): Derived for the checkpoint altitude, the angle between the Velocity Vector and the line of sight to the target. Setting the proper TPA at checkpoint ensures the pipper arrives at the aim point close to the planned release altitude.

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 pipper is on 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.

Zmin: Minimum release/firing altitude for a given Z diagram based on terrain, fusing, threat or frag. Also referred to as Rmin (Release Minimum). Releasing below Zmin should never be attempted.