CNATRA P-1208 (Rev. 02-19)

Subj: FLIGHT TRAINING INSTRUCTION, OPERATIONAL NAVIGATION, T-45 MPTS AND IUT

1. CNATRA P-1208 (Rev. 02-19) PAT, "Flight Training Instruction, Operational Navigation, T-45 MPTS AND IUT" is issued for information, standardization of instruction, and guidance for all flight instructors and student aviators within the Naval Air Training Command.

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

3. Recommendations for changes shall be submitted via the electronic TCR form located on the CNATRA website.

4. CNATRA P-1208 (09-16) PAT is hereby cancelled and superseded.

T. H. SHEPPARD
By direction

Distribution:
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FLIGHT TRAINING INSTRUCTION

FOR

OPERATIONAL NAVIGATION T-45 MPTS AND IUT

P-1208
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INTERIM CHANGE SUMMARY

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HOW TO USE THIS FTI

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

Use your FTI to prepare for lessons and flights, and afterward to review. Your Student Guides specify FTI reading assignments prior to flight procedure lessons. 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-45C. 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-45C NATOPS Flight Manual.
CHAPTER ONE
LOW ALTITUDE TRAINING (LAT)

100. INTRODUCTION

The Low Altitude Training (LAT) Environment is defined in the LAT Flight Training Instruction (FTI), P-912, as any fixed wing flight below 1500 ft Above Ground Level (AGL) when not in the takeoff or landing phase. Flying in this environment presents a unique set of challenges to the Naval Aviator, especially when combined with other mission tasks. There are a variety of situations that could force you into operating in the low altitude regime, either as a planned operation or a contingency. This stage of instruction will introduce and develop the foundational skills required to safely fly and navigate in the LAT Environment using dead reckoning, pilotage and INS aided navigation. These are fundamentals that must be thoroughly understood and adhered to on every flight. The objective of this training stage is twofold: (1) develop foundational knowledge of the dynamics and challenges of operating in the low-altitude environment, and (2) to introduce the requisite skills necessary to operate safely at high speeds in close proximity to the ground, to include pre-mission planning, chart interpretation, navigation, and aircraft maneuvering.

Critical theory as well as background information on the various internal and external factors that are specific to low altitude fixed wing flight can be found in the LAT FTI, P-912. It is assumed that all instructors and students are familiar with that FTI, as that information will be leveraged in this instruction. Planned parameters assume 500 ft AGL as the target altitude and 360 Knots Ground Speed (KGS) as a constant unless another airspeed is specified.

The low altitude environment is unforgiving with numerous threats to avoid, the most persistent of which is the surrounding terrain. While a deck bust in ACM will result in a simulated rocks kill and embarrassment in the debrief, violating LAT procedures can kill you.

101. TRANSITION TO THE LAT ENVIRONMENT

The objective for the following rules is to expeditiously and safely enter the LAT environment from the enroute portion of the flight. They can also be used to regain desired flight parameters after a planned or unexpected deviation. It is always acceptable in the training command to utilize a less aggressive, fuel conserving descent to arrive on time, airspeed and altitude if desired or comfort level dictates.

Typical LAT entry flight profile will begin during the enroute portion and shall follow normal rules for IFR/VFR limitations. Below 5000 ft AGL begin to shallow your descent to no more than a 10° descent by 1500 ft AGL. Starting at 1500 ft AGL intercept the LAT Small Descent Rule of Thumb (ROT) which is explained below. Within 5 NM of route entry point, accelerate to planned ground speed.
When VMC with the entry point or working area in sight, cancel if IFR, check in with the Flight Service Station (FSS) or other controlling agency. Reset your RADALT when below 5000 ft AGL, set Altimeter, Squawk to 4000 or as assigned, Hack the clock. A useful mnemonic to ensure completion of these tasks is "TRASH":

- Talk (FSS or required ATC radio call)
- RADALT (good tone, set)
- Altimeter (set)
- Squawk (4000 or as assigned)
- Hack (clock started)

LAT checks must still be completed IAW Training Rules. Do not descend below 1500 ft AGL without a properly functioning RADALT. If unable to verify proper RADALT function level off at a safe altitude above the LAT Environment to check system function.

102. MINUTE-TO-LIVE RULE

The minute-to-live rule is an alternate method by which to enter the LAT Environment. It provides an opportunity for a gentle, fuel efficient descent when time and space allow.

103. LAT SMALL DESCENT RULE OF THUMB (ROT)

LAT Small Descent ROT: The maximum dive angle in the LAT Environment, relative to terrain, is equal to the desired altitude loss in hundreds of feet.

This rule works up to a 10-degree descent or descents from 1500 feet AGL (assuming a 500 feet AGL target altitude). For example, at 800 feet AGL, use a negative 3 degree FPA to capture 500 feet AGL. For larger descents FPA should be reset every 500 feet of descent.

104. MAXIMUM RECOVERY MANEUVER (MRM)

The Maximum Recovery Maneuver is designed to quickly displace the aircraft in the vertical, building separation from the ground and any obstacles. Although it can be used during any time of uncertainty, its specific purpose is to avoid terrain that is obscured by clouds. If you find yourself in any situation in which you want to expedite a climb above all obstacles, execute the following procedures and initiate the recovery when obstacle clearance is assured. These procedures are similar to the push over in the Vertical Recovery that you learned during the Familiarization stage and are more restrictive than those found for the MRM in the LAT FTI (P-912). These procedures shall be used for the T-45.

1. Unloaded roll to less than 90 degree AOB
2. Loaded roll to wings level
3. Throttle MRT

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4. Perform a 4-G / 17 unit pull to a 45-degree nose-high attitude

5. At 250 KIAS, begin a 5-10 unit pushover (similar to FAM vertical recovery) until 20-degrees nose high.

6. Adjust nose attitude to intercept 200 KIAS / MRT Climb until clear of terrain (approximately 20-25 degrees nose up).

Recognize that, within the contiguous United States, as long as you are above 14,505’ MSL, you will be clear of all terrain. If necessary, you can recover earlier if terrain clearance assured.
CHAPTER TWO 
MISSION PLANNING

200. INTRODUCTION

Preflight planning is critical to flying in the low altitude environment. A thorough understanding of the proposed route to include general navigation, significant terrain features, hazards to flight, and other pertinent information are required to prevent a mishap. This chapter will discuss general planning factors to take into consideration when planning a low-level flight.

All pertinent regulations, including FAR 91, CNAF M-3710.7, and the AP/1B apply to all routes flown within the US. Failure to follow all regulations could result in flight violations and dangerous situations.

201. WEATHER

Weather can have a significant impact on the success of a mission and must be thoroughly briefed. Knowing and understanding the effects of factors such as sun angle, cloud bottoms/tops, precipitation, and visibility plays a pivotal role in executing a safe low-level mission. Weather conditions need to be carefully considered even if the weather minimums are legal for proposed low altitude training, as these conditions can adversely affect pilot visual perception or emergency situations. When in doubt, climb-to-cope to avoid any unsafe conditions.

The weather minima for low-level flights on IR and VR routes are 3000/5 while on the low-level portion of the route for the entire route flown. Missions shall not be flown unless the weather is above these minimums and is forecast to remain so. During the flight, the weather shall be continuously assessed, and the mission shall be discontinued if the weather deteriorates below minimums or any aircraft inadvertently enters IMC.

202. BASH

While operating in the low altitude environment, birds present a major risk to aircraft. Impacting even a small bird can have serious implications to flight safety. Prior to any flight on a low-level route, the aircrew shall conduct a BASH evaluation via the USAF Avian Hazard Advisory System (AHAS) website at http://www.usahas.com/. Reference local IFG or SOP to determine the procedures that apply based on the BASH condition.

During the flight, continually assess bird activity and take the appropriate action (discontinue route, climb as necessary, etc.).

203. MILITARY TRAINING ROUTES

MTR stands for Military Training Route. According to the Flight Information Publication General Planning, “Airspace of defined vertical and lateral dimensions established for the conduct of military flight training at airspeeds in excess of 250 knots indicated airspeed (KIAS).” MTRs are used by all four Services for routine training. There are several types of MTRs:
Instrument Flight Rules (IFR) Military Training Routes (IR) – Routes used by the Department of Defense for the purpose of conducting low-altitude navigation and tactical training in both IFR and Visual Flight Rules (VFR) weather conditions below 10,000 ft mean sea level (MSL) at airspeeds in excess of 250 KIAS. When flying an IR route, you will need to be cleared to operate on the route by the controlling agency.

VFR Military Training Routes (VR) – Routes used by the Department of Defense for the purpose of conducting low-altitude navigation and tactical training under VFR below 10,000 MSL at airspeeds in excess of 250 KIAS. For VR routes, you do not need clearance to enter the route. You may transit to a VR route either VFR or IFR; if you go IFR, you will need to cancel prior to entering the route.

Slow Speed Low Altitude Training Routes (SR) – Not an MTR according to General Planning (GP), but otherwise treated just like one. SRs are low-level routes at or below 1500 ft AGL, 250 KIAS or less, and are published in the Area Planning (AP/1B).

If you’re planning a Low-Level (whether you’re flying on an MTR or not) you should be plotting crossing MTRs on your chart. This can help give you the heads up you need to avoid a midair.

204. MISSION PLANNING FACTORS

For all flights, the minimum altitude for CNATRA aircraft is 500 ft AGL. However, the route will be flown at either the published route minimum altitude or 500 ft AGL, whichever is higher.

When planning for airspeed, you must balance a variety of factors. In CNATRA, the most pressing factors are fuel burn and maneuverability. Secondary concerns include windscreen limitations for bird impact and risk of overstress or stall. In the fleet, other factors may come into play as a result of mission planning factors (enemy defenses, time-on-target, type of attack, etc.).

During single-plane ONAV and Section Low-level stages, routes are planned to be flown at 360 KGS. Care should be taken at higher MSL elevations, where 360 KGS may result in lower indicated airspeeds. Minimum indicated airspeed shall be briefed with T-45 LAT Rules along with the other required brief items. 340 KGS is the recommended minimum ground speed for low altitude training. Maximum airspeed should be set for 400 KGS. A high potential for overstress exists if you exceed this parameter.

Turns on the route are PLANNED for 60 degrees AOB and 2Gs; however, there is no 60 degree AOB limit while flying. The relationship between AOB and G required during a turn is discussed in the LAT FTI.

205. AREAS OF AVOIDANCE

1. Do not overfly airports or violate associated control zones. Avoid uncontrolled airstrips by 3 miles if you are below 1,500 feet AGL. (FLIP AP/1B).
2. Do not overfly any congested area, city, town, or settlement, or over an open-air assembly of persons. You must remain 1,000 feet above or 2,000 feet horizontally from the highest obstacle. (FAR 91).

3. Do not overfly noise sensitive-areas (e.g., breeding and poultry farms, resorts, beaches, national parks). Avoid by 1 mile if you are lower than 3,000 AGL. If it is necessary to overfly wild fowl habitations, maintain at least 3,000 feet AGL. (FAR Part 91).

4. Do not fly into restricted areas without clearance from the controlling agency. (FLIP AP/1B).

5. Do not make simulated attacks on installations important to national defense. You may not simulate attacks on refineries, chemical plants and other potentially dangerous targets.

6. On single-plane ONAV flights, attacks may be simulated by fleet experienced IPs. Roll-aheads are forbidden. Depending on local SOP, an angle-off pop-up may be demonstrated at the instructor’s discretion.

7. Do Not begin a route greater than five minutes from the scheduled entry time without re-coordination with the scheduling agency. Flight TAC LEAD is responsible for briefing crossing route conflicts on the divert charts, and each page of the low-level chart.

206. LOW ALTITUDE SAFETY CONSIDERATIONS

Terrain and Obstacles

Obstacles in the low altitude environment include both natural and man-made. Natural obstacles can be anticipated by detailed preflight chart study while the AP/1B and Chart Update Manual (CHUM) can be used to annotate and mark the latest man-made obstacles. Together, these steps in preflight planning will provide reasonable protection against the ever-changing landscape of communication towers, power lines, and logging cables in the more mountainous areas.

While flying, the aircraft has two main systems that will help protect from CFIT: the radar altimeter (RADALT) and GPWS/TAWS. The RADALT is the primary instrument used to maintain safe separation from the ground but has limitations that you should be aware of. First, it is not a forward-looking instrument and has no capability of predictively clearing the aircraft’s flightpath. Second, it does not work in AOBs greater than 40 degrees and can be inaccurate in turns (During turns precise vector control is critical). The TAWS and GPWS systems provide some additional warning of impending CFIT in certain situations and includes a degree of forward-looking capability. Both systems attempt to determine the aircraft’s position relative to the terrain and calculate its trajectory and determine if the recovery trajectories result in CFIT.
Bird Strikes

Bird-strikes have occurred as high as FL 200, but by far greater numbers of bird strikes occur in the low altitude environment. As part of preflight planning, attention must be paid to local Bird/Animal Strike Hazard (BASH) conditions. BASH advisories take into account migratory bird seasons, time of day when most large birds of prey are likely to be flying, and the normal concentration of bird population in specific geographical location. As an in-flight consideration, most large birds tend to dive upon encountering an aircraft, though on occasion they’ve been known to climb. Regardless of the bird reaction to an encounter, in the low altitude environment, the pilot should always climb. Flying with the visor down is another important safety consideration and will pay great dividends should a strike occur in the vicinity of the windscreen.

Sun Angle

Sun position has been a contributing factor in a number of low altitude mishaps. Glare in the early morning or late afternoon can affect visual perception of the pilot heading into the sun or create deep shadow which can mask significant terrain features for the pilot headed away from the sun.

Turbulence

Turbulence can actually make the low altitude environment unflyable. In extreme conditions, a pilot’s planned flight path can be drastically altered by powerful up or downdrafts. Mountainous areas of the country must be treated with respect. If a pilot encounters moderate turbulence in flats areas between mountains, it is a good indication that more extreme turbulence will be encountered at the point where the air is pushed vertically by the terrain.

Over Water

Over water low altitude flying has always been deceptively dangerous. Not only is there a false sense of security with the absence of vertical obstacles, but certain sea conditions virtually eliminate the pilot’s ability to judge his/her height above the water. Water is just as hard as any terrain at 360 KGS; therefore, flying over it demands the same strict adherence to terrain clearance tasks, observance of minimum altitudes and the use of radar altimeter.

Lookout Doctrine

Other civilian and military aircraft are always a concern, especially in a VFR environment. Just because you might be operating in a Restricted Area, a Military Operating Area, or an MTR doesn’t mean you are the only show in town. There may be other military aircraft or light civil aircraft flying in close proximity. Lookout doctrine is necessary in peacetime or war and you can’t let that break down. If it does, then you are task saturated and flying too low.
CHAPTER THREE
LOW-LEVEL PRE-FLIGHT PLANNING

300. INTRODUCTION

As discussed in Chapter One, low-level flying can be extremely demanding and requires effective prioritization in order to complete the mission safely and successfully. One method of “increasing the size of your bucket” is to spend a significant amount of time during pre-flight planning getting to know the route you will be flying and what to expect while on it. This chapter will discuss several facets of pre-flight planning that will help prepare you for what to expect during a low-level flight.

301. LANDMARKS

Knowing the route and the information available on your chart is critical, but translating the 2D picture into the 3D world can be difficult. Paying special attention to the symbology on the chart and thinking carefully about its implications will pay dividends during the flight. Notice the symbols for roads, railroad, and rivers. Check where the roads go; a road between large towns is likely to be heavily traveled and wider than one connecting small country towns. At crossroads, try to project what may be there beside the roads. What vertical definition might you see? Railroads have more stringent requirements for construction than highways and you see them easily. Even an abandoned roadbed may be easy to see and use as a landmark. Rivers and streams may not be very good, especially during floods and droughts. If you can tell which way rivers are flowing, you may be able to funnel to a larger stream or a recognizable bridge. Forget trying to count the streams you cross; not all are always shown on the charts.

When performing a chart study, using tools such as satellite imagery can help translate the picture into what you can actually expect to see. When studying specific points, it is beneficial to look at both the specific facets of that point (e.g., colors, layouts, readily identifiable features, etc.) and the surrounding features that can aid in finding that point (funneling features, limiting features, etc.).

302. POSITIVE LANDMARKS

Positive landmarks can be positively identified and plotted as a point on a chart. Mountains and large natural bodies of water are very good positive landmarks. You need not pass directly over a positive landmark for it to be useful to you. Be cautious when using man-made landmarks, as they may have changed, moved, or no longer exist. See next for common examples.
303. LINEAR LANDMARKS

Linear landmarks are features which can be positively identified but not specifically plotted because they extend for some distance. Features such as roads, railroads, coastlines, power lines, and rivers may make good timing checkpoints if they are perpendicular to the course line and
have other specific environmental particulars that identify your position. A power line should be large and not easily confused with other lines near. Rivers must be identified positively. It helps if they are either isolated or very large, and you should have some confirming landmark to ensure that you have the right one. Realize that some defining characteristics of a linear landmark can be used as a positive landmark if the feature is unique, readily apparent, and small enough to provide a definitive plot of your position.

![Figure 3-2 Linear Landmarks](image)

- A Road "T" intersection with town (Positive)
- B Refinery (Positive)
- C Buildings (Uncertain)
- D Smokestack (Positive)
- E Oil field (Uncertain)
- F Dry creek bed with intermittent water (Linear and Uncertain)
304. UNCERTAIN LANDMARKS

Uncertain landmarks are features that the pilot suspects he can correlate with the chart, but they may not be fully reliable. Generally, navigate from the chart to the landmarks; not the other way around. All landmarks are not always shown and charts are not always current. Always check a chart’s edition revision date. Uncertain landmarks such as oil wells and windmills may be repetitious. You cannot navigate from oil well to oil well in the Permian Basin of west Texas, nor, from oil field to oil field. Uncertain landmarks may be objects that look much alike; if you see the oval symbol for a racetrack on your chart and you see a racetrack on the ground, is it a horse track, a dog track or a high school athletic track? Check the surroundings. A high school athletic track will certainly have a high school nearby, and will probably be in town, while a horse or dog track is usually more removed. An automobile race track will have identifiable mechanical facilities and a horse track will have stables.

305. FUNNELING FEATURES

Funneling is simply using a readily identifiable feature (mountain range, valley, river, etc.) to guide you towards another feature. Once you intercept such a linear landmark and know where it leads, you can use it to guide you to your next checkpoint. In essence, a linear landmark can be used to “funnel” you to a checkpoint.

An example of a potential funneling feature is a road or railroad. It is quite possible that your route will parallel a road or railroad for a leg or considerable portion of a leg. In this case, it is important to keep the road in sight while maintaining your correct position and distance from it. For instance, if your course line stays to the left side of the road and never crosses it, then you should always remain left of the road and never cross it.

306. LIMITING FEATURES

Limiting features prevent pilots from overflying/missing a designated checkpoint through careful recognition of prominent terrain feature(s) and corresponding action. While arguably the most important when familiarizing yourself with any route structure, a good ONAV pilot will identify limiting features on every checkpoint as a back-up to clock-chart-ground scan.

A limiting feature can be any type of landmark, but a positive or linear landmark may be preferred. For example, if a river or large mountain range is on the opposite side of a turn point and you find yourself approaching that feature, you know to turn prior to crossing it even if you cannot positively identify your checkpoint.

307. DATE ON THE CHART

How much time has there been for structures to be built and how much likelihood is there that something new was erected? If you have a 1980 chart of an oil producing area, you may expect radical changes owing to the boom of the 1980s. On the other hand, if your chart is dated within the last year or two, minimal changes have probably occurred. In any case, get the latest edition of the chart! Don’t use old charts!
308. CHART UPDATE MANUAL (CHUM)

Use the latest CHUM or supplement to identify the current edition of the chart you need. It will list additions or deletions concerning obstructions on the current edition of the chart.

309. PILOT POINT OF VIEW

Altitude, airspeed, light conditions, and obstructions must be considered when selecting visual navigation features. At high altitude, visibility may be as great as 100 miles with ample checkpoints, but 100 miles ahead, only a large city might serve as a landmark. From 500 feet AGL, you have a limited radius of vision. Compare that with the extended field of view you have at 6,000 feet AGL. Look for large features and consider the possibility of an undercast; in conjunction with time and course, check directly under you as well as ahead.

At low altitude, you must consider the oblique perspective you will have from your cockpit (Figure 3-3). Experience is a great teacher in this respect. Pay careful attention to how things look while you’re flying and note the differences in what you expected to see based on their appearance on the chart and on satellite imagery and how they actually look while flying over/around them.

Figure 3-3 View from 500 ft AGL and ½ Mile
As airspeed increases, you have less time to interpret, analyze, and locate landmarks, intermediate checkpoints, and checkpoints. Early or late in the day, consider the effect of shadows on checkpoints. A long shadow may make an object more visible, or it may hide another, leading to dangerous situations when flying in mountainous terrain. Shadows in northern latitudes will cause snow to remain in some places much longer than in others; the presence of a large patch of white can make a landmark much easier to see due to the contrast while also making it harder to identify because of glare. Finally, consider vegetation and terrain. Which way does the ground slope? Is it higher than your landmark? Might a ground slope lead you to your landmark? From any knowledge of the country you have, what effect will vegetation have on your checkpoints? It will have less effect around El Centro, California, where there is little vegetation. Mississippi, on the other hand, is full of tall trees. In northern locations the effect of vegetation can be dramatic. If the predominant vegetation is evergreen trees, there will be little seasonal difference, as is the case with the ocotillo cactus in southern California and the live oak trees of south Texas. But grass turns brown and disappears in some places, and leaves fall off trees, changing the overall appearance of the surface. Imagine what it will look like.

310. ROUTE FAMILIARITY

Mentally flying a route almost to the point of memorization will significantly reduce the visual navigation in-flight workload. You must spend time flying the route while studying the chart and satellite imagery. The more pre-mission study, the smoother your visual navigation flight will be.

*Additionally, students should prepare a briefing board with the route drawn and all significant points, navigation features, turns, crossing routes, and choke points annotated. Furthermore, all crossing MTR routes shall be annotated on either the kneeboard or bingo chart.*
CHAPTER FOUR
LOW-LEVEL NAVIGATION

400. INTRODUCTION

Navigating in the low altitude environment can be accomplished through a variety of methods. In the TRACOM, which method you use will be dictated by the MCG. Due to improvements in technology, the primary method of navigation is using GPS and INS along with defined waypoints to find your way along the route. It is still critical that you learn the basics of pilotage and dead reckoning should you find yourself without either of those systems. The purpose of this chapter is to provide you with various techniques for navigating in the low altitude environment.

401. DEAD RECKONING NAVIGATION AND PILOTAGE

To successfully fly a low-level route, the combination of dead reckoning and pilotage must be used.

Dead Reckoning is the sole use of time, distance, and heading to get from one fix to another fix. Obviously, basic air-work is of prime importance when using this method. Precise control of heading and airspeed is mandatory in order to stay on course and on time. Fly the exact headings listed on your chart using the wind corrected capabilities of the system. For timing on the route, you will want to use a clock with elapsed time capability. Although the clock in the aircraft can be successfully used for this purpose, it is not always the most reliable instrument. Using a dedicated timer/stopwatch, a wristwatch, a phone, or any other method may be more advantageous. Set it to zero prior to the first checkpoint and start it when you cross the first checkpoint and do not reset it. While flying, cross-check the elapsed time with the tick marks on your chart for monitoring your position.

Pilotage is the use of charts and landmarks for navigation. This is where much of your preflight preparation in terms of visualizing what you will be seeing along the route can pay off. Look for unique features as discussed in Chapter Four to back up your use of dead reckoning in precisely locating your position and recognizing deviations quicker, which will make corrections significantly easier to implement. Although the primary method of navigating from point-to-point along a route is through the use of dead reckoning, developing your ability to translate the symbology on the chart to what you see is critical to a successful flight. To do this, first find something that is readily identifiable on the chart (a road/railroad, a valley, a uniquely shaped terrain feature, a large mountain peak, etc.), then attempt to find it outside of the jet.

"Clock-chart-ground" is the scan that you must develop during the ONAV syllabus. If you have controlled your airspeed and heading properly, your clock will correspond to the time ticks on your chart. If you know that you should cross a railroad track at an elapsed time of 12 + 36, then look for a railroad track beginning early – you must look ahead for terrain features. Note any deviations from your planned timing and make the appropriate corrections. While performing this scan, continue to attempt to correlate what you are seeing on the chart to what you are seeing outside of the aircraft (i.e., backup your dead reckoning with pilotage). If you do not locate your
checkpoint, turn on time. If you disregard your timing and continue straight ahead, you will become disoriented and perhaps even lost.

**Disorientation**

If you find yourself unable to locate your position on a chart, remain calm and follow these procedures:

1. Determine what is wrong. "Anxiety" disorientation can occur even with the pilot exactly on course if he fails to identify an anticipated landmark and misconstrues it as proof of being lost. Be sure that you are off course. Do not immediately break down your scan and go "ground to chart." Review your progress from your last known position and determine the cause and extent of any error. Possible causes include errors in heading, airspeed control, timing, or planning; malfunction of instruments or navigation aids; and wind. Deviations around weather can place you in unfamiliar territory.

2. Check the clock immediately. Timing will be a factor in determining the extent of disorientation and the correction required. Where should you be at the present elapsed time? If you are able to determine the cause of your disorientation (e.g., poor airspeed control), you can begin to adjust your scan based on where that deviation may place you (e.g., slow airspeed will result in you being behind timeline).

3. Check your fuel state. Compare your available fuel with the MFR (minimum fuel required to complete the route) and bingo fuel. The disorientation may have caused more problems than just navigation. If lost, remember the Five C’s: Confess, Climb, Conserve, Communicate, and Comply. Take action before your fuel state becomes a significant factor.

4. Do not complicate matters. Immediately upon realizing that a problem exists, decide on a plan. Avoid wandering aimlessly while planning what to do next. Stick with what you know - time, distance, and heading. Normally, continue flying preplanned headings and times while climbing to a higher altitude to increase visibility. Be aware of the top of the route structure. If you must go higher, be sure to slow to 250 KIAS.

5. Reorient. You must find landmarks and identify them on the chart (e.g., backup your dead reckoning abilities with pilotage). Take care to avoid following a hunch or making a decision based on uncertain information. Comply with FAA speed restrictions (250 KIAS) if you suspect that you have exceeded the applicable route widths described in FLIP AP/1B.

**Course/Time Corrections at Checkpoints**

If you see a checkpoint ahead and slightly off course and you know you are supposed to pass directly over it, maneuver to fly over it. If it is too close or you see it late, maneuver to put it on your tail as you turn to the outbound heading. Try to reach it on the planned inbound heading, if you can pass over it, you can turn directly to the correct outbound heading. Check your time and adjust power and airspeed as necessary to correct for being early or late at the turnpoint.
Time Corrections

Timing is very important in operational navigation, both in locating yourself along your course line and in correcting your position. You should consistently check your time and make an adjustment any time you find your timing off by more than five seconds. You may be fast or slow, so be sure to correct in the right direction. If you are supposed to be at a bridge at 10+00 but you fly over it at 9+50 then you are fast, ahead of your clock.

One technique to help correct your low-level timing that you have already learned in primary flight training is the proportional method. Using the proportional method, for every second off your planned ETA, change your IAS by 1 knot and hold this new airspeed for the number of minutes equal to your GS in NM/min. If you are 20 seconds late, increase airspeed by 20 knots and hold this correction for 6+00 minutes. You can use fractions and multiples of this method to adjust speeds and timing. Instead of 20 knots for 6+00 minutes, you could use either 10 knots for 12+00 minutes or 40 knots for 3+00 minutes. Once you are back on time, return to your planned airspeed, incorporating any required adjustment. Analyze the recent correction. Why were you off time? Consider wind, course corrections, your own airspeed control, and take them into account.

Another technique is to use geometry to fix timing. When approaching a turn point, you can either cut the turn point off to make up time or go around the turn point to add time. Before doing this, be cognizant of the route structure. Also, realize that this method of correction is not as precise as the previous technique, but it allows for rather large corrections (which may lead to an overcorrection) while maintaining a constant airspeed.

Course Corrections

Course corrections may be rapid or gradual, depending on the situation. If you see your checkpoint straight off to one side when it should be directly underneath, you have to maneuver to get on course after the checkpoint. You can also apply a calculated correction: 10 degrees for one minute for each mile off course (360 KGS). You have to estimate accurately how far off course you are, but you can do that by reference to such items as section lines, known landmarks, and experience.

Be careful of large changes; like timing corrections, smaller corrections are usually better. A large heading change of 30 degrees for one minute will move the track three miles, but changes the view that you planned to have. Do you know what to look for? You can become disoriented easier. Use 10 degrees for three minutes instead, provided you have sufficient leg time. As always, turn on time. Course corrections take time because they decrease your forward travel. Any course correction will make you lose time, though perhaps not enough to matter if small. Check time as soon as possible after a course correction, especially a large one, and apply any necessary time correction.
Airspeed Corrections

Adjust power to planned settings as required to maintain target Ground Speed (GS). The correlation of GS to KIAS depends on altitude and wind speed/direction, so any changes in elevation, heading, or wind speed/direction will have an effect on the KIAS required to maintain 360 KGS. As such continually crosscheck GS during the flight and make the appropriate corrections.

If speed deviations occur, make the correction the same magnitude as the error. For example, if your airspeed is 20 knots slow, add power appropriately. When the desired speed is attained, reduce power to a setting higher than before. Using airspeed to correct for early timing should be limited to no more than a 20 knot reduction. If a larger correction is required utilize geometry, such as a turn off of course while maintaining flight path inside the route structure. Keep airspeed above briefed minimum airspeed. This can be especially challenging in areas of higher elevation.

402. SYSTEM NAVIGATION

The Global Positioning System Inertial Navigation Assembly (GINA) is a navigation-grade strap down inertial system with an embedded GPS receiver. The GINA ring laser gyro and inertial-grade accelerometers determine aircraft movement to provide attitude, velocity, and heading, generating an aircraft position that is then refined by the GPS. Coupling this information with coordinates for the various turn points along the route allows a pilot to navigate a route relatively easily and accurately, freeing up more time to perform TCTs and other MTs.

System Symbology

The HSI display is the primary instrument for navigation information when using the system.

Figure 4-1 HSI Display with Sequential Steering
The sequential steering string (Figure 4-1) is displayed as dashed, dotted, or solid lines on the HSI when two or more waypoints have been entered into a sequence, that sequence is boxed on the SEQ DEP page, and SEQ is selected on the HSI. The sequence lines are displayed to the edge of the active MFD display area, including the area outside the compass rose, as determined by the selected HSI scale. Waypoints in the sequence can be automatically incremented in flight through the use of the appropriate AUTO sequence (AUT1, AUT2, or AUT3). Upon reaching the last waypoint in the sequence string, AUTO is unboxed and steering to the last waypoint in the string is retained.

**NOTE**

With AUTO sequence selected, only the waypoints in the selected sequence can be selected.

With a waypoint selected, you will get navigation information to that waypoint (i.e., bearing and distance), the amount of time required to reach that waypoint at current speeds, and the expected fuel remaining once reaching that waypoint. With CRS boxed, you will also see the selected courseline through the appropriate waypoint. When CRS and AUTO are both selected, you will have steering from your present position to the first waypoint in the sequence until the waypoint is reached, at which point the courseline will switch to the course required to go from that waypoint to the next waypoint in the sequence. To remove this line, unbox CRS.

Other useful information that can be found on the HSI is the ground track marker and the groundspeed readout. The ground track marker (Figure 4-1) displays the actual aircraft magnetic track over the ground. A technique for using the ground track marker to maintain a selected course is to fly a heading that places the ground track marker directly inside the waypoint steering arrow on the compass rose. The groundspeed readout is located in the center of the HSI just below the aircraft symbol. Alternatively, GS can be found on the left side of the HUD when in the NAV master mode.

In addition to the HSI, you can use the course deviation situation steering arrow in the HUD when the selected steering is TACAN, waypoint (WYPT) or waypoint offset (WO/S) and course (CRS) is selected. The HSI display mode, CDI or PLAN, doesn't affect the HUD steering arrow display format. The orientation of the situation arrow indicates the difference between the aircraft ground track and the course line setting. This information can be used to quickly identify any deviations from course without having to go heads-down to look at the HSI. The two dots represent the same deflection scale as the HSI CDI display. The reference dots are removed when the deviation from the selected course is within one degree with TACAN selected, 0.4 nautical miles with waypoint or waypoint offset selected and the landing gear up, or 0.03 nautical miles with waypoint or waypoint offset selected and the landing gear down. The HUD displays all pertinent information for this phase of flight and will be the primary instrument used to execute low level flights. Waypoint identifier, timing, and direction can all be derived from the HUD.
System Setup and Flying the Route

For any flight in which you will be navigating from point to point on a low-level route using the capabilities of the system, begin by inputting the appropriate coordinates into any of the available waypoints of the system, either via manual entry or by transferring them from the Mission Data Loader. To aid in locating your desired LIP, you can use a waypoint offset. Once this has been accomplished, populate the appropriate sequence with each of the desired waypoints in the appropriate order by selecting SEQ DEP from the DATA page and boxing EDIT, then typing in the corresponding waypoint number for each waypoint on the DEP and pressing ENT. Ensure that the sequence you have populated is also boxed. On the HSI, select sequence and verify that the sequence appears correct. When ready to fly the route, box AUTO for the appropriate sequence to get automatic sequencing during the flight. As the aircraft proceeds along the route entered in the string, the steering automatically increments to the next waypoint in the string and the course setting is updated to the new leg bearing. This automatic waypoint change occurs when the range to the selected steer-to waypoint is less than five nautical miles and the difference between the waypoint bearing and aircraft ground track transitions from less than to greater than ninety degrees.

Corrections

Unlike dead reckoning, system corrections can be much simpler. Because the selected waypoint is visually displayed with accurate steering information and the time required to reach the waypoint, you simply need to adjust your heading and groundspeed such that you are pointed at the next waypoint with the correct amount of time required to reach that waypoint such that you will be on time at that point. Alternatively, you can still use geometry to shave or add time, but you can do so with the added benefit of selecting the next waypoint, making those corrections much more accurate.
CHAPTER FIVE
LOW-LEVEL FLYING

500. INTRODUCTION

The previous chapters provided much of the background information required to prepare for a flight in the low altitude environment, including pre-flight planning and navigation. The purpose of this chapter is to put it all together and to provide specific techniques for how to actually maneuver your aircraft in the low altitude environment.

501. ADMIN

Before the Brief

Your route of flight will either be dictated by the flight schedule or chosen by your instructor. You should contact your instructor the day prior to a scheduled flight to confirm the route to gather any other pertinent information about the flight. It is your responsibility to contact the appropriate scheduling activity to schedule the route. Any issues should immediately be brought to your instructor. Once you know what route you will be flying, ensure you have an up-to-date chart, and begin to familiarize yourself with all aspects of the flight, especially those listed in previous chapters concerning preflight planning.

Flying to the Route

Flying to the route can be accomplished under either IFR or VFR control; ask your instructor what type of flight plan you should expect. For IR routes, if you use a VFR flight plan, you’ll have to pick up an IFR clearance to enter and fly the route; if you depart IFR, you will simply need clearance onto the route. For VR routes, you can file an IFR flight plan to the first fix on the route, but you will need to cancel IFR prior to entering the route.

RTB from the Route

Upon exiting a VR route, you can pick up an IFR clearance or VFR flight following by contacting the appropriate agency. Upon exiting an IR route, you are still under an IFR clearance and must comply with your clearance. Contact the appropriate agency for follow-on clearances or to cancel IFR.

502. TAC ADMIN

Route Entry

Prior to entering the low altitude environment, execute an appropriate “G” Awareness maneuver per Training Rules if required. To enter a VR route, simply cancel IFR or VFR flight following when you are ready and begin the required items. This includes squawking 4000 and contacting the local FSS on 255.4. You do not need a response from the local FSS to enter the route. Be
sure to continue to monitor 255.4 for other aircraft operating on the route and for any aircraft on crossing MTRs.

To enter an IR route, let the controlling agency know that you have the intended entry point in sight. If they have not already cleared you onto the route, they should do so now. Depending on the operating procedures for the route, they may also clear you to switch to another frequency prior to entering the route. While on the route, although you are on an IFR clearance, you are MARSA with any other aircraft on the route. Also, you may or may not get any traffic calls to interlopers while on the route.

**Entry Comm Example:**

**ARTCC**

Hawk 201: “*Houston Center, Hawk Two Zero One.*”

Houston Center: “*Hawk Two Zero One, Houston Center, go ahead.*”

Hawk 201: “*Hawk Two Zero One, cancel IFR, would like to proceed VFR to point Alpha on VR-196.*”

Houston Center: “*Hawk Two Zero One, Houston, cancellation received, frequency change approved, squawk appropriate codes.*”

Hawk 201: “*Hawk Two Zero One, roger.*”

**FSS**

Hawk 201: “*San Angelo radio, Hawk Two Zero One.*” or “*Any radio, Any radio.*”

San Angelo radio: “*Hawk Two Zero One, San Angelo radio, go ahead.*”

Hawk 201: “*Hawk Two Zero One, single T-45, entering point Alpha on the VR 196 at 1730 Zulu, exiting point Golf at 1802 Zulu; 500 feet, 360 knots.*”

San Angelo radio: “*Hawk Two Zero One, San Angelo altimeter 29.92, no traffic on the route.*”

**LAT Checklist**

Prior to entering the low altitude environment, you must complete the LAT checklist. As a technique, use the RADALT going off at “Platform” as the cue for when to begin the LAT checklist. Below are the steps for completing the LAT checklist:

1. Mask on / Visor Down

2. RADALT "Good Tone," Good "R" & reset

5-2 **LOW-LEVEL FLYING**
3. Loose items – Stowed and secured

4. IFF 4000 / as assigned

The comm cadence for completing the LAT checklist is shown below and shall be verbalized over the ICS prior to reaching 1500 ft AGL.

“Mask on, visor down, loose items secure, good tone, good ‘R’, RADALT reset to XXX”

RADALT

The RADALT shall be set to no lower than 10% of the pre-briefed altitude (usually 450 for executing the route at 500 ft AGL). RADALT should be set before executing LAT Entry. If a LAW caution tone occurs during the execution of the flight, the student will immediately start a wings level climb back to 500 ft AGL or the pre-briefed altitude. At the same time, the student will verbalize “CLIMBING” over the ICS.

G-Warm

Due to terrain clearing tasks and the dangers of GLOC at low altitudes, the G-warm must be completed in a different manner than at higher altitudes. The G-warm prior to all low altitude training will be conducted once established in a MOA or on a VR/IR route, at 350 KIAS and at a safe altitude no lower than 1500 ft AGL. The G warm will consist of two level 90 degree 4G turns or one level 180 degree 4G turn.

Route TAC Admin

While flying the route, you can be in any one of the system Master Modes (e.g., NAV, A/A, A/G). There are pros and cons to each. NAV mode will provide GS and AOB ticks in the HUD. A/A mode will be the primary mode used in the fleet. A/G mode will be used for any target attacks. For both A/A and A/G mode, you must look at the HSI to get a GS readout.

If using the system for navigation, be sure to select the appropriate WYPT and box SEQ with AUTO sequencing if briefed to do so; otherwise, you will have to manually increment the waypoints during the flight. As a technique, do not include any fixes outside of the route (e.g., departure/arrival airfield, enroute NAVAIDs, etc.) in the sequence, as this tends to clutter up the display.

On the route, you should be continuously monitor how the flight is progressing relative to your plan. When reaching a turnpoint, turn to the planned heading and provide a “doghouse brief” to include actual time vs planned time, check estimated fuel left, minimum fuel required and bingo fuel against actual fuel left at each checkpoint. Initiate corrections.
503. LOW-LEVEL MANEUVERING

The basic maneuver descriptions in the P-912 FTI hold true for the T-45 in the LAT Environment. Below you will find T-45 specifics and points of emphasis while executing your flight.

**Route Entry**

Use one of the methods from Chapter One to facilitate the transition to the low altitude environment. You must effectively manage the 3D problem, trading altitude for airspeed as appropriate to arrive at your entry point at 360 KGS and 500 feet AGL. As you cross the route entry point, hack the appropriate clock to begin your timing. Low-levels are intended to be flown at 360 KGS and no lower than 500’ AGL. If route structure, bird activity or comfort level prevent this, level off at a higher AGL altitude. If outside the route structure, be sure to adhere to airspeed restrictions.

**Route Exit**

When exiting the route, ensure that you slow to the appropriate air speed prior to exiting the route structure (e.g., 250 KIAS below 10,000’ MSL). For a VR route, attempt to contact the appropriate FSS on 255.4 and change your squawk back to 1200. You can then contact the appropriate controlling agency to pick up either an IFR clearance or VFR flight following, as necessary. For an IR route, you must contact the appropriate controlling agency prior to leaving the route structure.

**Straight-and-Level Flight**

Straight-and-Level Flight is considered to be a flight path angle (FPA) between plus 1 degree and minus 1 degree, and an AOB less than or equal to 30 Degrees. During straight and level flight, it is not as simple as placing the Velocity Vector (VV) on the horizon bar; because of the variations in terrain elevation, especially subtly rising or falling terrain. You need to fly such that you remain at your desired AGL altitude. This requires a constant inside/outside scan to assess slope and look for obstacles. Your VSI may show either a climb or descent while your AGL altitude remains the same. As a technique, you could apply neutral to nose-high trim to ensure a climb during straight and level flight by relaxing backstick pressure. This could be useful during MCT. Three- to five-seconds is the maximum time allowed for MCT during straight-and-level flight. Ignoring the flight path vector for more than 5 seconds can induce deviations, including roll deviations and steep FPAs that are unpredictable and hazardous. After MCT, complete a new visual assessment of the terrain and scan available visual cues. Example: If the mission requires map study, check terrain, check visual cues, spend no more than 3-5 seconds on chart study, start cycle over. If you cannot find what you are looking for on the chart - **Do not break 3-5 second MCT**! Abandon MCT, complete TCT, and try again. Do not allow aircraft stability and long TTI to create a false impression of unlimited MCT.
Level Turns

Level Turns present a much more demanding scan than straight-and-level flight. First, visually clear the terrain prior to starting the turn. Assess slope, as velocity vector/nose position will have to be adjusted immediately if terrain is rising. For turns greater than 30 degrees, roll into the turn and apply “G” passing through 30-45 degree AOB, depending on roll rate. Set 4Gs or 14 units AOA (whichever comes first, but do not exceed CNATRA training rules) while adjusting bank angle to hold level flight and adjust power to maintain airspeed. You would like to spend as little time as possible in a turn due to the low TTIs, the lack of MCT, and the loss of the RADALT at normal AOBs. Recognize that low-level flying is intended to be dynamic; these flights are not intended to be low-level instrument flights. Turns should be executed at 4Gs, as this minimizes time outside of the RADALT envelope, and provides a margin of aerodynamic safety before aerodynamic stall. As the turn begins, monitor the nose position relative to the horizon, and use the velocity vector to monitor the flight path vector, ensuring that level flight is maintained. For turns less than 30 degrees, use AOB and G as necessary to change heading.

During a turn, you should be watching for any small amount of lateral nose drop (nose slice) to the inside of the turn. This can be observed by picking a reference on the aircraft (nose, canopy bow, and mirror) and watching it track level across the horizon/terrain (not necessarily level relative to the horizon bar in the HUD). The velocity vector provides a rapid cue to detect nose slice. *If nose slice is detected, it must be corrected immediately.* It is corrected by first decreasing bank angle, and second, by increasing the "G." If you try to correct the situation by just applying more "G," you will accelerate your descent towards the ground! If a climb is detected in a turn, correct back to level (relative to the terrain) but to *not* attempt to "fix" the climb with a descent while in the turn.

Since TTIs are extremely small during low altitude turns, scan must be extremely disciplined. MCT is limited to Critical Tasks such as clearing your flight path. The proper scan should move from the aircraft HUD out to the canopy bow and back. In this way aircraft position in relation to the horizon and upcoming terrain are scanned in the turn. Because of the steep AOBs used in low-level flying, the RADALT may not be accurate/functioning beyond 30-40 degrees AOB. One last point to think about, if you roll into a turn at 500' AGL, once established in the turn, the radar altimeter may show approximately 530-540 feet due to the bank angle. *Do not* mistake this as a climb and try to correct. Once complete with a turn then correct back down to desired altitude.

Ridgeline Crossings

There are three methods for negotiating ridgelines; utilizing natural breaks, the straight-ahead approach, and the 45° angle off/parallel method described below.

1. Natural Breaks. Probably the best way to negotiate a ridge is to do a good map study during your preflight planning, find natural breaks or low areas, and go through the gaps and passes.
2. Straight-Ahead. The simplest method is to approach the ridge straight-ahead, climb to clear it and then descend down the back slope. This task presents one of the biggest challenges for your low altitude maneuvering skills. You must determine when to pull up and when to recover on the backside. Additionally, these demands require perceptual judgments in the areas where your visual perception is the weakest: distance estimation.

   a. The first step is to determine when to start your climb. As a general rule, you can wait until the top of the ridgeline is about 3 to 5° above the horizon bars on your HUD. Now pull to place the velocity vector to a minimum of five degrees above the ridgeline to ensure a minimum clearance of 500 ft crossing the ridge.

   b. As the terrain begins to pass under the horizon bars, begin a gentle push in order to cross the terrain in a level attitude. This is critical in order to prevent excessive climb once you have cleared above the terrain.

   c. Now that you've solved when to pull-up, the level off and crossing over the top you have two options to get back down:

      i. The Wings Level Bunt is the easiest, safest, and in many tactical cases, the best. It allows you to assess the backside for hidden ridgelines prior to committing your nose below the horizon. The bunt should be started as the top of the ridgeline falls to the bottom of the HUD/canopy FOV. Use the radar altimeter for AGL altitude control. On the backside of the ridge use the Small Descent ROT to get back down to the pre-briefed altitude. If at any point you can't rely on the radar altimeter or are unable to accurately assess the terrain gradient, stop the bunt, and start your recovery.

      ii. The second option is to roll to 120° AOB; letting the intentional overbank help you achieve a roll-out dive angle for recovery. Initially target a FPA to parallel the back slope of the Ridgeline but not more than -10 degrees. Intercept the LAT Descent ROT when wings level. Descending terrain may delay a decrease in AGL altitude. Be patient, the LAT Descent ROT will get you back to 500 ft AGL as terrain flattens out. An earlier climb on the front side of this maneuver will minimize ballooning on the back side. In both cases, on the back side you're falling like a rock. However, with the bunt you're floating, and with the overbank and the requisite amount of positive "G" (approximately 2Gs) you remain in the seat.

         At no time in the TRACOM is it acceptable to be over 120° AOB or steeper than -10 FPA when BELOW 1500 ft AGL.

   d. In summary, use the velocity vector to start your pull-up and set your terrain clearance. Watch out for shadowing with low sun angles and low contrast hills. If in doubt, start up early.
3. 45°/Parallel. In cases where your navigation will allow deviation this approach is optimum.
   a. As you approach the base of the ridgeline, a turn is executed to place your aircraft approximately 45° off axis in respect to the ridgeline. The aircraft is then flown up the side of the ridgeline utilizing the same pull up and recovery described in the Straight-Ahead method.
   b. What this maneuver should look like is a shallow climb to a level turn across the terrain, to an over banking turning pull to roll out and recover down the backside.

4. Comments
   a. The best method is to do your mission planning and avoid crossing high peaks.
   b. It is critical to cross the terrain in a level flight path. This increases SA.
   c. It's better to start the pull up early rather than late.

5. Common Errors
   a. Pulling up late and trying to maintain low altitude up the face of the terrain. Results in "ballooning" over the top.
   b. Not crossing the top of the terrain in level flight.
   c. Starting the bunt or pull down late.

*Once wings level and established below 1500 ft AGL on the back side of the ridge, the student will verbally acknowledge that the RADALT is operable with a “good RADALT” call over the ICS.*

**Plan ahead**

If you want to fly a smooth aircraft you will need to have a plan. In the low altitude environment, you need to manage immediate Terrain Clearance Tasks (TCTs) but you must also be thinking ahead to where you’re going to be in the next 5 seconds, and where you want to be in another 30 seconds, 1 minute, etc. Pick an appropriate path through your route based on terrain features, special operating procedures, etc. You should never be surprised by something that pops up in front of you.

**Comfort level**

Comfort level is defined as the state of flight in which you feel that you can operate safely; it does not mean that you are completely comfortable with no stress, but that all external and internal stresses are at a manageable level. You may not be “comfortable” the first time you go down to 500’ AGL, but that is different from not being able to do it safely. Although the goal is
to fly at 360 KGS and 500’ AGL, there are circumstances that may preclude this. Be aware of how changing flight environments, varying speeds, and pilot workload can affect comfort level. Over prolonged periods of straight and level flight, comfort level may change depending on the changing conditions of the mission and the terrain. If you find yourself feeling uncomfortable, unsafe, getting behind the jet, in uncertain terrain, higher than expected bird activity, etc., you may have reached your comfort level and need to climb. Although slowing down can also alleviate the problem, we will discuss below why this is not a good option in most cases.

**Climb to cope**

“Climb to cope” is a phrase you will hear often when preparing to fly on a low-level route. It means that, for any unsafe or unexpected situation, your first reaction should be to climb away from terrain and establish more margin between you and hitting the ground. Any time you hit a bird, have an emergency, are unsure of the terrain/weather in front of you, execute a climb as necessary. For certain situations, this may be as simple as climbing to a few thousand feet, while others will require a more aggressive climb and possibly exiting the route (to climb to MSA if encountering IMC for example). If doing so, remember that you are only authorized speeds in excess of 250 KIAS when operating within the lateral and vertical confines of the route.

**Do not go belly up to terrain**

When you are maneuvering an aircraft, your flight path doesn’t go exactly where your nose is. You tend to arc, even in a coordinated turn, with your aircraft going somewhere under your nose/belly (depending on how hard you turn). With that being the case, you generally can’t see the path your aircraft is taking through the sky while in a turn. This is important in the low altitude environment because you will often be maneuvering to avoid terrain. If you wait until the last moment to maneuver to avoid terrain you will be flying past that terrain feature with the terrain underneath your belly, which is both a place you can’t see and a place where your aircraft is going. That runs the danger of pancaking into a mountain that you think you’re going to clear when you’re really not. To avoid this, start your turn early so that you can roll out prior to passing the terrain so you can see how close you are (and, if you are too close for comfort, make another adjustment to stay clear).

**If you have to go belly up to terrain, take close aboard the terrain you can see Canopy Bias**

There may be times when you aren’t able to be wings level flying past terrain. You may be constricted based on turns to the route structure, or you may already be flying between terrain features that don’t allow you to early turn (for example, a valley that curves). If this is the case, you **MUST** turn to avoid hitting the terrain. A good rule of thumb to follow in this case would be to take close aboard whatever terrain feature you can see (i.e., what’s off your canopy), reference Figure 5-1. If a valley is a mile wide, and you’re within a quarter mile from terrain on one side, you know you’ll be clear of the terrain on the other side, even though you can’t see it.
If you do not need to turn, be wings level

There are a couple reasons why you want to avoid remaining in an angle of bank when you do not need to be. One we already talked about is you may be masking terrain under your belly. Another reason is your RADALT is designed to work while you’re straight and level, not in a turn. There may be times when your scan breaks down, you end up in a slight descent (even easier to do if you’re not wings level), and the only thing that saves you from slowly descending into the ground is your RADALT. Don’t take away that extra layer of protection if you don’t need to.

If you do need to turn, be assertive

As we talked about already, turns put you at a higher level of risk than flying straight and level. It should not come as any surprise then that if you need to turn, minimizing your time in the turn will help keep you safe; the goal is to execute a safe turn as expeditiously as possible so that you can go back to flying wings level. How hard you need to turn depends on the situation—are you flying through a valley where if you float this turn you’ll hit a mountain? Are you over flat
terrain and just making a turn to point toward your next checkpoint? You will obviously need to be more aggressive in the former case, but as a place to deviate from, you can target 4Gs for all your turns. That said, you should still be smooth when executing these turns. Jerking the controls around will not help you fly a good aircraft and will generally increase your anxiety level, leading to further mistakes down the road.

**Speed is life**

Corner airspeed in the T-45 is above 400 knots and varies with altitude. That means any time you are slower than that, you are incapable of max performing your aircraft (though if you snatch on the “G,” you may see an overstress). If you get slow, not only do you run the risk of an accelerated stall, but you could run out of airspeed completely during maneuvers. To prevent this, any time you are nose is high, the throttle should be forward. Remember, an MRT 300 knot climb will put your velocity vector somewhere between 5-10 degrees high. So if you’re crossing a ridge that is steeper than that you will slow down no matter where your throttle is. You do not want to approach that situation with a slow airspeed and low power setting. Additionally, if you find yourself ahead on timing, it would be advisable to find an alternate method to correct for timing using geometry within the route structure.
CHAPTER SIX
ROAD RECONNAISSANCE

600. INTRODUCTION

Road Reconnaissance (RR) missions in the training command will develop your tactical formation skills in a dynamic environment. This mission increases task loading by training you to fly as a section, acquire targets, and then prosecute simulated target attacks as a section.

601. PURPOSE

You will apply the skills developed in the Tactical Formation stage, ONAV stage, and Weapons stage. Combining these three stages will help prepare you for more complex follow-on mission sets at the FRS and later in the fleet. The foundations of fleet Air-to-Surface tactical employment are predicated upon the successful prioritization of: formation, sensor, and communication (form, sensor, comm). We will introduce this method to you. This is intended to develop you as a more capable and effective wingman; a necessity for follow-on training and the future missions that you will fly.

The formation to accomplish this mission will be defensive combat spread (DCS). As a sensor you will rely on a combination of visual target acquisition and waypoint aided acquisition. We will also introduce you to the mirror pop-attack, a standard fleet maneuver, designed to allow a section to deliver weapons simultaneously to a target, and then egress expeditiously to safety.

Radio communication between TACLEAD and TACWING will be based upon standardized fleet brevity, modified for the training command when necessary.

602. PLANNING

Students will use the same planning methods you learned in ONAV. The Instructor or stage manager will select a route, and you will prepare the charts and visual aids required to fly the route safely. VR or IR routes may be selected; during planning, you must ensure that both aircraft can remain within the route structure during the tactical portion of the flight. If necessary, a route can be constructed within a Restricted Area or MOA as long as the necessary training objectives can be met. For fuel planning purposes, multiply the estimated fuel remaining (EFR) for each leg by 1.2 to account for fuel burned during low-altitude tactics. Plan to fly the route at 300 KIAS. Timing is not a specific training objective for the Road Reconnaissance stage.

603. FORMATION

Defensive Combat Spread (DCS) is the basic formation for Air-to-Surface missions. It allows the section to maintain visual mutual support, while allowing sufficient mission crosscheck time to acquire targets, and to efficiently execute a weapons delivery profile, even in mountainous terrain. Additionally, it allows the section to maneuver aggressively for weapons delivery attacks as well as defensive considerations. When flown at low altitude, TACWING shall always fly stepped up on TACLEAD, never flying lower than TACLEAD. In-place turns, TAC
turns, shackles form the basis of the formation keeping during RR missions. Power settings will be set in order to maintain 300 KIAS with G and AOA as necessary to maintain proper position.

With the TACLEAD in level flight at 300 knots, TACWING will fly (DCS) on either side of TACLEAD: .8-1.0 NM abeam, with at least 1,000 feet of step up. Altitude will be selected by the flight TACLEAD based on several factors including, but not limited to: Route structure, terrain, or other altitude restrictions, etc. The RADALT shall be set as high as practical. Wing Stan Notes will delineate specifics for each route.

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**Figure 6-1 Defensive Combat Spread**

604. RESPONSIBILITIES

1. TACTICAL LEAD RESPONSIBILITIES
   a. Ensure the formation’s overall safety; to include compliance with all IR/VR route requirements.
   b. Target Acquisition.
   c. Communications necessary to ensure: Safety, remaining on the route, and preparing for and executing target attacks.
   d. Weapons delivery/Target attack.

2. TACWING RESPONSIBILITIES
   a. Formation. Prioritize deconfliction from TACLEAD and maintaining DCS.
   b. Navigation. Ensure the section remains clear of terrain, on the route structure, and clear of avoidance areas.
   c. Weapons delivery/Target attack. Executing a target attack.

6-2 ROAD RECONNAISSANCE
605. MANEUVERING

The TACLEAD maneuvers the flight, while the TACWING is responsible for maintaining flight deconfliction and remaining in defensive combat spread. The TACLEAD must both navigate the flight into a position to attack the target and then maneuver the flight off target for maximum mutual support. Use maneuvers learned in Tactical Formation. As in TacForm, the TACLEAD initiates the communications for all maneuvers. TACWING will acknowledge the TACLEAD’s call with his call sign (ex. “Rage 12”).

CAUTION

Road Recce missions are flown at low to medium altitudes. Maintaining safe separation from terrain is critical. TACWING shall remain above TACLEAD’s altitude at all times. During attacks, a 1000 ft buffer will be established and maintained between TACLEAD and TACWING.

Check Turn

Use the check turns for heading changes of less than 30-45 degrees. The TACLEAD initiates the turn by calling, “Rage, check left/right, 210.” Both members turn immediately to the new heading and TACWING corrects to maintain combat spread.

TAC Turn

For heading changes between 60 and 120 degrees, use the TAC turn. The TACLEAD initiates the turn by calling, “Rage, tac left/right.” The flight maneuvers as in TacForm, and TACWING adjusts his turn to maintain combat spread.

Shackle

This is the same shackle used in Tactical Formation. Use the shackle in Road Recce to correct for a sucked or acute TACWING or to move TACWING to the other side of the section. It maintains the section heading, allows a check behind the section, and is expeditious. The TACLEAD initiates the maneuver by calling, “Rage, shackle, 150.”

TACWING will respond to all heading changes with call sign and heading.

606. WEAPONS SET-UP

Carriage of ordnance is prohibited on Road Reconnaissance missions. Stores Display setup for air-to-surface weapons delivery shall be a simulated weapons load-out of RKTS/CCIP. Target height will be briefed by your IP. The CCIP cue represents the impact point of the rocket given immediate employment and is only valid when slant range is determined to be less than 12,000 ft. Outside of 12,000 ft., the CCIP marker will flash three times per second. Once a valid solution is reached, the CCIP cue will remain steady.
CHAPTER SIX  OPERATIONAL NAVIGATION T-45 MPTS AND IUT

The Master arm switch will be set to ARM once the flight is FENCED IN and approaching the first target. Master Arm will be set to safe upon completion of the off target maneuver after the last target attack when FENCED OUT is called.

607. ROAD RECCE ATTACK PROCEDURES

RR attacks are broken down into four phases – a successful attack incorporates 1) Textbook DCS Formation, 2) Target Acquisition, 3) Soundly executed Attack procedures/pop mechanics, and 4) effective off target mechanics to quickly redress the formation. Form, Sensor, Comm.

The sequence begins with the formation in DCS. Target ‘talk-on’ is initiated by the TACLEAD aircraft to correctly identify the target. This process should utilize easily distinguishable terrain features working large to small. The TACLEAD locates the target approximately 8-10 miles ahead of the section and funnels his TACWING’s eyes onto the target area. Clear and concise radio transmissions are essential.

Sample Target Talk-On

Rage 11: “Between the sections is a road running east/west.”
Rage 12: “Contact.” or “Looking.”
Rage 11: “Follow the road west to an intersection.”
Rage 12: “Contact.”
Rage 11: “South east of the intersection is a substation.”
Rage 12: “Contact.”
Rage 11: “The substation is the target.”
Rage 12: “Tally Target.”
Rage 11: “Egress 270.”
Rage 12: “Rage 12, 270”

Target Attack

The mirror pop is the method used to attack the target. Base altitude for the attack will be established by Wing Stan Notes for individual routes but shall be at least 3000 ft AGL. TACLEAD initiates the attack at 3.8 NM from the target if ranging is available or when the target is observed 5-7 degrees depressed in the HUD. The sight picture at this point for TACWING will be approximately 8-10 degrees. When the TACLEAD initiates the “pop,”

6-4  ROAD RECONNAISSANCE
commence a level turn at MRT with a 17-unit pull away from the section to place the target 30 degrees left/right of the nose.

Upon completion of the turn, execute an unloaded roll to wings level and immediately execute a 17 unit pull to 30 degrees flight path angle (velocity vector) of the HUD. At reversal altitude (1000’ prior to Apex altitude), TACLEAD will initiate a roll-in and transmit “Rage 11 in on the left/right.” Wing should wait for TACLEAD’s call and the appropriate altitude, then immediately roll-in and transmit “Rage 12 in on the right/left.” Once visual, your scan should now be a continuous target, TACLEAD, altitude, scan until weapons release.
TACLEAD’s dive angle shall be 20º +/- 5º. Dives outside of 15-25º range, as referenced with the velocity vector on to slightly above the target, shall be aborted and the pickle button shall not be pressed; however, if aborting the attack, you must still maneuver the aircraft in a way that will allow you to quickly recover in your altitude sanctuary and deconflict from TACWING. Weapons release should occur once a valid solution is reached (e.g., CCIP marker is no longer flashing, AGL altitude based on dive angle).

Figure 6-4 TACWING Z Diagram (referencing Base Altitude)

TACWING’s dive angle should be 25º +/- 5º. Dives greater than 30º nose low shall be aborted and the pickle button shall not be pressed. You must maneuver the aircraft to recover in your altitude sanctuary and deconflict from TACLEAD. Weapons release should occur once a valid solution is reached (e.g., CCIP marker is no longer flashing, valid parameter and AGL altitude based on dive angle).

Restrictions

TACLEAD and TACWING will both focus on pulling the target into the HUD FOV before commencing an outside scan to acquire their TACWING. A 45º offset and 45º nose high pop is authorized if briefed and both aircraft are slick or carrying pylons only. 45º nose high pops are prohibited when carrying BRU-38’s on either aircraft executing a pop. Both aircraft shall execute the same pop parameters then follow their respective Z Diagrams. The same parameters for reversal altitude, apex, release and recovery altitude apply for TACLEAD and TACWING Z-Diagrams respectively, regardless of 30º or 45º pop used.

Attack Communication

The minimum comm calls required by each aircraft for an attack are call sign popping, in, and visual or blind. Below is an example of an attack comm sequence:

Rage 11: “Rage 11 popping/level.”

Rage 12: “Rage 12 popping/level.”

6-6 ROAD RECONNAISSANCE
Rage 11: “Rage 11 in.”

Rage 12: “Rage 12 in.”

Rage 11: “Visual.”

Rage 12: “Visual.”

**Off Target Mechanics**

Upon reaching designated recovery altitude, initiate a $4G / 17\alpha$ recovery to level flight. Communicate “C/S, off” complete the shackle, and return to combat spread formation on the opposite side of the formation. Throttle as required (typically a reduction), execute a $4G / 17\alpha$ pull to level flight, and transmit “C/S, off.” Finally, look at your TACLEAD/WING and assess your position to make the correct turn to the egress heading. Due to the nature of mirror pops, it is likely that the section will be established in an off-heading shackle after the recovery. As a section the goal is to maneuver your aircraft back into DCS, flowing in the dictated egress heading.

**Off Target**

The minimum comm calls required by each aircraft for off-target are call sign off, and visual or blind. Below is an example of an off-target comm sequence:

Rage 11: “Rage 11 off.”

Rage 12: “Rage 12 off.”

Rage 11: “Visual.”

Rage 12: “Visual.”

**Blind Contracts**

There will be times off-target that you will be unable to visually acquire your TACLEAD/TACWING due to multiple factors such as environmental conditions or poor off-target geometry. The flight TACLEAD is always responsible for the safety and mission accomplishment of the section. As such, we will always allow him/her the courtesy of directing appropriate action when one or both aircraft are blind.
In the Attack: (at completion of ‘in on the left/right’)

<table>
<thead>
<tr>
<th>RAGE 11 (LEAD)</th>
<th>RAGE 12 (WING)</th>
<th>Appropriate Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Rage 11 visual 6 clear.”</td>
<td>“Rage 12 blind.”</td>
<td>*Option for Rage 11</td>
</tr>
<tr>
<td>“Rage 11 blind.”</td>
<td>Rage 12 blind taking high cover.”</td>
<td>Rage 12 immediately takes high cover</td>
</tr>
</tbody>
</table>

* Rage 11 assesses relative position of Rage 12 with horizon to determine most appropriate action. When on or below the horizon it’s recommended that Rage 11 direct Rage 12 to take high cover. Regardless, Rage 11 accepts responsibility for deconfliction until Rage 12 has regained sight.

** Rage 11 accepts Rage 12 recommendation or directs high cover. Regardless, Rage 11 continues to attack the target regardless of visual/no joy communication.

NOTE

1. At no point shall the TACLEAD aircraft ever take high cover on any attack.

2. The visual aircraft assumes responsibility for deconfliction at all times.

3. At no point shall TACWING ever direct TACLEAD to continue.

High Cover

When directed to take high cover the TACWING shall initiate a 17 unit wings level pull to zero the VSI, continue across the target, and turn to the briefed egress heading. Once wings level on the egress heading, use the small decent rule of thumb to descend no lower than 4000 MSL, all the while attempting to regain sight of TACLEAD. Continue to duplicate/mirror TACLEAD communication (‘Rage 11 Off’) until regaining sight and immediately report ‘visual’ when mutual support reestablished.

Mutual Support

Mutual support extends beyond the scope of ensuring each aircraft is safe from enemy air assets to areas more consistent with day to day flight operations and contract obligation. If the TACLEAD aircraft forgets to communicate a FENCE-IN call prior to commencing the route – it might be a good idea for his TACWING to back him up. At the same time when TACLEAD is...
blind off target it would certainly behoove TACWING to efficiently communicate their position and appropriately direct TACLEAD’s aircraft or eyes in order to regain formation integrity.

The true key to successful road recce missions is the essential element of teamwork. Accomplished through dedicated preparation, steadfast devotion to study and chair-flying the procedures together – success will be defined via a more realistic outcome of mission accomplishment versus individual achievement.

**Lead Change**

For an efficient tactical lead change to occur in dynamic flights, clear communication is required. When the pre-briefed time or scenario occurs and a lead change is required, students will utilize the **LARS (TACLEAD, altitude, RADALT, squawk)** acronym to pass and take the TACLEAD while remaining in combat spread and progressing to the next target.

Rage 11: “You have the lead on the left/right, I’m climbing to 4000, resetting my RADALT, strangling my squawk.”

Rage 12: “I have the lead on the right/left, I’m descending to 3000, resetting my RADALT, picking up the squawk.”

The new TACHEAD will be Rage 11 and the new TACWING will be RAGE 12.

**608. CONTINGENCIES**

Should the flight TACLEAD find himself/herself out of position to execute a safe target attack, the decision should be made to skip the target and maneuver the formation to set-up for the next target attack.

Rage 11: “The substation is the target.”

Rage 12: “Tally target.”

Rage 11: “Skip it. Rage, Tac left 150.”

Rage 12: “Rage 12, 150.”

**Level Attacks**

Level attacks will normally be used when route altitudes are restricted by ATC or for weather. The procedures are the same in both cases. A level attack consists of the same MRT 17 unit turn away from the section, followed by 5 seconds wings level, and then an MRT 17 unit turn to put the nose on the target. Both aircraft will target 350 KIAS on the attack. All aircraft conducting attacks will verbally acknowledge that level attacks will be utilized prior to the first target attack. “Level” will be called by TACLEAD and TACWING in place of the "popping" call.
Rage 11: “Rage 11, level.”

Rage 12: “Rage 12, level.”

Rage 11: “Rage 11, in.”

Rage 12: “Rage 12, in.”

Rage 11: “Visual.”

Rage 12: “Visual.”
CHAPTER SEVEN
SECTION LOW-LEVELS

700. INTRODUCTION

Up to this point, the ONAV syllabus in the training command has developed your skills in navigating within the confines of a VR route as a single ship to arrive on target, on time. Road reconnaissance flights developed your skills in navigating the more permissive altitude restrictions of an IR route while performing the responsibilities of TACLEAD or TACWING to identify and attack planned targets and targets of opportunity while familiarizing you with mutual support doctrine. In the SLL Stage, you will combine and refine the skills and procedures you have developed previously. You will now fly point-to-point in section along a VR route while providing mutual support for the purpose of arriving at a preplanned target for multi-ship weapons delivery. These flights simulate a low-level section ingress to a target attack in a high threat environment, and will provide the foundation for further training in the FRS and eventually, the fleet. Someday soon, the towers you are avoiding now may be replaced by ZSU-23’s and SA-6’s in operational missions. Remember that all the formation, low-level flying, and weapons delivery skills are TOOLS to put steel on target, on time.

701. FLIGHT PLANNING ROUTES AND CHARTS

The same strip chart(s) used for single-plane ONAV will be utilized for these flights, although additional notation and chart preparation will be required for the two-plane mission. Specifically, notations for types of turns used at checkpoints, offsets to the course line for obstacle avoidance, and action areas should be noted. The same fuel planning numbers and 360 KGS should be used.

OPERATIONAL TERMS

**Time on Target (TOT):** Predetermined time (local or Zulu) at which an aircraft’s munitions are delivered onto the target. TOTs are typically at the top of the minute for simplicity sake.

**Push Time:** Predetermined time (local or Zulu) at which point the TACLEAD aircraft is overhead a predetermined point in space from which point it can be assessed that a TOT may be achieved.

**Initial Point (IP):** Predetermined point precisely 10 NM from target at which point final preparations for attack shall be made.

**TACLEAD:** Maintains overall responsibility for navigation, communication, target acquisition, and formation maneuvering.

**TACWING:** Maintains overall responsibility for collision avoidance within the section, backing up TACLEAD navigation, and attack responsibilities.
ONAV Trail: A tactical formation utilized primarily for negotiating steep, winding terrain in the low-level arena. It is defined as .7-1.0 NM in trail within 45 degrees left or right of TACLEAD’s tail, and co-altitude or above. TACWING should maintain 100% sight of TACLEAD aircraft at all times in this formation. Terrain clearing tasks are the number one priority.

TACLEAD shall thoroughly brief when and how he plans to get into, utilize, and get out of this formation along the route.

702. FLIGHT PREPARATION

Students are responsible for scheduling the route specified for use on the published flight schedule.

Waypoint navigation is encouraged but not mandatory.

Route structure, Weather, Sun Azimuth/Elevation, and winds shall be drawn neatly on dry-erase board and appropriately labeled.

Joker Fuel should be initially set to the min fuel required to commence the route.

Bingo Fuel should be thereafter set to either: each corresponding point MFR or the single MFR from the furthest point on the route structure to anticipated RTB via administrative profile.

Weather - per requirements of MCG for stage.

Brief

The Section TACLEAD IP will normally conduct the full brief for the flight.

While individual briefing techniques vary from instructor to instructor, it is not uncommon for IPs to simulate an actual mission via Situation, Mission, Execution, Admin/Logistics, Command and Control format.

A/A TCN: TACWING will have A/A TCN ranging to TACLEAD.

Debrief

Using a ruler on the whiteboard, students shall write down the environmental conditions, alibis, actual take-off time, actual Push Time, and TOT.
703. MULTI-PLANE NAVIGATION

Pre-plan specific courses of action during the low-level. This preplanning will be critical to mission success, and will allow decision-making efforts to be focused elsewhere in this dynamic environment. Some items of consideration:

1. Offsetting section to one side of the course line for avoidance of obstacles.

2. Determining which side Wing will fly off TACLEAD during appropriate phases of the route.

3. Determining what types of turns will be executed at checkpoints and other action points.

4. Any additional considerations, which will allow you to more fully focus your attention on the route, and to provide mutual support.

704. FLIGHT PROCEDURES

These will be full systems flights. Having the section arrive on-target, on time will be emphasized and graded. Use the system to your best advantage to achieve this goal, but don’t neglect intermediate checkpoint identification as a tool to build SA.

705. RESPONSIBILITIES

TACLEAD

1. Navigation: Keep the flight within the route structure and maintain SA at all times. Keep the flight on time.

2. Locating the target: Visually acquire the target and place the section in an advantageous position to prosecute it.

3. Communications: Give verbal commands for turns, obstacle avoidance, and target description.

4. Formation Maneuvering: Maneuver the flight throughout the route to maintain mutual support.

TACWING

1. Lookout: Primarily responsible for collision avoidance between the two aircraft. Keep TACLEAD in sight, maintain proper position, and clear your flight path. TACLEAD is driving the flight, but you are responsible for your own aircraft’s obstacle clearance and avoidance of birds, etc.
2. Navigation: Know where you are on the route at all times and be ready to assume the TACLEAD if necessary.

3. Attack: Be ready to attack the target on TACLEAD’s commands.

706. ROUTE ENTRY/TACADMIN

Prior to approaching the first designated point on the route the TACLEAD aircraft will direct the flight to FENCE-IN. At this point low altitude checks will be completed as in earlier ONAV flights and the A/G stores page will be checked to ensure BOMB/CCIP is the preselected method of delivery. With NAV mode reselected and Low Altitude checks complete the TACLEAD will initiate the FENCE-IN in accordance with TW-1/TW-2 Joint TACSOP.

Once FENCED-IN the TACLEAD aircraft will ensure the section is aimed at the first point and in-line with the first route leg as soon as practical, but no later than 5 miles prior to route entry. All entry procedures, such as cancellation, FSS notification, squawk, and setting 360 KGS remain the responsibility of the TACLEAD aircraft.

Once the previous items are completed, TACLEAD will direct combat spread at which time TACWING will maintain at or above TACLEAD’s altitude throughout the remainder of the flight.

707. FLYING THE ROUTE

Altitudes

TACLEAD shall strive to maintain 500 feet AGL throughout the entirety of the route structure. TACWING shall be no lower than TACLEAD. While it is incumbent upon both aircrew to thoroughly familiarize themselves with the route - TACWING’s knowledge of the route structure must be impeccable, since he will need to split his scan to the front (clearing the flight path), and to the side (to stay in position abeam TACLEAD). Minimal to zero time is available to reference a chart or stop watch.

TacForm

When performing TacForm, TACWING will be responsible for aircraft deconfliction and will deconflict high unless otherwise declared over the radios. A TACWING’s deconfliction will always be greater than or equal to 500 feet separation from lead. If aircraft cross directly above and below each other, TACWING will need at least 500 feet of altitude clearance. Otherwise, he must pull lag or lead as necessary to obtain minimum clearance. TACWING must always be vigilant of the top of the route structure. If TACWING does not have TACLEAD in sight, TACWING must respond to TACLEAD’s call to maneuver by saying “Negative, (call sign) blind.”
Turns

All Turns will be executed at 4Gs or 14 units, whichever comes first.

For turns of 0-30 degrees, TACLEAD should call for a check turn. If a check turn is planned along the route, TACWING should strive to show up to at the turn point the same number of degrees acute or sucked that the turn is planned for so as to be in combat spread after the turn is executed. Check turns can also be used to re-establish combat spread should TACWING get out of position. To execute the turn, simply apply the corrections listed above to re-establish your aircraft on bearing line.

A shackle can be used to move TACWING to the opposite side of the formation. To execute a shackle, TACLEAD will call for the maneuver, at which point wing will respond with his/her call sign while simultaneously executing a climbing turn into TACLEAD to establish 45 degrees off-heading and at least 500’ of clearance. Recognize that, since you are climbing, power will be required to maintain 360 KGS. After the aircraft cross, wait an appropriate amount of time before reversing back to the original heading via a level turn. Once established in a wings-level attitude, use the Small Descent ROT to descend back to altitude. Since this maneuver is executed at something greater than 300 KIAS, the timing will vary and will not be the same as a shackle performed up at altitude.

Alternatively, a shackle can be called to help correct formations that are not easily corrected via one of the previously mentioned techniques. To perform a shackle to fix the formation, the acute aircraft will turn greater than 45 degrees into the other aircraft while the suck aircraft will turn less than 45 degrees. Both aircraft should drive towards crossing each other, but the acute aircraft should pass in front of the sucked aircraft and begin his/her reversal, as that aircraft will have more degrees of turn required to get back to the original heading. Remember, TACWING is always responsible for deconfliction, and will have to climb as necessary regardless of whether they are the acute or sucked aircraft.

For turns of 30-45 degrees, TACLEAD should call for an off-heading shackle. The procedures for doing so are similar to the shackle described above and off-heading shackles performed during the tac form stage.

For turns of 45-120 degrees, TACLEAD should call a TAC turn. Depending on the geometry, TACWING may need to elevate to establish a safe pass while turning into the TACLEAD. If the TACLEAD calls a tac turn into TACWING, TACWING may need to elevate to allow TACLED to pass below with 500 ft of separation.

All turns greater than 120 degrees should be accomplished through in-place turns. Be mindful of executing an in-place turn that results in backwards flow along a route.

Corrections

Since TACWING does not have sufficient altitude to change his energy package, Shackles will be the primary method to return an out-of-position TACWING to the abeam position. If TACWING is sucked, he will need to float his turn to the point of aircraft crossing during the shackle. Conversely, if acute, TACWING will need to pull more than 14 units AOA in an effort
to pull back to TACLEAD by the point of aircraft crossing while ensuring deconfliction. If TACWING is sucked at the shackle cross point, he will need to reverse to the new heading early and then allow for a slightly increasing separation (get pointed downrange, then worry about getting wide). If TACWING is acute at the cross point, he will need to float his next turn as much as possible until seeing approximately .6 or .7 DME, then perform a hard pull to the new heading (get wide first, then get pointed downrange).

Communications

Besides calling turns, TACLEAD and TACWING will announce any relevant obstructions by describing the obstruction (tower, airport, etc.), a clock code in relation to TACWING, and a distance estimate. This is especially critical if the section will bracket an obstruction.

708. ATTACKS

SNA’s should plan to make an attack on one planned target near the end of the route. One additional mid-route target may be selected for attack if briefed.

Attack Procedures and Timeline

Approaching the target, TACLEAD will direct the flight to commence engagement, provide relative bearing to the target, and communicate the egress heading. TACLEAD should initially ensure the section is positioned correctly for the attack by ensuring the target is centered in the HUD field of view and that TACWING is on side of the egress direction. TACLEAD will line up his own aircraft on the run-in line, give the command “Action” at 4 miles from the target, and proceed in his altitude block performing a simulated level lay-down delivery by dragging the CCIP cross over the target. TACWING, upon hearing the “Action” command, but no later than 4nm from the target, will roll into a level 4G/14 unit, 90-degree turn towards TACLEAD while maintaining the briefed or called groundspeed.

After rolling wings level, TACWING will return to altitude and time for 5-6 seconds while maintaining 360 KGS. TACWING will then reverse their turn via 4G/14 AOA pull to place the target directly on the nose of the aircraft and similarly execute a level lay-down delivery of their own.

10 NM “Hammer, Attack”

Flight TACLEAD initiates attack sequence by communicating over tactical frequency “Hammer, Attack.” (No response required by TACWING.)

At this time, all aircraft within the flight complete air-to-surface checklist by ensuring A/G Master Mode is selected with CCIP (BOMB) and placing the Master Arm Switch to ARM.
8 NM “Nav Check”

Flight TACLEAD confirms target location via ‘Nav Check’ to the target via exactly what is shown on MFD as Radial/DME. (No response is required by TACWING unless target position discrepancies exist.)

6 NM “Egress”

Flight TACLEAD confirms pre-briefed egress heading upon attack completion.

TACWING REPLIES with tactical call sign and appropriate egress heading.

4 NM “Action”

Either a directive call from Flight TACLEAD “Action” or automatic. TACWING will execute 4G/14 AOA turn 90 degrees toward the TACLEAD aircraft ensuring safe separation is maintained for formation deconfliction.

Upon completion of 90 degree turn, TACWING will immediately roll wings level for 5-6 seconds of timing/spacing.

Immediately after 5-6 seconds (approximately 1 mile separation), TACWING will resume 4G/14 AOA turn to place the target (target waypoint) under the nose.

Upon flying over-head the target, each aircraft will ‘pickle’ simulated ordnance on designated target(s).

Off Target Tactical Rendezvous/Redress

Similarly to Strike sorties, ”pickle,” pause, pull (when appropriate for egress heading), MSTR ARM – SAFE, communicate. Once simulated release has occurred, each aircraft will communicate “off safe” via tactical communication.

Once ‘off safe,’ TACLEAD may initiate a multitude of rendezvous techniques to redress the formation to combat spread. Most notably on the VR-1266, TACLEADs may execute a 90 degree turn opposite the direction of action for approximately 4-6 seconds, or upon hearing TACWING call ’off safe,’ resume appropriate direction of travel to redress the formation and resume navigation along the route. Regardless of technique, TACLEAD will initiate status off target via “Visual/Blind.”

NOTE

If both aircraft are blind off target, TACWING is responsible for deconfliction by immediately climbing to 1000 AGL until regaining sight.
Pay close attention to the brief for specific instructions and Instructor Techniques for redressing the formation and regaining mutual support.

Figure 7-1  On-Axis Attack Profile

**Egress**

If egress is in the same direction as the initial attack heading (see Figure 7-1), TACLEAD will, immediately after the simulated delivery, perform a level 14 unit AOA, 90-degree turn to the side TACWING was on prior to the “Action” call. TACWING will then roll wings level, time 7-8 seconds, and reverse back to the egress heading. TACWING will simply turn to parallel the egress heading after weapons delivery. TACWING should keep sight of TACLEAD during TACLEAD’s off target maneuver. After rollout on the egress heading, TACLEAD must then reacquire sight of TACWING and call a shackle if section integrity dictates.
If egress heading is perpendicular to the initial attack heading (see Figure 7-1), TACLEAD will proceed past the target maintaining his attack heading for 7-8 seconds. At the completion of timing, TACLEAD will perform a level 14 unit AOA 90 degree turn (maintaining 360 KGS) towards the egress heading. TACWING will perform the same turn immediately after the simulated delivery. Once both aircraft have reacquired sight of each other, TACLEAD will dress the section as in the straight ahead egress.

**709. ADMINISTRATIVE REJOIN/RTB**

At the completion of the route the Flight TACLEAD will initiate the administrative RTB via KNOCK-IT-OFF with follow-on direction to FENCE-OUT. At this point both aircrew will initiate a smooth, level pull to the pre-briefed altitude/airspeed/heading and commence a tactical rejoin.

While TACWING commences the rendezvous TACLEAD initiates the standard route exit communication via appropriate FSS on 255.4 and resets squawk according to the brief. Once TACWING has effectively returned to a parade position the Flight TACLEAD will initiate Battle Damage Checks for each aircraft before FENCE-OUT communication is complete.
CHAPTER EIGHT
EMERGENCIES

800. INTRODUCTION

There are a variety of emergency situations you may encounter during low-level flights, and it is impossible to cover every possible contingency. This chapter will discuss some common themes to consider if faced with an emergency situation.

801. GENERAL EMERGENCY CONSIDERATIONS

This is the first training you will do that puts you close to the ground for an extended period of time. This environment affects the most likely threats to you and your aircraft and the action you must take to avoid them. The first step is to climb to a safe altitude (AKA “Climb to Cope”). This allows you to assess the situation without having to concentrate on ground avoidance as you would at 500 feet AGL.

You should have an emergency safe altitude calculated and entered on the jet log for each leg of the low-level route. Flying at this altitude will ensure safe clearance from all obstructions so that you can devote your attention to the immediate problem of weather, aircraft malfunction, or navigation error.

Two of the biggest hazards to low-level flight are birds and the ground. A disciplined low-level scan will help you to avoid both of these hazards. You can give yourself added protection from birds by keeping your helmet visor down. If you are blinded by a bird strike through your canopy, you must first try to maneuver away from the ground and slow down. Communications will be extremely difficult, if possible at all, and forward visibility may be nonexistent. It is advisable to fly with a zero trim setting or slightly nose up for this reason.

If the emergency requires ejection, consider that the best airspeed for ejection is below 250 knots. If possible, slow the aircraft before ejection to reduce the windblast. Ejection seat trajectory is improved if you zoom climb to trade airspeed for altitude. Additional altitude increases time for seat/man separation and parachute deployment. Do not delay ejection if the aircraft is nose down or out-of-control at low altitude.

802. BINGO

You may be faced with an unplanned, low-fuel divert. This is an emergency situation and requires quick and well-advised actions on your part. Bingo information should be calculated for each of the route checkpoints to include fuel and magnetic course and distance; and recorded on the jet log for later transfer to the charts.

1. Climb to conserve fuel and increase visibility. Know the optimum altitudes for various fuel states and distances (refer to the NATOPS Pocket Checklist). If fuel state allows, the option to remain below any overcast weather is desirable. Sea level cruise numbers from NATOPS are a
good reference but do not provide for SOP minimums. You may have to climb through an overcast. Do not run out of fuel to avoid some clouds but ensure you have terrain clearance met.

2. Proceed at maximum range airspeed, if fuel available, or follow the BINGO profile and squawk emergency.

3. Use all available navigation aids, IFF, radio communications facilities, radar, etc., to verify accurate navigation. Check the standby compass.

4. Proceed to the destination airport and set up for an approach (straight, downwind entry, etc.).

5. Make a maximum range idle descent in accordance with the BINGO chart. However, if you find yourself high on the approach remember that IDLE with speed brakes doesn't burn any more gas than a normal IDLE descent.

803. SUITABLE DIVERT AIRFIELDS

To be usable as a divert field, an airstrip must meet the divert field criteria for your local SOP. Consideration must be made as to the seriousness of the emergency situation requiring a divert. An ideal divert field would be military, with arresting gear, servicing equipment and personnel, security, etc.

Primary, secondary and tertiary divert fields can be identified and used in priority order depending on how critical the emergency is. A "land as soon as possible" emergency, for instance, may require you to land at a small civilian field with a short runway and few services. Divert fields will be identified by a blue circle. A blue arrow with divert information will point from each turnpoint to the nearest divert field.

Reasons that may require you to divert: aircraft system trouble, bird strike or midair collision. If aircraft system trouble is detected climb to cope then execute NATOPS procedures. Decide if a divert is required. If you have a bird strike (or any midair collision), determine if the aircraft is controllable. If controllable, establish a shallow climb of 5-10 degrees and slow down, following NATOPS procedures for damaged aircraft. If the aircraft is uncontrollable, eject.

Know your diverts ahead of time and ensure they are loaded in a waypoint. This will provide an expeditious initial steer in the event of a divert scenario.
CHAPTER NINE
CNATRA T-45 LOW ALTITUDE TRAINING RULES

Required Briefing Items

1. Currency Requirements:
   - Within 30 days of last flight

2. Weather Requirements:
   a. Daylight between 30 minutes after sunrise until 30 minutes before sunset
   b. VMC with a defined horizon
   c. 3000’ / 5 NM along entire route/area
   d. Weather shall be continuously assessed throughout the flight.
   e. Descent through a solid overcast in an attempt to achieve visual meteorological conditions (VMC) while not under positive IFR control is prohibited.

3. CFIT Avoidance:
   a. Use local altimeter setting.
   b. Terrain Clearance Tasks take priority over all other tasking.
   c. Mission Crosscheck Time (MCT) maximum is one (1) second in a turn, five (5) seconds straight and level.
   d. Low altitude Warning system (RADALT): _______ ft AGL
   e. Minimum Altitude: _______ ft AGL
   f. Area Emergency Safe Altitude: _______ ft MSL
   g. Minimum airspeed: _______ KIAS
   h. Wingman never flies below TACLEAD’s AGL altitude.
   i. Wingman is primarily responsible for flight deconfliction and collision avoidance except for TAC turns into wingman; however, all members of the flight are responsible for collision avoidance (not required for if single aircraft).
j. All turns below 1000 ft AGL shall be made level and closely monitored for nose slice.

k. Pilot shall take immediate, proactive steps to maneuver aircraft back within briefed limits if any altitude warnings, aural or visual, are triggered or if airspeed drops below minimums.

4. LAT Checks shall be completed prior to entering the LAT environment.

5. All aircraft shall monitor a common frequency.

6. Any aircraft may call “Knock It Off.” All aircraft shall acknowledge the KIO call, roll wings level and climb-to-cope above the LAT environment (1500 ft AGL minimum or Emergency Safe Altitude if IMC). Aircraft shall KIO for any of the following reasons:

   a. Interloper aircraft enters the mission area and is detrimental to flight safety.

   b. Inadvertent IMC or weather deteriorates below minimums

   c. Birdstrike

   d. Loss of Situational Awareness

   e. Unsafe Situation / Emergency

   f. Crossing border of authorized training area

   g. Actual or suspected A-LOC or G-LOC

   h. Overstress

   i. Training rule violation

   j. BINGO Fuel

   k. Any aircraft descends and remains below the pre-briefed minimum altitude for an unsafe duration (not to exceed 3 seconds) or does not respond immediately to calls to correct.

   l. Any aircraft descends in a turn that was intended to be level

   m. Aircraft rocking its wings

   n. Aircraft goes NORDO or loses ICS

   o. Two or more aircraft lose sight

9-2 CNATRA T-45 LOW ALTITUDE TRAINING RULES
p. Training Objectives achieved

7. Be aware of the high mid-air potential following a KIO.

8. Do not attempt to re-enter a MTR after leaving the route structure.

Planning Requirements / Standard Operating Procedure

1. The Low Altitude Training (LAT) environment is defined as any fixed wing flight below 1500 ft AGL when not in the takeoff or landing phase.

2. All aircrew shall have flown at least once in the previous 30 days before flying in the LAT environment.

3. Daylight, outside 30 minutes of sunrise or sunset, are specific to flight in the LAT environment and do not have to include transit to or from above 1500 ft AGL unless further restricted by Training Wing.

4. Minimum altitude for CNATRA aircraft in the LAT environment is 500 ft AGL. This may be further restricted by local SOP.

5. Low Altitude Warning system (e.g., RADALT) shall be set to no lower than 10% below the briefed minimum altitude. For Pop Attacks, the planned run-in altitude shall be referenced.

6. Area Emergency Safe Altitude shall be briefed and is defined as the highest of either 1500 ft AGL or 1000 ft (2000 ft in mountainous terrain) above the highest terrain or obstacle within 25 NM of any point of the planned low altitude environment.

7. Minimum Safe Altitude is defined as 500 ft AGL above any obstacle within 5 NM of center line for each leg of a route.

8. LAT flight requires (if equipped) operable RADALT, HUD and GINA. Any other installed systems that aid in terrain avoidance shall also be operational and in use (e.g., TAWS, GPWS).

9. Routes shall be coordinated/scheduled with all local agencies in accordance with Flight Information Publication (FLIP) AP/1B, respective Training Wing instructions, procedures, and directives.

10. All crossing MTR’s/routes shall be deconflicted and should be annotated on charts.

11. LAT sorties shall include a thorough brief of the planned route and operating area to include route restrictions, crossing routes, obstacles, potential hazards, an assessment of possible environmental factors (smoke, haze, sun angle, etc.), and all planned tactical turns.
12. LAT checks shall be completed (T-6 and T-45) prior to entering the LAT environment and verbalized between all aircrew in an aircraft:

   a. Mask - Securely Fastened
   b. Visor - Down
   c. Good "R" in the HUD (if equipped) with good warning tone
   d. Loose Items - Stowed and secured
   e. G-warm complete

13. The G-Warm shall be conducted at a safe altitude with maximum G approaching amount anticipated on that flight.

   a. The spacer-pass on a strike flight, to include Pop Attacks, shall satisfy the requirement for a G-Warm. Do not descend in the spacer pass.
   b. If planned G is less than 4 G’s a G-Warm is not required but it is recommended.

14. LAT terminology:

   a. A "KIO" call stops the entire mission for the flight and all aircraft shall Climb-to-Cope above the LAT environment (1500 ft AGL minimum or Emergency Safe Altitude if IMC). Training shall not be resumed after a "KIO."
   b. "Terminate" directs an aircraft to cease a maneuver.
   c. "Abort" is applied to an Air-to-Surface delivery and directs initiation of the safe escape maneuver with a clear flight path. It does not necessarily direct an exit from the LAT environment unless briefed.
   d. "Climb" is a directive call to increase altitude above a hazard or to regain parameters.
   e. "Climb," "Abort," and "Terminate" do not imply a "KIO" or leaving the LAT environment.

15. Except for a "KIO", training may resume once all aircraft:

   a. Have verbal confirmation of what caused the situation
   b. Agree the situation no longer affects the flight, and
   c. With Mission Commander approval
16. Planning factors pertaining to G and airspeed are described in pipeline specific FTIs. G, AOA, and aerodynamic limitations of any T/M/S NATOPS shall not be exceeded to include accelerated stalls (e.g., pitch-buck for T-45 aircraft).

17. Minimum airspeed for the T-45 in the low altitude environment is 300 KIAS.
APPENDIX A
GLOSSARY

A

AP/1B: Flight information publication with information on training routes in North and South America; published by the Department of Defense.

ATA: Actual time of arrival at a checkpoint.

B

BASH: Bird Aircraft Strike Hazard.

Bingo: Aircraft is considered to be in an emergency/fuel critical situation.

Blind: No sight (or lost sight) of Wingman.

Bucket: A graphic illustration of a pilot’s capacity to maintain situational awareness during high task loading and a means of teaching load shedding priorities.

C

Checkpoint: A landmark used as a time and/or course reference.

CHUM: DMA Aeronautical Chart Updating Manual; contains changes to individual DoD charts; published by the Department of Defense.

Climb to Cope (CTC): This is a maneuver where by the pilots stops his maneuvering close to the ground and climbs to a predetermined AGL altitude in order to address an urgent/emergency situation. Resumption of low altitude flight can only occur with verbal concurrence from all members in the flight.

Comfort Level (CL): The minimum AGL altitude, at which a pilot can fly and accomplish all Terrain Clearance Tasks and Mission Tasking. A perceptual concept, CL concedes individual differences and is never a hard altitude. It will vary according to terrain, aircrew skill, currency, and degree of training in the low altitude environment.

CFIT: Controlled Flight Into Terrain

CUS: Magnetic course line on the low-level jet flight log.

D

Dead Reckoning: Use of time, distance and heading for purposes of navigation.
DIST: Distance in nautical miles on the low-level jet flight log.

Dive Recovery Rules: Mathematically derived low altitude dive recovery rules which incorporate initial dive angle, maximum TAS, minimum G-loading and pilot reaction time in order to safely step down to comfort level or in the case weapons delivery avoid impact with the ground or shrapnel.

E

EFL: Estimated Fuel Left at a checkpoint, on the low-level jet flight log.

EFR: Estimated Fuel Required for one leg of a flight, on the low-level jet flight log.

ETA: Estimated Time of Arrival on the low-level jet flight log; not Zulu or local time, but cumulative time from first checkpoint.

ETE: Estimated Time Enroute; the time on one leg of the mission on the low-level jet flight log.

F

Flight Path Angle (FPA): The difference between the velocity vector and the horizon bars on the HUD.

Funneling: Following a linear feature such as a road, river, etc., to locate a predetermined checkpoint.

I

Intermediate Checkpoint: A pilot-chosen checkpoint between the AP/1B checkpoints of a Low-Level High-Speed Training Route.

J

Jet Navigation Chart (JNC): A Department of Defense navigation chart for use at very high altitudes; scales 1:2,000,000.

Joint Operations Graphic (JOG): A Department of Defense chart for precision work such as locating a target or computing loft bombing pull-up point; scales 1:250,000.

K

Knock it Off (KIO): A directive call stops the entire mission for the flight and all aircraft shall Climb-to-Cope above the LAT environment (1500 ft AGL minimum or Emergency Safe Altitude if IMC). Training shall not be resumed after a "KIO."

A-2 GLOSSARY
L

**Landmark:** Terrain feature used to visually navigate.

M

**MEF:** Maximum Elevation Figure; the tallest object in a grid of a chart used in low-level navigation.

**MFR:** Minimum Fuel Required; minimum fuel to complete an entire route from a checkpoint; on the low-level jet flight log.

**Mission Tasks (MT):** Administrative tasks conducted at comfort level essential to mission accomplishment: Navigation, lookout doctrine, communication, switchology, and threat avoidance/reaction etc.  \( MT = CT + NCT \)

**Mission Crosscheck Time (MCT):** The maximum permissible time, which a pilot can safely divert attention from TCT in order to attend to MT.

N

**No Joy:** No sight (or lost sight) of target.

O

**Operational Navigation Chart (ONC):** A Department of Defense navigation chart for use above 5,000 AGL; scaled 1:1,000,000.

R

**Recce:** Pilot's terminology for reconnaissance.

**Road Recce:** Reconnaissance along a linear feature (road, river, or railroad, etc.)

S

**Sectional Chart:** A civilian chart scaled 1:5,000,000. Published by the National Oceanic and Atmospheric Administration.

**Shackle:** A Road Recce maneuver used to correct the formation and check six; not the same as the shackle in Tactical Formation. See also Weave.

**Speed-rush Baseline (SRB):** A physiological phenomenon whereby human peripheral visual perception becomes accustomed to high rates of terrain passage. This physical speed acclimatization requires lower and or faster flight to deliver the same speed sensation.
Strip Chart: The chart of a particular mission cut and pasted to kneeboard size.

T

TACTACLEAD: The Tactical TACLEAD of a multiplane mission; as opposed to the Flight TACLEAD. Can be either pilot of a two-plane mission.

TACWING: The Tactical Wingman of a multiplane mission.

Tactical Pilotage Chart (TPC): A Department of Defense navigation chart for use below 5,000 AGL; scaled 1:500,000

Tally: Target in sight.

Terminate: Directive call to cease a maneuver.

Terrain Clearance Tasks (TCT): Cockpit tasking involved entirely with avoiding terrain.

Time to Impact (TTI): Time, measured in seconds, in which deviation from low altitude level flight will result in terrain impact. Time to Impact is affected by AGL altitude, TAS, and the angle of deviation in degrees from level flight.

Turnpoint: A checkpoint that requires a heading change.

V

Visual: Wingman in sight.

W

WAC Chart: World Aeronautical Chart. A civilian chart scaled 1:1,000,000.