NAVAL AIR TRAINING COMMAND

NAS CORPUS CHRISTI, TEXAS **CNATRA P-912 (New 07-07)**

FLIGHT TRAINING INSTRUCTION

LOW ALTITUDE AWARENESS TRAINING (LAAT)

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1. CNATRA P-912 (New 07-07) PAT, "Flight Training Instruction, Low Altitude Awareness Training" is issued for information, standardization of instruction, and guidance of all flight instructors and student aviators within the Naval Air Training Command.

2. This publication shall be used as an explanatory aid to Low Altitude Awareness Training Curriculum. It will be the authority for the execution of all flight procedures and maneuvers herein contained.

3. Recommendations for changes shall be submitted via CNATRA TCR form 1555/19 in accordance with CNATRAINST 1550.6E.

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TABLE OF CONTENTS

LIST OF EFFECTIVE PAGES .... **iv**
INTERIM CHANGE SUMMARY .... **v**
TABLE OF CONTENTS .... **vi**
TABLE OF FIGURES .... **vii**
TABLE OF TABLES .... **viii**

CHAPTER ONE LOW ALTITUDE AWARENESS TRAINING (LAAT) **1-1**
100. INTRODUCTION 1-1
101. BACKGROUND 1-1
102. THEORY OF FLIGHT IN THE LOW ALTITUDE ENVIRONMENT 1-2
103. PHYSIOLOGICAL CONSIDERATIONS 1-7
104. LOW ALTITUDE SAFETY CONSIDERATIONS 1-8
105. LOW ALTITUDE PHYSICS 1-9
106. 50% RULE TABLE AND DIVE RECOVERY RULE 1-12
107. BASIC MANEUVERS 1-13
108. CNATRA LOW ALTITUDE AWARENESS TRAINING RULES 1-19

APPENDIX A GLOSSARY **A-1**
A100. GLOSSARY OF LOW ALTITUDE AWARENESS TRAINING (LAAT) TERMS A-1

TABLE OF FIGURES

Figure 1-1 Task Management: "Bucket" 1-4
Figure 1-2 Task Management Timeline.......... 1-6
Figure 1-3 Level Turn Bank Angle And "G".......... 1-12

TABLE OF TABLES

Table 1-2 **Wings Level Bunt Time to Impact (Zero G) 1-10**
Table 1-3 **Time to Impact (sec), Turn with 10° Overbank 1-11**
Table 1-4 **50% Rule with associated AGL and FPA 1-12**

CHAPTER ONE
LOW ALTITUDE AWARENESS TRAINING (LAAT)

100. INTRODUCTION

The projection of sea power ashore brings to the theater of war a unique blend of capabilities and vulnerabilities. Capabilities, because modern Naval power can physically travel to the vicinity of a conflict with vast firepower and sustainment, and at the same time provide a formidable presence to support diplomatic operations. Vulnerabilities, because not only are operations from the sea intense and dangerous, particularly from the standpoint of Naval Aviation, but because by nature of the limited space available aboard a Carrier Battle Group (CVBG) and associated Amphibious Ready Group (ARG), Naval Strike Aviators and their aircraft cannot be tightly specialized, but must have the ability to execute a wide range of tactical missions.

Because of the unique performance requirements imposed on 21st century Naval Aviation to safely meet these challenges, the Naval Aviator will not only be required to develop expertise in the execution of a variety of tactical missions, but within subcategories of similar missions, he must acquire the knowledge and capability to employ flexible techniques in order to achieve mission success regardless of external factors. The Low Altitude Awareness Training (LAAT) presented in this Flight Training Instruction (FTI) is a small but important sample of such multifaceted training.

This instruction is intended as a low altitude safety adjunct to the Tactical Formation, Operational Navigation, and Weapons Flight Training Instructions. Its primary purpose is to standardize the rules of conduct in the Low Altitude flight regime throughout the Training Commands. This FTI provides information and procedures on:

1. High speed flight in the Low altitude environment; task loading and its effects; the physics of maneuver close to the ground; the hazards of low altitude flight; Terrain Clearing Tasks; Mission Cross Check Time; Climb to Cope; 50% rule and Dive recovery; LAAT Training rules.

101. BACKGROUND

With the proliferation of increasingly capable surface to air weapons, air to air weapons, and sophisticated Integrated Air Defense Systems (IADS) during the decades of 1970 and 1980, it became apparent to aviation planners that tactical jet aircraft operations in the low altitude environment had to be explored and exploited to the greatest extent practicable.

The immediate benefits were obvious. If terrain could be utilized to directly mask the approach of striking aircraft, the reaction time available to Surface-to-Air Missile (SAM) or Anti Aircraft Artillery (AAA) system operators would be significantly reduced. Slowing system operator reaction time would subsequently affect the possibility of weapons being employed before a striker could deliver ordnance onto the target and safely egress.

As our knowledge of enemy weapons systems increased, other exploitation of enemy systems became apparent. Even if the threat knew the strikers were coming, either by intelligence or some form of early warning radar, our use of indirect terrain masking would make enemy fire control acquisition extremely difficult. During indirect masking, the enemy might physically be able to see a striker coming, but because of the radar clutter generated by a high track-crossing rate and a high target speed in front of vertical terrain, it would limit his ability to acquire the striker with his fire control radar, and thus be unable to employ his weapon.

There was yet another benefit. Training to employ strike aircraft at low altitude has given U. S. Forces the capability and option of visually attacking targets even during low prevailing ceilings and generally poor weather conditions. This last benefit is perhaps the most enduring. As IADS continue to become more capable; as shear numbers of AAA pieces and hand held Surface to Air Missiles (MANPADS) continue to flood potential theaters of operation, the advantage of the low altitude visual attack has been reduced. But battlefield environmental conditions such as rain, clouds, dust, and smoke are still factors to be reckoned with. Until technology produces a means of consistently and accurately targeting through these obscurations, the low altitude approach remains a viable option. Because it is a legitimate option but is also such a high-risk regime to fly in, proper training must be conducted to minimize both peacetime and wartime losses.

Rediscovery of the tactical potential of low altitude flight after WWII resulted in a great deal of training emphasis in that environment. But until fairly recently, the training always focused on low-level navigation, target area mechanics, weapons employment, and threat avoidance. There was no emphasis in the area of terrain avoidance. Only in the most cursory manner were the mechanics of avoiding the ground addressed, and such treatment was at best non-standard. Tragically, the loss of aircraft and lives reflected the lack of standardization in Low Altitude Training.

It was the Arizona Air National Guard's, 162nd Tactical Fighter Group, flying head-up display (HUD) and inertial navigation system (INS) equipped A-7 Corsairs out of Tuscan Arizona, who first developed the concepts that are addressed in this FTI. With a bit of higher mathematics and a lot of flight testing, the 162nd Tactical Fighter Group (TFG) developed such low altitude instructional concepts as the "Bucket", Terrain Clearance Tasks (TCT), Mission Tasks (MT), Knock it Off (KIO), Climb to Cope and various dive recovery rules. These concepts are now used fleet wide in Navy and Marine Corps Strike/Fighter communities, and though originally designed for HUD/INS equipped tactical aircraft, the LAAT concepts presented in this FTI are applicable to safe conduct of any airframe flying low and fast.

102. THEORY OF FLIGHT IN THE LOW ALTITUDE ENVIRONMENT

High-speed flight in the low altitude environment is by definition a regime of aircraft operation that is both high workload and high risk. It is an environment in which task saturation can overtake a pilot before there is clear awareness of developing danger. In order to help mitigate the potential consequences of task saturation during low-level flight, it is important that aircrew who will be exposed to low altitude flight training have at the minimum a basic understanding of the following concepts:

Bucket. The "bucket" is an illustrative reference used to describe the finite capacity a human pilot has for input and subsequent action in the low altitude environment. The analogy of a finite bucket represents maximum human capacity, and subdivisions within that set equal the divisions of tasking in terms of priority.

Essentially, the bucket illustration is a visual means of showing the only acceptable task prioritization in the low altitude environment. Within the bucket are two categories of tasking:

1. **TCT** which involves any mental or physical effort expended to avoid hitting the ground.

TCT includes four sub-tasks:

a. **Aerodynamic control of the aircraft**. Process of maintaining the aircraft within its operating envelope to include angle of attack (AOA), airspeed, and G limits. Basically what is required to keep the aircraft flying.

b. **Vector control**. Process of assessing and modifying the aircraft vector in elevation, azimuth, and velocity relative to the terrain. Vector control includes attitude (pitch and roll) and is the key TCT crosscheck variable.

c. **Altitude control**. Process of assessing and modifying the aircraft altitude in relation to the terrain. Vector and altitude are the two physical variables that define the boundaries of safe low altitude maneuvering.

d. **Time control**. Involves knowing when and for how long to "ignore" vector and altitude control. Time control is the key to proper task management, it is the least measurable part of TCT, the hardest to learn and by far the most difficult to control.

2. **MT** which encompasses any and all remaining activities required to accomplish the mission.

Within the category of MT, there are two subdivisions:

a. **Critical Tasks** (CT), which are functions demanding immediate attention in order to successfully accomplish the mission.

b. **Non-Critical Tasks** (NCT), which are functions that can be addressed on a more flexible time window.

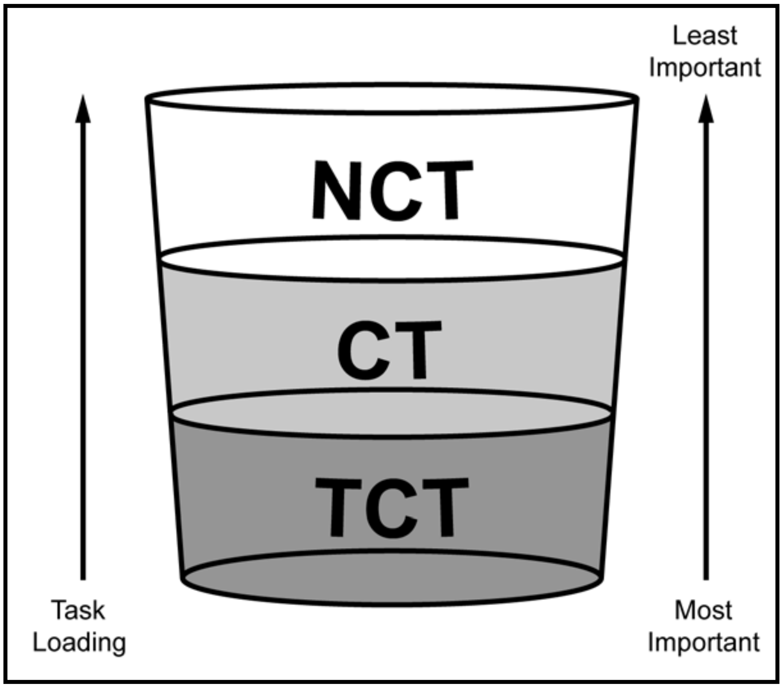

Figure 1-1 Task Management: "Bucket"

NOTES

1. Remember that TCT is your primary task and therefore should be **FIRST IN** and **LAST OUT** of the "Bucket".

2. Mission Crosscheck Time (MCT) can be easily visualized as the unfilled portions of the bucket after TCT but before MTs (CT and NCT) are added.

3. After all TCT have been accomplished, we add CT and NCT, respectively, in the room remaining in the bucket.

4. Generally speaking, we do fine when all of our tasking is within the bucket and we manage them in order of priority. Sometimes there is simply not enough room for all of the tasks at hand. When this occurs, and you have either more TCT than the bucket will hold or you allow some of your TCT to be replaced by MT, ground impact will result.

Tasking Priorities

Many accidents have occurred in the low altitude environment because of a wrong application of tasking priorities. Controlled flight into terrain results when a pilot prioritizes MT over TCT at a critical point in the flight. With terrain obviously being the biggest threat, **no MT should ever take precedence over TCT**. To further prioritize activities while flying low and fast, mission tasks are divided into the two subcategories of critical task and non-critical tasks.

1. **Critical tasks** such as maintaining situational awareness, threat awareness (other than terrain awareness), and route navigation are crucial to mission accomplishment and must therefore claim priority after TCTs.

2. **Non-critical tasks** on the other hand, such as communications, stores selection, HUD mode changes, and environmental control adjustments, while having impact on the mission, can be accomplished on a flexible basis, as the situation allows.

When task loading becomes extremely high, the first tasking to be loadshedded are non-critical tasks. As task loading continues to increase, critical tasks are eliminated, and in certain regimes of low altitude flight such as during a turn, all mission tasks must yield to TCTs.

Overtasking Cues are the signs of psychological and physiological stress which manifests themselves in one or more of the ways listed below.

1. Momentary indecision or confusion (feeling of being “behind the aircraft”).

2. Wasted movements in the cockpit.

3. Missed tasks and checks.

4. Erratic or inconsistent basic airwork.

5. Loss, late or non-standard verbal response.

6. Loss of overall situational awareness.

It cannot be overemphasized that aircrew need to understand these cues in order to have a frame of reference for recognizing overtasking and misprioritization of cockpit tasking.

MCT is that time spent away from TCTs for the purpose of accomplishing either a CT or a NCT. Stated another way, it is the time available to accomplish critical and non-critical task after TCTs have been performed. A sample task management timeline might look something like the following illustration:

Aircraft straight and level, up to 5 sec of MCT…… in a turn, NO MCT

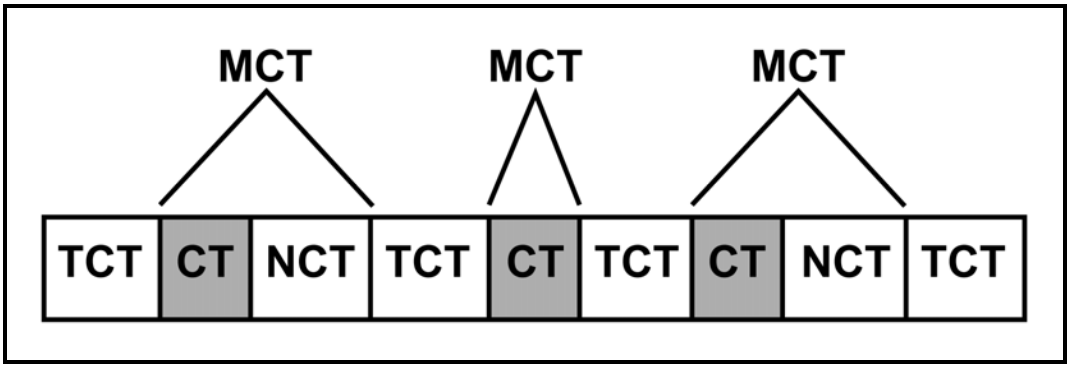

Figure 1-2 Task Management Timeline

Whether you are a single-seat fighter pilot or a member of a multiplace crew, the same set of priorities and sequence has to take place. For example, take a "time slice" out of a mission and look at the tasks facing you as shown in Figure 1-2. At time t = 0, you start with and establish safe TCT. Based on several factors, you may have some MCT available to divert from TCT to accomplish part of the CTs and maybe even some of the NCTs. However, after a given amount of time you must return to TCT. And so the cycle continues, TCT then CT and NCT, and back to TCT. This is simple in concept and easy to do for a short period of time, but it is extremely demanding to accomplish for long periods. It is obvious that any error in MCT control can lead to missing a critical TCT cycle and result in ground impact.

Without a doubt, the most difficult part of low altitude flying is the constant task management of time control. Although visual illusions (misperceptions) or a basic lack of hand-eye flying skills can cause ground impact, the vast majority of accidents are caused by a lack of proper TASK MANAGEMENT. Not knowing or forgetting: **WHAT** to look for, **WHEN** to look for it, **WHERE** to find it, or **HOW** to use it are basic ingredients of almost all low altitude accidents. In short, the pilots placed some MT ahead of TCT. This misplaced priority or task saturation occurs when the existing task loading requires more capability than we have available at that particular moment. We can only do so much at any given point, and the acceptance and ability to detect this in ourselves is a requirement for low altitude survival.

The level of effort expended by a pilot to maintain terrain clearance tasking is affected by four major factors:

1. **Maneuver:** Bank angle, "G" loading and speed.

2. **Aircraft capability:** What is functional in the jet i.e. HUD, Radar Altimeter etc.

3. **Pilot capability:** Currency, do I feel up to the task today, or behind.

4. **Environment:** Terrain flat, rough, up-sun, down sun, visibility clear, hazy…

These various factors can lead to tasking conflicts, which ultimately call for the pilot to judge his personal performance limits. If a conflict occurs between TCT and CT, the pilot has no choice but to either cease MT temporarily, and concentrate on TCT, or decrease maneuver intensity in order to reduce TCT demands thereby allowing room in the bucket for MT.

103. PHYSIOLOGICAL CONSIDERATIONS

Visual (Central v. Peripheral). Human vision is divided into two basic categories; central vision and peripheral vision. Central vision with its small field of view of approximately 2º is the primary means of information gathering and is consciously controlled. Central vision has very good acuity, can distinguish objects with very low contrast and has a high “G” tolerance. The capabilities of central vision are in direct contrast to peripheral vision, which in human visual perception, acts more as a spatial orientation tool. Peripheral vision is subconsciously controlled and has a very wide field of view. Acuity is poor with a limited ability to discriminate high contrast objects. Significantly, peripheral vision has a low “G” tolerance, an attribute which can be used by the pilot to recognize personal “G” limitations.

Optical Flow Pattern. This low altitude phenomenon actually contributes to a pilot’s ability to predict and control ground track, direction and rate of movement toward or away from a desired course. It is based on the way objects flow below, around, and past the pilot’s eye as he flies over and around terrain. Without actually focusing on any one object or portion of terrain near the aircraft, a pilot, by subconsciously evaluating the optical flow, can determine spatial position relative to terrain and manmade obstacles. With experience, a pilot can use this phenomenon with a surprising degree of accuracy, but it is by no means a substitute for proper use of instrumentation.

Speed Rush Baseline. Another low altitude phenomenon that is established by subsequent perceptual evaluations of altitude above ground level and speed. Speed rush is basically a sensation of rapid movement created by the apparent relative motion of the optical flow pattern. At a given speed and above ground level (AGL), it takes a pilot about 30 seconds to 1 minute to adapt to the rapid movement of the flow pattern and thereby establish a perceptual baseline. From the pilot’s standpoint, the more time spent at a given speed and AGL, the greater is his comfort level and the perception of safety. While such a comfort level can allow a pilot to maneuver confidently in the low altitude environment, it is an unreliable indicator of safety. Only frequent cross checks of an accurate radio altimeter and a positive flight path angle when engaged in heavy mission tasking, will provide protection from impacting the terrain.

Seat of the Pants. Without going into a lengthy medical discussion on how the inner ear vestibular and peripheral somatosensory sensors work, there is an important point to be made on how they play a role in low altitude flight and special orientation. These sensors are “caged” for 1 G flight, therefore the “seat of the pants” feel is unreliable in anything other than 1 G flight. Therefore a crosscheck of aircraft instrumentation coupled with visual sensory information should be used in the Low Altitude Training (LAT) environment for spatial orientation.

104. LOW ALTITUDE SAFETY CONSIDERATIONS

Safety Considerations:

1. **MTR** stands for Military Training Route. According to 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:

   a. **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.

   b. **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.

   c. **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.

2. **Weather conditions** should always be taken into consideration. CNATRA has established a ceiling of 3000 ft AGL and visibility of at least 5 statute miles as the minimum acceptable weather conditions in which to conduct low altitude operation. Weather minimums have been established for the preservation of life and assets. Such minima constitute a lawful written order, which must be adhered to. Cloud layers, prevailing visibility, obscurations such as smoke, fog and haze need to be carefully considered even if the weather minimums are legal for proposed low altitude training, as these conditions can adversely effect pilot visual perception.

3. **Obstacles** in the low altitude environment range from natural to man made, and all of them can potentially bring low altitude operations to a sudden and disastrous halt. 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 manmade 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.

4. **Bird-strikes** have occurred as high as FL 200, but by far the greater numbers of strikes have occurred 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 in to 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 for obvious reasons, 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.

5. **Sun position** has been a contributing factor in a number of low altitude mishaps. Glare in the early morning or late afternoon can effect 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.

6. **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.

7. **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 pilots ability to judge his height above the water. Water is just as hard as any terrain at 360 KIAS, therefore flying over it demands the same strict adherence to terrain clearance tasks, observance of minimum altitudes and the use of radar altimeter.

8. **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 on a MTR doesn't mean you are the only show in town. There may be other military aircraft operating around you or just some light civil aircraft trying to find its way home. 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. You should always check the vicinity of your operating area or low-level route for victor airways, small airfields and other crossing low-level routes.

105. LOW ALTITUDE PHYSICS

While there is no difference in the physics that govern high altitude flight and low altitude flight, there is a significant difference in physics application with respect to safety. Safe operation in the low altitude environment demands a greater preflight knowledge and in-flight awareness of specific laws and pilot controlled variables than does operation at altitude. There are four pilot controlled variables involved in terrain clearance tasks:

1. Flight path angle (FPA)

2. Centripetal acceleration or "G"

3. Bank angle

4. True Airspeed

By knowing what these variables are we are able to determine a valid Time To Impact (TTI) for any regime of low altitude flight. For example, the formula used to determine **TTI resulting from straight and level** flight deviations is expressed as follows:

$$TTI = \sqrt{\frac{\text{Altitude (AGL)}}{(\text{TAS} \times 1.69) \times \sin(\text{FPA})}}$$

	FPA=-1°		FPA=-2°	
	480 kts	240 kts	480 kts	240 kts
100 AGL	7	14	3.5	7
300 AGL	21	42	10.5	21
500 AGL	35	70	17.5	35

Table 1-1 Straight and Level Time to Impact Values (in seconds)

At 500 ft AGL, 360 KTAS, a flight path deviation of just -2° would render a TTI of 21.2 seconds. A deviation of -10° would result in a 9.4 second TTI.

NOTE

"G" force and centripetal acceleration are not factors in TTI from straight and level flight; only flight path angle is important.

TTI for a wings level bunt is another matter. The primary factors in calculating TTI for this regime is AGL, "G" factor and time. For a wings level bunt, the TTI is calculated based on AGL and the time that zero "G" is held. The following equation is used to calculate TTI in a wings level bunt. Note that the TTI is the same for a given AGL regardless of TAS and that the only other variable is time. You are accelerating each second and the altitude lost is proportional to the square of time. This means that in the third second you will lose nine times the altitude you lost in the first second. Therefore the important item to take away from this discussion is that time is the key factor in performing a bunt. Too much time can result in burying the nose beyond the point of possible recovery.

$$TTI= \sqrt{\frac{2 \times AGL}{(32.2 - (G \times 32.2))}}$$

	180 kts	240 kts
100 AGL	2.5 sec	2.5 sec
300 AGL	4.3 sec	4.3 sec
500 AGL	5.5 sec	5.5 sec

Table 1-2 Wings Level Bunt Time to Impact (Zero G)

Calculating the TTI for turns is a bit different from wings level or zero "G" bunt. Bank Angle beyond that required for a level turn (over-bank) and G-forces are the primary factors. The real danger in over-banking close to the ground is in the failure to detect the condition until it is too late. Most pilots associate "G" force in a turn as the element required to accomplish a level turn. As angle of bank (AOB) increases, so does the centripetal acceleration requirement to maintain level flight. The graphic below shows the exact AOB and "G" required for each turn to maintain level flight. Unfortunately visual perception of proper AOB and seat of the pants perception of required G-force in a turn is unreliable for the following reasons:

1. Normal environmental visual cues do not provide the AOB sensitivity to detect over-banks. For a given turn, it is virtually impossible for a pilot to distinguish between an under-bank and an over-bank until the aircraft begins to physically displace. Monitoring bank angle is a function of TCT that is ignored or neglected only at a pilot's peril.

2. In normal turns, most pilots are accustomed to the feel of the "G" force required to hold an aircraft level. In the high load turns common in the low altitude environment however, the "G" felt by the pilot seems exactly the same in a slight under-bank as it does in a slight over-bank. At altitude there is no consequence for this misperception, as the time to discover the deviation results only in the gain or loss of a few hundred ft. Next to the ground at 500 ft AGL however, the lack of time available to discover the error and implement a correction can be fatal. Therefore, G-force, while a significant variable in TTI calculations, is **not** a reliable cue for the pilot in determining the status of his low altitude turn. Many pilots have impacted the ground in controlled flight, while experiencing a high degree of comfort from "seat of the pants" feel!!

	2 G 60 deg (70 deg)	3 G 71 deg (81 deg)	4 G 75 deg (85 deg)	5 G 78 deg (88 deg)	6G 80 deg (90 deg)
100 AGL	4.4	2.7	2.6	2.5	2.5
300 AGL	7.7	4.7	4.5	4.3	4.3
500 AGL	9.9	6.1	5.8	5.7	5.6

Table 1-3 Time to Impact (sec), Turn with 10° Overbank

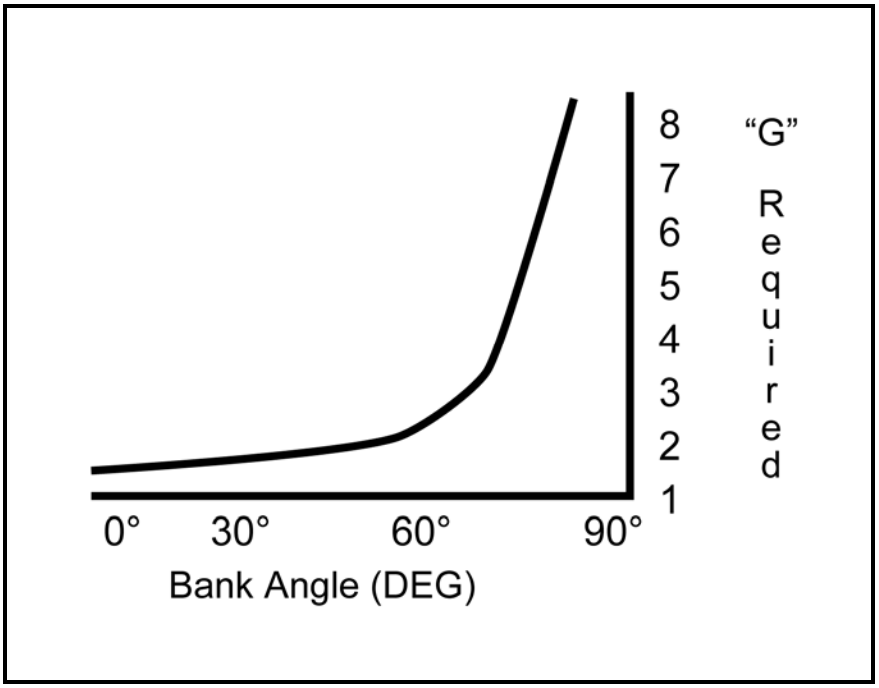

Figure 1-3 Level Turn Bank Angle And "G"

106. 50% RULE TABLE AND DIVE RECOVERY RULE

The 50% rule is a simple set of do-not-exceed dive angle numbers corresponding with specific AGL altitudes that ensure a safe expeditious descent from 5000 ft AGL to a point where the dive recovery rules apply. For example a pilot at 4000 ft AGL would use a 20° FPA until reaching 3000 ft AGL then decrease his FPA to 15° until 2000 ft AGL and so on.

Altitude (AGL)	Dive Angle
5000'	25°
4000'	20°
3000'	15°
2000'	10°
1000'	5°

Table 1-4 50% Rule with associated AGL and FPA

The dive recovery table is the natural extension of the 50% rule. It is platform specific and is dependent on several factors including aircraft performance capabilities. It is mentioned here because it is an important concept and much more exposure will occur in the fleet. An extensive amount of flight testing and evaluation goes into calculating the specific numbers. Dive recovery numbers for Training Command (TRACOM) aircraft have not been validated. Until the numbers are validated, Chief of Naval Air Training (CNATRA) has directed that the "minute to live" rule will be utilized to get to the low altitude environment.

107. BASIC MANEUVERS

Basic Maneuvers (Techniques). There are three basic maneuvers that must be learned in order to operate at low altitude: straight and level flight, level turns, and ridgeline crossings.

1. **Straight and Level**

   a. **Purpose.** To discuss the proper use of visual cues, available mission crosscheck time and flight techniques for holding a constant altitude at low altitudes.

   b. **Technique**

      i. Scan terrain to assess slope/obstacle.

      ii. Visual cues to include in scan:

         (a). Vertical Speed Indicator (VSI) - Remember, VSI at 0 ft per minute (FPM) does not mean you will not impact the ground (upslope).

         (b). Velocity Vector - Back up visual assessment of terrain clearance.

         (c). Radar Altimeter - Should remain steady, even if VSI shows you are in climb/descent (upslope/downslope).

      iii. Aircraft Trim - Most feel comfortable with neutral to nose high trim. The nose high trim insures a climb during straight and level flight by relaxing backstick pressure. This could be useful during MCT.

      iv. MCT - Flying straight and level is relatively simple when MCT is not required. However, the low altitude mission will always require mission tasking in some form (flying formation, visual lookout, navigation, radar work, etc.). Utilize 3-5 second chunks of MCT. 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 3-5 seconds on map study, start cycle over. If you cannot find what you are looking for on the map - <u>DO NOT BREAK 3-5 SECOND MCT</u>! Abandon MCT, complete TCT and try again.

      v. Airspeed Selection - In almost all cases, a slower speed will lower comfort level due to the decreased workload and stress/anxiety levels. If you find yourself below comfort level (i.e., not able to complete mission tasks) and due to the tactical scenario cannot climb, a slower airspeed may help (if tactically feasible).

c. **Hints/Comments**

i. Do not allow aircraft stability and long TTI to create a false impression of unlimited MCT. Utilize 3-5 second blocks of MCT maximum.

ii. Be aware of how changing flight environments, varying speeds and pilot workload 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.

d. **Common Errors**

i. Exceeding available MCT.

ii. Poor airspeed/altitude/heading control.

2. **Level Turns**

a. **Purpose**. To discuss the procedures and techniques for executing level turns at low altitude.

b. **Technique**

i. 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.

ii. Roll into the turn and apply "G" passing through 30-45 degree AOB, depending on roll rate. Attain the desired "G" while adjusting bank angle to hold level flight. Adjust power to maintain airspeed.

iii. As the turn begins, monitor the nose position relative to the horizon. 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, mirror) and watching it track level across the horizon. In HUD equipped aircraft, the velocity vector provides a rapid cue to detect nose slice. <u>IF NOSE SLICE IS DETECTED, IT MUST BE CORRECTED IMMEDIATELY</u>. 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!

iv. Scan - Since TTIs are extremely small during low altitude turns, scan must be extremely rapid. The proper scan should move from the aircraft reference or 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. The following cues should be monitored:

(a) Cockpit/aircraft Reference - As discussed above.

(b) Velocity Vector - Remember, for rising terrain the velocity vector will have to be maintained above the horizon in order to remain at the same AGL altitude.

(c) VSI - Can aid in detecting descents.

(d) Radar Altimeter - Depending on the angle of bank during the turn, the radar altimeter may not be useful. Most radar altimeters are only good up to about 30-45 degrees of bank. However, often they will work past that AOB. If working, it will provide an immediate indication of altitude loss. One last point to think about, if you roll into a turn at an even 500 ft once established 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.

v. MCT - There is NO time available for mission crosscheck other than 1 second scans of the airspace and terrain into the turn. <u>Turning and looking is extremely dangerous.</u> The procedure should be: check for nose slice and that turn is level, scan ahead of turn for obstacles and slope of terrain (1 second max), recheck for nose slice.

vi. Clearing Vertical Terrain - Use the following to help aid in assuring clearance of terrain. If a piece of terrain is moving back on your canopy, you will clear to the outside of that terrain. If the terrain is moving forward on your canopy, you'll clear it to the inside. If it is not moving on the canopy bow, roll out, and you will pass behind the terrain. If any doubt exists, reduce bank angle, increase "G", and climb over the terrain.

vii. Rollout - Rollout at desired heading, adjust power and altitude as required. Begin straight and level scan and MCT. Avoid climbing by properly reducing "G" as AOB decreases.

c. **Hints/Comments**

i. The velocity vector/cockpit reference (if equipped) is the most consistent cue to FPA positions and rate of change. This should be the primary reference during the level turn.

ii. If you descend, reduce bank while maintaining current "G" and climb back to the original altitude. If climbing, adjust your G/AOB combination to stop the climb. <u>Do not try to correct back down to the original altitude during a turn</u>, wait until after you roll out.

iii. In some aircraft, the buildup of AOA as the turn is started can lead to a false perception that a climb has been initiated because the nose can move up significantly relative to the horizon.

iv. If mission tasks require attention during a turn, you have two alternatives; rollout and complete tasks (preferred) or decrease bank/increase "G" and enter a climbing turn (this increases MCT to 2 seconds max). <u>Do not attempt to perform mission tasks while in a level turn</u>!

d. **Common Errors**

i. Not clearing turn/checking terrain.

ii. Improper G/AOB combinations causing slight climbs.

iii. Not noticing and correcting nose slice **immediately.**

iv. Looking while turning or exceeding 1 second MCT.

3. **Ridgeline Crossings**

a. **Purpose**. To discuss the procedures and techniques for performing ridgeline crossings safely and expeditiously while minimizing exposure to the threat.

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

i. Natural Breaks. Probably the best way to negotiate a ridge is to do a good map study during your preflight planning, find natural breaks, and go through the gaps and passes. Beware because gaps and passes are often Lines of Communication (LOCs), and might be bristling with enemy defenses.

ii. 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, avoid highlighting yourself over the top and decide 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 degrees above the horizon bars on your HUD (or above the horizon for non-HUD equipped aircraft). Now pull to place the velocity vector (or Whataburger) 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, and thus excessive exposure time once you have unmasked above the terrain.

(c). Now that you've solved when to pull-up, the level off and are crossing over the top, how do you get back down? You have three options:

(1). 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 dive recovery and quickly pick up your dive recovery rules. If at any point you can't rely on the radar altimeter or accurately assess the terrain gradient, STOP THE BUNT AT -10° FPA MAX and start your recovery.

(2). The second option is to roll to 90 - 120 degree AOB and unload, letting the intentional overbank help you achieve a roll-out dive angle for recovery. Again a -10° FPA is a good place to stop rollout and accomplish a standard dive recovery. This method offers a more comfortable ride and is tactically about the same as a bunt. In both cases, you're falling just like a rock; but with the bunt you're floating, and with the overbank and a little "G" you remain in the seat.

(3). The last method is the most aggressive and involves either an inverted turning pull or a pure inverted pull. This method is useful if you've delayed your pull-up too long and cross the ridgeline with +5 to +10 degrees FPA. Accomplish the inverted pull or inverted turning pull, again stopping at -10°, and accomplish a standard dive recovery. When utilizing this method, be prepared to stop the pull quickly, roll-out and recover, in case you're surprised by what's on the other side of the ridge.

NOTE

While this technique is widely used in the fleet, it will not be used in the TRACOM.

(d) In summary, use the velocity vector (or Whataburger) 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. Pick your method of pull-down and stop it at not more than -10° FPA.

iii. 45° AOA/Parallel. In cases where your navigation will allow deviation or a threat in the rear quarter requires the maintenance of both terrain masking and minimum altitude, this approach is optimum.

(a). As you approach the base of the ridgeline, a turn is accomplished 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 "gouge" described in the straight and level 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.

(c). If done properly, this method will provide the most indirect masking on the near side of the terrain, while at the same time providing the shortest exposure time across the top of the terrain.

c. **Hints/Comments**

i. The best method is to do your mission planning and avoid crossing high peaks.

ii. It is critical to cross the terrain in a level flight path. This will minimize exposure to the threat.

iii. It's better to start the pull up early than late, you will still have direct masking from threats on the far side of the terrain, and indirect masking from threats behind the aircraft.

d. **Common Errors**

i. Pulling up late and trying to maintain low altitude up the face of the terrain. Results in "ballooning" over the top.

ii. Not crossing the top of the terrain in level flight.

iii. Starting the bunt or pull down late.

108. CNATRA LOW ALTITUDE AWARENESS TRAINING RULES

1. Currency: within 30 days of last flight.

2. Weather requirements: 3000/5, with a defined horizon. Weather shall be continuously assessed throughout the Low Altitude phase of the sortie.

3. Descent through a solid over cast in an attempt to achieve visual meteorological conditions (VMC) conditions below, while not under positive IFR control is prohibited.

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

5. All crossing MTR's/routes shall be deconflicted and annotated on charts.

6. LAT sorties shall include a thorough brief of the planned route / operating area to include: route restrictions, crossing routes, obstacles, potential hazards, and an assessment of possible environmental factors (smoke, haze, sun angle, etc).

7. Minimum airspeed shall be briefed for type aircraft.

8. Wingman never flies below lead's AGL altitude.

9. Wingman is responsible for deconfliction and collision avoidance except for TAC turns into wingman.

10. Minimum altitude for CNATRA low altitude training is 500 ft' AGL.

11. If equipped, an operational radar altimeter is required.

12. Radar altimeter shall be set no lower than 10% below the briefed minimum altitude.

13. A "G" awareness maneuver will be performed prior to performing section low altitude training.

14. Any aircraft may call "knock it off". All aircraft should acknowledge the KIO call, roll wings level and climb-to-cope. Aircraft shall KIO for any of the following reasons

    a. Any aircraft descends and remains below the minimum pre-briefed altitude.

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

    c. Any aircraft goes No Radio (NORDO) or loses Intercommunication System (ICS).

    d. Loss of situational awareness.

e. Any unsafe condition or emergency occurs.

f. Weather deteriorates below minimums or inadvertent Instrument Meteorological Conditions (IMC).

15. Following a “KIO”, LAT training will not be resumed without verbal confirmation from all aircrew in the flight.

APPENDIX A
GLOSSARY

A100. GLOSSARY OF LOW ALTITUDE AWARENESS TRAINING (LAAT) TERMS

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.

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.

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.

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.

50% Rule: Maximum dive angle to be utilized for entering the low altitude environment from a given **AGL** altitude; e.g., 5000 ft **AGL** cruise-max dive angle = 25°.

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**.

Probability of Kill (P_k): The mathematic probability in percentage that a specific target in question will be destroyed or permanently disabled by a given action. Usually refers in the Joint Munitions Manual, to the effectiveness of various munitions against specified target types. Also used to describe the consequences for the pilot who ignores or forgets TCT.

Terminate / Knock it off: A radio call made in the low altitude environment which: results in the suspension of an intended low altitude maneuver (**terminate**), or causes a cessation of low altitude flight entirely, combined with an immediate climb to a pre-briefed AGL altitude (**KIO).**

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.