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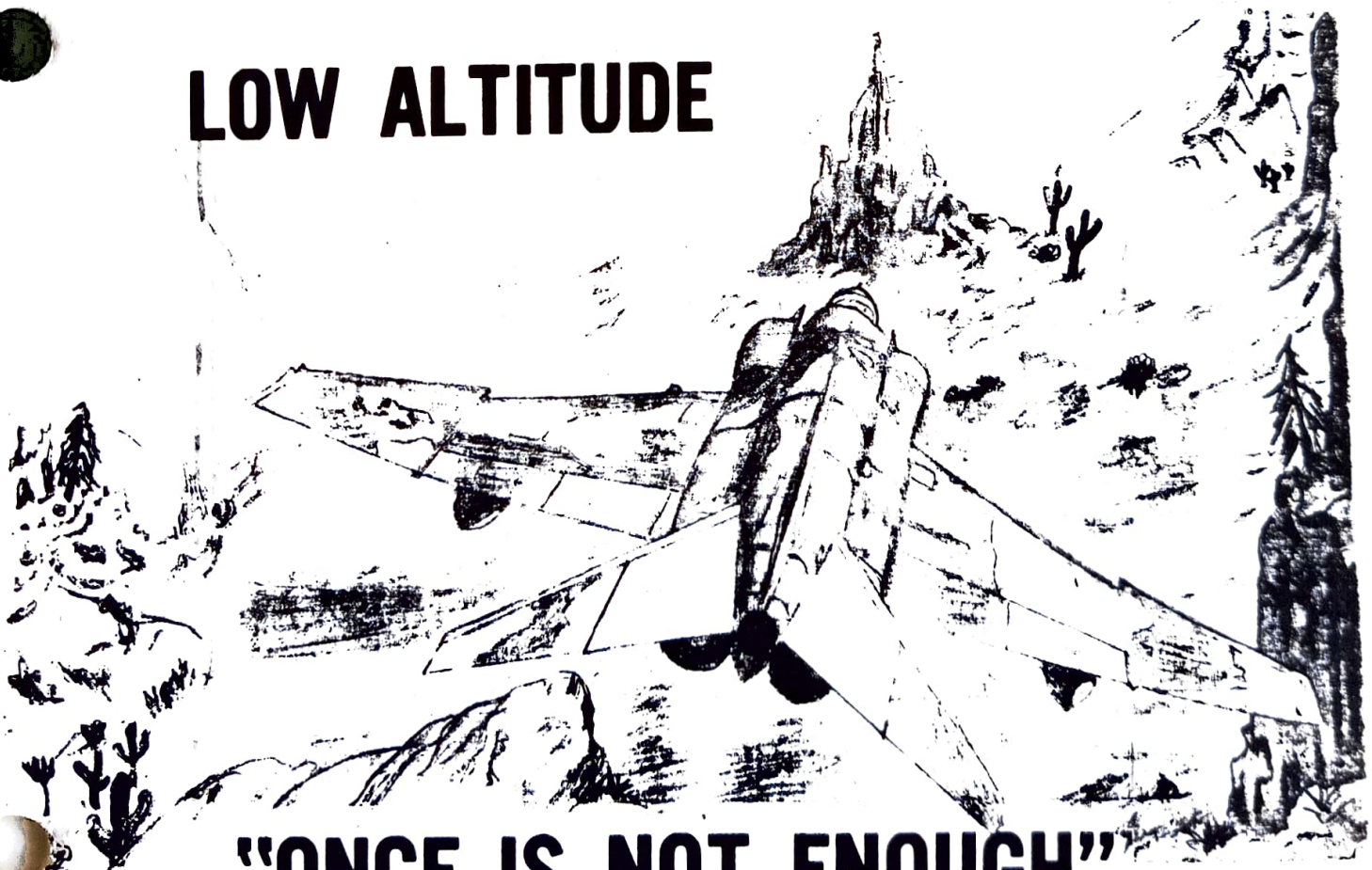
NEW INFORMATION PAMPHLET #14

LOW ALTITUDE



"ONCE IS NOT ENOUGH"

LOW ALTITUDE

GOAL: The goal of a low altitude flying training program should be to increase aircrew proficiency in flying and maneuvering at low altitudes at combat airspeeds.

WHY? To exploit an area that may allow us to operate with minimum detection (surprise) and below some of the enemy threat envelopes.

HOW? You don't just drop to 100 feet AGL on your first low altitude mission and beam around with your hair on fire. Rather, we must use a BUILDING BLOCK APPROACH based on a solid FOUNDATION OF AHC and BFM. During AHC/BFM you learn how to fly the airplane...learn the feel of the aircraft throughout the performance envelope...learn about turning room required versus turning room available...learn about turn radius. The famous fighter pilot query, "Have I ever, in recent history, made this corner before?", applies to fighter maneuvering during GAT as well as ACT.

The sane and logical approach, then, is based on building skills such as level turns at higher altitudes such as in the 500-1000' AGL regime. As the skills are mastered--you step down. This should be done at the individual's own pace with no stigma attached to being the last jock qualified at 100' AGL. This implies and requires the concept of COMFORT FACTOR during step down training. Comfort factor also implies that after a period away from the low altitude arena even a jock who has been previously qualified may find that he needs to step himself back down. To fly well in the low-altitude arena, you must fly there often--ONCE IS NOT ENOUGH.

When F-4 crews master single-ship maneuvering they should proceed with 2-ship low level formations, comm out turns, and tactics. In the F-4, attention must be given to teaching the WSO comm out turn geometry and crew coordination. He who believes that the WSO is only an INS operator in the low altitude regime is severely limiting his tactics and combat flexibility/capability. Two well trained men who complement each other in their responsibilities and tasks make the F-4 a flexible and potent weapons system. Situation awareness and knowledge of low level considerations by both crewmembers built through a solid training program is essential to safe training.

Ridge crossing considerations, terrain masking, formations, tactics, comm out turns and crew coordination must be addressed during any low altitude training program. Remember, the building block approach is the key.

LOW ALTITUDE MANEUVERING

ROE: Some ROE that are a sensible approach to low altitude step down and awareness training follow:

1. The wingman will fly no lower (AGL) than his leader. It is the leader's responsibility to know and honor his wingman's capability.

2. The minimum altitude any crew will fly is that altitude at which he can turn level or the altitude at which the crew can comfortably perform their job.

3. Each individual will be allowed to progress at his own rate. He will progress to lower altitudes when he can consistently comply with the first and second rules.

FORMATION CONTRACT/CHARTER

1. The wingman will always strive for the line abreast position.

2. The man caught out in front is responsible for re-establishing line-abreast formation

3. The wingman will remain within 90^{o} of the leader's heading.

Following are four articles reprinted from the Spring 77 edition of USAF Fighter Weapons Review. Take a close look at them. Can you answer the following:

How do I make a level turn?

What crew coordination techniques should I use?

How should I cross ridge-lines when I have a bandit on my tail?

How should I fly comm-out turns?

What are the individual responsibilities of an F-4 crew/flight at low altitude?

What are some techniques for low altitude navigation?

What happens to aircraft pitch attitude when you select afterburner?

What about complacency?

What problems are associated with flat terrain...rolling terrain...sloping terrain...sun angles and shadows?

FLY SMART

Like a Fox!

Air-to-Surface Target Destruction With Force Survival

By
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We have seen how our air-to-air combat capability is developed through a step-by-step program from BFM through ACT. Our air-to-surface combat capability must progress in the same manner if we are to train for highly demanding missions. Medium altitude, low threat tactics are relatively non-demanding, and a good combat capability can be developed with little attention paid to step-by-step training programs. At the other end of the spectrum, however, we find demands for combat capability which require such training programs.

Multiple low altitude attacks in a high threat environment are representative of that end of the spectrum. The workload on the aircrew is at, or beyond, the level found on a full blown ACT mission. Indeed, a low level, high threat GAT mission often includes (1) defending against and/or killing bandits during the execution of high speed terrain following navigation and (2) target acquisition and destruction, while maintaining mutual support to detect and outfly other bandits or SAMs and avoid areas of concentrated AAA—the whole thing being done comm-out, of course. It's a demanding mission and not for the faint of heart or those behind the power curve.

Two basic questions arise in the jock's mind, and even more so, in the minds of supervisors outside the trenches. Can this be done effectively, and if so, can it be done safely? The answer to both is an emphatic "Yes, if...." The "yes" is a fact. It has been done before and is being done right now. The "if" deserves some discussion and is the basis for this section. Success or failure in low altitude/high threat GAT depends on the "if," which, of course, is an effective training program to prepare ourselves for this demanding environment.

In our air-to-air training we don't move from BFM directly to multi-bogey ACT. To do so would not be safe or effective training. Likewise, we cannot step directly from a box pattern into a high threat/low altitude GAT mission. It's not effective, and is even less safe than the previous example, due to the unforgiving nature of your average rock (which invariably lurks much closer to lethal range than it did in ACT). There are intermediate training steps and prerequisite training principles which must be mastered first to insure safety and combat effectiveness.

A thread (more like a chain) of continuity exists between successful air-to-air and successful high threat ground attack tactics. Formations, mutual support concepts, crew coordination, lookout, and, most important, basic fighter maneuvers, are identical in purpose and similar in execution. Of these, BFM is most critical because,as the name implies, certain maneuvers are basic to fighter employment.

ACM is also important, and will develop skills which can be transferred to the GAT environment. In ACM, BFM and crew coordination are integrated with mutual support concepts to develop proficiency in employing two or more fighters operating in concert toward a common goal. That goal is the ability to patrol and engage effectively. Formations and crew responsibilities are designed to optimize maneuverability, mutual support, lookout, and lethality in an offensive or counter offensive posture. Again, these same functions and principles will be basic to high threat GAT.

Along with BFM and ACM, low level terrain masking navigation is often overlooked to a critical training task for high threat GAT. The reason that DR and visual navigation are our primary means becomes apparent after you have to perform multiple breaks at low altitude. It's easy to get lost! Proficiency must be attained in practicing single-ship, low level, terrain following navigation (after mastering the straight line type).

When BFM, ACM, and single-ship low level tasks are mastered, they can be brought together into low level formation maneuvering and navigation. ACM formations and the maneuvering and crew responsibilities are modified to comply with principles and techniques learned in low level terrain masking and navigation. Who will navigate, clear terrain, fly formation, clear for threats, and whatever? Attempt to work up to a complete comm-out capability along a random route. Learn to use the radio only by exception - not as a rule.

At this point we should be able to take our handful of fighters and optimize the formation and crew duties to fit the weather, terrain, and expected threat. Take it anywhere in the world at high speed, low altitude, and do it well (which fills the effectiveness and safety squares). But we have not rolled-in to release that first piece of ordnance. The ability to fight our way in (and out) had to come first, but that alone is not sufficient. We still have to destroy the target.

Beating the dirt well in a manual manner in a tactical situation requires a greater degree of flying and thinking skill than your average range mission, as do automatic releases and electric dirt beating. But, the toughest parameters to achieve are for a manual release. Since we have to be prepared for the worst, we must be good tactical manual bombers. Whether we are or not depends primarily on one skill area: BFM. Maneuvering the airplane to put it where you want it is the name of the game. And, just like BFM at altitude, recognizing angle, range, overtake, and energy state is a must to help us decide how to put it where we want it. We usually add to this a maximum of five seconds tracking time to refine our solution.

We begin with the box pattern, but unless we intend to fight from a box pattern, we shouldn't continue to train in it after the basic bombing "wire" is mastered. Likewise, we can't take the step directly fro... box patterns to tactical pops (at least not safely and effectively). After achieving proficiency in BFM, and consistent qualification from a box pattern, we should combine the two and explore other ways to get to the same release point. Whether it be from high base curvilinear, pop-ups, double bat turns with quarter roll, or whatever we intend to use in combat, the progression should be the same. A scored tactics range is even more desirable as long as it is used under reasonably controlled conditions. Don't increase an aircrew's workload by a factor of twenty by introducing any problems other than consistently achieving release parameters from varied tactical approaches with a minimum of outside crutches.

At this point we've got all the basics down pat. We can navigate, formate, and attack consistently well at low altitude. And we can do it comfortably with minimum comm.

Only now can we introduce the real reason for all of this: enemy defenses. The variables of defensive mix, weather, terrain, and mission are endless, but we are ready to tackle the problem. High threat, demanding tactics won't work without a firm foundation in the basic skills required to execute them. In our program we have built that foundation.

It will become evident that the articles in this section lean very heavily toward the low altitude environment. This does not mean that low altitude is the only answer, but rather is a result of techniques developed to safely train in an environment which we may be required to exploit.

Beyond the low altitude articles, ideas are presented to tactically enhance conventional weapons training, Maverick, and Pave Spike training and, finally, a realistic approach to "putting it all together" in Ground Attack Tactics.

When You Have To Go Low

By
Captain JOHN JUMPER
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Walk up to any fighter pilot in any bar and ask him how he plans to get to the target. His answer will go something like this:

"In the weeds, my boy, fifty feet and six hundred knots; yes sir, down there on a first name basis with the gophers. Hell, half of those pinkos will blow their toes off trying to get me."

Anyone who has had the opportunity to train in the very low altitude environment can appreciate the skills required to execute the plan to which we subscribe with much bravado at the bar. Statistically, the threat from mother earth has proven much more lethal than any MiG or SAM. The old saying that the ground in the training environment is twice as hard as the ground in combat signifies the unforgiving nature of low altitude training.

The most difficult problem to overcome in a safe and effective low altitude training program is finding people with experience to teach the techniques required to use terrain, make a level turn at low altitude, and retain mutual support. Recent combat experience and training emphasis have not provided expertise in this arena. So, what do we do? Here's one approach to low altitude training that has been proven to be safe and effective.

The first step is to understand our objectives. As a tactical option, low altitude gives us the potential to evade the threat. To be successful at this, our objective would be to properly terrain mask and maintain a low altitude posture for prolonged periods of time, including turns and repositioning. Add to these training objectives consideration of the mission, such as, single-ship low altitude employment being less demanding than tactical formation employment, although individual skills of masking and level turns are the same.

We will have a good start on our low altitude program if the squadron "standards" presented earlier include daily use of tactical formation and comm-out turns. This type of repetition builds awareness outside the cockpit, which will be of obvious import in the low altitude environment.

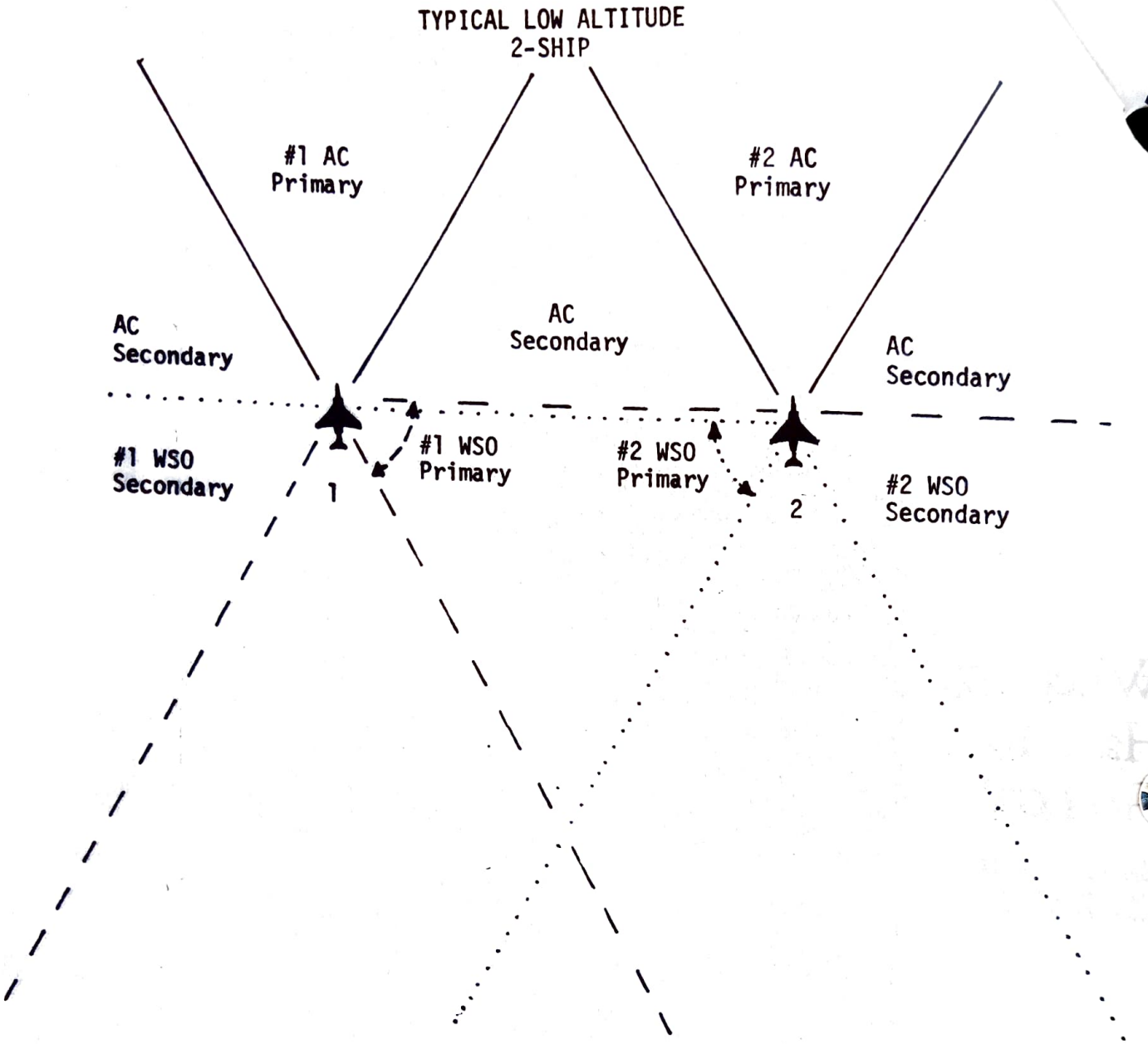
There are several rules which are inviolate. These rules form the basic discipline of low altitude training and should be emphasized to the same degree as ROEs. The rules are:

1 The wingman will fly no lower (AGL) than his leader. Although this time-honored rule addresses the wingman, it is actually the leader's responsibility. As leaders, we should know the wingman's capabilities and fly at his lowest safe altitude.

2 The minimum altitude the wingman will fly will be where he can be comfortably and simultaneously performing visual lookout responsibilities and turn level when a turn is required. The three elements in this rule determine the lowest safe altitude in low altitude training. The element of comfort is satisfied when we are at an altitude which allows us to look around. Many people can fly extremely low, with their full attention focused on the bushes and rocks dead ahead. Additionally, we cannot expect the WSO to efficiently carry out his responsibilities when he feels compelled to constantly check twelve o'clock. The element of visual lookout is the purpose of any tactical formation and should be practiced constantly. The level turn builds proficiency in maintaining a low altitude posture. This also gives the leader an idea of where the wingman is comfortable, and helps him determine when the wingman is ready to progress to a lower altitude.

3 The wingman will be allowed to progress at his own rate. This does not mean that our new guy will be able to set the mission's pace, but rather he will comply with the pace set by the leader and the first two rules. He will progress to a lower altitude when he can consistantly comply with rules 1 and 2.

Perhaps the most important rule in low altitude training is one that is implied rather than stated. Those charged with low altitude training must realize the depth of their responsibility. We are developing an important combat capability in a deadly serious environment. We cannot allow those who do not respect the need or the seriousness of low altitude training to jeopardize those programs we do have.



#1A a. Primary Navigation
b. Avoid Rocks

#2B a. Visual Lookout
b. Nav Aids (min time)
c. Monitor #2's Position
d. Short Peeks at Radar and APX

#2A a. Mutual Support
b. Avoid Rocks
c. Follow Low Altitude Charter

#2B a. Visual Lookout
Comm-out Maneuvering

Ideally, we would like to design a low altitude formation which would offer the maneuverability of a single-ship while retaining visual cross coverage. Not surprisingly, the formation which comes closest to this is our old standby, 5,000' to 7,000' line-abreast. The two-ship formation is stressed for utility in the jamming environment. This does not mean that more than two aircraft cannot be used during certain phases of a combat profile. It does mean that control of more than two aircraft during hard maneuvering in the target area is extremely difficult. See "Limited Comm Maneuvering," TAB 76-4.

Visual lookout responsibilities are the same for low altitude formations as those normally associated with line-abreast formations. Studies have revealed, however, that our ability to detect and acquire is much greater at low altitude than at higher levels. As an example, observe how we might go about finding a small screw dropped on a garage floor. We instinctively get our eyeballs down to floor level to maximize vertical development of the dropped object. Our eyeballs' search pattern is much like a flashlight being shone parallel and very close to the floor surface. Conversely, if we stood on a chair to find our elusive screw, the flashlight pattern of our eyeball would highlight only one spot on the floor at any one time.

Obviously, our analogy breaks down when searching for a screw in the grass (who said that?). If the object of our search were very small (threaded type) or the grass very tall (non-threaded type), we would have to elevate our eyeballs to gain line of sight to the objective. Thus, we implement maneuvers such as the pop-up.

This increased detection capability serves to immediately command our attention when anything is moving in relation to our aircraft. We can also rapidly detect irregularities in the environment such as the square bush which is really a tank. With a little practice, we can begin to see things well outside our span of normal visual responsibility. (See Air Combat Maneuvers, this issue, for a detailed discussion of visual lookout.)

What do we mean by "low altitude?" How low is "low?" Given the constraints of our individual training environments, the goal should be 100 foot capability. Experience has shown that most guys in continuation training can comply with the first two rules at 500 feet over flat terrain. A proven method to test this ability is as follows:

1 Start at 1,000' and 400 KCAS (close). Do a series of two normal delayed turns (using the radio) followed by two in-place 180° turns. These should be 4 G constant speed turns.

2 Descend to 500' and repeat the sequence. Transition to comm-out turns when capability has been demonstrated (in the F-4, external tanks should be dry and rig check complete).

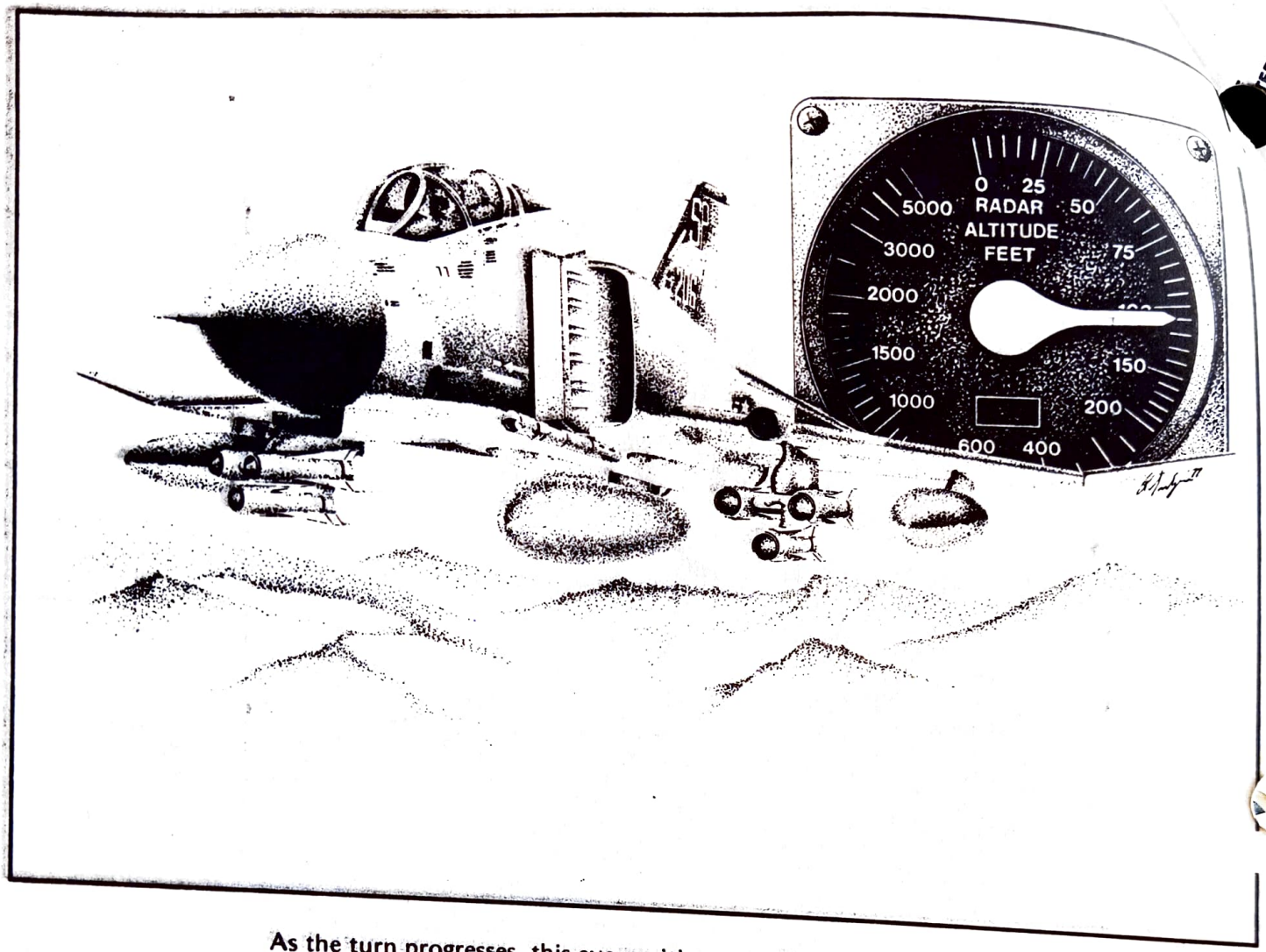
3 Increase airspeed to 500 KCAS and continue to maneuver at 500 feet using 5 G turns.

Using this sequence, we have established the pace which will be standard. Progression to lower altitude should include some straight and level time prior to maneuvering. In addition, a warmup at 500' is good practice even for experienced crews.

★ As we progress lower, the most difficult skill to learn or teach is the level turn. The following techniques are designed to provide constant awareness of the aircraft's nose track, relative to level flight. This is done in three distinct stages:

★ 1 Roll-In. When the turn is signalled or called, check for a visual reference 90° to the flight path. This will preclude the distraction of checking the compass, and the reference can be used for any delayed or in-place turn. The roll-in should be a rapid, unloaded roll to a bank angle which will allow the nose to track a straight line along the horizon. Obviously, we don't know what that bank angle is until we are established in the turn and can identify trends in nose position.

★ 2 Establishing the Turn. In order to monitor trends in nose position, the eyes should be focused on the ground at left ten o'clock (for a left turn), so that peripheral vision includes the nose of the aircraft at one extreme and a view of the terrain being turned into on the other.



As the turn progresses, this eye position allows constant cross check of proximity to the ground vs any tendency the nose has to rise or fall. Corrections should be made by adjusting bank angle. Use of rudders is not recommended once the turn is established since your inputs will disturb our interpretation of nose position. Once a smooth nose track is established, we can briefly afford to check the progress of the turn, position of lead, and area of lookout responsibility.

★ 3 Roll-Out. Just prior to roll-out, make a final check of the nose position. If it's still good or slightly rising, roll unloaded to wings level. If slightly below the level reference, roll out with a slight back stick pressure to break the descent. During roll-out, the eyes should shift to focus attention directly over the nose. This will allow immediate correction of any tendency to climb or descend.

The most common mistake in low altitude turning is the initial tendency to climb. This is usually caused by starting the turn lower than the comfort factor mentioned in Rule 2. Remember, the roll-in is critical. If a level nose track is not established rapidly, then there is no reference on which to base correction. If a climbing trend is evident from the roll-in, do not attempt to overbank down to the original altitude. If we are unable to start the turn properly, it is unlikely that we will be able to correct to that altitude while turning. We should attempt to stop the climb and complete the turn at an altitude where we can comfortably establish the proper references.

Up to this point our discussion has been dedicated to basic rules and techniques for maneuvering at low altitude. We have used level terrain to familiarize our new guy with flying close to the earth in a predictable environment.

In rough or rolling terrain, our three basic rules apply, but with several additional considerations. We should all realize that there is no such thing as "contour flying" in a high-speed fighter. Our job is to know how to use the terrain to minimize exposure. Rolling terrain can be extremely deceptive, especially over the desert or snow where gradual slopes offer no contrast with their background. It is easy to be lulled into the sensation of level flight when actually flying constant altitude over downward sloping terrain. If our crosscheck does not include terrain between our present position and the horizon, then gradual upslopes in the terrain may cut actual ground clearance dangerously short.

Low sun angles also require special consideration. Rolling terrain is especially difficult to detect when flying into early morning or late afternoon sun. In rough terrain, long mountain shadows also disguise changing terrain features.

* In each of these situations a low altitude posture can be maintained by selecting a visual reference point on the ground about halfway between your present position and the horizon, directly ahead in your line of sight. Experience has shown that even the most highly qualified crews average 200-300' AGL over low contrast rolling terrain in order to conform with the stated rules.

Another basic skill is proper use of terrain in crossing ridgelines. In most situations, we would like to minimize exposure on both sides of the ridge to be crossed. Figure 19 illustrates the most common mistake in crossing a ridgeline. Our new guy assumes a suicide vector headlong toward the base of towering peak A.

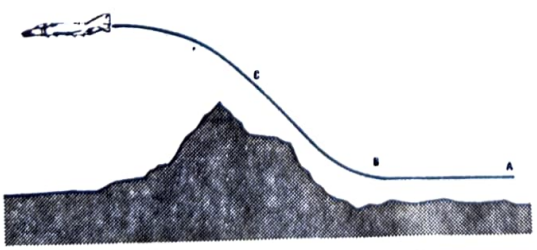


FIGURE 19

To insure sufficient energy to climb the mountain, our friend pushes up to a speed approaching warp eight. Approaching point B, our friend chances a glance in his mirror to observe his WSO, and sees a white-knuckled grip on the top of his instrument panel, eyes fully dilated to f/1.0, while attempting to generate a plea for altitude. At the last possible second, our tiger generates a pull up the face of the mountain. At point C comes the realization that no amount of G will significantly alter his predetermined trajectory toward the moon. This is called the IVANTHANKSYOUVERYMUCH technique.

Observe Figure 20, which is the technique used to minimize exposure on both sides of the ridge. We start a climb so as to cross the ridge in level flight and begin an immediate descent back to low altitude on the far side.

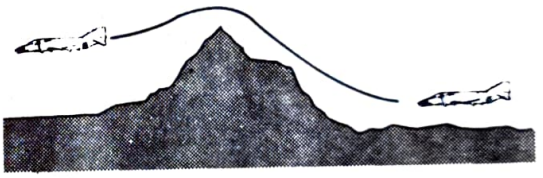


FIGURE 20

This can usually be accomplished with a bunt initiated at the peak of the ridgeline.

Where terrain varies drastically from one side of the ridge to the other, as in Figure 21, a roll to 135° bank and pull down the face of the far side of the ridge may be in order.

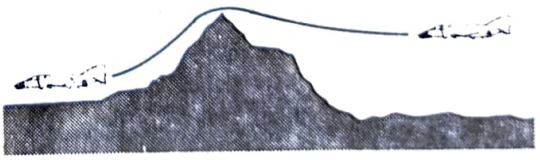


FIGURE 21

The roll is initiated at the apex of the ridge with a slicing pull to point the nose at a realistic level-off point. Initial attempts at this maneuver should be restricted to 20° nose down until you are familiar with turn performance and lead points in this environment.

The technique of rolling inverted and pulling at the apex is not considered a viable technique in combat where it is unlikely that we would desire to introduce ourselves into an unknown valley inverted.

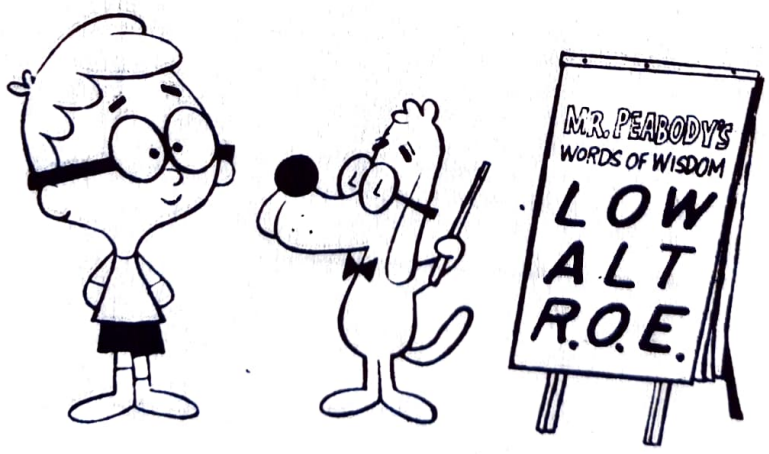
In the F-4, effective low altitude employment assumes mutual trust between cockpits, especially back to front. During initial training, there are several short "peace of mind" calls which will build this trust and free the WSO's attention to visual lookout.

When maneuvering in the proximity of terrain higher than the aircraft, a call of "rocks" by the AC will let the WSO know that the AC is aware of the action to be taken. Conversely, the WSO should use the same term to challenge his front-seater's awareness of threatening terrain.

During turns or maneuvers where terrain may momentarily break line of sight to the wingman/leader, the term "visual" should be used between cockpits when line of sight is regained.

When crossing ridgelines, the front-seater should use the term "bunt" or "rolling" to signify his intentions for descending back to low altitude. Where integrated crews are used, the need for these calls will diminish as mutual trust builds.

In presenting these rules and techniques for low altitude flying, it would appear that a significant volume of sorties must be dedicated to turns and masking. Although we all realize that dedicated sorties are not available, this training can be accomplished in conjunction with normal routes to and from ranges, low level navigation, etc. The benefits of aggressively pursuing low altitude training in the familiar environment of our own local areas will prove themselves in advanced scenarios such as Red Flag. Moreover, when the demands of the battle arena necessitate low altitude employment, we will have developed that combat capability.



COMM-OUT Turns

Doing It With Your Mouth Shut

By
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The ability to freely maneuver a two-ship formation without use of the radio will be an obvious requirement to effectively counter the jamming threat.

The starting point to develop this capability is the daily practice of comm-out turns. These turns are simple and can be established as a standard of two-ship maneuvering after proficiency in tactical formation, delayed, and in-place turns has been demonstrated.

After progression to the tactical environment, proficiency in basic comm-out turns will be used as the standard to develop capability for repeated attacks in a jamming environment and limited comm air-to-air employment.

The mechanics of comm-out turns are similar to normal delayed turns. Each maneuver is initiated by a signal from the leader with either a hard check turn or a weave turn. These will be illustrated as the discussion progresses.

There are three basic contracts between the leader and his wingman:

1 The wingman will always strive for a line-abreast position.

2 The man in front is responsible to get the formation back to line-abreast.

3 The wingman will not exceed 90° of his leader's heading.

Now to the turns themselves.

1 Delayed 90° turns away from the wingman (Figure 22): #1 initiates the maneuver with a check turn away from #2 of approximately 30°. The check turn is an abrupt maneuver performed in three distinct steps: roll-in, turn, and roll-out. Beyond being a basic signal, the check turn serves two purposes. The first is to deconflict flight paths, which becomes important in the low altitude environment if #2 is forward of line-abreast, and second to back up the signal, so that if #2 misses the signal, he can detect the 30° heading differential.

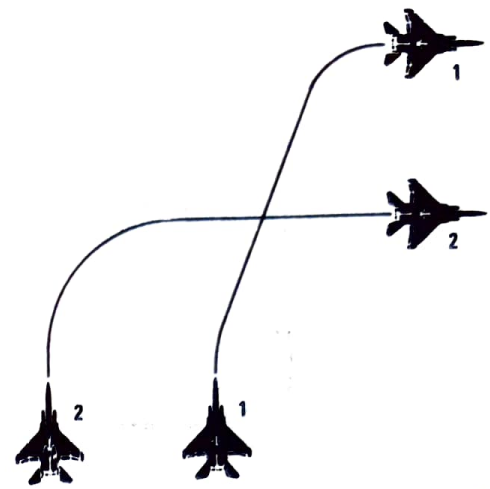


FIGURE 22

When #2 sees the signal, he simply turns 90° into the leader. Lead completes the turn by allowing #2 to drift slightly further toward three o'clock than the normal delayed 90° turn to compensate for the initial check turn. In the low altitude environment, #1 WSO supports #2 during his turn and cues #1 AC to complete the turn.

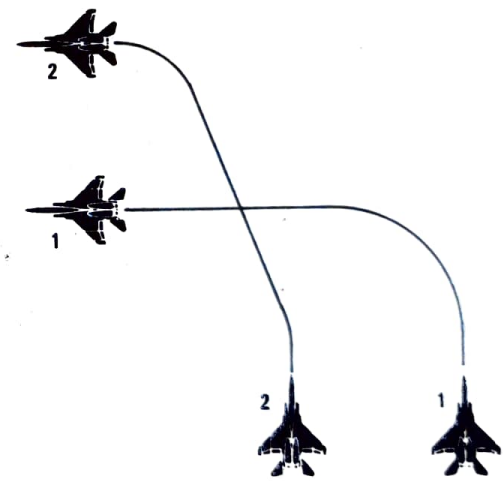


FIGURE 23

2 Delayed 90° turn into wingman (Figure 23): Lead simply turns 90° into the wingman. In the low altitude environment #2 should build the habit of performing a 30° check turn away from #1. This will show lead that #2 has seen the signal and serves to deconflict flight paths when lead is forward of line-abreast. At medium altitude, and with vertical turning room available, this is not necessary. The #2 AC and WSO use cues previously described to complete the turn. As proficiency builds, the normal 90° turn signals can be used for turns of 60° and 120°.

3 Delayed 45° turn away from wingman (Figure 24): This turn is initiated with the standard 30° check turn away from #2. When the leader sees that #2 has turned approximately 45°, he initiates a weave turn in front of #2. The weave turn signals #2 to stop his turn and continue on present heading. The weave turn is distinguishable from the check turn by severity. Instead of the abrupt roll, turn, roll sequence, #1 maintains his turn until required to reverse to gain line-abreast on the new heading.

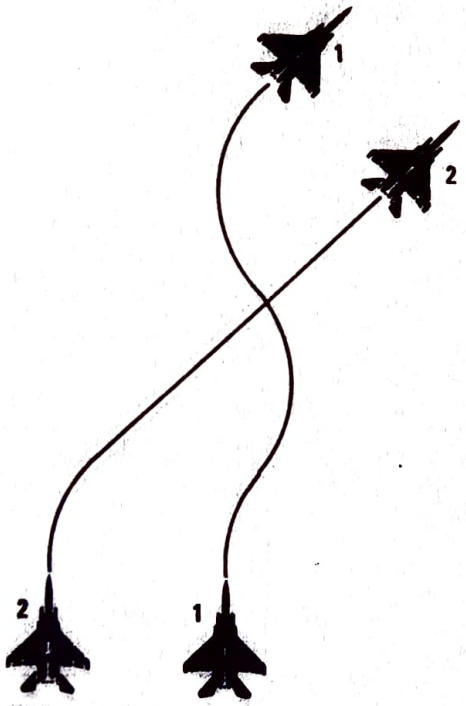


FIGURE 24

4 45° turn into wingman (Figure 25): Lead simply turns 45° into the wingman, who then maneuvers as required to line-abreast. The wingman will obviously interpret lead's initial move as a 90° turn and react accordingly. Once lead rolls out after 45°, #2 will be in front of lead's wingline and, referring back to his basic charter, will maneuver back to line-abreast. This is done most quickly by crossing #1's flight path; however, #2 can also maneuver on the same side as indicated.

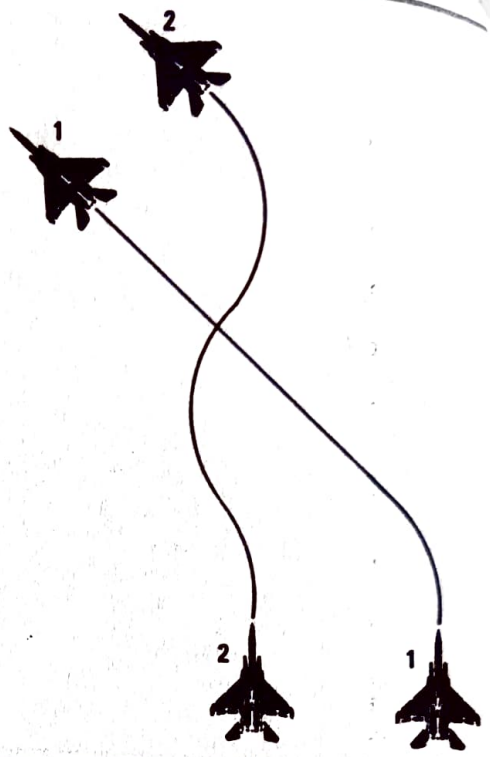


FIGURE 25

From the previous discussions, we can now establish several rules-of-thumb. They are:

1 A 30° turn is used by lead to get the wingman moving in his direction, either for a 90° or 45° turn.

2 A weave turn is used to signal the wingman to roll out and continue straight ahead.

3 The wingman always maneuvers to comply with his basic charters, since there are no signals from wingman to leader.

4 In-place 180° turn away from wingman (Figure 26): #1 simply turns 180° away. His intent is obvious since there is no check turn, but a continuous turn of 180°.

5 180° turn into the wingman (Figure 27): It is preferable to make 180° turns away from the wingman whenever possible, both in terms of time and complexity. When a 180° turn into the wingman is required, two delayed 90° turns are used. Lead initiates the maneuver with a normal 90° turn into #2. As soon as #1 crosses #2's flight path, and #2 has started to maneuver back to line-abreast, #1 initiates the second delayed 90, using the 30° check turn.

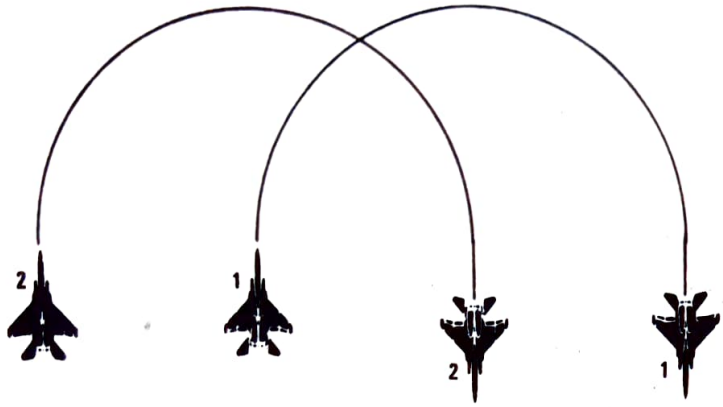


FIGURE 26

There are, of course, situations where the line-abreast position will be lost due to missed signals or hard maneuvering. This is especially true in the low altitude environment where there is no vertical maneuvering room to gain energy for corrections. In these situations, we must fall back on our basic charter and rules-of-thumb to re-establish the formation.

The example in Figure 28 shows #2 trailing after missing a 180° turn signal. Lead, being the man in front, is responsible for line-abreast. He initiates a weave turn in front of #2, signaling #2 to hold his heading, and reverses his turn to complete the maneuver.

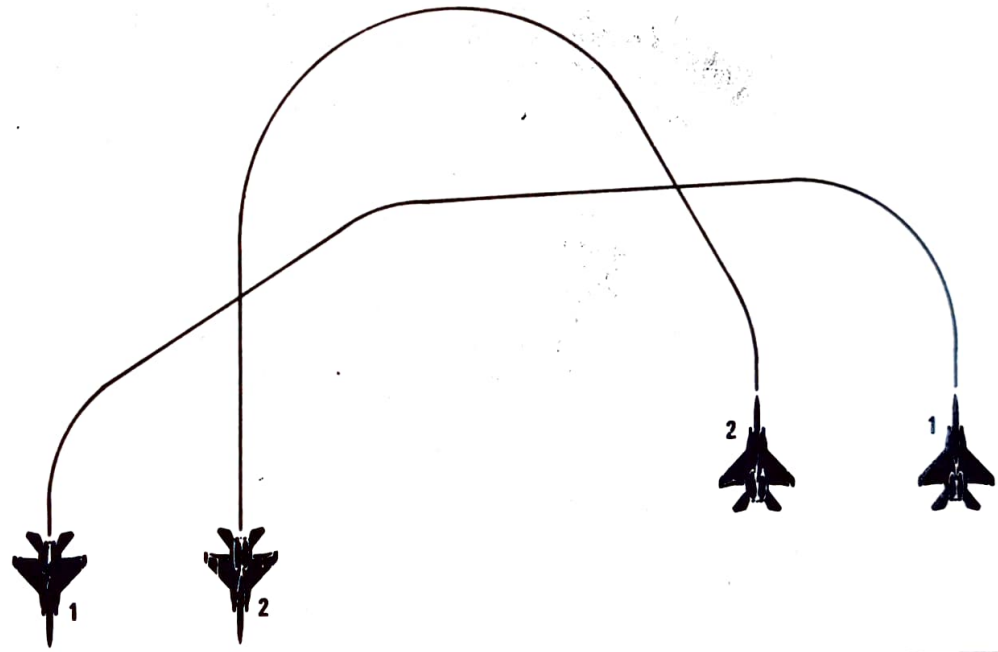


FIGURE 27

If, for some reason, #2 was in front, he would maneuver as required to regain line-abreast per rules-of-thumb.

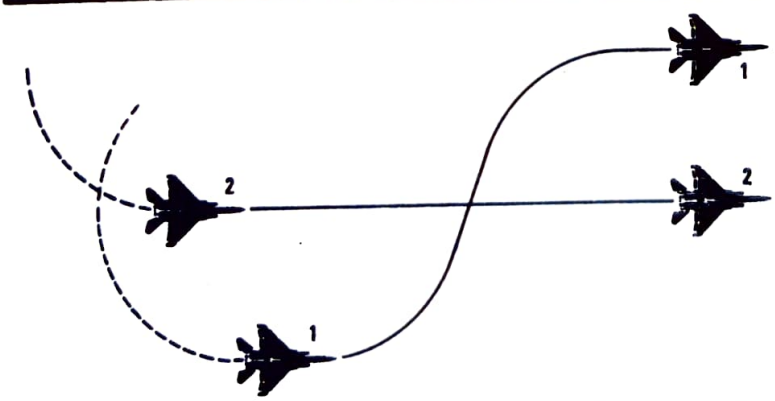
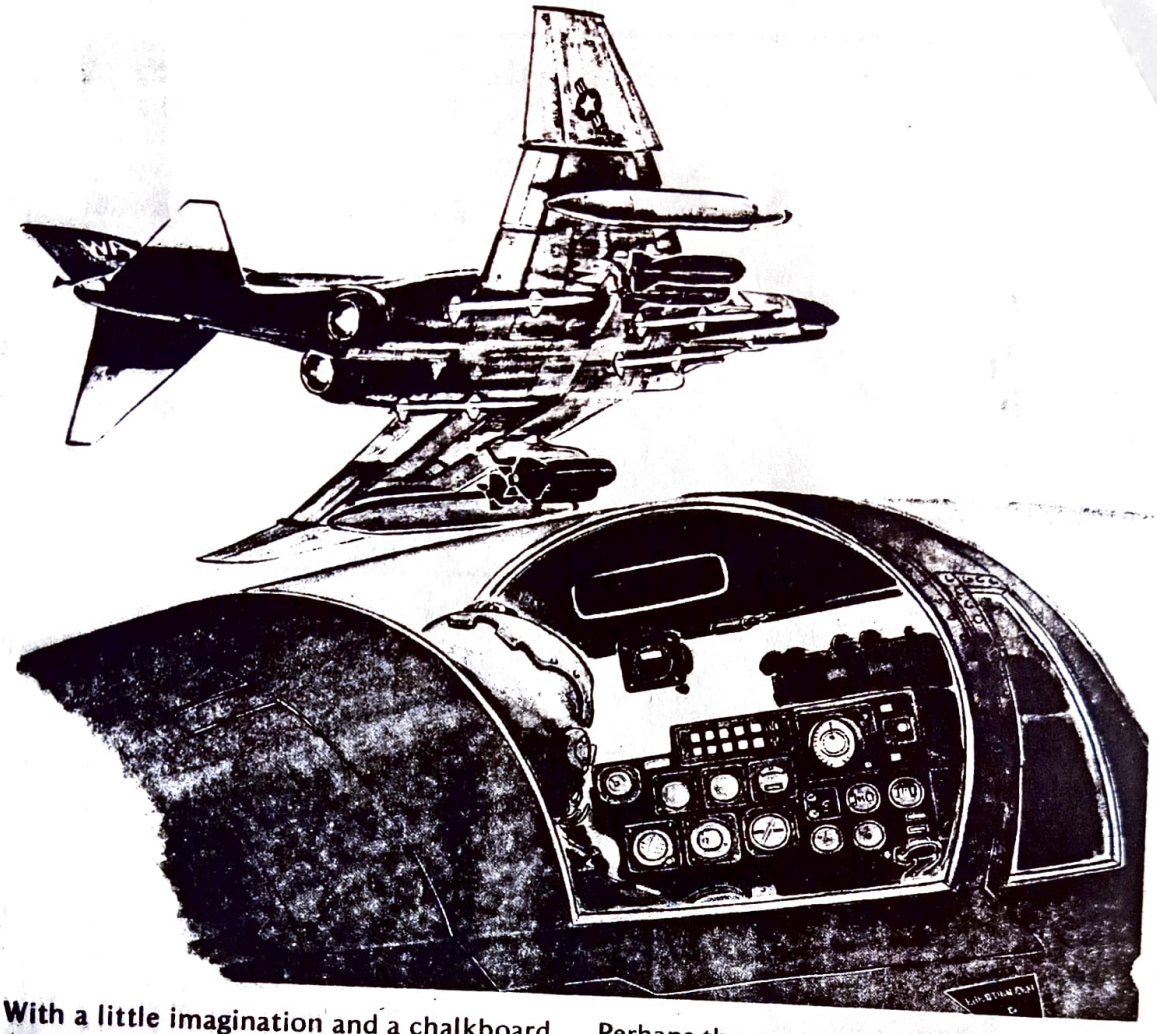


FIGURE 28



With a little imagination and a chalkboard we can easily see how the check turn and weave turn can be combined to signal a turn to any desired direction. The energetic chalk man will also be able to find exceptions to the rules-of-thumb. For instance, why couldn't we use a check turn to signal a 90° turn in either direction for the trailing wingman in Figure 28? In fact, we could; but, the immediate goal should be to master basic turns.

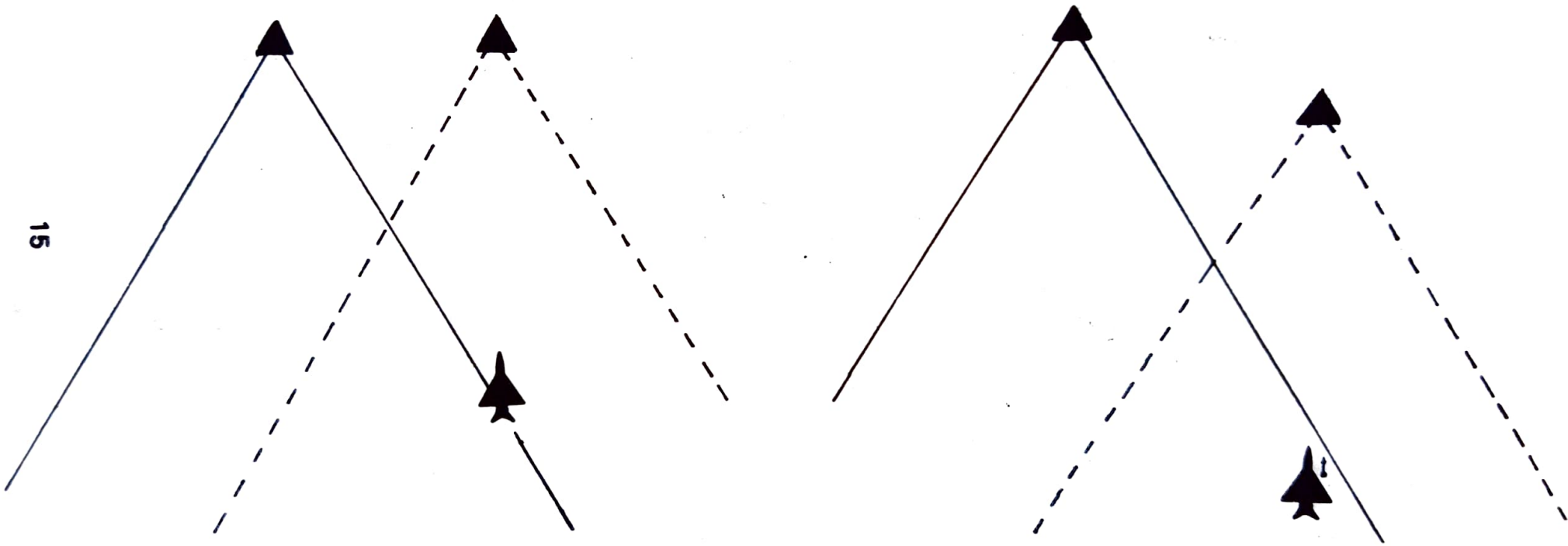
In teaching comm-out turns, the leader should discipline himself to carry each turn to its logical conclusion. When #2 misses a signal, go ahead and complete the turn and see if he can fall back on his basic charter to make the correction. Missed signals are to be expected, but so is the ability to correct.

Perhaps the greatest benefit from these maneuvers is their effect on building individual awareness and anticipation. These qualities replace the radio command crutch and the results are tangible. WSOs are responsible for accurately reading flight path relationships to call turns and share responsibility in detecting signals. We all become involved in responsibilites outside the cockpit while developing a needed tactical skill. In addition, no special training is required. These turns can be practiced any time we need to turn the formation. And, combat capability is another step closer.

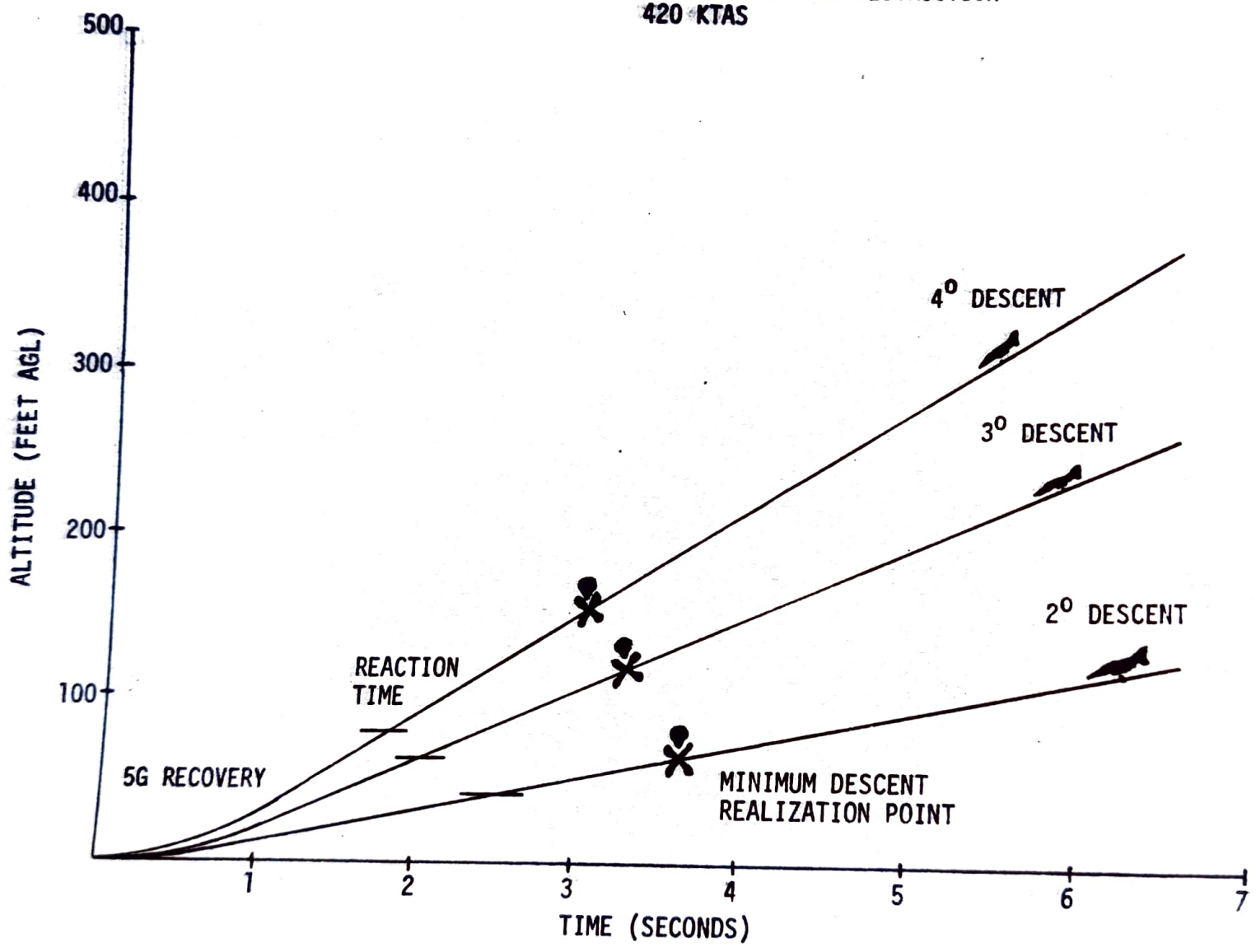
NOTE: Specific attack tactics using principles of limited comm-maneuvering are presented in TAB 76-4.

VISUAL LOOKOUT

IT'S A "HEADS-OUT" PROBLEM
AT ANY ALTITUDE



COMPLACENCY/DISTRACTION-CAN YOU AFFORD IT?
TIME FOR DISTRACTION PRIOR TO DESTRUCTION
420 KTAS



Visual Low Level Navigation

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When you can overfly the IP on time, at over 500 KTAS and altitudes below 100 feet, and subsequently "Push it up" and "Take it down," you have arrived, baby! You can hack it! And that is absolutely Sierra Hotel because you need the two primary things low altitude flying provides: a way to survive enemy defenses during INGRESS/EGRESS, and surprise in the target area.

Unfortunately, low level combat capability does not materialize simply because we need it. We must train to develop it. The purpose of this section is to share some ideas necessary to accomplish the required training. These ideas concern planning, route study, techniques for actually flying in the weeds without busting your butt, and a check-out/training program.

PLANNING

The basic foundation for low-level flying is adequate mission planning. Good planning allows mission success, while poor planning usually generates a frustrating, non-productive thrash through the boonies. Unfortunately, the difference between bad and good planning sometimes isn't evident until the airborne aviator has already slipped into Pioneer Mode: temporarily disoriented, traversing strange looking lands while sucking up uncharted SAMs!

While low-level mission planning is very similar to planning other missions, several aspects deserve extra attention to avoid dangerous pitfalls. These special points involve enemy defenses, turn points, terrain, airspeed, and basic philosophy of navigation.

The best way to survive enemy defenses is to simply avoid them. Where avoidance is not entirely possible, plan your low-level to traverse the outer limits of threat envelopes. Since the enemy doesn't always include your intel shop on their distribution list for orders of battle, likely threat locations should be avoided whenever possible, such as cultural developments with military value, choke points, LOCs, and so forth.

The turn points selected for the route should be closely scrutinized. Whenever possible, select turn points that have significant vertical development. They are the easiest to identify and use. Some flat features, such as road intersections, railway crossings, and bridges, can be used, especially if they are located in proximity to vertical developments. Select turn points that are unique, one-of-a-kind, and distinct in size and position. An intersection of dirt roads in an area of many dirt roads is obviously not unique, and should be avoided. Examine the map carefully to insure that your selection does not have a "twin" nearby. Remember, you are going to attempt identification from 100' AGL.

Think carefully about the terrain. Obviously, low altitude provides both direct and indirect masking, and this must be carefully exploited. Also consider the visual effect of background color relative to the lizard paint job on your jet. An F-4 at 30' AGL in the middle of a desert valley can easily be seen up to ten miles away, due to contrast and shadow. If you haven't any deserts in your area, how are you fixed for snow?

An often overlooked low level planning factor is airspeed. Flying 600 knots at 100' may make you feel quite secure from defensive reaction (not always true), but may result in an unacceptable fuel flow. Reaching bingo fuel prior to the target is not tactically sound. Aircraft control at high airspeed and low altitude is a demanding and time consuming effort, and must also be considered.

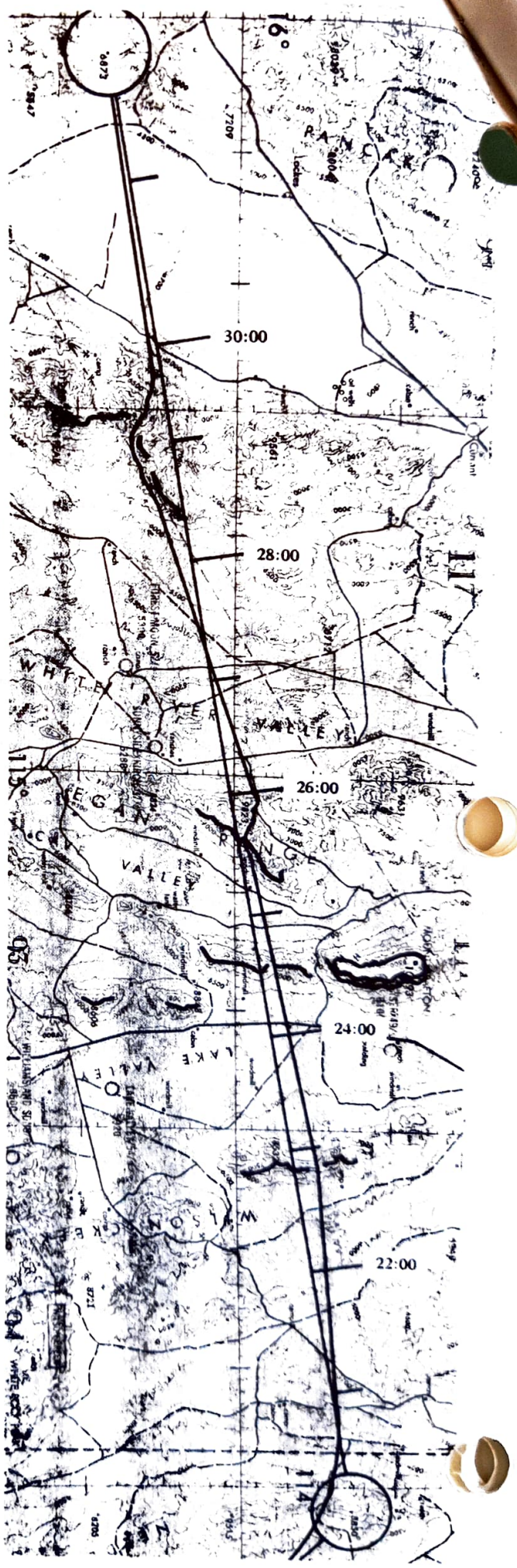
Finally, and this will sound familiar, remember that dead reckoning (DR) is the name of the game. As you plan, remember that visual navigation is the oldest and most reliable method of accurately traversing the ground. Plan to maintain a heading and airspeed for a predetermined length of time, and to compare salient ground features with those depicted on a map. INS, LORAN, TACAN, and radar are aids to navigation, but they are only aids. Most disorientation in low level navigation results from nonjudicious use of nav aids. When in doubt, believe basic DR, not INS bearing.

STUDY

Perhaps even more important than planning the route to be flown is studying the route. A less than optimum route can still be successfully flown if adequate study allows optimum execution. One obvious reason for detailed study is that there will be no time to do so at 100' during first look navigation. The most cosmic aviator could be overstressed by not planning ahead.

A unique feature of studying a visual low level route is that learning the basics of heading, distance, and time are not enough. The geographic features of the route must receive great attention. Notice that the route as drawn on Map 1 (black line) is not necessarily the actual preplanned ground track of the aircraft (blue line). By converting the contours on the map into a mental picture of vertical development, a path of least resistance becomes apparent. This technique is known as "track crawling." Since you are going to fly as low as you can, it should seem reasonable to avoid exposing yourself by flying directly over high terrain if there is any easy way around it. Also notice that the map must be converted into three dimensions so you can visualize the picture you'll have out the front window. That picture is guaranteed to look different than you expected! In fact, expect the unexpected. Don't expect to see all the things you planned, and do expect to see numerous terrain/cultural features you hadn't anticipated. Subtle changes in elevation and intervening terrain will effect your view drastically at low level.

Study each leg for geographic funneling. Simply stated, geographic funneling is using the terrain features at the limits of your down-track visibility (line of sight, or visual area of coverage) to guide you to a turn point or intended route of flight. The down track visibility limit is usually defined by intervening terrain. As you approach the vision-limiting terrain, fine tune your navigation to the specific saddleback, peak, etc. that you have preplanned as your track-crawl route. It may help to shade in the areas of vertical development on your map, as in Map 1. Another key point is map study for significant features 3-5 miles left and right of track. These points are very helpful in course correction and basic funneling.

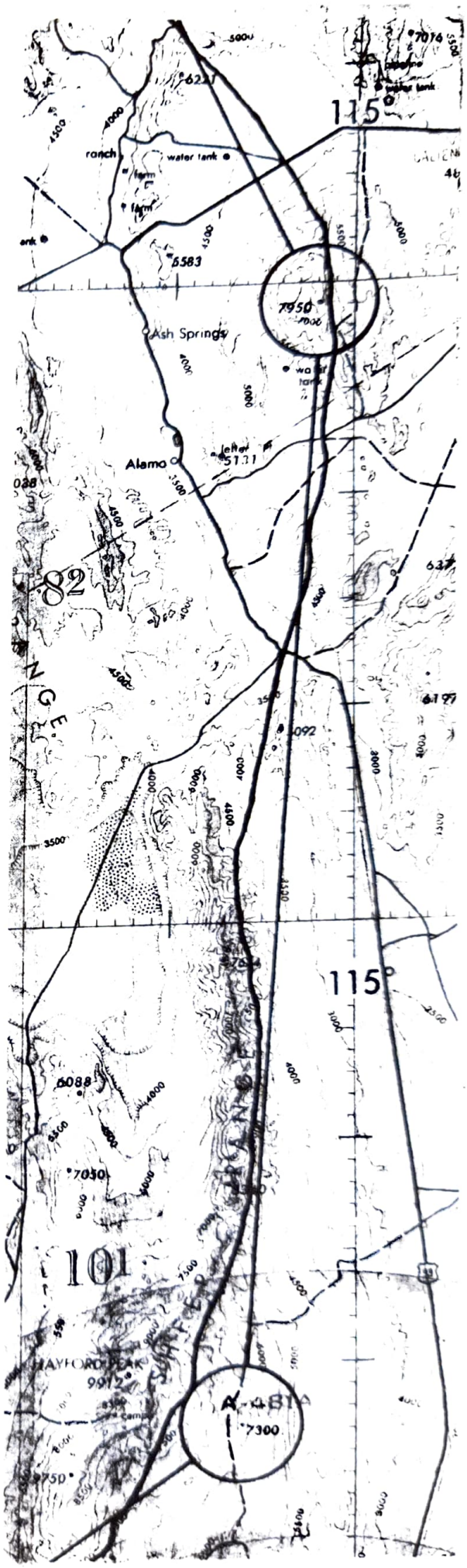


MAP 1

For example, as you cross the ridgeline at the 26:00 point (Map 1), the terrain between the 28:00 tick and the 30:00 tick could be used for geographic funneling. As you pass the 26:20 point, a look out the front window should show a very high peak to the left of your nose, with some rising terrain on the nose. In order to fly the preplanned track, you fly at the left edge of the rising terrain, keeping the 11,298' peak on the left edge of the radome. As you get closer, hug the rough terrain with your right wing until it appears that you'll either have to climb or impact the ridge in front of your nose. At that point, execute a right turn through the narrow valley and follow it through. The narrow valley will be hidden from view until you are upon it, but the large peak and ridgeline on your right will funnel you to it.

It may be quite helpful during route study, to select a few Lines of Position (LOPs). An LOP is any geographic or cultural feature that allows you to assess your position relative to the desired ground track. For example, using Map 1, as you crest the saddleback at the 22:45 point, you can see the two individual peaks left of track (8,848' and 8,606'), and the very high peak (10,993') right of track. In the right quarter panel you should see a gap at the end of the ridgeline which runs south from the 10,993' peak. The saddleback you want to cross should be right out front. Other good LOPs are parallel ridgelines, valleys, LOCs, etc. The sheep range ridgeline and US Highway 93 on Map 2 are good examples. It is at least a confidence builder to know that you really aren't disoriented.

An often overlooked aspect of studying a low level route is the selection of time lines. Time lines are specific, readily identifiable points which enable an accurate assessment of actual time versus preplanned time control. For example, LOCs which are perpendicular to the route make excellent time lines. Notice the road at the 24:00 time tick on Map 1. At low level, you won't see the road until you are upon it; however, it serves as an ideal point to crosscheck enroute timing. As a rule-of-thumb, being within 10 seconds of preplanned time at a specific time line or turn point is acceptable.



MAP 2

Crossing an LOC other than perpendicular is not accurate, because being a mile or two either side of track causes you to cross the LOC at a different time. (Ref: the time tick 21:15 on Map 1.) Perpendicular ridgelines, road intersections, or cultural developments may be equally good timing points, and they do not have to be on the route of flight. As you pass abeam a good timing point, you can make a fairly accurate assessment.

Will the road at 27:10 serve as a good time line? No! The dirt roads just prior to and just past the 27:00 tick may be confusing.

EXECUTION

Many hours of planning and study can be rendered useless on a low level if during execution, some important skills are not properly employed. These skills include navigation, aircraft control, terrain awareness, crew coordination, and employment of ECM.

As stated earlier, basic navigation at low level is dead reckoning: the maintenance of a heading and airspeed for a predetermined length of time. In this case, the heading is actually an average ground track. While external navigation aids (including INS) can serve as confidence builders, they must not be relied upon to the exclusion of preplanned visual references. In addition, DR means that you should turn at the preplanned elapsed time when you cannot positively identify a turn point.

The normal sequence of navigation, assuming you know your present position, is from the map to the clock to the ground outside. Check the map for the next significant terrain feature or time line that is likely to be seen and note its position down track in minutes or miles. (With practice you will soon be able to translate minutes into a distance down track to look for the feature. An alternative is to add distance ticks to your map and look "X" miles down track). Check your clock to see if an airspeed adjustment is necessary. If so, use one of the standard techniques for timing control. The 'gator can be doing this while the nose-gunner looks at the terrain out front and identifies the features noted on the map. For example, after passing turn point C on Map 1, note that the next likely terrain feature that will be seen is a peak with a definite saddleback at the 22:45 point, or about 2 to 2½ minutes down track. Make timing corrections as necessary (here the 'gator does his trick) while the AC looks out the front window to identify that saddleback. In this case, fly right at it. As you identify the point toward which you want to fly, point at it immediately to avoid having to make a larger change in heading as you get closer to it. This does two things for you. First, it will prevent large course overshoots if you should temporarily ignore the desired direction of flight; secondly, it will preserve the preplanned picture out the front window. Waiting until you are further down track to make adjustments to course will skew the outside picture so that it may not resemble what you expected to see.

If you are in doubt as to your exact location, or know that you are definitely lost, don't panic! Instead, change the map/clock/ground relationship. First, identify terrain features, then check the clock for elapsed time. Now, by checking the map on both sides of the corresponding time tick, try to correlate what you see outside with the respective area of the map. This should allow you to determine at least the general area you are in. This technique will work very well if you make a reasonable effort to stay on time, and IF you turn on time when you cannot identify a turn point. Remember that if you are slightly off course, the picture out front will be different than preplanned.

While convincing yourself that you know where you are and where you are going, it is critical to be acutely aware of aircraft control techniques at low altitude and high calibrated airspeed. An otherwise minor error becomes an accident investigation at low altitude. First, the nose-gunner's eyes belong outside within ten o'clock to two o'clock of the nose as much as possible (99% of the time). It is his responsibility to avoid scratching the paint job on those pesky rocks and trees. His map, if he must look at it, should be raised to eyeball level, slightly offset so only a small eye movement is required to sneak a peak at it. And, for GIB's sake, don't stare at the clock while you figure your time. Take only a quick peek if you must. Also, set the throttle friction tightly. This helps control both aircraft-induced and aircrew-induced throttle creep. (Note: Aircrew-induced creeping throttles are directly related to ground clearance: the closer to the ground you go, the straighter your left arm becomes). Finally, be aware that high calibrated air-

speed at low altitude results in a very pitch sensitive control stick. A moment's inattention could result in a very short, gearup landing. So, stay heads up!

TERRAIN

In addition to all the other problems you face at low altitude, the terrain you fly over contains other hazards besides rocks and trees. Very flat terrain or calm water is surprisingly dangerous because of the lack of depth perception. As you tend to become comfortable over flat terrain, it is very easy to sink to dangerously low altitude without realizing it. Flat sloping terrain is all the more hazardous because of the insidious change in elevation as you fly into a gentle upslope. Flying across sloping terrain may provide a false horizon that can slowly draw you off course as you dip a wing to maintain "level" flight.

Rolling and mountainous terrain present their own problems and are discussed in the previous article. However, it should be understood that obstructing terrain, like enemy defenses, should be flown around rather than over when possible.

ECM

Well, sport, it looks like you've got it made; one minute to the IP, exactly on course, on time, and armed hot for the pop-up attack when your 'gator calls a MiG at right four o'clock 4,000', closing. WTFO! You planned a beautiful low level, avoided the SAMs, used terrain masking all day long, and you were so low you parted the front lawn at Base Ops. How did they find you? Could be they found some stray electrons you spit out by not turning off all possible emitters. Some obvious examples of systems that should be off are IFF/SIF, TACAN, and the radar ("standby" if it is needed for weapons delivery). Some not so obvious systems are the radar altimeter (who cares about actual altitude when you're that low?) and the ECM pod (standby mode is desirable - an automatic jammer may just highlight your position). Now you've taken your best shot at becoming electronically invisible. (Note: RDR altimeter should be used initially during training to calibrate the eyeball).

"MAVERICK - TRAINING TO FIGHT" See TAB 76-4.

"PAVE SPIKE - THE BIONIC POD" See TAB 76-4.

RECAP

Plan the low level mission carefully and fly the mission as planned. Translate your two-dimensional map into a three-dimensional picture. Look closely at vertical development on the map and how it will appear from the cockpit at 100' to 200'.

Fly basic DR and rely on it. Aids to navigation are aids only. The INS simply confirms basic DR.

Correct navigational errors as soon as they are noted. Rule-of-thumb: 10 seconds off at any specific time line or turn point you can buy. Two or three miles left/right of course line is no problem if you planned it that way. Make small heading corrections early.

When a turn point is not visually sighted, turn on time. Accept the possibility that you planned a poor visual turnpoint.

Read from map to clock to ground. If I look at my map and tell the front-seater that we will go through a saddleback at 22:45 and in fact we do, than I have satisfied map/clock/ground.

Conversely, if I'm lost or disoriented, I go back to reference heading/ground/clock/map. Look outside, pick up a prominent ground reference, check enroute or elapsed time, and then consult the map to confirm your position.

LOW LEVEL CHECK OUT/TRAINING PROGRAM

It should be obvious to the most casual observer that we don't race out of operations with our hair on fire and actually fly our first visual low level at 100' and 540 knots. Like air-to-air, we have a building block approach. DACT is flown after proficiency in AHC-BFM-ACM-etc..

How do we do it? It makes sense to start out at a comfortable altitude, around 500', and comfortable airspeed progressing as suggested in the previous article. It also makes sense that crew coordination is basic to this training process. As opposed to radar low levels which burden the WSO with the majority of critical tasks, realistic visual low level training tasks both crewmembers to their combined limits. Each crewmember must know his specific tasks, and how and when his activities interface with those being performed by his counterpart.

When the horn blows, it's too late to train.

TAXI
1. Nosegear steering
2. Wheel brakes
3. Flt Instruments
4. Oxy dilute lever

BEFORE TAKEOFF
1. Optical sight
2. Harness & leads-fasten
3. Int wng trans sw-norm
4. stab augs-engage
5. Flt controls-✓
6. Slats flaps
7. Anti ice-as req
8. Stab trim- 1-3
9. Fuel Quan-✓
10. Canopies
11. Defog-footheat-temp
12. Command sel valve
13. Lower eject hand-clr

CH	PRES	AGENCY	AUX
1	252.3	Sq comm	
2	265.6	Clnc del	
3	275.8	Ground	11
4	236.6	Tower	
5	365.8	Dept	
6	252.5	GCI arr.	
7	255.8	Low lev	
8		Gecko	307.3
9	226.2	Crow Val	
10	336.9	Crow Val	
11	250.9	Crow Val	
12	351.0	Kidskin	
13	325.8	Clark App	
14	277.2	Comm post	13
15	344.6	Metro	
16	267.6	Aux 3	3
17	303.6	Job Con	
18	355.8	Sof	
	273.5	ATIS	9

AFTER RWY LINE UP
1. External trans-
2. Anti-skid - on,light out
3. Compass hdg-✓
4. Pitot heat - on
5. IFF - as req
6. CB -✓
7. Warn lites -✓

AFTER TO/CLIMB
1. Gear-up
2. Flaps slats-up/norm

DESCENT/BEFORE LANDING
1. Defog footheat
2. Bearing dist sel
3. Nav mode
4. Radar alt
5. Pres alt
6. Comm anten
7. Arm Switch-safe
8. Stab augs
9. Landing taxi lite
10. Fuel quan
11. Anti ice

CLARK CH 99 N1511 E12033

CUBI CH 48 N1448 E12016
CH 99 216/30

BASA CH 99 N1459 E12029
199/14

MANILA INT N1431 E12101
CH 99 148/49
CH 112 DME only

LIBERTY IAF N1535 E12026
CH 99 340/24

SNOOK IAF N1520 E12031
CH 99 340/8

RED HORSE(CUBI)
CH 99 220/57
CH 48 225/26
N1429 E11957

DIVERT
CUBI 217/28 20001bs

	ALT	TAS	HDG	TIMERS PU	TIMERS REL	WND CORR TMR	WND CORR K-CR	ACT OAP	ACT RNG	REL ALT
ILADD	1900'	500	214	3.7	6.0	.07	36.9	S156.5 W117.9	105 x 100	2856'
5BRS	1900'	500	214	49.3	6.0	.16	36.9			2856'
2BRS	1900'	500	214	27.7	6.0	.12	36.9			2856'
VLADD	1400'	500	214	3.7	6.0	.06	31.5			2356'

	SUU CONVENT MILS	BASE AS	BASE ALT	POPS PUL	POPS APX	REL ALT	REL AS	WND CORR HT	WND CORR XWND	MIN ALT
45HADB	151±.5	300	14.6			8.2	450	1.6	17.8'	5100'
30	132±.6	350	8.6	6.1	8.1	3.7	450	1.2	10'	2100'
20	140±.6	350	6.1	4.1	5.6	2.6	450	1.0	9.5'	1600'
15	136±.7	380	4.6	3.1	4.3	2.1	450	.8	9.0'	1600'
10	94 ±.8	400	3.6	1.9	2.9	1.1	450	.5	4.5'	700'
STR LO	38		3.6	1.9	2.6		450	.1	1.0'	675'

CROW VALLEY PARAMETERS TGT ALT 600'MSL