BY ORDER OF THE COMMANDER AIR EDUCATION AND TRAINING COMMAND

AIR EDUCATION AND TRAINING COMMAND MANUAL 11-251

10 SEPTEMBER 2024

Flying Operations

T-38C FLYING FUNDAMENTALS

COMPLIANCE WITH THIS PUBLICATION IS MANDATORY

ACCESSIBILITY: Publications and forms are available for downloading or ordering on the e-Publishing website at www.e-publishing.af.mil.

RELEASABILITY: There are no releasability restrictions on this publication.

OPR: 19 AF/A3V

Certified by: 19 AF/A3 (Col Brian L. Patterson)

Supersedes: AETCMAN 11-251, 4 April 2017

Pages: 203

This manual implements Air Force Policy Directive (AFPD) 11-2, *Aircrew Operations*, and Air Force Instruction (AFI) 11-200, *Aircrew Training, Standardization/Evaluation, and General Operations Structure.* It contains the basic principles, procedures, and techniques to accomplish the various missions of the T-38 in any major command (MAJCOM). This publication is the primary T-38 mission employment reference document for Air Education and Training Command (AETC). With the exception of associate instructor pilot (IP) programs, this publication does not apply to the Air Force Reserve Command or the Air National Guard. This publication does not apply to the United States Space Force. It addresses basic flying tasks and planning considerations and is designed to be used in conjunction with Air Force Manual (AFMAN) 11-202, Volume 3, *Flight Operations*, AFMAN 11-2T-38, Volume 3, *T-38 Operations Procedures*, AFMAN 11-2T-38, Volume 1, *T-38 Aircrew Training*, AFMAN 11-2T-38, Volume 2, *T-38 Aircrew Evaluation Criteria*, and technical order (TO) 1T-38C-1, Flight Manual. If conflict arise between this publication and those mentioned above, the source publication takes precedence. When encountering situations not specifically covered by this publication, use safety considerations as a guide in determining the best course of action.

This publication requires the collection and/or maintenance of information protected by the Privacy Act of 1974 authorized by Title 10, United States Code, section 9013, Secretary of the Air Force. The applicable Systems of Records Notice (SORN) F011 AF XO A, Aviation Resource Management System (ARMS) is (are) available at: **https://dpcld.defense.gov/privacy/SORNS.aspx**. Ensure all records generated as a result of processes prescribed in this publication adhere to AFI 33-322, *Records Management and Information Governance Program*, and are disposed in accordance with the Air Force Records Disposition Schedule, which is located in the Air Force Records Information Management System. Refer recommended changes and questions about this manual to 19 AF/A3V using the DAF Form 847, *Recommendation for Change of Publication*; route DAF Forms 847 from the field through the appropriate Standardization and Evaluation functional chain.

This publication may be supplemented at any level, but all Supplements must be routed to 19 AF/A3V for coordination prior to certification and approval. The authorities to waive requirements in this manual are identified with a Tier ("T-2, T-3") number following the compliance statement. See DAFMAN 90-161, *Publishing Processes and Procedures*, for a description of the authorities associated with the Tier numbers. Submit requests for waivers through the chain of command to the appropriate Tier waiver approval authority for tiered compliance items; submit requests to the OPR for non-tiered compliance items. The use of the name or mark of any specific manufacturer, commercial product, commodity, or service in this publication does not imply endorsement by the Department of the Air Force.

SUMMARY OF CHANGES

This change updates referenced publications and procedural guidance from those publications, implements formation approach guidance, removes guidance referencing formation landings and DD Form 175s, and updates T-38C-specific DD1801 information. Techniques have been expanded for adjusting seat height, assessing sink rate in the pattern, overhead break turn mechanics, closed pull mechanics, transition to landing, full aft stick stall, tactical straight-ahead rejoin overshoots, single-engine safety considerations, and fluid maneuvering exercise levels. Additionally, guidance has been provided for how to accomplish heat-to-guns exercise from a 6K perch setup. It also incorporates techniques for dealing with electronic flight bags (EFBs), and non-precision continuous descent final approach (CDFA). Direct references to flight manual information have been removed to protect scientific and technical information (STINFO) data in accordance with (IAW) AFI 11-215, *Flight Manuals Program*. Bold italics for procedural guidance have been removed to align with the tiering structure of DAFMAN 90-161.

Chapter 1

MISSION PREPARATION

1.1. Overview. The objectives of every sortie in flying training are to achieve competency in flying maneuvers, maximize situational awareness (SA), increase decision making skills, and successfully apply task management skills. Preparation for any training mission should be based on these objectives. The overall mission objective should give the "big picture" of what needs to happen to accomplish a successful sortie. More specific objectives should be used to determine success in relation to the syllabus, course training standards, continuation training requirements, etc. A valid objective is realistic, achievable, and measurable.

1.2. Mission Briefing and Debriefing.

1.2.1. General Rules of Engagement (ROE). During briefings and debriefings, the briefer is in charge and should be the only one speaking until he or she asks for inputs. Any questions or comments should be saved until requested by the briefer. Generally, no food or drink is allowed during briefings without the approval of the briefer.

1.2.2. Briefing. The aircraft commander (AC) or flight lead must ensure the mission is thoroughly briefed IAW AFMAN 11-series publications and include discussions on formal special interest items (SIIs). Other members of the flight or formation should be prepared for the brief and assist the AC or flight lead as directed. The brief should focus on successfully accomplishing all the objectives.

1.2.2.1. Standard Mission Elements. Mission elements may be briefed as "standard" provided they are published, and the proficiency level of all flight members would allow them to be briefed as such.

1.2.2.2. Expectations. On student training sorties, the student is expected to obtain relevant notices to air mission (NOTAMs), temporary flight restrictions (TFRs), bird hazards, weather, airfield status, threat of the day, emergency procedure of the day, etc., and have a lineup card prepared. On nonstudent training sorties, the briefer assigns these responsibilities. Before the brief, all crewmembers should ensure all go/no-go items are accomplished and life support equipment is available and inspected for flight.

1.2.3. Debriefing**.** The main goal of the debrief is to determine if mission objectives were achieved and/or to address an item/area that did not meet standards or showed lack of progression. Before the debrief, the student (or designated crew member) should post the objectives and cue the T-38 Mission Debrief System recording to the G-exercise (or as directed by the debriefer). If the T-38 Mission Debrief System is used, it should be loaded and prepared as directed by the debriefer.

1.2.3.1. The debriefer should curtail time spent on administrative items based on the experience or proficiency level of the flight members and avoid an item-by-item description of every event that occurred. Instead, the debriefer should focus the debrief to what went right and what went wrong, with emphasis on the root cause analysis of relevant errors and provide effective instructional fixes on how to improve on subsequent missions. The debriefer should relate everything back to the mission objectives.

1.2.3.2. For student sorties, the instructor pilot (IP) should identify areas of emphasis for the next sortie and provide focused instruction on them in this sortie's debrief. The IP should summarize at the end with emphasis on the major learning points and considerations for future missions.

1.2.4. Formation Debrief. The flight lead should focus on formation-specific items, leaving single-ship execution for individual aircraft debriefs. The amount of debrief allotted to the entire flight is also affected by the skill level of the flight members, the presence of solos in the flight, and the potential benefit to the entire flight of the items being discussed.

Chapter 2

GROUND OPERATIONS

2.1. Objectives. The objectives of ground operations are to prepare the aircraft safely and correctly for flight and return the aircraft to parking after flight.

2.2. Checklist Discipline. Ensure completion of all IAW with the applicable flight crew checklist. However, aircrew need not reference the checklist to complete each individual item. It's allowable to accomplish a few items and then refer to the checklist to ensure completion of all items. The pilot at the controls should initiate all checks and ensure the asterisked items are accomplished. At a minimum, verbalize items required by governing instructions, supplements, and/or local guidance.

2.3. AF Form 781, *ARMS Aircrew/Mission Flight Data Document*, Review and Walk Around. Ensure the AF 781s are complete, correct, and the aircraft is airworthy. Perform a walk around IAW the flight crew checklist. If any doubt exists as to the condition, setting, or operation of any system, consult a qualified maintenance representative.

2.4. Ground Visual Signals. Keep hands clear any time someone is under the aircraft. The crew chief is the aircrew's safety observer. Monitor the crew chief's signals closely for safety actions. Visual signals are IAW AFMAN 11-218, *Aircraft Operation and Movement on the Ground*.

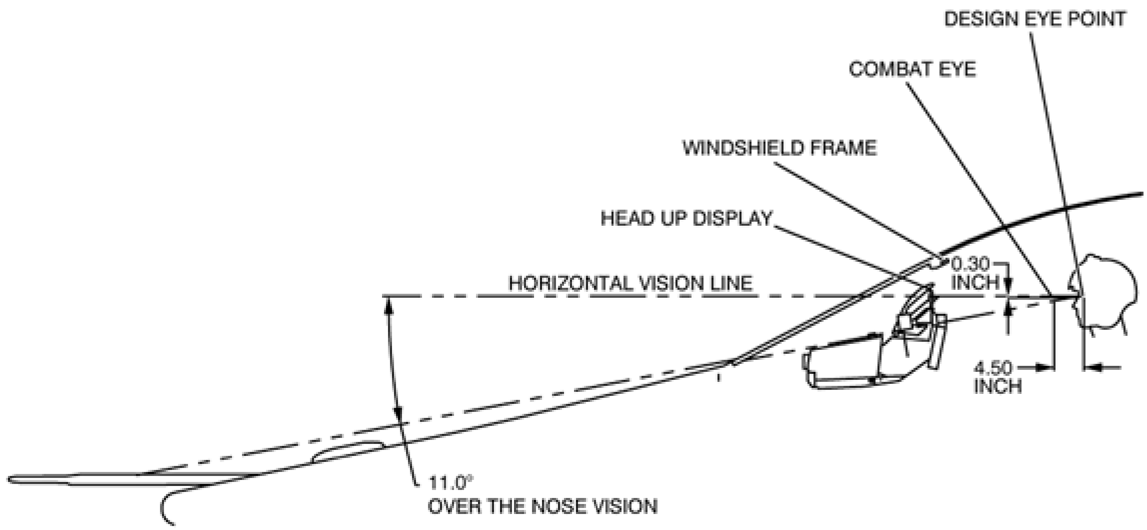
2.5. Foreign Object Damage (FOD) Avoidance. To reduce the risk of FOD during ground operations, do not place objects on the cockpit glareshields and safely stow the helmet visor cover before engine start or while the engines are running unless the canopies are down and locked. In addition, do not allow personnel to climb on the aircraft with either engine operating, and do not hand objects over the cockpit side unless the engine on that side is shut down and has stopped rotating. Loose items in the cockpit also pose a hazard to the multi-function display (MFD), up front control panel (UFCP), and electronic engine display (EED) glass. Crews must exercise caution to ensure items, especially the helmet and oxygen hose, do not strike these components.

2.6. Seat Height. All visual references in this publication are in relation to adjusting the seat height to Design Eye Position (DEP). A basic procedure to attain the DEP is to sit comfortably a normal upright body position and adjust the seat to look directly down the glare shield (tangential to it) over the nose of the airplane. Other techniques to achieve sitting at DEP are:

2.6.1. Lowering the seat until aligning the tip of the pitot tube with the top of the heads-up display (HUD) camera case.

2.6.2. Lowering the seat until the traffic collision avoidance system (TCAS) upper antenna is not visible anymore.

Figure 2.1. Design Eye Position (DEP) Diagram.



2.6.3. Backrest adjustment (Martin Baker Mk-16T only). The backrest can be adjusted to a more forward position which increases sitting height by approximately 2 inches. This allows for the improved visibility and ability to reach cockpit controls for aircrew of smaller stature. Reference the flight manual for more information.

2.7. Taxi Operations.

2.7.1. Clear in all directions before advancing the throttles. Keep the use of power to a minimum. Normally, a power setting less than 80 percent revolutions per minute (RPM) should be enough to taxi. Check the nosewheel steering and brakes when taxiing out of the parking spot IAW the flight manual. Keep the nosewheel steering engaged to the max extent practical during taxi.

2.7.2. In congested areas, reduce throttles to idle before turning to avoid jet blast damage to ground equipment, aircraft, and personnel. Check the flight instruments during a turn onto the taxiway or ramp, not the marshaling turn out of the chocks. Aircrews should taxi at a moderate speed, normally not greater than 25 knots groundspeed (GS) (available on the MFD while taxiing). As a technique, taxi no faster than the reported runway condition reading (RCR). Stagger only in authorized areas. Slow down and taxi on the centerline in congested areas. While in ramp areas, minimize any checks and prioritize clearing for traffic.

2.7.3. Use the brakes sparingly to prevent wear and overheating. When using the brakes, ensure the throttles are in idle. Adjust taxi speeds during high or gusty wind conditions to prevent exceeding the canopy airspeed limit. When opening the canopy in high or gusty winds, hold the canopy frame to prevent rapid fly-up.

2.7.4. When taxiing closely behind aircraft with engines running, lower the canopies to prevent exhaust windblast effects. IAW AFMAN 11-218, do not taxi within 10 feet of any obstacle, and do not taxi within 25 feet of an obstacle without a wing walker. For additional procedural guidance, refer to AFMAN 11-218, AFMAN 11-2T-38V3, and the flight manual.

2.8. Instrument Cockpit Checks. Before flight, aircrew will ensure primary means of navigation are operational and monitor navigation system integrity throughout the flight.

2.8.1. Navigation Publications. Ensure all publications required for departure, enroute, destination, and alternate are current.

2.8.2. Vertical Velocity**.** All should indicate zero.

2.8.3. Attitude System. Set the standby attitude indicator at 3 degrees nose low. If the climb/dive marker (CDM) is selected, the CDM will show level when the aircraft is on level ground while the flat portion of the waterline will correspond to the boresight. If the CDM is not selected, the waterline symbol should indicate 3 degrees nose low if on level ground.

2.8.4. Heading System**.** Ensure the electronic horizontal situation indicator (EHSI) is within 8 degrees of the magnetic compass and within 5 degrees of a known heading. Check for correct indicator movement in turns.

2.8.5. Airspeed Indicators. Check for proper indications on the HUD, MFD, and standby indicators.

2.8.6. Altimeters. The maximum error of each altimeter at a known elevation point is 75 feet.

2.8.7. Embedded GPS/Inertial Navigation System (INS) (EGI) Area Navigation (RNAV) Check. Prior to conducting RNAV operations, verify the currency of the International Civil Aviation Organization (ICAO) database, the aircraft's present position (PP) during alignment, the GPS is providing civil (C) code data; blended "EGI" solution, and verify the EGI accuracy the flight manual. To operate in the terminal area using RNAV procedures, ensure the EGI accuracy (ACCR/FOM) is 7 or less. RNAV enroute navigation operations may be conducted with the EGI operating in the INS only solution provided a full gyrocompass alignment has been completed IAW the flight manual.

2.8.8. Flight Director System and Instrument Landing System (ILS) Check: Tune and identify an appropriate ILS frequency, set the final approach course, and select ILS as primary navigation source (PNS). Absence of a course deviation indicator (CDI), a vertical deviation indicator, or pitch and bank steering indicates either a lack of data or a system failure. Glideslope raw data and pitch steering may not be present until proximity to the glideslope transmitter is resolved. Consideration should be giving to taking the active in ILS to ensure LOC centers and a GS is visible (typically above horizon line).

2.8.9. TACAN/VOR/DME Checks: **(Note:** CDI displays should be checked with either TACAN or very high frequency omnidirectional range (VOR) as the PNS).

2.8.9.1. TACAN, VOR, and distance measuring equipment (DME) Channels. Tune and identify appropriate TACAN, VOR, and DME channels. Verify the MFD NAV data block displays the correct channels. The NAV data block indicates the TACAN station identifier, if available. With valid signals, check that the range data block contains valid data, and the primary flight reference provides a CDI for both TACAN and VOR as the PNS.

2.8.9.2. Bearing Pointers**.** Ensure the bearing pointers point toward the stations.

2.8.9.3. CDI Requirements. If aircraft is not equipped with an Electronic Flight Instrument System (EFIS), center the CDI, and check for proper CDI displacement. One technique is to change the course by 5 degrees and verify the CDI deflects one dot.

2.8.9.4. TO-FROM Indicator. If aircraft is not equipped with an Electronic Flight Instrument System (EFIS), change the selected course past 90 degrees from the centered CDI course and check that the TO-FROM indicator switches sides.

2.8.9.5. Navigational Aid (NAVAID) Ground Checkpoint Checks. At designated ground check points, the allowable bearing pointer and CDI error is ± 4 degrees from the depicted course to the station. The allowable DME error is ½ nautical miles (NM) or 3 percent of the distance to the facility, whichever is greater. (**Note:** When a designated ground checkpoint is not available, the VOR and TACAN are both considered reliable for instrument flight if the systems check within ± 4 degrees of each other against collocated VOR and TACAN stations.)

2.8.10. Side Slip Symbol. Check to ensure that the side slip symbol (trapezoid shape located below the bank arrow on the HUD and the MFD EADI) indicates properly in turns.

2.9. End of Runway (EOR).

2.9.1. Check the front cockpit (FCP) speed brake switch to ensure it is centered and up.

2.9.2. Review takeoff procedures as well as how to handle serious emergency procedures during and immediately after takeoff. Review briefed go/no-go criteria. A common technique is to set the go/no-go speed as the green speed and single-engine takeoff speed (SETOS) as the yellow speed. Another common technique is to set Guard (243.00) in the backup ultra-high frequency (UHF) radio as the UHF backup frequency in case of MDP failure during a time critical emergency.

2.9.3. When inspecting the flight control surfaces during the before-takeoff checks, there are two separate tasks. The first task is to visually confirm free and proper movement of the flight control surfaces. Apply smooth and controlled stick movements while confirming the direction and deflection of each flight control surface. Failure to be smooth and controlled could place undue strain on the aileron control mechanisms. The second task is to check for rudder and aileron neutrality. With the stick and rudder pedals in the neutral position, check that all surfaces are approximately flush with the surface of the wing and the vertical stabilizer. It is crucial that this final flight control check occurs as close as possible to takeoff. The final check of aileron and rudder neutrality should occur no earlier than arriving at the EOR/hold short area and no later than taking the active runway. Check other aircraft for leaks, loose panels, proper configuration, streamers, FOD, etc. If able, make sure their stabilator is properly trimmed for takeoff by inspecting the alignment marks. Alert the aircrew if anything looks abnormal.

2.9.4. Ensure the data transfer system (DTS) card has been titled, as required, and that the appropriate display is being recorded via the video tape recorder (VTR) key display IAW mission requirements.

2.10. Taking the Active Runway.

2.10.1. Once cleared for takeoff, confirm the approach and departure ends of the runway are clear of aircraft.

2.10.2. Ensure the canopy is down and locked prior to engine run-up.

2.10.3. Note takeoff time and taxi into a takeoff position that allows maximum use of the runway. Release the nosewheel steering button during the last few degrees of turn onto the runway and ensure the nosewheel is centered by allowing the aircraft to roll forward once it is aligned with the runway.

2.10.4. Confirm the heading system is within tolerances.

Chapter 3

TAKEOFF, CLIMB, AND LEVEL-OFF

3.1. Introduction. This phase of flight is very dynamic and can be as complicated as any other part of the mission. Complex departure procedures may be required immediately after takeoff in the low altitude environment, and communications can be very busy leaving the terminal area. Emergency situations when they occur in this phase of flight, require forethought, and quick correct action. Solid preparation is essential to success.

3.2. Takeoff.

3.2.1. Description. Two takeoff options exist: static and rolling. The static takeoff is used early in training because it provides more time to accomplish required checks and verify proper engine operation. A static takeoff is also required at night and for solo students. A rolling takeoff aids traffic flow in a busy pattern and is a smooth transition from taxi to takeoff roll. Rolling takeoffs may increase takeoff distance by up to 300 feet.

3.2.2. Static Takeoff. Disengage the nosewheel steering. Remind the other crew member to guard the brakes. (When guarding the brakes, do not exert pedal pressure but be in a position to immediately assume control.) Exert as much pedal pressure as necessary to prevent creeping during the engine run-up. Look outside the aircraft and advance the engines to military (MIL) power to ensure the aircraft is not creeping forward or pulling to one side. If the brakes fail to hold at MIL power, reduce power and attempt to build sufficient hydraulic pressure by pumping the brakes. If the second attempt to keep the aircraft from rolling fails, consider aborting the aircraft. Once the lineup checks are complete, release the brakes, select maximum power (MAX), confirm afterburner operation, and confirm exhaust gas temperature (EGT) readings stabilize within limits.

3.2.3. Rolling Takeoff. Ensure all lineup checks prior to engine run-up are complete, and taxi onto the runway in a normal manner. After attaining proper runway alignment, check the heading system if not already accomplished, disengage the nosewheel steering, and advance the throttles to MAX. Confirm proper engine operation during the takeoff roll.

3.2.4. Takeoff during cold weather. During cold weather, the aircraft accelerates much faster than during normal standard day conditions and all fluids in the aircraft take longer to warm up. Consider using a static takeoff to allow more time to check oil pressure is within limits and to confirm proper engine and afterburner operation due to the high potential for compressor stalls. Communication might also be difficult if the cabin temperature is set to high/max heat during the wintertime. Use anti-ice as directed by the flight manual.

3.2.5. Takeoff Roll.

3.2.5.1. The time allowed by the flight manual for the afterburner to light starts at engine stabilization in MIL. If the timing is not met on an aborted rolling takeoff, consideration should be given to attempting a static takeoff prior to aborting the aircraft.

3.2.5.2. Maintain directional control by tapping the brakes until the rudder becomes effective. Once the rudder is effective, the pilot's heels should be dropped to the floor to ensure brakes are not inadvertently applied while using the rudder. Check the minimum acceleration check speed (MACS) and remain aware of go/no-go speeds.

3.2.5.3. Depending on aircraft gross weight, pilots should normally initiate backstick pressure at approximately 145 knots calibrated airspeed (KCAS) and set the bore sight cross (F-16 HUD) or waterline (MIL-STD HUD) at 7.5 degrees nose-high on the pitch ladder (**Figure 3.1**.). Nosewheel liftoff should occur at approximately 155 KCAS, and the aircraft should fly off the runway at approximately 165 KCAS depending on aircraft gross weight. When safely airborne with a positive climb, retract the gear.

Figure 3.1. Takeoff Attitude (Front Cockpit).

3.2.5.4. Hot Weather Consideration. Following gear retraction, ensure sufficient airspeed exists before retracting flaps, then check gear and flap indications to verify they are up.

3.2.5.5. Whenever significant crosswinds are a factor, use aileron into the wind throughout the takeoff roll to prevent an early liftoff of the upwind wing, and use rudder to keep the aircraft tracking down the runway. Crabbing into the wind on takeoff is required to prevent the jet from drifting across the runway. As airspeed increases, crosswind control inputs should decrease.

3.3. Climb. Climb IAW local procedures. If practical, use the flight manual performance data Mil Thrust Restricted Climb Schedule or a technique listed below.

3.3.1. In any case, smoothly reduce power out of MAX between 220 and 280 KCAS and terminate afterburner by 300 KCAS. Accelerate to and hold 300 KCAS using MIL power and approximately 12 degrees pitch until passing 10,000 feet mean seal level (MSL). Once past 10,000 feet MSL, accelerate in a shallow climb (approx. 1,000 to 2,000 feet per minute (fpm)) to the desired climb indicated Mach number (IMN) based on the climb technique selected. A common airspeed to accelerate to above 10,000 feet MSL is 350 KCAS. Do not exceed 300 KCAS below 10,000 feet MSL, and if carrying a Weapon System Support Pod (WSSP), do not exceed 400 KCAS above 10,000 feet MSL.

3.3.2. One technique is to follow the Tech Order Mil Thrust Restricted Climb Schedule using the CLIMB/MAX RANGE CRUISE CHART in the Performance Data Checklist. Use MIL power and pitch as required to achieve the scheduled Mach number for each 5,000 feet altitude step above 10,000 feet MSL. Note that following the Tech Order climb schedule requires a deceleration to cruise Mach once leveled off at cruise altitude.

3.3.2.1. As a technique, pilots may use the Divert Mode (DVT) profile. This commands the climb (CLM) airspeed caret to follow the Mil Thrust Unrestricted Climb Schedule, which mirrors the Restricted Climb Schedule above 10,000 feet MSL. Simply follow the CLM caret to maintain the Tech Order climb schedule.

3.3.2.2. To activate this feature, enter the Destination page of the UFCP by pressing the DST key. Then select UL-1 (DS) and then UL-4 (DVT). Ensure that the DVT profile is displayed on the bottom left corner of the MFD. Press ML-7 on the MFD to change Divert Mode profiles.

3.3.3. Another technique is to climb at the calculated cruise IMN. Calculate the cruise indicated Mach number (IMN) by using the Flight Manual Performance Data, or .52 Mach + altitude [in thousands]/100. Accelerate to and climb at this IMN after passing 10,000 feet MSL. Example: Climbing to 20,000 feet MSL (.52 Mach + 20) = .72 M Cruise IMN.

3.3.4. MAX Power Climb. In full afterburner, an attitude of approximately 20 to 25 degrees nose-high holds 300 KCAS. Passing 10,000 feet MSL, lower the nose and accelerate to and maintain .9 IMN.

3.3.5. Climb Check**.** Pilots may combine the climb check with the level-off check when cruise altitude is at or below flight level (FL) 180. Accomplish the climb check once above 10,000 feet MSL but prior to 18,000 feet MSL. However, it is desirable to remove moisture from the air conditioner prior to the freezing level.

3.4. Level-Off. The level-off should be a smooth, continuous pitch change to level flight. Avoid abrupt pitch changes and stair stepping to the desired altitude. Normally, a smooth level-off is accomplished as follows: when the instantaneous vertical velocity (IVV) is less than 6,000 fpm, begin the level-off at 10 percent of the vertical velocity; when IVV is greater than 6,000 fpm, reduce power, lower the nose to cut the picture in half about 2,000 feet prior in MIL power (or 4,000 feet prior in MAX power), and then use 10 percent of the vertical velocity. In addition, the TCAS system was not designed for aircraft with climb performance of the T-38, so be mindful of false RA generation when using high vertical velocities in areas of congested traffic.

3.5. Cruise. Attain cruise airspeed, set power, and trim the aircraft for level flight. A technique for attaining cruise speed at medium/low altitude (<10,000 feet MSL) is to set a fuel flow of approximately 1,000 – 1,100 pounds per hour (pph) per engine to maintain 300 KCAS. A technique for attaining cruise speed at normal cruise altitudes (FL180-FL280) is to set approximately 93 percent RPM on both engines or a total fuel flow of 1,800-2,200 pph and then fine-tuning as required to achieve pre-planned cruise Mach from Tab Data. A quick way to estimate cruise Mach is 0.52 Mach + altitude [in thousands]. Another technique is to use the range (RNG) profile in the emergency divert mode and fly the commanded calibrated airspeed (CAS) or IMN. When using this technique, pilots must be aware that the aircraft's range mode may command a max range speed which places the aircraft close to the edge of the engine operating envelope. This is more likely to occur at higher altitudes. Above FL280, a Min Mach caret (MM) appears on the airspeed indicator in the MFD. In all cases when flying above 35,000 MSL, pilots should fly a minimum speed of 0.9 Mach or higher, as indicated by the flight manual. Outside air temperature can be determined by referencing the data page on the MFD (select MB1-MB1-ML2 on the MFD). Pilots can also set the flight manual recommended fuel flows for other altitude and airspeed combinations.

3.6. Abnormal Procedures.

3.6.1. Overview. It is not the intent of this paragraph to cover every situation a pilot may encounter, to replace or supersede procedures in the flight manual, or to replace the use of sound judgment. Unusual or complex circumstances requires pilot judgment and systems knowledge to alleviate the situation. In an emergency, the supervisor of flying (SOF), tower personnel, runway supervisory unit (RSU) personnel, and other controlling agencies can assist the pilot. However, if anyone requests information at an inconvenient time, pilots should not allow themselves to be distracted from their primary responsibility of flying the aircraft by radio communications or other tasks. Pilots should take charge of the situation and not hesitate to direct controllers to stand by until in a position to safely provide the requested information. When making radio transmissions, be clear, concise, and emphasize exactly what assistance is needed. A pilot's priorities are always: Aviate, Navigate, Communicate, in that order.

3.6.2. Takeoff Aborts. If there is reason to abort the takeoff, do not hesitate to do so. If the pilot not flying sees something hazardous, they should immediately inform the pilot that is flying. If the AC is not flying during a time-critical situation that requires immediate action, and there is no time to relay this to the pilot flying the aircraft, the AC should take control of the aircraft and accomplish the appropriate procedures. The priorities for maintaining directional control are: rudder, differential braking, and nose wheel steering only as a last resort. Center the rudder pedals before engaging the nose wheel steering.

3.6.3. Wake Turbulence. Anticipate wake turbulence when taking off behind other aircraft on the same or parallel runways, especially if the wind is calm or straight down the runway. Wake turbulence is formed when an aircraft is creating lift, therefore plan to take off at a point prior to the preceding aircraft's rotation point or after their point of touchdown.

3.6.4. Barrier Operations. Procedures for barrier engagement are specified in the flight manual. The MA-1, MA-1A, and BAK-15 (61QSII) are the only suitable barriers. If aborting on a runway where the BAK-15 barrier is raised only on request, transmit "BARRIER, BARRIER, BARRIER" on the appropriate frequency.

3.6.5. Ejection**.** Pilots will use the command "BAILOUT, BAILOUT, BAILOUT" to initiate ejection actions if abandoning the aircraft becomes necessary. **(T-2)** If time and conditions permit, discuss and accomplish ejection procedures with the other crewmember using the term "ejection" rather than "bailout". In critical situations, do not delay an ejection waiting for the "BAILOUT" command, and do not delay an ejection once the command is given. As a technique, consider setting 2,000 feet into the above ground level (AGL) altitude warning function on non-low-level sorties to alert aircrew of inadvertent transition below minimum controlled bailout altitude (i.e. during an in-flight emergency).

3.6.6. Single Engine Taxi. Due to the lack of redundancy of the hydraulic and electrical systems with only one engine operating, do not taxi the T-38 single engine. However, clearing an active runway is allowable with downside hydraulics or if the landing gear is pinned.

3.6.7. Transfer of Aircraft Control without Intercom. In all cases, transfer of aircraft control should follow procedures found in AFMAN 11-2T-38V3. Transfer of aircraft control can result in disastrous crew confusion if not done in a positive, previously briefed manner. When the AC assumes control, the other crewmember must immediately relinquish all controls (stick, rudder, and throttles) and momentarily show both hands to the AC (use the mirrors as necessary). Normally, the AC maintains control for the remainder of the flight; however, some circumstances may necessitate a subsequent transfer of control. In these situations, the AC yawing the aircraft signals the transfer of aircraft control back to the other crewmember. The other crewmember must acknowledge by shaking the stick and looking for the AC to show hands clear.

3.6.8. Transfer of Aircraft Control during Critical Phases of Flight. During critical phases of flight, maintaining aircraft control often requires rapid intervention by the AC. The possibility exists for both pilots to simultaneously be on the controls until the transfer of aircraft control is complete. Pilots assuming aircraft control must be aware there are other control inputs that can affect the aircraft's performance but are not readily apparent. For example, a pilot assuming aircraft control to abort a takeoff may not be aware that the other pilot has mistakenly depressed the nosewheel steering button. If there is an overlap in aircraft control while the nosewheel steering button is depressed and the throttles are then retarded out of afterburner, the aircraft could enter an unrecoverable skid.

Chapter 4

TRAFFIC PATTERNS AND LANDINGS

4.1. Introduction. High volume traffic patterns require diligent visual lookout and a complete knowledge of traffic pattern procedures. For all patterns, the runway is the primary reference. The flight manual describes the basic procedures for flying the T-38 in the traffic pattern and landing environment. From the flight manual procedures, a variety of techniques can be used to land the aircraft safely and effectively. The remainder of this section outlines the techniques most commonly used and taught in T-38 Flying Training (FT) and pilot instructor training (PIT) environment.

4.2. Judgment in the Traffic Pattern. The pilot's judgment in determining whether an approach is safe must consider airspeed, aircraft buffet, angle of attack (AOA) indications, aural, HUD, and MFD stall warnings, and sink rate. When used together, these indicators can warn of an approaching stall. Heavy buffet or a high AOA indication in the traffic pattern may indicate one or more of the following conditions: an incorrect configuration, a miscalculated or poorly flown airspeed, too much backstick pressure, or an AOA or airspeed system malfunction. Low airspeed or high AOA may require a go-around. Also, erratic pitch changes can cause momentary flashing of the indexer lights. **Note:** More T-38 fatalities have occurred because of improperly flown final turns than for any other reason. In most cases, the sink rate developed first, and the stall warning was triggered during an unsuccessful recovery. The instantaneous vertical velocity indicator (VVI) is an excellent tool to assess a high sink rate early. As a guideline a normal overhead pattern with 60 or 100 percent flaps should require no more than 3,000 to 3,500 feet of sink rate in the final turn. A no-flap final turn should require no more than 2,000 to 2,500 feet of sink rate. <u>If stall indications or an excessive sink rate occur in the traffic pattern, immediately execute a stall recovery. Do not attempt to maintain the traffic pattern ground track because the altitude needed for recovery may significantly increase.</u>

4.3. Wind Analysis. Adjust all traffic patterns to compensate for known wind conditions. Use all available wind information to attain adequate downwind displacement during and after the break or pulling closed. Accurate pattern winds can be obtained on the MFD, and surface winds can be obtained from the controlling agency. Compensate for winds on inside downwind by crabbing into the wind to maintain the desired ground track to the perch. As a technique, reference the ground track (GT) indexer to establish the correct crab. With a strong headwind on initial, pilots should delay the break and begin the final turn earlier than for a standard wind condition with 10 knots of headwind component. The opposite is true for significant tailwinds on initial; move the perch point into the wind.

4.4. Normal Straight-In. Normally, slow to approximately 240 KCAS or less on base or approximately 10 to 15 miles from touchdown on an extended straight-in. Local procedures or traffic deconfliction may require adjustments. Avoid slowing to less than final turn airspeed for the current flap setting until established on final. Prior to intercepting the glidepath, establish the landing configuration and trim while allowing the airspeed to gradually decrease to the computed final approach airspeed (approximately .6 AOA). Strive to be configured at final approach speed upon intercepting the glidepath. From this point, follow procedures outlined in "Normal Final Approach" and "Landing Information" this section.

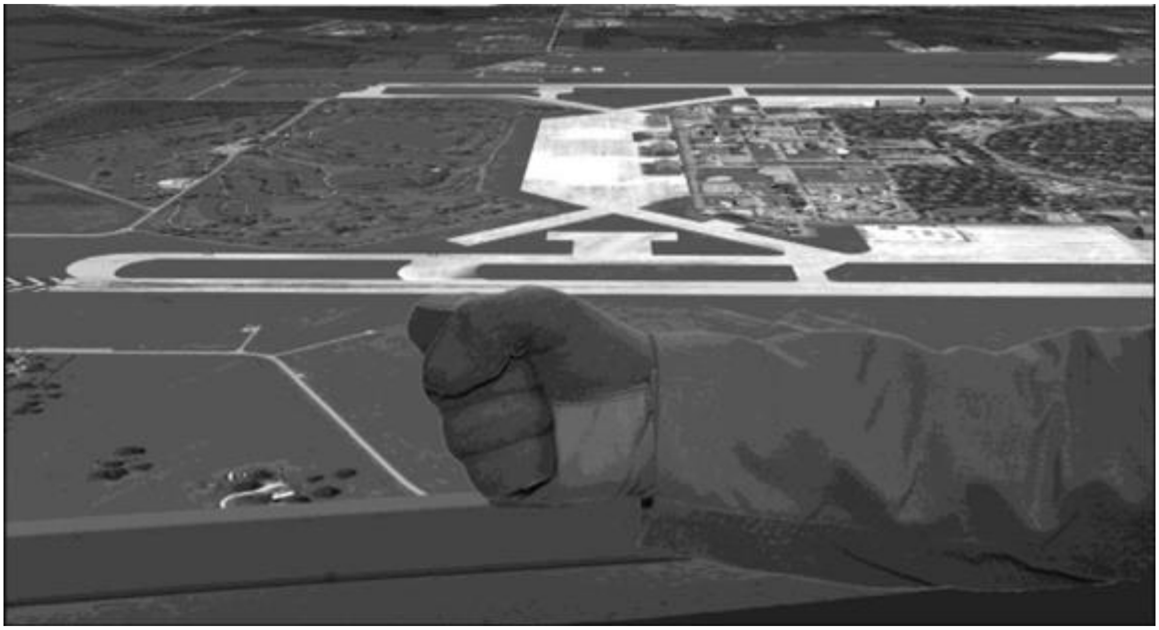
4.5. Normal Overhead.

4.5.1. Normal Break. The result of the break should be a properly spaced downwind with an established drift correction while maintaining traffic pattern altitude. Unless the controller directs otherwise, initiate the break between the approach end and 3,000 feet down the runway. Do not go into the break until 45 degrees off from preceding aircraft to ensure 3,000-foot spacing, and abeam another aircraft to ensure 6,000-foot spacing. Ideally, adjust the breakpoint for winds, and vary the bank angle or back pressure during the break to rollout on the desired ground track. Maintain level flight during the break. As a guide, the pitot boom and flightpath marker should be on the horizon during the break turn. One technique is to leave the throttles where they are on initial and use 0.6 AOA (green donut) throughout the break turn to reduce airspeed (no crosswind). As airspeed decreases during the break turn, reduce backstick pressure to maintain the green donut pull. During undershooting wind conditions, a lesser AOA and a reduced power setting are required to slow the aircraft down timely, and for overshooting winds and/or higher gross weights more power is required. Slow to below 240 KCAS, but no less than final turn airspeed by rollout.

4.5.2. Normal Closed Pattern. With clearance for the closed pattern, begin the pull-up with a minimum of 240 KCAS. Normally, power should be in MIL, although a closed pull-up from a go-around may require less power. Execute a climbing 180-degree turn, maintaining a minimum of 200 KCAS until wings-level on downwind. A common technique is to initiate the turn with a vertical pull to 15-20 degrees nose-high depending on pattern altitude (less if initiating from a go-around/low approach) before rolling into a 60-degree bank climbing turn towards inside downwind. At about 300-500 feet below traffic altitude, increase bank to 90 degrees of bank to allow the nose to slice down towards the horizon. Using AOA, bank, and throttle modulation, target rolling out at traffic altitude near 220 KCAS with proper spacing. Setting a power setting of 80-86 percent RPM after rolling out on inside downwind should maintain 200-220 KCAS on inside downwind prior to configuration. Consider winds (overshooting or undershooting) when establishing the proper spacing and crab on rollout. Visually clear for traffic in the break and for other aircraft on downwind.

4.5.3. Normal Inside Downwind. Getting from the break or closed downwind to the perch incorporates pitch, trim, and configuration changes. Check runway displacement when rolling out on inside downwind using the runway as a primary reference and adjust spacing if needed. The normal no-wind spacing is approximately 1.1 to 1.3 miles for a 1,500-foot AGL traffic pattern (**Figure 4.1**.). One technique is to move the spacing reference 0.1 NM (or one finger for visual reference) for every 10 knots of crosswind. Care should be taken when using less than 1.0 NM spacing, even during strong undershooting wind conditions. As a guide, crab into the wind with twice as much crab as was used on initial. One technique is to have the runway heading set in the CDI course to provide quick heading reference since the canopy rail slopes and can present an illusion. Another technique is referencing the GT caret to maintain the appropriate crab. If the EOR can be selected as the steer point, the EGI can be used to check runway displacement when abeam the EOR. Compute and verify final turn and final approach airspeeds and strive to configure no later than abeam the touchdown point. Monitor airspeed during flap extension to prevent flap overspeed when lowering full flaps. Prior to beginning the final turn, ensure the landing gear is down and locked and the flaps have traveled enough to ensure no asymmetry exists (approximately 60 percent). Maintain a minimum of final turn airspeed. If using full flaps, a recommended technique is to configure no earlier than 220 KCAS to prevent a flap overspeed.

Figure 4.1. No-Wind Runway Displacement (1,500 feet AGL traffic pattern).



4.5.4. Final Turn. The goal of a final turn is to arrive over the desired rollout point, on the extended runway centerline, with appropriate heading, altitude, and airspeed. Normally, the rollout point is approximately 300 to 390 feet AGL at 1.0 to 1.3 NM from the threshold. Begin the final turn when abeam the no-wind rollout point, adjusted for winds. Other reference techniques include when aligned with the overrun chevron closest to the runway or when reaching approximately a 45-degree angle from the threshold. A preceding T-38 should be two-thirds of the way around the final turn to ensure 3,000-foot landing spacing or abeam for 6,000-foot landing spacing.

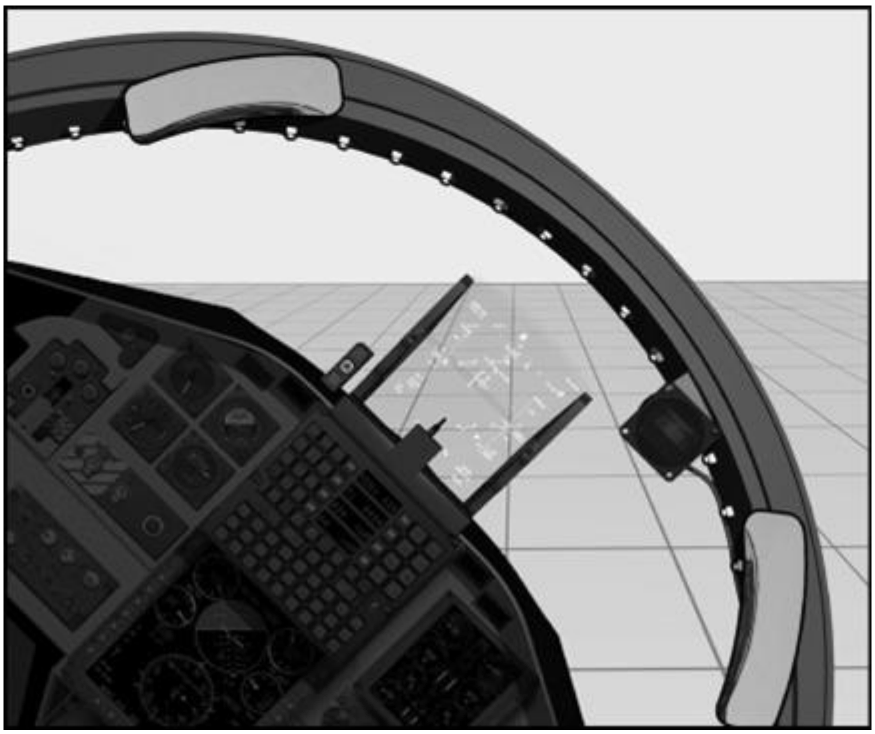
4.5.4.1. Flying the final turn.

4.5.4.1.1. Confirm configuration and enter approximately a 45-degree banked turn with a shallow rate of descent and blend in back pressure to establish an on-speed AOA. For a full flap pattern from a 1500’ AGL pattern altitude, an appropriate power setting after entering the final turn is approximately 90-91 percent RPM. Adjust power, bank, backstick pressure, and trim to hold final turn airspeed and fly over the rollout point, on altitude, and crabbed into the wind, if necessary**.** Maintain approximately .6 AOA throughout the final turn and on final, and do not allow the airspeed to decrease below final turn airspeed until initiating the rollout onto final.

4.5.4.1.2. A visual reference for pitch in the final turn is two-thirds ground and one-third sky in the front windscreen with the angled portion of the glareshield roughly parallel to the horizon. Also, the top corner of the HUD should be approximately on the horizon (**Figure 4.2**.). For a 1,500-foot pattern, the flightpath marker (FPM) should be approximately 6 to 7 degrees nose-low in the HUD/EADI. Whether using the HUD or visual references, the runway remains the primary reference and must be cross-checked in the attempt to intercept a 3-degree glidepath.

4.5.4.1.3. During the early part of the final turn, make a gear-down call. The vertical velocity should eventually indicate approximately double the pattern altitude (approximately 3,000 fpm for a 1,500-foot AGL traffic pattern). Halfway around the final turn, check altitude; the aircraft should lose about half the altitude between traffic pattern altitude and rollout altitude with approximately half of the lateral downwind displacement remaining. As a technique, consider the final turn made when <30 degrees of stabilized bank is required, <0.6 AOA required, and within 30 degrees of alignment to the landing runway, power may be reduced to begin slowing to final approach speed corresponding to the amount of bank needed to complete the turn.

Figure 4.2. Normal Final Turn.



4.5.4.1.4. For heavy weight final turns, final turn airspeed can end up being as high as 205 KCAS. In these scenarios, consideration should be given to configuring with 60 percent flaps to allow for a final turn airspeed window of 205-240 KCAS instead of 205-220 KCAS. This increased airspeed window allows for increased concentration on final turn mechanics instead of focusing on not over speeding the flaps.

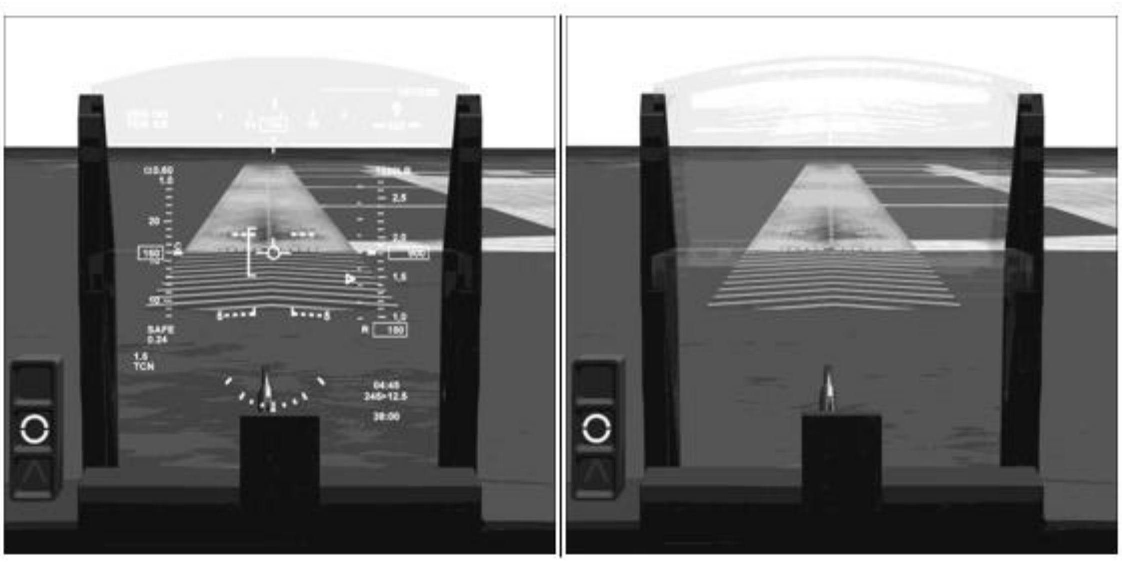
4.5.4.2. Rolling Out on Final. Rolling out on final, crab into the wind as necessary, and raise the nose of the aircraft to capture the glidepath based on the desired aimpoint as the aircraft slows down. Once established on final and on airspeed, the vertical velocity should be approximately 700 to 900 fpm.

4.6. Normal Final Approach. On final approach, the goal is to maintain the desired glidepath, aimpoint, and final approach speed until transitioning to a flare and landing.

4.6.1. Glidepath**.** Use the runway and surrounding environment as the primary reference for establishing a 2.5 to 3-degree glidepath. Once the proper aimpoint is set, the HUD pitch scale should indicate 2.5 to 3 degrees nose-low with the FPM on the aimpoint. Trim off stick pressures to aid in glidepath control. Corrections to glidepath are made by increasing or decreasing the current pitch until the desired glidepath is regained. To correct for a steep glidepath, aim slightly shorter until re-intercepting a 2.5 to 3-degree glidepath. To correct for a shallow glidepath (being "drug-in"), aim slightly longer until re-intercepting a 2.5 to 3-degree glidepath. In either case, do not allow an excessive descent or sink rate to develop. During gusty wind conditions/thermal turbulence, a common error is to "chase the FPM" and trying to hold it exactly at the threshold which leads to shifting the aimpoint constantly short or long. In this case make sure to keep the "average aimpoint" on the threshold.

4.6.2. HUD OFF Aimpoint (Full Flap). For a normal final approach, the aimpoint is approximately at the top of the HUD combining glass (the lower piece of glass in the HUD) based on the DEP discussed in **paragraph 2.6**. One technique is to note the FPM position in the HUD; when the HUD is off, use this point. This is not a fixed point in the HUD, but rather an approximation which varies based on winds, glidepath corrections, etc. The point in the windscreen that appears stationary (it just grows bigger as the aircraft approaches it) is the true aimpoint. This aimpoint needs to be maintained (assuming on glidepath) until reaching the transition point. When using the HUD, the FPM helps pilots visualize the aimpoint (**Figure 4.3**.).

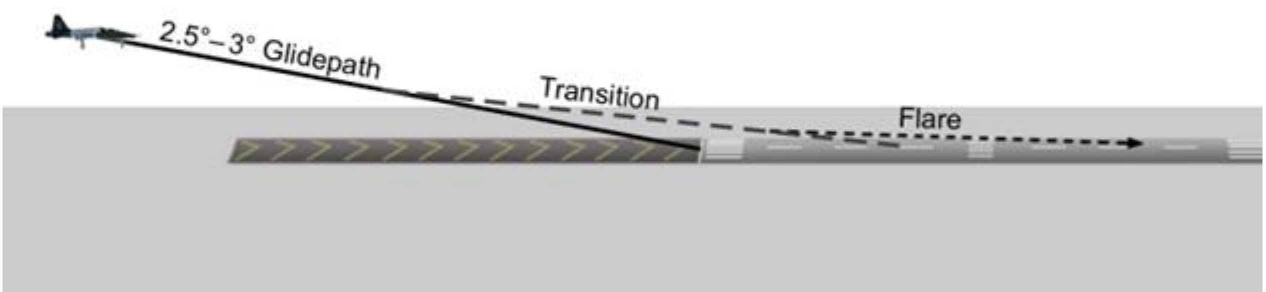
Figure 4.3. Landing Picture (HUD ON and HUD OFF 3 Degree Glidepath).



4.6.3. Airspeed. Ideally, the aircraft should be flown at the computed final approach speed and 0.6 AOA. With gusty winds, increase the final approach and landing speed by one-half the gust factor IAW the flight manual. Approximately 90 percent RPM should maintain on-speed indications on a normal glidepath with gear and full flaps. When adjusting the glidepath, a power adjustment may also be required. If there appears to be a calibration discrepancy between the airspeed and AOA indications, take all factors (such as aircraft feel) into account to determine the appropriate speed to fly. Fly either 0.6 AOA indication or the calculated airspeed whichever is greater.

4.7. Landing Information. The basics for landing the T-38 involve flying down the glidepath at final approach speed to a desired aimpoint. As the aircraft approaches the aimpoint, the pilot reduces power and transitions the aircraft to level flight, where the aircraft is flared down to touchdown airspeed in ground effect (**Figure 4.4**.). Incorporating the lessons from AFFTC-TIM-10-01, *T-38C Optimal Landing Technique Determination*, the designated normal landing zone is 150 to 1,500 feet down the runway. The transition to landing techniques described below allow for a fully flared landing between 150 and 1,500 feet down the runway if executed properly. Pilots should prioritize landing fully flared over landing by a certain distance but should not hesitate to go-around if an improperly executed transition to landing puts runway stopping distance into question.

Figure 4.4. Final Approach.



4.7.1. Glidepath**.**

4.7.1.1. The desired glidepath is 2.5 to 3 degrees with an aimpoint at the threshold. A 3-degree glidepath positions the aircraft 300 feet AGL at 1.0 NM from the threshold.

4.7.1.2. The desired touchdown point must be altered in cases where prudence would dictate a slightly longer aimpoint, such as in runways where there are hazards in the underrun environment, no underrun, or raised lights at the threshold. Generally, an aimpoint 100 to 200 feet past the threshold (around the top of the numbers on an instrument runway) is sufficient to provide a margin of safety and still ensure adequate runway remaining for landing rollout.

4.7.2. Transition. The transition phase is where the pilot transitions from maintaining glidepath, aimpoint, and airspeed to level flight in preparation for the flare. The transition involves both a power reduction and a pitch change. Gross weight, airspeed, winds, height above the runway, descent rate, and AOA affect the timing of the power reduction and the rate of pitch change. As the aircraft completes the transition, it must be positioned at the correct altitude, pitch, and airspeed to flare. A properly trimmed aircraft requires less backstick forces on final, which makes the transition much easier. During T-38 flight testing described in AFFTC-TIM-10-01, two optimum landing techniques were determined. The two throttle modulation methods are the Latch to the Threshold Shallow (LTT Shallow) Technique and the Crack Shift Idle Technique.

4.7.2.1. The Latch to the Threshold (LTT Shallow) throttle modulation method technique was found to be the most comfortable for the pilots during testing. This method is considered well suited to a shallower, power on approach as it involves a slow power reduction, preserving some thrust until crossing the threshold. Favor a 2.5-degree glidepath and keep the aimpoint at the threshold. When using full flaps start reducing power gradually and at a rate in proportion with the approach rate of the threshold starting at approximately 750 to 500 feet from the threshold. If using 60 percent flaps start the throttle modulation approximately 1,000 feet from the threshold.

4.7.2.2. The other primary landing technique is referred to as “Crack, Shift, Idle”. The timing and application of the four aspects of this technique may vary depending on a variety of factors to include airspeed, glidepath, and wind.

4.7.2.2.1. Crack – At approximately 1,000 feet from the desired aimpoint (typically the threshold), reduce power by pulling back on the throttles approximately 1 inch. If the aircraft is trimmed, the aircraft should try to maintain approach speed. To compensate, increase backstick pressure to maintain the flight path marker on the desired aimpoint. Many runways have an underrun of approximately 1,000 feet long to help with this estimate. Another technique for estimating 1,000 feet is to take the distance from the threshold to the “Captain’s Bars” and transpose that distance in front of the threshold. Reducing the power in the crack starts the deceleration process.

4.7.2.2.2. Shift– Approximately 500 feet from the threshold, apply slight backstick pressure to move the flight path marker to 100-200 feet beyond the threshold (or other previous aimpoint). This slightly shallows out the glidepath while continuing to aid the deceleration process.

4.7.2.2.3. Idle – Reduce power to idle when certain of aircraft landing beyond the runway threshold, but no later than crossing the threshold if at the correct height (usually occurs at 300-500 feet from the threshold). The power pull should be adjusted to make the aircraft cross the threshold at 5-10 knots below calculated approach speed.

4.7.2.3. Flare – As the aircraft approaches the ground, smoothly apply backstick pressure, raising the flight path marker to level to stop descending and maintain level flight with the main landing gear 1-2 feet above the ground. As the aircraft continues to decelerate, more backstick pressure is required to maintain level flight. As the aircraft approaches touchdown speed (20-25 knots below approach speed), the aircraft should settle to the ground.

4.7.2.4. For a landing 150 to 1,500 feet down the runway, the aircraft should cross the runway threshold approximately 5 to 10 feet off the ground and 5 to 10 knots below final approach speed. As the aircraft approaches the desired height above the runway, pilots should shift their eyes towards the end of the runway and increase backstick pressure to smoothly arrest the descent. The aimpoint continues to shift down the runway. Shifting eyes down the runway helps pilots pick up peripheral cues to judge and arrest descent at the right height. It also helps to maintain directional control, especially during crosswinds.

4.7.2.5. If the glidepath is steeper than normal, a greater pitch change is required to arrest the descent. With a larger pitch change, the pilot must delay the power reduction until a normal transition line is established.

4.7.2.6. If the aircraft is coming in from below a normal glidepath, power should be held until a normal transition line is established (at which point the rules of thumb listed above apply). If buffet is felt during the transition, delay the power reduction, or consider adding power as required to avoid stall indications.

4.7.2.7. Premature touchdowns can result from insufficient backstick pressure in the transition, early or rapid power reduction causing a sink rate, or an incorrect perception of aircraft height and descent rate. If an excessive sink (>590 fpm with <1,700 pounds of fuel IAW the flight manual) develops, execute a stall recovery. With a strong headwind or gusty crosswinds, use caution when reducing power to idle.

4.7.2.8. Long, fast touchdowns can result from a delayed or slow power reduction.

4.7.2.9. Sinking flares, firm touchdowns, or hard landings can result from excessive (>10 feet height above threshold) height at the end of the transition. Excess height results when: the transition is started too high (shifting the aimpoint early); back pressure is applied too rapidly (shifting the aimpoint too fast); airspeed is carried too long; or height is not judged correctly.

4.7.3. Flare and Landing. The flare is where the aircraft remains in level flight and dissipates kinetic energy to slow to touchdown speed. Since power is reduced to idle during the transition, remaining in level flight involves a pitch change as the airspeed decreases. Ideally, the aircraft reaches touchdown speed in the landing attitude as the main gear smoothly touches the runway (fully flared) approximately 150 to 1,500 feet down the runway. Landing deviations can result from conditions established in the transition or from flare execution.

4.7.3.1. A low height at the end of the transition or insufficient back pressure to maintain level flight during the flare causes premature (early or short) touchdowns.

4.7.3.2. Excessive back pressure during the flare, with sufficient airspeed, causes the aircraft to balloon. If this happens, consider if a go-around is required. Otherwise, momentarily relax back pressure, reestablish the correct height, and continue the flare to landing. In no case should the nose be actively pushed down to the runway since this might induce a high sink rate.

4.7.4. Heavy Weight Landing. The speed reduction from final approach speed to landing speed is the same for the lightweight and heavyweight landing (approximately 25 knots). However, the power reduction may need to be slower (or later) to prevent slow airspeed, a sink rate from developing, or landing short. If the pilot is not certain that the sink rate has been adequately reduced, the power reduction should be delayed, and a longer and (or) faster touchdown should result. This may indicate that a go-around for stopping distance is required.

4.7.5. Landing on Alternate Sides of the Runway. When traffic permits, land in the center of the runway. However, during a busy traffic pattern or when using reduced runway separation, plan the final approach and landing using alternate sides of the runway, keeping the aircraft toward the center. When landing on alternate sides of the runway, position the runway centerline between the main landing gear and wingtip opposite the side of the runway the aircraft is landing on. For example, on the right side of the runway land with the centerline between left main landing gear and left wingtip. Don’t allow the aircraft to drift across the runway centerline. The two sides of the runway are referred to as the “hot side” (the side of the runway opposite the turnoff taxiways) and the "cold side" (the side of the runway adjacent to turnoff taxiways).

4.7.6. Visual Glide Slope Indicators. Approach lighting systems, including visual approach slope indicator (VASI) and precision approach path indicator (PAPI) systems, can help establish a safe glidepath. For normal transition approaches where the aimpoint is the runway threshold, these systems are good for reference 3 to 4 miles out but show below glidepath indications inside approximately 1 mile.

4.7.6.1. Standard VASI and PAPI. The standard VASI and PAPI have a 2½- to 3-degree glideslope and a glidepath intercept point (aimpoint) approximately 1,000 feet beyond the runway threshold. The glidepath is normally coincidental with the ILS or precision approach radar (PAR) glideslope and will produce a threshold crossing height of approximately 40-50 feet. When flying the standard VASI or PAPI glidepath down to the flare, expect to land up to 2,000 feet down the runway. This is normally not desired during a normal transition approach where landing 150 to 1,500 feet down the runway is desired.

4.7.6.2. Other Approach Lighting Systems. Some Air Force bases use the Pulsating Visual Approach Slope Indicator (PVASI) and most naval air stations use the Fresnel Lens Optical Landing System (FLOLS). Refer to *Flight Information Publications (FLIP)* for complete guidance on these systems.

4.8. Full Stop Landing and Aerobrake.

4.8.1. Ensure the throttles are in idle. On a full-stop landing after touchdown, smoothly increase back pressure to attain approximately a 10 to 12-degree pitch attitude for an aerobrake. A technique is to place the bore sight cross slightly above the 10-degree nose-high reference line. Just prior to the loss of stabilator authority, lower the nosewheel to the runway. Aerobrake as appropriate for gross weight (e.g., with 1,000 pounds of fuel remaining, the maximum attitude of 12 degrees can be achieved at about 130 KCAS). Do not aerobrake abruptly—a lightweight T-38 can be pulled dangerously into the air.

4.8.2. Smoothly fly the nose to the runway approaching 100 KCAS. Heavyweight aircraft stopping characteristics are different than lightweight characteristics. The aerobrake can begin at a faster calibrated airspeed, and the nose settles to the runway sooner following the aerobrake. Because the touchdown airspeed is higher, the stopping distance is longer, and the wheel brakes will initially feel less effective. After lowering the nosewheel to the runway, keep the stick full aft to increase weight on the main gear and use cautious wheel braking to prevent possible skidding.

4.8.3. Approximate normal landing distance is computed by adding 2,500 plus the fuel from the touchdown point. For example, with 1,200 lbs (2,500 + 1,200) + 500-1,000 foot touchdown point = 4,200-4,700 feet runway required. For complete landing distance calculations reference the checklist or aircraft manual.

4.9. Rollout and Wheel Braking.

4.9.1. During a landing roll, apply aileron into the wind, and maintain directional control with the rudder. After lowering the nosewheel, check for brake system pressure by gently pressing the brake pedals. To prevent possible directional control problems, make sure both pedals are applied with equal pressure in one smooth brake application. Do not pump the brakes unless a single application provides insufficient pressure.

4.9.2. Use steady braking to reduce to taxi speed. Keep the stick full aft until 50 KCAS to maximize aerodynamic deceleration. Maintain directional control with the rudder and differential braking until the aircraft reaches taxi speed, then use nosewheel steering. When routinely operating from very long runways, practice the braking technique required to stop on shorter runways. A technique is to use three times the speed of the remaining runway in thousands of feet to estimate if the appropriate braking has been used. For example, ground speed should be no greater than 90 knots for 3,000 feet remaining, 60 knots for 2,000 feet remaining, and 30 knots for 1,000 feet remaining.

4.9.3. When landing in the center of the runway or on the hot side, plan to cross to the cold side with speed under control and sufficient distance down the runway to prevent a conflict with other traffic. If turning off the runway prior to the end, clear for any following aircraft on the runway before crossing to the cold side. Comply with local procedures.

4.10. Touch and Go Landing.

4.10.1. At touchdown, advance power to MIL (or MAX, if required) and smoothly lower the nose slightly below takeoff attitude to just prior to the nosewheel touching the runway. Do not release backstick pressure abruptly. Check the engine instruments and accelerate to takeoff airspeed.

4.10.2. When reaching takeoff speed (approximately final approach speed), establish the takeoff attitude, and allow the aircraft to fly off the runway. Then follow initial takeoff procedures. High gross weights, high temperatures, high-pressure altitudes, full flaps, etc., may adversely affect acceleration. Consider selecting afterburner under these conditions. Another technique is to retract the flaps to 60 percent until reaching 200 KCAS to avoid losing altitude as the flaps are retracted beyond 60 percent.

4.11. Crosswind Landing.

4.11.1. Final Approach. Counteract the drift by crabbing into the wind until touchdown. The crab angle is reduced when both main tires are on the ground. When the crosswind component exceeds 15 knots, plan to touch down on the upwind side of the runway. Reference AFMAN 11-2T-38V3, AETC supplement for specific crosswind restrictions.

4.11.2. Full-Stop Landing.

4.11.2.1. When the crosswind component exceeds 15 knots, maintain the landing attitude and do not aerobrake. Maintaining the landing attitude requires additional backstick pressure as airspeed decreases. Increasing backstick pressure too rapidly may result in the aircraft becoming airborne or drifting across the runway.

4.11.2.2. Tire damage is highly probable if pilots allow the aircraft to drift across the runway by not applying aileron into the wind. To prevent drift, use rudder to crab into the wind to keep the jet tracking straight down the runway. The amount of crab necessary to prevent drift once the mains are on the runway will be less than the amount of crab used airborne due to the amount of drift killed by the friction of the main tires contacting the runway. Applying aileron into the wind aids in directional control, helps prevent compression of the downwind strut, and prevents the upwind wing from becoming airborne.

4.11.2.3. Just prior to the loss of stabilator authority, lower the nosewheel to the runway and apply aileron into the wind. Do not lower the nose prematurely with a crosswind. Insufficient crosswind controls may result in compression of the downwind strut and poor directional control and, when combined with weathervaning, can result in damage to the downwind tire.

4.11.2.4. Applying these techniques during crosswind landings may increase the landing distance by approximately 50 percent. Expect to be farther down the runway when the nose lowers, with less runway remaining to stop the aircraft.

4.11.2.5. Consideration should be given to scenarios that combine a change in aircraft configuration (60 percent flaps or no flap), a wet runway, and/or crosswind procedures. The addition to landing distance in each scenario is based on the change to either aerodynamic braking or a change in the friction coefficient affecting actual braking. In the case of a wet runway and crosswinds greater than 15 knots, expect greater than a 50 percent addition to landing distance. In this case, the wet runway causes reduced braking action resulting in approximately a 30 percent increase in landing distance and the crosswind procedures causes reduced aerodynamic braking resulting in approximately a 50 percent increase in landing distance. Because each increase affects a different form of braking, the total landing distance will be additive for a worst-case scenario. For example, with 1,000 lbs: 1.8 x (2,500 + 1,000) + 1,000-foot touchdown point = 7,300 feet runway required. In this scenario, 7,300 feet is greater than 80 percent of a 8,000 foot runway, which would drive an alternate runway selection or the use of a barrier and/or minimum-run landing in the case of an emergency.

4.12. No-Flap Patterns and Landings.

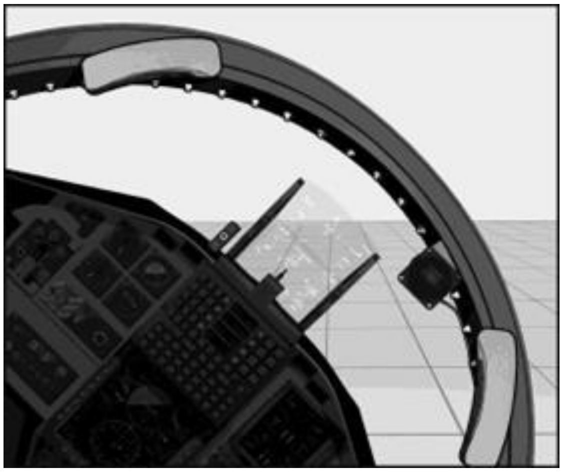
4.12.1. No-Flap Straight-In. Practice a no-flap straight-in to prepare for an actual emergency that requires a no-flap landing. The basic procedures for flying the approach are the same as the normal straight-in. Use caution when configuring to avoid losing altitude due to the increased drag from gear extension.

4.12.2. No-Flap Overhead. The reason we do no-flap overhead patterns is to maximize no-flap landing training. For an actual emergency requiring a no-flap landing, a straight-in approach should be flown. Due to the increased final turn airspeed and resulting increased turn radius, the no-flap pattern requires a wider downwind displacement. The no-flap no-wind spacing is approximately 1.5 miles for a 1,500-foot AGL traffic pattern (**Figure 4.5**.). One technique is to move the spacing reference 0.1 NM (or one finger for visual reference) for every 10 knots of crosswind. Care should be taken when using less than 1.5 NM spacing.

Figure 4.5. No-Flap Runway Displacement (1,500 feet AGL traffic pattern).

4.12.2.1. Flying the No-Flap Final Turn. The desired rollout point for a no-flap final turn is the same as for a normal overhead. Since the aircraft requires a wider spacing, the visual reference for the perch occurs sooner than approximately the 45-degree angle point as per the normal pattern. Using the normal spacing visual perch point would lead to a late perch and long final rollout point. Confirm configuration and enter approximately a 45-degree banked turn. For a no-flap pattern from a 1500-foot AGL pattern altitude, an appropriate power setting after entering the final turn is approximately 87-88 percent RPM. Let the nose of the aircraft fall very slightly, and smoothly add back pressure to establish an on-speed AOA. The visual reference for a no-flap final turn is approximately half ground and half sky with the angled portion of the glareshield roughly parallel to the horizon (**Figure 4.6**.). The horizon should approximately touch the top corner of the combining glass. In a 1,500 foot pattern, the FPM is approximately 4- to 6-degrees nose-low in the HUD; however, the aircraft pitch attitude is higher than that seen during the normal final turn. Trim to reduce stick pressure as pitch and airspeed are changed. Maintain approximately 0.6 AOA throughout the final turn and on final, and do not allow the airspeed to decrease below final turn airspeed until initiating the rollout onto final.

Figure 4.6. No-Flap Final Turn.



4.12.2.2. Rolling Out on a No-Flap Final Approach. During rollout on final, reduce power to attain final approach airspeed as soon as practical. Because of the reduced drag with flaps up, a larger power reduction is needed to slow at the same rate as an aircraft configured with full flaps. Without the flap/slab interconnect, more aft stick travel is required to arrest the sink rate as the glidepath is captured.

4.12.3. No-Flap Final Approach.

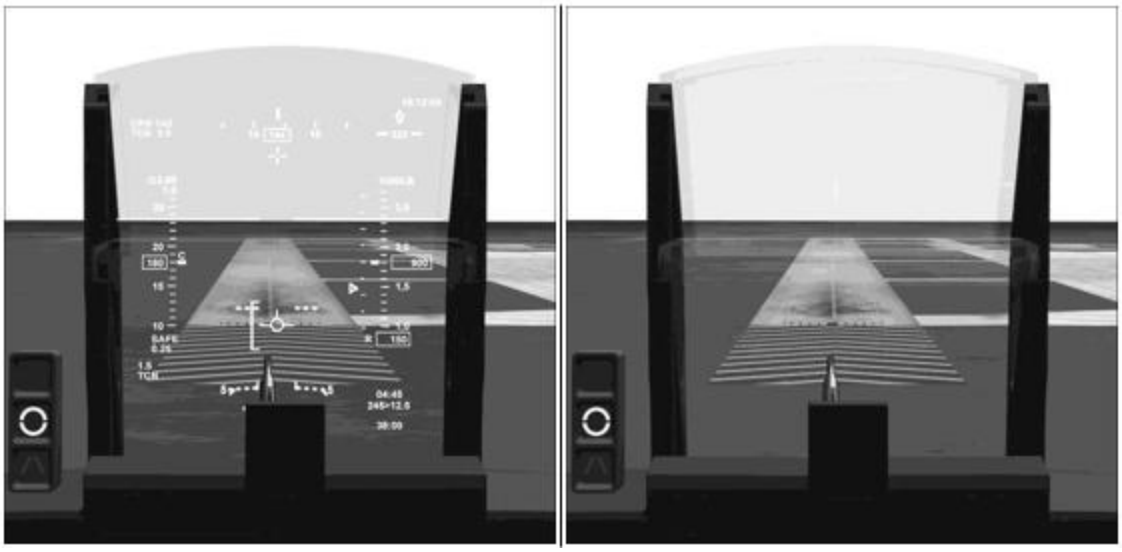
4.12.3.1. HUD OFF Aimpoint (No-Flap). For a no-wind, no-flap final, place the desired aimpoint about one-third of the way up from the bottom of the HUD, or abeam the top of the AOA indexer (**Figure 4.7**.). Trim off backstick pressure, and monitor aimpoint, airspeed, and glidepath. The transition and landing phases are the same as a normal landing. A shallower 2.5-degree glidepath is preferred for a no-flap landing. Because of the reduced drag without flaps, power reduction normally needs to begin sooner than on an approach with full flaps. Exercise diligence when reducing power and transitioning to the flare to avoid a sink. Without the flap/slab interconnect, more aft stick travel is required to achieve the desired pitch change, arrest the sink, and flare.

4.12.3.2. Due to higher landing speed and less effective aerobraking on a no-flap approach and landing, expect landing distances to be approximately twice the landing distance of a normal landing at similar fuel weights. Reference the no-flap landing checklist in an actual emergency.

4.12.3.3. Calculated no-flap landing distance is computed by adding 2,500 plus the fuel from the touchdown point and multiplying it by two. For example, with 1,200 lbs: 2 x (2,500 + 1,200) + 500 feet touchdown point = 7,900 feet runway required.

4.12.3.4. When the crosswind component exceeds 15 knots, apply the crosswind landing procedures shown in **paragraph 4.11**. The no-flap crosswind landing distance will be longer than most runways, reference **paragraph 4.11.2.5** for additional landing distance factors to consider.

Figure 4.7. No-Flap Landing Picture (HUD ON and HUD Off).



4.13. Single-Engine Patterns and Landings.

4.13.1. Single-Engine Pattern. Fly single-engine patterns from a straight-in approach. Set the simulated failed engine not less than 60 percent RPM during a simulated single-engine approach. Power on the good engine is approximately 98 percent on glidepath. Use the rudder to counteract the yaw induced by asymmetrical thrust ("step on the good engine"). Yaw is greater during low-airspeed, maximum-thrust situations such as a single-engine go-around. Once established on a 2.5 to 3-degree glidepath, take out the rudder input and accept mildly uncoordinated flight as to not induce a rolling moment in the flare due to increasing rudder effectiveness as backstick pressure is applied.

4.13.2. Single-Engine Landing. The single-engine landing is similar to the normal landing with the following exceptions: With 60 percent flaps selected, drag is not as great as with full flaps, and power must be reduced slightly sooner than a full flap landing under the same conditions to touch down in the same location. However, use caution to prevent landing short of the desired touchdown point. Ensure both throttles are checked in idle for touchdown. When performing an actual or simulated single-engine full-stop landing with 60 percent flaps, the landing roll should be approximately 500 feet longer. If heavy weight or if landing distance is critical, consider using full flaps when landing is assured according to the flight manual, but use caution to prevent early/abrupt touchdowns.

4.13.3. Touch-and-Go from a Single-Engine Landing. Use both engines for the takeoff following a simulated single-engine touch-and-go landing.

4.13.4. Go-Around from a Single-Engine Approach. If a go-around is required for any reason other than a planned single-engine go-around practice, use both engines. Refer to **paragraph 4.14** for single-engine go-around practice procedures.

4.13.5. Single-Engine Safety Considerations. Heavy fuel loads, high outside air temperatures, high pressure altitudes, or a combination of these conditions makes single-engine approaches more difficult. These conditions may also result in MIL power being insufficient to maintain level flight while configured. If these conditions exist, consider configuring the aircraft just prior to intercepting the glideslope. Maintain final approach speed plus 20 knots (yellow speed for the T-38C) until established on final and reduce airspeed slowly to final approach speed (green speed for the T-38C).

4.14. Practice Single-Engine Go-Around.

4.14.1. The setup and planned execution should be pre-briefed and may be accomplished from either a straight-in or overhead pattern. The aircraft should be stabilized on final at final approach airspeed with the simulated inoperative engine set no less than 60 percent RPM.

4.14.2. If the single-engine go-around is practiced from an overhead pattern, fly the final turn portion of the pattern with 60 percent flaps or full flaps, using both engines until rolling out on final. Once on final, simulate the engine failure, and then apply the boldface to initiate the go-around. Use coordinated rudder to offset the adverse yaw produced by one engine in afterburner. The landing gear retraction should be initiated once it's assured the aircraft will not touchdown, and at latest after achieving a positive climb rate (VVI and altimeter). Once the simulated single-engine go-around exercise is complete, advance the simulated inoperative engine to MIL prior to coming out of afterburner on the other engine. <u>If an unsafe situation is developing, immediately abandon the simulated single-engine go exercise and recover the aircraft using both engines.</u>

4.15. Low-Closed Traffic Pattern. Use a low-closed traffic pattern to practice circling approach procedures. The procedures for a low-closed pull-up are the same as for the normal closed pull-up except pilots must adjust the pull-up to attain the published low-closed altitude and a wider downwind displacement. Be aware of the reduced power and pitch requirements since the downwind altitude is lower. From the downwind position, fly the practice circling approach as described in **Chapter 7**.

4.16. Traffic Pattern Irregularities.

4.16.1. Excessive Sink Rates:

4.16.1.1. Excessive sink rates are insidious and potentially deadly in the traffic pattern. If allowed to continue, recovery may not be possible due to engine response time, lack of excess thrust, and (or) insufficient altitude.

4.16.1.2. Excessive sink rates are generally not accompanied by approach to stall indications. Vertical velocity is the primary indication of excessive sink rate.

4.16.1.3. In the final turn from a standard overhead pattern, vertical velocity should not normally exceed twice the pattern altitude. However, the MFD's instantaneous vertical velocity will only indicate an excessive sink rate with a vertical velocity of 4,000 fpm or greater for 60 percent and full flaps, or 3,000 fpm or greater for no-flaps. On short final, a vertical velocity of approximately 700-900 fpm is normal. Anything greater may be an indication of excessive sink rate. In most mishaps the sink rate developed first and were followed by a stall during the recovery. **Note:** Any time an excessive sink rate is encountered in the traffic pattern, immediately execute a stall recovery. Proper stall/sink rate recovery procedures take priority over maintaining the published ground track.

4.16.2. Stall Indications in the Traffic Pattern.

4.16.2.1. An actual stalled condition is immediately preceded by heavy, low-frequency buffet, and in most cases, moderate wing rock. The actual stall is indicated by a combination of a very high sink rate, heavy buffet, and high AOA (above 1.0). Training and recovery techniques must concentrate on the approach-to-stall characteristics to prevent an actual stall.

4.16.2.2. Individual aircraft performance may differ. Reference **paragraph 5.7** for additional information on airframe buffet levels. The sequence of flight characteristics up to and beyond the approach-to-stall indication include:

4.16.2.2.1. Light Buffet. The light buffet is defined as the buffet at 0.6 AOA (green donut). This is the optimum final turn AOA.

4.16.2.2.2. Moderate Buffet. Moderate buffet is the buffet from approximately 0.7 AOA to the definite increase in buffet intensity. (Red chevron above green donut).

4.16.2.2.3. Definite Increase in Buffet Intensity (DIBI). The definite increase in buffet intensity is the point where the buffet increases in amplitude, but the frequency becomes slower and irregular. Wing rock may occur. This typically occurs above 0.8 AOA.

4.16.2.2.4. Heavy Buffet. Heavy buffet is the buffet from AOA higher than the definite increase in buffet intensity to the point where the stick is at the aft stop.

4.16.2.2.5. The aural, HUD, and MFD stall warnings (a boxed, blinking, STALL warning displayed on the HUD and MFD, and a stall warning tone, when the landing gear is extended, and the AOA is at or above 0.80).

4.16.2.2.6. Low-frequency, high-intensity airframe buffet.

4.16.2.2.7. Glareshield shaking, erratic buffet (no set frequency).

4.16.2.2.8. Wingtips stall first and may cause a wing to drop.

4.16.2.2.9. Light wing rock due to alternately stalling wingtips.

4.16.3. Recovery Procedures for Stall, Approach-to-Stall, or Excessive Sink Rate:

4.16.3.1. Any time a definite increase in buffet intensity or aural, HUD, and MFD stall warnings, or excessive sink rate are encountered in the traffic pattern, pilots should immediately execute the stall/sink recovery (MAX, Relax, Roll). Simultaneously advance both throttles to MAX, relax backstick pressure as required, and roll the wings level. Rudder can be an effective way to initiate the roll to wings level; however, use caution to avoid over-controlling. Approaching wings level, maintain an AOA just below the definite increase in buffet intensity and achieve a positive nose track until establishing a climb. **Note:** Maintaining an AOA just below the definite increase in buffet intensity may activate the aural, HUD, and MFD stall warnings.

4.16.3.2. Once a safe climb has been established and obstacle clearance is assured, relax backstick pressure to allow the aircraft to accelerate. Avoid heavy buffet or secondary stall during the recovery. Since decreasing bank significantly reduces the stall speed, do not delay raising the nose after the wings are level. Airspeed can also be used as an indication of maximizing performance. In general, excess thrust during recovery should be used for establishing a climb versus increasing airspeed. Therefore, airspeed should not increase during the recovery, but should remain constant (not decrease).

4.16.4. Avoiding Stall/Sink Rate Situations. Avoiding situations that can lead to a stall/sink rate is the best way to prevent one. Four pilot-controlled variables determine controlled patterns—attitude, airspeed, configuration, and power. When one or more of these variables is flown incorrectly, pilots tend to allow a sink rate to develop in order to hold the other variables in the optimum range. For example, a pattern can appear normal in every respect as long as the pilot allows a sink rate to compensate for an improperly set bug speed. Any combination of situations can rapidly deteriorate into a stalled or sink-rate condition without exaggerating any single condition. Some of these situations include the following:

4.16.4.1. Beginning the final turn with an improper configuration.

4.16.4.2. Beginning the final turn with less than the computed final turn airspeed.

4.16.4.3. Beginning the final turn with inadequate downwind displacement.

4.16.4.4. Beginning the final turn with an excessively nose-low attitude.

4.16.4.5. Flying a stabilized final turn with more than 0.6 AOA or 45 degrees of bank.

4.16.4.6. Using low power settings.

4.16.4.7. Making abrupt control movements.

4.16.4.8. Overbanking to correct an overshooting final turn.

4.16.5. Rudder Overcontrol. When configured, the T-38's 30 degrees of available rudder is highly effective in rolling the aircraft. Although the rudder is not needed to coordinate flight, it may be useful during high AOA or asymmetric thrust situations. When rudder is applied, expect up to a one second delay between the rudder input and noticeable aircraft response. Furthermore, expect the resultant roll to continue for up to one second after the control input has been neutralized. To prevent over-control, use only small rudder inputs as required in the traffic pattern. In no case should pilots wait until sensing an aircraft response before removing rudder input when the landing gear is extended. Overcontrol of the rudder during an aerobrake can put the aircraft in an unrecoverable attitude with a potentially fatal outcome.

4.16.6. Balloons, Bounces, and High Flares:

4.16.6.1. Balloons, bounces, and high flares are the result of abrupt control inputs in the transition and flare or a misjudgment of the height above runway. They can all result in the same dangerous situation—an aircraft above the runway with insufficient airspeed for a controlled descent.

4.16.6.2. In mild cases, they may only result in a firm landing. In extreme cases, they can result in a wing rock, wingtip contact with the runway, or departure from the prepared surface.

4.16.6.3. For minor deviations, reestablish the landing attitude and continue with a flare and touchdown. Pilots may need to fly the aircraft back to the runway or accept a hard landing and (or) bounce while waiting for acceleration. In all cases, use extreme caution to avoid approach-to-stall indications or wing rock. Recovery should appear much like a landing attitude stall recovery with most of the pilot's concentration focused on keeping the wings level and flightpath down the runway. For larger or more pronounced deviations, immediately perform a go-around. Simultaneously select MIL or MAX power and establish a safe pitch attitude.

4.16.7. Over rotation. An abrupt or excessive application of backstick pressure during a takeoff usually causes over rotation. However, during a touch-and-go landing, maintaining the landing attitude while increasing the power may also cause over rotation. Over rotation can lead to a premature liftoff at a potentially dangerous airspeed. To correct this situation, establish the normal takeoff attitude, select MAX if necessary, and allow the aircraft to accelerate. It may be necessary to allow the aircraft to settle back to the runway to accelerate in a three-point attitude to attain safe flying airspeed and avoid approach to stall indications.

4.17. Go-Around.

4.17.1. Go-Around from the Final or Landing Phase. To ensure a safe go-around, advance power to MIL (MAX, if required), accelerate to at least the final approach airspeed, and consider retracting the landing gear only after ensuring touchdown will not occur. Ensure sufficient airspeed exists before considering retracting the flaps. Once safely climbing, follow local procedures for ground track and altitudes. Use caution not to overspeed the gear, gear doors, or flaps. If the runway is clear, it's not necessary to offset to the side of the runway.

4.17.2. Go-Around from the Final Turn.

4.17.2.1. On a go-around from the final turn, the potential for gear or flap overspeed is high. Therefore, cross-check flight parameters during the go-around. MIL is not always required in these situations. To execute a go-around from the final turn, maintain a minimum of final turn airspeed, climb or descend as required, and retract the gear and flaps only after attaining a safe flying airspeed. If the runway is clear, it's not necessary to offset to the side of the runway. Maintain 240 to 300 KCAS on the go-around.

4.17.2.2. With the aircraft under control and if time permits, notify the RSU or tower when initiating a go-around. Never break out from the final turn; execute a go-around instead. Consider lowering flaps to 60 percent when going around from an overshooting, no-flap final turn. If a dangerous situation develops, do not attempt to conform to the prescribed traffic pattern ground track**.** Prioritize maintaining aircraft control.

4.17.3. Touching Down During a Go-Around. If an airborne go-around is impossible, continue to fly the aircraft to touchdown. Do not attempt to hold the aircraft off the runway in a nose-high attitude. Instead, maintain the landing attitude and accept a touchdown. Then perform a takeoff in the same manner as the takeoff phase of a touch-and-go landing, using MAX power if necessary.

4.18. Alternate Gear Extension. Allow extra time for the gear extension when using the alternate system. After practicing an alternate gear extension, ensure the alternate release handle is fully stowed. Then reset the landing gear system. Accomplish this by moving the landing gear handle down, then up, and then back to the down position.

4.19. Abnormal Procedures.

4.19.1. Alternate Gear Extension. Under conditions requiring alternate gear extension, the front cockpit pilot must be prepared to lower the landing gear with the alternate gear release handle. Without intercom, the rear seat occupant may signal the need to use the alternate gear release system by lowering the landing gear handle. The front seat pilot should recognize the lack of gear down indications and accomplish the alternate gear extension procedures.

4.19.2. Airspeed Indicator Malfunction. With a known or suspected airspeed indicator malfunction, ensure the pitot heat is on, and establish a known power setting or fuel flow for the desired cruise airspeed, and refer to the checklist. If the airspeed malfunction is caused by an air data computer (ADC) failure, AOA is unavailable. If possible, use a chase aircraft for recovery. If one is not available, use known pitch and power settings (RPM or fuel flow) in combination with the AOA system to approximate desired airspeeds. (A 0.3 AOA equals 230 + gas; a 0.5 AOA usually indicates a safe gear-lowering speed.) Pilots can use the AOA system to safely recover the aircraft because it is independent of the pitot static system. Ground speed should still be displayed on the MFD and can be used to approximate airspeed.

4.19.3. Bird Strike. A bird strike poses a hazard to low-altitude operations, particularly in the traffic pattern and on low-level navigation routes. The two most serious forms of damage from bird strikes are engine failure and cockpit penetration. In the traffic pattern, consideration must be given not to make an aggressive bird avoidance maneuver that may lead to a more severe stall or ground impact situation. Due to the critical nature of cockpit penetration, thoroughly brief procedures for transfer of aircraft control and reestablishment of inter-cockpit communications. If a bird strike penetrates the cockpit, be alert for possible engine damage due to possible FOD ingestion from the broken canopy.

4.19.4. Go/No-Go Decisions from a Touch-and-Go Landing. Although takeoff and landing data (TOLD) for touch-and-go landings is impractical, the following rules of thumb are useful:

4.19.4.1. Normally, at or near the point of touchdown, both an abort and a takeoff are safe options, even with a single-engine failure. The abort is possible because the aircraft is lighter than on initial takeoff. Barring a catastrophic, compound problem, the takeoff is equally safe. At touchdown, the aircraft is no more than 25 knots below final approach speed with most of the runway remaining. In most cases, either option should work, provided pilots stick to their original decision and correctly apply the procedures.

4.19.4.2. For a no-flap touch-and-go, an abort requires further consideration. By regulation, the landing fuel weight will be below 2,500 pounds. According to the flight manual, the stopping distance for a no- flap landing is approximately 2 x (2,500 + fuel weight). For fuel weights closer to 2,500 pounds, the stopping distance from the actual touchdown point could exceed the actual runway available. A takeoff decision in this scenario should be the safer option.

4.19.4.3. The go/no-go decision is largely a matter of pilot preference, but the most common technique is to consider the throttle position. That is, if the throttles are in idle when the problem occurs, leave them there because the pilot is psychologically prepared to land. However, if the pilot has advanced the throttles or the engines have stabilized in MIL power, pilots should consider continuing the takeoff. In either case, apply the appropriate boldface for the selected decision.

4.19.4.4. As with other emergency situations, pilots should weigh all factors, including the runway remaining, runway condition, configuration, aircraft weight, weather, barrier type, and obstacles on departure. In any case, two fundamental questions serve pilots well: (1) is a safe abort possible? And (2), is a safe takeoff possible? Take the time to answer these questions on the ground—before flying. This discussion highlights the emphasis on landing on speed in the desired landing zone—to provide maximum runway remaining to stop (or go) during an emergency.

4.19.4.5. After-Landing Procedures with an Emergency. If needing assistance from fire department or maintenance personnel following an emergency landing, hold the brakes and show hands clear. This signals to the ground crew that they are clear to inspect the aircraft. Do not actuate switches without visual coordination with the ground crew.

Chapter 5

TRANSITION

Section 5A—General Methods and Procedures

5.1. Introduction. Transition flying in the T-38 incorporates areas of training in which pilots learn and practice the basics, including takeoffs, landings, and a wide variety of area work. Transition training is flown single ship, with an emphasis on using primarily outside, visual references—the horizon, ground, runway, etc. The basic objective of transition flying in the T-38 is to build a solid feel for the aircraft's performance capabilities through a large portion of its flight envelope, including stalls, aerobatics, advanced handling characteristics, and normal and emergency traffic patterns.

5.2. Area Orientation. Maintain area orientation using all available means (ground references, NAVAIDs, or horizontal situation display [HSD]). Ground references should be the primary reference, when available. There are three methods of using the aircraft instruments—HSD, center radial, and pie-in-the-sky as follows:

5.2.1. HSD/SIT Method. The HSD/SIT can depict flying zones based on the data transfer system (DTS) load. With the correct area boundaries depicted on the HSD/SIT, turn as required to maintain the aircraft symbol within the confines of the depicted flying training zone boundaries. Select an HSD/SIT range which allows sufficient detail to determine proximity to borders and turn direction. Normally, 15 or 30 NM ranges are sufficient. Momentarily increasing the display scale can prevent confusion when trying to discern between training zone boundaries.

5.2.2. Center Radial. The center radial technique is best used in narrow areas (20 radials wide or less). With the center radial dialed in, the center of the area is always towards the CDI.

5.2.3. Pie-in-the-Sky. The pie-in-the-sky technique is best used in wide areas (20 radials wide or more). Dial in one course boundary bearing (not radial) and mark the other course boundary bearing with the heading marker. Keep the head of the bearing pointer—which always falls—between the head of the course arrow and the heading marker.

5.3. Energy Management.

5.3.1. **General.** Energy management requires maintaining effective combinations of altitude, airspeed, power settings, and AOA or G loading. Airspeed provides the kinetic energy required to maneuver the aircraft. Altitude provides potential energy that may be exchanged for airspeed. Power settings, AOA, and G loading control can be used to gain or lose energy.

5.3.2. Exchanging Altitude and Airspeed. Altitude and airspeed can be traded at a given rate. The most common rule of thumb is 1,000 feet of altitude is worth about 50 knots of airspeed. Pilots can exchange altitude and airspeed in these proportions by using MIL power with the canopy bow on the horizon or 80 to 85 percent RPM at 20 degrees nose high.

5.3.3. Optimum Energy Level. To do aerobatic maneuvering in a standard FT or PIT military operations area (MOA), the optimum energy level allowing for nearly all maneuvers is 300 KCAS at an altitude midway between the top and the bottom of the MOA. Minimum and equivalent energy levels (the altitude-airspeed relationship) may be calculated using the 50 knots at 1,000 feet exchange rate rule shown earlier in **paragraph 5.3.2**. For example, 16,000 feet MSL at 300 KCAS is approximately the same energy level as 14,000 feet MSL at 400 KCAS.

5.3.4. Losing Energy. Losing energy is easy using low power settings, increased drag due to configuration or speed brakes, and (or) increased AOA/G loading. A simple way to lose energy is to perform a constant speed descent until the desired energy level is reached. Applying increasing backstick pressure until achieving moderate buffet (see **paragraph 5.7.3**) also helps to lose energy. Use caution to avoid causing an over-G when airspeed is greater than corner velocity.

5.3.5. Gaining Energy. The best way to gain a large amount of energy is a wings-level climb at or near the tech order climb schedule. Gaining energy is enhanced with light AOA or G loading and maximization of excess thrust with the aircraft lift vector pointed vertically up. MAX power could be used (within engine envelope restrictions) but is rarely the most fuel-efficient way to gain energy. Many pilots use MIL power for most energy-gaining maneuvers. Do not hesitate to use MAX power for small, quick changes in airspeed or when the aircraft is already at a high calibrated airspeed (CAS).

5.3.6. Maneuverability Diagrams.

5.3.6.1. An energy maneuverability (EM) diagram (Reference Performance Data section of the flight manual) plots airspeed or Mach against turn rate with lines of constant G-load, turn radius, and specific excess power (P_S or "P- sub-S") contours represent the performance capabilities of an aircraft for a given set of flight conditions, including altitude, configuration, weight, and power setting.

5.3.6.2. The lines on the diagram represent the aircraft's ability to change altitude, airspeed, and direction of flight by considering lift, aerodynamic drag, structural limits, thrust, weight, and velocity.

5.4. Flight Control Characteristics.

5.4.1. Rudder. Effective use of the rudder is important throughout the T-38 flight regime and should not be ignored. Generally, the rudder is more effective at high AOA and less effective at low AOA.

5.4.2. Ailerons. Ailerons are most effective at low AOA and become less effective as AOA increases. Be cautious of aileron sensitivity and rapid aircraft roll rates; at high speeds and low AOA, large stick deflections may exceed aircraft limits.

5.4.3. Speed Brake. The speed brake has minimal effect below 250 KCAS. Little or no pitch change occurs when activating the speed brake below 250 KCAS. At airspeeds above 250 KCAS, speed brake extension causes a slight pitch up, and retraction causes a slight pitch down. The pitch changes are not abrupt and can be easily overcome with smooth control inputs.

5.4.4. Trim Techniques. Proper trim technique is essential for smooth and precise aircraft control during all phases of flight. The basic rule for proper trim is simple: Establish and hold a desired attitude by applying control stick pressure, then trim to relieve the pressure. Normally, large trim changes are not necessary. Use "clicks" of trim when trimming the aircraft.

5.5. Pilot-Induced Oscillation (PIO). Over-controlling pitch corrections can result in a PIO, especially at high airspeeds. During a PIO, the pilot's control inputs lag the aerodynamic forces acting on the aircraft, and flight deviations increase as attempted corrections are input. If at low altitude or in close proximity to another aircraft and cannot just release the stick, pilots should apply and hold some back pressure on the stick. In other words, freeze the stick slightly aft of neutral until the oscillations stop.

5.6. G-Awareness Exercise.

5.6.1. Perform the G-awareness exercise to warm up or assess each pilot's personal G-tolerance and practice the timing and execution of the anti-G straining maneuver (AGSM). Also, check the anti-G suit and the aircraft's system for proper operation. Use MIL or MAX power and 420±20 KCAS to provide adequate airspeed to sustain the appropriate Gs without losing excessive altitude.

5.6.1.1. Accomplish the AGSM by firmly contracting the muscles of the legs, abdomen, and chest. As the amount of G increases, increase the intensity of the strain, and attempt to exhale through a closed airway. Continue to strain and simultaneously breathe approximately every 2-3 seconds. Do not hold the strain too long (more than 3 seconds) without breathing as this reduces G tolerance.

5.6.1.2. It is important to start the AGSM before the onset of G forces and maintain the strain throughout the period of increased G loading. The AGSM is more difficult to do properly and more tiring when pilots execute high-G maneuvers while looking over their shoulder. Increased emphasis on the AGSM is necessary during high-G maneuvers. If gray out occurs at the onset of G forces, application of the AGSM may not eliminate the gray out. If altitude and/or airspeed are not critical, return to 1 G flight, re-apply the AGSM, and then continue maneuvering. Use caution not to exceed aircraft or personal G limits.

5.6.2. MIL Power G-Warm-up/Awareness Turns: Set the FPM approximately 8 to 10 degrees nose-low to maintain 4.0-4.5 Gs and approximately 18-20 degrees nose-low to maintain 5.0-5.5 Gs. One technique is to set the FPM approximately half the aircraft's MSL altitude ÷ 1,000 to maintain 4.0-4.5 Gs and approximately the aircraft's MSL altitude ÷ 1,000 to maintain 5.0-5.5 Gs.

5.6.3. MAX Power G-Awareness Turn: Attain 420±20 KCAS, roll to approximately 120º of bank, and pull the LV down using approximately 4 Gs while simultaneously selecting MAX power. Perform a ≤4 G loaded roll to roll out of bank to set the FPM approximately 8-10º nose low. Increase backstick pressure to 5 to 5.5 Gs and adjust LV as necessary to maintain required G and airspeed. Terminate afterburner (AB) while beginning to roll out of the turn.

Section 5B—Aircraft Handling

5.7. Airframe Buffet Levels. As a baseline for common reference, this manual uses the following terms for airframe buffet levels, described in order of increasing AOA:

5.7.1. Light Tickle. Light tickle is the first consistent appearance of high frequency, low amplitude vibration on the airframe due to AOA. The lower the airspeed, the higher the AOA at which this occurs - typically at about 0.55 AOA during clean, 1 G flight at speeds below 300 KCAS, to about 0.4 AOA at 400 KCAS.

5.7.2. Light Buffet. Light buffet is a consistent, light airframe vibration that normally occurs at 0.6 AOA (green donut).

5.7.3. Moderate Buffet. Moderate buffet is a consistent, moderate airframe vibration that normally occurs from approximately 0.7 AOA to the definite increase in buffet intensity, just short of wing rock.

5.7.4. Definite Increase in Buffet Intensity (DIBI). The DIBI is the point where the frequency of airframe vibrations becomes inconsistent, irregular, and slower with the amplitude often increasing beyond the moderate buffet level. This typically occurs above 0.8 AOA—usually closer to 0.8 AOA with the flaps up, and potentially 0.86 AOA to above 0.9 AOA with the flaps at 60 or 100 percent. In some aircraft, the DIBI may not be noticeable prior to entering wing rock.

5.7.5. Heavy Buffet. Heavy buffet is the buffet from AOA higher than the definite increase in buffet intensity to the point where the stick is at the aft stop.

5.7.6. Wing Rock. Wing rock normally occurs just prior to a fully developed stall and includes exaggerated, alternating drops of each wing.

5.8. Aircraft Handling Characteristics (AHC).

5.8.1. The following exercises display the handling characteristics and qualities of high-performance, swept-wing aircraft. They are exercises, not precise maneuvers. Developing a feel for handling characteristics is more important than achieving specific parameters. When observing or flying these exercises, note when the flight control surfaces are most effective and how airspeed and AOA changes affect the aircraft handling characteristics.

5.8.2. Variations in aircraft rigging, coupled with flight control inputs, may cause as severe wing rock or other abnormal rolling tendencies (e.g., while executing AHC maneuvers, bank angle exceeds 90 degrees or stabilizes over 60 degrees). If aircrews suspect rolling tendency is abnormal, they should discontinue the maneuver, recover the aircraft, and consider conducting a controllability check if necessary. Write the aircraft up in the AF Form 781 following completion of the mission.

5.9. Full Aft-Stick Stall.

5.9.1. This stall demonstrates aircraft characteristics throughout the stall regime and shows the importance and effectiveness of relaxing backstick pressure during a stall recovery. In this stall, the stall progresses far beyond the situation encountered in normal flight or approach-to-stall training. The full aft-stick stall may be flown either configured or in the clean configuration.

5.9.2. This exercise demonstrates the aircraft's stability in a stall, the ability to recover from any stall simply by relaxing backstick pressure, and the excessive altitude lost when recovering from a stall without using increased power. Always consider increasing power to minimize altitude loss in an inadvertent stall recovery.

5.9.3. Begin in level flight below FL 200 with power set at 80 percent RPM minimum IAW AFMAN 11-2T-38V3 AETC Supplement.

5.9.4. As airspeed decreases, hold the pitch constant by smoothly and steadily pulling the stick straight back to the stop with no aileron inputs. Mild wing rock is normal as AOA increases.

5.9.5. Approaching full aft stick, wing rock occurs, and a high sink rate develops. Keep the ailerons neutral and the stick full aft against the stop. Note the buffet and AOA progression—especially the definite increase in buffet intensity more than 0.8 AOA, full stall around 1.0 AOA, and fully-developed stall at 1.1 AOA. In the fully developed stall with gear and flaps down, pitch stabilizes slightly nose-low, airspeed settles around 140 KCAS, AOA reaches the stop at 1.1, and vertical velocity increases to a 6,000-fpm descent. In the fully developed stall in a clean configuration, vertical velocity displayed in the aircraft can increase to a 9,950-fpm descent, but actual descent rate may be significantly higher.

5.9.6. After the stall is fully developed, recover by leaving the power alone and relaxing backstick pressure. As the airspeed increases, smoothly reapply backstick pressure and add power as required. Recover to a level-flight attitude. Use caution not to overspeed the gear and (or) flaps during the recovery.

5.9.7. Slight variations in aircraft rigging, coupled with flight control inputs, may cause severe wing rock**.** If bank exceeds 90 degrees or stabilizes over 60 degrees, discontinue the exercise and recover the aircraft from the stall. If the aircraft displays abnormal rolling tendencies, follow guidance in **paragraph 5.8.1**. Write the aircraft up in the AF Form 781 following completion of the mission. Watch for potential gear or flap overspeed if configured.

5.10. Simulated Trim Failure.

5.10.1. Simulated inoperative trim familiarizes pilots with the stick pressures required when the stabilator trim fails. If the pilot releases pressure on the control stick after the stabilator trim has failed, the stick should move to the trimmed position and the aircraft aerodynamically hunts for the trimmed airspeed.

5.10.2. Begin with airspeed above 300 KCAS and trim the aircraft for level flight. Without re-trimming, slow the aircraft to normal final approach airspeed. As the airspeed decreases below 240 KCAS, configure the aircraft with gear and full flaps. Note the increase in stick forces as the airspeed decreases and the configuration changes. One technique is to press the TAKE OFF TRIM button to observe how it may alleviate excessive stick forces if the trim button has failed.

5.10.3. After experiencing the pressures at final approach airspeed, re-trim the aircraft to relieve the stick pressures. Without trimming the aircraft, execute a simulated go-around, retracting the gear and flaps, and accelerate to an airspeed above 300 KCAS. Note the increasing stick pressures associated with the configuration and airspeed changes. Turn the aircraft and note how increased bank helps maintain altitude and provide relief from the constant forward stick pressures.

5.10.4. After completing the exercise, and before any other maneuvering, re-trim the aircraft. If approach-to-stall indications are encountered at any time, simultaneously execute stall recovery procedures and re-trim the aircraft to eliminate unwanted stick pressures.

5.11. Rudder Effectiveness at Slow Speed.

5.11.1. This exercise demonstrates flight characteristics during the landing phase and the measurable delay between the time a rudder input is applied and the time it takes effect on the aircraft. With the aircraft configured with gear down and flaps at any setting (e.g., full, 60 percent, or no-flap), apply varied amounts of rudder inputs for varying lengths of time and examine the roll characteristics.

5.11.2. First, configure the aircraft and achieve a level attitude and 45 degrees of bank with approach-to-stall parameters (approximately 0.8 AOA) simulating a level final turn traffic pattern stall.

5.11.3. Then, as quickly as possible, apply full top rudder and wait until the aircraft begins to react. At that time, neutralize the rudders and note how the aircraft over-corrects to approximately 45 degrees of bank in the opposite direction. Maintain neutral aileron inputs to isolate rudder characteristics. Note the effectiveness of the rudder with full deflection and the delay between rudder input and aircraft reaction.

5.11.4. Using the same setup up as in **paragraph 5.11.2**, now apply full top rudder and immediately take out the input before the aircraft begins to react. The aircraft tends to right itself close to level flight. **Note:** When applying near-full rudder deflection, it is important to return the rudder to neutral quickly to avoid excessive bank in the direction of rudder deflection.

5.12. Aileron Effectiveness Exercise.

5.12.1. This exercise demonstrates the increased effectiveness of the ailerons at low G-loads and AOA. With the power set between 85 percent RPM and MIL power, roll the aircraft at various G loads and AOA using only the ailerons. One technique is to establish a 20-degree nose-high pitch attitude, set the power at approximately 90 percent RPM, and allow the airspeed to decrease to 150 KCAS. At 150 KCAS, increase backstick pressure to attain moderate buffet. Maintain this buffet and roll the aircraft using the ailerons. Note the roll rate. Next, while maintaining the moderate buffet and the same aileron deflection, smoothly unload the aircraft to approximately 0.5 G. Note how the roll rate increases. Ailerons become more effective as the angle of attack decreases, regardless of airspeed. Relaxing backstick pressure reduces angle of attack, thereby increasing aileron effectiveness.

5.12.2. Another technique is to set approximately a 10-degree nose-high pitch attitude, set the power at approximately 90 percent RPM, apply aileron in one direction and enough rudder in the opposite direction of the aileron deflection to maintain level flight. Then, increase backstick pressure and observe that the ailerons become less effective as AOA increases, and the aircraft begins to roll in the direction of the rudder input. Next, while maintaining the same aileron deflection, begin to push the stick forward reducing the AOA and observe that the aircraft begins to roll in the direction of the aileron deflection as the rudder input is lessened as the AOA decreases.

5.13. Turn Reversals.

5.13.1. This exercise demonstrates the tactical usefulness of turning the aircraft with ailerons alone under a low AOA condition vice turning the aircraft with the rudder alone under higher AOA conditions. The order in which the turns are accomplished is not important but both turns should be flown between 350 and 400 KCAS with a minimum of MIL power.

5.13.2. For both turns, roll the aircraft into approximately 90 degrees of bank and increase the backstick pressure to achieve approximately 4 Gs. Be careful not to exceed the asymmetrical G limits of the aircraft during this exercise.

5.13.3. After establishing approximately 4 Gs, accomplish one reversal by unloading the aircraft and using only the ailerons to quickly reverse the lift vector, and establish a 4 G turn in the opposite direction. Note how quickly the aircraft accomplishes the turn and how little airspeed is lost during the reversal.

5.13.4. After establishing approximately 4 Gs again, accomplish one reversal by using only the rudder. Altitude and energy will determine whether to use the top or bottom rudder. If using the top rudder, note the airspeed bleed off during the reversal. If using the bottom rudder, note the altitude loss. In both cases, the reversal will be slower than the one accomplished with ailerons and low AOA.

5.13.5. This exercise has applicability to aircraft engaging in basic fighter maneuvers (BFM). As a defensive aircraft maneuvers at the bottom of the fight airspace, just above the fight floor, the pilot may choose to use top rudder to reverse direction instead of unloading the aircraft and using ailerons because top rudder will cause the aircraft to gain altitude in the turn. Conversely, if the pilot were to unload and use a rapid aileron roll to reverse the turn, the aircraft will descend, potentially through the fight floor.

5.14. Accelerated Stall.

5.14.1. This stall demonstrates the effect that increasing AOA has on turning performance and airspeed loss. For this exercise, use approximately 300 KCAS to decrease the necessary G loading and the potential to exceed G limits and to reduce the time required to reach the increased buffet or mild wing rock.

5.14.2. Begin by entering a 2 to 3 G turn with MIL power and approximately 300 KCAS. Increase the bank and backstick pressure as required to achieve the light buffet in a level turn. Note the turn rate and "light tickle". This is the optimum turn performance for the T-38.

5.14.3. Then, rapidly increase the bank and backstick pressure to achieve either increased buffet or mild wing rock. Note that the turn rate will increase initially, but as the AOA continues to increase, the turn rate will decrease, and the airspeed loss will increase. This is also very evident during HUD VTR review during the debrief.

5.14.4. Without reference to any cockpit indications, the pilot should be able to note when the AOA has increased beyond a useful point. Next, relax the backstick pressure to decrease the AOA and continue the turn with a light buffet.

5.14.5. This exercise has applicability whenever a pilot demands a higher turn rate or a smaller turn radius than the aircraft can sustain at the given power setting, altitude, weight, velocity, configuration, and G-loading. Whether in the break turn for an overhead pattern or a break turn for a BFM fight, pilots must recognize whenever the AOA has increased beyond a useful point and the aircraft is no longer responding correctly, and they must be able to make the appropriate correction, even without referencing cockpit instruments.

5.15. Pitchback.

5.15.1. A pitchback is similar to an Immelmann except it begins with a bank angle greater than 0 degrees (but less than 90 degrees) and uses less altitude. The objective is to minimize turn time while maneuvering using visual references. Concentrate on the simple mechanics of flying a pitchback without regard to energy level.

5.15.2. Enter the pitchback from level flight with 450 to 500 KCAS. With the power at MIL, roll to the desired bank angle, neutralize the ailerons, and apply backstick pressure to attain

4.0-5.0 Gs. Maintain 4.0-5.0 Gs or a light buffet as airspeed decreases and a straight-nose track through approximately 180 degrees of turn.

5.16. Sliceback. A sliceback is similar to a split-S except it begins with a bank angle greater than 90 degrees (but less than 180 degrees) and uses less altitude. The objective is to reverse direction of travel using potential energy (altitude) to maintain or gain airspeed. Enter the sliceback with 200 to 300 KCAS. With the power stabilized at MIL, roll to the desired bank angle, neutralize the ailerons, and apply backstick pressure to attain the light buffet. Maintain the light buffet and a straight-nose track through approximately 180 degrees of turn. The higher the entry airspeed, the more pilots need to watch the Gs at the bottom, and use caution for rolling inputs which could cause an asymmetrical over-G.

5.17. Pitch-to-Slice Exercise. Start the exercise by executing a pitchback at 450 to 500 KCAS at MIL power and a bank angle greater than 0 degrees (but less than 90 degrees). The pilot should turn their head to look straight back toward the tip of the vertical tail; pick a point above them (a cloud if available; if not available, pick an imaginary point); and execute a 4.0-5.0 G straight pull. As the aircraft pulls through the horizon (at greater than 90 degrees of bank), continue with a sliceback with a straight pull at the light buffet. Continue to look at the vertical tail and pick a point on the ground to pull to. The exercise is complete when the aircraft returns to level flight in a bank greater than 0 degrees (but less than 90 degrees). This maneuver teaches a reliance on visual lookout and clearing while sensing bank and pitch by looking outside the cockpit as well as flying the aircraft by feel for buffet and G.

5.18. Low-Speed Stability Exercise.

5.18.1. Commonly referred to as the "stab ex," or "stab demo," this exercise demonstrates the stability potential of high-performance aircraft at extremely low airspeeds. Establish a 60-degree nose-high pitch attitude using the gun cross and set power at a minimum of 85 percent RPM. Use the power setting to control the airspeed bleed off and altitude gain.

5.18.2. As the airspeed decreases through 170 KCAS, smoothly unload the aircraft. With the aircraft unloaded, note how far the airspeed decreases without stall indications or loss of control. As the aircraft passes level-flight attitude, apply full backstick pressure and attempt to maintain level flight. Note the initial complete ineffectiveness of backstick pressure followed shortly by onset of stall indications.

5.18.3. Once again, unload the aircraft and note how stall indications cease. Maintain positive G until reaching an airspeed between 175 and 200 KCAS; then recover the aircraft to level flight. Do not move the throttles until greater than 175 KCAS unless required for safety. Maintain oil system limitations throughout this maneuver. If the airspeed decreases below stabilator effectiveness, the aircraft will immediately stall and may enter post-stall gyrations.

5.18.4. Because the coefficient of lift for a symmetrical airfoil is always zero at 0 G, the wing cannot exceed the critical AOA. Therefore, when faced with a nose-high, low-airspeed, unusual attitude, unloading the aircraft will ensure aircraft control as long as possible.

5.19. Slow Flight. Slow flight demonstrates the low-speed handling characteristics of the T-38 and emphasizes the importance of smooth control inputs during this flight condition. After configuring, slow to 10 knots below computed final approach airspeed. Normally accomplish slow flight in level flight; however, a slight descent may be required. The AOA indexer lights will show a slow indication (approximately 0.7 AOA). Perform coordinated turns, using various angles of bank. Note how the AOA changes with fore and aft stick movements, throttle movements, and changes in bank.

5.20. Slow Flight Recovery Demonstration.

5.20.1. This demonstration shows the effects of various flap settings on aircraft acceleration at low airspeeds. It is particularly applicable to aircraft handling during the flare and (or) go-around.

5.20.2. In level flight with gear down, full flaps, slow flight airspeed, and a constant power setting, retract the flaps to 60 percent. Note how the aircraft accelerates and the AOA decreases. Reestablish full flaps and slow flight airspeed. When stabilized in level flight and maintaining a constant power setting, fully retract the flaps. Note that, as the flaps pass through 60 percent, the aircraft starts to accelerate and the AOA decreases. Maintain level flight and do not allow the aircraft to develop a descent rate. As the flaps continue toward the full-up position, the buffet increases, airspeed decreases, and aircraft approaches a stall. Once the flaps are up, use power as required to maintain final approach speed to complete the demonstration. If approach-to-stall indications are encountered, execute the approach to stall recovery procedures provided in **paragraph 4.16.3** to recover the aircraft.

5.21. Supersonic Flight.

5.21.1. Due to its unique nature, this type of flight requires additional planning considerations. Prior to the preflight briefing, check the forecast temperature at the supersonic run altitude, and review engine operating limitations, associated emergency procedures, the afterburner climb schedule, and any local coordination requirements and restrictions. During flight, use actual outside air temperature (OAT) displayed on the MFD DATA display page to verify the minimum Mach number.

5.21.2. The single significant consequence of going supersonic is wave drag. This increase in total drag starts slightly above critical Mach (noticeable by .95 Mach). The transition from subsonic to supersonic flight occurs with little apparent aircraft reaction. At Mach 1, a detached shock wave forms in front of the pitot tube causing the altimeter and vertical velocity indications to jump. Because the engines are operating in an area of increased stall susceptibility, use caution when terminating the supersonic run. Smoothly retard one throttle out of afterburner and ensure proper engine operation before retarding the second throttle out of afterburner. Also, do not allow the airspeed to decrease below the IMN recommended in the flight manual. Finally, use caution to prevent exceeding Mach 1 during the descent below FL 300.

Section 5C—Traffic Pattern Stalls and Approach-to-Stall Training

5.22. Purpose.

5.22.1. The Air Force has lost many lives and aircraft due to traffic pattern accidents. It is particularly easy to put the T-38 into an unrecoverable stall or sink rate situation before the indicators get the pilot’s attention.

5.22.2. Stall training in the MOA develops many critical skills that can prevent catastrophe in the traffic pattern. Stall training keys on the important areas of recognition and recovery. Approach-to-stall training is not a precise maneuver. It is designed to teach stall recognition and stall recovery. Although approach-to-stall training simulates conditions that may arise in the traffic pattern, this training is applicable to all phases of a T-38 mission. Practice with flaps up, 60 percent or full flaps. Note the less defined onset of the increased buffet at lower flap settings. There will be a greater possibility for a secondary stall during no-flap approach-to-stall training.

5.22.3. It is important that pilots can recognize all approach-to-stall characteristics. Individual aircraft can have slightly different handling characteristics near the approach-to-stall region. The definite increase in buffet intensity can occur slightly before or after the aural, HUD, or MFD stall warnings (triggered at and above 0.80 AOA). To gain an understanding of the feel of the aircraft at the definite increase in buffet intensity, the AC/instructor can brief to ignore the aural, HUD, or MFD stall warnings during MOA stall training. Another reason for needing to understand the feel of the aircraft at the definite increase in buffet intensity is so that, during the stall recovery, pilots can maximize aircraft performance by flying just shy of the definite increase in buffet intensity. It is not abnormal during a wings-level, MAX power stall recovery to be at or above 0.80 AOA and have the aural, HUD, or MFD stall warnings activated.

5.23. Turning Approach-to-Stall Exercise. Establish the landing configuration, with parameters IAW AFMAN 11-2T-38V3 (at or below FL 200 and set power at 80 percent RPM minimum no later than deceleration through 200 KCAS) and fly a simulated final turn with an intentional error. Possible errors include a level final turn, a diving final turn, or an overshooting final turn. For the level final turn, maintain a constant bank angle and allow the airspeed to decrease until reaching the definite increase in buffet intensity, or the aural, HUD, or MFD stall warnings. For errors other than the level final turn, progressively increase the bank and backstick pressure. For any of the above examples, as the pilot detects a definite increase in buffet intensity, the aural, HUD, or MFD stall warnings, however briefed by the AC/instructor, immediately execute the stall recovery.

5.23.1. Level Final Turn Setup/Characteristics. As a technique, after establishing a normal final turn (approximately 45 degrees of bank and 3,000 fpm descent rate) roll out to approximately 30 degrees of bank and raise the nose 4 to 5 degrees while pulling the power no lower than 80 percent RPM IAW AFMAN 11-2T-38V3. The characteristics will be a slower stall onset rate and slower rate of recovery. This setup is a useful training aid identifying the different stall characteristics listed in **paragraph 5.7**.

5.23.2. Diving Final Turn/Overshooting Final Setup/Characteristics. As a technique, after establishing a normal final turn, continue to increase bank to 60 degrees of bank while increasing backstick pressure and pulling the power no lower than 80 percent RPM minimum. The characteristics will be a quicker stall onset rate and proportionally quicker rate of recovery.

5.24. Landing Attitude Approach-to-Stall Exercise. Establish the landing configuration, set the power (80 percent RPM minimum at or below FL 200 IAW AFMAN 11-2T-38V3**)**, attain a landing attitude, and allow the airspeed to decrease. A common technique is to maintain level to approximately 1,000 fpm vertical velocity. As the pilot detects a definite increase in buffet intensity, or the aural, HUD, or MFD stall warnings, however briefed by the AC/instructor, execute the stall recovery. Use greater finesse to recover due to the slow stall speed in a wings-level situation.

5.25. Stall and Approach-to-Stall Recovery Completion. Recovery is complete when the descent is stopped, a positive controlled wings-level climb is established (altimeter and vertical velocity reversed), and airspeed is not decreasing.

Section 5D—Abnormal Flight Recoveries

5.26. Purpose. Pilots may find themselves in a flight attitude where loss of aircraft control is imminent unless a proper recovery is immediately initiated. Although the recoveries indicated in paragraphs **5.28** and **5.29** may appear simple, the events leading up to them can result in confusion or disorientation that would severely hamper recovery efforts.

5.27. Abnormal Recovery Setup Guidelines.

5.27.1. During any abnormal flight recovery setup, IP vigilance is paramount. Do not compromise safe flight during IP demonstration or student performance of recovery training. In all situations where transfer of aircraft control is involved, it will be accomplished IAW AFMAN 11-2T-38V3.

5.27.2. Abnormal flight recovery training should be thought of in the following three phases of proficiency: (**Note:** These phases are not necessarily linked to a particular block of training but are linked to the student's flying abilities and situational awareness.)

5.27.2.1. The IP demonstrates and flies the complete setup and recovery while delivering appropriate verbal instruction. Once the student has seen the recovery demonstrated and has a basic grasp of why the recovery training is performed, the IP begins setting up recovery situations for the student and talking the student through the recovery procedures.

5.27.2.2. When the student shows proficiency in the recovery procedures, the IP begins setting up observable situations requiring an abnormal flight recovery. When the setup is completely developed, the IP transfers control of the aircraft to the student, using the verbal command, "*You have the aircraft— recover*". The student takes the aircraft and recovers from the abnormal attitude.

5.27.2.3. Once the student has seen all the different types of setups and can confidently and proficiently recover from various situations, the IP sets up abnormal flight recoveries randomly throughout the area profile. Once the setup is complete, the IP directs the student to take the aircraft with "*You have the aircraft*". The student takes the aircraft with proper transfer procedures and recovers in the appropriate manner.

5.27.3. Once a student learns the correct stick and throttle inputs, it is imperative to build judgment and ability to recognize abnormal flight and the need to accomplish an abnormal flight recovery. The IP should concentrate primarily on developing the student's SA.

5.28. Nose-High Recovery.

5.28.1. Use a nose-high recovery to return to level flight following an unrecognizable or potentially unsafe nose-high attitude. Choose a recovery technique commensurate with the severity of the nose-high attitude. Make any required power increases smoothly to prevent engine compressor stalls and flameouts and use no less than 80 percent RPM during the setup of the nose-high recovery.

5.28.2. Some instances, such as moderate pitch attitudes or near wings-level attitudes, may simply require relaxing backstick pressure and maintaining slight G forces while recovering to level flight. However, extreme pitch attitudes may require rolling toward the nearest horizon and pulling the nose down to a level-flight attitude. In addition, extremely low airspeeds may require an unloaded recovery resembling the low-speed stability exercise.

5.28.3. With all these techniques, if airspeed is sufficient as the nose approaches the horizon, rollout and return to level flight. If airspeed is insufficient to comfortably maintain level flight (less than approximately 200 KCAS) as the nose passes the horizon, delay the rollout until the nose is below the horizon and continue to accelerate in a slight descent until the aircraft can return to level flight.

5.29. Nose-Low Recovery.

5.29.1. Use a nose-low recovery to return to level flight or a slight climb following an unrecognizable or potentially unsafe nose-low attitude in the minimum turn radius. The minimum turn radius is achieved by maintaining the aircraft at the aerodynamic or G limit between approximately 250 KCAS and corner velocity (approximately 400 KCAS). To achieve this, quickly roll the aircraft to the nearest horizon and apply backstick pressure to achieve the moderate buffet or desired recovery G (whichever comes first). Normally, 4.0 to 5.0 Gs are sufficient for an expeditious recovery in the MOA. In a nose-low recovery situation where proximity to the ground is a concern, do not hesitate to pull to the aerodynamic/G limit of the aircraft.

5.29.2. Adjust power and (or) speed brakes to maintain the airspeed between approximately 250 and 400 KCAS. The “feel” of the aircraft may be used to help analyze airspeed. If the aircraft is at the desired G limit and no buffet is felt, reduce the airspeed to minimize the turn radius. If a moderate buffet is felt prior to reaching the desired G, set the power to at least MIL until the buffet begins to go away at the desired recovery G.

Section 5E—Aerobatic Maneuvers

5.30. Purpose. Aerobatic maneuvers exploit the maneuvering envelope of the aircraft, develop skills and confidence required to employ combat aircraft, improve energy management skills, and build three-dimensional SA. Similar to transition maneuvers, aerobatics require a disciplined composite cross-check, using references inside and outside the cockpit. For example, airspeed, altitude, and G loading must be verified inside the cockpit; clearing and ground track control must be accomplished using outside references; and attitude and area orientation usually require both inside and outside references. When available, use outside references to enhance clearing and maneuver precision.

5.31. Aerodynamic Parameters. The mechanics of performing aerobatic maneuvers in the T- 38 are essentially the same as in previous training, but differences exist in power settings, airspeeds, G loadings, required airspace, and handling characteristics. Entry parameters for each maneuver are summarized in **Table 5.1**. Fly all aerobatic maneuvers using the range of airspeeds and power settings within specified parameters. Remain in visual meteorological conditions (VMC) during aerobatic maneuvering.

Table 5.1. Summary of Entry Parameters for Aerobatics.

Maneuver	Airspeed	Power Setting
Lazy Eight	350 to 400 KCAS	95 percent RPM
Barrel Roll	375 to 400 KCAS	95 percent RPM
Loop	500 KCAS	MIL power
Split-S	200 KCAS	MIL power
Immelmann	500 KCAS	MIL power
Cuban Eight		
Cloverleaf	450 KCAS	MIL power

5.32. Factors Affecting Aerobatic Maneuvers in the Vertical. Several factors work together to affect the altitude required to complete over-the-top or split-S type maneuvers. They are entry airspeed, power setting, aircraft weight, and pilot technique. The following general rules of thumb apply when flying aerobatic maneuvers:

5.32.1. Turn radius depends on G loading and airspeed.

5.32.2. Holding other parameters constant, higher G loading reduces the altitude required to complete the maneuver, while higher airspeed increases the altitude required.

5.32.3. Higher power settings improve turn performance at low airspeeds. Thrust offsets the higher induced drag present under higher AOA, thus preserving airspeed (and, therefore, G available). In contrast, a lower power setting combined with high-induced drag degrades the ability to acquire or sustain G available. Combinations of these variables can cause up to a 2,000 to 3,000 feet difference in altitude required for an over-the-top maneuver.

5.32.4. As a guide, plan for at least 10,000 feet when accomplishing aerobatics in the vertical plane (over-the-top and split-S-type maneuvers).

5.33. Energy and Airspace Requirements.

5.33.1. **Table 5.2** shows distances from the start of the actual maneuver to completion of the maneuver. Theses distances do not include any airspace used in setting up the maneuver or any airspace used to perform the flyout following the maneuver.

Table 5.2. Airspace Requirements.

Maneuver	Lateral Distance Required	Altitude Required
Lazy Eight	2 nm forward; 6 nm in direction of turns	4,000 to 6,000 feet above
Barrel Roll	3 nm forward	4,000 to 8,000 feet above
Loop	1 to 2 nm forward	8,000 to 10,000 feet above
Split S	1 nm forward; 1 nm behind	7,000 to 10,000 feet below
Immelmann	1 nm forward	8,000 to 10,000 feet above
Cuban Eight	1 nm forward; 2 nm behind	
Cloverleaf	3 nm forward; 2 nm in direction of first turn; 3 nm opposite direction of first turn	

5.33.2. Entering an over-the-top maneuver involves flying the aircraft to a point where entry parameters can be reached with sufficient airspace above or below required to complete the maneuver. The overall energy level must be assessed and adjusted, if required, to meet entry parameters.

5.33.3. Once the desired energy level has been attained, the aircraft must be flown to an altitude that permits starting the maneuver. If this involves a descent, one technique is to lead the pullout by 10 knots and (or) 500 feet for each 10-degree nose-low (for example, for 50-degrees nose-low, lead the pullout by approximately 50 knots and (or) 2,500 feet). If the over-the-top maneuver involves achieving the starting altitude at the completion of the maneuver, ensure that the altitude for starting the maneuver allows for a buffer below the starting altitude so that airspace limits are not violated (do not start the maneuver at the airspace floor with no room below for error).

5.33.4. Energy can be affected by how the maneuver is flown. Low energy can be affected in one of two ways. First, if airspeed is relatively high, but altitude is low, fly the first portion of the over-the-top maneuver using 4.0 to 4.5 Gs (vertical airspace permitting). Then use the light tickle and "float" the upper portion of the pull. This technique may offer the opportunity to gain energy during the loop. If airspeed is low (regardless of altitude), pull closer to 5.0 Gs initially to make it over the top with greater than the minimum over-the-top airspeed of 150 KCAS. This should allow the aircraft to complete the loop; however, this technique may result in an overall energy loss. High energy can easily be reduced by increasing induced drag (higher AOA and G loading) during the maneuver. Additionally, over-the-top maneuvers will lose approximately 500 feet of energy for each maneuver (loop) or leaf (Cuban Eight or cloverleaf).

5.34. Aileron Roll. Aileron rolls can be performed at any airspeed and at various pitch attitudes. The T-38 is capable of an extremely high roll rate, so relax control pressure during the last part of the roll to prevent overshooting the wings-level attitude. Stay smooth, and don't attempt to keep the nose on a point. Adhere to flight manual restrictions when performing continuous aileron rolls.

5.35. Lazy Eight.

5.35.1. Entry parameters are 350 to 400 KCAS using 95 percent RPM.

5.35.2. From straight-and-level flight, pick a point 90 degrees off the nose (in the direction of the first turn). Start a smooth, climbing turn in that direction so the nose describes an arc above the horizon, reaching the maximum pitch attitude at approximately 45 degrees of turn.

5.35.3. One technique is to drag the landing gear handle (left turn) or NAV backup control panel (right turn) across the horizon. This should equate to approximately 30 degrees to 40 degrees nose-high. The nose should then start back down, passing through the horizon after 90 degrees of turn with approximately 90 degrees of bank at approximately 200 KCAS. As the nose passes through the horizon, locate a reference point out the top of the canopy approximately 90 degrees off the nose and begin a smooth, gradual rollout and pull-up, planning to reach the maximum nose-down pitch attitude after approximately 135 degrees of turn. At this point, the canopy bow should be on or near the horizon (approximately 20 degrees to 30 degrees nose-low).

5.35.4. Complete the first half of the maneuver after approximately 180 degrees of turn in a wings-level flight attitude with the entry airspeed. Enter the second half of the maneuver by turning in the opposite direction. Complete the lazy eight with the aircraft headed in the original direction at entry airspeed.

5.35.5. The emphasis is on flying a smooth, symmetrical maneuver with constantly changing parameters.

5.35.6. A lazy eight will require approximately 2 NM forward, 6 NM laterally—in the direction of the turns—and 4,000 to 6,000 feet above.

5.36. Barrel Roll.

5.36.1. Entry parameters are 375 to 400 KCAS using approximately 95 percent RPM.

5.36.2. The barrel roll is a coordinated roll in any direction in which the nose of the aircraft describes a circle around a point. Choose a point on or slightly above the horizon and maneuver the aircraft to attain entry parameters in a wings-level attitude with the aircraft 30 to 45 degrees to the side of the selected point. Begin a rolling pull in the desired direction and use smooth control inputs to maintain a circular flightpath around the reference point. The aircraft should be (1) in 90 degrees of bank directly above the selected reference point, (2) in a wings-level inverted attitude when passing abeam the reference point at 180 degrees of roll, (3) in 90 degrees of bank directly below the selected reference point, and (4) in a wings-level upright attitude when completing the maneuver. The pitch at (1) and (2) should be the same number of degrees above and below the reference point.

5.36.3. Another technique is to begin the maneuver by choosing a desired roll axis from which to fly the barrel. Offset this roll axis the number of degrees that defines the size of the roll (normally 30 to 45 degrees). Pick a point on the horizon twice the number of degrees of the offset in the desired direction of the roll. For example, if selecting a 45-degree offset, pick a point 90 degrees off the nose.

5.36.4. Begin a coordinated roll and pull to fly the nose of the aircraft to be inverted at the point. Continue the coordinated roll or pull to fly the aircraft back to the original offset heading. The aircraft should be at 90 degrees of bank as the nose of the aircraft passes the original roll axis (both on the first and second half of the roll), and the degrees nose-high and -low at these points are defined by the number of degrees of the original offset. The ending airspeed should be approximately the same as the entry airspeed for a symmetrically flown maneuver, but symmetry is more important than finishing at entry airspeed.

5.36.5. Maintain positive G loading throughout the roll. To gain energy, use higher power settings or a lighter G loading.

5.36.6. A barrel roll will require a forward distance of approximately 3 NM and 4,000 to 8,000 feet above.

5.37. Loop.

5.37.1. Entry parameters are 500 KCAS using MIL power.

5.37.2. Begin the loop with entry airspeed and approximately 10,000 feet of usable airspace above. Smoothly apply backstick pressure until reaching approximately 4.5 to 5.0 Gs in a straight pull. Continue to increase backstick pressure to maintain the light buffet “green donut.” Ensure wings are level when passing through the horizon inverted. Maintain backstick pressure to maintain the light buffet to light tickle as Gs build to approximately 4.0 to 5.0 on the bottom side of the loop. Finish the maneuver in level flight at entry parameters, unless flowing immediately into another maneuver.

5.37.3. A loop will require approximately 1 to 2 NM forward and 8,000 to 10,000 feet of airspace from the start of the pull until maneuver completion. This does not include airspace used to set the maneuver up or post-loop maneuvering. Expect to lose 500 feet of energy per loop.

5.38. Split-S.

5.38.1. Entry parameters are 200 KCAS using MIL power.

5.38.2. The split-S is essentially the last half of a loop. Enter the split-S from a slight climb to ensure completion of the roll to the wings-level inverted attitude before the nose reaches the horizon. One technique is to begin the maneuver with 230 KCAS, pull 10 degrees nose high, unload and roll to a wings level inverted position (front cockpit reference—canopy bow on the horizon). Once inverted, neutralize the ailerons and increase backstick pressure to attain light buffet in a straight pull. Maintain the light buffet until reaching 4.0 to 5.0 Gs or the completion of the maneuver.

5.38.3. The maneuver is complete when the aircraft is wings level approximately 180 degrees from entry heading. There is no exit airspeed, although exits as high as 380 to 440 KCAS are typical. If the maneuver is intended to blend into another maneuver, the pull may be modified to attain desired follow- on entry airspeed. A split-S requires approximately 1 NM forward, 1 NM behind, and 7,000 to 10,000 feet below.

5.39. Immelmann.

5.39.1. Entry parameters are 500 KCAS using MIL power.

5.39.2. The Immelmann resembles the first half of a loop followed by a half roll at the top. Begin the Immelmann by using the same mechanics as a loop. Just prior to reaching the inverted, level-flight attitude (front cockpit reference—canopy bow on the horizon), relax backstick pressure (to approximately 0.5-1.0 G but no less than 0.0 G) and execute a half roll in either direction. Complete the maneuver in level flight 180 degrees from the original heading.

5.39.3. An Immelmann will require approximately 1 NM forward and 8,000 to 10,000 feet above.

5.40. Cuban Eight.

5.40.1. Entry parameters are 500 KCAS using MIL power.

5.40.2. Begin the Cuban eight by using the same mechanics as a loop. Continue to pull through the inverted, level-flight attitude. As the aircraft approaches a 45-degree, nose-low inverted attitude, relax backstick pressure and execute a half roll in either direction. Initially place the gun cross at approximately 45 degrees nose-low and hold it until beginning the next 4.5 to 5.0 G pull-up. In the 45-degree dive, the G loading will be approximately 0.7 to hold the dive angle and aimpoint. In the dive, look through the HUD, and pick an object on the ground and don't let it move in the HUD. Do not allow the nose to drift up as airspeed increases until initiation of the pull-up.

5.40.3. To obtain entry airspeed for the second half of the maneuver, lead the pull-up by approximately 50 knots (10 knots for each 10 degrees nose-low). Initiating a 4.5 to 5.0 G pull at 450 KCAS will allow the aircraft to descend another 2,500 to 3,000 feet before the FPM passes through the horizon. Repeat the entire maneuver, except at the 45-degree, nose-low inverted attitude, the direction of roll will be opposite that of the first roll. Complete the maneuver in level flight, at entry speed, and heading in the original direction. Make sure to use visual references and look outside while crosschecking aircraft parameters inside the cockpit frequently. This maneuver has a high potential for losing awareness on the aircraft attitude (infamous “Cuban 9”).

5.40.4. A Cuban eight will require approximately 1 NM forward, 2 NM behind, and 8,000 to 10,000 feet above.

5.41. Cloverleaf.

5.41.1. Entry parameters are 450 KCAS using MIL power.

5.41.2. A complete cloverleaf consists of four identical maneuvers (“leaves”), flown consecutively and in the same direction, with each entry heading 90 degrees from the previous one.

5.41.3. From level flight, choose a 90-degree reference point and then begin a 2.0 to 3.0 G pull- up. Approaching 45 degrees of pitch, begin a slow, rolling pull to lay the aircraft on its back at the selected 90-degree reference point. The airspeed should be between 175 to 200 KCAS as the aircraft passes through the inverted, level-flight attitude.

5.41.4. The pullout part of each “leaf” resembles a split-S. Smoothly increase backstick pressure to maintain the light buffet as the Gs increase. After passing the nose-low, vertical position, adjust backstick pressure to arrive at the level-flight attitude with entry airspeed. Continue the maneuver by starting the next “leaf”.

5.41.5. A cloverleaf will require approximately 3 NM forward, 2 NM in the direction of the first turn, 3 NM opposite the direction of the first turn, and 8,000 to 10,000 feet above. **Note:** Because most of a cloverleaf will be away from the first turn, the pilot should turn into the closest border for the first leaf.

Chapter 6

FORMATION

Section 6A—Formation Administration

6.1. Introduction. The purpose of flying formation is to provide the mutual support required to accomplish a given mission. Whether the mission is air superiority, interdiction, or close air support, mutual support is essential for mission accomplishment. More than any other type of flying, formation provides the best environment for building confidence and for teaching self-reliance, self-discipline, and the proper application of aggressiveness in military flying. Procedures used in formation typically remain the same whether in two-ship or larger formations. Differences in procedures will be highlighted throughout this chapter.

6.2. Responsibilities.

6.2.1. Flight Lead. The flight lead is ultimately responsible for the safe and effective conduct of the mission. The flight lead plans, briefs, and debriefs the flight. This position gives both the authority and the responsibility to ensure the flight proceeds as intended. The flight lead must concentrate efforts on accomplishing the mission, achieving objectives, and returning with the flight intact. The flight lead must consider the capabilities of all flight members in planning a sortie. Taking this into consideration, the flight lead should optimize training for all flight members and plan missions accordingly, to include briefing mission-specific parameters.

6.2.1.1. Nav Lead. This may be used when the flight lead wants the wingman to navigate and clear. The lead flies the wing position, deconflicts within the flight, and keeps the radios (e.g., battle damage [BD] check).

6.2.1.2. Administrative (Admin) Lead. This is used to pass lead responsibilities to another member of the flight. The admin lead is expected to run all aspects of the profile to include navigating, managing the radios, and making changes to the profile if external conditions dictate. With an admin lead change, the aircraft within the flight are administratively renumbered to match the position being flown (e.g., Sling 11 is now "2" for intraflight communication purposes but retains Sling 11 as his or her callsign). However, the flight lead still retains ultimate authority for the formation. Flight leads should consider passing the squawk with the admin lead to allow the aircraft primarily responsible for clearing outside the flight to have the TCAS available (e.g., when splitting fuel and number 2 gets the lead during an FT or PIT mission, or when number 3 is given the lead during a four ship).

6.2.1.3. Tactical Lead. This may be used when the flight lead needs the wingman to lead an event or segment of the flight. In this case, the wingman would pick up tactical, navigation, and radio responsibilities, but not the overall flight leadership responsibility.

6.2.2. Wingmen. Wingmen must be tasked commensurate with their skill to achieve the mission. Tasks include mission planning, threat study, and providing information in the brief. Once airborne, the wingman must execute the plan as briefed. Whether the flight is taxiing out to the runway or flying up initial, look and sound good, match lead's configuration, and always anticipate, never assume, and always have an aggressive attitude. To contribute successfully, wingmen must prioritize tasks based on the phase of flight. Accomplishing the following responsibilities in order will help safely execute the mission: VIS, COMM, MUTUAL SUPPORT! In other words, stay visual, be in the perfect formation position and deconflict from lead, be on the correct frequencies, then do everything else (FENCE in (reference **paragraph 6.5.2**), managing avionics, setting up weapons, etc.). As proficiency and task management allow, the wingman should also strive to back up the flight lead.

6.2.3. Flight Discipline. The effectiveness of a formation mission is highly dependent on solid flight discipline, which begins with mission preparation and continues through briefing, ground operations, flight, and debrief. Mission effectiveness requires an in-depth knowledge of flight rules, unit standards, and procedures. When lead establishes the precedent, those orders must be followed. However, the wingman must speak up rather than allow the flight to enter an unsafe or unauthorized situation. If directed tasks are beyond a wingman's ability, the wingman must immediately inform lead. Uncompromising flight discipline is essential for successful mission execution.

6.2.4. Collision Avoidance. Each aircrew member shares the responsibility of avoiding a collision. The wingman retains primary responsibility for deconfliction between flight members. This responsibility transfers to lead if the wingman becomes blind or is placed in a blind cone during maneuvering. If any conflict develops between flight members, they should take immediate action and then transmit their intentions as time permits ("*Reno 2 is going high*"). Avoid attempting to direct other flight members because they may misunderstand or be unable to perform the directed course of action.

6.2.4.1. Lead. Flying in the lead position allows the most flexibility to clear visually for the flight while interpreting traffic calls from air traffic control (ATC). Lead should focus on avoiding traffic and maintaining a safe altitude above the ground. If a wingman becomes blind or placed in a blind cone during tactical maneuvering, lead assumes responsibility for intraflight deconfliction. If a wingman calls "padlocked" (has to keep eyes on the other aircraft to avoid losing sight), the wingman maintains deconfliction. Lead should maneuver to alleviate the padlock situation.

6.2.4.2. Wingmen:

6.2.4.2.1. Normally, wingmen are responsible for ensuring deconfliction. If any conflict exists between flight members, the wingman should maneuver predictably and then transmit specific intentions, affording the other aircraft a means to deconflict. For example, the wingman will transmit, "*Reno 2 is going low*", while crossing lead's flightpath in a delayed turn nearly in-plane. The transmission indicates Reno 2 will be maneuvering below lead to remain well clear. Lead may then maneuver anywhere away from the wingman's predictable plane of motion (POM). This technique prevents an aircraft from directing a course of action the other aircraft may be unable to perform.

6.2.4.2.2. While maintaining position in formation, wingmen also have standard visual lookout responsibilities. If they discover a traffic conflict, they will initiate a directive call to eliminate any conflict. They will follow with a descriptive call to allow other flight members to acquire the traffic and maneuver appropriately. The descriptive call should follow the bearing, range, and altitude (BRA) format, for example, "Reno 21, climb, traffic, 12 o'clock, 1 mile, level." Wingmen will also provide mutual support by maintaining SA through calls from controlling agencies describing the position of potential traffic conflicts.

6.2.5. Visual Lookout. All flight members share visual lookout responsibilities. Excellent visual lookout depends on the ability to focus and refocus the eyes at appropriate ranges throughout the flight. Lookout priorities can change at a moment's notice, depending on the mission, weather, threats, altitude, and formation.

6.2.5.1. Lead. In addition to briefing visual lookout responsibilities, lead must clear in the direction of the flight, focusing on avoiding traffic and maintaining a safe altitude above the ground. While employing in a tactical formation, lead shares responsibility with wingmen to visually clear for threats and traffic conflicts.

6.2.5.2. Wingman. The wingman's primary job is to execute disciplined visual lookout without sacrificing proper formation position or deconfliction responsibilities. Emphasis on deconfliction is directly related to aircraft proximity. For example, in fingertip, deconfliction requires more attention than in route or tactical. Beyond fingertip, the wingman must continue an active and systematic visual lookout with an emphasis on deconflicting with other flight members. Visual lookout priorities should be briefed by lead.

6.2.5.3. Traffic Conflict. Initiate a directive call to eliminate immediate conflict. Follow-up the directive call with a descriptive call to allow other flight members to acquire the traffic and maneuver appropriately ("*Buzz 21, climb, traffic 12 o'clock, 1 mile, level*"). TCAS can aid in awareness of potential traffic conflicts but shouldn't replace a vigilant visual lookout. Cross-checking the TCAS will help to focus the pilot's visual search as well as adjust the aircraft's flightpath if necessary. Pilots will respond to all TCAS resolution advisories (RAs) IAW AFMAN 11-202V3. If a TCAS intruder will pass within 1 NM or 1,000 feet of the formation without visual contact, consider a directive call to maneuver the formation away. Pilots may use EFBs with automatic dependent surveillance-broadcast (ADSB) information only as a secondary SA enhancement tool.

6.2.6. Fuel Awareness.

6.2.6.1. All flight members must understand the factors to consider in determining joker and bingo fuel. Afterburner should not normally be used after reaching bingo fuel unless required for safety of flight. Flight members should increase their frequency of fuel checks during high fuel flow operations (e.g., extended trail (ET), fluid maneuvering (FM), and low altitude training). Lead must continually monitor the flight's fuel state and adjust the profile, frequency of ops checks, and joker or bingo, as necessary.

6.2.6.2. Unless already established on the return to base (RTB) phase of flight, wingmen will inform lead when reaching joker and bingo and receive an acknowledgment. If fuel drops below joker before informing lead, wingmen will reference the fuel state from bingo ("*Iron 2 is bingo plus 1*").

6.2.6.3. Radio Discipline and Procedures. Preface all communications to external agencies (except for wingman acknowledgment) with the complete flight callsign. Communications are a good indicator of flight discipline. Radio calls should normally begin with the full callsign ("*Ground, Sling 11, taxi 4 T-38s with Zulu*" or "*Reno 11, FENCE-in*"). Voice recognition is often a significant factor in tactical operations, but it should not be relied upon for primary identification or communications. Intraflight radio calls to a specific position should reference that position ("*Bam 2, breakout*"). Normally, flights will operate on UHF with outside agencies and very high frequency (VHF) intraflight. As a technique, VHF can be referred to as "Aux". Setting split volumes could help determine which radio is being used by lead. Wingmen should acknowledge "go" radio frequency changes with callsign and position ("*Mega 21, cleared as filed, squawk 2345, go channel 4*", acknowledgments: "*2, 3, 4*"); do not acknowledge radio frequency changes initiated with "push." In most cases, wingmen will mimic lead's radio transmissions. Use extreme caution when using call signs with single digits (i.e., Titan 1 flight) since they could be confused with intraflight call sign usage of "Titan 2" meaning the position number in the flight. After an admin lead change, the flight call sign will be used by the aircraft flying in the #1 position (even though it might be Titan 2 who is now leading the formation). Intraflight communication always uses the formation callsign plus the specific position number.

6.2.6.3.1. Lead. Ensure calls are clear and concise and combine calls when practical. Delay frequency changes or flight check-in as necessary based on wingman proficiency or flight conditions.

6.2.6.3.2. Wingmen. Change radio frequencies only when directed by lead. When performing a channel change, maintain formation position unless otherwise prescribed or briefed. During task intensive situations such as IMC fingertip, if unable to change frequencies, maintain the proper position, and communicate on the intraflight frequency until the channel change can be accomplished. To minimize head-down time, a technique is to identify the raised "5" button on the UFCP. UHF preset frequencies may be incremented or decremented via the "2" or "8" buttons by feel and then visually confirmed. Wingmen will mimic the format of lead's calls, but will provide accurate information ("*Vega 31, Ops Check*", "*1 is 2.3, 5 Gs*", "*2 is 2.1, 4.5 Gs*", etc.). Unless briefed, lead speaks for the flight when communicating with other agencies until flight split up. Wingmen will normally respond to all directive calls, unless briefed otherwise or if the wingman's action is obvious. Query lead if calls are unclear.

6.3. Visual Signals.

6.3.1. When using visual signals, use AFPAM 11-205, *Aircrew Quick Reference to Aircraft Cockpit and Formation Flight Signals,* to the maximum extent possible. Any nonstandard visual signals must be briefed. Do not hesitate to use the radio to avoid confusion. To minimize confusion, only the pilot at the controls should give visual signals to another aircraft in the formation. Visual signals must be clear and appropriate for range (e.g., slight wing rock to reform from route versus large wing rock from tactical).

6.3.2. Wingmen should acknowledge all visual signals. This acknowledgment may take the form of a head nod, a thumbs-up, or a change in formation position as appropriate. To minimize confusion, make the head nod big and clear. If a wingman does not acknowledge a signal, it should be interpreted as a request for clarification. Repeat the signal or make a radio call. Pass visual signals down the line, if appropriate.

6.4. Inflight Checks. Each flight member must accomplish required checks IAW the flight manual. Visual signals or radio calls from lead may be used to initiate required checks for the appropriate phase of flight. Wingmen should be given an appropriate amount of time to complete inflight checks. Lead should adjust the formation position, if necessary, based on wingmen's skill level. Lead should also avoid any abrupt maneuvering to afford wingmen time to accomplish cockpit tasks without compromising deconfliction abilities. While performing inflight checks, wingmen will continue to prioritize their attention on lead, using only short glances to perform cockpit duties.

6.4.1. Ops Check. When conducting ops checks on the radio, use the following format: "*Buzz 31, Ops Check, 1 is 2.3, 5.5 Gs*", "*2 is 2.2, 5.8 Gs*". If accomplishing an admin portion of the mission (departure, RTB, etc.), Gs need not be included. Upon completion of ops checks following high-G maneuvering (i.e., > 4 Gs), pilots may reset their G meter.

6.4.2. FENCE Check. "FENCE-in" is normally directed by lead upon entering the MOA/route. "FENCE-out" will normally be accomplished exiting the MOA or route at lead's direction. Items to accomplish will vary with the mission type and will change during follow-on training. Pilots may accomplish items in any meaningful sequence or cockpit flow. Use the following format ("*Bully 01 Fence In/out*", "*2, 3,* and *4*"). The FENCE acronym is one good technique for accomplishing required items in FT and is explained as follows:

6.4.2.1. **F** ire Control - Master Arm and EGI Master Mode (NAV, air-to-air [A/A], or air-to-ground [A/G])

6.4.2.2. **E** mitters - TCAS, A/A TACAN, radios, and RALT

6.4.2.3. **N** AVAIDS - HSD and area setup

6.4.2.4. **C** amera - Confirm VTR on

6.4.2.5. **E** lectronic Countermeasures (ECM) – counter measures dispenser (CMD)

6.5. Lead Changes. Lead changes require a clear transfer of responsibilities from one flight member to another. During the lead change, both pilots should monitor the other aircraft to ensure separation is maintained.

6.5.1. Do not initiate lead changes with the wingman further aft than a normal fingertip or route position, or greater than 30° aft from line abreast (LAB). When a lead change is done from a close formation, the designated wingman moves out and forward to ensure wingtip separation while primarily focusing attention on lead. The wingman accepts the lead after reaching lead's 3/9 line and assumes lead responsibilities. As a technique, reference the canopy bow between the FCP and RCP to assess 3/9 line. The old lead will assume wingman responsibilities. Unless changed by the new lead, the formation will remain in the formation from which the position change was initiated. For example, if the position change was initiated from route, the flight will remain in route.

6.5.1.1. Lead Change Comm Example from Tactical Line Abreast.

6.5.1.2. Fiend 01: "*Fiend 2, you have the lead on the left/right*."

6.5.1.3. Fiend 02: "*Fiend 2 has the lead on the left/right*."

6.5.2. Three- and four-ship lead changes should be accomplished over the radio with the new lead's acknowledgment.

6.5.2.1. 4-Ship Lead Change Comm Example.

6.5.2.2. Octane 01: "*Octane 3, you have the lead on the left/right*."

6.5.2.3. Octane 03: "*Octane 3 has the lead on the left/right*."

6.6. Ground Operations.

6.6.1. Chocks. Engine start and check-in procedures will be IAW unit standards or as briefed. If delays occur, inform the flight lead as soon as possible but not later than the briefed check-in time. If visual, pass a thumbs-up to lead when ready.

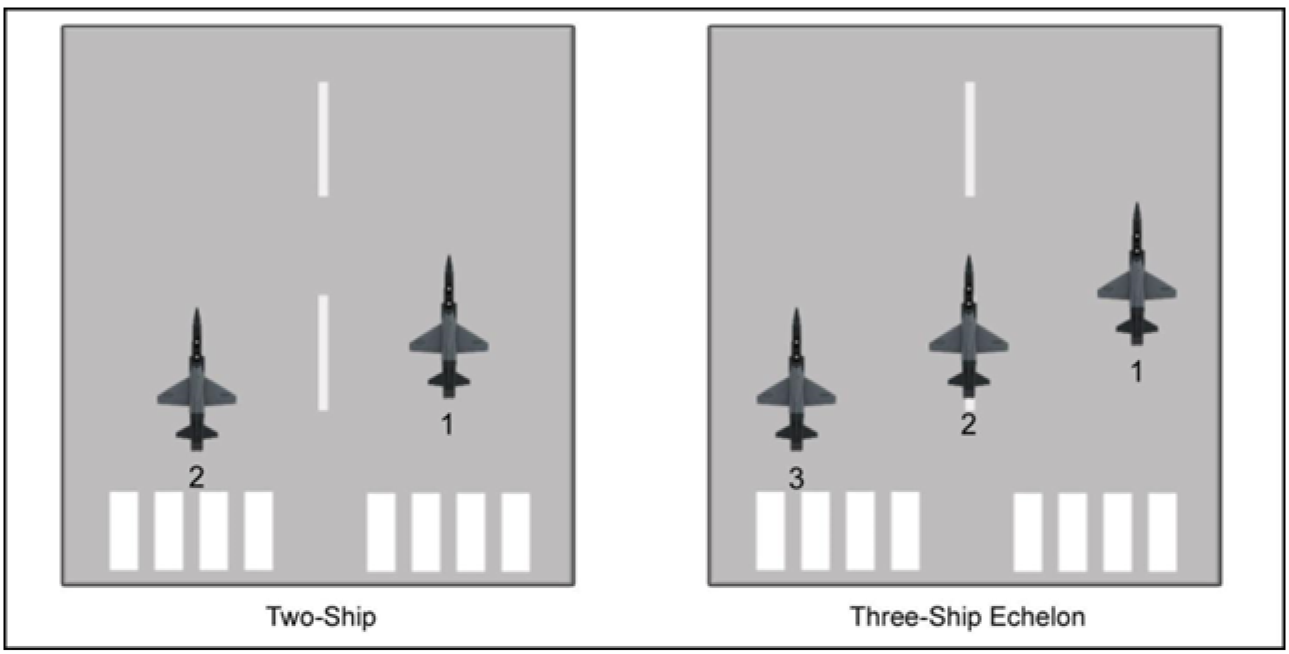
6.6.2. Taxi. Lead should taxi at a speed that allows wingmen to attain proper spacing. Wingmen will match lead's configuration, inspect each other for proper configuration and abnormalities prior to takeoff, and continue inspecting throughout the sortie. An approximate reference for 150-foot staggered spacing is the main gear of the preceding aircraft just above the 2.5-degree pitch-line (~2 degrees NL in HUD).

6.6.3. Runway Lineup (Two-and Four-Ship). Runway lineup is normally determined by wind direction and other factors such as direction of traffic and weather turn out. Lead will ensure wingmen have sufficient room to maneuver into position. Minimum wingtip spacing is 10 feet wingtip clearance but may be wider as desired or required. On the runway, a head nod is used for visual signals instead of a thumbs-up.

6.6.3.1. Two-Ship. Each aircraft will usually take the center of its half of the runway. Wing will line up lead's main gear doors as a fore and aft reference (**Figure 6.1**.). Once in position with canopy closed, the wingman will give lead a head nod to signal ready for engine run-up.

6.6.3.2. Three-Ship. Normal three-ship lineup is echelon (**Figure 6.1**.). If required however, three-ship formations may use any four-ship lineup as briefed.

Figure 6.1. Two-Ship/Three-Ship Runway Lineup.

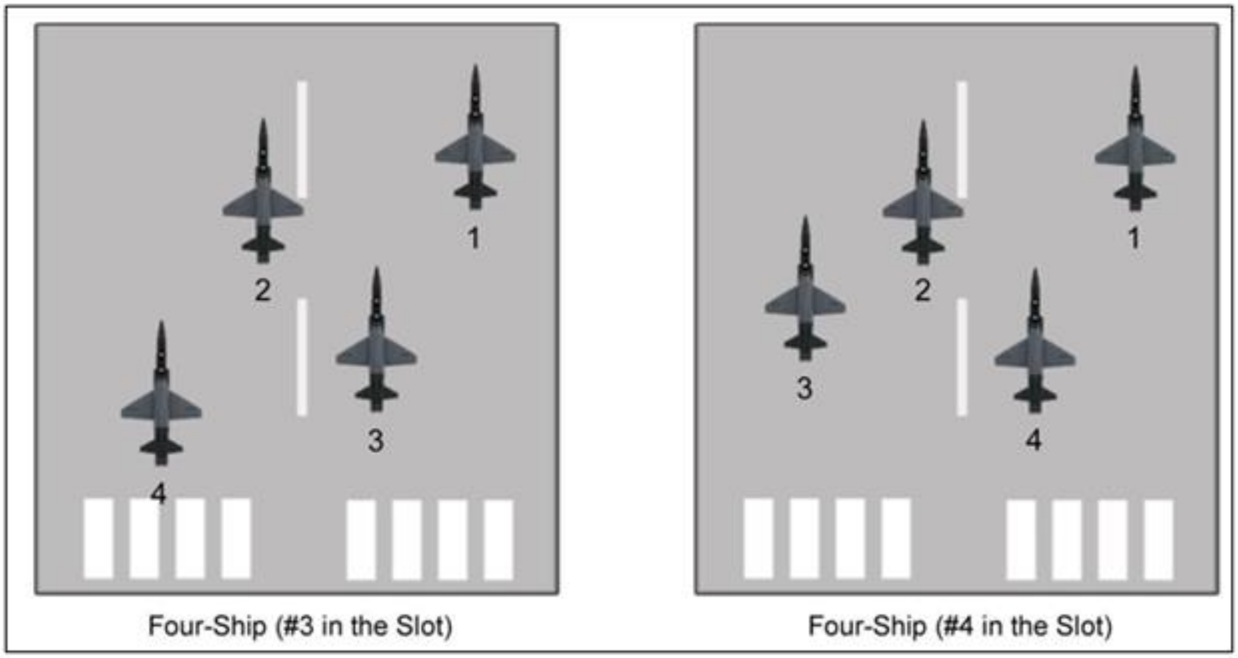


6.6.3.3. Four-Ship. Number 3 or 4 can line up in the slot. In either case, lead should line up as far to the side of the runway as practical. Number 2 will place the wingtip closest to lead on the centerline and line up the gear doors.

6.6.3.3.1. Number 3 in the Slot. Normally a four-ship lineup will have number 3 in the slot. Number 3 lines up between lead and number 2, pushing forward to clearly see number 2's visual signal and maintaining nose-tail clearances. Number 4 will line up offset from number 2's jet blast while aligning the gear doors of number 3 (**Figure 6.2**.).

6.6.3.3.2. Number 4 in the Slot. Number 3 will line up with wingtip clearance on Number 2 in echelon position. Number 4 will pull in between lead and number 2 with nose-tail clearance (**Figure 6.2**.).

Figure 6.2. Four-Ship Runway Lineup.



6.6.3.3.3. Four-Ship Signals. Number 4 will use a head nod to signal ready for engine run-up, and the signal should be relayed up the line (4—3—2). Number 3 may need to relay the ready signal via the radio if the lead element is displaced down the runway.

6.6.4. Engine Run-up. Once all aircraft have signaled "ready," lead may direct run-up visually or over the radio. During the engine run-up, continue to focus attention primarily outside the aircraft with only short glances inside the cockpit. Signal ready for takeoff with head nods up the line. If three is unable to see two for any reason, call "ready" after receiving four's head nod.

6.7. Formation Takeoff.

6.7.1. Lead.

6.7.1.1. A helmet tap is the preparatory command for brake release and selecting MAX afterburner. The execution command is a head nod. As the chin hits the chest, simultaneously release brakes and select MAX, reduce power slightly on both engines approximately ½-inch back from MAX but not less than minimum afterburner (around 60 percent nozzles on most jets), and verify both afterburners have lit.

6.7.1.2. Confirm wingman is safely airborne before retracting the gear and flaps. The visual signal for gear retraction is the gear doors opening. Begin a smooth power reduction out of MAX between 220 and 280 KCAS and afterburner operation should be terminated by 300 KCAS. Monitor wingman throughout the takeoff. Pay close attention to airspeed to prevent the possibility of overspeeding gear or flaps during the takeoff.

6.7.2. Wingmen.

6.7.2.1. Monitor lead for the preparatory and execution signals**.** Release the brakes and aggressively advance the throttles to MAX afterburner when lead’s chin hits his or her chest. Tap brakes as required to maintain position initially. Do not ride the brakes to stay behind the lead aircraft. Confirm two good afterburner lights.

6.7.2.2. If a substantial power advantage or disadvantage is apparent, request one increase or decrease in power (e.g., “*Rocky 3, give me one/push it up*”). Use caution to prevent pulling the throttles out of afterburner. If wing cannot remain in position (either overrunning lead or falling behind) with power set between minimum and MAX afterburner, wing should check both throttles in MAX, maintain separation from lead, and perform a separate takeoff.

6.7.2.3. Rotate with lead’s aircraft and concentrate on maintaining a proper position. Normally, the first indication of lead’s rotation will be the movement of the stabilator or the extension of the nose gear strut. Duplicate lead’s pitch attitude for lift-off.

6.7.2.4. When both aircraft are airborne, maintain a stacked-level position until retracting the gear and flaps. The visual signal for gear retraction is lead’s gear doors opening. Confirm the gear and flaps are retracted then move into fingertip.

6.7.2.5. After takeoff, if ahead of lead, check slightly away from lead, while continuing to fly off lead, if possible. Lead may pass the lead to wing if conditions warrant.

6.7.3. Interval Takeoff. When ready for takeoff, lead will release the brakes and perform a takeoff. Wingmen will delay brake release a minimum of 10 seconds for a single aircraft or 15 seconds for an element takeoff after the preceding aircraft IAW AFMAN 11-2T-38V3. If not executing a 2+2 interval takeoff, each aircraft should steer toward (but not cross) the center of the runway after the start of the takeoff roll. To help expedite the rejoin, lead should terminate afterburner early (220 KCAS minimum), continue to accelerate to 300 KCAS in MIL power, and climb at a reduced power setting. Unless briefed otherwise, number 2 will rejoin to the inside of the first turn out of traffic. If necessary, coordinate for an intermediate level-off to maintain visual VMC until wingmen are joined. Wingmen should delay coming out of afterburner until sufficient overtake is achieved.

6.7.4. Rolling Interval Takeoff. When cleared for takeoff, lead will taxi into position and perform a normal single-ship rolling takeoff then follow the procedures above. After takeoff has been initiated by lead, wing will taxi into position and perform a normal single-ship rolling takeoff with a minimum of 10 seconds interval IAW AFMAN 11-2T-38V3.

6.8. Instrument Trail Departure.

6.8.1. When flying an instrument trail departure, the priority is to follow basic instrument flying procedures. Strictly adhere to the briefed climb speeds, power settings, altitudes, headings, and turn points. All aircraft will use 30 degrees of bank for all turns. Takeoff spacing will be no less than 20 seconds IAW AFMAN 11-2T-38V3. Unless briefed otherwise, each aircraft or element climbs at 300 KCAS with 600 degrees EGT and maintain briefed spacing until all aircraft have reached VMC and are cleared to rejoin. Another technique for keeping a standard climb is to climb at 5 degrees nose-high, modulating power as required to maintain 300 KCAS.

6.8.2. Until join-up, each pilot or element lead should call with altitude and heading when passing multiples of 5,000 feet and when initiating any altitude or heading change. As a technique, DME can be added to this call if it enhances situational awareness. Until visual contact, each pilot or element will maintain at least, 1,000 feet of vertical separation from the preceding aircraft or element except where departure instructions specifically prohibit compliance IAW AFMAN 11-2T-38V3. If 1,000 feet of separation prevents the wingmen from complying with the minimum safe altitude, lead may reduce the vertical separation to 500 feet.

6.8.3. If a visual join-up at level-off is not possible, lead should request 1,000 feet of altitude separation for each succeeding aircraft or element. Wingmen should call visual on preceding aircraft and rejoin only after directed by flight lead. If local procedures allow, use the TCAS to aid in enhancing positional awareness on all formation members. Do not allow this additional SA tool to detract from precisely flying instrument trail departure procedures.

6.9. Area, MOA, or Route.

6.9.1. G-Awareness Exercise. Formation G-awareness exercises should be flown from line-abreast formation (in four-ship, wall or box formations only) as described in **paragraph 6.26** for two-ship and **paragraph 6.40** for four-ship. Normally, perform two 180-degree turns for formation G-awareness exercises. Maintain minimum spacing required by AFMAN 11-2T-38V3 but a common technique is to strive for 6,000 feet lateral separation before beginning a turn. While maintaining deconfliction, emphasis should be on the AGSM, G-awareness, and correct operation of equipment, not on perfect formation position.

6.9.2. After completion of the G-awareness exercise, wingmen should deconflict, select MIL power, attain 350 KCAS, and regain line abreast formation position.

6.10. Knock-It-Off (KIO) and Terminate Procedures. Use KIO or terminate procedures to direct aircraft to cease maneuvering. A KIO or terminate applies to any phase of flight and all types of missions. Refer to AFMAN 11-2T-38V3, as supplemented.

6.10.1. Any flight member can initiate a KIO or terminate. Make directive radio calls if danger is imminent. Call KIO when safety of flight is a factor or where doubt or confusion exists. Call "terminate" when safety of flight is not a factor.

6.10.2. Initiation of a KIO or terminate will start with flight callsign, followed by each flight members transmitting their position number—in order—with "knock-it-off" or "terminate" IAW AFMAN 11-2T-38V3. Aircraft with radio failure should signal KIO with a continuous wing rock.

6.10.3. For example, if anyone transmits, "*Iron 11, knock-it-off*", all flight members respond in order as follows: "*Iron 1 knock-it-off*", "*Iron 2 knock-it-off*", "*Iron 3 knock-it-off*", "*Iron 4 knock-it-off*". When hearing a KIO or terminate call, or observing a continuous wing rock, all participating aircrew will clear the flightpath, cease current maneuvering, climb or descend to a prebriefed safe altitude (1,000 feet AGL minimum), and acknowledge with callsign or a wing rock IAW AFMAN 11-2T-38V3. If able, the aircraft that initiated the KIO or terminate should give the reason after the KIO drill is complete, if not obvious (e.g., "*Iron 2 engine flameout*"). If any flight member fails to respond correctly, the sequence should be initiated again. Lead should be directive before resuming maneuvers.

6.11. Recovery.

6.11.1. Battle Damage (BD) Check.

6.11.1.1. Perform a BD check when directed by the lead aircraft from either fingertip or route. The signal is either a radio call or a visual "checkmark" signal. To perform the check, make a slight check turn away from lead (fingertip), and climb only as necessary to visually inspect the top of the near side of the aircraft. Continue the inspection by dropping down to inspect the lower side of the aircraft; perform a cross under; and inspect the lower and upper side of the opposite side of the aircraft. Upon completion, remain on that side and assume the proper formation position. While inspecting the other aircraft, look for any damage, leaks, missing panels, or any irregularities.

6.11.1.2. During the BD check, the aircraft fulfilling appropriate lead responsibilities must navigate and clear for the formation (NAV lead) while the wingman maintains deconfliction within the formation.

6.11.1.3. Use the intraflight radio to pass discrepancies; otherwise, pass a thumbs-up after returning to the formation position (fingertip/route) from where the check started. The lead aircraft then passes the lead to the wingman and performs a BD check.

6.11.1.4. For a three- or four-ship BD check, lead directs number 2 to check the flight. All other aircraft maintain their position while number 2 checks the entire formation and returns to the original position. When number 2 is in position, number 3 (three-ship) or number 4 (four-ship) is automatically cleared to check number 2.

6.11.2. Splitting the Flight. When splitting the flight becomes necessary, lead will verify that wingmen have a positive fix from which to navigate IAW AFMAN 11-2T-38V3. Additionally, lead should coordinate with ATC for separate clearances before clearing the wingman off.

6.11.3. Formation Approach. The formation approach normally terminates in VMC with either a formation low approach or a formation drop-off. The flight lead should thoroughly brief the formation approach and approach termination, to include relevant contingencies. Although the flight lead bears primary responsibility, pilots in both aircraft should prioritize flight path deconfliction and maintain awareness of the proximity to their element mate even after being clearly established as single-ships. As an example, if the landing aircraft is unable to land from a formation drop-off (e.g., poor approach or birds on final), both aircraft must be prepared to maintain safe separation as the lead aircraft coordinates for appropriate follow-on actions (e.g., rejoin, enter the visual flight rules (VFR) pattern as single-ships, obtain separate clearances with ATC, etc.).

6.11.3.1. Lead aircraft.

6.11.3.1.1. Normally, the best wingman consideration a lead can offer is to fly the best single-ship approach possible. Gear and full flaps are normally lowered with one visual signal or radio call unless briefed otherwise. After confirming a safe gear indication for both aircraft, transmit a "gear down" call for the flight. Unless one aircraft will circle or side-step, the formation should fly the final approach speed for the heaviest aircraft. If one aircraft will circle or side-step from the approach, configure with 60 percent flaps and fly the final turn airspeed for the heaviest aircraft.

6.11.3.1.2. For a formation low approach, monitor the wing aircraft throughout the transition from the configured approach to the climb-out. Follow single-ship go-around procedures in **paragraph 4.17.1** [**Exception:** When advancing the power, normally remain below MIL to allow a margin for wingman power adjustments.] A visual signal is not required to raise the gear and flaps. If a visual signal is briefed, normally use one visual signal to raise both the gear and flaps. If the formation is going to (re)enter IMC following the low approach, ensure the initial established climb gradient affords the wing aircraft enough time to regain the fingertip position beforehand.

6.11.3.1.3. For a formation drop-off, plan the approach with the aircraft planning to go around to be on the side of the formation most appropriate for maneuvering away from the landing aircraft and for follow-on maneuvering. Coordinate for the appropriate ATC clearances and instructions as soon as feasible, prior to initiating the formation drop-off.

6.11.3.1.3.1. Clearing the wing aircraft off to land while the lead aircraft executes the appropriate follow-on maneuver (go-around, missed approach, climb-out, circling maneuver, or side-step maneuver) is the preferred method for executing a formation drop-off. This method simplifies the wing aircraft's responsibilities: ensure flight path deconfliction and safely transition to a single-ship landing. To drop off the wing aircraft, ensure the formation is lined up on the appropriate runway, able to maintain visual contact with the landing environment, and in a position that allows the wing aircraft to transition safely to a single-ship landing. Confirm the wing aircraft has the runway in sight (e.g., "*Talon 2, confirm you have the runway in sight*"). Where there are multiple runways in proximity, confirm the wing aircraft has the appropriate runway in sight (e.g., "*Talon 2, confirm you have Runway 15C in sight*"). After the wing aircraft has the runway in sight, clear the wing aircraft off (e.g., "*Talon 2, cleared off to land*"). After the wing aircraft's acknowledgement, ensure flight path deconfliction by positively maneuvering away from the wing aircraft and executing the follow-on maneuver.

6.11.3.1.3.2. Clearing the wing aircraft off for a follow-on maneuver while the lead aircraft transitions to a single-ship landing requires additional considerations from the lead aircraft. Ensure the formation is lined up on the appropriate runway, able to maintain visual contact with the landing environment, and in a position that allows the wing aircraft to transition safely to the follow-on maneuver.

6.11.3.1.3.2.1. If follow-on maneuver for the wing aircraft is a go-around, missed approach or climb-out, the lead aircraft must ensure the wing aircraft fully understands the ATC clearance/instruction before clearing off the wing aircraft. This may require additional intraflight communication if the wing aircraft is under a high task load (e.g., fingertip in IMC) and unable to write clearances/instructions or setup instrumentation for navigation. With a correct read-back of the ATC clearance/instruction from the wing aircraft, clear the wing aircraft off with directions for the specified follow-on maneuver (e.g., "*Talon 2, Cleared off to climb out*"). After the wing aircraft acknowledges the "cleared off" instructions with a verbatim read-back, positively confirm separation of the wing aircraft, ensure flight path deconfliction, and transition to a single-ship approach and landing.

6.11.3.1.3.2.2. If the follow-on maneuver for the wing aircraft is a circling maneuver or side-step maneuver in an environment with multiple runways, the lead aircraft must ensure that the wing aircraft has the correct runway in sight (e.g., "*Talon 2, confirm you have Runway 15C in sight*" instead of "*Talon 2, confirm you have the runway in sight*"). After the wing aircraft has the runway in sight, clear the wing aircraft off with directions for the specified follow-on maneuver (e.g., "*Talon 2, Cleared off to circle*"). After the wing aircraft acknowledges the "cleared off" instruction with a verbatim read-back, positively confirm separation of the wing aircraft, ensure flight path deconfliction, and transition to a single-ship approach and landing by re-configuring with full flaps and slowing to final approach speed.

6.11.3.1.4. If unable to accomplish the required actions for the formation drop-off in a timely manner, the lead aircraft should transition to a formation low approach and notify the controlling agency.

6.11.3.2. Wing aircraft.

6.11.3.2.1. Fly normal fingertip references (see **paragraph 6.12**) until on glidepath. Assume the "stack level" position when VMC or on glidepath (whichever occurs later), or as briefed. The vertical reference for stacking level is to place the helmet of the front cockpit pilot in the lead aircraft on the horizon. The front cockpit (FCP) visual reference for fore and aft is head abeam the slab bolt; lead's main landing gear should resemble a figure 8. at 50-feet of spacing (see **Figure 6.3**.). The rear cockpit (RCP) visual reference for fore and aft is head abeam the aft edge of the burner cans/nozzles/tail pipes (space between lead's main landing gear). Lateral spacing ranging from 10-feet to 50-feet wingtip clearance should be adequate in all cases, provided the lead aircraft lands near the center of his or her side of the runway. Attempt to stabilize at a given spacing in the 10- to 50- foot range, as briefed or as directed by other guidance (syllabus or unit standards). See **Table 6.1** for front and rear cockpit references for wingtip clearances of 10, 25, and 50 feet.

Figure 6.3. Formation Approach Stack Level, 25 and 50 foot spacing.

Table 6.1. Spacing References in the Stack Level Position.

Wingtip Clearance	Front Cockpit	Rear Cockpit
10 feet	Position light aligned with the leading edge of the gear door.	Look straight down the wing line.
25 feet	Position light in the center of the gear door.	Position light slightly forward of the leading edge of the gear door.
50 feet	Position light aligned with the trailing edge of the gear door.	Position light in the center of the gear door.

6.11.3.2.2. For a formation low approach, maintain a stacked-level position until retracting the gear and flaps. Confirm the gear and flaps are retracted, then smoothly move into the fingertip position.

6.11.3.2.3. If landing from a formation drop-off, acknowledge the lead aircraft's request to confirm the landing runway is in sight with a verbatim read-back (e.g., "*Talon 2, runway in sight*"). With the runway in sight, read back the lead aircraft's "cleared off" instructions verbatim (e.g., "*Talon 2, cleared off to land*"), positively confirm separation of the lead aircraft, ensure flight path deconfliction, and transition to a single-ship approach to landing. If required, re-configure with full flaps and slow to final approach speed.

6.11.3.2.4. If executing a go-around, missed approach, or climb-out from the formation drop-off, read back ATC clearances/instructions verbatim and only when fully understood. Query the lead aircraft for clarification as needed and do not sacrifice basic aircraft control while attempting to write clearances/instructions or setting up instrumentation for navigation. When cleared off, read back the lead aircraft's instruction verbatim (e.g., "*Talon 2, cleared off to climb-out*"), ensure flight path deconfliction by positively maneuvering away from the lead aircraft, and execute the cleared maneuver.

6.11.3.2.5. If executing a circling maneuver or side-step maneuver from the formation drop-off, acknowledge the lead aircraft's request to confirm the appropriate runway is in sight with a verbatim read-back (e.g., "*Talon 2 has Runway 15C in sight*"). Acknowledge the lead aircraft's "cleared off" instructions verbatim (e.g., "*Talon 2, cleared off to sidestep*"), ensure flight path deconfliction by positively maneuvering away from the lead aircraft, and execute the cleared maneuver.

6.11.4. Formation Missed Approach. The potential for a lost wingman and for spatial disorientation in the wing aircraft is high if the formation approach does not break out of the weather. The lead aircraft should monitor the wing aircraft throughout the transition from the configured approach to the climb-out. Follow single-ship go-around procedures in **paragraph 4.17**. **Exception:** When advancing the power, normally remain below MIL to allow a margin for wingman power adjustments. The lead aircraft should use the radio to direct gear and flap retraction. Establish and maintain at or above the minimum required climb gradient. As a technique and without sacrificing smooth flight control inputs, radio calls to the wing aircraft stating current aircraft attitudes can help mitigate spatial disorientation.

6.11.5. Formation VMC Drag. These procedures may be used to achieve minimum runway separation of 3,000 feet between aircraft in formation for single-ship landings. Prior to directing the formation to drag under instrument flight rules (IFR), lead should slow to 250 KCAS and coordinate with the appropriate ATC agency. Lead will ensure that all aircraft will be able to maintain VMC from the drag point to landing before directing the formation to drag IAW AFMAN 11-2T-38V3.

6.11.5.1. Pilots will initiate the drag no later than 8 miles from the runway. **(T-2)** On instrument final approaches, the drag is normally accomplished to establish separation prior to the final approach fix or glideslope intercept.

6.11.5.2. When lead directs the formation to drag, wing should select idle and extend speed brakes until airspeed is below 240 KCAS, then select landing gear down, flaps 60 or 100 percent, and speed brakes up. Wing should set TCAS appropriately as task management permits.

6.11.5.3. The wingman should maintain final approach airspeed minimum and remain within standard formation parameters.

6.11.5.4. Lead maintains 250 KCAS until 5 miles from the runway, then selects idle power and speed brakes down until below 240 KCAS. Once below 240 KCAS, lead should select landing gear down, and flaps 60 or 100 percent, and speed brakes up.

6.11.5.5. Lead should maintain a minimum of 180 KCAS until 3 miles from the runway, and then slow to final approach speed.

6.11.6. Traffic Pattern.

6.11.6.1. Once established in the VFR overhead traffic pattern, turns away from wing will normally be in echelon. On or before turning initial, lead should place wingmen on the side opposite the direction of the break. Initial is usually flown in fingertip formation; route formation is more prudent with reported bird activity or other hazards; tactical initial may be flown IAW local guidance.

6.11.6.2. Lead should break at the beginning of the break zone. Wingmen will delay 5 seconds before initiating the break. This normally provides a minimum of 3,000 feet spacing. If greater spacing is required, the wingmen will delay the break (8 seconds normally provides 6,000 feet of spacing). When approaching the perch point, wingmen will cross-check the runway and lead to ensure proper spacing from both.

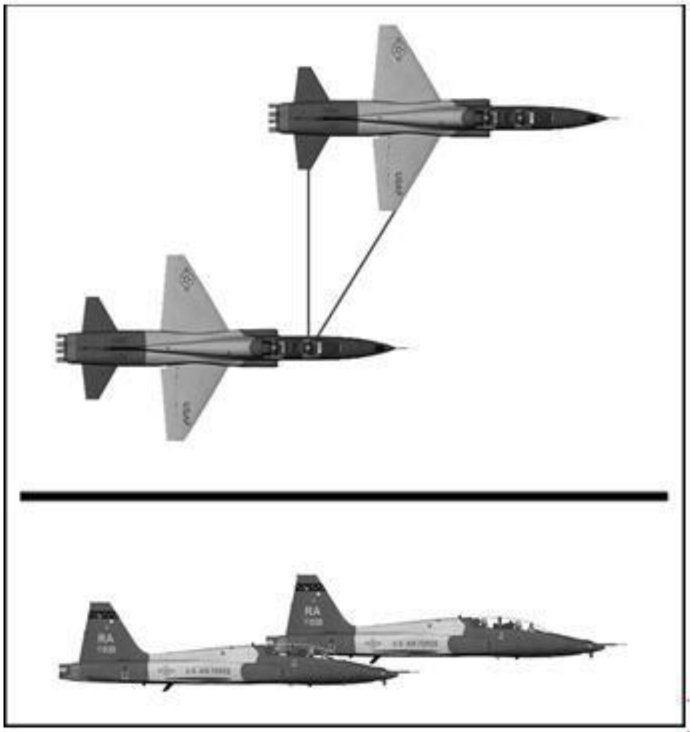
6.11.6.3. In a four-ship, lead and number 2 should avoid slowing so rapidly that trailing wingmen cannot maintain sufficient spacing.

Section 6B—Basic Formation

6.12. Fingertip.

6.12.1. Fingertip formation (**Figure 6.4**) is used for weather penetration, airfield arrivals and departures, and show formations. Wing maintains wingtip clearance while flying a position from which the front cockpit (FCP) pilot looks down the leading edge of lead's wing. An FCP pilot position abeam the slab bolt provides approximately 3 feet of wingtip separation. **Note:** "Abeam the slab bolt" implies visually sighting along a line from the FCP to the front slab tip to the slab bolt as shown in **Figure 6.4**. From the RCP, lining up the position light with a point on the intake halfway between the wing root and the lower leading edge of the intake (with head abeam the trailing edge of the burner cans) provides 3 feet of wingtip clearance.

Figure 6.4. Two-Ship Fingertip.

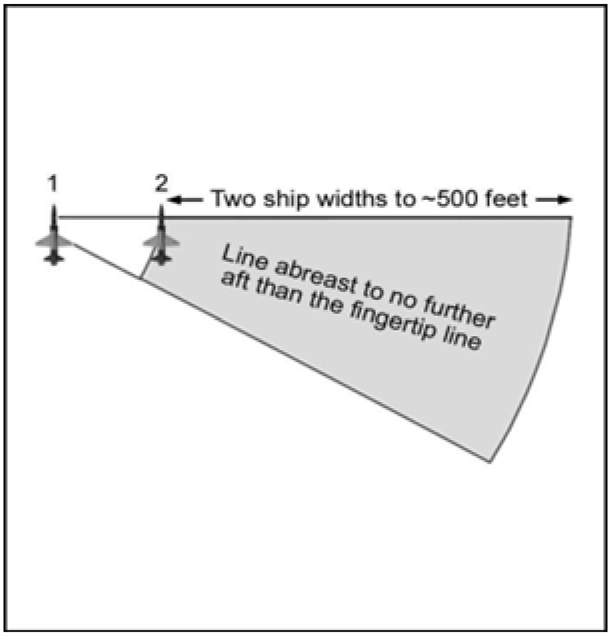


6.12.2. Wing-work Exercise. When accomplishing the wing-work exercise, fly a series of modified lazy eight maneuvers**,** using up to 3 Gs and 90 degrees of bank in an airspeed range of approximately 200 to 400 KCAS. Lead will emphasize clearing, smoothness, and providing a stable platform with consistent, predictable roll rates and no sudden changes in backstick pressure. Wing will use small throttle or stick movements and trim to maintain position, while avoiding the tendency to stare at any one spot. Practice using all of lead's aircraft as a reference.

6.12.3. When flying fingertip in a 3- or four-ship formation, there is no difference for numbers 2 and 3. Number 4 will fly the normal fingertip position and strive to line up the helmets of numbers 1 and 3. When number 3 is adjusting, number 4 should consider flying a stable position off number 1 while monitoring and maintaining lateral separation from number 3.

6.13. Route Formation. A route formation (**Figure 6.5**) is flown to enhance clearing and visual lookout, increase flight maneuverability, and ease the completion of inflight checks, radio changes, and other cockpit tasks. Lead should send wingmen to route with a radio call or visual signal. Route is flown from two ship-widths of spacing out to approximately 500 feet. Fly no farther aft than the extended fingertip line, no farther forward than line abreast, and, when wings level, maintain a level stack. On the inside of a turn, stack below lead's POM only as necessary to keep lead in sight. On the outside of a turn, maintain the same vertical references used in echelon. In a three- or four-ship formation, number 2 sets lateral spacing for the formation. Number 3 should fly line abreast with number 2, matching lateral spacing from number 1. Number 4 should line up the helmets of numbers 3 and 1. Lead should limit bank angle to 60 degrees with wingmen in route.

Figure 6.5. Route Formation.



6.14. Chase. Chase is used for a variety of reasons, including performance assessment and assistance during an emergency. The chase pilot is primarily responsible for aircraft separation.

6.15. Echelon.

6.15.1. Echelon is a multi-ship formation where all wingmen are on the same side of the formation. Lead directs the flight into echelon by dipping a wing in the desired direction or making a radio call ("*Sling, echelon left/right*").

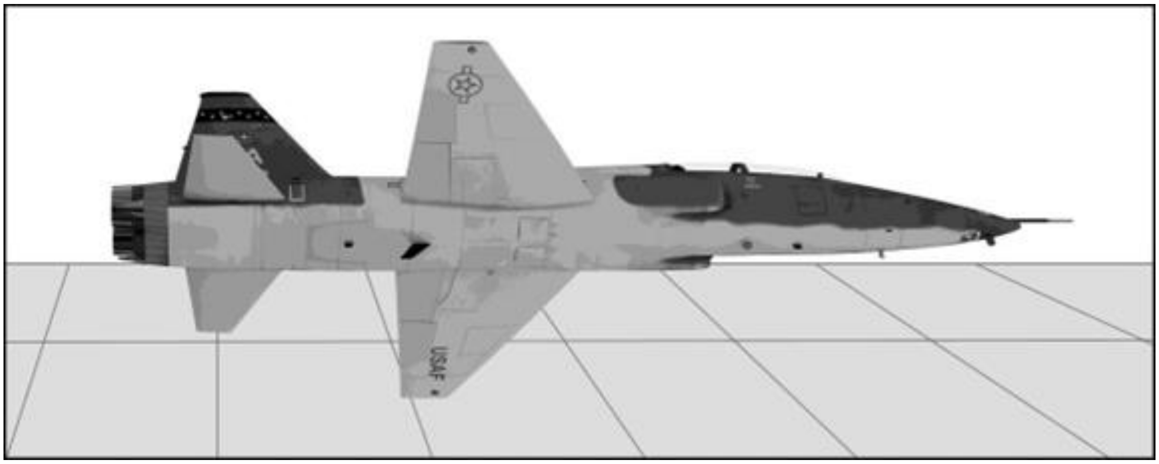
6.15.2. Unless prebriefed (like turns in the VFR overhead pattern), lead normally directs echelon turns with a radio call or visual signal for two-ship formations. In a three- or four- ship formation, an echelon turn is implied when the wingmen are on the same side. All aircraft must be very aware of the importance of smooth corrections, positive backstick pressure, and the need to avoid unloading while in the turn.

6.15.3. Echelon turns can be performed at a variety of airspeeds. A common technique as lead is to initiate echelon turns between 300 to 350 KCAS and to minimize throttle movements during the turn to give the wingmen a more stable platform to follow.

6.15.4. Except for very gentle turns into the echelon, always turn away from the echelon and plan to limit bank to 60 degrees maximum**.** Number 2 should match lead's roll rates. Once established in a turn, the horizon should split lead's lower intake (**Figure 6.6**.). As in fingertip, the FCP pilot's helmet should be abeam the slab bolt. Use power to make fore/aft corrections, backstick pressure to maintain horizontal spacing, and bank to make corrections up or down.

6.15.5. When in the number 3 or 4 position, the basic references are the same as those for number 2. However, cross-check lead's position in relation to the horizon, so as not to over adjust for every correction number 2 or 3 makes.

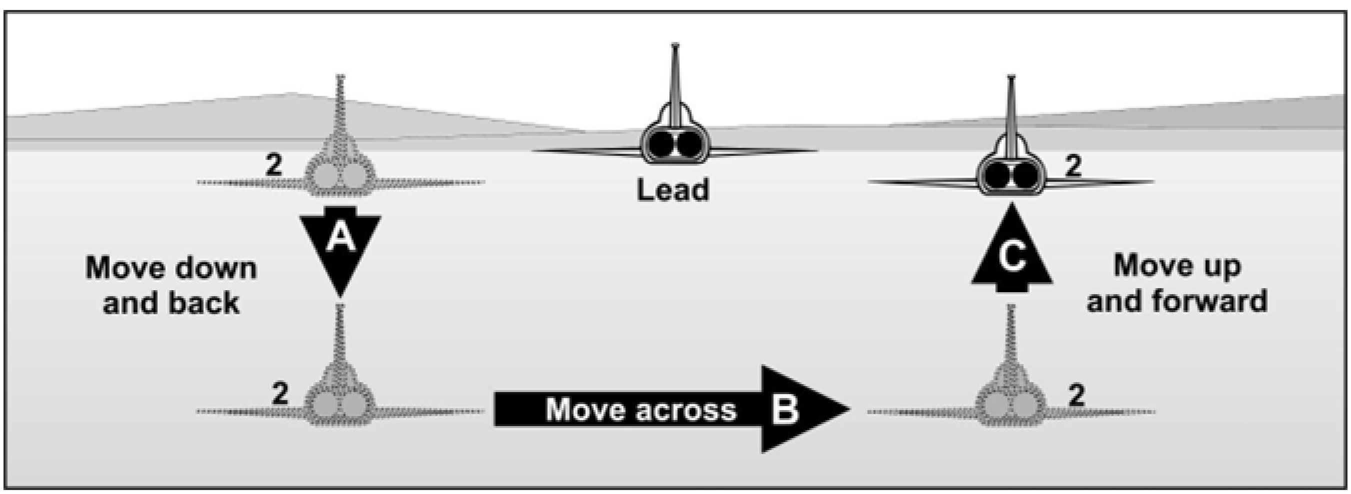
Figure 6.6. Echelon Turn.



6.16. Crossunder.

6.16.1. Two-Ship Crossunder. Except for prebriefed events (like the BD check), lead normally directs a crossunder with a radio call or visual signal. When using a wing dip signal, the size of lead's signal should be appropriate for the distance to the wingman. On lead's signal, the wingman reduces power as required until a small forward line-of-sight (LOS) rate develops. The wingman will move back and slightly below lead's POM and add power to stop lead's forward LOS. The wingman will then move across and behind lead with a minimum of nose-tail clearance, adding power as required so as not to fall any further behind. Once on the opposite side and with wingtip clearance, the wingman will add power to move up and forward into fingertip (**Figure 6.7.**).

Figure 6.7. Crossunder.



6.16.2. Four-Ship Fingertip Crossunder. In a four-ship fingertip or route formation, a wing dip toward number 2 signals a crossunder for numbers 3 and 4, and a wing dip toward number 3 signals a crossunder for number 2. If number 2 is crossing to the side that numbers 3 and 4 are on, number 3 should smoothly move out to create room for number 2. Number 2 begins a normal crossunder but must ensure adequate spacing before crossing lead's 6 o'clock. As number 2 attains position, number 3 begins flying off number 2 while referencing lead. If numbers 3 and 4 are crossing simultaneously, number 3 begins smoothly dropping down and aft in a normal crossunder and establishes nose-tail clearance off number 2 before crossing. As number 3 begins the crossunder, number 4 performs a crossunder on number 3, normally crossing number 3's 6 o'clock as number 3 crosses behind lead. Number 4 must anticipate LOS rates and power changes to avoid falling aft.

6.16.3. Four-Ship Echelon Crossunder. In a four-ship echelon formation, lead's radio call or wing dip (always away from the echelon) directs the entire formation to change sides. Ideally, as number 2 begins the crossunder, all the wingmen move together. The entire formation is in a straight line as the wingmen cross lead's 6 o'clock. Then all the wingmen assume their position on the other side of lead. A wing dip toward the echelon is meaningless. Any other formation change, like returning to fingertip, requires a radio call.

6.17. Pitchout.

6.17.1. The purpose of a pitchout is to provide spacing for a rejoin or follow-on maneuvering. After the signal or radio call, lead clears and then turns away from the wingman, using G forces to attain 300 KCAS unless briefed or directed otherwise. Lead will normally fly a level turn of about 180 degrees. However, lead may climb, descend, and (or) adjust the degrees of turn as necessary for weather, area orientation, or energy management. Lead should allow enough time for the wingmen to complete the pitchout, and then direct the rejoin with a radio call or visual signal.

6.17.2. Wingmen keep lead or the preceding aircraft in sight, delay 5 seconds (or as briefed), and then turn to follow, using about the same bank angle and G loading. A 5-second delay provides approximately 1 NM spacing. After turning approximately 90 degrees**,** the wingman will vary bank angle and backstick pressure as necessary to attain desired spacing. The wingman should roll out behind and slightly below lead or the preceding aircraft and maintain 300 KCAS until directed to rejoin.

6.18. Take Spacing.

6.18.1. Take spacing is normally used to increase range when reversing the direction of the flight is not practical (e.g., practice rejoins). When these procedures are not specified in unit standards, they must be thoroughly prebriefed. These are VMC-only maneuvers.

6.18.2. Lead will direct the wingman to take spacing with a prebriefed visual signal or radio call. The wingman will acknowledge with a radio call or by maneuvering away from lead to take spacing. Spacing can be achieved with a combination of wingman maneuvers, wingman deceleration, and lead acceleration.

6.18.3. One technique, usually done at 300 KCAS, is to direct the wingman to take spacing, which the wingman does by performing a series of check turns behind and below lead's jet wash. When the desired spacing is achieved, the wingman calls "ready". If the plan is for a three- or four-ship to take spacing, procedures for each aircraft should be thoroughly briefed.

6.19. Practice Lost Wingman Exercise. This exercise exposes new pilots to procedures that are critical during lost wingman scenarios in actual instrument meteorological conditions (IMC). Practice this exercise in two-ship formation, in day VMC, using the procedures in AFMAN 11-2T-38V3. Lead will initiate a practice lost wingman exercise with a radio call. Lead will acknowledge the wingman's "practice lost wingman" radio call by transmitting attitude, altitude, heading, airspeed, and other parameters as appropriate. The wingman will execute the appropriate procedures, to include a radio call. The wingman may signify completion of the exercise (as determined and briefed by the flight lead) by calling visual. **Note:** The IP or safety observer in the wing aircraft will monitor lead to ensure separation throughout the exercise.

6.19.1. Practice Lost Wingman Comm Example.

6.19.2. Bully 01: "*Bully 2, Go practice lost wingman.*"

6.19.3. Bully 02: "2". "*Bully 2 is practice lost wingman*."

6.19.4. Bully 01: "*Bully 1, wings level, 15 thousand, heading 350, 300 knots*."

6.19.5. Bully 02: "2". "*Bully 2 visual.*"

6.20. Rejoins.

6.20.1. Overview.

6.20.1.1. The purpose of a rejoin is to get the flight back together safely and efficiently. Lead will initiate rejoins with a radio call or a visual signal (wing rock) and, when necessary for energy management or area orientation, may use slight climbs or descents during the rejoin. Lead should consider initiating the rejoin via a radio call, especially when lead cannot see wingmen.

6.20.1.2. Lead should monitor wingmen closely during all rejoins. Airspeeds and bank angles are normally prebriefed or unit standard. Lead should consider making a radio call if flying a different airspeed or bank angle. Wingmen should always use LOS cues and airspeed awareness when rejoining.

6.20.1.3. For standard rejoins from basic formation positions (other than tactical formation positions), lead will maintain 300 KCAS, and 30 degrees of bank, if turning. For standard rejoins from tactical formation positions, lead will maintain 350 KCAS, and 45 degrees of bank, if turning. The rejoin discussions in paragraphs **6.20.2** and **6.20.3** apply to rejoins from all formation positions, including the terminal phases of tactical rejoins. The initial phase of tactical rejoins is discussed in **Section 6C**.

6.20.2. Straight-Ahead Rejoin.

6.20.2.1. Straight-ahead rejoins can be accomplished from a variety of situations, including pitchouts, take spacing, and instrument trail. A standard straight-ahead rejoin is to the left wing for number 2 and the right wing for numbers 3 and 4.

6.20.2.2. When initiated from a position behind lead (from a maneuver that places wingmen in trail at lead's 6 o'clock), fly to a position slightly below and at approximately 0-degree aspect angle (AA) from lead, avoiding lead's, and preceding wingmen's jet wash/wake turbulence. Using power for closure, 50 knots of overtake is usually adequate when starting from 1 NM. Approaching 2,000 feet, modulate power to arrive at 2,000 feet with approximately 20 to 30 knots of overtake. At 2,000 feet lead's wingspan is approximately 13 mils the width of the HUD bore sight/gun cross (see **Attachment 2**, *Stadiametric Ranging*). At approximately 1,500 feet behind lead, the figure-eight design of the two tailpipes is visible, but two separate engines are not distinguishable. At this point, bid away from lead's 6 o'clock position to a route position, on the side to be rejoined to, and continue to reduce overtake. To make the bid, put the wingtip of the flight path marker just outside of the wingtip of lead's aircraft. Maintain the new heading and do not check back into lead. If too large of a bid was taken, check back to the original heading (parallel lead's fuselage), but do not reduce wingtip separation until reaching the wing line. A technique to reduce overtake at this point is to retard the throttles at a rate equal to the aft LOS rate of lead on the canopy, such that lead's LOS freezes once the aircraft arrives in the route position. Use speed brakes as required to assist in slowing the LOS rate. Then, with overtake under control, close from route to fingertip.

6.20.2.3. During a rejoin in a climb, the aircraft is more responsive to throttle reductions when decreasing overtake and slowing lead's aft LOS rate on the canopy compared to during a level-flight rejoin. A common error is for wing to stagnate during a climbing rejoin prior to reaching the fore/aft references for the route position. To prevent this, the pilot should begin to reduce overtake later and the throttle movement should be slower and less than what is required during a level-flight rejoin. During a descending rejoin, the opposite is true. The aircraft is less responsive to throttle reductions when decreasing overtake and slowing lead's aft LOS rate on the canopy compared to a level-flight rejoin. A common error during the descending rejoin is for wing to overshoot the fore/aft references for the route position. Therefore, the pilot should begin to reduce overtake sooner, and the throttle movement should be faster and more than what is required during a level-flight rejoin.

6.20.2.4. For three-ship and four-ship formations, aircraft will rejoin in the proper numerical sequence on their respective side. Maintain a minimum of 500 feet spacing from the preceding aircraft until that aircraft has stabilized in route. Each aircrew will monitor the preceding aircraft's rejoin for excessive closure and anticipate overshoot and breakout situations from preceding aircraft.

6.20.3. Turning Rejoins.

6.20.3.1. Rejoins to Number 2 (Inside the Turn).

6.20.3.1.1. The visual signal for a turning rejoin is also a wing rock with the first wing dip in the direction of the rejoin. Because turning rejoins can be accomplished from many different positions, wingmen must initially assess the combinations of range, aspect, energy state, and heading crossing angle (HCA) to establish appropriate AA, pursuit curves, and overtake airspeeds.

6.20.3.1.2. After the rejoin signal and lead's turn, the wingman begins a turn in the same direction to create lead pursuit. Simultaneously establish vertical separation, establish approximately 30 knots of airspeed overtake, and adjust lead and lag pursuit to maintain moderate aspect angle.

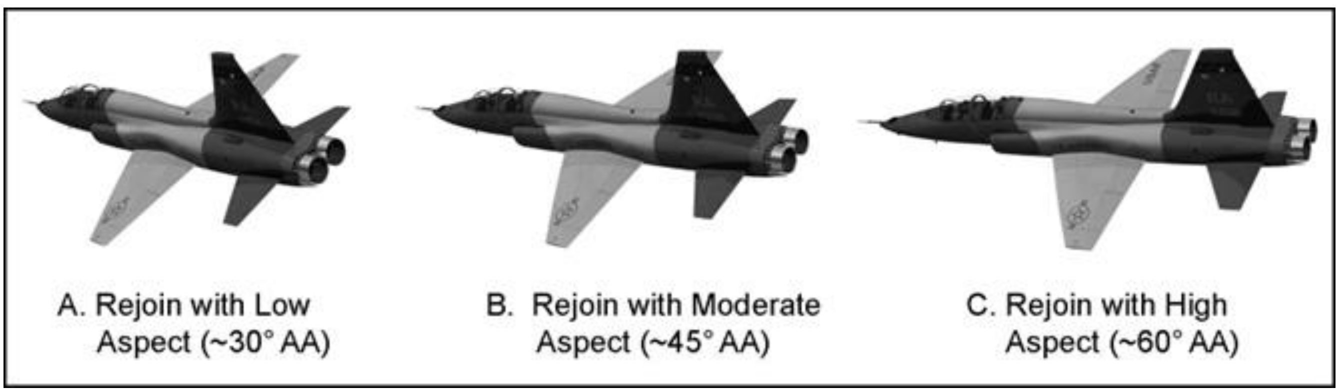
6.20.3.1.3. Use the airspeed indicator and visual cues to judge closure on lead. Control closure by adjusting the pursuit curve (aspect angle) and the power. Use the speed brakes as needed, but plan the rejoin so that speed brakes are not required to complete the rejoin. Complete the rejoin to fingertip similar to reforming from the route position.

6.20.3.1.4. During a turning rejoin, wingmen should establish and maintain about 50 feet of vertical separation below lead's POM until stabilized in route formation. A technique for determining 50 feet of vertical separation is to use the length of lead's jet above the horizon. Lead will start climbing in the canopy as range decreases inside of 1,000 feet, but the pilot will be able to see the horizon under them and above the canopy rail. Other airspeed aspect combinations may be used if needed to complete the rejoins. Regardless of the rejoin combinations, airspeeds should be less than 50 knots overtake for low aspect rejoins, 30 knots for medium aspect rejoins, and 10 knots for high aspect rejoins when within 3,000 feet of lead. Avoid the tendency to reduce closure by increasing G inside the turn.

6.20.3.2. Rejoins to Number 3 or Number 4 (Outside the Turn). For three-ship and four-ship formations, aircraft will rejoin in the proper numerical sequence. Number 2 rejoins to the inside of the turn, and numbers 3 and 4 rejoin to the outside. When the flight lead uses a visual signal to initiate the rejoin, each wingman will repeat the signal for aircraft in trail. Maintain a minimum of 500 feet spacing from the preceding aircraft until that aircraft has stabilized in route. Rejoining aircraft should cross below the preceding aircraft's jet wash with a minimum of nose-tail clearance. Each aircrew should monitor the preceding aircraft's rejoin for excessive closure and anticipate overshoot and breakout situations from preceding aircraft.

6.20.3.3. **Figure 6.8** shows three different visual references for various AA rejoins. View B (approximately 45-degree AA) is the preferred picture to maintain throughout the rejoin. This AA optimizes the use of airspeed and geometry while allowing flight lead the flexibility to maneuver the formation as necessary. View C (approximately 60 degrees AA) should be avoided because it demands too much flight lead monitoring, and view A (approximately 30 degrees AA) does not maximize the benefit of geometry or lead pursuit and potentially wastes fuel in a "tail chase".

Figure 6.8. Various Aspect Views.



6.21. Overshoots.

6.21.1. Overview. The purpose of an overshoot is to safely dissipate excessive airspeed or decrease excessive angular overtake during a rejoin. Wingmen must not delay the overshoot in an unusually aggressive attempt to "save" a rejoin. Always keep lead and the preceding aircraft in sight during any overshoot.

6.21.2. Straight-Ahead Rejoin Overshoot. A properly executed straight-ahead rejoin with excessive closure (V_c) will result in a pure airspeed overshoot several ship-widths out, with a slight diverging vector. Select idle and speed brakes (if required) as soon as excess overtake is recognized. Guard against turning back into lead while looking at them. A small, controllable 3/9-line overshoot is easily managed and can still result in an efficient rejoin. Retract the speed brakes and increase power just prior to achieving co-airspeed (stagnant LOS) to prevent falling aft.

6.21.3. Turning Rejoin Overshoot.

6.21.3.1. A properly executed turning rejoin with excessive V_c results in a combination airspeed-aspect overshoot in a POM about 50 feet below lead. The decision to overshoot should be made early so the wingman crosses lead's low 6 o'clock with a minimum of approximately two ship lengths spacing. In all cases, ensure nose-tail separation can be maintained. Select idle and speed brakes as required, depending on excess airspeed.

6.21.3.2. Once outside the turn, use bank and backstick pressure as necessary to stabilize in route echelon position. During the overshoot, fly no higher than route echelon. The more airspeed and (or) angle-off, the more turn radius required to solve the problem. In addition, a co-speed overshoot due to an angular problem may not require flying outside of lead's turn circle. Instead, flying to lead's low six o'clock may allow enough forward visibility to safely align fuselages and stop the overshoot. When range, LOS, and angle-off are under control, return to the inside of lead's turn, reestablish an appropriate aspect angle, and complete the rejoin to fingertip.

6.21.4. Three- and Four-Ship Overshoot Deconfliction. As with a rejoin, maintain a minimum of 500 feet spacing from the preceding aircraft until it has completed the overshoot and is stabilized. If overshooting, preceding aircraft should inform the other wingmen with a radio call. Maintain nose tail clearance minimum during an overshoot.

6.22. Breakout.

6.22.1. The **HITS** acronym describes when a breakout is required. When in close formation, the wingman must break out when (1) their presence constitutes a **H**azard to the formation, (2) unable to remain in formation without crossing **I**n front of/under lead, (3) directed (**T**old) to break out by lead, or (4) they have a loss of **S**ituational awareness of their position relative to lead. Breakouts may also be flown as training exercises.

6.22.2. For breakouts, predictability is critical for all players. Lead should continue the current maneuver with the current power setting if possible. However, if the wingman is in sight, maneuvering to obtain, increase, or guarantee separation may also be appropriate or necessary. In all cases, lead should try to stay visual and be directive with the wingman as appropriate (e.g., "*Pistol 2 rollout, visual is your right 2 o'clock high*", "*rejoin, left turning*", etc.).

6.22.3. Wingmen should clear in the direction of the breakout, maneuver to ensure safe separation from other aircraft, and notify lead, if required, when conditions permit. Once safe separation is assured, the wingman may rollout to attempt to regain the visual. After the wingman calls visual, lead will direct them to the desired formation.

6.22.4. Control inputs can vary anywhere from maximum rate stick deflection to avoid collision to a small check turn away. If breaking out due to a lost-sight situation, the wingman will break away from lead's last known position or direction of turn, using power and speed brakes as required.

6.22.5. A breakout exercise may be accomplished from a variety of positions and situations. Lead will direct the breakout with a radio call, after which the wingman will simultaneously execute an appropriate breakout maneuver and make a radio call ("*Pistol 2's breaking out*"). The culmination of the exercise is the same as described in **paragraph 6.22.3**.

6.23. Close Trail.

6.23.1. Lead initiates close trail with a radio call from fingertip, echelon, or route. Lead will wait for wing's "in" call (e.g., "*Iron 2's in*") before maneuvering and then use any combination of turns, modified lazy eights, or barrel rolls.

6.23.2. Over-the-top maneuvering in close trail is not permitted per AFMAN 11-2T-38V3. Be smooth and predictable, avoid rapid or inconsistent roll rates, and maintain a minimum of 1 G. Plan to use no more than 4 Gs for close trail.

6.23.3. Wing will acknowledge the call to go close trail ("2"), maneuver to the close trail position, and call in. Proper position is one to two aircraft lengths behind lead and just below lead's jet wash.

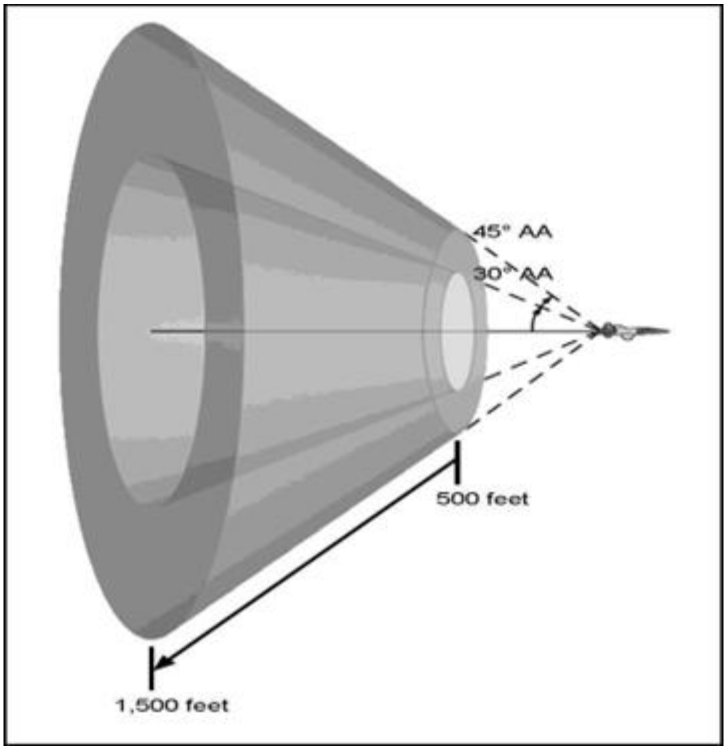
6.23.4. In the correct vertical position, pilots should see space between the forward edge of lead's horizontal stabilator and the trailing edge of lead's wing. To prevent encountering jet wash, never fly higher than a position where that space disappears.

6.23.5. For a fore/aft separation reference, use the relationship between the tips of lead's horizontal stabilator and the ailerons. At approximately one ship length, the stabilator tips are lined up with the outer two-thirds of the ailerons. At approximately two ship lengths, the tips are lined up with the mid- point of the ailerons. When aft of the proper position or when lead is turning at higher G loadings, pilots may need to fly slightly inside the turn to gain or maintain position.

6.23.6. End the exercise by directing wing to the desired formation using visual signal or radio call ("*Buddy 2, reform left*"). If returning to fingertip, lead must avoid any significant power changes until wing is in position.

6.24. Fighting Wing. Fighting wing is flown as a maneuverable two-ship administrative formation. Lead directs number 2 to the fighting wing position with a radio call ("Iron 21, go fighting wing"). There is no requirement to call in position. The fighting wing position is a cone 30- to 45-degree AA from lead, 500 to 1,500 feet aft **(Figure 6.9.)**. As wing, pilots can approximate the forward limit of the cone (45-degree AA) by aligning lead's wingtip with the middle of the aft canopy and the aft limit (30-degree AA) by aligning lead's wingtip with the front canopy bow/windscreen. Another technique to estimate AA is to compare the apparent wingspan to the apparent length of the T-38. At a 30-degree AA, the apparent length equals the apparent wingspan. At a 45-degrees AA, the apparent length is approximately 30 percent longer than the apparent wingspan. For estimating range, at 500 feet pilots should easily read lead's tail number; at 1,000 feet, pilots should easily see, but not be able to read, lead's tail number, and pilots should be able to discern two separate tail pipes; at 1,500 feet, pilots should be able to see the letters on the tail. The wingman should strive to maintain a position inside lead's turn circle using lead and lag, resulting in lower power settings**.** Lead will not fly aerobatic maneuvers with the wingman in fighting wing. Wingmen may use rolling maneuvers to maintain or regain position IAW AFMAN 11-2T-38V3 restrictions.

Figure 6.9. Fighting Wing Cone.



Section 6C—Tactical Formation

6.25. Types and Principles.

6.25.1. "Tactical" is an umbrella term covering several formations characterized by increased separation between the members of the flight. Tactical is the primary formation flown when employing fighter aircraft. It is designed to optimize weapons and radar employment while improving visual lookout and increased maneuverability. A variety of tactical formations may be flown depending on the number of aircraft in the formation and the type of employment desired. For two-ships, tactical formations include line abreast and wedge. Both may be referred to on the radio by their separate names; however, if the lead refers to "tactical" or "line", this is understood to mean "line abreast". For four ships, tactical formations include fluid four, wall, and box or offset box. Regardless of the variety of tactical formation being flown, some basic principles apply:

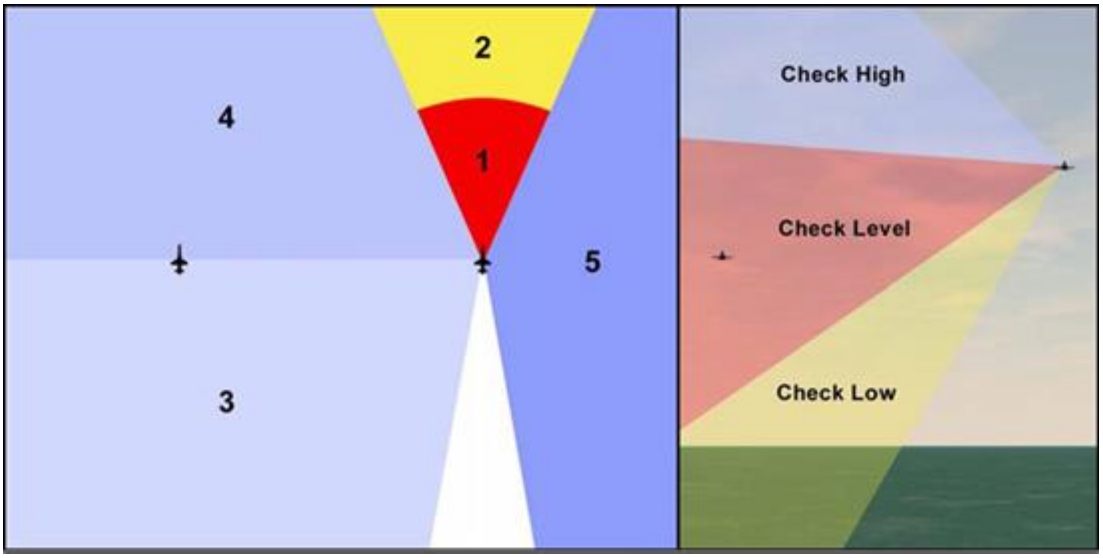
6.25.1.1. The lead aircraft is primarily responsible for maneuvering the formation, and the wingman is primarily responsible for maintaining formation position and deconfliction.

6.25.1.2. The wingman's primary reference for heading and airspeed is lead. The lead must cross-check the wingmen to monitor their positions, and the wingmen must back lead up by monitoring area orientation, navigation, etc.

6.25.1.3. Both aircraft share equal responsibility with visual lookout—one of the primary reasons for flying tactical line abreast. Line abreast provides excellent lookout capability. Scan patterns should include the extremes above and below the horizon. See **Figure 6.10**.

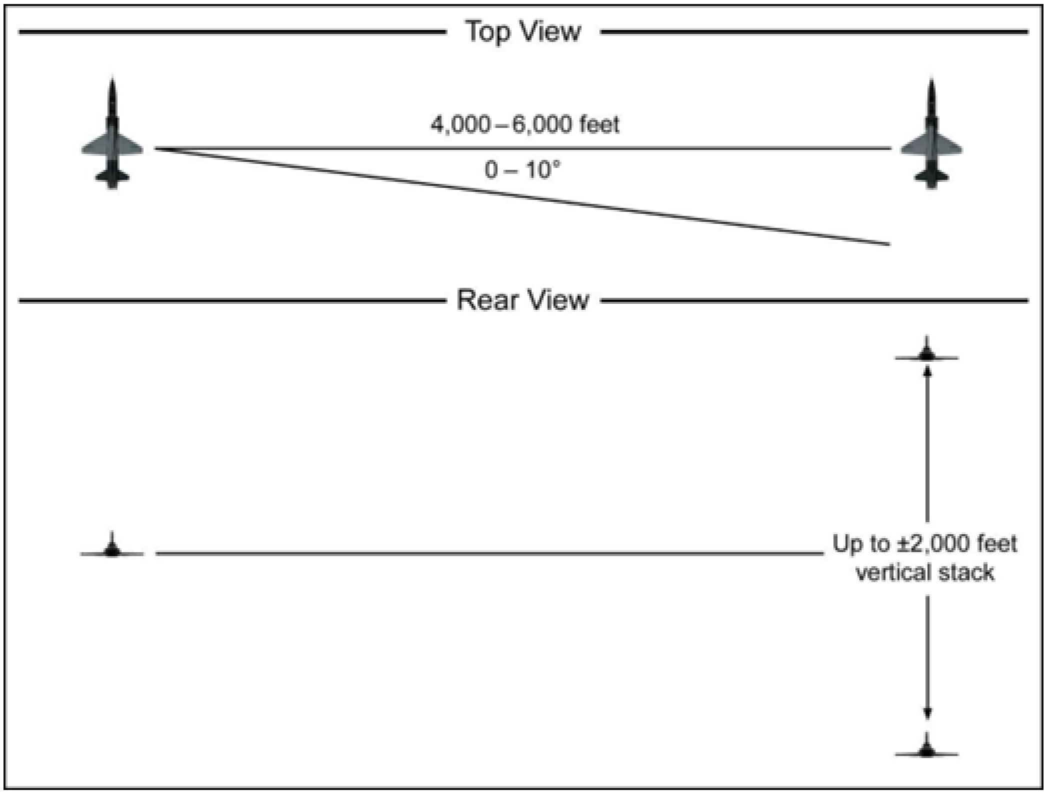
6.25.2. Tactical formations are normally flown at airspeeds near corner velocity (350 to 400 KCAS), but other airspeeds may be flown. Unless otherwise briefed, the standard airspeed for tactical formation is 350 KCAS at or above 10,000 feet MSL, and 300 KCAS below 10,000 feet MSL.

Figure 6.10. Visual Lookout Priorities in Tactical Formation.



6.26. Line Abreast (LAB). The parameters of this tactical formation are line abreast to 10 degrees aft, 4,000 to 6,000 feet spacing, and a vertical separation (stack) up to +/- 2,000 feet (**Figure 6.11**.).

Figure 6.11. Line Abreast.



6.26.1. To enter line abreast formation, lead may use a radio call (e.g., "Rocky 51, line left/right") or a visual signal by porpoising the aircraft. The wingman then moves out into the line abreast position clearing the flightpath while moving out. In order, the priorities for correcting formation position are line, spacing, and vertical stack. Strive to fly line abreast—no further aft than 10 degrees—by varying power and trading altitude for airspeed (or vice versa) to make fore or aft corrections. With zero HCA, a visual reference for LAB is the other aircraft just over the front part of your shoulder.

6.26.2. Visual references for lateral spacing include the following: (**Note:** These references can change based on environmental conditions)

6.26.2.1. At 4,000 feet, the VHF antenna (shark fin) disappears, the underside rotating beacon disappears, and (or) the canopy bow disappears, and both canopies blend into one.

6.26.2.2. At 6,000 feet, the "L" formed by the aft edge of the vertical stabilizer and the burner cans start to disappear (depending on environmental visibility). Also, depending on the environmental conditions, the canopy disappears or blends into the aircraft.

6.26.2.3. Outside 6,000 feet, most details disappear, and the aircraft loses most of its definition.

6.26.3. The air-to-air (A/A) TACAN (AAT) is a useful tool for pilots to calibrate their eyes. Use 0.7 NM for an approximate 4,000-foot range and 1.0 NM for a 6,000-foot range.

6.26.4. Strive for a vertical stack of approximately 500-1,000 feet but remember that stack is a tertiary priority and should only be increased as proficiency allows. When restricted by airspace or weather, wingmen may be required to fly co-altitude with lead. Depending on assigned altitude, level stack may place the other aircraft significantly above the horizon. Wider spacing (6,000 feet versus 4,000 feet) and higher altitude result in lead aircraft being higher above the horizon than closer spacing and lower altitude. TCAS and/or verifying altitude between aircraft should be cross-checked to confirm level stack when necessary. The wingman can assess stack visually by putting the lead approximately one fist height below the horizon for a 1,000-foot stack and one-half a fist below the horizon for a 500-foot stack. TCAS may also be used to assess stack.

6.26.5. When given the signal to go to line abreast, the wingman will:

6.26.5.1. Clear the flightpath in the direction of the turn away from lead.

6.26.5.2. Turn away from lead to achieve 4,000 to 6,000 feet of lateral spacing. One technique for achieving the appropriate spacing is cross-checking lead's heading then check away 15-20 degrees while increasing airspeed 1 knot for every degree used to check away (15-20 KCAS) to ensure zero LOS rate.

6.26.5.3. Roll back to lead's approximate heading when approaching 4,000 to 6,000 feet of lateral spacing and set power and airspeed to match lead's current parameters.

6.26.5.4. Assess LOS and adjust power, airspeed, and heading as required to zero out LOS and HCA.

6.27. Tactical Formation Turns.

6.27.1. Radio Calls and Visual Signals. Accomplish small course corrections through check turns. Accomplish turns of more than 30 degrees by means of a delayed turn (45 through 90 degrees), in-place turn, or fluid turn. For reversing the flightpath 180 degrees, use a hook turn or cross turn. Radio calls or visual signals may be used to signal tactical turns. For example, the radio call for a delayed 90-degree turn would be "*Buzz 21, 90 left/right.*" No radio response is required from the wingmen. All tactical turns except a cross turn or hook turn into the wingman may be signaled with a wing flash in the direction of the turn. Lead should show the wingman the full planform (approximately 90 degrees of bank) when signaling a tactical turn to avoid confusion with minor course corrections (usually use 30 degrees of bank or less). If needed to attract the wingman's attention, a "zipper" (double-click on the radio microphone switch) may be combined with the visual signal. Wingmen should assume a delayed 90-degree turn until signaled otherwise.

6.27.2. Turn Contract. As turns are executed, all aircraft need to adhere to a "contract" during the turn to help ensure turn rate and radii are similar. Use the following parameters for contract turns: MIL power, G to hold altitude and airspeed (at medium altitude, approximately 0.35 AOA or just short of the light tickle). The second aircraft to turn (the aircraft getting turned into) may vary power, altitude, and G as necessary to finish the turn in position on the appropriate side of the formation. At lower altitudes, all aircraft must remain aware of terrain elevation, descent rate, and bank angle.

6.27.3. Deconfliction. The wingman takes the initiative to deconflict from lead. If the wingman is stacked high or low, the wingman should maintain that stack when commencing the turn especially if he or she is the first to turn. If there was no stack at turn initiation, there may be no need for further deconfliction due to built-in lateral spacing. The wingman should always be clearing their flight path and "telegraph" (signal) their intentions for vertical deconfliction when necessary by positively maneuvering the jet. Both lead and wing are ultimately responsible for flightpath deconfliction and must clear during turns and take appropriate evasive action if required. If the formation is assigned a hard altitude (no altitude block), the wingman should climb or descend slightly for deconfliction if necessary—both aircraft must adhere to the cleared altitude.

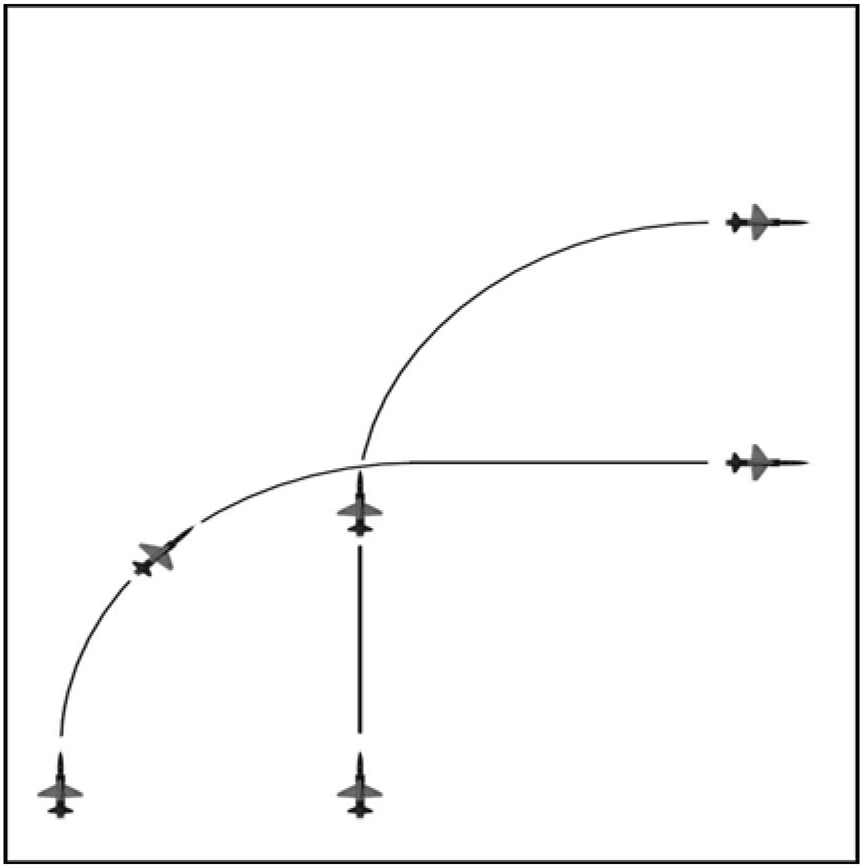
6.28. Delayed 90-Degree Turns.

6.28.1. Turns Into the Wingman (**Figure 6.12**.).

6.28.1.1. If the turn is called over the radio, lead begins the contract turn immediately after the call. Otherwise, lead's contract turn into the wingman signals the turn. As lead begins the turn, the wingman continues straight ahead and deconflicts the turn by maintaining or obtaining sufficient vertical clearance. The wingman should use this opportunity to clear lead's new 6 o'clock position.

6.28.1.2. The wingman initiates a 90-degree contract turn to rollout in tactical on the other side of lead. The timing for starting this turn occurs just prior to observing a rapid increase in lead's LOS. If the wingman is in position, the increase in LOS will occur after lead has turned approximately 45 degrees or just prior to looking down lead's engine intakes. This reference does not work if wing is out of position. If out of position, the wingman must vary the timing and G loading of the turn, based on lead's LOS, to finish the turn in position. Generally, when inside 6,000 feet or aft of LAB, the wingman should begin the turn earlier than looking down lead's intakes. When outside 6,000 feet or forward of LAB, the wingman should begin the turn after looking down the intakes. Also, when in proper position, at lower altitudes, the wingman should begin the turn later. The opposite is true at higher altitudes.

Figure 6.12. Delayed 90-Degree Turn.

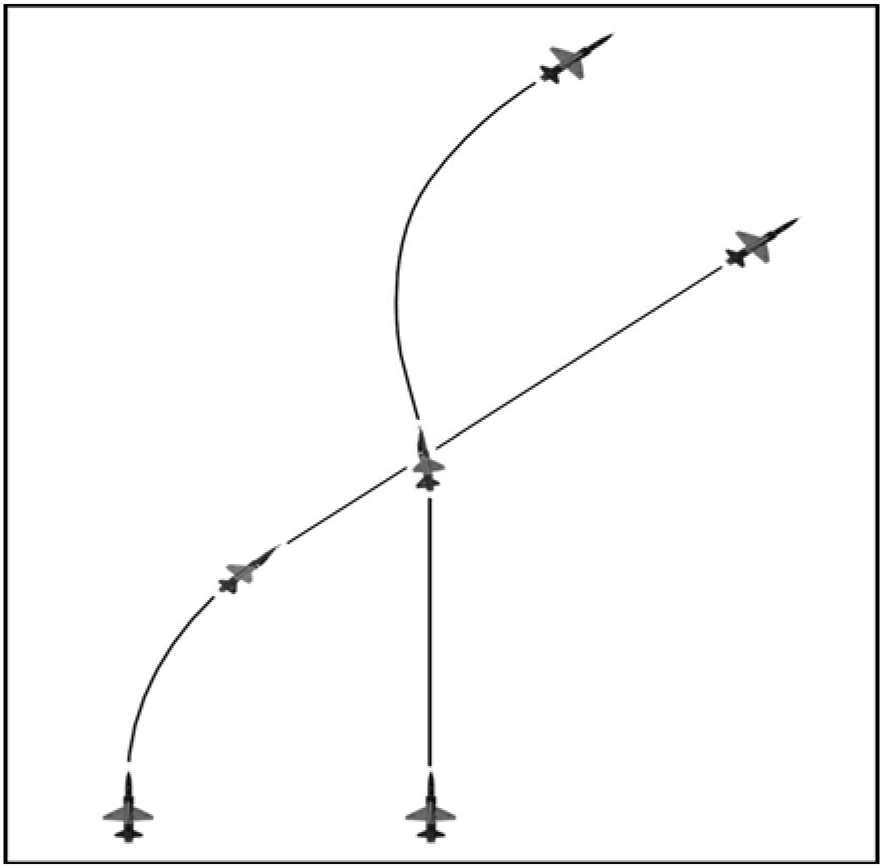


6.28.2. Turns Away From the Wingman. This is a mirror image of the 90-degree turn into the wingman. When directed, the wingman begins a contract turn into lead and uses all available references to rollout after approximately 90 degrees of turn. Lead delays and then performs a contract turn to rollout on the desired heading. After lead rolls out, the wingman is responsible for obtaining the correct position.

6.29. Delayed 45-Degree Turns.

6.29.1. Turns Into the Wingman (**Figure 6.13**.). If the turn is called over the radio, lead begins the turn immediately after the call. Otherwise, lead's turn into the wingman signals the turn. As lead begins the turn, the wingman continues straight ahead and deconflicts by maintaining or obtaining sufficient vertical clearance. The wingman should use this opportunity to clear leads new 6 o'clock position. When lead rolls out, the wingman maneuvers as required to achieve a tactical position on the other side of lead's aircraft by either delaying the turn until lead crosses the 6 o'clock position or by immediately maneuvering to the other side of lead. Either way, the aircraft being turned into should pass in front of (not over top or underneath) the other aircraft for the geometry to work out. During comm-out turns, lead must ensure the rollout occurs before the wingman begins a delayed 90-degree turn. If the wingman begins a 90-degree turn, lead should use the radio to achieve the desired turn ("*Vega 2, rollout*").

Figure 6.13. Delayed 45-Degree Turn.



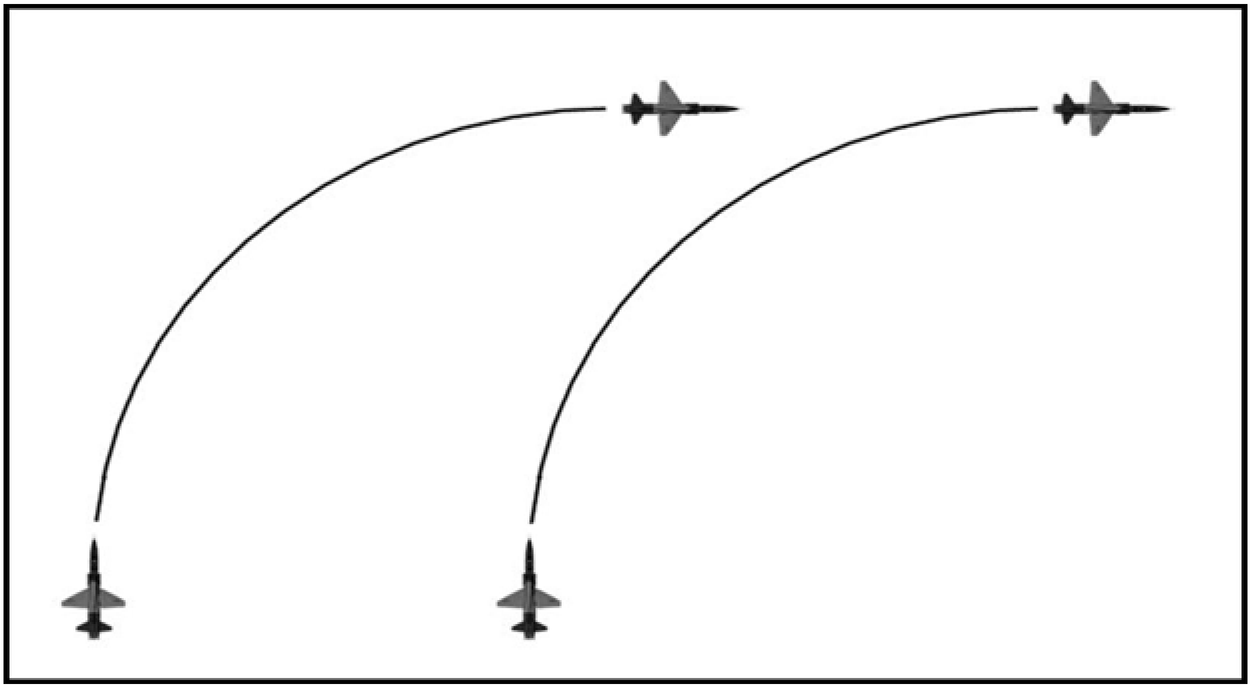
6.29.2. Turns Away From the Wingman**.** This is a mirror image of the 45° turn into the wingman. The wingman begins a contract turn into lead when directed. Lead signals the wingman's rollout by beginning a contract turn into the wingman. Lead will maneuver to the opposite side of the wingman in LAB position. After lead rolls out, the wingman is responsible for obtaining the correct position.

6.30. Other Tactical Turn Variations. For turns greater than approximately 60 degrees, lead will generally direct a delayed 90-degree turn. For turns between approximately 30 to 60 degrees, lead will generally direct a delayed 45-degree turn. For turns approximately 30 degrees or less, lead will call a check turn and turn to the desired heading. In all cases, the wingman's responsibility is to maintain or regain position.

6.30.1. Check Turns. The check turn is usually no more than 30 degrees of turn. Initiate the turn by transmitting "*Felon 31, check (degrees to turn) left/right*." Normally, both aircraft execute simultaneous contract turns, and the wingman remains on the same side.

6.30.2. In-Place Turns (**Figure 6.14**.). Use an in-place turn when desiring the formation to maneuver in one direction at the same time. To initiate, lead transmits "*Felon 31, in-place 90 left/righ*t." Both aircraft turn at the same time—in the same direction—using contract turns. If executed from line abreast tactical, a 90-degree turn will put the formation in trail at whatever lateral spacing existed prior to the turn.

Figure 6.14. In-Place 90-Degree Turn.

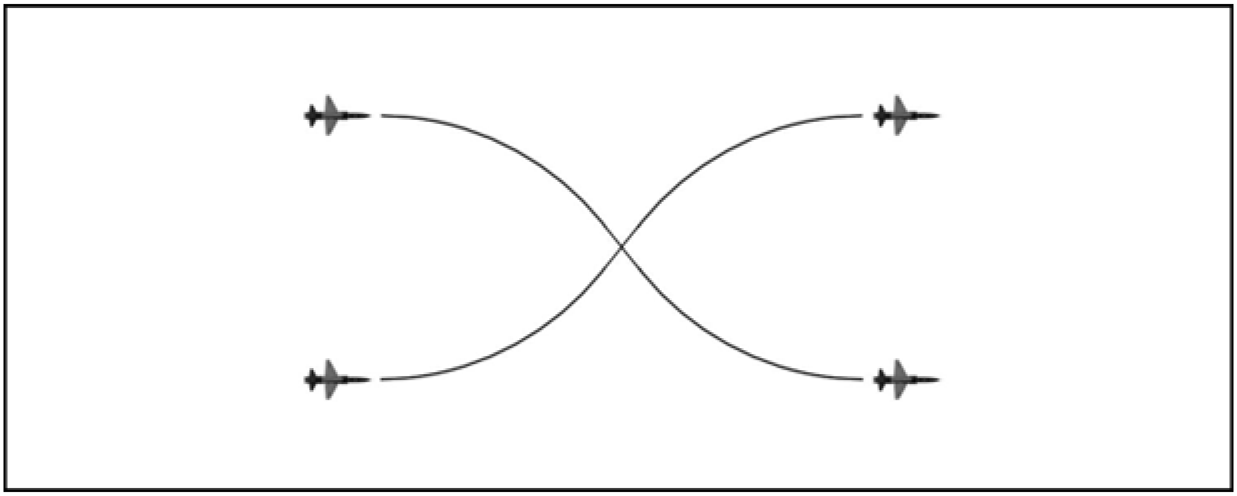


6.31. Shackle.

6.31.1. Use a shackle (**Figure 6.15**) to put the wingman on the opposite side or to allow him or her to regain the correct position. Initiate the shackle by transmitting, "*Mega 21, shackle*." Both aircraft turn toward each other, with the wingman ensuring vertical deconfliction. Generally, the wingman rolls out with lead to minimize fore-aft LOS. Both aircraft reverse the turn after crossing flight paths. Lead rolls out on the original or desired heading, and the wingman assumes proper tactical position.

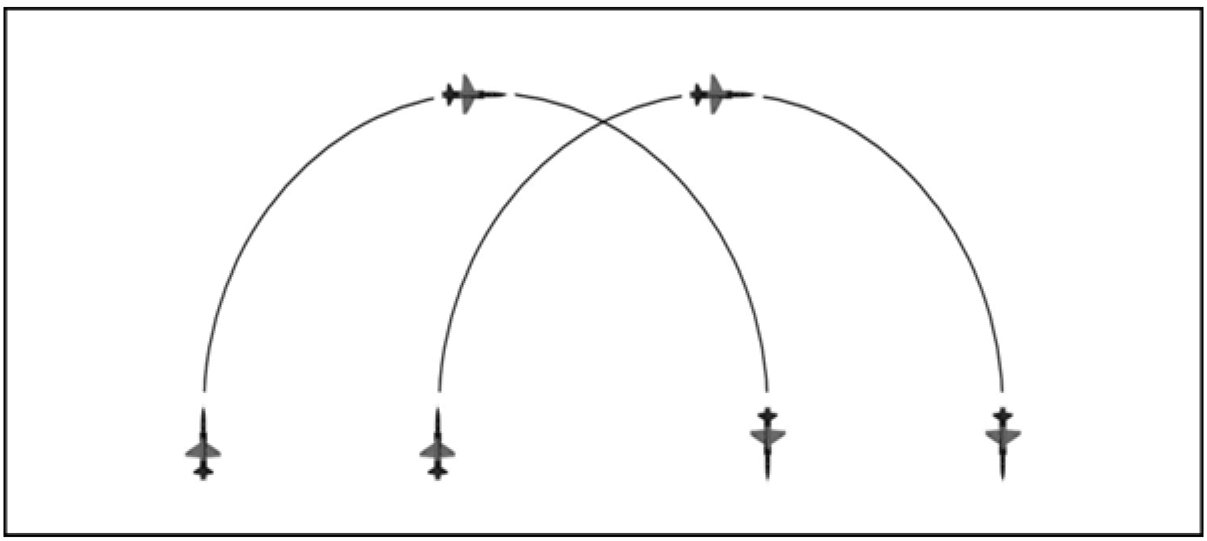
6.31.2. If not starting out line abreast, aircraft will maneuver during the shackle as appropriate for the situation. If the shackle is to allow the wingman to correct a forward position, the correct lead maneuver may be to continue straight ahead. If the wingman is behind at the start of a shackle, use less bank angle and (or) angle-off to regain the proper position. If the wingman is ahead at the start of a shackle, use more bank angle or angle-off to regain the proper position.

Figure 6.15. Shackle.



6.32. Hook Turns. During a hook turn (**Figure 6.16**), the formation turns 180 degrees with both aircraft performing a contract turn at the same time in the same direction.

Figure 6.16. Hook Turn.



6.32.1. Hook Turns Into the Wingman. A hook turn into the wingman will be called over the radio ("*Bam 41, hook right/left*"). During the first half of the turn, lead is responsible for keeping the wingman in sight and aligning fuselages at the half-way point through the turn. Shortly after halfway through the turn, the wingman should acquire, maintain sight of, and fly off of lead. If the turn is flown properly, the wingman will roll out in the correct position. If not, the wingman must maneuver to obtain the proper spacing and position.

6.32.2. Hook Turns Away From the Wingman. Hook turns away from the wingman may be signaled visually by a wing flash or called over the radio. If initiated with a wing flash, lead will begin turning when the wingman begins to turn. Lead's immediate turn tells the wingman this is not a 90- degree turn. For the first half of the turn, the wingman should match lead's turn rate, be at 0 degrees AA and HCA at the 90-degree point of the turn. Shortly after halfway through the turn, lead should acquire and maintain sight of the wingman.

6.33. Cross Turns.

6.33.1. Cross turns (**Figure 6.17**) are another 180-degree reversal option. Both aircraft make a contract turn into each other with altitude split for flightpath deconfliction. Two basic challenges occur during the turn: (1) reacquiring visual contact with the other aircraft, and (2) too much lateral spacing caused by the T-38's turn performance.

Figure 6.17. Cross Turn.

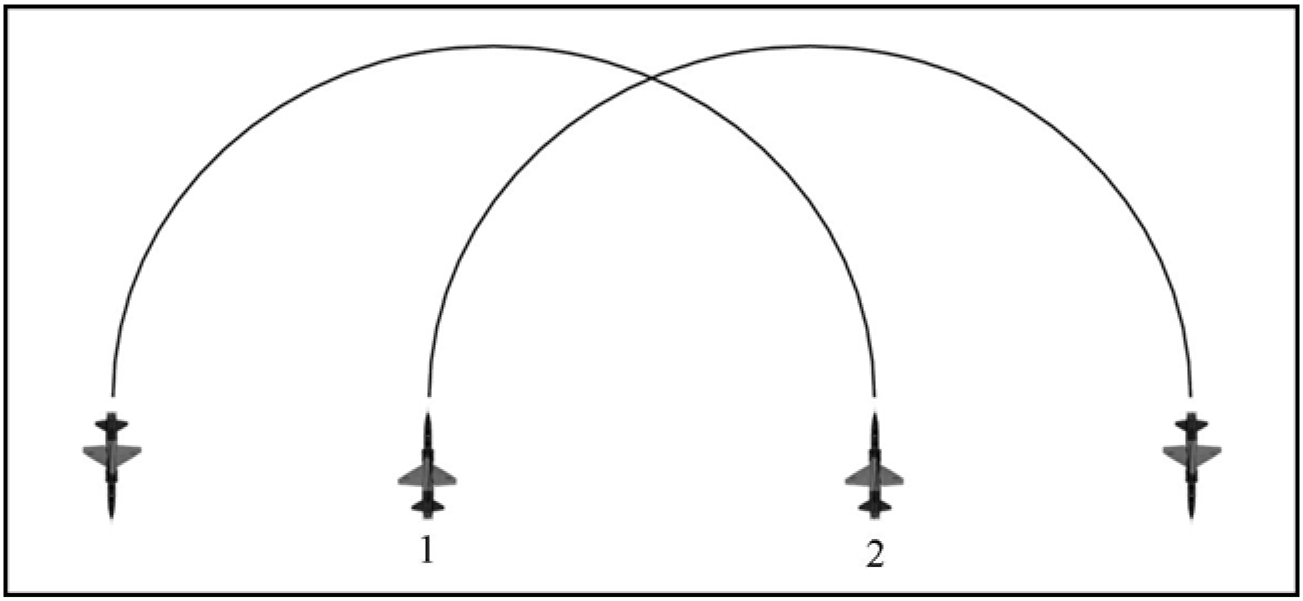
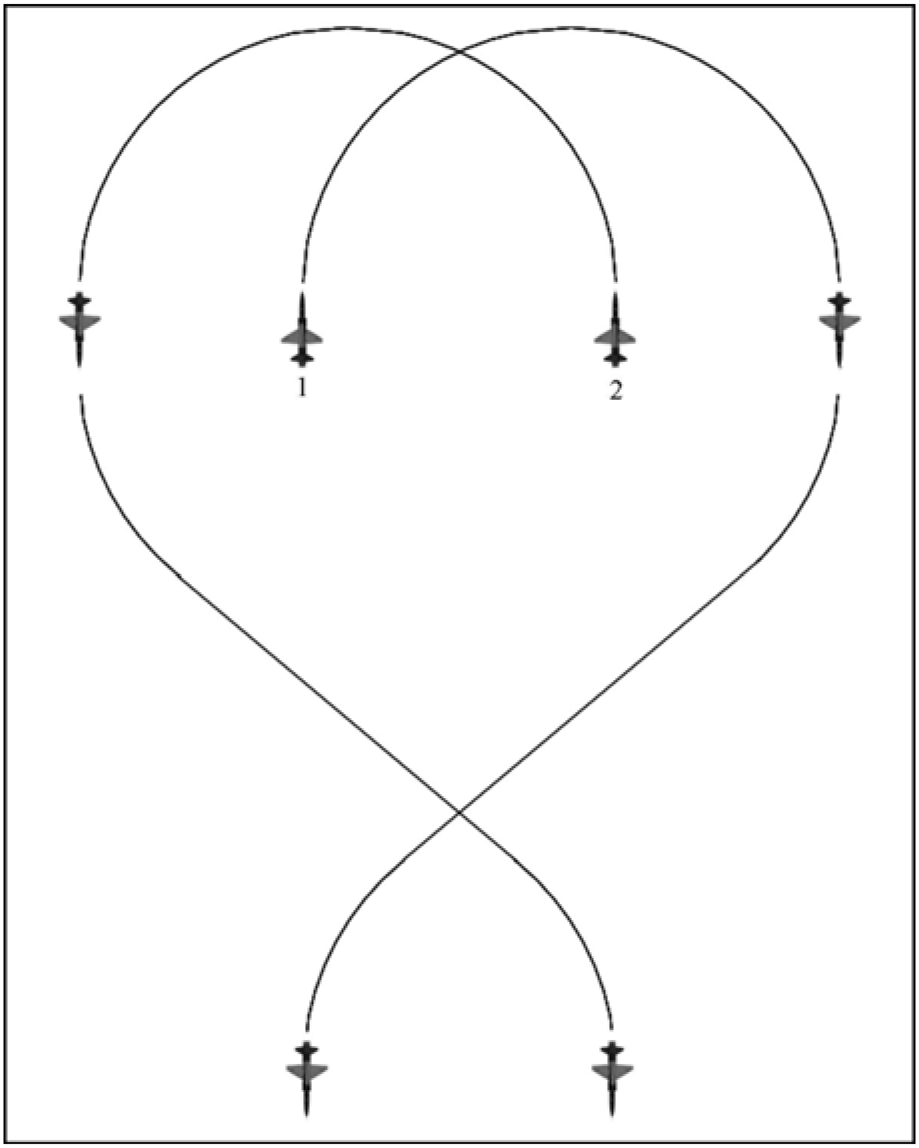


Figure 6.18. Cross Turn with Shackle.



6.33.2. Cross turns will be executed on a verbal command from lead ("*Buzz 31, cross turn*"). Immediately, both aircraft will commence a contract turn toward each other. Aircraft should cross after 60 to 90 degrees of turn and continue their turn through 180 degrees. The flight is now on a reciprocal heading, but, because of the large turn radius, the lateral separation will be wide (2 to 3 NM) if the original spacing was correct. Conversely, if the wingman's spacing was initially wide, a cross turn should result in reduced lateral separation.

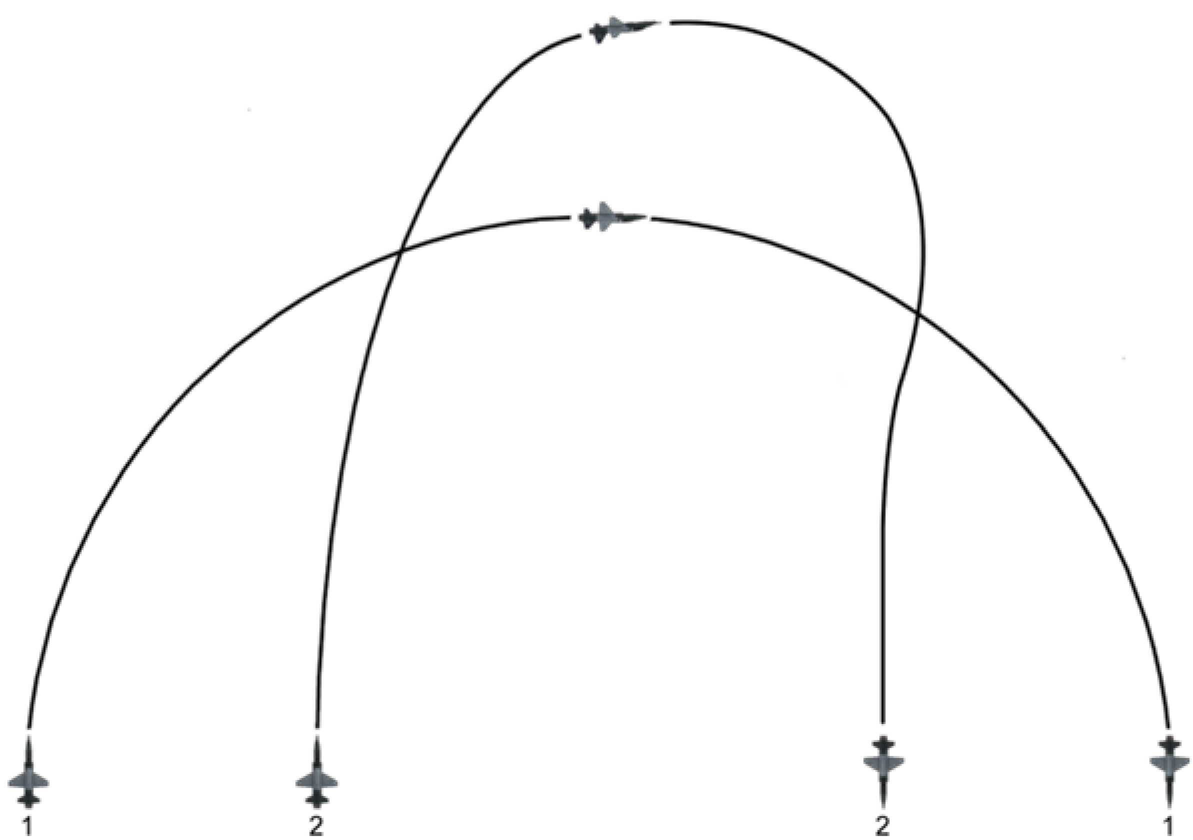
6.33.3. As quickly as possible after turning through 90 degrees, each pilot must reacquire and maintain visual with the other aircraft. If the other aircraft is not reacquired during the second half of the turn, call "blind" immediately upon rollout.

6.33.3.1. Following completion of the turn, unless briefed otherwise, wing should begin to correct back to the tactical LAB position. To correct lateral spacing, lead may direct a shackle (**Figure 6.18**.). If the wingman is blind but lead is visual, lead may direct a shackle while maintaining altitude separation and attempting to talk the wingman's eyes back onto lead.

6.33.3.2. Due to the distance between aircraft, it is possible for neither pilot to regain sight after the cross turn. If this happens, both aircraft should maintain the reciprocal heading until directed otherwise by lead. Lead is responsible for ensuring altitude separation.

6.34. Fluid and Easy Turns. These turns are used to maneuver a formation when there is very little G or excess thrust available (heavy weight and (or) higher altitudes). Lead will normally make heading changes in 90-degree increments, using approximately 45 degrees of bank and maintaining airspeed and altitude. Also, fluid turns are almost purely "geometry" turns with power settings normally constant. If a 180-degree turn is required, combine the techniques for two 90-degree turns (**Figure 6.19**.). The radio call for a fluid turn is "*Snake 21, fluid left/right*." No acknowledgement is required. Easy turns are used when the flight lead wants to climb during a turn or save fuel while maneuvering. The radio call for an easy turn is "*Snake 21, easy hook left/right.*" No acknowledgement is required. For an easy turn, lead should use bank and pitch as required to hold airspeed and continue the previous maneuver, whether climbing, descending, or a level turn. Military power is usually the constant setting for climbing easy turns. The wingman should attempt to match lead's airspeed and maintain the same relative position from lead so as to roll out in the assigned formation position. The flight can gain anywhere from 6 to 7,000 feet of altitude during a climbing easy hook turn.

Figure 6.19. Fluid Turn.



6.34.1. Turns Into the Wingman. As a wingman, start a turn in the same direction as lead (**Figure 6.19**.). Whatever bank angle technique is used, wingmen must continuously monitor lead's position. The aircraft should normally have 20 to 30 degrees of turn completed as lead passes the 6 o'clock position, depending on lead's position at the start of the turn. For example, if the aircraft's position was behind lead's when the turn started, pilots may want to delay the cross. If the aircraft's position was ahead, pilots may want to cross earlier. Once lead's flightpath is crossed, adjust the turn to assume proper spacing and lower the nose to pick up airspeed, if necessary.

6.34.2. Turns Away From the Wingman. The wingman is immediately behind at the onset of the turn. He or she will roll into more bank than lead and lower the nose slightly to gain airspeed to move to the inside of the turn behind lead. As the turn progresses, the wingman will reduce the bank to attain proper lateral spacing and trade excess airspeed for altitude as he or she approaches the LAB position.

6.35. Belly Check. A Belly Check is a momentary reduction in bank performed by a turning fighter to clear the area hidden by the fuselage of the aircraft. This is typically a maneuver performed in formation, often by the inside fighter of a formation executing a tactical hook turn.

6.36. High Altitude Tactical. When flying tactical formation above FL 250, the following techniques are useful:

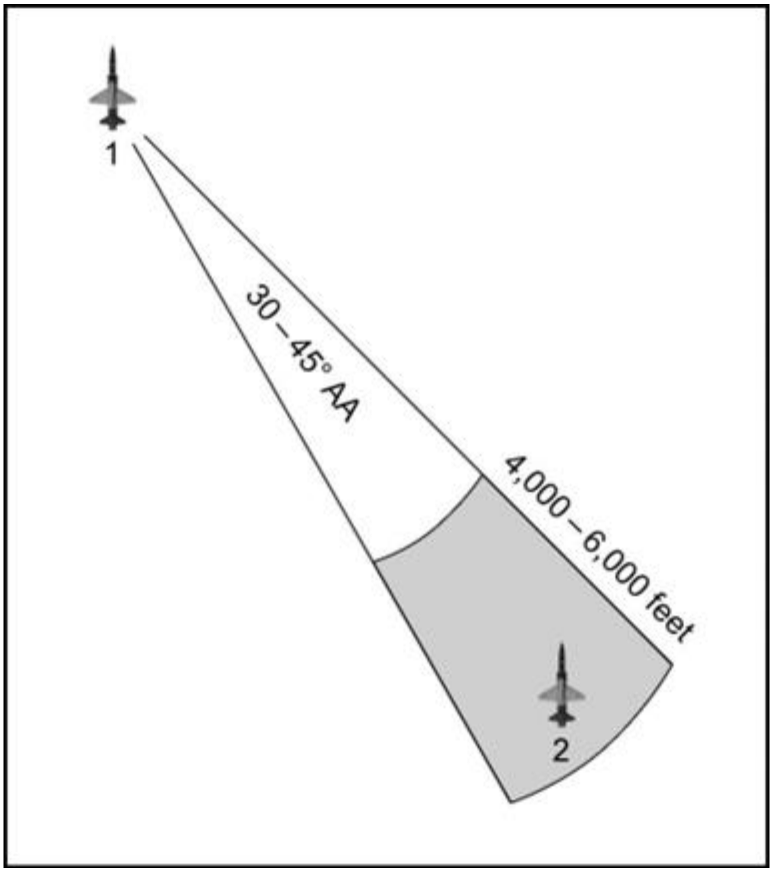
6.36.1. Normally, 0.85 to 0.9 IMN is a good airspeed range because it provides both maneuverability and good fuel flow at the higher altitudes. These speeds also provide excess power and, except with extremely cold outside air temperatures, will maintain operations within the engine envelope.

6.36.2. Reference AFMAN 11-2T-38V3 restrictions. Do not plan formation flights above FL 350. However, the aircraft must be operated above FL350, use 0.9 IMN or slightly higher as the base airspeed.

6.36.3. Energy conservation is a priority at the higher altitudes because less thrust is available. Additionally, throttle movements must be small to avoid compressor stalls. The basic maneuvering remains the same, but due to the increased emphasis on energy conservation, buffet should be avoided as much as possible. To accomplish this and to compensate for the higher true airspeed, use earlier lead turns than at lower altitudes. For example, during a delayed 90-degree turn into, start the turn as the other aircraft turns through approximately 30 degrees of turn (rather than 45 degrees). This should be apparent with the LOS concept discussed in **paragraph 6.28**.

6.37. Wedge. Lead might direct the wingman to wedge formation (**Figure 6.20**) when terrain, tactics, etc., require an increased degree of flight maneuverability. The wedge position is primarily used in the low altitude environment. Turns do not need to be called. The wingman maneuvers as required to maintain position. Wedge is defined as a position 30 to 45 degrees off lead's 6 o'clock (30 to 45 degrees AA) at a range of 4,000 to 6,000 feet. Maneuver as required to maintain position to include crossing lead's 6 o'clock if required.

Figure 6.20. Wedge Formation.



6.38. Tactical Rejoins.

6.38.1. Overview**.** Initiate all rejoins with a wing rock or radio call. Wingmen will acknowledge all radio calls to rejoin and the rejoin will not begin until all wingmen have acknowledged the call. **(T-2)** The standard platform for lead is 350 KCAS, 45 degrees of bank, and level flight. Different parameters may be briefed or called on the radio. Proficient wingmen will not require a radio call when different parameters are used. Wingmen should strive to maintain closure during the rejoin.

6.38.2. **Straight-Ahead Tactical Rejoin.** As the wingman, rejoin to the side occupied when given the radio call or visual signal. Unlike a normal straight-ahead rejoin from a trail position, a tactical straight-ahead rejoin begins from a lateral spread. The mechanics of flying this maneuver will vary based on position when initiating the rejoin. If necessary, maneuver vertically or laterally to gain turning room. The following should provide a systematic approach on which to build from a LAB starting position:

6.38.2.1. If there is stack greater than 500 feet, attempt to work toward a stack-level position.

6.38.2.2. Roll and pull the aircraft to put lead slightly forward of the LAB picture on the canopy (approximately 15-20 degrees of HCA).

6.38.2.3. Use power as required to remain slightly aft of LAB (90 degree AA off of lead). The aimpoint should be towards the close trail position (slightly aft/low).

6.38.2.4. As range closes (approximately 1,5000 feet away), lead will begin to move further forward on the canopy if nothing is done with HCA. As this begins to occur, start taking out some of the HCA (align fuselages) to maintain lead in a slightly forward of LAB position on the canopy.

6.38.2.5. Tactical Straight-Ahead Rejoin Overshoot. If angular or airspeed closure is excessive, consider overshooting behind all preceding aircraft's 6 o'clock position with a minimum of nose-tail clearance or execute a breakout, whichever is more appropriate. If deciding to breakout, ensure an altitude stack that vertically deconflicts from the lead/preceding aircraft. Use caution when executing a breakout in the low-level environment and always ensure terrain clearance. If closure is so excessive requiring wing to lose visual of lead, consider this a breakout. Select idle and speed brakes (if required) as soon as excess overtake is recognized. Guard against turning back into lead while looking back at them. A small, controllable 3/9 line overshoot is easily managed and can still result in an efficient rejoin. Retract the speed brakes and increase power just prior to achieving co-airspeed (stagnant LOS) to prevent falling aft.

6.38.3. Turning Rejoin into the Wingman. Even before lead turns, wing has excessive AA and must use lag pursuit. Maneuvering to lag helps solve the initial AA problem but introduces excessive HCA as the wing approaches lead's turn circle. An initial move in the vertical is therefore required to build maneuvering room (turning room) to solve HCA. As wing approaches leads turn circle, available turning room must be used to zero out HCA or to align fuselages. With wing slightly outside lead's turn circle, wing should see a slight forward LOS rate across the canopy out of lead. At this point, wing should modulate power to stabilize lead's LOS on the canopy to cross lead's six o'clock at the desired range (about one to two ship lengths) while remaining clear of his or her jet wash. Wing maneuvers back inside the turn at the desired airspeed and AA. From here, wing follows the turning rejoin procedures described in **paragraph 6.20.3** to the briefed or directed position. As proficiency increases, wing can work to cross lead's six o'clock at closer ranges to a point to where wing performs a maneuver like the second half of a crossunder to the inside of lead's turn.

6.38.4. Turning Rejoin Away from the Wingman. As soon as lead turns, wing is outside the turn and needs to maneuver to the inside of the turn with lead pursuit. Use caution because an excessive amount of lead pursuit may result in excessive AA, HCA, and (or) closure. Cross lead's six o'clock while remaining clear of the jet wash and assess the aircraft's energy (airspeed, altitude differential, and angular closure). One technique is to point the aircraft inside of lead's turn circle and then rollout and drive to the desired AA line. Once inside lead's turn, wing follows the turning rejoin procedures described in **paragraph 6.21.3** to the briefed or directed position.

6.39. Extended Trail (ET) Exercise.

6.39.1. Desired Learning Objectives (DLO). The ET exercise is an initial building block that introduces some of the concepts and skills required in future short-range BFM. The ET exercise allows pilots to practice the use of pursuit curves and dynamic maneuvering in relation to another aircraft. The DLOs of ET are to practice recognizing and solving problems of range, closure, AA, HCA, angle-off, and turning room from short-range, simulated "offensive" position behind a cooperative aircraft flying a scripted training profile.

6.39.2. The ET Cone. The cone for ET is defined as 30°- 45° AA on lead and between 1,000 to 3,000 feet range. Wing evaluates position in the ET cone using visual references and stadiametric range estimation.

6.39.2.1. Visual References. For wing, the reference for the 30° and 45° AA is the same as for the fighting wing position (see **paragraph 6.24**.). For visual ranging:

6.39.2.1.1. At 1,000 feet, pilots should easily see, but not be able to read, lead's tail number, and they should be able to discern two separate tailpipes.

6.39.2.1.2. At 3,000 feet, pilots can just start to make out detail on the airplane. Pilots should be able to recognize detail such as a clearly visible canopy and canopy bows, shoulders (intakes), distinct lines where the wings and tail meet the fuselage, a distinct horizontal stabilizer, and clear lines where the colors on the paint scheme change.

6.39.2.1.3. At 4,000 feet, just outside the ET cone, is where the VHF antenna ("shark fin") disappears; however, this reference requires the belly of lead's aircraft to be in view.

6.39.2.2. Stadiametric Range Estimation. Stadiametric ranging (described in **Attachment 2**) is another technique that can be used to determine ranges. The HUD symbology provides known size references for stadiametric ranging. "Mil-sizing" lead relative to HUD symbols does not require lead to be within the HUD field of view (FOV). Pilots should be able to visualize references to HUD symbols with lead outside the HUD FOV. Wingmen must maintain a vigilant composite cross-check, especially outside of the cockpit and with lead's aircraft, to recognize cues that could result in a potential deconfliction problem with lead.

6.39.3. Exercise Setups. There are two ways to send wingmen to the ET position—the ET Exercise and the Perch Setup (which is accomplished from tactical line abreast discussed in **paragraph 6.40**.).

6.39.4. Responsibilities. All pilots must fulfill the following common responsibilities during the ET Exercise and Perch Setup:

6.39.4.1. Collision Avoidance. As with other formation maneuvering, each pilot has the responsibility to take whatever action is necessary to avoid a collision. Because of the dynamic nature of the extended trail position, the problems of collision avoidance are compounded and require uncompromising flight discipline. All flight members must be vigilant regarding clearing their flightpath and recognizing and avoiding the prebriefed minimum range limitation (often called "the bubble").

6.39.4.2. Fuel Awareness. Because the Extended Trail Exercise and Perch Setups generally involve higher power settings for longer periods of time, all pilots must continually monitor their fuel state to prevent overflying joker/bingo. Lead should call for an ops check prior to each engagement. Ops checks accomplished between engagements or after the last engagement should include G's.

6.39.5. ET Exercise. Accomplish the entry ET exercise from any basic formation position. Lead initiates the entry with a radio call ("Colt 21, go extended trail") and wing acknowledges ("2"). Lead maneuvers by pulling away from wing with a military power and moderate G turn. Wing maneuvers as required to attain the ET cone. Once wing calls in ("Colt 2's in"), Lead begins the maneuvering phase.

6.39.5.1. Maneuvering Phase. The purpose of the maneuvering phase is to allow the offender to explore the ET cone against a dynamic platform and develop a crosscheck for both aircraft to ensure SA is maintained: floor awareness, MOA boundaries, remain visual and manage energy. From the basic formation entry or after the reposition phase from the perch entry, the offender will initiate the maneuvering phase with an "in" call ("Colt 2's in"). Unless briefed otherwise, the defender's power setting will be 550 degrees EGT and the offender's power setting will be 600 degrees EGT for the maneuvering phase. The flight lead may brief different power settings for defender and offender to achieve a DLO. As wing gains proficiency, the flight lead may brief to allow offender the ability to modulate power, which will transfer positively to follow-on training.

6.39.5.1.1. Defender. Defender's specific DLOs are to challenge offender with aerobatic maneuvering while maintaining visual or SA on offender's position, maintaining area orientation, and properly managing energy. Defender is not required to perform maneuvers to the precise parameters used in transition flying and should vary the attitudes and airspeeds as necessary for effective training, area orientation, visual lookout, and smoothness.

6.39.5.1.1.1. Consider offender's skill level while maneuvering to prevent exceeding their capabilities but continue to challenge offender with ET position problems to solve. High-G maneuvers are of little value if offender is unable to maintain the proper position. Remain constantly aware of G forces because offender is often exceeding lead's G level to maintain or regain position.

6.39.5.1.1.2. Limit ET maneuvering to turns, lazy eights, barrel rolls, cloverleafs, loops, and Cuban eights. Do not perform abrupt turn reversals; that is, turns in one direction followed by a rapid, unanticipated roll into a turn in the opposite direction. Defender should not maneuver to force offender to overshoot.

6.39.5.1.1.3. Defender should attempt to keep offender in sight but shouldn't sacrifice flightpath deconfliction to do so. However, the defender should develop a cross-check that allows the defender to maintain situational awareness of the offender's position and monitor the overall energy state and the floor.

6.39.5.1.2. Offender. Offender's specific DLOs are to maintain the ET cone without stabilizing on defender's turn circle. The offender must constantly assess visual cues to assess and control range, AA, HCA, and closure. Based on these cues, the offender must select the appropriate pursuit curve, and utilize AOA as required to reposition the aircraft as required. The correct ET position is rarely static in relation to defender. Offender should strive to maintain a position from which defender can stay visual. Avoid the defender's jetwash by avoiding defender's POM when crossing defender's turn circle. If it's determined the aircraft will pass through defender's jetwash, unload the aircraft to approximately 1 G to prevent an asymmetric over-G.

6.39.5.1.3. Lost Sight. If the defender loses visual, the defender will transmit "*C/S (1/2) no joy*" and continue to maneuver predictable (continue the turn). **(T-2)** The offender will immediately transmit "continue" if visual with the defender. **(T-2)** If the offender is not visual, a "knock-it-off" will be transmitted and the offender will lag the defender's last known position. **(T-2)** Reference **paragraph 6.60.2**.

6.39.5.2. Terminate and flight rejoins. Terminate the ET exercise according to AFMAN 11-2T-38V3. Normally, the defensive aircraft should terminate at a time that is advantageous for the flight in relation to MOA boundaries and profile management, however the offensive aircraft may terminate for DLO attainment. An example terminate comm flow:

6.39.5.2.1. Colt 1 or 2: "*Colt Terminate*"

6.39.5.2.2. Colt 1: "*Colt 1 Terminate*"

6.39.5.2.3. Colt 2: "*Colt 2 Terminate*"

6.39.5.3. Post-terminate Maneuvering: After the terminate call, if ET exercise was initiated from a formation position other than line abreast, wing should attain and maintain the ET position until lead directs a rejoin or another formation position. If returning to line abreast, follow guidance in **paragraph 6.40.8.1**.

6.39.6. Energy Conservation. Energy conservation is very important for wing. Buffet in a high-performance airplane signifies a loss of energy. When encountering buffet, wing must decide what is more important, nose track or energy. If nose track is more important, wing may have to sacrifice airspeed by pulling in the buffet.

6.39.7. Training Rules. AFMAN 11-2T-38V3 provides training rules, including KIO, terminate, and minimum weather requirements. In addition:

6.39.7.1. Extended trail is limited to two-ship formations. **(T-2)**

6.39.7.2. When one or more flight members lose visual contact, follow the loss of visual contact procedures in AFMAN 11-2T-38V3.

6.40. Perch Setup. The purpose of the perch Setup is to introduce and practice a composite cross-check, the admin setups, terminations, and resets used in follow-on training such as BFM. The need for standardization of the setup is critical for reconstruction, debriefing, and assessment of DLOs.

6.40.1. The DLOs of the Perch Setup are as follows:

6.40.1.1. To practice maintaining briefed training parameters.

6.40.1.2. To introduce and practice a composite cross-check, admin setup, termination and reset for advanced maneuvering.

6.40.1.3. To practice maneuvering to, entering, and maintaining the ET cone from a position outside the cone.

6.40.1.4. To introduce and practice the application of A/A training rules (TR).

6.40.2. Each exercise is preceded by a descriptive preparatory radio call by lead ("*Colt 21, next exercise is Perch Setup, (Offensive/Defensive) for #2*.") followed by an acknowledgement from wing ("*2*"). Each pilot must strive to be in the correct starting position and must not call ready until the prebriefed starting parameters have been achieved.

6.40.3. Avionics. Lead and wing should select the A/A master mode after lead's descriptive preparatory radio call ("*Colt 21, next exercise is Perch Setup, (Offensive/Defensive) for 2*."). Check that A/A master mode is selected prior to the respective ready call (See FENCE In).

6.40.4. Floor. 10,000 feet MSL (or as briefed for local airspace requirements).

6.40.5. Lead. Starting parameters for lead are altitude as briefed, 350 ±10 KCAS.

6.40.5.1. Once lead has achieved the correct starting parameters, lead calls ready ("*Colt 1's ready*.").

6.40.5.2. After wing's ready call, lead directs a check turn ("*Colt 21, check 45 left/right*"), and turns 45 degrees away from wing for a defensive setup and into wing for an offensive setup.

6.40.5.3. As the offender achieves near pure pursuit, the defender reverses the turn direction while monitoring the offender, modulates power as required to arrive at the fight's on at 315 ±10 KCAS, and adjusts bank angle and Gs to set the desired AA of 30 to 45° while maintaining altitude. Decelerating from 350 KCAS and arriving at the fight's on with less than 320 KCAS and 30° to 40° of AA is a challenge. During the initial check turn, modulate power and pull to the buffet to bleed down to 320-330 KCAS; then allow the jet to decelerate the last 5 to 15 knots with throttle modulation after reversing the turn and have set the desired AA. For a level flight, 40° AA reference, the defender should look over their shoulder and see the offender slightly above the horizon (roughly a beer can on its side) and roughly a beer can in front of the rear canopy bow. The offender's lateral position can also be visualized above the wingtip (in relation to the aircraft) or just outside the wingtip (in relation to the horizon). See **Figure 6.21**. A common error during this phase is not to maintain level flight while looking at the offender. Maintain a composite cross-check.

6.40.5.4. Once the offender calls "fight's on," the defender begins the briefed exercise phase (as defined below).

Figure 6.21. 40-Degree AA Picture from Lead Aircraft Front Cockpit.

6.40.6. Wing. Starting parameters for wing is stack level with lead, 350±15 KCAS, and 1.1±0.1 line abreast.

6.40.6.1. If starting parameters have been achieved, wing calls ready ("*Colt 2's ready*.") after lead's ready call. If starting parameters have not been achieved, wing responds with the appropriate alibi (for example, "*Colt 2, standby airspeed*"), and then calls ready ("*Colt 2's ready*.") when within starting parameters.

6.40.6.2. At the check 45 left/right call, the offender executes a contract tactical turn to near pure pursuit (lead under the HUD gun cross) and then modulates power to arrive at the fight's on call at 350 ±10 KCAS while maintaining near pure pursuit.

6.40.6.3. As range decreases, the offender calls down ranges until 3,000 feet ("6,000…5,000…4,000"). The offender estimates ranges using visual references or the stadiametric ranging technique discussed in **Attachment 2**.

6.40.6.4. At 3,000 feet, the offender initiates the Reposition Phase with a fight's on call ("*Colt, fight's on.*").

6.40.7. Reposition Phase. The purpose of the reposition phase is to allow the offender to solve range, aspect, closure, and HCA issues against a stable platform. Always enter the reposition phase from a perch entry.

6.40.7.1. Defensive aircraft. The defender's specific DLOs are to maintain visual and practice the composite cross-check. The execution entails setting power at 550 EGT and performing a continuous 2 to 3 G descending turn maintaining 315 ±10 KCAS. The defender's cross-check is the same as described in **paragraph 6.39.5.1.1.3**.

6.40.7.2. Offensive aircraft. The offender's specific DLOs are to position the aircraft at the inside of the defender's turn circle and near the forward edge of the ET cone (1,200-1,500 feet and 40-45 AA), execute a controlled reposition (do not penetrate the 500 foot bubble), and then continue to maneuver as required to maintain the ET cone. Reference **Paragraph 6.39.5.1.2.**, **Figure 6.32**, and **Figure 6.31**.

6.40.7.3. Flight lead may brief to omit the reposition phase described above. In this case, the defender begins the maneuvering phase after offender's "Fight's on" call.

6.40.7.4. At "Fight's on" call, initiate ET Maneuvering Phase and continue as described beginning in **Paragraph 6.39.5.1**.

6.40.8. Reset to Line Abreast. From a perch entry, the normal post-terminate maneuver is a reset to tactical with a climb back to the starting altitude block.

6.40.8.1. After the terminate call, the offender lags the defender, roll wings level and set military power. The defender sets military power, initially continues their turn but then times their turn reversal to place the offender into a line abreast position. The timing of defender's turn reversal will be relative to wing's position at the terminate call. Once line abreast, both aircraft should attain and maintain 350 KCAS in the most energy efficient manner available, then set pitch as required to return to the starting altitude block. The wingman should make necessary correction to attain and maintain 4,000 to 6,000 feet spacing.

6.40.8.2. Avionics. Lead and wing will return to the NAV master mode after the terminate drill or no later than completion of the FENCE Out check; refer to unit specific standards.

6.40.8.3. After the termination drill, an optional reference heading by lead may be given to increase wing's SA. Wing must continuously assess lead and maneuver to stay in position.

6.40.8.4. Flight leads may utilize "easy" turns as needed for MOA awareness. An "easy" turn is flown by modulating G to maintain a slight climb while executing tactical turns (45/90/180), see **paragraph 6.34**.

6.40.8.5. The reset to line abreast is dynamic due to the likely differences in airspeed between defender and offender. Minimal time should be spent heads-down in the cockpit for both aircraft while the formation resets to tactical. After achieving line abreast, lead must maintain a vigilant lookout for wing as wing solves tactical formation problems.

6.40.9. 6K Perch Setup. The 6K perch setup is an alternate setup that may be used for the Heat-to-guns exercise in **paragraph A3.6**. The flight lead normally directs the wingman to 9,000 feet LAB at the planned "Fight's On" airspeed, typically 415 KCAS. The flight lead checks both aircraft in the direction of the defending aircraft. As the offender reaches pure pursuit, the defender reverses the turn and sets the appropriate aspect angle. The offender monitors the range and calls "Fight's on" at 6,000 feet. The offender holds the defender under the gun cross until reaching 6,000 feet and continues to modulate power to maintain the briefed "Fight's on" airspeed. For a T-38C, the wingspan is 4 mils at 6,000 feet. This is one mil larger than the inside gap of the gun cross and one mil smaller than each side of the horizontal arms of the gun cross. The AAT will display 1.1 nautical miles (NM) due to system lag.

6.41. Four-Ship Tactical. A four-ship formation combines the basic elements of two-ship tactical formation into a formation of four aircraft. The three four-ship tactical formations include fluid four, wall, and box or offset box. With the increased number of aircraft in the formation, all flight members must maintain visual awareness or SA on the other aircraft to ensure deconfliction. Strictly adhering to the contract turns and aggressively maintaining proper formation position will greatly reduce the risk of a midair collision. Although each pilot maintains an obligation to maintain visual on all aircraft, there are situations that may prevent this. The priority for wingmen is to maintain visual with, and maneuver in relation to, their element lead. Number 3's priority is to maintain visual with number 1, while fulfilling element lead responsibilities for number 4. Any time these priorities cannot be fulfilled, the flight must be informed with a timely "blind" call. It is imperative for all flight members to fly the aircraft efficiently and to try to anticipate what lead may do next.

6.41.1. Fluid Four. This is a simple and efficient formation for medium and high altitudes. Element leads (numbers 1 and 3) fly two-ship tactical LAB. Numbers 2 and 4 fly a fighting wing position off their respective element lead, striving to maintain a position on the outside of the formation when not maneuvering (**Figure 6.22**.). Tactical turns (**Figure 6.23**) are made between number 1 and number 3, the same as in two-ship tactical. Element leads can make it easier for their respective wingmen to stay in position by pausing momentarily between banking up and beginning to pull during turns, allowing the wingman to begin to maneuver for the turn.

Figure 6.22. Fluid Four Formation.

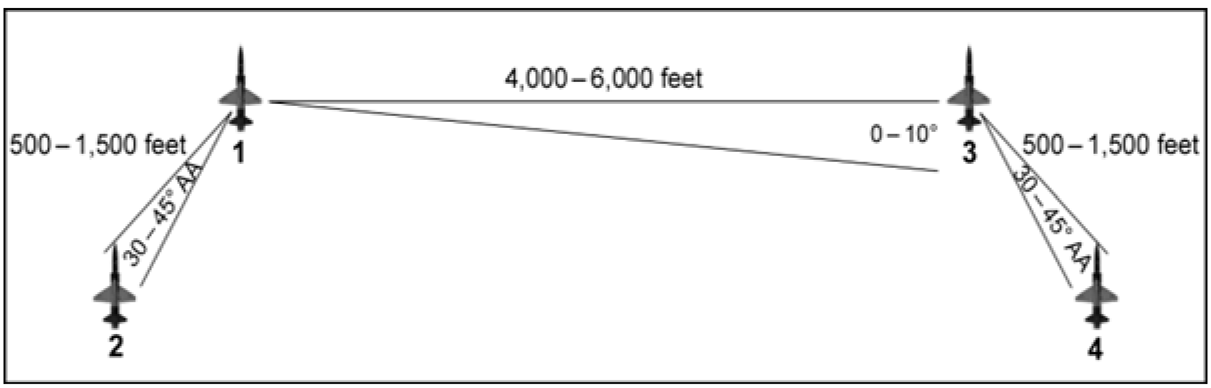
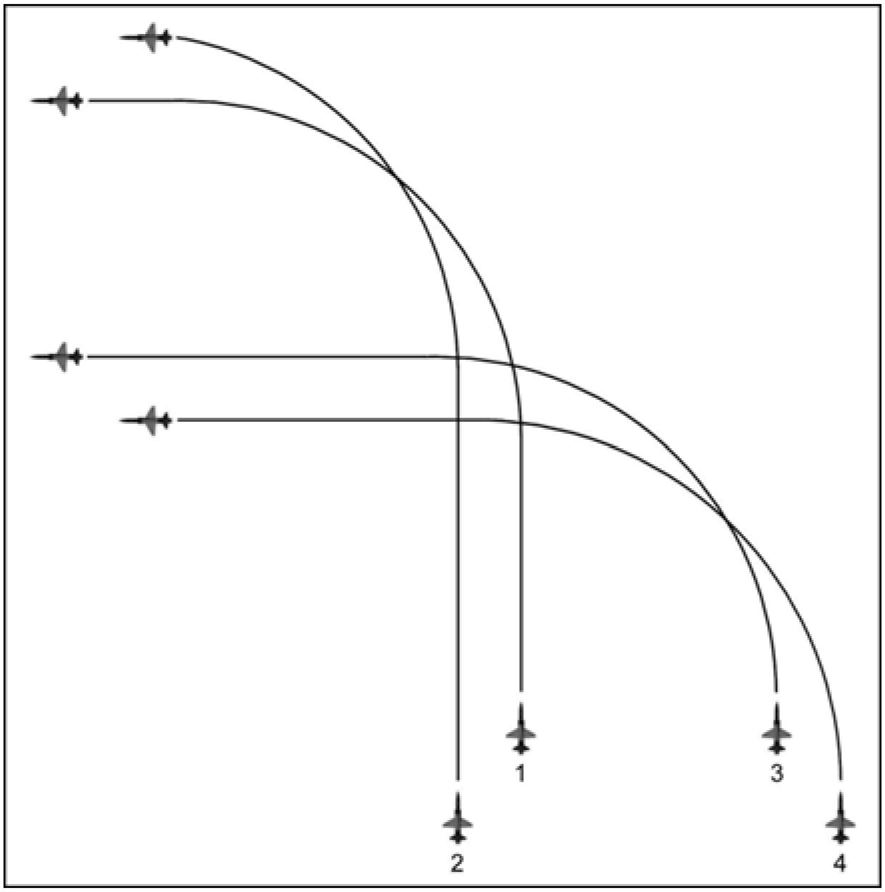


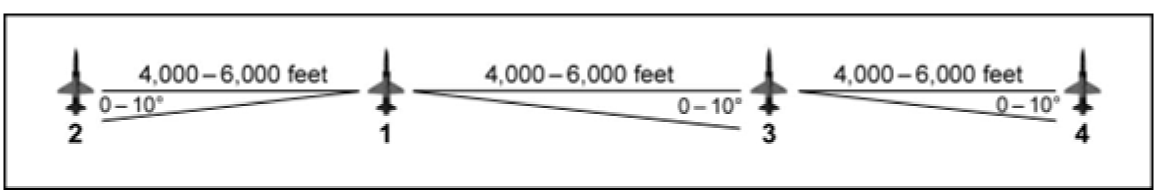
Figure 6.23. Fluid Four Turns.



6.41.2. The highest potential for conflict occurs during the turns as the elements cross during the turn. If the element leads are LAB at the start of the turn, this conflict is minimized but still exists if the wingman in the element being turned into has fallen back. If the element being turned into is aft of LAB at the start of the turn, there is a much higher opportunity for conflict, and all players must use extreme caution. Vertical stack between the element leads minimizes the opportunity for conflicts. However, the primary means of deconfliction is visual lookout. If the wingman of the high element is below his or her element lead, use extra caution to ensure deconfliction between wingmen during turns.

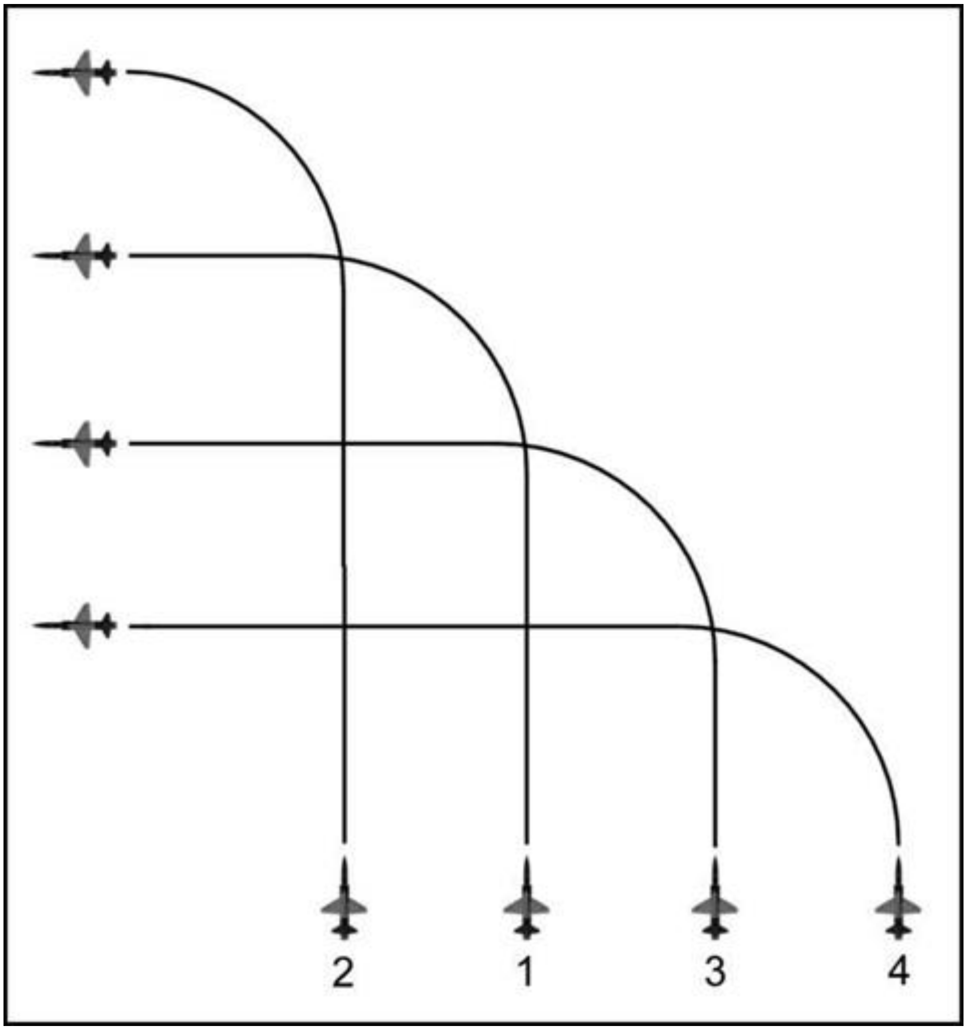
6.41.3. **Four-Ship Wall Formation.** The four-ship wall formation (**Figure 6.24**) is four aircraft in line abreast tactical formation. To establish the formation, all flight members fly line abreast tactical formation as described in **paragraph 6.28**. The wingmen (numbers 2 and 4) fly line abreast off their respective element leads. The flight lead should brief specific stack guidance for all wingmen.

Figure 6.24. Four-Ship Wall Formation.



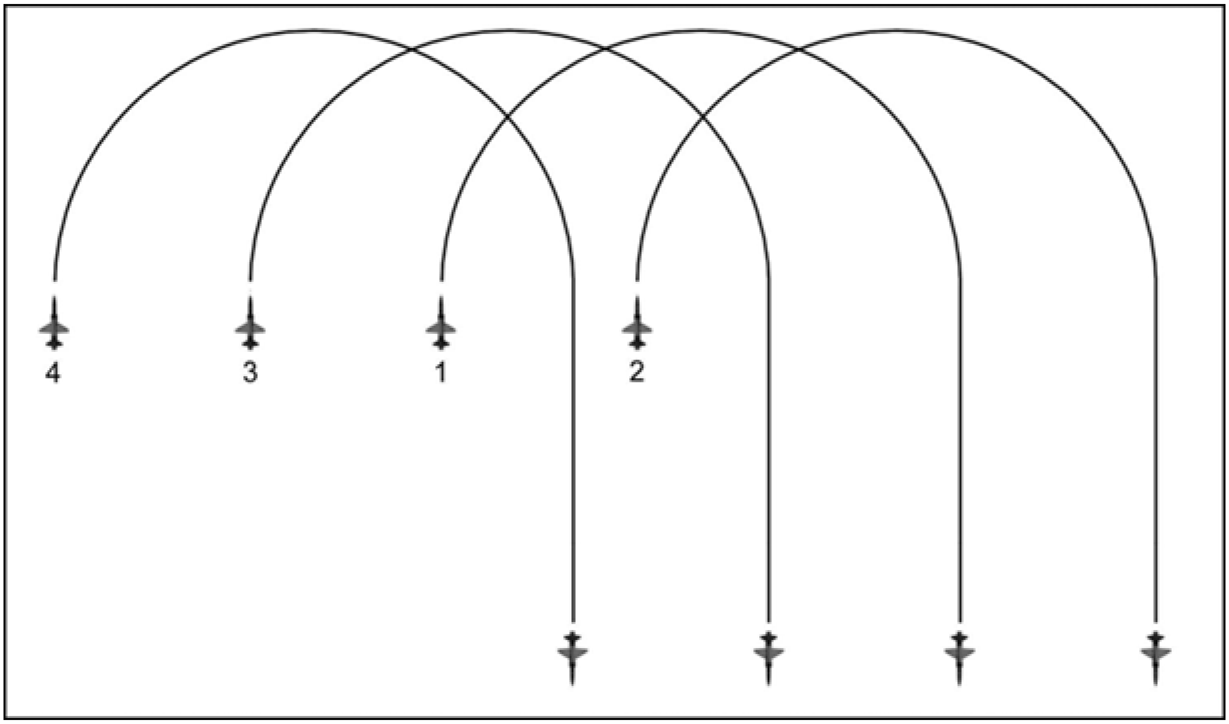
6.41.3.1. Four-Ship Wall Delayed Turns. Delayed turns (**Figure 6.25**) are executed similar to a two-ship tactical formation. Turns are directed by a radio call or visual signal. If lead gives the signal requiring number 4 to be the first to turn, number 3 should repeat the signal down to number 4. The wingman on the outside of the turn (the first aircraft to turn) flies a contract 90-degree turn, and each pilot in succession uses two-ship line abreast references and adjustments to execute a contract 90-degree turn. As number 1 completes the turn, wingmen maneuver to regain position. As in fluid four, conflicts are minimized if all aircraft are relatively line abreast at the start of the turn. If aircraft have fallen back, the potential for conflicts is increased.

Figure 6.25. Four-Ship Wall Delayed Turn.



6.41.3.2. Four-Ship Wall Hook Turns. Hook turns are tactical turns executed by all members of the formation simultaneously, resulting in line abreast formation heading approximately 180 degrees from the original heading (**Figure 6.26**.). Potential for conflicts during hook turns increases if flight members do not fly the contract turn causing the turn radii to be different.

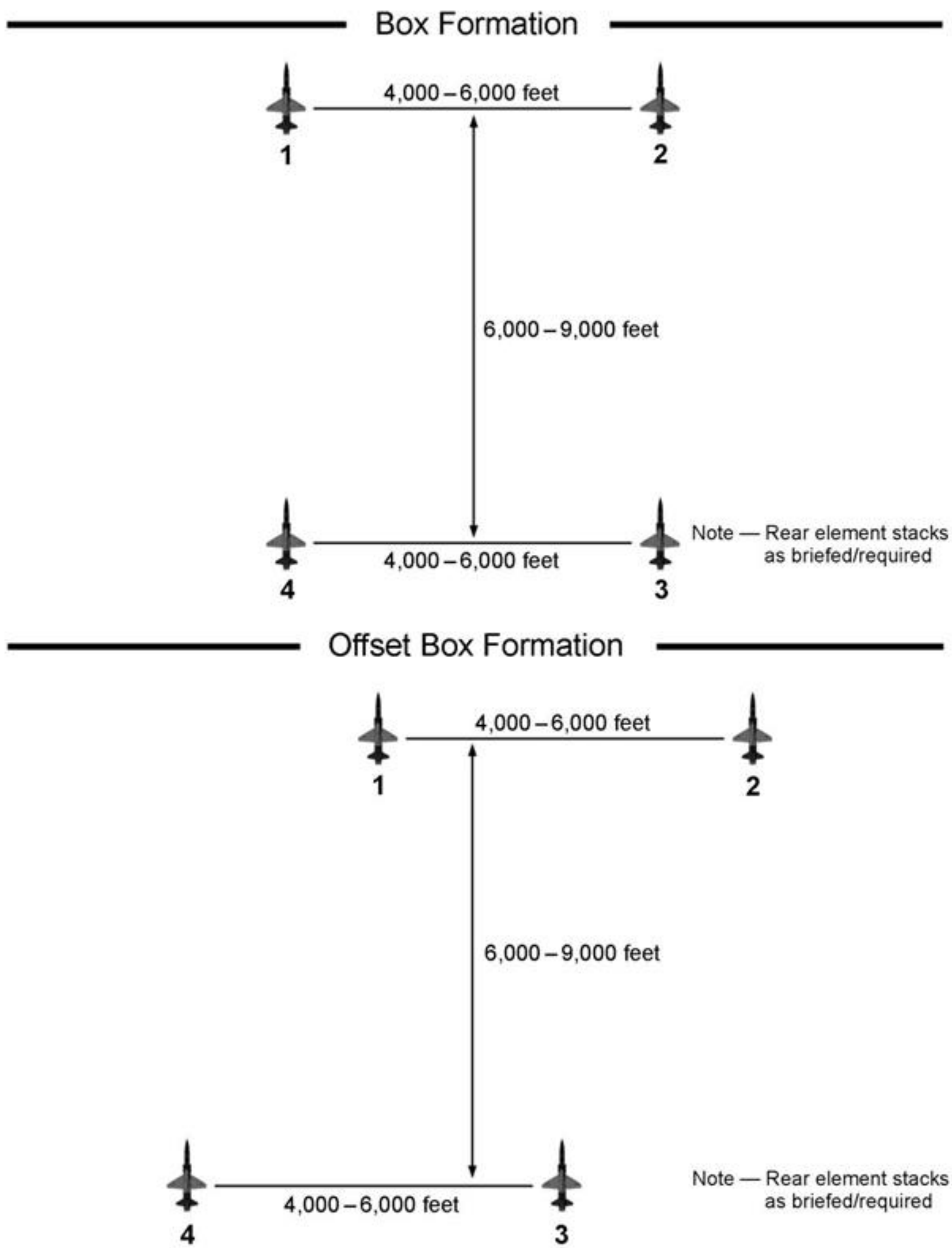
Figure 6.26. Four-Ship Wall Hook Turn.



6.41.4. **Four-Ship Box or Offset Box Formations:**

6.41.4.1. Overview. Four-ship box formation is essentially two elements flying line abreast tactical, separated in trail by 6,000 to 9,000 feet (**Figure 6.27**.). Unless specifically briefed by the flight lead or directed by their respective element lead, number 2 and number 4 can be on either side of their element lead, and the side number 2 and number 4 are on is irrelevant to one another. The rear element can fly directly in trail of the lead element (box) or offset the lead element (offset box) at lead's discretion. Generally, by flying offset box, it is easier for all flight members to maintain visual contact with one another. In offset box formation, number 3 may elect to place number 4 in the slot. The rear element should normally stack either high or low from the lead element, based on the brief or environmental conditions, unless required to maintain level because of weather or airspace restrictions. Cockpit visibility from the lead aircraft and the small size of the T-38 can make visibility between the front and rear elements a challenge because of environmental conditions and range. This may result in the rear element padlocking on the lead element to maintain visual.

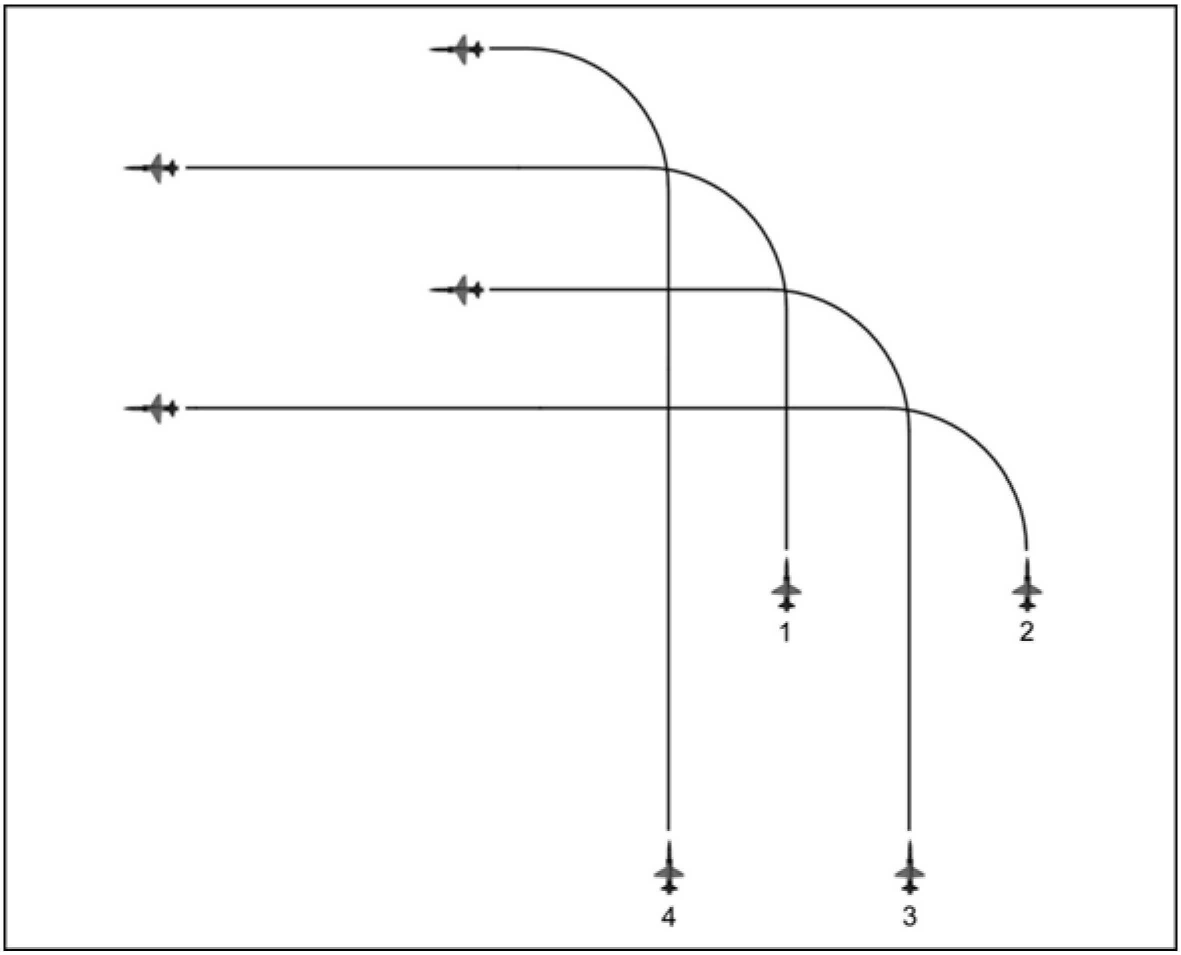
Figure 6.27. Box and Offset Box Formation.



6.41.4.2. Box Formation Turns.

6.41.4.2.1. Lead directs delayed 45- and 90-degree turns with a radio call or visual signal. Each element performs a standard delayed turn (**Figure 6.28**), with number 3 turning the trailing element to finish in the correct position relative to the leading element.

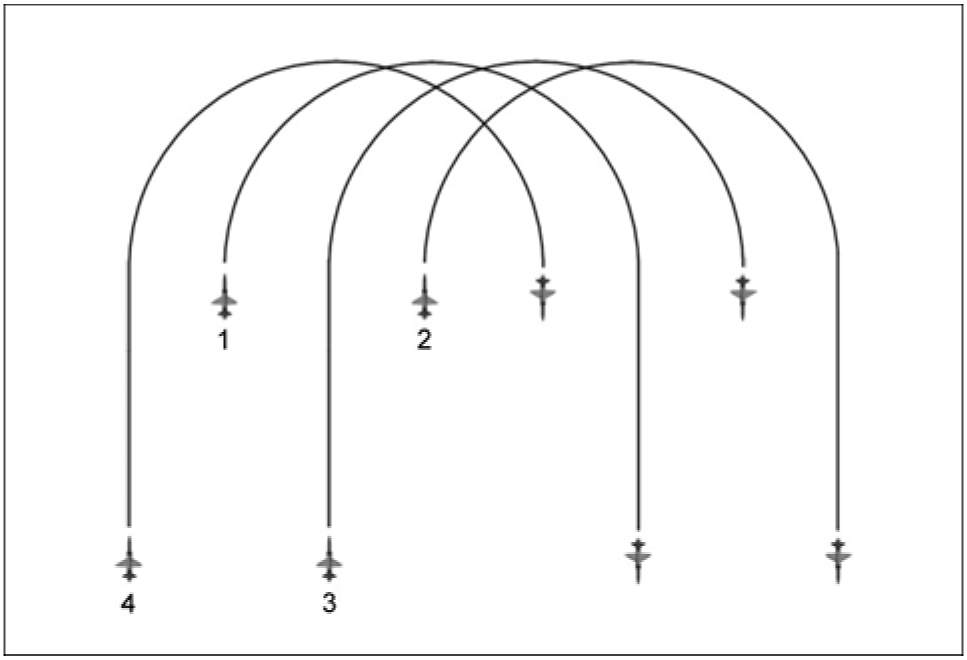
Figure 6.28. Offset Box Formation Delayed Turn.



6.41.4.2.2. For turns in box formation, the rear element must delay for several seconds prior to initiating its turn. One technique is for the trailing element to attempt to turn over the same geographical point or the "same point in the sky". For turns in offset box formation, the timing for the trailing element's turn could vary from 3 to 4 seconds (when turning away from the rear outrigger) to 7 to 10 seconds (when turning into the rear outrigger).

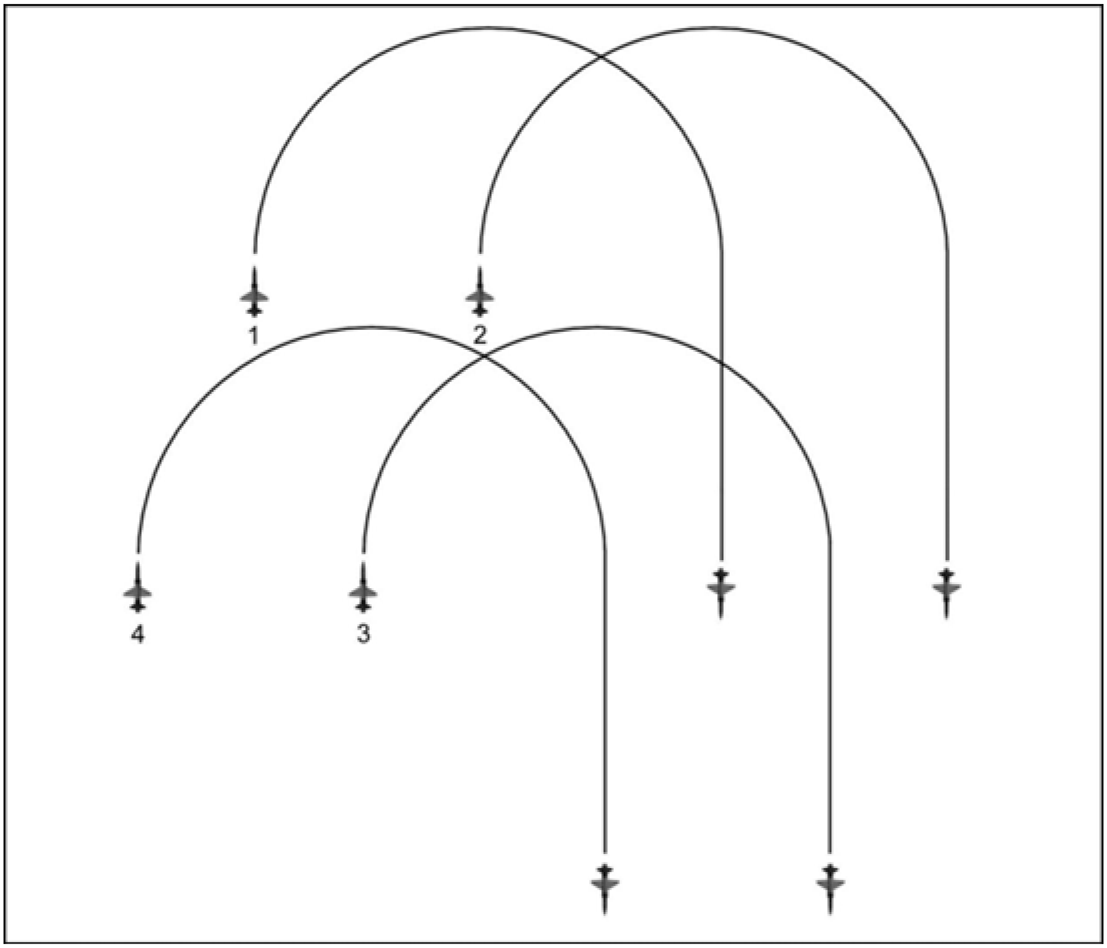
6.41.4.2.3. For hook turns in box or offset box formation, lead directs the turn with a radio call ("*Card 1 and 2, hook left/right*"). The standard hook turn while in box formation is for the second element to delay, so as to remain in trail ("*Card 3 and 4, hook left/right*"). (**Figure 6.29**.). Each element performs a contract hook turn, with all four pilots turning in the same direction. Number 3 delays momentarily prior to turning the second element to complete the turn in trail of the lead element. (Generally, the trailing element must start its turn before the lead element passes). If starting level with the lead element, the trailing element must immediately climb or descend to establish vertical deconfliction.

Figure 6.29. Offset Box Formation Hook Turn.



6.41.4.2.4. If lead intends all aircraft to simultaneously hook, thereby placing the trailing element in front, lead will call for an in-place hook turn ("*Colt 21, in-place hook left/right*") (**Figure 6.30**.). This will put the trailing element out in front of the lead element. A second in-place hook turn in either direction will put the four-ship back in standard box formation. One possible application of an in-place hook turn is while accomplishing a G-awareness exercise.

Figure 6.30. Offset Box Formation In place Hook Turn.



6.42. Three- and Four-Ship Tactical Rejoins. The basic two-ship tactical rejoin concepts also apply to three- and four-ship formations. All three- and four-ship tactical rejoins should be called on the radio and acknowledged and the rejoin will not begin until all wingmen have acknowledged. Number 2 and number 3 should call when selecting idle power, speed brakes, or are overshooting to provide awareness to the following aircraft.

6.42.1. Straight-Ahead Rejoins. Wingmen rejoin on lead as described in **paragraph 6.38.2** (straight-ahead tactical rejoin). Wingmen should rejoin in sequence and fly no closer than 500 feet to the preceding aircraft until the preceding aircraft are stable in a route or closer formation position.

6.42.2. Turning Rejoins. In a four-ship tactical formation, number 2 rejoins to the inside of lead's turn, number 3 rejoins to the outside of lead's turn, and number 4 rejoins to the outside of number 3. Wingmen should rejoin in sequence and fly no closer than 500 feet to the preceding aircraft until the preceding aircraft are stable in a route or closer formation position. Each wingman is responsible for keeping the preceding aircraft in sight and should avoid becoming a conflict or hazard to formation aircraft ahead or behind. All rejoins will be flown from the inside of the turn to allow lead to monitor his wingmen during the rejoin.

6.43. Three-Ship Options. Maintenance problems will occasionally cause one aircraft to "fall out," leaving a three-ship. Specific details—deputy lead, callsign changes, positions to fly, planned position changes, etc.—should be briefed by lead for each mission.

Section 6D—Fluid Maneuvering (FM)

6.44. Objectives. FM is an advanced building block that introduces the concepts and skills required in future medium-range BFM. FM builds on the short-range maneuvering practiced in ET by requiring the understanding of turn circle geometry and the creative use of pursuit curves and energy management to close from medium to short-range. The objectives of FM are to:

6.44.1. Introduce and practice the admin setups, terminations, and resets for medium-range BFM.

6.44.2. Introduce and practice the application of air-to-air ROE.

6.44.3. Practice recognizing and solving problems of range, closure, aspect, angle-off, and turning room from a medium-range, simulated "offensive" position behind a cooperative aircraft flying a scripted training profile.

6.44.4. Practice setting and controlling AA and maintaining briefed training parameters for the training aircraft.

6.44.5. Practice maneuvering to, recognizing, and stabilizing in the ET cone from a position well outside that cone, simulating the recognition of a weapons engagement zone (WEZ).

6.45. FM Responsibilities.

6.45.1. Collision Avoidance. Flight members must vigilantly clear their flightpath to recognize and avoid the prebriefed minimum range limitation ("the bubble").

6.45.2. Fuel Awareness. Because FM generally involves higher power settings for longer periods of time, pilots must continually monitor their fuel state to prevent overflying joker or bingo. Leads will call for an ops check before and between engagements.

6.45.3. Setup Standardization. During FM training, the need for setup standardization is critical to the reconstruction, debriefing, and assessment of desired learning objectives. It follows, therefore, that the training aircraft must not deviate from the prebriefed profile ("contract"). Leads are primarily responsible for accurately briefing and aggressively controlling these aspects of FM. The pilot in the maneuvering aircraft must strive to be in the correct starting position and must not call "ready" until the prebriefed starting parameters can be achieved.

6.46. FM Exercise. In addition to fulfilling the common responsibilities in **paragraph 6.47**, the two pilots in an FM exercise have distinctly different roles. (See paragraphs **6.50** through **6.62** for details of these roles.)

6.47. Training Aircraft. Although the primary training objectives are for the maneuvering aircraft pilot, there are significant training opportunities for the training aircraft. These include over-the-shoulder SA, POM assessment, lift vector control, floor awareness, G awareness, and energy management. The responsibilities of the pilot in the training aircraft include adjusting bank or backstick pressure to "set" the aspect, monitoring the maneuvering aircraft, and, most importantly, flying the prebriefed parameters ("the contract").

6.48. Maneuvering Aircraft. FM's primary objectives are for the pilot in the maneuvering aircraft. The responsibilities of the pilot in the maneuvering aircraft include being in level, near-pure pursuit to start (gun cross on training aircraft), helping the training aircraft pilot adjust the starting aspect, and remaining vigilant for high over-G potential situations. Between setups, the maneuvering aircraft should maintain or regain the prebriefed position until directed otherwise by lead while climbing at MIL power or 350 KCAS back into the briefed starting block.

6.49. FM Exercise Levels. The building block approach is used in FM training by decreasing the maneuvering limitations of the training aircraft as the wingman's proficiency increases (**Table 6.2**.).

Table 6.2. Fluid Maneuvering Exercise Levels (Training Aircraft).

FM Level	Maneuver	Gs	Airspeed	Power
1	Level to slightly descending	2 to 4 (note 1)	400 (note 1)	550 EGT
2			250 to 400	
3	Slight climb/descent up to +/- 30 deg pitch (MAX 120 degrees	2 to 4		
4 (note 2)	Slight climb/descent up to +/- 30 deg pitch (Max 120 degrees bank)	2 to 5		Military

NOTES:

1. Maintain constant G and airspeed. Increase G as proficiency allows.

2. IP demo or continuation training only. The wingman is allowed use of power up to MAX afterburner.

6.50. Special Instructions (SPINS), Training Rules (TRs), and ROE. These three terms intertwine in their application to training scenarios. Violation of TRs has serious implications for flight safety. Adherence to TRs is essential to becoming a disciplined combat aviator. Outside the FT and PIT environment, AFMAN 11-214, *Air Operations Rules and Procedures*, mandates numerous TRs, which have been developed over years of combat aviation training and are designed to provide a safe, effective training environment. Although AFMAN 11-214 does not apply in FT or PIT, the concept of TRs remains the same. The term "ROE" has real-world combat applications but is also commonly used in training. The following ROE apply:

6.50.1. The floor is 1,000 feet above the bottom of assigned airspace.

6.50.2. Power setting—MIL power or less. See **Table 6.2**.

6.50.3. The "bubble"—1,000 feet. (If a transition to ET is briefed, the 1,000-foot FM bubble is no longer applicable after the "in" call.) When the maneuvering aircraft closes to approximately 2,000 feet and approaches a stabilized position, the training aircraft should begin a level to slightly descending turn, maintaining constant G and airspeed.

6.50.4. The training aircraft should not execute turn reversals after the call to begin maneuvering.

6.51. Starting Parameters. A T-38's 400 KCAS, 4 G turn radius at 15,000 feet MSL is approximately 5,200 feet. Therefore, the FM exercise begins at or slightly outside the training aircraft's turn circle as follows:

6.51.1. Altitude block—15,000 to 17,000 feet MSL. (This may be adjusted.)

6.51.2. Airspeed—400 (±10) KCAS.

6.51.3. Maneuvering aircraft pursuit—pure pursuit, stacked level.

6.51.4. Aspect angle—30 to 45 degrees or as briefed. The maneuvering aircraft is just forward of the training aircraft's wingtip. (This may be adjusted for training objectives.)

6.51.5. Range—6,000 feet.

6.51.6. Stack—Level (±500 feet)

6.52. Setup Comm. Each setup should be preceded by an ops check, a descriptive preparatory call ("*Lance 01, next set FM level 3 for #2*". "*2*".)

6.53. FM Exercise Setups. There are three ways to set up the FM exercise; from directed positions, from a pitchout, or from line abreast formation. Flexibility affords every opportunity to maximize training despite area and (or) weather constraints.

6.53.1. From Directed Positions. This option is a little more comm-intensive but is especially efficient for dealing with weather-restricted airspace. Lead maneuvers or directs the flight as necessary back into the block and back to clear airspace for the next setup. The maneuvering aircraft simply maintains a directed position until directed to a different position by the flight lead.

6.53.2. From a Pitchout. Lead can accelerate in a route position to starting airspeed before the pitchout or direct acceleration afterward. The maneuvering aircraft delays to rollout 7,000 to 9,000 feet (about 5 to 6 seconds) behind lead. The training aircraft turns to acquire a visual and set the desired aspect. When the range decreases to 6,000 feet, the call is made to begin maneuvering.

6.53.3. From Tactical Line Abreast Formation:

6.53.3.1. After maneuvering into the block, completing setup admin, and acknowledging the descriptive call for the next exercise, the maneuvering aircraft slides out to 7,000 to 9,000 feet LAB. If transitioning from a 350 KCAS climb or tactical, an acceleration maneuver is required and should be directed by lead ("*Lance 01, push it up, reference heading 180*", "*2*".) If transitioning from 400 KCAS tactical, no acceleration maneuver is required. The wingman should strive to be ready before the flight lead. Once the flight lead calls "Lance 1 ready", the wingman responds immediately with a status call ("*Lance 2 ready*" or "*Lance 2 standby airspeed/stack/spacing/etc.*"). If the wingman makes a "standby" call, they must call ready once in starting parameters for the exercise.

6.53.3.2. After the "ready" calls, lead directs a check turn ("*Lance 01, check left.*" The training aircraft normally turns about 45 degrees away from the maneuvering aircraft but may adjust as necessary. The maneuvering aircraft continues the turn as needed to place the gun cross on the training aircraft. The training aircraft acquires visual on the wingman, remains on the roll-out heading until the wingman has achieved pure pursuit, and then reverses the turn and adjusts backstick pressure to "set" the desired aspect. The maneuvering aircraft should verify the correct aspect angle and call "ease off" or "tighten up" if required. When range decreases to 6,000 feet, the call is made to begin maneuvering from the maneuvering aircraft ("*Lance 01, fight's on.*")

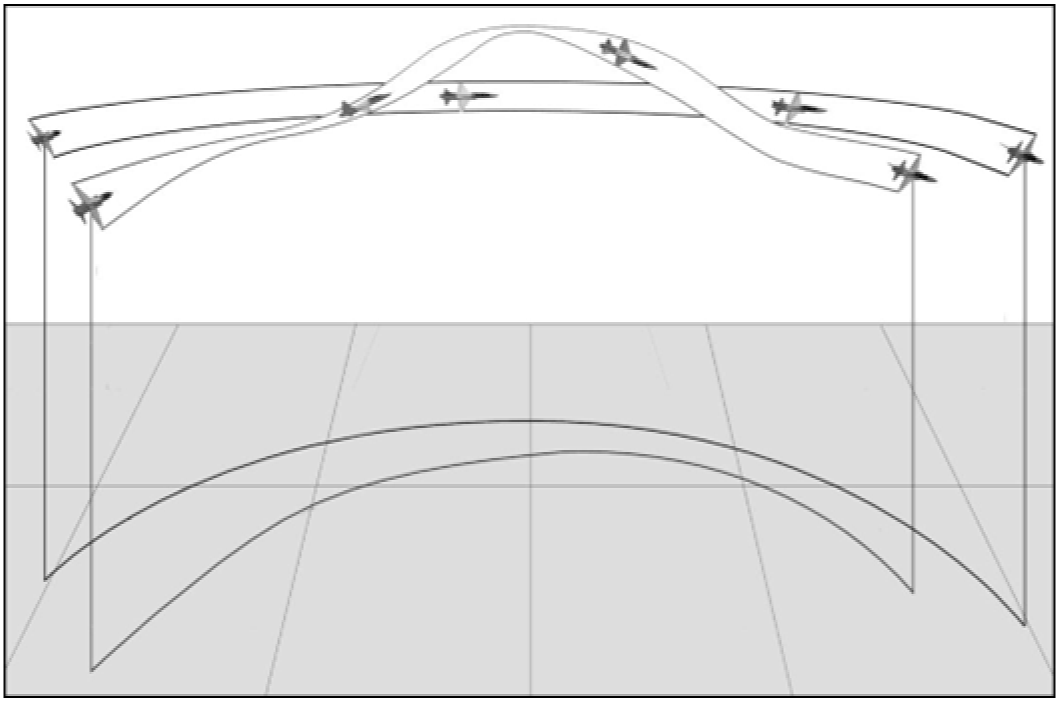
6.54. Initial Moves:

6.54.1. Finding the Turn Circle. If the call to begin maneuvering comes right at 6,000 feet, the opening move is normally a delay to preserve turning room. From 6,000 feet, just a small delay will preserve the optimum turning room for the offensive break turn, which should be executed on—or close to—the training aircraft's turn circle. Use caution during this delay to ensure the airspeed does not increase beyond that desired for the break turn. The aspect of the training aircraft will increase during this delay. The delay may be accomplished in-plane or out of plane. (Many pilots prefer to create some vertical turning room as well by adding a slight climb to their delay.)

6.54.2. Break Turn. A break turn too early—from inside the training aircraft's turn circle—will cause a cut across training aircraft's turn circle, which quickly decreases range, but also creates very high aspect. A break turn too late will waste turning room, cause a turn circle overshoot, and result in excessive lag and range. To execute the first break turn, roll to place the lift vector approximately on or slightly below the training aircraft and smoothly apply backstick pressure in a symmetrical pull to stop the training aircraft's LOS across the canopy. The goals of the first break turn are to realign fuselages as much as possible and decrease range while preserving enough energy and turning room to solve subsequent geometry problems. Heightened G awareness and careful reference to current G on the HUD are required to prevent over-Gs during the first break turn.

6.55. Lag Reposition. The lag reposition (**Figure 6.31**) is used to generate turning room to solve excessive closure and angle-off problems.

Figure 6.31. Lag Reposition.

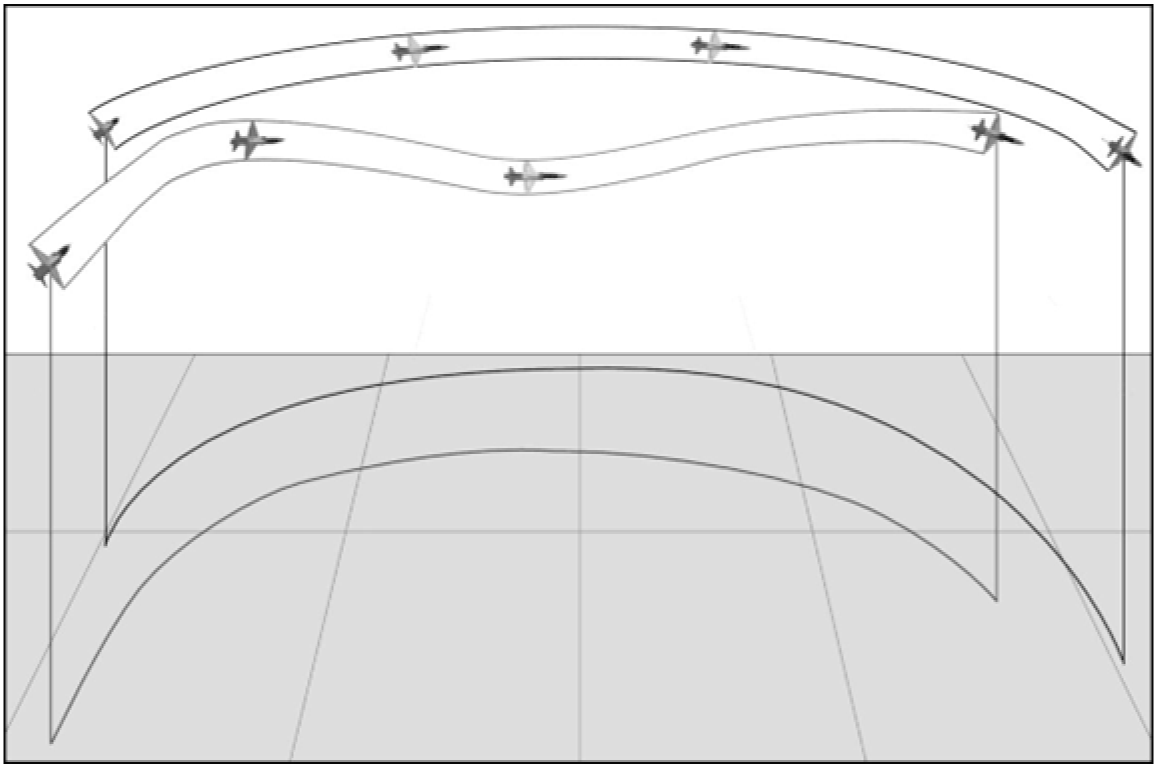


6.55.1. Position the aircraft's lift vector up and out of the training aircraft's POM. (The out-of-plane angle required will vary. In cases where aspect is decreasing too slowly, a lift vector position of more than 90 degrees to the training aircraft's flightpath may be necessary). Add backstick pressure as required to generate turning room.

6.55.2. Once sufficient turning room has been achieved, crisply roll back to place the lift vector on or below the training aircraft and pull to attempt to align fuselages. Use the radial G and out-of-plane turning room made available by the lag reposition to help establish lead pursuit. Once established in the ET cone, call "in." The entire lag reposition is normally flown at the maximum allowable power setting (MIL for FT or PIT).

6.56. Lead Reposition. The lead reposition (**Figure 6.32**) is used to generate closure to decrease range while preserving or building energy.

Figure 6.32. Lead Reposition.

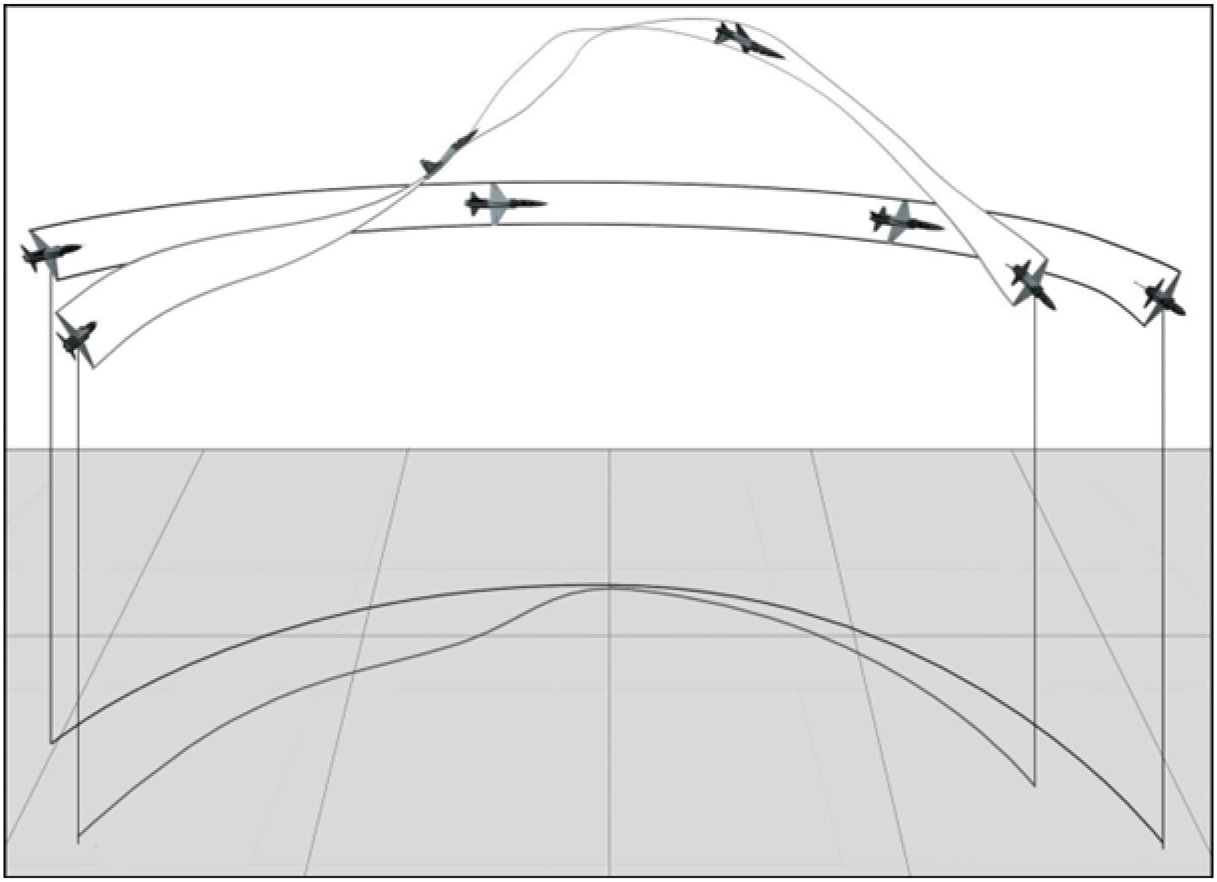


6.56.1. Place the nose and lift vector such as to pull lead pursuit in a POM below the training aircraft. How much lead and (or) descent will vary with range, closure, energy state, and the training aircraft's LOS. This out-of-plane maneuver uses turning room below lead. Analysis of the training aircraft's LOS will inform the pilot whether more or less lead pursuit is needed. When desired range or closure is reached, a lag maneuver or reposition may be required to preserve turning room for realigning fuselages. Once established in the ET cone, call "in".

6.56.2. Until the endgame, the lead reposition is normally flown at the maximum allowable power setting (MIL for FT or PIT). Note that the "picture" during a lead reposition may at times look very similar to that of a turning rejoin.

6.57. Quarter Plane. The quarter plane (**Figure 6.33**) is an exaggerated lag reposition used as a last- ditch maneuver to control closure and prevent a 3/9-line overshoot (often referred to as "preserving the 3/9-line") at close ranges and high LOS rates.

Figure 6.33. Quarter Plane.



6.57.1. Crisply rollout of plane and pull to the training aircraft's high 6 o'clock. The pull out-of-plane is at least—and often more than—90 degrees from the training aircraft's POM, but the amount depends on closure, range, and aspect. This pull to the training aircraft's "high six" reduces closure and aspect to prevent the loss of 3/9 line advantage.

6.57.2. A momentary power reduction may be required, but leaving the power back at high AOA with the nose up can quickly result in an excessive loss of energy.

6.57.3. Following the pull, and once assured the 3/9-line advantage will be maintained, unload and crisply roll to regain a visual and analyze the aircraft's new position. Key on the training aircraft's LOS. If the training aircraft is still moving aft, the closure problem is probably not yet solved. If the training aircraft is stopped or moving forward, closure is under control. Once established in the ET cone, call "in".

6.58. Transition to ET. If briefed, FM may culminate with a transition to the maneuvering phase of the ET exercise. A radio call from the maneuvering aircraft (e.g., "*Lance 2's in.*") usually marks the transition, after which both pilots adhere to ET parameters and restrictions.

6.59. Post-Terminate Flow. The normal post-terminate maneuver is a reset to line abreast with a climb back to the starting altitude block. The reset to tactical is dynamic due to the likely differences in airspeed between lead and wing. Minimal time should be spent heads down in the cockpit for both lead and wing while the formation resets to tactical line abreast. Lead must maintain a vigilant lookout for wing as wing solves tactical formation problems.

6.59.1. After the terminate or knock-it-off call, wing should check to lag the training aircraft and set military power. Lead should reverse the direction of turn, set military power and achieve and maintain 350 KCAS in the most energy efficient manner (airspace permitting).

6.59.2. The timing of lead's turn reversal will be relative to wing's position at the terminate call and will put wing line abreast. Once LAB, wing should set pitch and airspeed as required to remain line abreast and attain 4,000 to 6,000 feet spacing. Lead may use small check turns, if necessary, to aid in putting wingman in line abreast position.

6.59.3. The only communication required is during the termination drill. After the termination drill, a reference heading by lead may increase wing's SA but is optional. Wing must continuously assess lead and maneuver to stay in position.

6.59.4. Once the formation is reset to line abreast, wing must rely on visual cues from lead's aircraft to maintain tactical position and continue an efficient climb to the starting altitude block. During the climb, it is essential both aircraft maintain 350 KCAS without bleeding off airspeed in the turns. Lead may elect to turn at less AOA than a level tactical turn. Wing must evaluate lead's turn rate and adjust turn timing and turn rate to stay in position. Typically, these turns are referred to as "easy" turns.

6.59.5. Avionics**.** Lead and wing should return to the NAV master mode no later than completion of FENCE OUT.

6.60. Blind Procedures. If any aircraft goes blind, immediately call "no joy". If the maneuvering aircraft is blind, lag the training aircraft's last known position and power modulate as required to maintain current airspeed (300 KCAS minimum) and altitude. If the training aircraft is blind, remain predictable (which usually means continuing the turn under current parameters).

6.60.1. If the other aircraft is visual, direct the blind aircraft to continue while talking the blind aircraft onto the visual. "*Lance 2, no joy*". "*Lance 2, continue, visual is your right 2 o'clock, slightly low*." Once the blind aircraft calls "tally," continue maneuvering. If the blind aircraft does not regain the visual immediately, either aircraft may call a knock-it-off.

6.60.2. If both aircraft are blind, call a knock-it-off, establish altitude deconfliction, and the training aircraft must be directive with the wingman to deconflict and regain mutual support**.**

Section 6E—Handling Abnormal Situations in Formation

6.61. Takeoff Aborts.

6.61.1. Formation Takeoff:

6.61.1.1. If an abort becomes necessary, maintain aircraft control, ensure separation from the other aircraft by maintaining the designated side of the runway, and make a radio call as soon as practical ("*Flank 2 is aborting, barrier, barrier, barrier.*"). However, do not sacrifice aircraft control to make a radio call.

6.61.1.2. During a formation takeoff, there will normally be no sympathetic aborts within the element after brake release. Sympathetic aborts can create situations where a good aircraft is risking simultaneous barrier engagement, hot brakes, or blown tires.

6.61.1.3. During an abort situation, the aircraft continuing the takeoff should maintain its side of the runway, select full afterburner, and execute a normal single-ship takeoff. If lead determines both aircraft should abort, lead should direct the flight to abort. For example, lead will transmit, "Sting 21 flight, abort, abort, abort." Being in minimum afterburner and still overrunning lead could be the first indication that lead is aborting. If this occurs, accomplish a separate takeoff.

6.61.2. Interval Takeoff. If aborting as lead, make a radio call to wingman. It is difficult for the wingman to recognize an abort using only visual cues. If, the wingman has not already released brakes, the wingman will reduce power and hold position until lead clears the runway. If the wingman has already started the takeoff roll but still below 100 KCAS, consider aborting due to the likelihood of insufficient spacing to takeoff behind lead. If the wingman is already above 100 KCAS, the takeoff should be continued using MAX afterburner.

6.61.3. Element Abort. If an element abort is necessary, each aircraft must maintain its respective side of the runway and make every effort to stop prior to the end of the runway. Any aircraft requiring a barrier engagement should transmit its callsign and "barrier, barrier, barrier." If neither aircraft can stop prior to the end of the runway, the first aircraft to the barrier will engage the barrier and the second aircraft will take any necessary action to prevent barrier engagement, to include departing the runway surface.

6.62. Airborne Emergencies. As much as possible, maintain formation integrity for all airborne emergencies. If any aircraft malfunction occurs while in close formation, ensure aircraft separation before handling the emergency. The pilot of an aircraft experiencing an abnormal situation will advise lead of the problem, their intentions, and any assistance that is required.

6.62.1. Lead. As a minimum, offer the lead to a wingman after being informed the wingman has an aircraft malfunction once their aircraft is in a position to take the lead. If the wingman refuses the lead, try to pass the lead on recovery and on final with clearance to land or as the situation dictates. Except in unusual circumstances, do not land in formation with a disabled aircraft. If the wingman can transmit and receive with the radio, give him or her verbal assistance as necessary. Follow the preflight briefing instructions for emergencies so the wingman knows what to expect.

6.62.2. Wingman. When an aircraft malfunction is discovered, call "knock-it-off' and then inform lead of the problem. Normally, if a pilot can communicate with outside agencies and navigate, take the lead when offered. As much as possible, avoid flying the wing position with an emergency. If it's necessary to fly the wing position with an emergency, fly no closer than route spacing when weather allows.

6.62.3. Radio Failure. An aircraft experiencing radio failure will normally assume or retain the wing position. If experiencing radio failure as lead, put the wingmen in route and give the appropriate AFPAM 11-205 visual signal, then pass the lead to either number 2 or number 3 as appropriate. If experiencing radio failure as a wingman while in close or route formation, maneuver within close or route parameters to attract the attention of another flight member and give the appropriate visual signals. In other positions, do not rejoin closer than 500 feet. Rock wings to gain lead's attention and wait for a rejoin signal from lead. When signaled, rejoin as close as necessary to pass the appropriate visual signals.

6.62.4. Lost Wingman Procedures: Lost wingman procedures are IAW AFMAN 11-2T-38V3.

6.62.4.1. Lead. To minimize the possibility of a lost wingman situation, brief pertinent IMC procedures during the preflight briefing. Bring all wingmen into fingertip spacing, and reform any three- or four- ship formation into fingertip prior to entering IMC.

6.62.4.2. Wingman. Keep in mind that lost wingman procedures do not guarantee obstacle clearance when close to the ground. Therefore, each pilot who is executing lost wingman procedures is responsible for terrain and obstacle clearance.

6.62.5. Bird Strike. If a bird strike appears imminent, do not hit the other aircraft in an effort to miss the bird. The primary concern is still aircraft separation. If a bird strike does occur, ensure aircraft separation before handling the emergency.

6.62.6. Lost Sight. In some cases, losing sight of the other aircraft does not require a breakout or lost wingman procedure because sufficient spacing already exists. If the other aircraft is not in sight when anticipated, use the following procedures:

6.62.6.1. Notification. Notify the other aircraft of the situation ("*Sting 2's blind, fifteen thousand.*"). In some cases, heading or turn information may also be appropriate with this call. If only lead is blind, the call "*Sting 2, posit?*" is posed as a question for the wingman, who responds with position in relation to lead ("*Sting 2, visual, your right 3 o'clock, high*").

6.62.6.2. One Aircraft Is Blind. If the other aircraft has not lost sight, transmit "visual" with a relative position to the blind aircraft. If lead is the blind aircraft, but the wingman has lead in sight, lead has the option to direct a rejoin or continue to search for the wingman based on the response to a "posit" call.

6.62.6.3. Both Aircraft Are Blind. If both aircraft have lost sight, lead should immediately ensure a minimum of 1,000 feet altitude separation. Once separation is assured, TCAS may be used to affect the rejoin. By determining relative position and heading, lead can determine a rejoin geometry that will allow both aircraft to close and regain the visual. Lead will be directive and may use terms as" "reference" for heading, "set" for airspeed, and "maintain" for altitude. Wing should comply with these directives establishing lead's determined geometry to attain visual. Both aircraft should maintain altitude separation until one aircraft regains visual. The aircraft that gains visual may request the other aircraft to rock its wings for positive identification. The aircraft with the visual is responsible for maintaining separation and may request the other aircraft to maneuver to maintain the visual.

6.62.6.4. Three- or Four-Ship Formations. All members of a multi-ship formation should strive to maintain visual on all other members of the formation. However, the wingman's primary responsibility is to maintain visual on his or her element lead. If a member of the flight loses sight of any other aircraft, call blind or visual with the number of aircraft seen ("*Snake 4, blind*" or "*Snake 4, blind, visual two aircraft*"). With high situational awareness, call blind on the appropriate aircraft ("*Snake 3, blind on Snake 2*".) During wall or offset box, if a wingman loses sight of the opposite wingman but has maintained visual on his or her element lead and lead, a "blind" call would not be required. If any doubt exists, call "blind".

6.62.7. Midair Collision. If a midair collision occurs between formation members, under no circumstances should they act as chase ships for each other.

6.62.8. Ejection. If one aircraft in a formation must perform a controlled ejection, the chase ship should fly abreast of the disabled aircraft and no closer than 1,000 feet.

6.62.9. Spatial Disorientation.

6.62.9.1. Lead. If experiencing spatial disorientation as lead, immediately advise the wingmen, and if possible, transfer aircraft control to the other crewmember. If transfer of aircraft control is not an option, confirm attitude with the other crewmember or wingmen. If symptoms persist, terminate the mission, and recover the flight by the simplest and safest means possible.

6.62.9.2. Wingman. Wingmen experiencing spatial disorientation should advise their other crewmember and (or) lead when disorientation makes it difficult to maintain position. The crewmember not in control of the aircraft or lead should advise the wingman of aircraft attitude, altitude, heading, and airspeed. If symptoms persist and conditions permit, lead should establish straight-and-level flight for 30 to 60 seconds and consider passing the lead to the disoriented wingman. If necessary, terminate the mission and recover by the simplest and safest means possible.

6.62.9.3. Three- and Four-Ship. Lead should separate the flight into elements to more effectively handle a wingman with persistent spatial disorientation symptoms. The element with the disoriented pilot should remain straight-and-level while the other element separates from the flight.

Chapter 7

INSTRUMENTS

7.1. Introduction. Instrument flying procedures are described in detail in AFMAN 11-202V3, *Flying Operations*. There will be circumstances when pilots must rely on their instrument flying ability to operate safely. This section provides familiarization with a few of the instrument procedures specific to the T-38.

7.2. Instrument Cross-Check. The control and performance concept is the foundation of good instrument flying. The T-38 HUD is certified as a primary flight reference (PFR) and may be used as a standalone reference for instrument flight. **Note:** Use the UFCP AUTO/DAY/NIGHT toggle switch and H BRT control to set the desired HUD brightness during changing visual conditions. A solid instrument cross-check will use control instruments (attitude indicator, HUD pitch/bank scales, and engine tachometers) and performance instruments (HUD or MFD altimeter, airspeed indicator, vertical velocity, AOA, and horizontal situation indicator [HSI]) to:

7.2.1. Establish an attitude and power setting on the control instruments. The boresight/gun cross serves as the control reference, and the FPM/CDM serve as the performance reference for climb/descent gradients.

7.2.2. Trim until control pressures are neutralized.

7.2.3. Cross-check performance instruments to determine if the established attitude and power settings are providing the desired performance.

7.2.4. Adjust attitude and power setting using control instruments, and re-trim as necessary.

7.3. Prior to Instrument Takeoff (ITO). Prior to an instrument takeoff, review and update weather conditions and TOLD; review the instrument departure, radar routing, terminal approach NAVAIDs and radar approach capability at the departure airfield, and review an emergency return plan based on single-engine climb capability and obstacle features of the departure airfield. Set up all NAVAIDs accordingly.

7.4. Rear Cockpit Takeoffs with an Instrument Hood. As pilots flying in the rear cockpit start to close the canopy, pull the instrument hood forward enough to ensure it will remain clear of the canopy rails and the canopy piercer on top of the ejection seat. When the rear canopy is fully closed, pull the instrument hood back out of the way.

7.5. ITO. The ITO is similar to the transition takeoff except pilots will transition to instruments as outside visual references deteriorate. Once airborne, hold a wings-level, takeoff attitude by setting 7.5 degrees nose-high on the bore sight cross (F-16 HUD) or waterline (MIL-STD HUD) and confirm a definite rate of climb. After verifying a positive climb on the altimeter and a positive vertical velocity, retract the landing gear and flaps. As visual references deteriorate, the decision to transition to either the HUD or EADI will be based on proficiency, experience, and comfort level with interpreting the applicable display. During this critical phase of flight, a composite cross-check is essential especially if using the HUD as the primary flight reference. **Note:** Use extreme caution when transitioning to instruments during the takeoff. The pitch changes associated with gear and flap retraction in the T-38 may cause momentary disorientation at very low altitude. A proper instrument cross-check is essential to maintain SA during this phase of flight.

7.6. Instrument Departure. In most cases, pilots use the restricted MIL power climb schedule for instrument and navigation departures. Be sure to maintain a constant cross-check to divide attention between aircraft control, departure procedures, and checklist duties. This can be accomplished by quickly completing one item at a time and returning to the instrument cross-check in between, with primary emphasis on the EADI or HUD.

7.7. Level Off. The lead point for level off, from either a climb or descent, will vary depending on the vertical velocity being flown. The following techniques will help pilots develop smooth lead points:

7.7.1. With low or moderate climb or descent rates, begin the level-off at 10 percent of the vertical velocity reading. For example, with a vertical velocity of 2,500 fpm, begin the level-off 250 feet early.

7.7.2. With a vertical velocity greater than 6,000 fpm, reduce the pitch attitude by one-half at 2,000 feet prior to level-off, and then use 10 percent of the vertical velocity.

7.8. Arc and Radial Intercepts.

7.8.1. Turn Radius.

7.8.1.1. Arc and radial intercept techniques are based on making a 90-degree turn, using 30 degrees of bank in no-wind conditions. Because these techniques are also based on established turns, the slower the aircraft rolls into 30 degrees of bank, the more the pilot will need to "pad" the lead point. Turn radius lead points for the T-38 in miles can be calculated using the following techniques:

7.8.1.1.1. For higher airspeeds (greater than 300 KCAS), Mach number - 2 = approximate turn radius (in miles) using 30 degrees bank.

7.8.1.1.2. For slower speeds, 1 percent of GS = approximate turn radius (in miles), using 30 degrees bank.

7.8.1.2. To adjust for less than 90 degrees of turn, use the following techniques:

7.8.1.2.1. For a turn of 60 degrees, use one-half of the calculated lead point.

7.8.1.2.2. For a turn of 45 degrees, use one-third of the calculated lead point.

7.8.1.2.3. For a turn of 30 degrees, use one-sixth of the calculated lead point.

7.8.2. Arc-to-Radial Intercepts. After calculating the lead point, use the 60-to-1 rule to translate the lead point in miles to the lead point in radials. For example:

7.8.2.1. Using the 1-percent technique, flying at 250 GS corresponds to a 2.5 NM turn radius. By applying the 60-to-1 rule, on the 10 DME arc where there are 6 radials per mile, use a lead point of 15 radials.

7.8.2.2. At .5 Mach, using the Mach-number-minus-2 technique, the turn radius is 3 NM. On the 20 DME arc where there are 3 radials per mile, use a lead point of 9 radials.

7.9. Basic Aircraft Control Maneuvers:

7.9.1. Vertical "S" Maneuvers. Fly Vertical "S" maneuvers as described in AFMAN 11-202V3, at various airspeeds and configurations. Normally, use a vertical velocity of 1,000 to 2,000 fpm and a 1,000-foot altitude block. The following techniques can be used to anticipate the pitch and vertical velocity changes at different airspeeds: IMN x 1,000 = vertical velocity change for a 1-degree pitch change. For example, at .6 IMN performance is about 600 fpm per degree of pitch change.

7.9.2. Steep Turns. Practicing steep turns builds confidence and instrument skills that sometimes become necessary when 30 degrees of bank is not sufficient for safety or other reasons. Practice steep turns at various airspeeds using 45 to 60 degrees of bank. AFMAN 11-202V3, describes factors associated with flying steep turns. Holding the HUD FPM or CDM on the horizon line can be used to maintain altitude. The HUD heading scale or EHSI can be used for rollouts. In the T-38C, the EHSI makes lead points for rollout negligible, usually less than 5 degrees.

7.9.3. Instrument Aileron Roll. The instrument aileron roll is one of the confidence maneuvers discussed in AFMAN 11-202V3. As the name implies, this maneuver builds confidence and teaches aircraft control throughout wider ranges of pitch, bank, and airspeed. It also helps develop skills required to recover from unusual attitudes, using the EADI during extreme pitch and bank attitudes. Perform instrument aileron roll as described in AFMAN 11-202V3, using a minimum of 300 KCAS and 85 percent RPM.

7.9.4. Unusual Attitudes. Refer to AFMAN 11-202V3, for procedures on recovering from instrument unusual attitudes.

7.10. Direct to Fix (Fix-to-Fix with EGI). Proceeding direct to a radial/DME fix is not a basic requirement to operate in the National Airspace System (NAS) nor does it comply with Federal Aviation Administration (FAA) accepted practices and procedures. Therefore, T-38 pilots will normally use the aircraft's RNAV capability (EGI) when proceeding direct to a fix.

7.10.1. For pilot to file or accept a clearance to navigate direct to a radial/DME fix, either the aircraft must be RNAV capable; the flight must be conducted where radar monitoring by ATC is available; the locally defined arrival/departure procedures must have been authorized by the FAA; or an operational necessity must dictate the requirement.

7.10.2. To proceed direct to a fix using the EGI, type the name of the fix into the UFCP and verify that the bearing and range to the steerpoint make sense. Next, either select EGI as the PNS and center-up the CDI or select any PNS and center the ground track indicator (PFR, HSD or SIT display) on the EGI pointer. An additional option is to align the FPM in the HUD with the Target Designator (TD) box.

7.11. Fix-to-Fix. In accordance with USAF and FAA guidance, EGI is the primary means to navigate directly to a radial/DME fix. However, proceeding directly to a VOR/DME or TACAN fix without the use of EGI can be accomplished to understand the basics of maintaining SA off a ground NAVAID or common reference point (e.g., determining position relative to another aircraft off of a bullseye point) and is a valued core competency skill for AF pilots. Normally, this training will only be accomplished in the simulator. The following are some techniques to accomplish a fix-to-fix.

7.11.1. Tune the TACAN or VOR/DME equipment (VOR and DME stations must be collocated). Set the radial for the fix. Then visualize the navigational situation on the HSI compass card. The NAVAID will be represented by the center of the compass card. The outer ring of the compass card will represent the greater of either the aircraft's current DME or the DME of the fix.

7.11.2. Turn in the shortest direction to a heading somewhere between the head of the bearing pointer and the radial of the desired fix. If the DME of the fix is greater than the aircraft's current DME, the heading should be closer to the desired radial and vice-versa. This initial heading will get the aircraft moving in the general direction of the fix until the following procedures can fine-tune the heading.

7.11.3. To fine-tune the heading to the desired fix, mentally place the aircraft and the desired fix on their respective radials at the appropriate relative position from the center of the compass card (NAVAID). Turn the aircraft until the line between these two points is parallel to a line from the center of the compass card and the upper lubber line with the two fix points vertically one above the other.

7.11.4. Update the fix-to-fix periodically remembering that the relative size of the compass card will change as the airplane moves in relation to the NAVAID. If the initial heading does not keep the aircraft moving toward the fix, there is probably a wind effect. When making adjustments to the fix-to-fix heading, take this wind effect into account in the new heading.

7.12. Arrival Checks. AFMAN 11-202V3 describes how to prepare for an instrument arrival or approach. One technique for accomplishing arrival checks is the "WHOLDS" check. This check is meant to be a memory aid to ensure required items are accomplished enroute to an initial approach fix (IAF), a holding fix, or prior to beginning an enroute descent. It may also be used between approaches. If an item such as a descent check or obtaining the weather has been accomplished, it does not need to be re-accomplished between approaches.

7.12.1. WHOLDS—A Memory Aid.

7.12.1.1. **W** eather. Recheck weather (if appropriate). Determine the landing runway and altimeter setting, and ensure the weather and airfield are suitable for the approach.

7.12.1.2. **H** olding or Heading and Attitude Systems. Obtain clearance to hold, review the holding pattern, and determine the appropriate point to slow to holding airspeed. Review holding entry techniques to determine the most appropriate entry. Check heading and attitude systems.

7.12.1.3. **O** btain clearance for the approach and coordinate for climb out instructions if applicable.

7.12.1.4. **L** etdown Plate Review or Lost Comm. Review the IAP. Refer to AFMAN 11-202V3, for approach review techniques. Set up NAVAIDs as appropriate. Coordinate lost communication procedures (if required) and consider a plan for a backup approach.

7.12.1.5. **D** escent Check. Items on the descent check, such as altimeter settings and airspeeds, may need to be updated during the approach. Check the heading and attitude systems.

7.12.1.6. **S** peeds. Consider when to slow from cruise mach to penetration, holding or approach speeds.

7.12.2. Alternative Memory Aids.

7.12.2.1. **ADRWHO—A** TIS, **D**escent check, **R**eview let down plate (approach), **W**eather, **H**olding, **O**btain clearance

7.12.2.2. **NORM— N** - **N**AVAIDs set, **O** - **O**btain clearance, **R** - **R**eview approach, **M** - **M**inimum and (or) missed approach.

7.13. Holding.

7.13.1. AFMAN 11-202V3, provides guidance for holding. Most holding fixes are defined by DME limits; however, there are still many holding patterns that require timing. ATC expects aircraft to slow to holding speed no earlier than 3 minutes prior to the holding fix.

7.13.2. As a technique, begin reducing speed 5 to 10 NM prior to the holding fix (1 to 2 minutes) to ensure entering holding at the holding airspeeds prescribed in the flight manual. Approximately 88 to 90 percent RPM will maintain holding airspeeds in level flight. When correcting for position and (or) winds, adjust the displacement on the outbound leg to intercept the holding course inbound.

7.13.3. A technique for a no-wind starting point follows: 360 divided by DME equals the number of radials displacement desired at the outbound DME limit. For example, a 30 DME outer limit for holding requires about 12 radials of displacement (360 ÷ 30 = 12).

7.14. Enroute Descents. Enroute descents usually provide the quickest and most efficient way to get from the middle or high-altitude structure to a landing. The goal of an enroute descent is to arrive at a point from which vectors to an instrument final can be followed. Continually update the progress of the enroute descent. If in doubt, the conservative choice is to get down a little early. The following techniques will help determine an appropriate pitch gradient:

7.14.1. Mathematical Gradient. Divide the altitude to lose (in thousands of feet) by the distance to travel (in NM) and then translate the result into degrees of pitch change. For example, the aircraft is at a cruising altitude of FL 270, 60 NM from the desired point to reach the final approach fix (FAF) altitude of 2,000 feet MSL. So, with 25,000 feet to lose in 60 NM, a descent gradient of 417 feet per NM is necessary. Because each degree of pitch change results in 100 feet per NM, a nose-low attitude of 4 to 5 degrees will work.

7.14.2. Visualizing the Gradient. Divide current altitude (in thousands of feet) by the distance to travel (in NM), and then superimpose that ratio using the first 10 degrees of dive gradients on the EADI. Designate the 10-degree nose-low line on the EADI as the distance to travel. Then visually determine where the altitude-to-lose (in thousands of feet) falls between the level flight line and the 10-degree dive line. For example, using the same scenario as in **paragraph 7.14.1**, the aircraft needs to lose 25,000 feet in 60 NM. Designate the 10-degree dive line to be the 60 (NM) and superimpose the 25 (thousands of feet) on the EADI as a visual ratio of altitude over distance. The 5-degree dive line would represent 30 (thousands of feet), so 25 (thousands of feet) would fall about 4 degrees nose-low.

7.14.3. Pitch/Power Techniques. During the initial portion of a high-altitude descent—or if the potential for icing exists—consider power settings of at least 80 percent RPM. Also consider engine operating restrictions when changing power at high altitudes. Headwinds and tailwinds can drastically affect the descent distances resulting from any pitch and power setting combination. **Table 7.1** lists pitch and power setting combinations for various 300 KCAS descent gradients.

Table 7.1. Techniques for Various 300 KCAS Enroute Descent Gradients.

Descent	Pitch Change	Power Setting	Configuration
200 to 250	2 to 2.5 degrees	91-89% RPM / 20-25%	Clean
300 feet/nm	3 degrees	~86% RPM / 30% nozzles	
500 feet/nm	5 degrees	80% RPM	
700 feet/nm	7 degrees	Idle	
1,000 feet/nm	10 degrees	80% RPM	Speed brake
1,300 feet/nm	13 degrees	Idle	

7.15. VORTAC Penetration. The purpose of a VORTAC (very high frequency omni-directional receiver/tactical air navigation) penetration is to descend from an enroute altitude to a position from which an approach and landing can be made using the VORTAC as the primary NAVAID. If the VORTAC and EGI steerpoint are identical or close, use caution not to confuse the bearing pointers. Select the correct PNS before passing the IAF. Penetrations are normally flown at 300 KCAS. However, flying the penetration at a slower speed, or slowing down early, is allowed if it makes sense based on the distance remaining to the FAF. Pilots should target being at 220-230 KCAS entering the configuration window described in **paragraph 7.16.1.2**. Remember, descent gradient is based strictly on pitch attitude (independent of airspeed). Therefore, an idle descent at 7 degrees nose-low and 300 KCAS will get the aircraft lower in less forward distance than an idle descent at 6 degrees nose-low and 240 KCAS. Deceleration in a descent can be controlled by extending the speed brake (SB). Idle/7 degrees NL/SB takes approximately 7 miles to slow from 300 to 230 KCAS. 80 percent RPM/5 degrees NL/SB takes approximately 5 miles. If holding is not accomplished, slow to 300 KCAS, and set the inbound course prior to the IAF. Consider requesting maneuvering airspace if the assigned inbound heading does not conveniently align with the initial inbound course. Remember to set the local altimeter setting IAW Flight Information Handbook procedures.

7.16. Precision Approaches:

7.16.1. Instrument Landing System (ILS). The ILS is a precision approach that provides the pilot with final approach course and glidepath information, as follows:

7.16.1.1. Intercepting Final:

7.16.1.1.1. If the aircraft is still up near 300 KCAS during the last segment of a penetration (or while turning onto the base leg), start slowing down. No later than dogleg to final or approximately 10 to 15 NM from touchdown, the aircraft should be slowed to 240 to 260 KCAS. **Note:** From 85 to 87 percent RPM will hold these airspeeds.

7.16.1.1.2. If a VORTAC is located on or near the field, selecting TACAN or VOR as the PNS can provide useful information for position orientation and can provide a lead radial for starting the turn to intercept the final course. If the VORTAC is not located on the field, consider setting the EGI steerpoint to the field or the FAF to maintain orientation relative to the field or the FAF.

7.16.1.1.3. No later than after commencing the turn to final, select ILS as the PNS and set the published front course either via UFCP or MFD rocker switch. If the course was previously set and EGI was the PNS, double-check that the EGI did not change the course while updating the navigation solution. Once ILS is selected, all VOR steering disappears. Use all available references and SA for the turn to final; don't expect the bank steering bar to guide the aircraft perfectly onto final. If established on a dogleg to final within 30 degrees of the final course, starting the turn to final as the CDI begins to move should allow a comfortable intercept without overshooting final.

7.16.1.2. Prior to the FAF. The aircraft should be configured approximately 2 to 5 NM prior to the FAF/glide slope intercept. Pilots should plan their descent/airspeed to arrive at this configuration window at 220-230 KCAS. Trim and adjust the pitch attitude appropriately on the EADI as the aircraft decelerates. Power settings between 93 and 95 percent RPM will hold final approach airspeed in level flight with gear and full flaps. Use 90 to 91 percent RPM for configurations with 60 percent flaps.

7.16.1.3. Course and Glidepath Control:

7.16.1.3.1. On final, make heading changes of 5 degrees or less for precise course control. Bank angles of 5 degrees or less are sufficient for small, controlled heading changes. To prevent overcorrecting while on the final approach course, make small but positive corrections to centerline deviations. If configured on speed at glideslope intercept, a pitch change corresponding with the glideslope (normally 2.5 to 3.0 degrees) should provide a good initial rate of descent.

7.16.1.3.2. At final approach speeds, the aircraft is traveling at approximately 2.5 to 3 NM per minute so a 3-degree pitch change will produce a vertical velocity of about 750 to 900 fpm. In addition to using the Climb/Descent Tables in the *FLIP*, one can utilize the technique for calculating a desired VVI using the "60-to-1 Rules and Formulas" discussed in AFMAN 11-202V3. Adjust descent rate using pitch changes of 2 degrees or less to start. Then use changes of about 1 degree for precise glidepath control. Course and glideslope sensitivity increases as the aircraft approaches decision altitude (DA); therefore, smaller corrections are required to regain or maintain "on course, on glidepath."

7.16.1.3.3. Cross-check raw data (glideslope indicator, CDI) to ensure proper performance of the flight director steering. Pilots must avoid the tendency to chase the flight director. Constantly monitor altitude in relation to appropriate weather minimums and (or) DA. Monitor altitude in relation to localizer minimums in case glideslope information becomes unreliable.

7.16.2. Precision Approach Radar (PAR). The PAR is a precision approach for which a final approach controller provides verbal course and glidepath information.

7.16.2.1. Intercepting Final. The precision final approach starts when the aircraft is within range of the precision radar, and contact is established with the final controller. Normally, this occurs approximately 8 miles from touchdown. Prepare and configure the aircraft the same as for an ILS.

7.16.2.2. Course and Glidepath Control. The same basic techniques for flying an ILS (**paragraph 7.16.1**) can be used to fly a PAR. Follow controller instruction for heading control. Bank angles of 5 degrees or less are sufficient for small, controlled heading changes. If called "below" or "above" glidepath, use pitch corrections of l degree on the EADI with corresponding 1 percent RPM changes. If called "well below" or "well above" glidepath, use pitch corrections up to 2 degrees with corresponding 2 to 3 percent RPM changes. As with the ILS, course and glideslope sensitivity increases as the aircraft approaches the DA.

7.16.3. Transition to Landing. When approaching the DA, start glancing outside to pick up the runway or approach lighting. Pilots will need to look through the HUD symbology to see the runway environment which may necessitate adjusting the HUD brightness down. Do not fixate on the HUD while attempting to acquire sufficient visual cues to continue the approach. Transition to a composite cross-check to gain adequate visual references but be ready to transition back to instruments if weather conditions deteriorate. After the runway is sighted, cross-check visual cues, glidepath lighting, and instruments to ensure that a safe landing is possible. Following the glidepath of a precision approach down through minimums to a landing leads to a touchdown approximately 2,000 feet down the runway. Do not transition the aircraft's glidepath to the threshold ("Duck Under") in accordance with AFMAN 11-202V3.

7.16.4. Precision Approach Backup. When flying a precision approach, be ready to transition to a backup approach. This could be a transition from a PAR to an ILS (or vice versa), or to a non-precision approach. To make this transition easier, have the approach page and or approach minimums readily available.

7.17. Non-precision Approaches.

7.17.1. Intercepting Final. If intercepting a localizer final, use the same techniques as described for precision approaches (**paragraph 7.16.1.1**.). If intercepting a VORTAC final from an arc 12 to 15 NM from the field, normally a 10-degree lead point provides a comfortable intercept to final. This is indicated by the CDI "coming off the wall." Once established on a dogleg to a VORTAC final, approximately 3 to 4 degrees of CDI deflection should provide a good point to turn to intercept final.

7.17.2. Prior to the FAF. Prepare and configure the aircraft the same as for a precision approach (**paragraph 7.16**.**)**.

7.17.3. Non-Precision Final Descent.

7.17.3.1. The goal of a non-precision final is to descend to an altitude—below the weather—from where a safe transition to landing is possible. Therefore, it is imperative that pilots plan and fly the descent to reach the minimum descent altitude (MDA) prior to the visual descent point (VDP).

7.17.3.2. "Dive and Drive" Method. At the FAF, or when directed by the controller to "descend to your minimum descent altitude", lower the nose about 4 to 5 degrees on the EADI. Reduce power by approximately 10 percent RPM to maintain final approach airspeed in the descent. Normally, a descent rate of 1,200 to 1,500 fpm will ensure the aircraft arrives at the MDA prior to the VDP. Use caution for intermediate stepdown restrictions prior to the MDA. As a technique, reduce descent rate 200 to 300 fpm prior to the MDA. Level off above the MDA by an amount appropriate for the pilot's proficiency level and readjust power (93 to 95 percent RPM will hold final approach airspeed).

7.17.3.3. Continuous Descent Final Approach (CDFA). At the FAF, or when directed by the controller to "descend to your minimum descent altitude," lower the nose to set the glidepath with the help of the CDM or the FPM. The Descent Angle is found in the profile view on the approach plate but be aware that this angle may not necessarily be from the

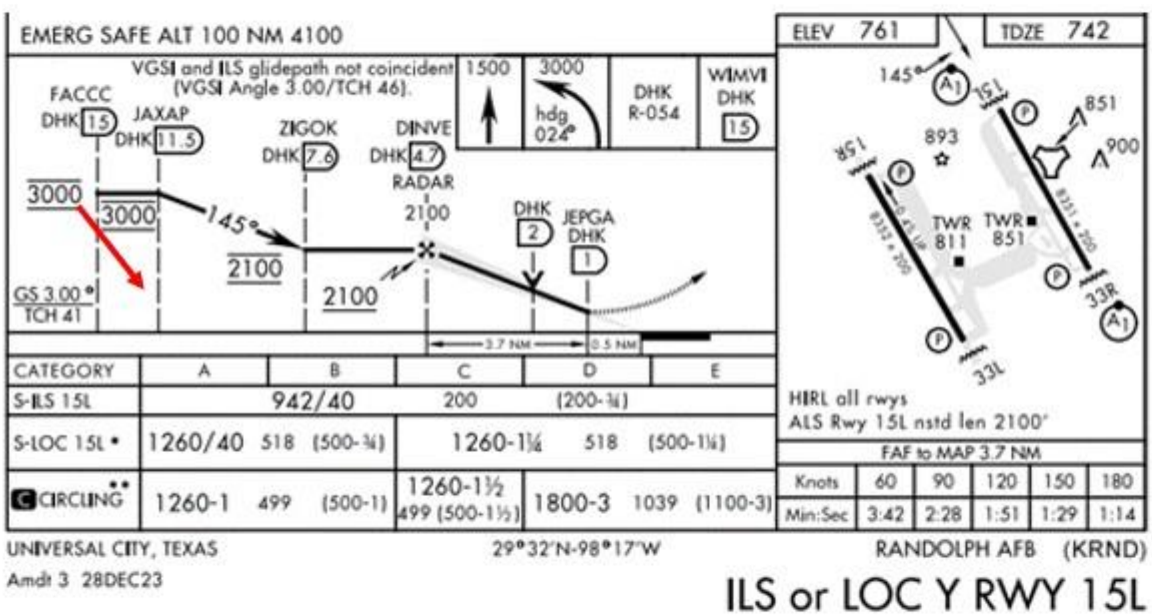
FAF for approaches with stepdown fixes. With both the descent angle and ground speed, use the Climb/Descent Table in the *FLIP* to find the appropriate feet per minute (fpm) descent rate. Additionally, AFMAN 11-202V3 provides a technique for calculating a 2.5- or 3-degree VVI. For reference, flying at 180 knots ground speed equates to approximately a 900 fpm on the VVI for a 3 deg glidepath. If no glideslope angle is published, pilots should calculate the required descent angle in the following way: (FAF Altitude – touchdown zone elevation [TDZE])/DME from threshold. Looking at the approach plate below: (2,100 feet – 742 feet)/4.2NM = 323 feet/NM. Reference the RATE OF CLIMB/DESCENT TABLE (back of the approach book or in ForeFlight under DOD tab, in Legends folder, Gen Info & Legends) in *FLIP* for precise information. If preflight planning allows, it is highly suggested to calculate "check altitudes" to confirm flying a correct glidepath down to derived decision altitude (DDA = MDA + 50 feet).

7.17.3.3.1. Find the altitude change per nautical mile corresponding to the descent angle or calculate it.

7.17.3.3.2. Find the TDZE.

7.17.3.3.3. Calculate MSL altitudes for distances between the FAF and the VDP.

Figure 7.1. Approach Profile for CDFA Example.



7.17.3.3.4. Here is an example calculation based on the LOC Y RWY 15L approach (**Figure 7.1.**): 3.00 deg glideslope is a change of 320 feet per 1 NM or 32 feet per 0.1 NM. The TDZE is 742 feet MSL. The distance between the 2 DME published VDP and the threshold is 1.5 miles. 1.5 NM x 320 feet is 480 feet altitude change.

7.17.3.3.5. Add this altitude change to the TDZE and threshold crossing height (TCH). 742 feet + 41 + 480 feet = 1,263 feet MSL rounded to 1,260 feet MSL. It matches the published MDA of 1,260 feet MSL. Now repeat adding 320 feet per NM to the calculated to 1,260 feet MSL at 2 DME. This technique produces checkpoints to check altitudes as seen in **Table 7.2**.

Table 7.2. Example CDFA Check Altitudes.

4.7 DME (FAF)	4.0 DME	3.0 DME	2.0 DME
2,100 feet MSL	1,900 feet MSL	1,580 feet MSL	1,260 feet MSL

7.17.3.3.6. As the aircraft continues the approach, pilots can easily check if they are still on the correct descent angle to the DDA of 1,310 feet MSL (1,260 feet MDA + 50 feet)

7.17.4. Transition to Landing. If the runway environment is in sight at the VDP and the aircraft is in a safe position to land, a 3-degree nose-down pitch change along with a slight power reduction should set up a transition to landing for the normal landing zone. If pilots begin the transition late, or if the runway is sighted after the VDP, pilots can either accept a slightly longer landing (if runway length and condition allows) or, if weather and conditions permit, use a momentarily steeper glidepath to re-intercept a 3-degree glidepath. ***WARNING:*** Use extreme caution to avoid excessive sink rates (greater than 1,000 fpm VVI) during transition to landing. If not in a position to execute a safe landing, execute a low approach, missed approach, or climb out.

7.18. Area Navigation (RNAV).

7.18.1. Introduction. GPS provides many benefits over conventional NAVAIDs including increased flexibility and lower operational and maintenance costs. Most importantly, GPS increases safety through improved accuracy and reliability. To maximize these benefits, the FAA plans to continue reduction of expensive ground-based NAVAIDs. Consequently, pilots operating in the National Airspace System (NAS) will be expected to use RNAV, for both enroute and terminal area operations, as their primary navigation source. This chapter provides a framework of procedures and techniques to conduct RNAV operations in the T-38C.

7.18.2. Authorization. The T-38C EGI is authorized for IFR enroute and terminal RNAV operations in the National Airspace System.

7.18.3. Database.

7.18.3.1. GPS and other RNAV procedures rely on data extracted from the aircraft navigation database. The potential for serious navigation errors is created by inherent properties of database creation and its use by pilots and aircraft systems. To mitigate these potential errors, pilots must be familiar with the database properties of the T-38C and required procedures.

7.18.3.2. The T-38C utilizes the Digital Aeronautical Flight Information File (DAFIF) navigation database provided by the National Geospatial-Intelligence Agency (NGA). The database contains a filtered list of airports, navigation aids, waypoints, and instrument procedures. This navigation data is published on a 28-day cycle.

7.18.3.3. Use of the T-38C Navigation Data Verification Tool (NVT) IAW the current T-38C NavData Processing and Verification Guide to validate the DTC every DAFIF cycle is mandatory prior to conducting RNAV procedures. Pilots should ensure they have a current database loaded into the aircraft by checking the DTS tab on the MDP and confirming the ICAO dates are valid.

7.18.3.4. Only those approaches included in the database are authorized. Terminal area and instrument approach procedures must be retrieved in their entirety from the database. Pilots may not alter terminal procedures retrieved from the database or enter them manually. **(T-2)** This requirement does not prevent creation and storage of additional data; however, it cannot be part of a terminal procedure to include IAF or feeder fixes. This requirement also does not preclude pilots from complying with ATC instructions by proceeding direct to a point on a procedure, or by receiving ATC vectors onto course.

7.18.3.5. Not all STARs, SIDs, and IAPs are available in the T-38C DAFIF database. Just because there is an RNAV procedure in *FLIP*, does not mean there will be a corresponding procedure in the database. Many Vertical Navigation (VNAV) approaches will be depicted in *FLIP*, however, will not be available in the aircraft due to insufficient information in the DAFIF database to display a vertical glidepath. Additionally, there are certain leg types such as arcing, that the MDP cannot process, and thus, will not display. Finally, the database is filtered, limiting available airfield procedures unless they meet the following criteria: RWY >/= 6,000 feet, Cat D or E Straight-in with Lateral Navigation (LNAV) or LNAV/VNAV minimums, or GPS in title. It is not always possible to determine why a procedure is not available in the aircraft database but is depicted in *FLIP*.

7.18.3.6. Database errors have occurred at all stages of database development and use, for this reason a paper copy/digital copy of the applicable procedure must always be available to be crosschecked in the terminal environment IAW AFMAN 11-202V3.

7.18.3.7. Pilots must verify all retrieved database information against the *FLIP* paper/digital copy. Prior to commencing the procedure, pilots must confirm waypoint name and waypoint type, sequence, course distance and altitudes match charted information IAW AFMAN 11-202V3. Due to database related errors, or differences between the magnetic variation database compared to the date of the magnetic variation survey on charted procedures, the database information may not match the *FLIP*. Final course and distance tolerances may differ by up to 5 degrees and 0.1 NM respectively and still be flown, otherwise the procedure is not authorized. When verifying the database information of a standard terminal arrival route (STAR) with the *FLIP*, the maximum allowable tolerance between courses is 5 degrees. These same restrictions apply when comparing the *FLIP* products to the displayed approach as it is being flown. A good technique is to accomplish this data comparison during pre-mission planning on a desktop trainer that has a current ICAO database.

7.18.3.8. In addition, there are other allowable differences between the DAFIF database and *FLIP* data that do not prevent the procedure from being flown.

7.18.3.8.1. Differences between altitudes in the database and the charted procedure do not restrict use of a terminal procedure. Pilots will use the charted procedure for all altitude references in this case and report the difference as a database error.

7.18.3.8.2. DAFIF will sometimes display what appears to be a repetitive waypoint such as an IAF for a holding-in-lieu of procedure turn (H).

7.18.3.8.3. DAFIF listing (R) or (L), for right or left, following a waypoint. This depicts the anticipated turn direction. This turn direction may differ from the direction the flight director (FD) indicates, which usually selects the shortest turn.

7.18.3.8.4. IAP procedures from the DAFIF database do not always include step down fixes between the Final Approach Waypoint (FAWP) and MAWP that are depicted on an approach plate. Pilots will comply with step down fixes as depicted on the approach plate in IAW AFMAN 11-202V3.

7.18.3.8.5. Course-to-altitude (CA) legs may be present in the missed approach of retrieved procedures that are not included on the charted procedure. These legs are included from DAFIF and display an altitude 400 feet above the ground or the initial altitude in the published Missed Approach Procedure, whichever is higher.

7.18.3.8.6. Many STARs and SIDs will not show specific course, altitude, and distance information in the DAFIF TERM PROC when retrieved for comparison to the *FLIP*. This does not prevent the procedure form being flown; it puts more emphasis on the comparison of displayed leg data while flying. If deviations are determined beyond stated tolerances at any time during the procedure, discontinue the procedure.

7.18.4. Limitations.

7.18.4.1. The T-38C is not currently authorized to conduct Required Navigation Performance (RNP) Procedures. RNP procedure certification requires different equipment with much more accuracy compared to the T-38C EGI. Do not mistake an RNP procedure, any procedure with “RNP” in the title, with the RNP that appears on the MFD indicating the CDI sensitivity. The RNP in the T-38C refers to the phase of flight and associated CDI scaling.

7.18.4.2. RNAV Substitution. Full NAVAID substitution (Radial and DME) for an out of service NAVAID requires EGI compensation for the *FLIP* charted magnetic variation of the course to be flown on the procedure or route. Without this compensation, RNAV substitution is limited to DME only. Attempting to navigate Victor and Jet routes using an uncompensated EGI will result in significant deviations in desired ground track. Pilots are permitted to proceed direct to a NAVAID or an ICAO waypoint regardless of EGI compensation for magnetic variation.

7.18.4.3. RNAV Alternate Means. Pilots may define Victor and Jet routes in EGI using a flight plan if waypoints/NAVAIDs are retrieved from the database and all points associated with a change of course are entered. Additionally, for an EGI without magnetic variation compensation, the course to be flown must be defined by any combination of two waypoints or NAVAIDs.

7.18.5. General.

7.18.5.1. RNAV procedures are developed to ensure the least capable system meets a basic minimal compliance level. The T-38C may exceed basic compliance levels in many areas and may even automatically comply with the required procedures.

7.18.5.2. Receiver Autonomous Integrity Monitoring (RAIM) is required for use of GPS in IFR navigation. RAIM is continuously monitored in the T-38C, and confirmation of required accuracy is the absence of a pilot fault list (PFL)-- no news is good news. If RAIM is lost, an avionics malfunction would create a PFL. This would probably be due to a loss of satellite coverage. Due to the fact the T-38C has barometric aiding, where altitude information is provided directly from the ADC, RAIM validates GPS integrity utilizing just 4 satellites.

7.18.5.3. Pilots must check Predictive RAIM (PRAIM) prior to departure when possible IAW AFMAN 11-202V3. This may be accomplished during pre-mission planning via **www.sapt.faa.gov**, or by loading the planned IAP during ground operations. In the T-38C, PRAIM is automatically checked when an IAP is first loaded, and again when the aircraft is steering to and within 4 NM of the FAWP. When an IAP is loaded on the ground, the MDP uses 1+15 as the planned estimated time enroute (ETE) to determine the projected satellite coverage. If an IAP is loaded while airborne or is steering to and within 4 NM of the FAWP, the actual aircraft groundspeed and track are used to determine ETE, corresponding predictive coverage, and associated required accuracy. Again, as with RAIM, the absence of a PFL means the system meets required PRAIM requirements.

7.18.5.4. The FCP can monitor the HUD and MFD allowing a continuous CDI display in the HUD and an HSD or SIT display on the MFD. Additionally, the HUD will indicate when in the Terminal (TRM) and Approach (APR) phases of flight. FCP and RCP RNAV procedures are the same; there are just different techniques used to accomplish them due to the cockpit specific displays.

7.18.5.5. PFR or HUD are the primary displays for RNAV Terminal Procedures to comply with the accuracy mandated by CDI scaling. When PFR is used, momentary selection of HSD or SIT may be used to augment situational awareness. Flight director course selection is encouraged to assist lead-turn anticipation and procedure compliance. Pilots should calculate lead turns and watch for the “straddle countdown timer” to maximize situational awareness of when the FD will command a turn to intercept the next segment.

7.18.5.6. Pilot will verify the displayed RNP/CDI scaling is correct IAW AFMAN 11-202V3. It is imperative that pilots know the aircraft’s phase of flight and corresponding CDI scaling parameters. RNP is automatically adjusted based upon how the selected terminal procedure was built, and the current phase of flight, which is based on the distance from the airfield where the TERM PROC is selected.

Table 7.3. Auto RNP by Phase of Flight.

Phase of Flight	RNP/CDI Scale (Full scale deflection)
Enroute (> 30 NM)	5 NM
Terminal (TRM) (NLT 30 NM)	1 NM
Approach (APR) (Typically 4 NM from but NLT FAWP)	0.3 NM

7.18.5.7. When flying a Q or T jet route, the pilot should manually adjust the RNP to 2 NM or less. Additionally, some procedures are not built to scale down the RNP to 1 NM when outside of 30 NM from the airfield. In these cases, the pilot should manually adjust the RNP to 1 NM.

Table 7.4. Manual RNP by Phase of Flight.

Phase of Flight	RNP/CDI Scale (Full scale deflection)
Flying Q or T jet route	2 NM
Terminal Procedure (> 30 NM or at any distance on a STAR or SID)	1 NM

7.18.5.8. RNP equates to Phase of Flight; however, the MFD may indicate a lesser value based on procedure design. Actual Navigation Performance (ANP) is the estimated accuracy of the EGI/INS in tenths of a mile.

7.18.5.9. Suspend (SUSP) is an option at the bottom of the MFD when a TERM PROC is activated with EGI as PNS. Selecting SUSP allows pilots to select a course and prevents the flight plan from advancing to the next waypoint. It is critical to remember to deselect SUSP once the need to SUSP has passed. Selecting SUSP does not prevent the course from automatically changing when the EGI steer point is changed by other than the inc-dec. It also does not prevent the phase of flight from automatically changing at the prescribed distance.

7.18.5.10. The MDP defaults to “Direct-To” to automatically provide a turn radius corrected course to a selected waypoint. “Direct-To” can be manually de-selected on Menu2 of the MFD. If pilots do not want to move the inc-dec to advance a waypoint on the UFCP, they could consider deselecting “Direct-To” to prevent a change in a suspended course. This might occur while being radar vectored to final but not yet within a 90 degrees intercept to the final approach course. Some may prefer this technique as opposed to continuously changing the inc-dec between EGI steer point and UHF radio selection.

7.18.6. Preflight. In addition to departure, drop in, destination, and alternate airfield NOTAMs, pilots are required to check DAFIF and GPS NOTAMs. GPS NOTAMs may be checked through Flight Service Stations (FSS), or on the Defense Aeronautical Information Portal (DAIP) website by typing KGPS in the ICAO identifier window, or by selecting the GPS/WAAS tab. Satellites included in the NOTAMs as unserviceable are automatically excluded in the navigation solution due to Fault Detection and Exclusion (FDE).

7.18.7. Enroute.

7.18.7.1. Q/T (high/low) jet routes are designed for RNAV operations and the T-38C must comply with specific requirements in FAA AC90-100A. When RNAV Q and T jet routes are flown, pilots will:

7.18.7.1.1. Load all the route points to be overflown as FBY (default) in a conventional flight plan.

7.18.7.1.2. Use automatic waypoint (WP) sequencing.

7.18.7.1.3. Set CDI sensitivity to 2.0 NM or less and remain within full-scale deflection on the route and during turns at WPs.

7.18.7.1.4. Select and follow FD indications.

7.18.7.2. When programming Q/T jet routes into a conventional flight plan, it may be easier to load in reverse order since the adding sequence puts the next WP in front of the previous. While flying a flight plan with an RNAV route loaded, ensure the correct course is selected at the start and the course will automatically change to match charted information.

7.18.8. Departures/Arrivals.

7.18.8.1. Departure Procedures and Standard Terminal Arrival Routes are depicted as SIDs and STARs in DAFIF when loading TERM PROCs. Procedures without RNAV in the *FLIP* title may be flown using either conventional NAVAIDs or RNAV if they are found in DAFIF. Ensure to manually select CDI sensitivity to TRM (1.0) if established on a segment of the procedure outside of 30 NM from the procedure-based airfield. A good technique to monitor this requirement is to select the procedure-based airfield as the bullseye on the UFCP.

7.18.8.2. When verifying the database information of a STAR with the approach plate, the maximum allowable tolerance between courses is 5 degrees.

7.18.9. Holding: RNAV holding uses the same procedures associated with conventional NAVAID holding. However, selecting SUSP is required to prevent auto-sequencing when holding at a WP which is part of a FPL. When holding is complete, deselect SUSP to continue the flight plan as programmed. Most RNAV holding patterns are depicted with leg lengths that are shorter than the T-38 can fly comfortably. Use caution, as significant pilot attention is required to comply with the published procedure. The technique of using a 45-degree teardrop entry will approximate the required displacement to intercept the inbound course.

7.18.10. Approaches.

7.18.10.1. The original intent of a GPS approach was to transition from the enroute structure to an IAP with minimal communication while maximizing safety and efficiency. The Terminal Arrival Altitude (TAA) helps meet that objective. A TAA is equivalent to a minimum sector altitude on a conventional approach and gives obstacle clearance into the depicted IAF. Additionally, aircraft are expected to descend to the TAA upon procedure clearance and depicted distances from the IAF. These routings are made up of fly-by (FBY) waypoints that provide lead points to fly a charted track. Pilots may need to SUSP on the IAF and set a course in order to proceed direct. In this case, ensure to subsequently deselect SUSP to allow waypoint sequencing.

7.18.10.2. Another method to get to final is via a holding-in-lieu-of procedure turn. First, verify Category E minimums are published and that the procedure turn is not prohibited on the approach plate. It is critical to remember to SUSP on the IAF to prevent inadvertent waypoint sequencing. Slow to holding airspeed and determine entry using conventional holding entry techniques. The 80/260 turn reversal technique may be easier to execute than a teardrop entry. Use caution on the turn inbound as the FD may command a turn to a 90-degree intercept heading to the inbound course. For example, the FD could be directing a left turn to achieve that 90-degree intercept, even though the FAF is to the right of the aircraft. This could cause confusion on a teardrop entry as the FD would be commanding a turn away from the FAWP. It is important to deselect SUSP when the turn is complete and there is sufficient intercept to the desired waypoint. Like holding, these procedures are depicted with shorter than optimal leg lengths for a T-38C and require increased pilot attention to comply with the published procedure.

7.18.10.3. The last method to get to final is via radar vectors. Pilots have the option of loading an IAP procedure via an IAF or Vectors. The vectors option typically drops transition and IAF waypoints to shorten the procedure in the FPL. After the procedure is loaded, typically SUSP on the FAWP and set the final approach course. It may be helpful to SUSP on a waypoint further out on the approach if there is an altitude restriction associated with that waypoint. Pilots should calculate lead turns to maximize situational awareness of when the FD will command a turn to intercept the next segment. Selecting SUSP does not prevent the course from automatically changing when the EGI steer point is changed by other than the inc-dec.

7.18.10.4. Unlike a conventional NAVAID approach, distance to the next WP is displayed on an RNAV procedure. This makes it difficult to determine when to descend unless sequencing to that WP. When on an intercept within 90 degrees of final, deselect SUSP to allow proper sequencing past the next waypoint. It is critical to remember, when receiving radar vectors to GPS final approach, “established on course” is when the aircraft is within 1x the required accuracy for the RNAV or RNP segment flown (full scale deflection). One technique is to put the FAWP as the bullseye, allowing the pilot to have a quick reference available when considering when to configure or slow.

7.18.11. Final Approach.

7.18.11.1. Final course and distance tolerances may differ by 5 degrees and 0.1 NM respectively and still be flown, and the RNP needs to be 0.3 NM no later than the FAWP.

7.18.11.2. LNAV approach minimums may be lower than LNAV/VNAV minimums. This may be due to Terminal Instrument Procedures (TERPS) requirements of projecting the least desired point and altitude along the course at which the pilot initiates the MAP. To meet departure end obstacle clearance criteria, VNAV minimums are raised to ensure MAP obstacle clearance, thus sometimes greater than LNAV minimums. This certainly makes LNAV/VNAV approaches less effective in low ceiling conditions. However, under certain scenarios, the stable platform from a VNAV descent to landing may be useful.

7.18.11.3. LNAV approaches normally show a VDP along final which will aim the aircraft at a runway point of intercept coincident with glidepath indications. Since the MAWP is normally at the EOR, following the glidepath indications places the aircraft at the threshold Crossing Height (TCH) at the MAWP. For this reason, VDPs should normally be re-computed to maximize T-38C available landing distance.

7.18.11.4. If SUSP was used to maneuver the aircraft to final such as during radar vectors, it is critical that it be deselected for automatic WP sequencing to continue. SUSP will not prevent APR phase of flight and associated indications, but it will prevent WP sequencing. In this case, the distance will increase from the SUSP WP, and the bearing pointer will most likely be behind the aircraft’s position. As such, it will be impossible to properly define the MAWP. Any time SUSP is used, ensure to deselect it to continue the TERM PROC.

7.18.11.5. VNAV glidepath indications will appear when steering to the FAWP and within 4 NM and are like an ILS display but will be blue. It is important to note that VNAV is not calibrated like an ILS. An ILS provides a glidepath that funnels the aircraft to landing where a VNAV is a constant slope with one increment above or below equal to 75 feet. Thus, glidepath sensitivity remains constant throughout the descent. VNAV guidance should provide clearance from all step-down fix altitudes, however, pilots must monitor all stepdown fixes to ensure compliance. Pilots must comply with all step-down fixes depicted on the IAP IAW AFMAN 11-202V3.

7.18.12. Missed Approach.

7.18.12.1. Performing a missed approach from an RNAV approach utilizes the same procedures as a conventional approach. If upon reaching a VNAV DA or LNAV MAP, and either the runway is not in sight, or the aircraft is not in a position to make a safe landing, execute a MAP.

7.18.12.2. Additionally, there are other reasons that may preclude continuing an RNAV approach. The first is not receiving APR sensitivity at 4 NM prior to the FAWP indicated by an Avionics indication and "MALF" for GPS Approach Not Available. Should this occur, attempt to coordinate a new clearance. If this is not possible, do not descend from the FAWP altitude, proceed to the MAWP, and execute the MAP. Another reason to execute a MAP is if RAIM is lost after starting the descent inside the FAWP. Should this occur, immediately climb to the MAWP altitude via the MAP instructions.

7.18.12.2.1. During a MAP, the main objective is safely getting away from the ground. However, after executing the climb, retracting the gear and flaps, and making the radio call, it will be necessary to manually advance the EGI steerpoint past the MAWP. The TERM PROC is automatically inhibited at the MAWP and requires manual sequencing to display the remaining portion of the procedure and any subsequent TERM PROCs.

7.18.12.2.2. The NAV Data Block will only display up to the MAWP until the pilot manually sequences past it. Then, the NAV Data Block will display the remainder of the MAP and any follow-on TERM PROCs if programmed. An important exception is if there is a CA leg. The EGI will display "ALT" under the EGI range block and specify the MAP altitude to climb to in the NAV Data Block. This reflects the obstacle clearance instructions. In this case, the waypoint will automatically sequence once the altitude associated with that waypoint is exceeded.

7.19. Circling. Circling is accomplished at final turn airspeed with 60 percent flaps IAW the flight manual. During the instrument final approach, descend no lower than circling MDA for the runway to which the instrument approach is flown. Maintain circling airspeed and 60 percent flaps throughout the entire circling maneuver until aligned with the landing runway. Do not descend below MDA until in a position to place the aircraft on a normal glidepath to the landing runway. Once aligned with the landing runway in a safe position to land, slow to final approach airspeed and select full flaps, if desired. Use caution as circling approaches can be very task saturating. When in doubt, execute a go-around or missed approach immediately if safety of flight is in question.

7.19.1. Downwind Displacement.

7.19.1.1. For circling maneuvers requiring a downwind leg, proper displacement from the runway is critical (approximately 1.5 NM). A low circling altitude gives the sensation of being much wider than reality. Attempting to use sight pictures for the normal overhead pattern may cause an overshooting, high-bank angle situation during the turn to final. Do not hesitate to go around if overbanking is needed to prevent an overshoot.

7.19.1.2. Unlike the normal overhead pattern where much of the turn radius is consumed in the vertical, the circling final turn radius is almost entirely absorbed horizontally. The amount of spacing required to complete the turn to final will vary with airspeed (fuel weight), altitude, bank angle, and winds. Poor visibility may require pilots to stay closer to the runway, but do not use a displacement that requires more than 45 degrees of bank to complete the final turn. As a technique, plan to practice circling to remain within published visibility minimums.

7.19.2. Downwind Spacing Techniques. The following techniques assist the transition from the instrument approach portion to arrive at a perch with sufficient spacing to complete the final turn. **Note:** When using any of these techniques, correcting for winds is crucial.

7.19.2.1. To Circle 180 Degrees or the Opposite Direction.

7.19.2.1.1. Turn 45 degrees away from the runway until the aircraft has flown “down” the runway about the same distance as the desired displacement. Then turn to parallel the runway prior to the turn to final. For example, for a 10,000-foot runway, hold the 45-degree offset until approaching the end of the runway in forward runway distance covered. This will build about 10,000 feet of spacing.

7.19.2.1.2. A second option is to perform two 90-degree turns using the desired final turn bank angle— the first to turn perpendicular to the runway, and the second to turn to parallel. Keeping the runway in sight will be more challenging using this technique.

7.19.2.2. To Circle 270 Degrees. Fly past the runway 15 seconds. Then use the desired final turn bank angle to turn downwind. After passing the landing runway, a second option is to turn downwind, using a bank angle with twice the turn radius of the desired final turn bank angle.

7.19.2.3. To Circle 360 Degrees. Consider delaying the initial turn so to more easily keep most of the runway environment in sight throughout the turn. Beginning a 360-degree circle at the approach end of the landing runway will cause the aircraft to be belly-up to the runway environment, and potentially causing the pilot to lose sight of the runway.

7.19.3. Circling Considerations. Pilots must remain vigilant for stall indications and have the discipline to execute a go-around or stall recovery when required. The circling approach presents a potential sink rate problem in the T-38 that may not be accompanied by a stall warning. An overbank during a circling approach creates an insidious descent, which adds to the potential danger.

7.19.4. Unplanned Circling. There may be occasions which require beginning circling from final approach airspeed. For instance, if the runway becomes “wet” during a formation approach, one aircraft may have to circle to land while the other full stops. In these instances, remember to check and reset the flaps to 60 percent and accelerate to final turn airspeed before starting the circle.

7.20. Sidestep.

7.20.1. A sidestep maneuver is a small visual ground track adjustment at the end of a straight-in approach to allow an approach to one runway and a landing on a parallel runway. Where this maneuver is authorized, there may or may not be sidestep procedures or MDAs published on the approach plate. Per AFMAN 11-202V3, pilots will not side-step without a published side-step line of minima. Clearance to sidestep will be issued by the tower.

7.20.2. Although sidesteps are not circling maneuvers, one technique is to configure with gear and 60 percent flaps and maintain a minimum of final turn airspeed. In any case, maintain no less than final approach airspeed during the sidestep. Begin the sidestep maneuver once the landing runway is in sight and inside the FAF. Lower full flaps and slow to final approach speed when aligned with the landing runway in a safe position to land.

7.21. Missed Approach.

7.21.1. Perform a missed approach IAW conditions outlined in AFMAN 11-202V3, and the flight manual. Advance power to MIL, close the speed brakes if open, and raise the nose to the normal instrument takeoff attitude of 7.5 degrees. With a positive climb established on the altimeter and the vertical velocity reversing, retract the gear and flaps. Reduce power and increase climb as required to prevent gear/flap overspeed, especially following high-speed approaches and/or in cold weather. Accelerate to and maintain 240 to 300 KCAS in a positive climb until reaching missed approach altitude. Power may be reduced to 90 to 95 percent RPM to provide a more controllable rate of climb.

7.21.2. If a single-engine missed approach is necessary, apply single-engine go-around boldface. Pilots should climb only as necessary to clear obstacles at least until attaining final approach airspeed. If obstacle clearance is in doubt, consider delaying flap retraction and climb with 60 percent flaps between Final Approach Speed and 200 KCAS until a safe altitude for acceleration is reached. Use extreme caution in attempting to attain 5 degrees above the last known level-flight pitch attitude. If the ability to maintain airspeed, positive climb, and terrain clearance is in question, consider ejection.

7.21.3. For circling approaches, if the runway environment is not in sight at the missed approach point, execute the verbally issued climb out instructions or published missed approach. If the circling maneuver has been started and the airport environment is visually lost, perform a missed approach for the runway to which the approach was flown IAW AFMAN 11-202V3.

Chapter 8

NAVIGATION

8.1. Introduction. The purpose of navigation is to get from point A to point B. Whether accomplished on a cross-country mission or used to find a target, navigation requires significant preflight planning. Planning a navigation sortie requires consideration of many factors—runway length, barriers, servicing availability, airfield operating hours, etc.—taken for granted at the home field.

8.2. Preflight Planning. Prior to departing on any off-station mission, pilots should familiarize themselves with the strange-field procedures located in applicable *FLIP* guidance and Section II of the flight manual. Throughout all planning, be very careful to use accurate local or Zulu time, as appropriate. Before starting detailed mission planning, verify the following basic requirements:

8.2.1. Ensure planned arrival and departure times fall inside operating hours for the airfield and the transient alert or servicing fixed base operator (FBO).

8.2.2. Make a preliminary check of the weather, winds, NOTAMs, and airfield suitability and restriction report for showstoppers, like runway closures, winds out of limits, or forecasts below minimums.

8.2.3. Call the destination to ensure they are open, able to receive and properly service a T-38, have a place to stay (if applicable), and depart on schedule. If necessary, obtain a prior permission required (PPR) number. Additionally, ask the destination station the landing runway, multiple approach availability, serviceability of the start cart (has it been started and used recently?), and any unusual procedures or facility changes that are not in the NOTAMs. Variations in off-station pressure altitude, temperature, and runway length could result in TOLD numbers significantly different from typical home field computations. Where the combination of pressure altitude and temperature might be a factor, ensure the TOLD at the out base will not prohibit departure.

8.3. Single-Engine Planning. Due to the performance limitations of the T-38 during single-engine situations, departures require detailed planning IAW current MAJCOM and subordinate guidance to meet AFMAN 11-2T-38V3, requirements.

8.4. Planning an IFR Navigation Mission.

8.4.1. Weather and Winds. The weather and winds determine if takeoff is possible; where, how far, and (perhaps) how high of an enroute altitude is possible; whether it's possible to land at the destination; and if an alternate is required. Prior to the detailed planning, check the following:

8.4.1.1. Departure, enroute, destination, and drop-in weather—observation and forecast.

8.4.1.2. Climb and cruise winds, Delta-T, and temperature at altitude for each leg.

8.4.1.3. Surface winds at each base.

8.4.1.4. Possible hazards—icing, thunderstorms, etc.

8.4.2. Routing. Look at the high or low charts to determine the most suitable route of flight. Consider any hazards, no-fly areas, MOAs, standard terminal arrival routes (STAR), and preferred routing. Failure to consider these can cause lengthy delays or changes to the planned flight route.

8.4.3. Distance. Make sure planned leg lengths result in arriving at destination with enough fuel to complete training objectives and land with a buffer above minimum fuel. Planning to arrive at the destination with minimum fuel greatly reduces options available if facing delays or—worst case—if a divert is required. Headwinds and tailwinds are often significant factors. If the plan requires the use of reduced vertical separation minimum (RVSM) airspace, pilots will need a suitable alternate that does not require access to RVSM airspace (reference AFMAN 11-202V3). Some techniques for leg-length decision making are as follows:

8.4.3.1. High altitude, no wind, no drop-in, no WSSP, one approach to full stop—approximately 700 NM max.

8.4.3.2. High altitude, no drop-in, pod or clean, one approach— approximately 500 NM.

8.4.3.3. Drop-ins with various approach combinations, pod or clean—approximately 300 NM.

8.4.4. Adjustments for the WSSP:

8.4.4.1. Flying with the WSSP will cause higher fuel flows due to increased drag. The faster and farther to travel, the greater the fuel effect from a pod. Pay additional attention to adhering to WSSP speed restrictions.

8.4.4.2. Based on the flight manual's high altitude cruise charts and 11,000 to 12,000 pounds gross weight:

8.4.4.2.1. The WSSP will increase fuel consumption by about 125 pph per engine at FL 250 and 0.75 Mach. Depending on climb, descent, approach, and distance requirements, a reasonable technique would be to plan for using an additional 150 to 200 pounds for these scenarios.

8.4.4.2.2. The WSSP will increase fuel consumption by about 220 pph per engine at FL 350 and 0.9 Mach. Depending on climb, descent, approach, and distance requirements, a reasonable technique would be to plan for using an additional 250 to 300 pounds for these scenarios.

8.4.5. Cruising Altitude. Select cruising altitudes and airspeeds consistent with mission requirements, applicable directives, and safety. RVSM may restrict the ability to fly above FL 280. The optimum cruise-climb altitude chart in the flight manual provides the best altitude for initial level-off based on fuel weight. The best altitude for fuel economy will increase as gross weight decreases. However, due to the need to fly at higher Mach, the susceptibility of the J-85 engines to flameouts and compressor stalls and the inefficiency of the Propulsion Modernization Program (PMP) upgraded engines at higher altitudes virtually negate any fuel consumption advantage at higher altitudes. At or above FL 280, the min Mach (MM) caret will appear on the airspeed indicator in the MFD. MM is the minimum speed to cruise for the altitude corresponding to the black stripe region in the Engine Compressor Stall/Flameout, Susceptibility Areas diagram in the flight manual for the altitude and temperature conditions.

8.4.6. AF IMT 70, *Pilot's Flight Plan and Flight Log*. Although it can be very useful in many ways, the AF IMT 70 is primarily a fuel-planning template. It's necessary to do enough fuel planning to ensure mission safety. Beyond that, filling out an AF IMT 70 is left entirely to pilot technique.

8.4.7. DD Form 1801, *DoD International Flight Plan*. Air Force pilots are required to file a flight plan for all flights. Despite its title, the DD Form 1801 may be used for both domestic and international flight plans. Fill out the DD Form 1801 according to instructions in *FLIP*. See **Table 8.1** below for T-38C specifics on the DD Form 1801. See **Figure 8.1** below for an example DD Form 1801.

Table 8.1. T-38C Specifics for DD Form 1801.

Section	Block	Input	Remarks
7	Aircraft Identification	[Flight] Call Sign	No spaces
8	Flight Rules	I or V or Y or Z	I = IFR V = VFR Y = Initially IFR, then change of flight rule Z = Initially VFR, then change of flight rule
	Type of Flight	M	Military Aircraft
9	Number	#	Leave blank if single ship
	Type of Aircraft	T38	No suffix (e.g., T38C)
10	Equipment	DGILORTUVZ	DME, GNSS, INS, ILS, VOR, PBN, TAC, UHF, VHF, Other
	Transponder	EB1	Mode S, including aircraft identification, pressure-altitude and extended squitter capability. Dedicated 1090 MHz ADSB “out” capability.
15	Cruising Speed	M0## or N###	M = Mach N = Knots
	Level	F### or A###	F = Flight Level in hundreds of feet A = Altitude in hundreds of feet
	Route	As desired	
18	Other Information	PBN/B2C2D2S2 PER/E SUR/260B NAV/RNVD1E2A1 NAV/NON-FM IMMUNE VOR/ILS CODE/###### STS/NONRVSM	For NAV/RNVD1E2A1: D1 = departures (RNAV 1 SIDs) E2 = RNAV point-to-point A1 = arrivals (RNAV 1 STARs) To prevent assignment of a RNAV route or procedure, insert a numeric “0” for the appropriate segment of flight or remove the segment altogether (e.g., either

			NAV/RNVD0E2A0 or NAV/RNVE2 will prevent assignment of RNAV 1 SIDs and RNAV 1 STARs). For CODE/######: Refer to T.O. 1T-38C-1, Figure A-9-2, for the hexadecimal code assigned to the aircraft (lead aircraft for formations). Do not use the octal code listed in the same figure.
19	Survival Equipment	To indicate survival equipment, cross out 121.5, 500, 8364, Polar, Desert, Maritime, Jungle, Global, Fluorescent (Jackets/Light are pilot-dependent) and write 282.8 under Radio Frequency. Cross out Dinghies unless equipped with a raft.	

Figure 8.1. Example DD1801.

PRIORITY: FF

ADDRESSEE(S)

FILING TIME

ORIGINATOR

SPECIFIC IDENTIFICATION OF ADDRESSEE(S) AND/OR ORIGINATOR

3. MESSAGE TYPE: (FPL

7. AIRCRAFT IDENTIFICATION: RANDY19

8. FLIGHT RULES: I

TYPE OF FLIGHT: M

9. NUMBER

TYPE OF AIRCRAFT: T38

WAKE TURBULENCE CAT.: L

10. EQUIPMENT: DGILORTUVZ/EB1

13. DEPARTURE AERODROME: KRND

TIME: 1200

15. CRUISING SPEED: M080

LEVEL: F190

ROUTE: DCT SAT.SLUGG6

16. DESTINATION AERODROME: KAFW

TOTAL EET HR/MIN: 0055

ALTN AERODROME

2ND ALTN AERODROME

18. OTHER INFORMATION: PBN/B2C2D2S2 PER/E SUR/260B NAV/RNVD1E2A1 NAV/NON-FM IMMUNE VOR/ILS CODE/AE00C2 STS/NONRVSM)

NOT FOR TRANSMISSION

19. SUPPLEMENTARY INFORMATION

ENDURANCE: FUEL/ 0130

PERSONS ON BOARD: POB/ 2

EMERGENCY AND SURVIVAL EQUIPMENT: RDO/ ~~121.5~~ 243 ~~500~~ ~~8364~~

TYPE OF EQUIPMENT: ~~POLAR~~ ~~DESERT~~ ~~MARITIME~~ ~~JUNGLE~~

LIFE JACKETS: GLOBAL ~~JACKETS~~ LIGHT ~~FLUORESCEIN~~

RADIO FREQUENCY: 282.8

DINGHIES / COLOR / NUMBER / TOTAL CAPACITY / OTHER EQUIPMENT

~~DINGHIES~~ ~~COVER~~ RMK/ MIRROR, FLARES, ELT)

REMARKS: Wx briefed by AZ, 12 OSS

AIRCRAFT SERIAL NUMBERS AND TYPE OF AIRCRAFT IN FLIGHT: 63-8247 T38

CREW LIST: [ ] ATTACHED [X] LOCATED AT: KRND

PASSENGER MANIFEST: [ ] ATTACHED [ ] LOCATED AT:

NAME OF PILOT IN COMMAND

SIGNATURE OF APPROVING AUTHORITY

AIRCRAFT HOME STATION OR ORGANIZATION: 560 FTS, JBSA RANDOLPH, TX

DD Form 1801, MAY 87 *Previous edtion is obsolete.* DOD INTERNATIONAL FLIGHT PLAN

8.4.8. Destination Review. Note obstacles, airfield layout, barriers, approach lighting, type of visual glidepath guidance, field elevation, runway data, important frequencies, for the planned destination and any possible enroute or destination divert options.

8.5. Planning a VFR Navigation Mission. Maintaining SA will be different on a VFR mission because, although there are fewer distractions from ATC, pilots also receive less information. This affects how to plan the mission and the tasks to perform while airborne.

8.5.1. Weather and Winds. VFR conditions do not necessarily mean the absence of clouds. The pilot is responsible for determining that VFR conditions and cloud clearances can be maintained for the entire proposed route of flight.

8.5.2. Map Selection. Choose an operational navigation chart (ONC) or tactical pilotage chart (TPC) based on the desired level of detail. As a technique, use an ONC when flying above 6,000 feet AGL and a TPC when flying below. A joint operations graphic (JOG) chart may be used for detailed route study and preflight planning. World aeronautical charts (WAC) and sectional charts are the same scale as ONC and TPC respectively and include airspace boundaries and frequencies.

8.5.3. Map Preparation. There is a wealth of information available to put on a VFR map. Pilots may want to highlight emergency airfields, VORTAC stations, tower frequencies, etc. Additionally, pilots should mark turn points, courses, headings, checkpoints, obstacle elevations, etc., for the route. Pilots should plan to fly at 300 KCAS below 10,000 feet MSL and Max Range Mach above 10,000 feet MSL. Pilots may run either a continuous clock or individual leg times. Other useful information would include Class B, C, and D airspace boundaries and frequencies, conflicting airways, air route traffic control center (ARTCC) sector frequencies, and planned fuels. Flight planning software specified by MAJCOM provides excellent tools for preparing and printing VFR maps. Using planning software significantly cuts down the time spent preparing a VFR map.

8.5.4. Routing. Pilots must do enough research on special use airspace, victor airways, and Class B, C, and D airspace to avoid them. Don’t forget to consult the temporary flight restrictions (TFR) NOTAMs to identify any temporary airspace restrictions along the route of flight. Use very prominent features that will allow continued navigation despite potential low scattered clouds when selecting turn points.

8.5.5. Distance. When determining the length of a VFR leg, consider the planned altitude to fly and the winds at altitude. VFR legs between 250 and 350 NM work well, with or without a WSSP. This will allow fuel for several overhead patterns or the option of coordinating for practice instrument approaches after a VFR arrival. As a guide, do not plan a VFR leg greater than 400 NM.

8.5.6. AF IMT 70 for VFR Missions. Measure headings and distances directly from the VFR map. Compute GS by using the forecast winds and use it to determine the total time enroute and fuel required. As a technique, include all information needed for a VFR arrival (frequencies, pattern altitudes, etc.) on the map.

8.5.7. DD Form 1801 for VFR Missions. Refer to *FLIP General Planning*, Chapter 4-3, Item 15, “b. FLIGHT OFF AIRWAYS/ROUTES” and “SIGNIFICANT POINTS/POINTS ALONG AIRWAY/ROUTE” sections as a guide for developing VFR routes of flight.

8.6. Preflight Ground Operations.

8.6.1. Logistics. As many pilots have discovered over the years, being without necessary equipment, paperwork, or supplies can seriously degrade the cross-country experience. Maintenance should help launch the aircraft with tires and aircraft inspections that will last for the duration of the cross-country flight. In addition to personal baggage, before launching from any home station or out base, consider including the following "don't leave without it" items: **Note:** These are not all-inclusive.

8.6.1.1. Required low and high enroute charts.

8.6.1.2. Required approach plates and STARs.

8.6.1.3. Low-level and VFR maps.

8.6.1.4. Instrument hood.

8.6.1.5. Aircraft forms (AFTO Form 781-series).

8.6.1.6. Civilian and military fuel cards.

8.6.1.7. Fuel receipts.

8.6.1.8. Intake, exhaust, and HUD covers.

8.6.1.9. AOA vane lock.

8.6.1.10. Grounding wire.

8.6.1.11. Flashlights and clear visors.

8.6.1.12. Data transfer cartridge.

8.6.1.13. Charging cables and blocks for the EFB or Sentry/Stratus pucks if required.

8.6.1.14. Extra EFB if required.

8.6.2. Transient Alert or FBO Ground Crews. Ensure transient alert FBO personnel are familiar with starting and post-start procedures. Become familiar with how to operate the manual diverter valve in case it's necessary to explain its operation. Strange Field Procedures of the 1-T-38C-1CL-1 checklist provides T-38C compatible oil, fuel, oxygen, hydraulic, and air starting unit information.

8.6.3. Getting Clearance. Prior to engine start, determine the status of clearance with clearance delivery or ground control. If a delay is anticipated, consider postponing engine start until receiving clearance. Ensure it's possible to comply with any differences between the received clearance and the planned route of flight. For VFR flights, local directives and good sense may require pilots to ask for a squawk for flight following.

8.6.4. Cockpit Organization. Cockpit organization is very important. If paper publications are used, arrange them for easy access without cluttering up the cockpit. Arrange publications in the map case in the order of expected use. More than for other types of missions, pilots will need a place to write on short notice, so put mission data cards, AF IMT 70, and kneeboard near the pilot's writing hand. Do not have any publications loose with the canopy open. Position EFBs so that they are secure and do not block aircraft instruments or visibility. Consideration should be given to EFB orientation as they have been known to overheat when the screens are exposed to direct sunlight.

8.7. VFR Departure. After being cleared for takeoff, squawk “1200” and remain on tower frequency until departing their airspace. If departing an airfield that lies within Class B or C airspace, pilots must contact departure control after takeoff. Until exiting ATC airspace, comply with any instructions (headings, altitudes, squawks, etc.) issued by ATC. If departing from a civilian field, pilots will need to contact the nearest FSS the local VHF FSS frequency to activate a VFR FPL. Pilots are responsible for maintaining VFR cloud clearances. After leaving the tower frequency, pilots have two options:

8.7.1. VFR Option Number 1. Contact ATC for flight following. Squawk the assigned code (if other than 1200), and fly requested altitudes if weather allows. ATC will provide traffic advisories as time permits, but pilots must always aggressively clear for traffic. Pilots will be passed from controller to controller throughout the route of flight.

8.7.2. VFR Option Number 2. Pilots may remain on the FSS frequency for the entire route of flight. Pilots choosing this option must contact subsequent FSSs as the sortie progresses. Remember to set the local altimeter at least every 100 NM.

8.8. Enroute IFR and VFR.

8.8.1. Airspeed. When flying at high altitude, maintain an IMN appropriate for the engine envelope. The flight manual checklist’s Engine Compressor Stall/Flameout Susceptibility chart specifies a minimum IMN for a given altitude and temperature. Anything that induces turbulence or interrupts airflow, such as bank, yaw, or abrupt throttle movement, can increase susceptibility to flameout or compressor stall.

8.8.2. Groundspeed (GS) Check. Once stabilized at the planned cruise airspeed, compare the actual GS to the planned GS to determine the effect of the actual winds and how they might impact fuel planning.

8.8.3. Waypoint Checks. When passing planned waypoints, compare the actual fuel and flight time to those planned.

8.8.4. Flight Plan and Route of Flight Adjustments. Unusual ground delays, low altitude step-up restrictions, and/or non-forecasted headwind velocity could place the aircraft in a potentially fuel-deficient situation. Apply any significant differences between planned GS and/or fuel remaining to the remaining route of flight and modify the FPL, if necessary. In a worst-case situation, a divert to a suitable airfield short of the planned destination may be necessary. The emergency divert mode of the EGI can be helpful in determining fuel remaining at the destination.

8.8.5. Lead Points.

8.8.5.1. When flying on published jet routes or airways, remaining within the protected airspace requires the use of good lead points during turns to new courses. The most mathematically unusual situation occurs when making a significant turn over a VORTAC waypoint because the cone of confusion will begin at a rather large slant-range DME. The technique (Mach minus 2) will give the correct lead point in NM, but triangle hypotenuse math is required to turn it into a useable, close-to-the-station DME.

8.8.5.2. The following is an easier technique to calculate no-wind DME lead points for 30-degree bank turns at normal cruising airspeeds or altitudes: lead point equals 1 NM for each 30 degrees of turn plus altitude in NM above the station. For example, approaching a

VORTAC at FL 360, the aircraft would be turning from a 270-degree inbound course to a 330-degree outbound course. For this 60-degree turn, take 2 NM (1 NM for every 30 degree of turn) and add 6 (altitude in NM). The lead point would be approximately 8 DME.

8.8.6. Radio Frequencies. Maintain a record of assigned frequencies to re-contact a previous controller if sent to a bad frequency.

8.8.7. Positional Awareness. Because a radio or NAVAID failure can occur at any time, maintain constant positional awareness using NAVAIDs, map reading, and dead reckoning (DR).

8.8.8. Weather and Winds. Check the weather far enough out (80 to 120 NM) to be thoroughly prepared for arrival as well as any unexpected changes or diverts. In addition to checking destination or drop-in weather, pilots may want to check the weather at the planned alternate. Pilots should make a pilot report (PIREP) time permitting or if queried by a pilot to metro service (PMSV) forecaster. (The format is in the *Flight Information Handbook [FIH]*.) To obtain destination, drop-in, or alternate weather and winds enroute, there are several options:

8.8.8.1. Automated Terminal Information Service (ATIS). This is the easiest and quickest option but not always a reliable one. Some ATIS messages are less complete and less frequently updated than others, especially on weekends. Listen for the time group to see how old the information is and make decisions accordingly. Note the letter identifier for check-in with approach control.

8.8.8.2. PMSV. If the weather is poor, PMSV is usually a better source of updated information if it is available. The information provided should be current. Pilots can talk to a forecaster and ask real-time questions about trends, actual thunderstorm activity, divert options, etc.

8.8.8.3. Approach or Tower. Consider this option if: (1) unable to receive ATIS or contact PMSV, or (2) arriving at a civilian field with no ATIS. Use discretion on what could be a busy frequency. A quick request for the landing runway and current observation will give enough information to make initial decisions.

8.8.8.4. SOF. At military fields, the SOF on duty can be an excellent option in lieu of ATIS or PMSV. In fact, in certain circumstances (timing of exercises, ceremonial events, FBYs, etc.), talking to the SOF may be highly preferred.

8.8.8.5. FSS. Contact an FSS on frequency 122.2, using the callsign “radio” (e.g.: “Greenwood radio”). FSSs contain reliable, full-service teams, complete with PIREP information when it’s been provided.

8.8.8.6. Automated Weather Observation System (AWOS). Many civilian fields are modernizing their weather service by installing automated weather equipment to provide timely and accurate surface weather conditions to pilots, ATCs, other aviation users, and the national weather data network. AWOS provides an automated and continuous real-time weather reporting system that transmits weather data to both airport personnel and aircraft via VHF radio. AWOS collects and transmits data on wind direction and speed, altitude, density altitude, temperature, dew point, and relative humidity. It may also report cloud heights and thunderstorm activity.

8.8.9. VFR Altitudes Enroute. Fly appropriate VFR altitudes according to *FLIP*. Assuming pilots have cleared carefully for traffic and the weather, changing altitude at any time during the flight is allowed. Pilots do not need permission to alter altitude, but informing the controlling agency of intentions is a good idea if receiving flight following service. In formation, all flight members should be at an appropriate VFR altitude.

8.8.10. Encountering Unexpected Weather While VFR Enroute. If unexpected weather is encountered, pilots have the following three options:

8.8.10.1. Alter Route of Flight and Continue. Pilots may alter the route and/or altitude to avoid unexpected weather but must continue to maintain the required VFR cloud clearance and visibility requirements. Ensure fuel allows any deviations from the plan. Inform FSS personnel of any major route changes and pass them a PIREP describing the unexpected weather.

8.8.10.2. Return to Base of Origin or Divert. If pilots have not proceeded far from the departure field, turning around and returning there may be the best option. If significantly down track on the route, proceeding to an alternate airfield may be preferred. In either case, maintain VFR conditions and ensure sufficient fuel exists. Inform FSS personnel of route or destination changes; give them a PIREP; and obtain the NOTAMs for the new destination.

8.8.10.3. Pick Up an IFR Clearance. Contact an FSS or controlling agency to file an IFR clearance. (ARTCC frequencies can be found on *FLIP* low altitude enroute charts). Until an IFR clearance is activated, pilots must maintain VFR conditions. Picking up an IFR clearance while airborne is simple but requires some preparation. Pilots will be required to provide the same type of information on a DD Form 1801. Use the sequence on the back cover of the IFR enroute supplement to help organize and provide the right information.

8.9. VFR Lost Procedures. First, use every possible resource to regain positional awareness. Use EGI steering to determine the course to a known point. Use the lat/long present position on the MFD EGI display page or radial/DME from a known NAVAID to plot the aircraft's position onto the VFR map. If the DME is inoperative, attempt to identify location by cross-tuning radials from two different NAVAIDs. If, after using every possible resource for positional awareness pilots still cannot determine position, follow this habit pattern:

8.9.1. Climb—Conserve—Confess.

8.9.1.1. Climb. For fuel conservation, climb to the highest possible altitude below FL 180 allowing VFR weather clearances.

8.9.1.2. Conserve. Establish the maximum endurance airspeed for the aircraft's fuel weight. Another technique is to use the Endurance (ENDR) profile in the Emergency Divert Mode and fly the commanded CAS/IMN for current altitude. BNGO in the Emergency Divert Mode display block on the MFD also provides pilots with time to reach the selected Bingo fuel under current conditions when operating in the ENDR profile.

8.9.1.3. Confess: Call for help. Pilots admitting being lost and getting help early is far better than delaying until being low on fuel. Start with appropriate ARTCC and approach frequencies (try several if necessary), but do not hesitate to use guard frequency. For guard calls, preface the call with "mayday, mayday, mayday," give callsign, and request help from any agency hearing the transmission.

8.9.2. Several controlling agencies will probably answer the distress call. Select one and direct the rest to remain silent. Select Emergency on the identification, friend or foe/selective identification feature (IFF/SIF) using the UFCP or set code 7700 in Mode 3/A. When the Emergency function is selected, the IFF/SIF IDENT feature will not be available, so consider entering 7700 into the Mode 3/A instead. The controlling agency can give a heading and distance information to the nearest suitable airfield, home field, or destination.

8.9.3. Check the Compass. Ensure the EHSI is operating properly and compare it to the standby magnetic compass.

8.9.4. Without Radio Contact. Attempt to pick out a prominent landmark on the ground—a body of water, a town, a large airport, or a railroad crossing are all good landmarks. Try to orient the map with the selected landmark. If unable to locate the landmark on the map, do not wander aimlessly. Use an EFB if it's available and properly set up to display the aircraft's location. Fly a definite heading until being able to identify a good landmark.

8.10. IFR Arrival.

8.10.1. Descent from High Altitude. Consider preheating the canopies with the canopy defog because descents into warmer, humid air may cause the canopies to fog up.

8.10.2. Clearances. There are at least three clearances requiring careful attention during any arrival:

8.10.2.1. IAF or Beginning Enroute Descent. Before arriving at an IAF or holding fix, or before beginning an enroute descent, know clearances and any restrictions. These often include holding instructions, approach clearance, clearance to use maneuvering airspace, expect further clearance times, enroute descent instructions, etc. This is especially important when on an enroute descent in the event of radio failure.

8.10.2.2. Missed Approach or Climb out. Before the FAF, coordinate climb out, missed approach, alternate missed approach, and (or) departure instructions, as appropriate. Write them down!

8.10.2.3. Landing. Passing the FAF, ensure awareness of all clearances and restrictions; for example, proper runway, low approach, land, touch-and-go, option, sidestep, circling, restricted low approach, etc.

8.11. VFR Arrival on an IFR Flight Plan. If flying in Class A airspace or in IMC, coordinate with the enroute ARTCC for a descent to VFR conditions below the Class A airspace. Cancel IFR when able to maintain VFR and navigate to the airfield using a VFR map and NAVAIDs. Clear visually and over the radios. Coordinate with ATC to proceed VFR-to-initial or to a visual straight-in. When practical, remain on ATC frequency for traffic advisories.

8.12. VFR Arrival at an Unfamiliar Field.

8.12.1. Coordination. Know the classes of airspace affecting VFR arrival. These may be obtained from *FLIP AP/1* or the IFR Enroute Supplement. Pilots must abide by these airspace rules even when VFR. Approximately 40 NM out, pilots should check the weather and current runway (ATIS, if available). Approximately 30 NM out, contact ATC and request the VFR arrival.

8.12.2. VFR to Initial. Pilots should plan on a 3 to 5-mile initial. To maintain positional awareness approaching airports with several offset or crossing runways, keep SA on the inbound bearing to the field and the current heading comparing them to an airport diagram. Setting the runway heading for the heading set marker or the course window on the MFD is a familiar way to visualize the pattern for the correct runway. The IFR enroute supplement normally indicates the pattern altitude and direction of break, but listen carefully for modified instructions and other guidance like wake turbulence, runways, type landing, etc. Clear for other aircraft or helicopters, stay aware of wake turbulence separation, and be vigilant for degraded aircraft performance at high density altitudes.

8.12.3. Visual Illusions. Use caution when landing on unfamiliar runways. Start with a careful study of the airport diagram and the IFR Enroute Supplement so to know what to expect. Plan for how to adapt to a runway without an underrun or one with a displaced threshold. Remember that a wider runway may contribute to a high flare and a long or dropped-in landing, while a narrower runway may lead to an incomplete flare and early landing. Usually, a wider runway will have side stripe markings approximately 150 to 200 feet wide to help with depth perception. Use all available references to determine the height above the runway. As a technique, pilots should transition eyes to the departure end of the runway during the flare to help gauge height above the runway.

8.13. Off-Station, Post-flight Ground Operations.

8.13.1. Canopy Management and FOD. With so many items potentially cluttering the cockpit during a cross-country mission, pilots may want to leave the canopies closed until engine shutdown. In any case, double-check to ensure all loose items are accounted for and secure before opening the canopies.

8.13.2. Taxiing on a Strange Field. Although a progressive taxi can be requested from the ground or tower controller, pilots can maintain higher SA by referencing the airport diagram and signs posted along the taxi route. With a little prior study, pilots can often anticipate the taxi route and parking area. Many civilian and military transient operations use a “follow-me” vehicle as well. If desired to expedite the next leg, accomplishing a stored heading alignment once in parking and prior to engine shutdown can reduce alignment time to 1.5 minutes or less.

8.13.3. Closing Flight Plans. Normally, there is no need to close an IFR FPL with the FSS. The tower should do this automatically at a military or civilian field. However, because some civilian fields are not as reliable as others in always closing an IFR FPL, it is usually wise to verify with the FSS or tower that it has been closed. Remember, IAW AFMAN 11-202V3, pilots are responsible for closing a VFR FPL with a FSS.

8.13.4. After Engine Shutdown. Refer to the checklist and other appropriate items in the inflight guide. Conduct a thorough post-flight inspection of the aircraft and ensure transient alert personnel are familiar with the T-38’s servicing requirements. Also, ensure they properly secure, pin, and ground the aircraft. Pilots should be sure to be familiar with alternate fuel procedures, if applicable. Complete all required paperwork. When possible, give transient alert a phone number where the aircrew can be reached, even if it is the billeting number. Pilots are ultimately responsible for the aircraft until it returns to the home station. It’s highly recommended to check engine fluids prior to mission planning rather than waiting until step time.

8.13.5. Stopovers. As a technique, the following acronym—WANTS—will help pilots remember what to accomplish at a stopover location:

8.13.5.1. **W** eather, winds, temperatures, bird status.

8.13.5.2. **A** ctivate flight plan or **A**lternates and emergency fields.

8.13.5.3. **N** OTAMs.

8.13.5.4. **T** OLD.

8.13.5.5. **S** ID or departure instructions. Call the **S**UP, **S**OF, or command post.

Chapter 9

LOW-LEVEL NAVIGATION

Section 9A—Purpose

9.1. Introduction. The purpose of low-level navigation is to fly a preplanned ground track to a designated target to arrive at a designated time over target (TOT) or time to target (TTT). Flying high-performance jet aircraft on low-level missions puts pilots close to the ground at high speed. The proximity to the ground increases the risk. In addition to the ground, other threats include aircraft, birds, and obstacles. Therefore, the margin for error and the time to react are significantly reduced. The intent of low-level training in the T-38 is to provide the foundation from which to build as pilots transition into the Combat Air Force (CAF). Each low-level will be broken down into mission planning, briefing, and flying phases.

Section 9B—Mission Planning

9.2. Overview. The first step in preparing for the mission is becoming completely familiar with the route requirements and any associated restrictions. Consider referencing a sectional chart to determine National Airspace System restrictions. Applicable publications include FLIP General Planning (GP), AP/1B Manuals, the Chart Update Manual (CHUM), and command and local guidance. Low-level routes and corridors can be loaded in the DTC during mission planning for use in flight if desired and IAW training requirements.

9.3. Military Training Route (MTR) Selection.

9.3.1. In the United States, military low-level training is conducted in designated airspace as outlined in Federal Aviation Administration (FAA) publication 7610.4, *Special Military Operations*. Use *FLIP AP/1B* as the primary reference for MTR selection. The slow routes (SR) are not used by T-38s due to airspeed restrictions.

9.3.2. When selecting a route, identify the departure and recovery bases and find a route nearby. In many cases, the instrument routes (IR) and visual routes (VR) described in *FLIP AP/1B* are too long to successfully fly from the primary entry to the primary exit. Therefore, alternate entry or exit (or both) may have to be used. Route selection should be made so navigation to the desired entry, flying the route, and recovery to the desired destination can be completed within the T-38's fuel limitations.

9.3.3. For initial fuel planning, approximately 45 pounds per minute at 360 knots GS (6 NM per minute) works while on the low-level. (For example, in 40 minutes, 240 NM of low-level will use approximately 1,800 pounds of fuel.) The longer the planned low-level, the less fuel remaining for navigation to and from the route, and therefore, the closer the route needs to be to the planned departure or recovery base. Additionally, ensure the enroute and on-route weather meets the minimums required to fly the selected low-level. Refer to *AP/1B* for the VR weather minimums and AFMAN 11-2T-38V3 for the IR weather minimums.

9.4. Map Preparation. On low-level missions, each pilot must carry a current map of the route IAW AFMAN 11-2T-38V3. Refer to map preparation requirements in AFMAN 11-2T-38V3, and any command or local supplements.

9.4.1. Map Selection. For sufficient detail and quality of terrain features, a published TPC (1:500,000 scale) or a chart generated from flight planning software should be used. With greater detail, JOGs can be excellent for low-level missions. However, they can be cumbersome because of their size. For low-level routes flown with TPCs, pilots may want to carry JOG sections of the turn points and the target areas. Pilots may also find JOGs especially useful for detailed route study during preflight planning.

9.4.2. MTR Corridor.

9.4.2.1. Draw the MTR corridor from the planned entry point to the planned exit point, using the latitude-longitude of the published waypoints and designated route corridor lateral displacements. Additionally, make annotations for the vertical limits of the route segments. This step is imperative for flight safety and may be completed using approved flight planning software.

9.4.2.2. Study the route enough to gain an initial feel for all obstacles and terrain features at or above planned flight altitude. Highlight any obstacles or high-terrain features that may be a factor along the route of flight using appropriate thin-line “bubbles”. One technique is to use 2- to 3-mile bubbles to mark decision making points for those obstacles not acquired visually.

9.4.2.3. Lastly, use the appropriate sectional chart to determine all crossing MTRs. **Note:** Sectional charts do not show Slow Speed Low Altitude Training Route (SRs).

9.4.3. Emergency Route Abort Planning. Compute the emergency route abort altitude (ERAA) IAW AFMAN 11-202V3**.** Route abort frequencies can be obtained from the “postage stamps” on *FLIP* low charts. Highlight the map with emergency or alternate airfield locations and information such as VORTAC channels and tower and approach frequencies.

9.5. Route Development. As a minimum, pilots will need a route entry point, a high confidence “hack” point for the clock or timer, recognizable turn points, a clearly discernible initial point (IP), and an appropriate target. The best features for turn points are usually natural because these features change very little over time. Pilots may also use manmade features such as bridges, road intersections, and towers. Choose points for their uniqueness, vertical development, funneling features, and surrounding terrain. Avoid using features that may be hidden by high terrain or trees.

9.5.1. Route Entry and Hack Point. Note that the route entry point must be within the route corridor and should correspond with a published entry point (or alternate). An EGI steerpoint is an excellent confirmation of the entry point; however, a VORTAC radial and DME also works well. The hack point can either be the *FLIP*-designated route entry point or down track following an acceleration corridor or route entry corridor. Choose an easily discernible hack point because the first key to good DR is to start from a known point. Do not plan a hack point that requires an immediate turn to remain on course. The hack point is a high-task portion of the sortie. Therefore, minimize maneuvering to ensure a safe and effective route entry.

9.5.2. Turn Points. If planning a route using flight planning software, ensure the programmed profile reflects the method chosen to fly the route; otherwise, timing errors will be induced on the low-level. For example, if the flight plan reflects 45-degree bank turns and 4 G hard turns are used, the pilot will be ahead of time on each leg, and anticipated headings will be off by a factor related to the length of the next leg.

9.5.3. IP and Target. Choose an IP located about 1 to 3 minutes prior to the target. An IP should be an easily identifiable point used to fine-tune navigation and increase the probability of target acquisition. Choosing an easily identifiable IP in an advantageous position relative to the target is a good technique since pilots may not be able to choose the target in follow-on real-world scenarios. Minimize the heading change (up to 30 degrees) at the IP to increase the accuracy of the IP-to-target leg. If using a running time, pilots will normally continue the running time at the IP to the target. If the running time to the target is off, re-hacking at the IP may help identify the target.

9.5.4. Course Lines, Timing Marks and Mileage Ticks. When drawing course lines between the turn points, use thin lines and be sure to account for the turn radius corresponding to the planned GS and bank angle. Select a GS that easily converts to miles-per-minute, but still allows room for required airspeed corrections. A GS of 360 knots works well at relatively low MSL altitudes to allow an easy conversion to 6 miles per minute. It also permits enough airspeed correction capability to maintain above a minimum of 300 KCAS**.** Place timing tic marks along one side of the route to represent the timing intervals counting up from the hack point. A 1- or 2-minute interval is sufficient. Account for the fact that the IP-to-target run may be planned at a different airspeed. Mileage tics placed along the other side of the route can greatly enhance SA if EGI is used. Using 10 NM intervals for each route leg working back from each turn point is a common technique.

9.5.5. Headings and Drift Corrections. Plot the no-wind headings for each segment of the route and ensure proper application of the magnetic variation. Low-level winds are generally light, not exceeding 15 to 20 knots. However, they can be quite significant under certain weather conditions, such as wind shears, frontal passage, or thunderstorms. Wind direction and speed is available on the MFD on the wind direction and speed display below the right side of the EADI. The arrow indicates the magnetic wind direction. The drift angle and airspeed will change on each leg of the route, depending on the aircraft's heading in relation to the relative wind. Pilots must apply drift correction to maintain course and must also adjust airspeed to keep GS constant. Compute and post wind-corrected headings (or correction factor) for each leg of the route. If the planned GS is 6 miles per minute, a simple technique is to apply l degree of drift correction for every 6 knots of crosswind.

9.5.6. Calibrated Airspeed. Use the forecast temperature, pressure altitude, and low-level winds to compute wind-corrected calibrated airspeeds for each leg at the planned GS. To keep GS constant, KCAS should be decreased for a tailwind and increased for a headwind. To simplify airspeed computations, assume there is a one-to-one relationship for increases and decreases in airspeed between calibrated airspeed and GS.

9.5.7. Course Arrow Blocks. The course arrow block is a symbol used to efficiently present the information needed to help pilots fly the low-level. The course arrow block should include the information pertinent to navigation along the applicable leg of the route which, as a minimum, would include heading, airspeed, and leg time. This emphasizes the core requirements for good DR of time, distance, and heading. Additional information can be added per individual desires, but too much information could become distracting and divert the pilot's attention inside the cockpit when it needs to be outside.

9.5.8. Fuel Planning. Compute a planned fuel at designated points along the route. Refer to the flight manual charts for the required fuel flow. As a technique, a fuel flow of 1,350 pph/engine will normally maintain 350 KCAS. Additionally, compute a continuation fuel for the designated points along the route. Continuation fuel is the minimum required to complete the route at planned speeds and altitudes and RTB with the minimum required fuel reserves. Finally, compute and annotate the bingo fuel for RTB by the most practical means from the most distant point on the route. Consider factors such as cloud ceilings, winds, freezing level, MOAs, VFR hemispheric altitudes, forecast icing, and minimum required fuel reserves.

9.5.9. Restrictions. Highlight and plan to remain clear of any noise-sensitive areas or airfields specifically listed in *FLIP AP/1B* or local directives.

9.6. Routing To and From the Low-Level Route. Good route study includes more than the low-level route between the entry point and exit point. Pilots must have a solid understanding of how to get to and return from the MTR. According to *FLIP AP/1B*, flight to and from IR or VR routes should normally be conducted on an IFR FPL. Pilots should normally include the planned route of flight to and from the MTR on the map to include headings, airspeeds, and times. Ensure the planning includes both no-earlier-than and no-later-than takeoff times, which will allow the aircraft to enter the route on time and permit completion with the amount of fuel on board.

9.7. Scheduling. Schedule the low-level route for the desired entry time with the scheduling activity as designated in *FLIP AP/1B*. In instances where there is no published entry timing tolerance window or standard command or local guidance, coordinate an acceptable entry window with the scheduling activity. This becomes important in helping deconflict the route especially with multiple users of dissimilar aircraft. It becomes *most* important on VR routes where ATC is not responsible for the separation of aircraft. Deconflict with crossing routes by calling those routes' scheduling activity in *FLIP AP/1B*. **Note:** On routes with which the pilot is not familiar or does not routinely fly, it may be beneficial to accomplish this scheduling step early in the planning process to verify there is no unpublished or short-term restriction which would prevent flying the route.

9.8. Filing. File the low-level sortie on a DD 1801, following the procedures outlined in *FLIP GP*. If flying a local low-level route, the operations personnel at the duty desk typically file the requested local stereo FPL, like for other local mission profiles.

9.9. Map Study.

9.9.1. A detailed study of the map is essential after planning the route. Pilots must prepare so as to minimize heads-down time during the low-level. Noting the general shape of the land and its most significant features is a good starting point. A JOG (1:250,000 scale) may initially help interpret data on the TPC (1:500,000 scale).

9.9.2. Try to visualize the key points along the route and general features around them. Funneling features, such as converging ridgelines, rivers, and roads, are especially helpful in locating selected turn points. Use large, prominent features to funnel eyes to the smaller features leading to the turn points. (Navigate from large to small.) To make course measurements significantly more obvious on the route, note the expected distance left or right of features (towers, bridges, dams, river bends, etc.) the aircraft will be.

9.9.3. For mid-leg reference points, it is also critical to note the expected time along the route that point becomes significant. This chronological understanding of key navigation points will help reinforce clock-to-map-to-ground pilotage and minimize unnecessary deviations from basic DR. It is also a good technique to memorize the sequence of events, features, and actions required during the IP-to-target run. Thorough map study will significantly aid in a smooth, efficient brief of the sortie. Much of a map study will be accomplished by preparing the map and drawing the route. This step becomes especially important if aircrew are planning to fly a low-level with a map they did not prepare.

Section 9C—Briefing.

9.10. Overview. The overall effectiveness of the sortie can be dramatically affected by how thoroughly and completely the sortie is briefed. Reference the Avian Hazard Advisory System (AHAS) Web site (**http://www.usahas.com/**) prior to the brief and address any significant bird threats.

9.11. Route Briefing.

9.11.1. A commonly accepted technique is to structure the brief so the last thing covered is the low-level routing itself. This will emphasize the important points and keep them fresh in everyone's mind.

9.11.2. The briefing should include the plan for identifying and entering the route. While progressing down the route, highlight the critical action points—where it's expected to see good track or timing correction points, when to climb or laterally avoid unseen towers or airfields, how high to climb and remain in the route structure, where potential aircraft threats or crossing routes are expected, specific exit procedures, and what altitude, heading, and frequency to use in IMC.

9.11.3. Emphasizing specific action points along the route will set the groundwork for good DR (clock-to-map-to-ground). A thorough understanding of what to look for (and when) will also help minimize the airborne tendency to spend too much time map-reading or trying to make what can be seen on the ground fit what is seen on the map.

9.12. Emergency or Contingency Briefing. Emergency or contingency options pose their own unique challenges in the low-level environment. Pilots diverting their attention into the cockpit for too long may have catastrophic consequences. In all abnormal situations on the low-level, the first reaction should be "climb-to-cope". Pilots can cover emergency or contingency by leg during the brief, or it can be covered as a separate topic from the route brief. Remember, not all emergencies can be covered, but the more thoroughly pilots brief initial actions, how high (top of the block or ERAA), which way (left or right), which recovery field (primary or emergency), who to talk to, what frequency, the more likely they are to successfully recover the aircraft during a contingency situation. Many aircraft systems are available to assist in building SA in an emergency. Consider briefing incorporation of all EGI and HSD capabilities, even if the capabilities will not be used for the training portion of the sortie.

Section 9D—Flying the Route

9.13. Departure and Route Entry.

9.13.1. Before departing for the jet, referencing AHAS one more time may provide real-time radar tracking of bird activity.

9.13.2. During ground operations, if using an activated FPL for the low-level route, pilots should ensure:

9.13.2.1. Automatic (AUT) waypoint switching is selected on the UFCP NAV submenu display via Window 3L/UL-3. Automatic waypoint switching continues even when EGI is not the PNS.

9.13.2.2. The time on target (TOT) calculation method is set to either TOT or time to target (TTT), as appropriate. This is set in the FPL sub-menu at UR-2. Selecting the incorrect clock could result in confusing or erroneous data presentation throughout the sortie.

9.13.2.3. Each FPL low-level waypoint is set as a flyover (OVR) point. For OVR waypoints, switching occurs when the aircraft passes within 2 NM of the waypoint, and the EGI bearing pointer swings through the 3 or 9 o'clock position relative to the nose of the aircraft. The waypoint types are available on the MFD FPL display page by selecting the desired FPL. If necessary, change the waypoint type via Window 4L/UL-4 on the UFCP FPL submenu display. Designating enroute FPL waypoints as FBY waypoints could make departure and return navigation easier.

9.13.2.4. TOTs are programmed. The FPL waypoints with an associated TOT are designated in the FPL. Waypoint TOTs are visible on the MFD FPL display page by selecting the desired FPL or may be set on the UFCP FPL key display.

9.13.2.5. The flight plan waypoints are loaded correctly in the MDP. This can prevent loss of situational awareness once airborne due to a system malfunction, error made during mission planning, or mistakes in other avionics setup. The flight plan waypoints can be quickly verified by:

9.13.2.5.1. Displaying the flight plan track lines on the HSD. This may require the increase of the HSD's scale to see the entire flight plan. Verify the flight plan route (white line) displays correctly within the displayed route corridor, if available.

9.13.2.5.2. Performing a swing check. During mission planning, determine a bearing and range to each point along the route from a predefined position, typically the EOR. Flight planning software usually has a function that can do this automatically. Manual calculation can be done using the low-level map; however, it may not be as accurate. Once in the aircraft, activate the FPL. Then, when near the position from which the bearing and range were calculated, cycle through each route waypoint to be the EGI steerpoint to check the bearing and range against what was calculated during mission planning.

9.13.3. Maintain positional awareness enroute to the entry point, using all available visual references and NAVAIDs, to include EGI. If unable to make the originally scheduled entry time, coordinate for a new time or fly an alternate mission.

9.13.4. Make an entry call with the appropriate controlling agency or the route discrete frequency and perform a FENCE check into the low-level. Once inside the route structure, accelerate to the planned airspeed. Identify the entry or hack point as early as possible and maneuver the aircraft to overfly the entry point on the correct heading and at the correct airspeed.

9.13.5. Being at the correct airspeed and heading is more important than immediately descending to the planned route altitude. Start the clock as the aircraft passes over the hack point. The aircraft clock can be used via the UFCP; however, pilots should back it up with an additional hack, either on a watch or the EED clock. Positive identification of the hack point is of utmost importance.

9.14. Route Basics.

9.14.1. Priorities. Avoiding the terrain and anything attached to it is the most critical task during low-level flying. The priority will never change—keep the aircraft under positive control and at an appropriate altitude. Keep attention primarily out of the cockpit, and do not become fixated on the map, HUD, MFD presentation, or anything else inside the cockpit. Ensure the HUD brightness is at a low enough setting that it doesn't prevent effective clearing for hazards along the flightpath (e.g., birds, other aircraft, changing terrain, and towers). Comply with command-prescribed minimum altitudes, but do not exceed any crewmember's comfort level attempting to fly at that altitude. An unfamiliar route, poor visibility, mountainous terrain, or other factors may require a higher altitude to maintain a reasonable level of comfort.

9.14.2. Map-Reading and Pilotage.

9.14.2.1. Map-reading is the determination of aircraft position by matching symbols on a map with corresponding terrain features or manmade objects on the ground. Aircraft position should be determined, and navigational errors detected or corrected by using a clock-to-map-to-ground cross-check. Thorough route preparation, study, and briefing will have already determined the best "clock" points to make track or time verifications and adjustments. While flying the route, pilots must first stay aware of the time elapsed, remembering to consider any timing error from the last leg and how it might affect the aircraft's current position. Then reference the map for where that should put the aircraft (interpolating between tic marks, as necessary) and match the map with what can be seen outside.

9.14.2.2. When using the full system capabilities of the T-38C, including EGI and HSD, pilots must be extremely vigilant not to become complacent. Avionics systems, including information on EFBs, can provide information to enhance SA, but failing to integrate the information available with basic low-level flying skills can be catastrophic.

9.14.2.3. Basic pilotage requires pilots to maintain SA above and beyond the aircraft systems' capabilities. The aircraft systems can reduce the workload immensely; however, system errors, data input errors, and poor systems knowledge can negate any benefit gained from the added technology. Unchecked erroneous data may lead pilots out of the route structure or into unforeseen obstacles. Positional awareness is the only way to ensure terrain and obstacle clearance is maintained.

9.14.3. Flying the Plan. Flying well-planned, accurate headings and airspeeds on each leg will get pilots close to the selected points. Trust the plan and rely on good DR. Arriving over checkpoints at anticipated times confirms the accuracy of DR and indicates reliability of preplanned headings, winds, and GSs. If a prominent landmark is not available as a reference at a turn point, rely on DR and turn-on time. Conditions such as a cloud cover or extensive areas of featureless land or water may make map reading extremely difficult. By learning to apply the basic principles of DR (time, distance, and heading), pilots will minimize the loss of SA.

9.15. Altitude.

9.15.1. Judging Altitude. Assessing height above the ground can be done using several techniques. Obviously, the most accurate method is to use the radar altimeter (RALT). Pilots should cross-check the altimeter, against known elevations of towers, lakes, airfields, or peaks, and use those “snapshots” outside to calibrate their eyes and refine their ability to judge height visually. Set the RALT warning to activate at or above 90 percent of the planned low-level altitude (e.g., 500 feet AGL = 450 feet RALT setting).

9.15.2. Terrain and the Horizon. Altitude awareness and the ability to maintain a desired altitude are relatively easy over terrain where large ground objects are present. However, most pilots tend to descend lower than desired over flat, even terrain. This is especially true if there are few significant manmade or natural objects to reference for altitude, such as in high desert plateau country. Very flat terrain, snow, or calm water is exceedingly and insidiously dangerous due to the lack of reliable depth perception. Flat, up-sloping terrain is even more dangerous because of the insidious change in elevation. Flying across sloping terrain may provide a false horizon that can slowly draw pilots off course when dipping a wing to maintain level flight.

9.15.3. Terrain and Ridge Crossings. Flying low-level in an environment with rapidly changing terrain is demanding and requires constant positional awareness and SA. Realize that terrain can easily hide checkpoints or turn points. Fly upwind of ridges when possible and be alert for areas of turbulence on the downwind side of large terrain features. When planning to cross steep peaks or ridges, consider calculating a start-climb point. Begin the climb early enough to arrive at the minimum AGL altitude prior to the terrain feature or obstacle. To maintain the desired terrain clearance when crossing ridges, either bunt or roll, but do not exceed the limits established in AFMAN 11-2T-38V3.

9.15.4. Obstacle Avoidance. If lead is unable to visually acquire or ensure lateral separation from known vertical obstructions that are a factor to the route of flight, lead will direct a climb no later than 3 NM prior to the obstacle to ensure vertical separation by 2 NM from the obstacle IAW AFMAN 11-2T-38V3. If the vertical obstruction is visually acquired, avoid it vertically by 500 feet or laterally by 0.5 NM.

9.16. Heading Control. Make every attempt to cross the chosen route start point—usually the hack point—on the precomputed, wind-corrected heading. While on the route, “fly the plan”. If using pure DR, consider using the heading set function of the EGI to help maintain the proper heading. When using EGI steering, selecting the flight director or placing the flightpath marker directly over the steerpoint symbol in the HUD will provide wind-corrected heading information. When a heading correction is required, consider the following techniques:

9.16.1. Drift Analysis in Flight. In flight, use pilotage to compare the plan against what is happening. If the forecast winds were accurate, little or no change should be required to maintain the proper ground track. However, if the winds are inaccurate, adjustments will be required. Look for cues (e.g., blowing smoke or an unexpected crab to maintain a known ground track) to verify actual wind direction and adjust accordingly.

9.16.2. Heading Errors. Heading errors can be caused by extracting the wrong heading from the map during preflight planning, applying the magnetic variation incorrectly, or not maintaining the appropriate preplanned magnetic heading in flight. Flying the planned heading is essential. At 360 GS, a 10-degree heading error will take the aircraft 2 miles off the course in just 2 minutes.

9.16.3. Visual Track Correction. The simplest and most reassuring way to make a low-level track correction is to positively identify a ground reference and visually reposition the aircraft in proper relation to it. As soon as it's determined to be off course, immediately attempt to position the aircraft back on or near on track and assume the correct heading again. Be aware that this technique can add to the leg time. With EGI steering available, pilots can generally point at the next turn point and primarily work on timing corrections.

9.16.4. Heading Correction. If the distance displaced from the planned ground track is known, displacement errors can be corrected by using the 60-to-1 rule. At 360 knots GS, a 10-degree heading correction held for 1 minute will correct the aircraft back toward course 1 mile.

9.16.5. Take Advantage of Unmistakable References. Continue to adjust ground track and airspeed until aircraft position and elapsed time position coincide (especially at predetermined, unmistakable points). When identifying a landmark that indicates being off track, pilots should make small corrections immediately to avoid having to make large heading changes later as they get closer to the landmark.

9.17. Timing.

9.17.1. General.

9.17.1.1. The TOT can be based off a TTT hack or a real-time) TOT. If using a real-time TOT, back times up to takeoff to know the latest possible takeoff time to meet the TOT without modifying preplanned flight parameters. If planning to use aircraft-generated speed cues, ensure the correct format option (TOT or TTT) is set in the FPL sub-menu at UR-2. Allow for the possibilities of being delayed or getting to the start point early. An early arrival may necessitate holding at the entry point, if allowed.

9.17.1.2. When using a TTT running time hack, the system clock provides several unique options. Leg times can be used since the witness (WIT) function key on the UFCP will immediately zero out the clock and restart it. This can be accomplished quickly and easily at each turn point or at the IP.

9.17.2. Timing and Airspeed Errors.

9.17.2.1. Low-level route timing is dependent upon flying a precise GS for a precise amount of time. Inaccurately planned airspeed (not corrected for temperature, pressure altitude, or wind) or poor throttle control will almost certainly result in timing errors. Timing errors are further complicated by poor airspeed control when climbing, descending, and turning. For example, if airspeed and/or bank angles during turns are not as planned, the turn radius (and thus the timing) will be different. Additionally, timing errors are further complicated by incorrect map-reading and (or) the use of poorly defined landmarks for timing references.

9.17.2.2. If EGI steering is available and a TOT is set, the commanded airspeed will correct for timing errors. There are, however, no limits to the commanded airspeed, and the system could potentially place the aircraft outside the flight envelope and direct pilots to exceed airspeed training rules. Approaching the target, the TOT calculations may become less reliable. Disregard large commanded airspeed changes and be careful not to exceed command-directed minimum or maximum airspeeds.

9.17.3. Timing Corrections. There are two basic methods of correcting elapsed time errors on a low- level mission—changing the airspeed and changing the route of flight. The following subparagraphs indicate several methods of airspeed correction:

9.17.3.1. Airspeed Correction—10-Percent Method. This method is based on the approximation that a 10 percent increase or decrease of GS, held for 10 minutes, will gain or lose 1 minute. However, it is not necessary to wait until a 1-minute error exists because the time error (in fractions of a minute) is directly proportional to the duration of the speed change. The calculations for the 10-percent method are as follows:

9.17.3.1.1. 10 percent of GS = GS factor.

9.17.3.1.2. GS ± GS factor = corrected GS.

9.17.3.1.3. Maintain corrected GS for [number of seconds early or late x 10] seconds.

9.17.3.2. Airspeed Correction—Incremental Method. In the incremental method of time control, airspeed in miles per minute is used to determine the speed change. To obtain NM per minute, divide the planned GS by a factor of 60. At 360 knots GS, the aircraft is traveling at 6 NM per minute; at 420 KCAS, the aircraft is traveling at 7 NM per minute. To determine the speed change increment, multiply the NM per minute by a factor of 10 (for example: 6 NM per minute x 10 = 60 knots). Maintain corrected GS (GS ± the speed change increment) for 1 minute for every 10 seconds early or late.

9.17.3.3. Airspeed Correction—Proportional Method. This method is simple and closely resembles the incremental method. For each second early or late, increase or decrease airspeed by 1 knot for the number of minutes equal to the GS in NM per minute. For example, if flying a 360 knots GS route (6 NM per minute) and 10 seconds early, decrease airspeed by 10 knots and hold that correction for 6 minutes.

9.17.3.4. Airspeed Correction—Next-Leg Method. This method of timing correction is simple Airspeed (in NM per minute) is used to determine the speed change increment (in GS). First, determine the number of seconds early or late. Divide this by the time (in minutes) for the next leg of the low-level route. Multiply the dividend by the NM per minute. The result is the GS correction. Add or subtract the GS correction to the original cruise airspeed. Fly the corrected GS for the entire next leg. For example, if flying on a 360 knot GS route and 20 seconds late at the IP, the IP to target is 2 minutes and 40 seconds. Increase airspeed by 45 knots and hold the correction for the entire IP-to-target leg.

9.17.3.5. Airspeed Correction—Leg Correction Method.

9.17.3.5.1. Derived from the proportional and next-leg methods, the leg correction method uses a time or distance increment and the next-leg time or distance (either one works) to establish a correction factor for each leg. The time/distance increment is that time or distance at which the proportional method would result in a one-to-one relationship between speed change and seconds early or late. (For example, at 360 knots planned GS, the time or distance increment is 6 min/36 NM. This is because using the proportional method being 10 seconds early or late would result in a 10-knot correction held for 6 min/36 NM. At 420 knots planned GS, the time/distance increment is 7 min/49 NM).

9.17.3.5.2. When planning to use this technique, it is best to calculate the correction factor during the planning stage and annotate it on the low-level map. To calculate the correction factor, take the time/distance increment and divide it by the next-leg time/distance. For example, dividing the time/distance increment (6 min/36 NM) by the next-leg time/distance (4 min/24 NM), 6 min/4 min or 36 NM/24 NM yields a leg correction factor of 1.5. Write that correction factor on the low-level map next to that leg. When airborne, determine any timing deviation in seconds and multiply it times the leg correction factor. Apply that correction for the entire next leg. For example, 10 seconds late times the correction factor of 1.5 yields a correction of 15 knots, so fly 15 knots faster for the entire leg. Another technique, increase/decrease ground airspeed 30 knots per one minute for every 5 seconds in timing correction.

9.17.3.6. Airspeed Correction—Ground Track Method. This method is viable only when prominent ground features are used as turn points. If the aircraft is within 10 seconds early or late, plan to make the next turn point prior to or just after the desired turn point. Remember to add an additional ground track correction to return to the planned routing and consider the time required for route correction. This technique is heavily based on TLAR ("That Looks About Right") but can be used effectively to adjust timing and minimize task saturation. Another technique, a 20-degree check for 30 seconds for every mile off course.

9.18. Turn Point Techniques.

9.18.1. Approaching the Turn Point. Accomplish admin tasks early to avoid multiple cockpit tasks when performing high bank turns at low altitude. One commonly used technique to prepare for the next leg of the route is using the mantra "Time, turn, threats, gas" which provides a reminder of things to review. Determine the direction of turn and the desired new heading. Many pilots like to put the heading marker on the next heading. If the aircraft is approaching the turn point from a different ground track than the one on the map, realize that the preplanned turn to the next leg must be altered to put the aircraft back on track. Check outside references to visualize the approximate amount of turn required.

9.18.2. At the Turn Point. Cross-check time at (or abeam, if not directly overflying) the turn point to confirm overall elapsed time or the real-world time. Make necessary adjustments after rolling out of the turn. If rehacking at each turn point for DR, rehack just prior to starting the turn.

9.18.3. Making the Turn.

9.18.3.1. Low altitude turns make up 5 percent of low-level flying but account for 52 percent of all low-level accidents. Turn to the next leg when directly over the turn point, using the bank angle and G loading the planned ground track and timing are based on. If pilots do not visually acquire the turn point, they should turn on time. **Note:** Use caution when making turns at low altitude because sink rates can quickly develop if overbanked, and there will be little time or altitude with which to recover.

9.18.3.2. In the turn, 100 percent of the pilot's attention should be focused on making the turn until rolled out, wings level. Make the turn, maximizing outside references. Place the

HUD FPM on the horizon, roll and pull to maintain a level turn. In rising terrain, a level turn using the FPM or CDM may not provide sufficient ground clearance. If a descent is detected, immediately rollout of the turn and climb back to a minimum of the starting altitude at the beginning of the turn. If a climb is detected, control the bank to arrest the climb, but do not attempt to descend back to 500 feet during the turn. If the turn is misjudged, make corrections after rolling wings level and referencing the HSI and HSD.

9.18.3.3. It is critical that pilots clear throughout the maneuver. Clearing for where the aircraft is going will requires cross-check of the FPM, not focus on it. While in a turn, clear from the top of the canopy to the pitot tube, until approaching the outside reference point for rolling out on course.

9.18.4. Bank Angle and G loading. **Table 9.1** shows the Gs required to maintain coordinated level flight at higher bank angles and the time-to-impact from 500 feet AGL at various overbank or G conditions at any airspeed.

Table 9.1. Time-to-Impact (Overbank—From 500 Feet AGL).

Bank Angle	Gs for level turn	Overbank/Expected G	Time-to-impact
60 degrees	2 G	70 degrees/2 G	9.9 seconds
70 degrees	approximately 3 G	80 degrees/3 G	8.1 seconds
75 degrees	approximately 4 G	85 degrees/4 G	6.9 seconds
80 degrees	approximately 6 G	90 degrees/6 G	5.6 seconds

9.18.5. Effect of Undetected Descent—Time-to-Impact. **Table 9.2** shows the time-to-impact from 500 feet AGL at various dive angles and a speed of 360 KCAS. **Note:** Any bank angles greatly shorten the time-to-impact. Reference AFI 11-202V3 for additional information on low-level time-to-impact.

Table 9.2. Time-to-Impact (Attitude—From 500 Feet AGL).

Attitude	Time-to-Impact
- 2 degrees	approximately 25 seconds
- 5 degrees	approximately 10 seconds
- 10 degrees	approximately 5 seconds

9.18.6. After the Turn. After completing the turn, ensure NAVAIDs are set with the new heading, fuels are checked, and EGI steerpoint has updated to the next segment.

9.19. Approaching the IP or Target Area. Strive to fly over the IP as close as possible to the planned time. Make any small corrections to timing early to prevent large airspeed corrections later. Depart the IP on planned heading and airspeed. Deviate only as necessary to react to threats (birds, aircraft, obstacles, etc.). Everything that takes place in the target area is critical. In fact, pilots should have most of the IP-to-target run memorized so to not be heads-down in the cockpit trying to pick up references from the map.

9.20. Hands On Throttle and Stick (HOTAS) and Air-to-Air (A/A)/ Air-to-Ground (A/G) Master Modes. The T-38C provides avionics capabilities that are used in follow-on training and are similar to follow-on weapon systems. Use of these capabilities during FT missions for pilot familiarization with HUD and MFD symbology, task management training, and as a HOTAS exercise will help build sound habit patterns for follow-on training. In FT, the purpose of introducing these capabilities is not to understand weapons employment or how to achieve weapons release parameters. The following is a description of how the T-38C can be used in the FT environment during low-level training once the pilot understands the basic principles of flying low-level and demonstrates the ability to safely operate the T-38C in the low-level environment.

9.20.1. Pre-Mission Planning. Units will have a standard DTC load that will provide pilots with mission parameters in the mission planning software for the MFD weapon (WPN) display page that will be suitable for familiarizing pilots with A/G MFD and HUD weapons symbology during low-level missions. The following is an example of parameters that will accomplish this objective: RELEASE ALT: 0; RELEASE VELOCITY: 360; DIVE ANGLE: 0; CONFIGURATION: CLEAN; PROG: A; WPN: BDU-33; BREAK-X: **100**; RIPPLE: 0FT. Pilots should confirm these settings on the MFD WPN display page during the "DTC Data – LOAD/VERIFY" step of the "BEFORE TAXIING" checklist.

9.20.2. HOTAS Low-Level Exercises. While flying the low-level, pilots can use the T-38C HOTAS features (e.g., master mode switch [MMS], default display switch [DDS], weapon mode switch) to change HUD and MFD symbology as part of a task management exercise.

9.20.2.1. Route Entry to IP. Fly the low-level route in the NAV master mode.

9.20.2.2. IP-to-Target. In follow-on training, the IP-to-target run will be the point where tasking will shift to air-to-ground (A/G) weapons delivery. At the IP, it is optional to switch to the A/G continuously computed intercept point (CCIP) master mode using the MMS and overfly the target level straight through to get familiarized with the A/G HUD weapons symbology. Adhere to local guidance regarding pressing the pickle button over the target. If the pickle button is pressed while using the EGI, the bombing score page will appear, temporarily masking the instruments displayed on MFD.

9.20.2.3. Target Egress. Return to the NAV master mode for the remainder of the low-level route.

9.21. Route Exit.

9.21.1. Give the return route leg the same emphasis as the entry leg. If the target is not at (or near) the route exit point, it may be necessary to preplan an off-target point to start route egress.

9.21.2. Once clear of the MTR, the aircraft is no longer in the low-level structure and is, therefore, limited to 300 KCAS below 10,000 feet MSL. Consequently, a route exit almost always calls for an immediate climb, during which airspeed can be traded for altitude. FENCE out of the low-level.

9.21.3. Whether returning IFR or VFR, pilots will need to coordinate arrival with ATC. When exiting a VR, maintain VFR conditions until obtaining an IFR clearance. Continue on the planned IFR clearance when exiting an IR.

9.22. Abnormal Procedures.

9.22.1. Single-Ship, Low-Level Problems and Emergencies. Every low-level emergency, including encountering IMC, requires a climb to a safe AGL altitude. "Climb-to-cope" is a common phrase to describe the initial action when faced with a problem at low altitude. Pilots must put the aircraft into a position to safely analyze the situation and coordinate a recovery with outside agencies.

9.22.2. Unable to Make Radio Contact. If unable to contact a controlling agency while airborne, follow the local lost-communications procedures, specific route lost-communications procedures (listed in *FLIP AP/1B*), or general lost-communications procedures in the *FLIP Flight Information Handbook*. If able and with positional awareness, proceed to home base or the nearest suitable airfield, as appropriate, while handling the problem.

9.22.3. Low-Level Route Abort: Refer to AFMAN 11-2T-38V3 for route abort procedures.

9.22.3.1. VMC Route Abort Considerations. When aborting a route in VMC, the priorities are maintaining safe separation from the terrain, complying with VFR altitude restrictions, and maintaining VMC at all times. When conditions permit, ensure squawk modes and codes are correct and attempt to contact the controlling agency.

9.22.3.2. IMC Route Abort Considerations. When it becomes obvious the pilot cannot continue the route without going IMC, abort the route. Pilots must exercise extreme caution in marginal weather conditions and avoid the false sense of security the EGI provides. If possible, turn as necessary to remain VFR. If unable to avoid IMC while flying a low-level route, immediately climb on course to the RAA as a minimum. Make an expeditious climb, using MIL power and a maximum of 300 KCAS. High terrain may require the use of afterburner in some instances. In all cases, immediately establish a climb on course**.** Under no circumstances should pilots attempt to reenter the low-level route after initiating an abort. Route aborts are potentially disorienting and require an immediate transition to instruments and close attention to aircraft control and flight parameters. Once level at or above the RAA, squawk "emergency" as appropriate and coordinate for an IFR clearance to the destination airfield. If required to fly in IMC without an IFR clearance, cruise at appropriate VFR altitudes until IFR clearance is received. Because the RAA only provides obstacle clearance within 5 NM of the route, the recovery to the destination may require a higher altitude to ensure obstruction clearance.

9.22.4. Lost Procedures. If pilots miss consecutive checkpoints or turn points, do not recognize any references from their map, or are unable to reorient themselves (using the EGI if needed), abort the route and follow the VFR lost procedures in **Chapter 8**.

Section 9E—Low-Level Formations

9.23. Two-Ship, Low-Level Navigation. A successful two-ship, low-level mission is the culmination of all the navigation and formation training to this point, requiring a combination of solid low-level practices, formation skills, and discipline.

9.24. Preflight Planning. Preflight planning for a two-ship, low-level mission is usually more involved than either a single-ship, low-level mission or a standard two-ship formation mission. The major addition in the planning process is to effectively draw two parallel blackline routes one mile apart. This may require altering the choice of turn points to ensure the formation stays in the corridor, avoids obstacles, and can adjust for significant terrain changes. It is possible to use a preexisting low-level planned for a single-ship mission. However, extra time should be spent during the route study and briefing phases to ensure all formation members are aware of where the wingman should fly to comply with the considerations above.

9.25. Types of Low-Level Formations.

9.25.1. Tactical LAB. When flying over relatively level terrain, LAB formation can work well. The same parameters described in **Chapter 6** should be used, but the wingman should stack level to slightly high on lead. Low-level flying introduces some additional visual cues and takes some time to visually calibrate the proper distance. One technique for stack at 1.0 NM spacing is placing lead aircraft approximately one T-38 wingspan above the horizon for level stack and on the horizon for approximately 60-100 foot high stack.

9.25.2. Wedge. When substantial maneuvering is required or while are over terrain with vertical development, wedge formation may be a better choice than line abreast. It gives the wingman the flexibility to alter sides as necessary and may lessen lead's saturation in ensuring the wingman is on the proper side. The parameters described in **Chapter 6** should be used, but the wingman should stack level to slightly high on lead. One technique for stack at 1.0 NM spacing is placing lead aircraft approximately one T-38 wingspan above the horizon for level stack and on the horizon for approximately 60-100 foot high stack.

9.25.3. Fighting Wing. When a clearing formation is needed or aggressive maneuvering is required, fighting wing may be flown. The parameters described in **Chapter 6** should be used, but the wingman should stack level to slightly high on lead.

9.26. Departure. In addition to managing normal formation responsibilities, pilots must navigate to the start point and accomplish all other low-level entry requirements for the MTR. To enhance clearing and increase the formation's maneuverability, spread the wingman to route, fighting wing, or a tactical formation as soon as possible after takeoff. Unless weather or other procedures dictate, maintain a clearing formation to the route entry.

9.27. Route Entry. If not already accomplished, lead will put the wingman in fighting wing, wedge, or another formation suitable for visual lookout and maneuverability prior to route entry. In a relatively short span of time, lead must call "entering the route", locate the entry point, maneuver the formation as necessary for course alignment, call the time hack over the radio, and accelerate to the planned airspeed. Prior planning and solid SA are imperative for a smooth entry into the low-level structure.

9.28. Low-Level "Contract" and Priorities as Lead.

9.28.1. Do Not Hit the Ground or Anything Attached to It. As much as possible, lead should position the wingman on the side opposite high terrain features or known obstacles. Climb the formation in sufficient time to avoid all obstacles within 2 NM of the planned ground track unless they can be visually acquired and lateral separation for the entire formation from them can be ensured. Call out any obstacles (towers, etc.) that could be a factor to the formation. Direct the wingman to climb if flying lower than he or she should.

9.28.2. Maintain Vigorous Visual Lookout. Find, call out, and avoid any traffic or birds that could be a factor to the formation. Avoid conflicts and potential midair collision situations with the wingman. TCAS may help to focus the visual lookout and provide additional SA on traffic outside the formation.

9.28.3. Communications and Brevity Code. Use standard brevity code in referring to objects or positions on the ground. Unless lead briefs otherwise, formations use the following plan to communicate whether or not obstacles are in sight. The flight member sighting the obstacle transmits call sign and the clock position of the obstacle relative to their own aircraft position (e.g., "*Mach 2, tower, 1 o'clock 4 miles*"). The other flight member acknowledges (for example, "*Mach 1, contact*" or "*Mach 1, negative contact*"). For traffic acquired on the TCAS but not visually, transmit the position on the TCAS display (e.g., "*Mach 2, TCAS hit, left 11 o'clock, 5 miles, 300 feet above, descending*") The other flight member acknowledges (e.g., "*Mach 1, same*" or "*Mach 1, no joy*").

9.28.4. Navigate and Lead. Use single-ship, low-level route and timing corrections to fly the route, identify all turn points, and be in a position to arrive at the target on time. In addition to single-ship techniques, pilots will probably need to incorporate formation check turns, tactical turns, and shackles. Climb the formation for all avoidance areas that either aircraft in the formation will penetrate. Accomplish all turns as briefed, and, unless called otherwise, rollout of each turn on the heading for the next leg.

9.28.5. Maintain SA on the Wingman. Stay visual, direct formation adjustments as necessary, and stay aware of the wingman's fuel state. Initiate ops checks at appropriate intervals (every 10 minutes or every other leg, as a minimum).

9.29. Low-Level "Contract" and Priorities for the Wingman.

9.29.1. Do Not Hit the Ground or Anything Attached to It. Climb in sufficient time to avoid all obstacles within 2 NM of the ground track unless the pilots are able to visually acquire and ensure lateral separation from them. Call out any obstacles (towers, etc.) that could be a factor to the formation.

9.29.2. Maintain Vigorous Visual Lookout. Find, call out, and avoid any traffic or birds that could be a factor to the formation. Avoid conflicts and potential midair collision situations with lead and of course, stay visual—don't go blind!

9.29.3. Fly the Prebriefed or Directed Formation Position. Always strive for the briefed formation position unless turn requirements or safety dictate otherwise. In tactical LAB or wedge formations, stack level to slightly high. At 500 feet AGL, lead will be on the horizon to very slightly above the horizon when the wingman is stacked level at 6,000 feet laterally. Whenever a flightpath conflict with lead exists, cross high in relation to lead.

9.29.4. Maintain SA on Navigation, Route, and Timing. Strive to maintain sufficient positional awareness to expect key events such as turns, climbs, and position changes. Unless called otherwise, rollout of each turn on the planned heading for the next leg. Strive to maintain enough SA to confidently assume the lead if necessary.

9.30. Low-Level Turns as Lead.

9.30.1. Wingman on the Inside of the Turn. Begin the contract turn over the planned turn point to keep the aircraft on the planned ground track. Unless briefed otherwise, the wingman should climb to deconflict, if necessary.

9.30.2. Wingman on the Outside of the Turn. From tactical LAB, start the wingman turning early enough to allow for a delay until lead's aircraft is right over the planned turn point. A turn of 90 degrees will require a lead point of approximately 1 NM, a turn of 45 degrees will require a lead point of approximately 1/2 to 3/4 NM and a turn of more than 90 degrees will require a lead point of more than 1 NM. For a 90- or 45-degree turn, use the same references described in **Chapter 6** for tactical turns. For a turn of greater than 90 degrees, turn sooner than the 90-degree turn reference.

9.30.3. Turns of 30 Degrees or Less. Normally, lead can simply turn to the new heading; a delayed turn is not necessary. For a planned check turn into the wingman, brief the wingman to drop back closer to the 30-degree line before the turn. Depending on the formation at the time, it will always be lead's option to direct an unplanned check or tactical turn.

9.30.4. Misjudging a Tactical Turn. If lead misjudges the timing of a tactical turn at a turn point, the corrective action depends on several factors (threat, positional awareness, width of corridor, fuel remaining). It may be more important to maintain good formation (threat, fuel, good positional awareness) or, it may be more important to fly the route (poor positional awareness, narrow corridor). If maintaining formation parameters is most important and the lateral limits of the low-level corridor permits, lead may time the turn to complete it with the formation in the desired position, and then re-intercept the planned routing further down the route. If, however, corridor width will not permit, or if this would excessively degrades navigational SA, lead should turn over the planned point and have the wingman regain formation position as soon as possible.

9.31. Low-Level Turns as the Wingman. Turns during low-level tactical maneuvering will rarely be exactly 90 or 45 degrees. Wingmen must anticipate turns and remain aware of the new heading at each turn point. Once lead is established on the next leg of the route, expeditiously correct back to the briefed or directed formation position if out of position.

9.31.1. Wingman on the Inside of the Turn. Delay initiating the turn until lead has turned an appropriate number of degrees to allow completion the turn in the proper tactical position. For a turn of 90 or 45 degrees, use the same references as a turn in the MOA. For a turn of greater than 90 degrees, turn sooner than the 90-degree turn reference. If wingmen misjudge their turn, they should vary power and (or) G loading to compensate and regain proper tactical position. Unless briefed otherwise, climb to deconflict if necessary.

9.31.2. Wingman on the Outside of the Turn. Anticipate the turn and the call or signal from lead. Have the rollout heading in mind, execute a contract turn, and climb to deconflict if necessary.

9.32. Low-Level Position Changes. Accomplish position change by following the guidance in **Chapter 6**.

9.33. IP-to-Target Run. Lead will designate what specific target point each formation member will overfly in the target area and the formation position to fly. Lead should brief the wingman when and how to begin maneuvers to attain the planned formation position for target overflight. This maneuver can occur at a given distance from the target, over a specific ground reference, or upon lead's direction. If both aircraft overfly the same target point, ground tracks will be designed to ensure timing deconfliction. Maneuvers can include a check away from lead followed by a turn toward the target at a given range, or the wingman can deploy to wedge prior to turning in toward the target. The wingman must always remain visual with lead. All formation members should overfly their designated target point level-straight-through.

9.34. Target Egress. The flight lead should plan and brief a method for achieving a designated tactical formation (preferably LAB) off the target. An example would be a preplanned turn by the wingman to the egress heading, and a lead ground track to that heading that brings the wingman forward to LAB.

9.35. Lost-Sight Situations.

9.35.1. When Wingman Loses Sight. During low-level tactical turns, wingmen may momentarily lose sight of lead. This is acceptable if they regain sight of lead within approximately 2 to 3 seconds. However, if wingmen do not regain sight within approximately 2 to 3 seconds, or if they unexpectedly lose sight at any other time, transmit callsign along with "blind". Maintain current heading and climb to 1,000 feet AGL or as briefed to help ensure deconfliction and terrain clearance while searching for lead. If the wingman regains sight of lead, call "visual" and continue the mission. However, if unable to regain sight of lead after the climb, continue to ensure terrain clearance and follow lead's instructions.

9.35.2. Lead Actions When Wingman Loses Sight.

9.35.2.1. If the wingman calls "blind" and the wingman is in sight, start a climb to at least 1,000 feet AGL, and transmit callsign, the word "visual," and lead's aircraft's position relative to the wingman's position. If the wingman visually acquires lead in the climb, the formation may descend back to 500 feet AGL.

9.35.2.2. If the wingman is still unable to visually acquire lead, direct the wingman to maintain or pick up an appropriate altitude and heading. Consider a moderate, controlled wing rock, but guard against excessive maneuvering that could lead to disorientation. If necessary, rejoin on the wingman while talking their eyes onto lead's aircraft. Once the wingman is visual with lead's aircraft, direct an appropriate formation position and continue the route if conditions and corridor boundaries allow.

9.35.3. A "Double-Blind" Situation—Wingman and Lead Both Lose Sight:

9.35.3.1. If the wingman calls "blind" and lead does not have the wingman in sight either, lead should maintain the current heading and direct the wingman to maintain the same heading. Begin a climb to 1,000 feet AGL and direct the wingman to climb to 1,500 feet AGL.

9.35.3.2. If both aircraft regain sight of each other in the climb, lead may descend back to 500 feet AGL and continue the mission. If lead visually acquires the wingman in the climb, both will follow the procedures in **paragraph 9.35.2.1**. If neither aircraft regains sight, both will continue to the next turn point, using landmarks along the route to try to find each other. When arriving at the next turn point, if still not visually acquired, lead should be directive. Do not continue the route as a formation.

9.35.3.3. Lead must be aware of fuel remaining, subsequent aircraft scheduled on the low-level, and how much time can be spent attempting to get back together. Relay aircraft position to the wingman, using a timing reference or landmark along the route.

9.35.3.4. Normally, lead and the wingman will both abort the low-level route. Once they climb out of route, they do not reenter the MTR. If still unable to regain sight of each other with altitude deconfliction during the abort, accomplish single-ship recoveries. During single-ship recoveries, ensure altitude separation from the wingman until confirming radar contact with a controlling agency.

9.35.3.5. Techniques to help regain sight include using TCAS, comparing distance to next EGI turn point, differential airspeeds to create closure, ground references, position off bullseye, using air-to-air TACAN, holding at the next time point, etc.

9.36. Radio Failure.

9.36.1. Lead Loses Radio. Accomplish all radio failure cockpit and equipment checks. If radio failure is confirmed or strongly suspected, climb to a minimum of 1,000 feet AGL and rejoin the wingman. Once rejoined, give the appropriate AFPAM 11-205 visual signals, and follow the briefed no radio (NORDO) procedures.

9.36.2. Wingman Loses Radio. Accomplish all radio failure cockpit and equipment checks. If radio failure is confirmed or strongly suspected, climb to a minimum of 1,000 feet AGL and rock wings to get lead's attention. However, do not sacrifice aircraft control to gain lead's attention and do not close to within 500 feet of lead until given the proper signal. If lead notices the wingman flying at 1,000 feet AGL or higher and rocking their wings, climb to at least 1,000 feet AGL and have the wingman rejoin. Once rejoined, give the appropriate AFPAM 11-205 visual signals for the situation.

9.37. IMC Route Abort. Refer to AFMAN 11-2T-38V3 for route abort procedures.

9.37.1. Lead Actions. When possible, avoid IMC by climbing or turning. Use an in-place turn if necessary. If IMC penetration is imminent, attempt to rejoin the wingman while maintaining VMC. If unable to maintain VMC until the wingman is rejoined, execute the appropriate lost wingman procedures while ensuring the flight initiates a wings-level climb to RAA minimum with the required altitude separation. This will allow the wingman to stay above lead. RAA deconfliction should be briefed.

9.37.1.1. Ensure the wingman is paralleling lead's heading and squawk "emergency" on the IFF/SIF as soon as practical. To lessen the chances of a midair collision with the wingman, do not turn while in IMC.

9.37.1.2. If unable to reach VMC above the RAA, ensure altitude separation with the wingman and attempt to contact a radar facility. If unable to contact a radar facility, climb to a higher altitude while still ensuring altitude separation with the wingman. Continue to climb, and squawk "emergency" until reaching VMC or contacting a radar facility.

9.37.2. Wingman Actions. When directed, rejoin as expeditiously as possible without becoming a hazard to the formation. If unable to rejoin prior to entering IMC, the wingman should execute appropriate lost wingman procedures. Wingman should squawk as briefed as soon as task management allows so TCAS can confirm separation.

Chapter 10

NIGHT FLYING

10.1. Ground Operations.

10.1.1. Mission Briefing. In addition to the normal briefing items, night flying requires discussing, in detail, the lighting (cockpit, aircraft, airfield, and environment), taxi spacing and distance, radio procedures, alternate or emergency airfields, and a host of other items that, during day operations, are simply considered standard. Accomplishing something as simple as filling out a lineup card in black ink will ease the task requirements for night flight. If flying with an EFB, pilots should adjust the brightness to as dim as possible and consider selecting night mode in settings and inverting approach plate colors.

10.1.2. Preflight Power. If external power is available, pilots should use it to thoroughly check all aircraft lighting (interior and exterior) including the map light. Ensure the marshaller has two illuminated wands.

10.1.3. Interior Inspection and After Start.

10.1.3.1. During the interior inspection:

10.1.3.1.1. Dim the marker beacon and AOA indexer lights.

10.1.3.1.2. Rotate the three lighting rheostats on the right console (instrument, flood, and console lights) out of the OFF position.

10.1.3.1.3. Set the EED OFF/NIGHT/DAY (OND) power knob to night and adjust the EED brightness via the brightness (B) rocker switch.

10.1.3.1.4. Position the instrument panel map lights and the utility light as desired. Consider selecting the red lens on the utility light and flashlight.

10.1.3.2. With external power:

10.1.3.2.1. Adjust the lighting on the instrument, flood, and console lights to the lowest practical setting.

10.1.3.2.2. Dim the warning, caution, and advisory lights to avoid excessive cockpit reflection or glare.

10.1.3.2.3. On the UFCP, place the NT/AUT/DAY toggle switch to NT for the HUD night brightness range.

10.1.3.2.4. Adjust the display brightness of the UFCP using the UFCP U BRT rocker switch on the UFCP. **Note:** UFCP key illumination is controlled by the instrument light rheostat.

10.1.3.2.5. Adjust the display brightness of the HUD using the HUD H BRT rocker switch on the UFCP.

10.1.3.2.6. Set the MFD OND power knob to night and adjust the MFD display brightness via the BRT rocker switch.

10.1.3.3. Without external power, check all interior lights mentioned in paragraphs **10.1.3.2.1** through **10.1.3.2.6** after starting engines.

10.1.4. Before Taxi. If adequate airfield lighting exists, delay turning on the landing light until turning out of the chocks to avoid blinding the crew chiefs. Because the rotating beacon may hinder maintenance personnel while they are under the aircraft, consider turning it off.

10.1.5. Taxi**.** Taxi on centerline with a minimum of 300 feet spacing from preceding aircraft. Taxi speeds should be slower because speed and distance estimation are difficult during night operations.

10.2. Single-Ship Takeoff. Line up on the runway centerline and recheck the EADI and EHSI. After run-up checks and brake release, use the composite method of aircraft control used during day transition flying. Remain oriented to the instrument references as well as outside objects to minimize the chance of spatial disorientation. Certain weather conditions or a lack of visual cues may necessitate a complete transition to flight instruments immediately after takeoff. The rate of transition to instruments should correspond with the rate at which outside references fade. Ensure the aircraft is safely airborne before raising the landing gear handle and be aware that the retracting landing light can give a false sensation of increasing pitch.

10.3. Use of Night Visual References.

10.3.1. Visual references and depth perception change with night operations. To overcome the decrease in visual cues, use instruments to a greater extent. Throughout the sortie, continue to adjust cockpit lighting to maximize night vision, decrease glare, and minimize reflections.

10.3.2. At night, lighted objects often appear closer than they actually are. Because altitude and rate of descent are more difficult to judge close to the ground, rely more on the altimeter and IVV than on visual perception. Cross-check the EADI to determine the proper aircraft attitude when no definite horizon exists.

10.3.3. Although there is an increased emphasis on flight instruments at night, visual references are still the primary means of orientation during night VMC operations. However, pilots detect an unusual attitude or feel the effects of spatial disorientation, immediately make a transition to flight instruments, and recover.

10.4. Depth Perception. Use caution when descending for the initial traffic entry at night because height above the ground is difficult to judge. Check the altimeter closely during night operations to ensure a proper interpretation.

10.5. Night Optical Illusions. Use caution when flying approaches, especially to a strange field. Sloping or featureless terrain, sloping runways, varying runway widths, runway lighting intensity, and (or) weather phenomena can cause visual illusions at night. One of the best defenses against illusions at a strange field is thorough preparation. Study the airfield and approach diagrams and become thoroughly familiar with its lighting and glidepath guidance systems.

10.6. Visual and Instrument Straight-In Approaches. Whether practicing visual or instrument straight-in approaches at night, approach control normally provides positive radar control for pattern spacing and sequencing to final. Do not rely entirely on visual cues. Use composite flight references, to include glidepath, course, and lighting system guidance. When landing from a precision approach, pilots must comprehend that the aimpoint and touchdown point will be further down the runway than a normal day VFR landing.

10.7. Overhead Patterns.

10.7.1. Clearing. The night pattern can get very busy, so it is critical to clear visually, on the radios, and on TCAS. It is difficult to tell whether an aircraft is turning crosswind or pulling closed. Listening carefully to the radio call will aid in determining aircraft position and intention. If in doubt, turn crosswind, carry straight through initial, or break out, as applicable.

10.7.2. Pattern Entry and Break. Clear and complete the entry and turn onto initial or radar initial the same as during daylight operations. Because pilots may not see the runway clearly, initiate the break by referring to the ramp or other lighted areas on the field. Initiating the break with traffic abeam the aircraft on closed downwind will ensure 6,000 feet of runway separation. Continue to use a composite cross-check during the break to maintain aircraft control.

10.7.3. Final Turn and Final. Fly the turn to final and final approach using a composite cross-check, because some visual cues will be hard to see (e.g., a horizon). A good technique is to emphasize being on airspeed at desired altitudes for the perch, halfway through the final turn, and especially rolling out on final.

10.7.4. Transition to Landing and Landing. The references for night landings are the same as daytime references. The main difference between night landings and day landings is the lack of peripheral cues to help judge glideslope angle and height above the runway. Long, fast landings at night are especially dangerous as many of the daytime runway's cues may not be available. Approaching the overrun, the landing light will illuminate the surface of the overrun and runway, helping with depth perception. Do not use the runway lights as the only reference to judge height above the runway because they can lead to a high flare and a dropped-in landing. Plan to land on the runway centerline.

JEFFREY W. NELSON, Brig Gen, USAF
Director of Operations and Communication

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

10 USC § 9013, *Secretary of the Air Force*

FAA Publication 7610.4, *Special Military Operations*, 30 November 1998

AFPD 11-2, *Aircrew Operations*, 31 January 2019

AFI 11-200, *Aircrew Training, Standardization/Evaluation, and General Operations Structure*, 3 May 2022

AFI 11-215, *Flight Manuals Program*, 25 March 2019

AFI 33-322, *Records Management and Information Governance Program*, 23 March 2020

AFMAN 11-2T-38, Volume 1, *T-38 Aircrew Training*, 14 May 2020

AFMAN 11-2T-38, Volume 2, *T-38 Aircrew Evaluation Criteria*, 14 May 2020

AFMAN 11-2T-38, Volume 3, *T-38 Operations Procedures*, 14 May 2020

AFMAN 11-202, Volume 3, *Flight Operations*, 10 January 2022

AFMAN 11-214, *Air Operations Rules and Procedures*, 29 November 2022

AFMAN 11-218, *Aircraft Operations and Movement on the Ground*, 5 April 2019

DAFMAN 90-161, *Publishing Processes and Procedures*, 18 October 2023

AFPAM 11-205, *Aircraft Cockpit and Formation Flight Signals*, 9 August 2018

TO 1T-38C-1, *Flight Manual, USAF Series T-38C Aircraft*, 1 February 2020

AFMAN 11-2T-38, Volume 3, AETC Supplement, *T-38 Operations Procedures*, 24 August 2022

AFFTC-TIM-10-01, *T-38C Optimal Landing Technique Determination, Project Talon Spot*, May 2010

Prescribed Forms

None

Adopted Forms

DD Form 1801, *DoD International Flight Plan*

DAF Form 847, *Recommendation for Change of Publication*

AF IMT 70, *Pilot's Flight Plan and Flight Log*

AFTO Form 781, *ARMS Aircrew/Mission Flight Data Document*

Abbreviations and Acronyms

A/A—air-to-air

A/G—air-to-ground

AA—aspect angle

AAT—air-to-air tactical air navigation

AB—afterburner

AC—aircraft commander

ADC—air data computer

Admin—administrative

ADSB—automatic dependent surveillance-broadcast

AETC—Air Education and Training Command

AFI—Air Force Instruction

AFMAN—Air Force Manual

AFPAM—Air Force Pamphlet

AFPD—Air Force Policy Directive

AGL—above ground level

AGSM—anti-G straining maneuver

AHAS—avian hazard advisory system

AHC—aircraft handling characteristics

ANP—actual navigation performance

AOA—angle of attack

APR—approach

ARMS—Aviation Resource Management System

ARTCC—air route traffic control center

ATC—air traffic control

ATIS—automated terminal information service

AWOS—Automated Weather Observation System

BD—battle damage

BFM—basic fighter maneuvers

BRA—bearing, range, and altitude

CA—course-to-altitude

CAS—calibrated airspeed

CCIP—continuously computed intercept point

CDI—course deviation indicator

CDFA—continuous descent final approach

CDM—climb dive marker

CHUM—Chart Update Manual

CLM—climb

CMD—counter measures dispenser

DA—decision altitude

DAFIF—Digital Aeronautical Flight Information File

DAFMAN—Department of the Air Force Manual

DAIP—Defense Aeronautical Information Portal

DDA—derived decision altitude

DDS—default display switch

DEP—design eye position

DIBI—definite increase in buffet intensity

DLO—desired learning objectives

DME—distance measuring equipment

DR—dead reckoning

DTC—data transfer cartridge

DTS—data transfer system

DVT—divert

EADI—electronic attitude director indicator

ECM—electronic countermeasures

EED—electronic engine display

EEGS—enhanced envelope gunsight

EFB—electronic flight bag

EFIS—electronic flight instrument system

EGI—embedded global positioning and inertial navigation system

EGT—exhaust gas temperature

EHSI—electronic horizontal situation indicator

EM—energy maneuverability

ENDR—endurance

EOR—end of runway

ERAA—emergency route abort altitude

ET—extended trail

ETE—estimated time enroute

FAA—Federal Aviation Administration

FAF—final approach fix

FAWP—final approach waypoint

FBO—fixed base operator

FBY—flyby

FCP—front cockpit

FD—flight director

FDE—fault detection and exclusion

FEDS—firing evaluation display system

FENCE—fire control, emitters, NAVAIDs, communications, and electronic countermeasures (as in FENCE check)

FIH—Flight Information Handbook

FL—flight level

FLIP—Flight Information Publications

FLOLS—Fresnel Lens Optical Landing System

FM—fluid maneuvering

FOD—foreign object damage

FOV—field of view

FPL—flight plan

fpm—feet per minute

FPM—flightpath marker

FSS—flight service station

FT—flying training

GP—general planning

GPS—global positioning system

GS—groundspeed

GT—ground track

HCA—heading crossing angle

HOTAS—hands on throttle and stick

HSD—horizontal situation display

HSI—horizontal situation indicator

HUD—heads up display

IAF—initial approach fix

IAP—instrument approach procedure

IAW—in accordance with

ICAO—International Civil Aviation Organization

IFF/SIF—identification friend or foe/ selective identification feature

IFR—instrument flight rules

ILS—instrument landing system

IMC—instrument meteorological conditions

IMN—indicated Mach number

INS—inertial navigation system

IP—instructor pilot, initial point

IR—instrument routes

ITO—instrument takeoff

IVV—instantaneous vertical velocity

JOG—joint operations graphic

KCAS—knots calibrated airspeed

KIO—knock-it-off

LAB—line abreast

LCOS—lead computing optical sight

LNAV—lateral navigation

LOS—line of sight

LV—lift vector

MACS—minimum acceleration check speed

MAJCOM—major command

MAP—missed approach point

MAWP—missed approach waypoint

MAX—maximum afterburner/maximum power

MDA—minimum descent altitude

MDP—mission display processor

MFD—multi-function display

MIL—military (power)

MIL-STD—military standard

MM—min Mach

MMS—master mode switch

MOA—military operations area

MSL—mean sea level

MTR—military training route

NAS—National Airspace System

NAV—navigation

NAVAID—navigational aid

NGA—National Geospatial-Intelligence Agency

NLT—no later than

NM—nautical mile

NORDO—no radio

NOTAM—Notice to air mission

NVT—navigation data verification tool

OAT—outside air temperature

ONC—operational navigation chart

OPR—office of primary responsibility

PAPI—precision approach path indicator

PAR—precision approach radar

PFL—pilot fault list

PFR—primary flight reference

PIO—pilot induced oscillation

PIREP—pilot report

PIT—Pilot Instructor Training

PMP—Propulsion Modernization Program

PMSV—pilot to metro service

PNS—primary navigation source

POM—plane of motion

PP—present position

pph—pounds per hour

PPR—prior permission required

PRAIM—predictive receiver autonomous integrity monitoring

PVASI—pulsating visual approach slope indicator

RA—resolution advisory

RAA—route abort altitude

RAIM—receiver autonomous integrity monitoring

RALT—radar altimeter

RCP—rear cockpit

RCR—reported runway condition reading

RNAV—area navigation

RNG—range

RNP—required navigation performance

ROE—rules of engagement

RPM—revolutions per minute

RSU—runway supervisory unit

RTB—return to base

RVSM—reduced vertical separation minimum

SA—situational awareness

SB—speed brake

SETOS—single-engine takeoff speed

SOF—supervisor of flying

SORN—Systems of Records Notice

SPINS—Special Instructions

SR—slow routes

STAR—standard terminal arrival route

STINFO—scientific and technical information

SUSP—suspend

TAA—terminal arrival altitude

TACAN—tactical air navigation

TCAS—traffic collision avoidance system

TCH—threshold crossing height

TC—turn circle

TD—target designator

TDZE—touchdown zone elevation

TERPS—terminal instrument procedures

TFR—temporary flight restrictions

TOF—time of flight

TOLD—takeoff and landing data

TOT—time over target

TPC—tactical pilotage chart

TRs—training rules

TRM—terminal

TTT—time to target

UFCP—up front control panel

UHF—ultra high frequency

VASI—visual approach slope indicator

VDP—visual descent point

VFR—visual flight rules

VHF—very high frequency

VMC—visual meteorological conditions

VNAV—vertical navigation

VOR—very high frequency omni-directional receiver

VORTAC—very high frequency omni-directional receiver/tactical air navigation

VR—visual route

VTR—video tape recorder

VVI—vertical velocity indicator

WAC—world aeronautical charts

WEZ—weapons engagement zone

WIT—witness

WP—waypoint

WPN—weapon

WSSP—weapon system support pod

Terms

3/9 Line—An imaginary line extending through the 3- and 9-o'clock positions of an aircraft (also known as the pitch or lateral axis).

Abort—Directive to cease the action, attack, event, or mission.

Acceleration maneuver—A maneuver flown to increase airspeed. Zero G is optimum.

Admin lead—Used to pass lead responsibilities to another member of the flight. The administrative (admin) lead is expected to run all aspects of the profile to include navigating, managing the radios, and making changes to the profile if external conditions dictate (e.g., changing the bingo fuel with a change in the alternate). With an admin lead change, the callsigns within the flight are administratively renumbered to match the position being flown. Lead still retains ultimate authority for the formation.

Angle-off—The angle formed by the extension of the longitudinal axes of two aircraft; the difference in headings. Also called the heading crossing angle (HCA).

Aspect angle—The angle measured from the tail or longitudinal axis of one aircraft to another aircraft's position. For example, 0 degrees aspect angle is directly behind and 180 degrees aspect angle is directly in front. The aspect angle is independent of the other aircraft's heading.

Bingo—A prebriefed fuel state needed for recovery using prebriefed parameters.

Blind—No visual contact with friendly aircraft; the opposite of "visual".

Break (Up, Down, Right, or Left)—To perform an immediate maximum performance turn in the indicated direction. Assumes a defensive situation.

Cleared—Requested action is authorized.

Closure—Overtake created by airspeed advantage and (or) angles. The rate at which range decreases (also known as V_C: closure velocity "V-sub-C"). Closure can be positive (getting closer) or negative (getting farther away).

Cross turn—A 180-degree heading reversal by a flight where aircraft turn into each other.

Divert—Proceed to alternate mission or base.

Element lead—The pilot responsible for the conduct of a two-ship element. In a two-ship formation, the element lead is the flight lead (see definition). Number 3 is the element lead in a four-ship formation. (Normally, one wingman should not fly formation off of another wingman.)

Extension or acceleration maneuver—An unloaded maneuver, almost always at a high-power setting, to gain airspeed and either generate closure (decrease distance) or increase opening velocity (separation).

FENCE—The boundary separating hostile and friendly areas. Entering or exiting designated area.

FENCE check—Set cockpit switches as appropriate.

Flight lead—The individual typically in the #1 position in the formation, referred to as lead, and charged with the safe and successful completion of the mission. Wingmen may lead portions of the mission, but the designated flight lead does not change.

Formation drop-off—a type of formation split, normally at the end of a formation approach, where one aircraft continues down the glidepath to a landing while the other aircraft executes a follow-on maneuver (go-around, missed approach, climb-out, circling maneuver, or side-step maneuver, as appropriate).

Formation split—the coordinated separation of a formation flight into two or more separate entities, as elements and/or single-ships.

High six—A position physically above and behind an aircraft regardless of heading or bank angle.

Joker—Fuel state above bingo at which separation, bug out, or event termination should begin and proceed with the remainder of the mission.

Knock—**it-off—**Training term used to stop maneuvers in progress for safety of flight issues.

Lag pursuit—Maneuvering to control closure, range, and (or) aspect angle by positioning the lift vector (or flightpath) toward the outside of another aircraft's turn circle. Lag pursuit usually decreases aspect angle.

Lag reposition—An out-of-plane maneuver performed to control overtake, decrease aspect angle, and (or) prevent an overshoot by using vertical turning room above and behind another aircraft's plane of motion.

Lead pursuit—Maneuvering to control closure, range, and (or) aspect angle by positioning the lift vector (or flightpath) toward the inside of another aircraft's turn circle. Lead pursuit usually increases or maintains aspect angle.

Lead reposition—An out-of-plane maneuver generally performed to increase overtake and aspect angle and (or) decrease range by using vertical turning room below another aircraft's plane of motion.

Lift vector—An imaginary plane going vertically through the top of the aircraft, representing the plane of motion in a straight pull. "Set the lift vector" means to roll the aircraft to set the desired aimpoint to at the 12 o'clock high position.

Line abreast—Side by side. Typically a formation position but can be used to describe groups, contacts, formations or aircraft positions relative to each other.

Line of sight (LOS)—A direct line between two aircraft.

LOS rate—Speed of apparent drift of one aircraft in relation to another, speed of angular change of LOS.

Nav lead—May be used when lead wants the wingman to navigate and clear. Lead will fly the wingman position, deconflict within the flight, and keep the radios; for example, battle damage (BD) check.

Ops check—Periodic check of aircraft systems performed by the aircrew (including fuel) for safety of flight.

Overshoot (flightpath)—Results in one aircraft crossing through or behind the flightpath of the other aircraft, but not necessarily in front of the other aircraft's 3/9 line.

Overshoot (3/9 line)—Results in the aft aircraft flushing forward of the other aircraft's 3/9 line.

Perch—A position behind and to the side of an aircraft used to define a starting point for follow-on maneuvering.

Plane of motion—A plane extending from the flightpath of an aircraft to the center of its turn radius.

Pure pursuit—An aircraft with its nose pointing at another aircraft is in "pure pursuit".

Push—Change frequency without acknowledgment.

Quarter plane—A last-ditch maneuver used to prevent a 3/9 overshoot or to “preserve 3/9 line” at closer ranges and higher LOS rates.

Radial G—The vector sum of the aircraft’s lift vector and gravity when turning in a vertical POM; that is, the G effectively turning the aircraft.

Squawk—Operate IFF as indicated or IFF is operating as indicated.

Tactical lead—May be used when lead needs the wingman to lead an event (e.g., extended trail) or a segment of the flight. In this case, the wingman will pick up tactical, navigation, and radio responsibilities but not the overall flight lead responsibility. Individual callsigns do not change.

Terminate—Training term used to stop maneuvers in progress for non-safety of flight issues.

Turn circle—The flightpath described by an aircraft in a turn.

Turn radius—The distance between an aircraft’s flightpath and the center of the turn circle.

Turn rate—Degrees per second an aircraft turns.

Turning room—Volume of airspace in the vertical, horizontal, or both, which can be used to execute a desired maneuver.

Visual—Sighting of a friendly aircraft or ground position; the opposite of “blind”.

Zipper—A double-click of the microphone button used to attract the attention of another pilot in the formation without compromising mission information (e.g., callsigns or flight composition) or cluttering the frequency.

Attachment 2

STADIAMETRIC RANGING

A2.1. Stadiametric Ranging. Stadiametric ranging ("mil sizing") is a crude method for estimating target ranges. It uses the relationship between angles and the arcs they subtend over a given distance to help determine the distance to a target. A radian is the angular measurement in a circle where the arc length (radian) is equal to the radius length. One milliradian (mil) is an angular measure. Further explanation on calculations follows:

A2.1.1. One radian = 57.3 degrees (approximately)

A2.1.2. One mil = radian ÷ 1,000 = 0.057 degrees

A2.1.3. One degree = 17.45 mils

A2.1.4. One mil = arc length ÷ range

A2.1.5. Range can be any unit: foot, meter, etc.

A2.1.6. Example: 1 mil = 3 feet at 3,000 feet or 3 meters at 3,000 meters

A2.2. Range and Mils:

A2.2.1. Range and mils have the following relationship:

A2.2.1.1. Range = Wingspan / mils X 1,000

A2.2.1.2. Mils = Wingspan / Range X 1,000

A2.2.2. Since the size of the T-38 is known, mil sizing can be used to determine range from the other aircraft or predict aircraft size at a given range. **Table A2.1** shows T-38 mil sizes at 0° AA (T-38 wingspan = 25 feet 3 in) and at 90° AA (T-38 length = 46 feet 4 in) using stadiametric ranging**.**

A2.3. General Procedures and Examples. Since ET is flown at low AAs, these examples use wingspan as the known distance in examples for 0° AA.

A2.3.1. To determine range from another aircraft, divide wingspan in feet by apparent size in mils and multiply by 1,000. For example, a T-38 (25 foot wingspan) at 0° AA is 25 mils wingtip to wingtip in the HUD. The range is 25 feet divided 25 mils multiplied by 1,000 = 1,000 feet.

A2.3.2. To predict size (in mils) of another aircraft at a defined range, divide wingspan in feet by the desired range and multiply by 1,000. For example, at 6,000 feet and 0° AA, a T- 38 will be 25 feet divided by 6,000 feet multiplied by 1,000 = 4.1 mils.

Table A2.1. T-38 Mil Sizes at Various Ranges.

I	A	B	C	D	E	F	G	H
T		RANGE (feet)						
E M	AA (degrees)	6,000	5,000	4,000	3,000	2,000	1,000	500
1	0°	4 mils	5 mils	6 mils	8 mils	13 mils	25 mils	50 mils
2	90°	8 mils	9 mils	12 mils	15 mils	23 mils	46 mils	92 mils

A2.3.3. In general, mil sizing could be adjusted when not approaching the target at an exact aspect. However, consider the 0° AA number suitable for perch entries to ET.

A2.4. HUD Symbol References. Knowing what size, in mils, an aircraft should be at different ranges allows for the use of symbol references available on the HUD to determine the range from the aircraft. Dimensions of the HUD bore sight cross/gun cross are illustrated in **Figure A2.1**, dimensions for the MIL-STD HUD aircraft waterline are illustrated in **Figure A2.2**, and dimensions for the F-16 HUD FPM are illustrated in **Figure A2.3**. The following examples show how mil sizing can be used during FT formation flying when approaching an aircraft at low aspect, for example as wing during a straight-ahead rejoin or during the perch entry to ET:

A2.4.1. At 6,000 feet, Lead is approximately 4 mils which equates to slightly less than the width of a single horizontal line on the gun cross.

A2.4.2. At 5,000 feet, lead is approximately 5 mils which equates to the width of a single horizontal line on the gun cross.

A2.4.3. At 4,000 feet, lead is approximately 6 mils, approximately half the width of the entire gun cross.

A2.4.4. At 3,000 feet, lead is approximately 8 mils, approximately the width of the gun cross minus one of its horizontal lines.

A2.4.5. At 2,000 feet, lead is approximately 13 mils, the width of the gun cross.

A2.4.6. At 1,000 feet, lead is approximately 25 mils, approximately twice the width of the gun cross.

A2.4.7. At 500 feet (inside the cone), lead is approximately 50 mils, approximately 4 times the width of the gun cross.

Figure A2.1. HUD Boresight Cross/Gun Cross Mil Dimensions.

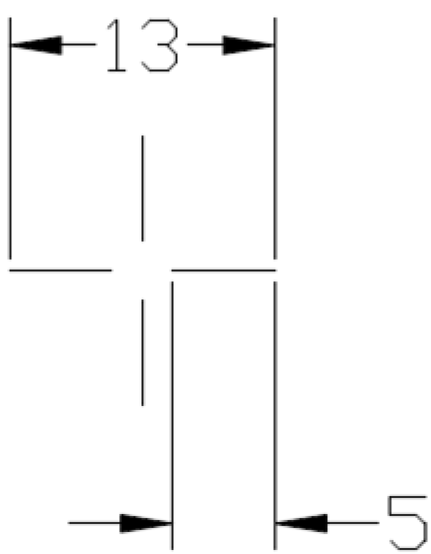


Figure A2.2. MIL-STD HUD Aircraft Waterline Mil Dimensions.

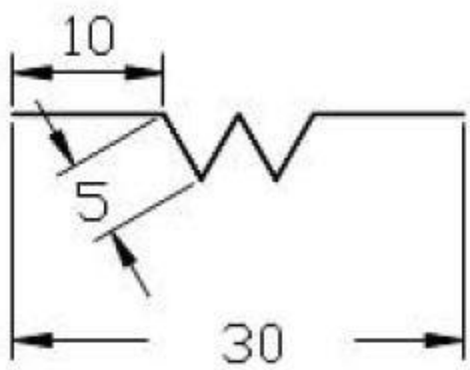
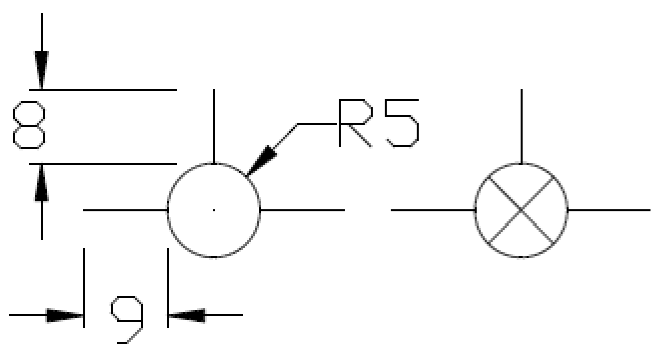


Figure A2.3. F-16 HUD FPM Mil Dimensions.



Attachment 3

GUNS-TRACKING EXERCISE AND HEAT-TO-GUNS EXERCISE

A3.1. Purpose. The purpose for the guns-tracking and heat-to-guns exercises is to build on the fundamentals learned in FM to place the aircraft in a position to employ weapons. The objectives are the same as those for FM (**paragraph 6.44**) but also include:

A3.1.1. Introduce and practice using HUD air-to-air symbology.

A3.1.2. Introduce simulated infrared missile and gun employment from a stabilized WEZ.

A3.2. WEZ. The WEZ is an area in relation to another aircraft from which valid weapons may be employed with the greatest probability of achieving desired results. The WEZ is different for each type of weapon. The exercises in this attachment will simulate the use of the AIM-9P air-to-air missile and the 20 millimeter (MM) cannon.

A3.2.1. The WEZ for the 20MM cannon during the guns-tracking exercise is a range between 2,500 feet and 1,000 feet and an AA <135 degrees. Desired aspect angle for gun employment is 20 to 50 degrees. Offenders must cease weapons employment with enough time and range to avoid a 1,000-foot training bubble.

A3.2.2. The WEZ for the AIM-9P during the heat-to-guns exercise is a range between 9,000 and 2,000 feet and AA <45 degrees.

A3.3. Control Zone. The control zone (Figures **A3.1** and **A3.2**) is generally defined as 2,500 to 4,500 feet behind the training aircraft's 3/9 line where range divided by 100, AA, and angle off nose are all roughly the same number, and when the maneuvering aircraft is on or near the training aircraft's turn circle. The control zone allows the maneuvering aircraft to "control" the training aircraft's actions by forcing it to keep turning for survival or immediately allow for a potential AIM-9P or gun WEZ entry. It is a position that also makes the training aircraft predictable prior to pulling lead pursuit or setting pure pursuit for weapons employment. The back of the control zone represents a "pressure" limit, forcing the training aircraft to turn to stay alive. The front of the control zone represents a "reaction" limit, generally forcing the maneuvering aircraft to reposition if closure or AA increases by even a small amount. In order to transition to a stable WEZ, it is critical to maintain energy while in the control zone. As a rule of thumb, the "heart" of the control zone is between 3,000 and 3,500 feet with an aspect of 30 to 40 degrees from the training aircraft. From this position, the maneuvering aircraft can transition to an AIM-9P or 20MM gun WEZ with enough time to employ valid ordnance and then reposition in a timely manner (if required).

Figure A3.1. The Control Zone.

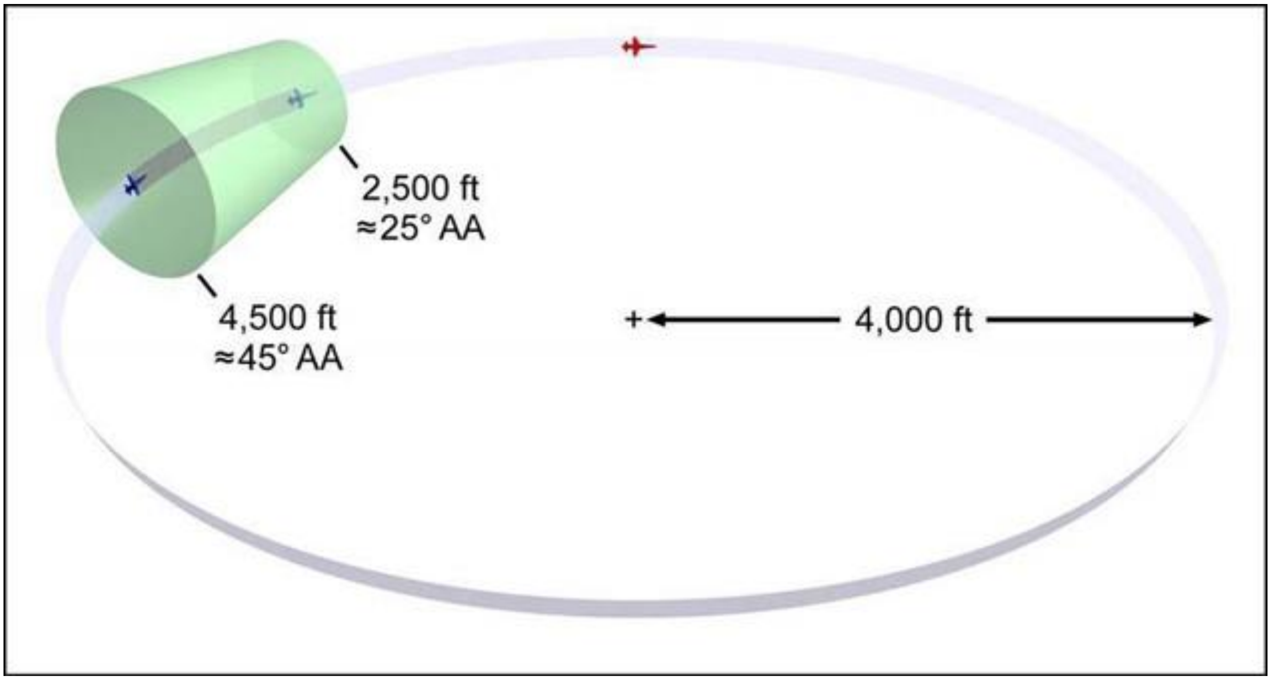
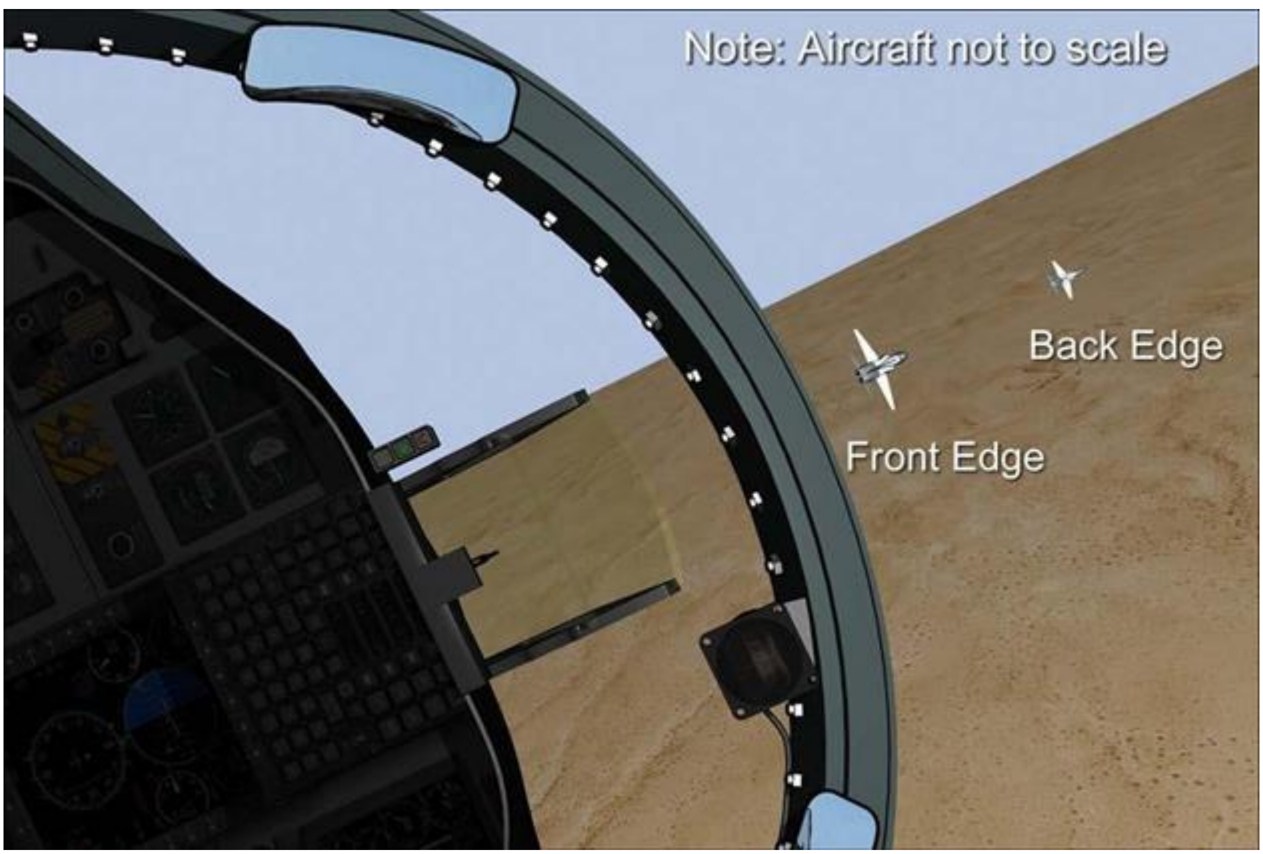


Figure A3.2. Control Zone Canopy Bow References.



A3.4. Shot Validity. Valid gun and missile shots must be taken from within the WEZ for the weapon and must meet either of the criteria in **paragraph A3.4.1**. or **paragraph A3.4.2** for sighting and time of flight (TOF). A snap is any valid gunshot less than 15 frames. A track is any combination of valid guns shots equaling 15 frames. The T-38C DTS records 30 frames per second.

A3.4.1. Gunshots Using the Enhanced Envelope Gunsight (EEGS) Funnel. Use the firing evaluation display system (FEDS) developed at trigger pull to determine TOF and valid frames. Any part of the center of the FEDS touching the target at the correct range (matching the width of the FEDS dots) counts as a valid frame.

A3.4.2. Gunshots Using the Lead Computing Optical Sight (LCOS). Use one frame per 100 feet (range to training aircraft) to assess TOF. A frame is assessed as valid if the two mil pipper is touching the target inside 2,500 feet after the TOF requirement is satisfied.

A3.4.3. AIM-9P Shot Validity. A valid uncage consists of the target's heat source in the 17.5 mil seeker reference circle (caged FOV) during the transition to the 30-mil (uncaged) circle. Once uncaged, the target must remain in the HUD FOV until pickle. The sun in the HUD FOV at pickle will invalidate the shot.

A3.5. Guns-Tracking Exercise:

A3.5.1. DLO. The DLO is a valid guns track. This exercise can be flown in conjunction with the heat-to-guns exercise.

A3.5.2. Guns-Tracking Exercise Setup and Special Instructions (SPINS) (**Figure A3.3**):

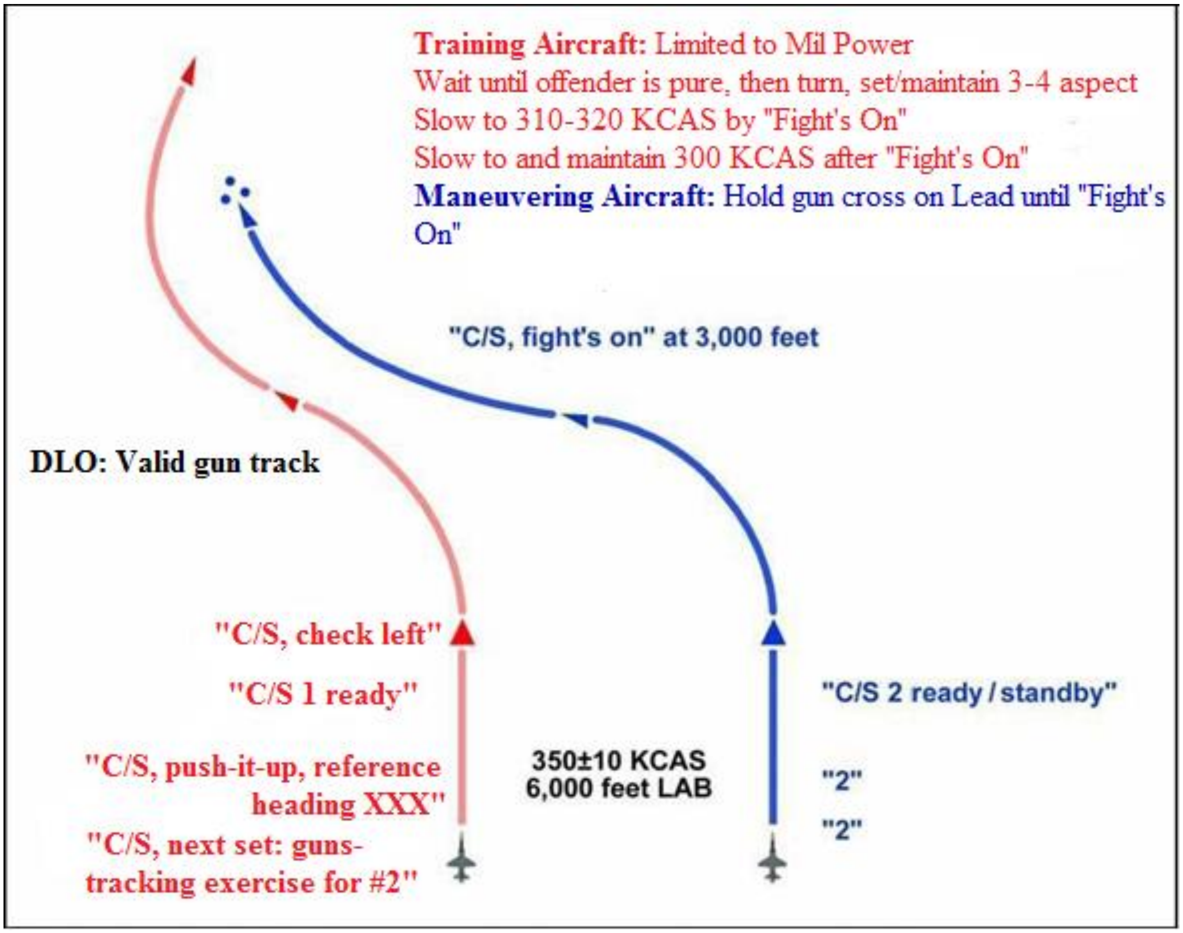
A3.5.2.1. Altitude block—15,000 to 17,000 feet MSL (or as briefed). Aircraft will be co-altitude (+500 feet) before beginning the exercise.

A3.5.2.2. Airspeed—350 (+/-10) KCAS.

A3.5.2.3. Range—6,000 feet line abreast.

A3.5.2.4. Minimum Range. The minimum range between aircraft at all times is 1,000 feet.

Figure A3.3. Guns-Tracking Exercise.



A3.5.3. Avionics. When the flight lead initiates the "next exercise" call, ensure air-to-air master mode is selected, and cycle the master arm and CMD switches as required to reset the weapons.

A3.5.4. Communication. When both aircraft are ready, lead will initiate a check 45 left/right away from the maneuvering aircraft. When the maneuvering aircraft reaches 3,000 feet with a 30- to 40 degree aspect, the maneuvering aircraft will make a "*C/S, fight's on*" call. Refer to unit standards for specific communications guidance.

A3.5.5. Training Aircraft. After the check left/right is initiated, the training aircraft will select MIL power and initiate a level turn away from the maneuvering aircraft while maintaining 350 KCAS. After 45 degrees of turn, roll out and regain the visual of the maneuvering aircraft. Once the maneuvering aircraft reaches pure pursuit, reverse the direction of turn and use G as required to ensure a 30- to 40-degree AA is set for the maneuvering aircraft. This picture equates to roughly one fist width above the canopy bow (**Figure A3.4**.). At the "fight's on" call, pull 4 Gs with MIL power in a level turn, allowing airspeed to slow toward 300 KCAS. Continue flying a level to slightly descending constant airspeed turn at MIL power (usually no slower than 300 KCAS).

Figure A3.4.

A3.5.6. Maneuvering Aircraft. After the check left/right is initiated, select MIL power and make a level turn toward the training aircraft while maintaining 350 KCAS. Pull the nose of the aircraft until just prior to achieving pure pursuit then reverse direction to maintain pure pursuit. At a range of 3,000 feet and a 30- to 40-degree AA, make the "fight's on" call. The maneuvering aircraft is in the heart of the control zone.

A3.5.6.1. Transitioning from the Control Zone to the Gun WEZ. Align POM with the training aircraft and pull lead to place the training aircraft inside of the gunsight. When transitioning from the control zone to a WEZ, the maneuvering aircraft is building geometric closure as it cuts to the inside of the training aircraft's turn circle. Be aware that the training aircraft will be cooperative and will not maneuver to present additional closure and POM problems for the maneuvering aircraft. Expect initially to maintain the "fight's on" power setting until established in the heart of the WEZ, followed by power modulation to sustain the WEZ. To control closure, reduce power as required once lead is assured. Generally, "lead is assured" if pulling the training aircraft into the HUD creates little to no buffet. With a good airspeed advantage, power can be pulled to idle as early as when the training aircraft reaches the canopy bow. The faster the training aircraft reaches the HUD, the earlier the power needs to be pulled back. Contrarily, if barely able to get the training aircraft to the HUD due to moderate buffet, lead may not be attained or maintained without an increased power setting, to include the use of afterburner.

A3.5.6.2. In Range. While maneuvering from the control zone to the WEZ, expect the training aircraft to be within range by the time lead and POM are solved; however, use mil sizing to ensure employment inside MAX range (2,500 feet).

A3.5.6.2.1. Funnel. The training aircraft is in range when the wings fill the width of the funnel at the middle pipper (2,500 feet). The minimum range of 1,000 feet is achieved with the training aircraft's wings reaching the edge of the funnel at the top dot.

A3.5.6.2.2. LCOS. The training aircraft is in range when the wings fill the width of the inner circle of the LCOS sight. The minimum range of 1,000 feet is achieved when the training aircraft's wings are at the edges of the outer circle of the LCOS sight.

A3.5.6.3. POM. The funnel and the gun-sight depression line connecting the LCOS pipper to the gun cross show the maneuvering aircraft's POM, making the POM solution intuitive. Nonetheless, pulling the gun cross in front of the training aircraft to its predicted flightpath before attempting to align the POM will mitigate over controlling inputs and aid in stabilizing the gunshot.

A3.5.6.4. Lead. With the funnel, a good technique of ensuring lead prior to weapons employment is to pull until the target aircraft's wings are just slightly overlapping the funnel at the 2,500-foot reference, then gently relax backstick pressure allowing the aircraft's wingspan to match the outside of the funnel edges. With the LCOS, pull lead to position the pipper on the training aircraft's nose, then gently relax backstick pressure allowing the aircraft to fly through the pipper.

A3.5.6.5. Gun Employment. Prior to opening fire, ensure feet are on the floor or exerting symmetric pressure on the rudder pedals. Unintentional yaw inputs will case POM errors. Using fine muscle movements, stabilize the aiming reference on the center of the target aircraft. Adjust power as required based on closure, aircraft buffet cues, and LOS rate. Small adjustments in backstick pressure and lateral stick displacement will be required to refine aiming based on continuously changing range and POM. Adjust for POM error using lateral stick pressure by attempting to adjust for one-half the distance of FEDS or LCOS pipper displacement. A controlled gunshot could be considered a 2- to 3-second lethal burst. This time may be shortened based on range, closure, and significant aiming errors. Consider it a waste of bullets to attempt a gunshot for longer than 3 seconds. Marksmanship is critical. At 60 rounds per second, 450 rounds of simulated bullets will be depleted in approximately 7 seconds. Expect approximately 90 to 120 degrees of turn to obtain a valid track prior to terminating the exercise. Be aware of the potential to fly through the target aircraft's jet wash.

A3.6. Heat-to-Guns Exercise:

A3.6.1. DLOs. The DLOs are achieved by employing a valid Fox 2, executing an effective turn circle entry, and achieving a valid guns track. A common termination point for the exercise occurs at the completion of a valid gun attempt or if the student fails to achieve a valid gun solution on the initial attempt.

A3.6.2. Heat-to-Guns Exercise Setup and Special Instructions (SPINS): Heat-to-guns can be flown from an in place 90 degree set up or a 6K perch setup. Units should determine specific SPINS for the heat-to-guns exercise.

A3.6.2.1. Heat-to-Guns from In Place 90 Turn (reference **Figure A3.5**.).

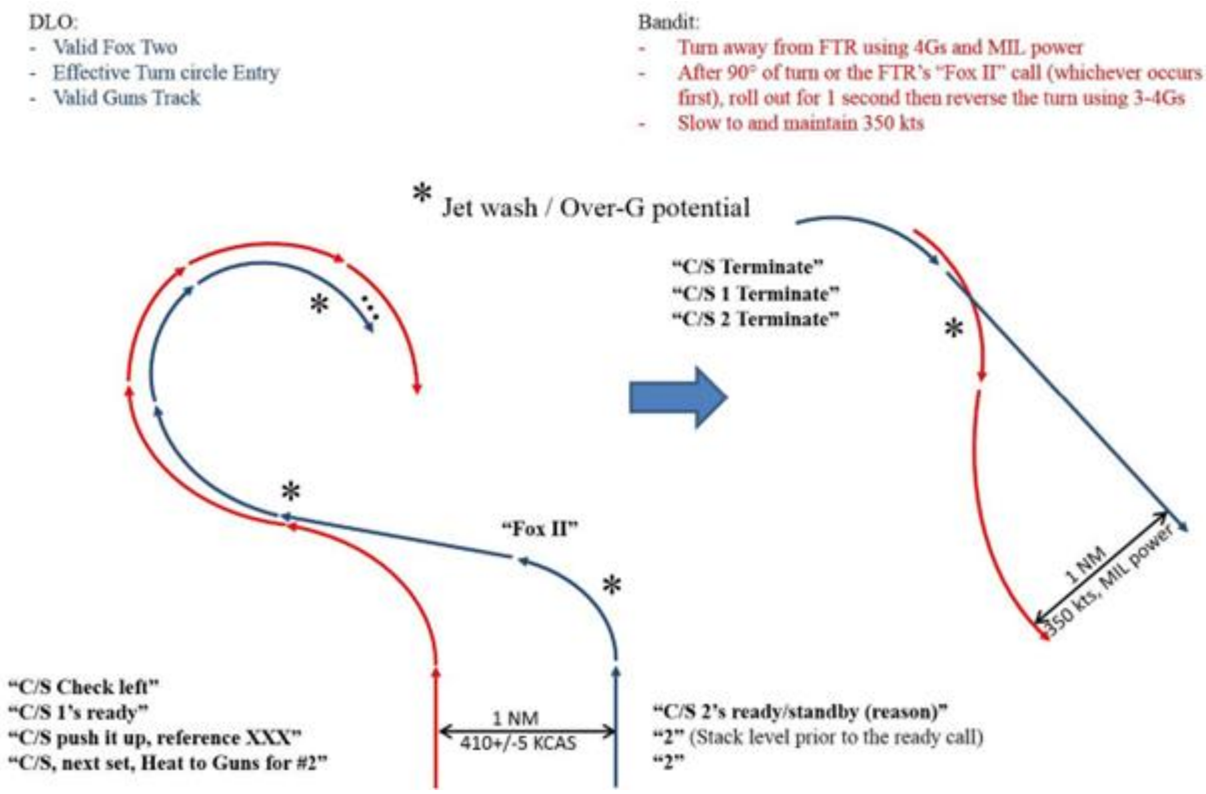
A3.6.2.1.1. Altitude block—15,000 to 17,000 feet MSL (or as briefed). Aircraft will be co-altitude (+500 feet) before beginning the exercise.

A3.6.2.1.2. Airspeed—410 +/-5.

A3.6.2.1.3. Range—6,000 feet line abreast.

A3.6.2.1.4. Minimum Range. The minimum range between aircraft at all times is 1,000 feet.

Figure A3.5. Heat-to-Guns Exercise from In Place 90.



A3.6.2.1.5. Avionics. Ensure air-to-air master mode is selected, and cycle the master arm and CMD switches as required to reset weapons.

A3.6.2.1.6. Communication. Refer to specific communications guidance in unit standards. See **Figure A3.5** for a communications example. Lead will initiate an ops check then inform the wingman of the next setup (e.g., "*C/S, next exercise will be a heat-to-guns for #2.*"). Two will acknowledge with position number. While in tactical formation, lead will then give a "*C/S, push-it-up*" call, with a reference heading if required. After reaching briefed starting parameters, lead will initiate a "ready" call. When both aircraft are ready, lead will call "*C/S, fight's on*".

A3.6.2.1.7. Training Aircraft. At the "fight's on" call, the training aircraft will initiate a MIL power, 4-G level turn away from the maneuvering aircraft. At 90 degrees of turn, roll out and modulate power not to exceed 410 KCAS. As soon as a "FOX 2" is called by the maneuvering aircraft, the training aircraft will either immediately reverse the turn (if still checking away) or begin a turn in either direction and maintain 3 to 4 Gs while slowing to 350 KCAS and MIL power. Continue flying a level to slightly descending constant airspeed turn at MIL power.

A3.6.2.1.8. Maneuvering Aircraft. At the "fight's on" call, start the AGSM, select MAX afterburner, set the lift vector (LV) on the training aircraft, and perform best break turn. The best break turn is accomplished by pulling the stick to a known 4-5 G position, then blending in backstick pressure to the single-rate beeper. As the training aircraft enters the HUD FOV, simultaneously relax the G, reduce the throttles to maintain 410 +10 KCAS, and attempt a valid AIM-9 shot. Call "FOX 2," and prepare to enter the training aircraft's turn circle (TC).

A3.6.2.2. Heat-to-Guns from 6K Perch Setup.

A3.6.2.2.1. Altitude block—15,000 to 17,000 feet MSL (or as briefed). Aircraft will be co- altitude (+500 feet) before beginning the exercise.

A3.6.2.2.2. Airspeed—410 (+/-5) KCAS.

A3.6.2.2.3. Range—9,000 feet line abreast.

A3.6.2.2.4. The flight lead checks both aircraft in the direction of the training aircraft. As the maneuvering aircraft reaches pure pursuit, the training aircraft reverses the turn and sets the appropriate aspect angle. The maneuvering aircraft monitors the range and calls "Fight's on" at 6,000 feet. The maneuvering aircraft holds the training aircraft under the gun cross until reaching 6,000 feet and continues to modulate power to maintain the briefed "Fight's on" airspeed. For a T-38C, the wingspan is 4 mils at 6,000 feet. This is one mil larger than the inside gap of the gun cross and one mil smaller than each side of the horizontal arms of the gun cross. The AAT will display 1.1 nautical miles (NM) due to system lag.

A3.6.2.2.5. Training Aircraft. At the "Fight's On" call, the training aircraft will set MIL power and tighten to 350 KCAS, and set 5°NL.

A3.6.2.2.6. Offender. At the "Fight's On" call, set power as required to maintain 415 KCAS, roll out and drive to the bandits turn circle while setting a 1-3° climb to avoid the bandits jet wash. Then prepare to enter the training aircraft's turn circle (TC).

A3.6.3. Turn Circle Entry Recognition Cues. Recognizing the proper TC entry cues proves vital to successfully entering the control zone (see **Figure A3.1**.). The maneuvering aircraft is on the TC when an increase in the aft LOS rate of the training aircraft occurs. Another recognizable cue happens when the rotational motion of the training aircraft turns into aft translational motion (AA stops increasing). Due to the low turn rates of the T-38, this increase in LOS rate is relatively subtle. The most common visual crutch is to begin maneuvering once the training aircraft reaches a point just outside the canopy bow.

A3.6.4. Assessing a WEZ. At the turn circle entry, begin AGSM, select G and power as appropriate (usually MIL), set the LV near the training aircraft, and start a light to moderate buffet pull. Be aware of the potential to fly through the training aircraft's jet wash. As the training aircraft approaches the canopy bow, assess range, aspect, and closure. The area within one to two fists of the canopy bow is referred to as the "assessment window". Commonly briefed cues to search for during this assessment include 3,000 feet of range, 30 to 45 degrees of aspect, and steady, controllable closure (referred to sometimes as the "rule of threes" or "attack cues"). Details on the training aircraft's jet provide the most accurate method to determine range. At 3,000 feet, the training aircraft has a clearly visible canopy and canopy bows, distinct lines where the wings and tail meet the fuselage, and clear lines where the colors on the paint scheme change. To determine 30 to 45 degrees of aspect, refer to the wingspan versus length relationship. To determine acceptable closure, the training aircraft's jet should slowly grow larger. If the jet is rapidly growing larger or smaller, improper closure exists. During the heat-to-guns exercise, range and aspect should look appropriate for transition to the gun WEZ. If all three cues from the training aircraft exist at the canopy bow assessment window, continue to pull the training aircraft into the HUD and employ ordnance. If one or more of the cues are not met, execute an ease reposition as described in **paragraph A3.6.6**. An ease reposition will help to solve range and aspect by realigning turn circles.

A3.6.5. AIM-9 Employment. When pulling the training aircraft into the HUD, consider a slight relax of G as required to slow the training aircraft's LOS rate to the missile seeker FOV. With the target's heat source in the missile FOV, uncage the missile. Attempting to hold or freeze the target aircraft in the center of the seeker FOV for too long can result in a significant closure problem and decrease the time available to prepare for follow-on maneuvers. After employing the AIM-9, call "*Vega 2, Fox 2*", roll out, and begin a slight climb (normally FPM 3 to 5 degrees above the horizon) to avoid the training aircraft's jet wash. Modulate power to accelerate back to or maintain 410 KCAS while approaching the target aircraft's TC.

A3.6.6. Ease Reposition. If the range, aspect, and closure cues are not met at the canopy bow assessment window, execute an ease reposition to drive the range and aspect lower. An ease reposition drives the maneuvering aircraft back toward the training aircraft's turn circle, reducing closure and aspect in the process. Execute an ease reposition by relaxing backstick pressure to reduce G. Modulate power as required to maintain the desired rate fight airspeed. When reducing G, the fighter will see aft LOS from the training aircraft (away from the canopy bow) as well as a reduction in aspect. Expect LOS to be immediate, although the amount of time required during the ease will vary based on the range, angles, and closure presented by the training aircraft at the time of the ease. Select MAX afterburner; reset the LV for best rate; and blend the G back in. Maintain the best rate until the training aircraft again enters the canopy bow assessment window. Assess and either execute another ease reposition or pull G as required to enter the AIM-9/gun WEZ.

A3.6.7. Gun Employment. Once committed to transitioning from the control zone to the gun WEZ, pull lead and establish POM while controlling closure. For mechanics, refer to gun employment in **paragraph A3.5.6.5**. While employing the gun, the maneuvering aircraft may need to reposition. The reposition is a calculated bid to lag, using the vertical and induced drag to solve range, aspect, and closure problems. The maneuvering aircraft should reposition for either fragmentation ("frag") created from the valid gun kill or range and closure problems created during the gun attempt. Always reposition the aircraft before entering the 1,000-foot bubble around the training aircraft.

A3.6.8. Reposition Mechanics. Rotate the LV away from the training aircraft; power placement, degree of LV change, G, and AOA used will depend on the severity of the BFM problem the maneuvering aircraft is trying to solve. If unsure, a good default is to use idle, set the LV 60 to 90 degrees above the training aircraft (typically, perpendicular to the horizon), and use a smooth but deliberate pull to the moderate buffet. Once arriving on or near the training aircraft's TC, begin pull back towards the training aircraft to reduce HCA and begin the reassessment. Throttle position will depend on LOS and range cues from the training aircraft. Recommit as required for an AIM-9 opportunity on the way back to the gun WEZ. Be aware of position relative to the training floor during the recommit.