



FFI FORMATION GUIDELINES AND STANDARD PROCEDURES

March 15, 2020 Version 3.2

The **FFI Formation Guidelines and Standard Procedures** manual was written in order to combine information taken from various sources into a single reference document for use as a study guide for clinics or as a standardization tool for training. This Guideline is intended for RV type aircraft, but serves well as a standard for other civil aircraft when used in conjunction with aircraft specific supplemental materials (Bonanza, Mooney, etc). This manual reflects, in a short format, the Formation Flying, Incorporated (FFI) standards. Additional references include, but are not limited to, the Formation Pilot's Knowledge Guide and the FAST Formation Guideline series.

POLICIES, PROCEDURES AND TECHNIQUES

Policies and procedures create predictability and consistency.

- Policies are broad specifications about how the FFI Program and FFI Leadership expect operations to be conducted to minimize risk. FFI Program Philosophy, Policy and Principles are set forth in the FFI Program Manual.
- Procedures dictate the manner in which the FFI Program and FFI Leadership intend to have various tasks performed. Pilots are expected to accurately follow the procedure methodology during FFI formation operations.
- Techniques are individual methods or behaviors. Techniques must be compatible with established policies and procedures, and are only effective if they do not interfere with the expectations, situational awareness, or effectiveness of the other pilots in the flight. Techniques that violate FFI Policy, or alter FFI Standard Operating Procedures, are not authorized, unless there is no safer course of action.

VISUAL SIGNALS

Visual signals, both aircraft signals and hand signals, are used to the maximum extent possible to keep radio calls to a minimum. Any non-standard aircraft or hand signals will be thoroughly briefed before flight. All members of the flight are expected to be familiar with all aircraft and hand signals to be used. Aircraft malfunctions or safety related issues will be communicated over the radio.

AIRCRAFT SIGNALS

The following aircraft signals, when initiated by Lead, are commands for all Wingmen in the flight:

WING ROCK: Lead uses rapid aileron inputs to mildly rock wings. The flight will rejoin in Fingertip, from Route, Diamond, or Close Trail. If joining from wings level Close Trail, #2 is expected to join on Lead's left wing (or as pre-briefed), and #3 and #4 will always join on the opposite side. If in a turn during the wing rock, #2 would join to Lead's inside wing, #3 and #4 would take the opposite side. If joining from Diamond, #4 is the only aircraft who will reposition, and will always return to the same side as his element / section lead (#3). From Route, each wingman closes to Fingertip spacing. If in Echelon with Route spacing, the wing rock would signal to close the spacing while remaining in Echelon. If joining from Extended Trail, Lead uses a large wing rock and Wingmen conduct a standard rejoin by going out on the rejoin line.

FISHTAIL: Lead uses small movements of right and left rudder to move Wingmen from any formation to Route, 2-4 ship widths wide.

PORPOISE: Lead gently porpoises his airplane several times using elevator inputs to move Wingmen from Fingertip to Close Trail. #2 will slide back and behind Lead, #3 moves behind #2, #4 moves behind #3. This also applies during taxi, to signal a move from stagger to trail. During taxi, Wingmen all need to pass this signal by rocking their elevators in the same manner.

HAND SIGNALS

Hand signals can be used to communicate most of Lead's instructions during a formation flight. However, radios should be used if there is an emergency, time is critical, or if hand signals are creating confusion.

Lead will strive to make hand signals easy to see, placed in the cockpit against a contrasting background to make them as visible as possible.

If the hand signal is understood, acknowledgement is accomplished with a head nod from the Wingman.

If the hand signal is not understood, the Wingman should maintain current position and do nothing. Lead will then either repeat the hand signal or use the radio to avoid any further confusion. Once the Wingman understands the signal, he / she should comply with Lead's command.

Individual hand signals are described in each appropriate section throughout this Guide.

Graphic depictions of typical hand signals may be found in the Formation Pilots' Knowledge Guide, published by the Formation and Safety Team (FAST) organization at flyfast.org.

PRE-FLIGHT BRIEF

All formation flights will be briefed thoroughly, without exception. If pilots in a planned flight are located at different airfields, it is preferred that they all co-locate to brief, but a telephone briefing is acceptable. Use of a briefing guide is encouraged. Samples of briefing guides are available for review and download at ffi.aero.

RADIO PROCEDURES

- Frequency changes will be either through hand signals or called over the radio (preferred).
- The terms "Go" and "Push" may be used by Lead depending on the situation, and specifics will be pre-briefed.
- If frequency changes are called over the radio by Lead using the term "Go", each flight member in sequence will respond "twoop", "threep", "fourp" as appropriate. If Lead uses "Push," just push the button, there should be no response. Each flight member should tune to the new frequency and await a check-in from Lead.

AIRCRAFT LIGHTING POLICY/PROCEDURES

- FAR 91.205 requires the *installation* of aviation red or white anti-collision lights (rotating beacon or strobe lights) on Standard Category aircraft manufactured after 1996. If required, these lights must be operational, and operated in accordance with FAR 91.209.
- FAR 91.209 requires that aircraft with installed red or white anti-collision lights must operate them from sunset to sunrise. However, FAR 91.209 also states that these lights may be turned off by the PIC in the interest of safety, based on the operating conditions.
- FFI policy with respect to aircraft lighting is that the Flight Lead will brief the use of any aircraft lighting to be illuminated during the flight. This pertains to landing, nav and strobe lights, as well as rotating beacons (as installed).
- FFI recommends that, if strobe lights or rotating beacons are briefed to be illuminated, that only the last aircraft in the flight illuminate those lights.
- Flight Leads must consider the ambient conditions, and the impact to the vision of the pilots in the flight, when determining which aircraft lights, if any, are to be illuminated during the flight.

TRANSPONDER AND ADS-B POLICY/PROCEDURES

- FAA Policy Guidance for Transponder and ADS-B operation for formation flights is as follows:
- AIM Chapter 4, Section 1, paragraph 4-1-20g.3 states:

When participating in a VFR formation flight that is not receiving ATC services, only the lead aircraft should operate their transponder and ADS-B Out. All other aircraft should disable transponder and ADS-B transmissions once established within the formation. NOTE – If the formation flight is receiving ATC services, pilots can expect ATC to direct all non-lead aircraft to STOP SQUAWK, and should not do so until instructed.

- FAA Advisory Circular 90-114B, ADS-B Operations, dated 12-30-2019 states, in paragraph 4.3.1.3:

Formation Operations. ATC uses established transponder and ADS-B transmission procedures when participating in formation operations. Per the Aeronautical information Manual (AIM) paragraph 4-1-20, if the formation flight is receiving ATC services, pilots can expect ATC to direct all non-lead aircraft to "STOP SQUAWK", and should not do so until instructed. For visual flight rules (VFR) formation flights not receiving ATC services, ATC directs that only the lead aircraft should squawk the assigned beacon code (1200). All other aircraft should disable transponder and ADS-B transmissions once established within the formation.

- Based on the above FAA policy guidance, the FFI transponder and ADS-B guidance is as follows:
 - Leads will brief, for all formation flights, that all wingmen will turn off or disable both transponder (STBY or OFF) and ADS-B transmissions (OFF or Disabled), prior to check-in and taxi, and for the duration of the flight.
 - Leads will squawk the appropriate transponder code and transmit ADS-B for the flight.
 - It is FFI policy that all aircraft are "established in the formation" upon engine start, and remain established in the formation throughout maneuvers such as takeoff rejoins, in-flight pitchouts and rejoins, and extended trail maneuvering.
 - At tower-controlled airports, Leads should request that "all wingmen stop squawk and ADS-B" during their first transmission to Ground Control. At non tower-controlled airports, in order to establish good habit patterns of compliance with this ATC requirement, Leads may direct this upon initial formation check-in, if desired, to support the pre-briefed (and required) mode of operation. For example, "Falcon Flight, squawk STBY, ADS-B OFF".
 - If a flight starts operations at a non-towered airport, or does an airborne rejoin while not utilizing ATC services, then subsequently utilizes ATC enroute or terminal services (for example, flight following, or a recovery as a formation to a towered airport), Leads should request that "all wingmen continue to stop squawk and ADS-B" during the initial check-in with the first ATC facility contacted.
 - For situations in which a flight launches as a formation, then subsequently breaks up and recovers as individual aircraft, Leads should brief all wingmen to squawk and transmit ADS-B as required by FARs upon flight break-up.

PREFLIGHT and ENGINE START

- It is preferable to position each aircraft so each pilot has a view of the other. Line abreast is preferred. At the very minimum, each pilot should be able to see each other's head.
- All aircraft will start engines on Lead's startup signal, or a time hack as conditions require.
 - If pre-briefed, and simultaneous starts are desired, start up will then be on command from Lead by raising his arm and using a finger twirl over the head, followed by:
 - 1) a head nod for execution, or
 - 2) Lead's prop beginning to turn for execution.
 - Start-ups using time hacks may be pre-briefed.
 - If line of sight to the Lead is an issue, Wingmen may pass the startup signal down the line. Wingmen may also start when they see Lead's (or other Wingmen's) prop begin to turn.
- After engines are running, each pilot will individually tune radios to the pre-briefed frequency.

In the case of formations with multiple elements, it will typically be pre-briefed to tune to the Working Frequency after engine startup, in which case, Lead will initiate a 'check in'.

Example: "Falcon flight check", followed by "twoop", "threep", "fourp".

- Lead will re-confirm the altimeter setting, and call the flight over to the next frequency.

Example: "Altimeter setting 29.92, Falcon flight Go 123.45", followed by "twoop", "threep", "fourp".

TAXI

- After frequency switch, Lead will call for taxi clearance if at a controlled airport, or begin his (her) taxi at an uncontrolled airport.
 - If Lead taxis on centerline, Wingmen follow close in trail, about 1 plane length clearance between planes.
 - If Lead staggers to the left or right of centerline, Wingmen will alternately taxi on opposite sides of the taxiway, while maintaining a safe nose to tail clearance. #2 sets spacing. #3 and #4 line up aircraft centerlines with #1 and #2 in front of them.
 - Lead will taxi at a slower speed than would be used for a single aircraft. Maximum taxi speed for Lead should be 15 knots or less, as indicated on Lead's GPS readout.
 - **To signal a move from stagger to trail**, Lead will cycle the elevator up and down repeatedly. Wingmen pass this signal down the line by cycling their elevators in the same manner. Even the last aircraft in the formation will cycle his (her) elevator for formation integrity.
- Wingmen will match lead's configuration with respect to flaps, elevator position, and other aircraft-specific configuration items during taxi.

RUNUP

- When taxiing into the run-up area, each pilot should attempt to match Lead's angle, and line up heads. Flank turns, etc., may be pre-briefed, depending on facility conditions.
- After completing his (her) run-up, each pilot checks over the adjoining aircraft to catch and notify of any out-of-the-ordinary conditions such as fluid leaks, open or unlatched doors/hatches/canopies, flaps or trim in an unexpected position, etc. Once ready, each pilot must look "down the line" (i.e. Lead looks at #2, #2 looks at #3, #3 looks at #4, etc.). The last pilot in the flight, whether #2 or #37, passes the **"thumbs-up" signal** when he (she) is ready to proceed. Each member of the flight in turn passes the thumbs-up smartly up the line (i.e. #4 passes it to #3, who passes it to #2, who passes it to Lead). Once Lead sees the thumbs-up from #2, he (she) knows the entire flight is ready.

FORMATION TAKEOFFS

It is important to consider engine power, aircraft weight, and propeller differences in planning the takeoff roll. Lead must take these performance differences into consideration, and use throttle settings appropriately. Lead should also attempt to match tailwheel A/C with tailwheel A/C, and nosewheel with nosewheel.

- All formation takeoffs will be performed with the flaps UP unless specific aircraft require a different configuration for takeoff.
- Lead should consider the crosswind component, as well as the makeup of his flight before opting for a formation takeoff. Formation takeoffs during very strong crosswinds should be avoided. A 10 knot crosswind component should be considered as the maximum.
- If a crosswind is a consideration, Lead lines up on the downwind side of the runway.
 - This is to ensure that his (her) prop wash does not affect the Wingman during the takeoff roll. Lead must taxi down far enough to ensure Wingman can pass behind, if required for crosswind positioning, and far enough to allow all the aircraft in the flight to taxi onto the runway.
- Lead comes to a complete stop when in position.
- Wingman should line up in a position that is acute of the normal bearing line, aligning Wingman's leading edge with Lead's trailing edge, and with sufficient wingtip clearance to ensure that each aircraft can clear the other in case of an abort or a blown tire. Typically each aircraft lines up on the center of his or her half of the runway, width permitting.
- Wingman also comes to a complete stop.
- Lead signals run-up with a twirled finger above the head.
- All aircraft firmly hold their brakes, run up to 1700 RPM, and check instruments.
- When Lead is ready, he (she) looks to Wing. Wing indicates ready with a head nod.
- Lead will slowly draw his (her) head back, and then give a large head nod forward. All pilots then release their brakes simultaneously and slowly advance the power.

This process should be slow and deliberate, taking at least 5 seconds for Lead to advance to the takeoff power setting, which is somewhat less than full takeoff power. Setting correct takeoff power must be tailored to the Wingman's power available, a technique learned through experience and practice.

- A smooth rotation should be at a slightly higher than normal speed, approximately 60 KIAS / 70 MPH.
- Once airborne, Lead will slowly accelerate to the standard climb speed of 100 KIAS / 115 MPH, or as briefed.
- Any aircraft aborting should announce “___’s aborting” on the radio, i.e. “2’s aborting”. If multiple formations are operating on the same frequency, or if there are multiple flights in the formation, the call sign should also be included, i.e. "Bravo 2's aborting".

INTERVAL TAKEOFF

In cases where there are more than a single element / section, or in the event that a formation takeoff is not practical, an interval takeoff with a join-up on departure will be used.

- The takeoff interval will be pre-briefed, typically waiting until the aircraft in front, or element in front, has lifted (daylight under the wheels) before the wingman (or second element) starts his (her) takeoff roll.
- It is essential that Lead begin a power and/or RPM reduction as soon as practical after takeoff, to allow Wing some power advantage.
- The lead will accelerate to and maintain 100 KIAS / 115 MPH, and a climb rate of 500 FPM, or as briefed. Lead will normally extend takeoff leg slightly before starting a shallow turn to facilitate the join-up.
- Following Wingmen / Element Leads can expect prop wash turbulence right after takeoff and should offset slightly to avoid it, or to get out of it.
- If Lead begins a turn, Wingmen will begin their turn to move to a rejoin position on the inside of Lead's turn as soon as a safe altitude has been reached, using the vertical stab on the outside wing to establish the rejoin bearing line.
- Use power to control the closure rate. Closure can be difficult to judge with a tail aspect, so wing should reference their indicated airspeed as compared to leads briefed airspeed, to help determine closure rate.
- During a turning rejoin, #2 ALWAYS joins on Lead's inside wing, #3 and #4 join on Lead's outside. In the case of a straight ahead rejoin, #2 is expected to join on Lead's left wing (or as pre-briefed), and #3 and #4 will always join on the opposite side.

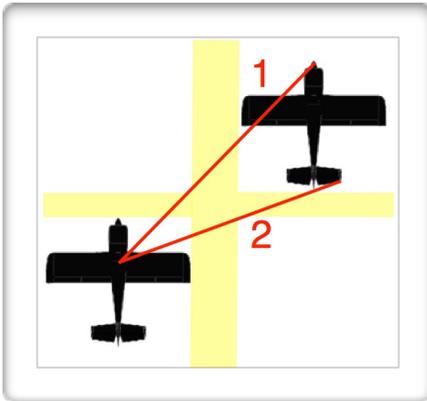
CLIMB

- Normal climb speed is 100 KIAS / 115 MPH. Lead will push the power up as high as possible once all Wingmen are aboard. Wing will call “gimme one” if necessary. Climb out is normally conducted in either fingertip or route formation, or both.

TRANSIT TO THE WORKING AREA / MANEUVERING

- Maneuvers are normally conducted at a baseline airspeed of 130 KIAS / 150 MPH, or as briefed, based on the performance of the aircraft in the flight.

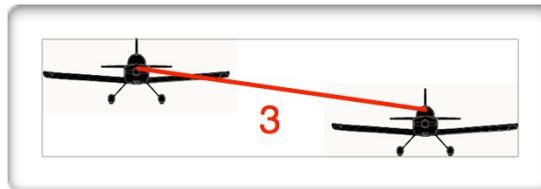
BASIC RV FORMATION POSITIONS



FINGERTIP POSITION

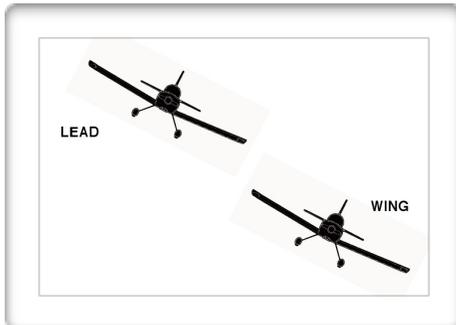
For RV to RV formation, **1 - line up the outside aileron hinge bolt on the prop spinner for the primary line of position (LOP)**, then **2- look for a small amount of opposite side elevator tip behind the rudder to fix a point on that primary LOP**. This reference establishes fore/aft (bearing), **3 - up / down (stepdown)**, and side to side. Clearance is provided in all 3 axes (no wingtip overlap, no nose-to-tail overlap, and positive stepdown).

With a constant speed prop, maintain 2400 RPM or greater, within a range of 2400 to 2700 RPM.

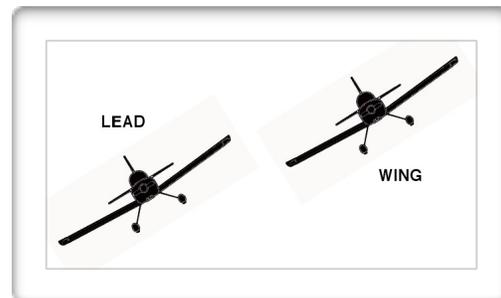


FINGERTIP TURNS

Wing will match Lead's angle of bank and maintain the same Fingertip reference as straight and level flight, either as a **TURN INTO** or a **TURN AWAY**. Sometimes referred to as **WELDED WING**.



FINGERTIP - TURN INTO



FINGERTIP - TURN AWAY

ROUTE

- To move Wingmen from any formation to Route, Lead gives the **fishtail signal by small left and right movements of the rudder**. Route formation is flown 2 to 4 ship widths wide, and forward of the normal reference, **aligning the leading edge of the wingtip on the spinner**. In turns, aircraft on the inside will maintain the approximate normal route reference and stack down far enough to keep Lead and other airplanes comfortably in sight. Aircraft on the outside of the turn will turn level with Lead by putting Lead on the horizon. (Similar to a slightly wide echelon turn).

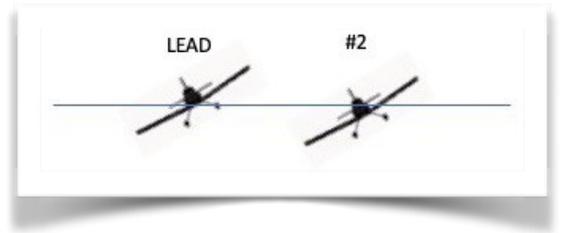
NOTE: Lead should give line-up position changes, frequency changes, and Ops checks (in-flight checks to include any prescribed checklists and periodic systems and fuel quantity checks) while in route position.

NOTE

Even if Lead hasn't called for an ops check, take other opportunities when not in close formation to look over your aircraft systems and fuel state.

ECHELON AND ECHELON TURNS (2-ship)

Echelon typically refers to a formation larger than a 2-ship, when all wingmen are on one side of the lead (as described on page 11). Echelon turns are typically flown during 3-ship, 4-ship (or larger) formation turns away from the wingmen when in Echelon formation. However, Echelon turns may be flown for practice during 2-ship training, as directed by the Lead via a radio call or hand signal. The hand signal for an echelon turn is a single fist held straight up, with index and pinky fingers extended.



Additionally, Echelon turns away from the Wingman *should* be flown during the following 2-ship operations:

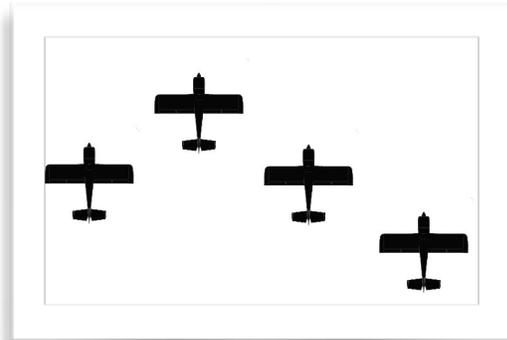
- When approaching the airport for an Overhead Recovery or a Formation Landing (once the flight has left the working area or the enroute phase, is descending towards the airport, and has switched to tower or CTAF frequency). This allows the Lead additional maneuverability when approaching the initial.
- During turns away from the Wingman when in the landing pattern for a formation (Element/Section) landing. This provides the Wingman an additional power advantage as the aircraft are slowed and the Element performs flap and gear configuration changes.
- During Echelon turns, the Wingman will match Lead's rate of roll and rotate about their own longitudinal axis. The Wingman maintains the same angle of bank as Lead, and the sight picture for the Wingman is to hold the bottom of the fuselage of the Lead aircraft on the horizon. This results in slight step-down the Wingman, as shown in the diagram above, identical to the step-down that exists in the straight and level position. During Echelon Turns away, the Wingman should not climb to maintain position, as is done during welded wing turns. The Wingman will require a significant power addition since they are on the outside of the turn. The outboard aileron hinge to spinner reference does not apply during Echelon turns, but the Wingman should fly so as to be in the correct reference Line of Position when Lead rolls out of the turn.

4-SHIP FORMATION

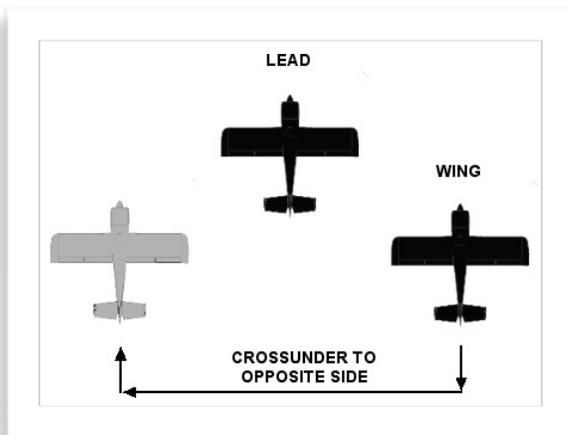
The basic 4-ship configuration for maneuvering, **and the formation from which all other 4-ship formations will originate** is the **FINGERTIP FOUR**.

FINGERTIP STRONG LEFT or RIGHT

The Fingertip references for #2 and #3 are the same, to put Lead's outside aileron hinge on the spinner and a little opposite elevator tip behind the rudder. #3 will dress across on #2, The term "dress" is #3's symmetry in relation to #2. #2 sets the tone, #3 matches. #4 will attempt to fly the same position off #3 but will also line up the heads of #3 and Lead. #4 can look through #3 and fly off Lead to prevent over-controlling. Turns will be flown in Welded Wing.



FINGERTIP FOUR (STRONG RIGHT)



CROSSUNDER

To cross #2, Lead will signal the crossunder with **arm bent at 90°, fist clenched**. If the formation is in Fingertip, Lead should hold the bent arm so both #2 and #3 can see the signal, or give the signal to #3, then #2. #3 will move the second element / section out, providing space for #2. When #3 has moved out sufficiently, #2 will cross under and move into position on Lead's opposite wing. The proper crossunder is then accomplished in a fluid motion, however it has 3 distinct parts. Power is reduced to move down and back, then slight aileron pressure or rudder is used to initiate the crossing rate, power is replaced as the aircraft moves across, below and behind, then advanced to move forward and up. Power is reduced when in position.

To cross the 2nd element / section (#3 and #4), Lead will signal with **arm bent at 90°, fist clenched, with two arm pumps**. When the 2nd element / section is moving across, below and behind the first element / section, the wingman in the 2nd element / section (#4) will also, simultaneously and automatically, without being signaled to do so, move further across his element / section Leader (#3) so as to assume the proper position on the new side.

4-SHIP FORMATION - STANDARD RULES

For purposes of standardization and communication by hand signals, ***the 4-ship flight will always return to the basic fingertip configuration prior to reforming from any non-fingertip formation to any other non-fingertip formation.*** This ALWAYS entails 2 moves, first to fingertip, and then to the new formation. If pre-briefed, this requirement may be modified by Lead.

FINGERTIP RIGHT to ECHELON RIGHT Lead's arm bent 90°, fist clenched. This signal MUST be visible to both sides of the formation, or given to each side of the formation (#2 and #3). #2 waits as #3 moves his element / section out and back, to allow #2 room to cross-under into position on Lead's right wing.

FINGERTIP RIGHT to ECHELON LEFT Lead's arm bent 90°, fist clenched, 2 arm pumps. #3 and #4 move as an element to #2's left wing. #4 crosses under #3 as the element is crossing under #2.

ECHELON RIGHT to FINGERTIP RIGHT Lead's arm bent 90°, fist clenched. #2 passes this signal to #3. #2 crosses under to Lead's left wing. #3 moves his element into position on Lead's right wing.

ECHELON LEFT to FINGERTIP RIGHT Lead's arm bent 90°, fist clenched, 2 arm pumps. #3 and #4 cross-under to move as an element to Lead's right wing, with #4 crossing under #3 as he (she) moves to #3's right wing.

FINGERTIP to DIAMOND Lead's arm bent 90°, four fingers extended, then closed with thumb pointing rearward, motions aft. If #4 does not move, Lead assumes he did not see the signal, and gives it again. In this case #3 may also relay this to #4 who moves into the slot position. #4 call's "4's in" when in position. If briefed, #3 signals a 'thumbs up' to Lead when #4 is in position.

DIAMOND to FINGERTIP Lead will gently rock his wings several times. #4 will move to his element lead's (#3) wing.

FINGERTIP to CLOSE TRAIL Lead gently porpoises his airplane several times with the elevator. #2 slides back and behind lead, #3 moves behind #2, #4 moves behind #3.

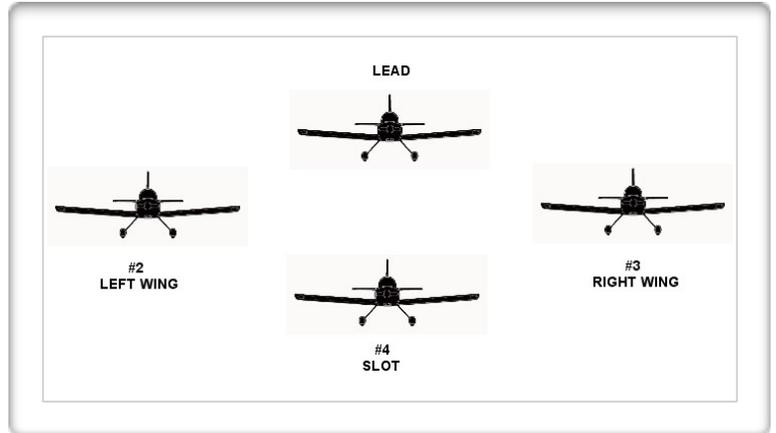
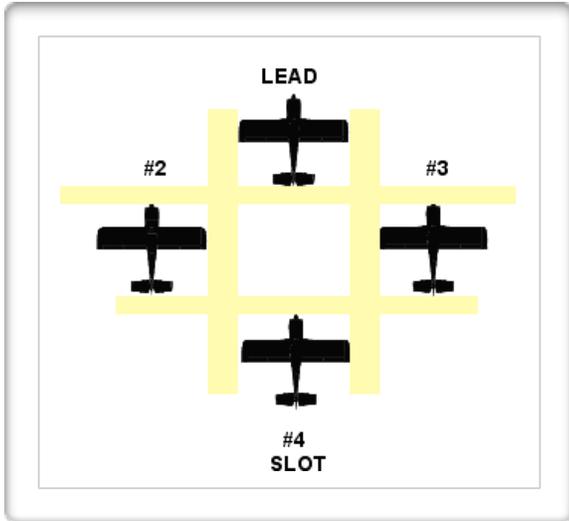
CLOSE TRAIL to FINGERTIP Lead rocks his wings several times, then starts a shallow turn. #2 rejoins on Lead's inside wing, #3 and #4 rejoin on Lead's outside wing.

DIAMOND to CLOSE TRAIL *If briefed*, Lead will use a porpoise signal to move the flight directly from Diamond to Close Trail without going back to Fingertip.

DIAMOND

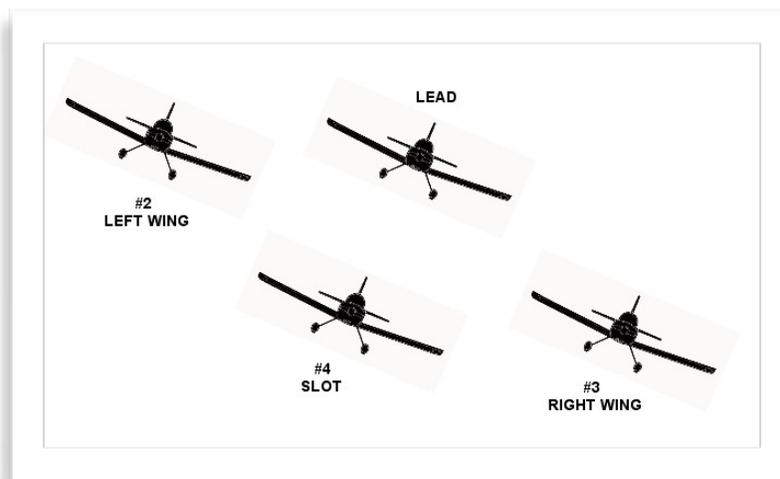
The formation enters Diamond from Fingertip. Lead signals #4 to the slot position with **arm bent at 90°, four fingers extended, then closed with thumb pointing rearward, motions aft**. #3 may need to relay this to #4. #4 calls "4's in" when established in position in the slot. Or, if briefed, #3 will give a thumbs up to Lead, indicating #4 is in position.

In Diamond, #2 and #3 fly the same reference as in Fingertip. #4 flies a Trail position behind and below the lead. #4's primary reference is Lead's center line, but he (she) needs to divide his (her) attention so as to fly normal Line of Position references off of both #2 and #3, splitting the difference if they are not perfectly dressed, #3 in perfect symmetry with #2. Once again, #4's stability is derived from Lead as his (her) primary reference but will also line up the aileron hinges to spinners of #2 and #3 as concentration allows.



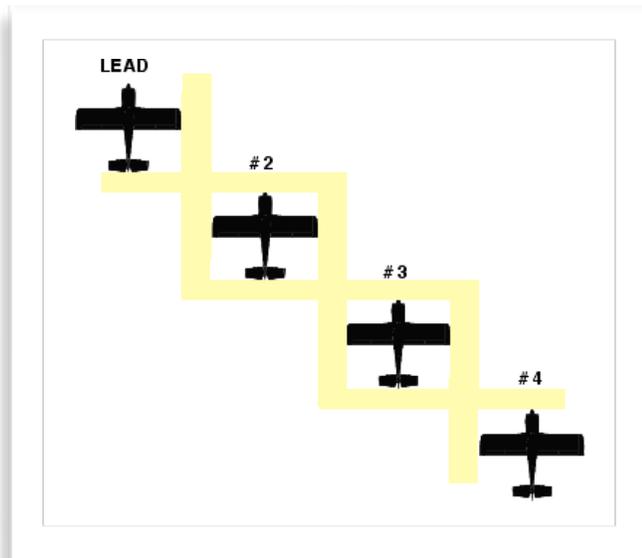
DIAMOND TURN

Wingmen maintain the same fingertip position in the turn, matching Lead's angle of bank and maintain the same fingertip references as straight and level flight, either as a TURN INTO or a TURN AWAY.



ECHELON

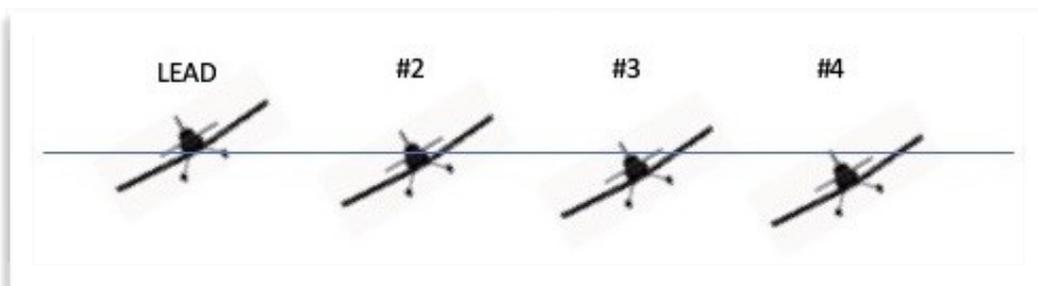
Echelon formation is defined as when two or more Wingmen are on the bearing line (Line of Position), all positioned on one side (left or right) of the lead aircraft (echelon right depicted). #2 maintains the same Line of Position and vertical step down between aircraft as in Fingertip. **#3 and #4 line up heads!**



NOTE
#3 and #4 line up heads!

ECHELON TURNS (3-4 Ship and Larger Formations)

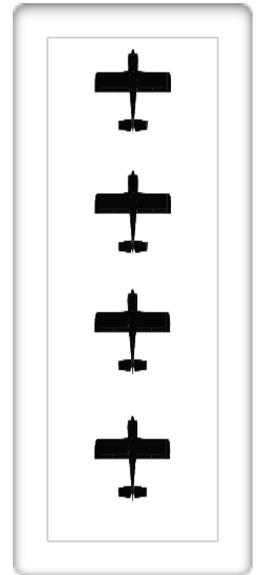
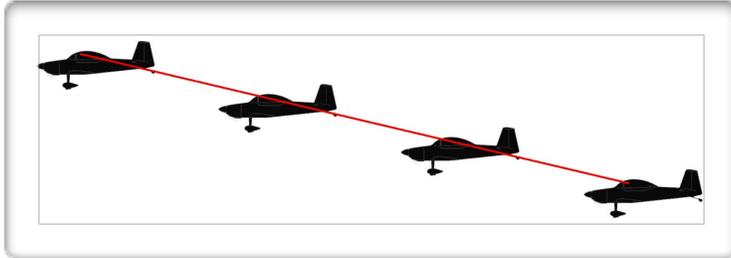
Echelon turns are normally flown as turns away from the wingmen in an echelon formation. Echelon turns are also applicable during 2-ship entries into the Overhead Break, and during 2-ship Element Landing patterns (as described on page 7). Each Wing will match Lead's rate of roll and rotate about their own longitudinal axis. Wingmen maintain the same angle of bank as Lead, and the sight picture for each Wing is to hold the bottom of the fuselage of the aircraft in front of them on the horizon. This results in slight step-down of each wingman, as shown in the diagram below, identical to the step-down that exists in the straight and level position. During Echelon Turns away, Wingmen should not climb to maintain position, as is done during welded wing turns. Wingmen will require a significant power addition since they are on the outside of the turn, #3 more than #2, and #4 more than #3. The outboard aileron hinge to spinner reference does not apply during Echelon turns, but each Wing should fly so as to be in the correct reference Line of Position when Lead rolls out of the turn. Turns into the echelon are to be avoided.



NOTE
**Turns into the echelon
are to be avoided**

CLOSE TRAIL

Lead will signal the move to Close Trail formation with an *elevator porpoise*. #2, #3, and #4 will drop back simultaneously and move into Close Trail, in sequence. #4 calls when all aircraft are in position by announcing "4s In". Each aircraft should attempt to fly just below the prop wash/wingtip vortices by lining up the tail wheel with the pilot's head (or looking straight into the exhaust stacks). Spacing between aircraft should be **1/2 to 3/4 ship length** from rudder to prop. Close Trail is a power anticipation exercise. Think about what is happening with Lead's airspeed and anticipate.



EXTENDED TRAIL

Extended Trail may be entered either from Echelon or from Close Trail.

In both cases, a 2 second interval will be used. Lead will signal Extended Trail by a radio call and will get an acknowledgement from Wingmen, i.e. "Gringo flight, go extended trail, 2 second interval, left (or right) turn away, acknowledge", followed by "2, 3, 4". The radio call is imperative to ensure all Wingmen are expecting, and prepared for, Extended Trail maneuvering.

If entered from Echelon, the break-up is accomplished as a normal pitchout (60° AOB, 2g turn) to achieve proper spacing.

If entered from Close Trail, the breakup will be accomplished by Lead conducting a level, low energy turn away to achieve sufficient spacing from the formation prior to transitioning to a maximum of 60° angle of bank. Wingmen will follow in similar fashion, using a low energy turn away, and a 2 second interval, to achieve proper spacing on the aircraft in front.

In both cases, Lead will keep the level turn constant until proper spacing is achieved and the last aircraft calls "In".

It is NOT necessary for #4 to wait until the formation is in a straight line at Lead's 6 o'clock position, #4 will call "in" as soon as proper spacing (500-1000 feet) is achieved during the breakup turn.

After the "In" call, Lead will conduct large Lazy 8s to allow Wingmen to use slight lead and lag on the aircraft in front to maintain **500'-1000' spacing in trail**, following, or adjusting to, the flight path of preceding aircraft to maintain proper nose to tail spacing. This is an energy management (radius of turn) exercise using slight lead and lag to maintain spacing with relatively constant power. When complete, Lead will roll wings level, delay long enough to allow Wingmen to stabilize in trail, then execute a large wingrock to signal a rejoin.

PITCHOUT (BREAKUP) AND REJOIN EXERCISE

The pitchout and rejoin exercise separates the formation to practice procedures to join the formation back up. The concepts of radius of turns, bearing line, and pursuit curves are critical to controlling closure rates and executing proper rejoin procedures.

Lead. Prior to the first breakup, Lead establishes the formation in straight and level unaccelerated flight, in echelon formation. Lead can initiate the breakup and rejoin in either direction based on weather, area management, etc. The pitchout / breakup turn by Lead should be 180° of turn, but throughout the exercise, Lead can continue the pitchout / break beyond 180° or vary the turn as necessary to avoid clouds or keep the formation in the assigned area. Lead must ensure Wingmen are in echelon on the opposite side of his break (Lead breaks away from the flight).

PITCHOUT (BREAKUP) AND REJOIN EXERCISE (continued)

- Lead gives the break up signal, (a circular motion, the number of fingers indicating the interval in seconds).
- 2 should acknowledge with a head nod, but should not pass the signal down the line.
- Lead clears the area, then may give the kiss-off signal prior to pitching out. This kiss-off signal is optional.
- Lead breaks away, expeditiously and smoothly rolling into a 60° AOB turn and smoothly increasing pull to 2 'g's.

The turn will typically be 180° of turn. Lead will maintain constant power and level altitude throughout the turn.

IT IS IMPORTANT FOR THE LEAD TO MAINTAIN A LEVEL TURN

- Each wingman will take a 2 second interval, then break using the same 60° AOB / 2 'g' turn.

Experience has shown that RVs using 2 seconds between breaks will yield approximately 800 – 1000 feet spacing on downwind. Count 'one thousand one, one thousand two'.

A 2 second interval is standard, but Lead may adjust the break interval as required.

Each wingman will maintain constant power, and level altitude throughout the turn.

IT IS IMPORTANT FOR EACH WINGMAN TO KEEP LEAD ON THE HORIZON

Wingman goal is to establish 800 – 1000 feet of separation and then use pursuit curves to stay there.

When Lead rolls out of the turn, each Wingman shall maneuver to place Lead at their 12 o'clock, on the horizon.

- When the trailing Wingman is comfortably in position in trail, he (she) will transmit "4's in", or # as appropriate.
- Lead will then roll using an exaggerated wing-rock and roll into a 20° to 30° AOB to begin the rejoin turn.
Lead maintains a constant 20° to 30° AOB while minimizing power changes.
- Wingmen will use 30° (or more) of bank to maneuver inside Lead's radius of turn (lead pursuit) while holding Lead on the horizon, until Wing arrives on the rejoin line. **For RVs, the desired rejoin reference line is to line up the vertical stabilizer on the outside wingtip.**
- Initially, Wingmen should learn to conduct rejoins with relatively fixed power. As proficiency is achieved, airspeed management should be utilized for expeditious rejoins. Up to 20 knots excess may be used for additional closure in the early phase of a rejoin.
- After arriving on the rejoin line, Wingman must continuously adjust his (her) AOB to maintain the reference line and should begin to align his (her) fuselage with Lead's.
- **#2 will always join to the inside of Lead, in Fingertip position. #3 and #4 will cross slightly below and behind Lead, through Close Trail, in order, and at a slow and controlled pace, and join to the outside of Lead's turn, into Fingertip position.**
- #3 and 4 will NOT pass or join aircraft in front during the rejoin until the preceding aircraft has moved into position.

OVERSHOOT / UNDER-RUN

The overshoot / under-run procedure is a safety procedure that allows Wingman to get out of an unsafe situation during the rejoin phase, stabilize clear of the flight, and then safely rejoin. Wing will initiate an overshoot when any of the following situations occur:

- If Wingman becomes **excessively acute** (ahead of the desired bearing line / rejoin line, approaching the abeam position of Lead).
- If Wingman gets **acute in close** to Lead and is too close to make angle of bank corrections.
- If Wingman experiences an **excessive closure rate**.
- Whenever Wingman is **uncomfortable** and in his judgment an unsafe situation has developed.

Overshoot / Under-run Procedure

Overshoot / Under-run by simultaneously executing the following steps:

- **LOWER THE NOSE** slightly to obtain sufficient stepdown.
- **REDUCE ANGLE OF BANK and POWER** and move **BELOW** and **BEHIND** Lead to a position **OUTSIDE** the Lead's radius of turn.
- Make a radio transmission stating "2 is overshooting".
- As you pass below and behind Lead's tail, begin to match Lead's angle of bank. Do not over bank back toward the Lead in an attempt to salvage the rejoin.
- When relative motion is controlled, as noted by an absence of closure with Lead, Wingman will complete their rejoin, by clearing the area to the inside, then moving back across at a safe distance to the bearing line, then completing the rejoin in a controlled manner. (Note, if a Wingman overshoots, the other wingmen behind that aircraft must stagnate their rejoin, and leave room for the overshooting Wingman to move back on to the bearing line, then follow him to the completion of the rejoin, as normal). If required, the Flight Lead should make directive comm to direct the wingmen to avoid potential conflicts.

LEAD CHANGE PROCEDURE

The Lead Change is a maneuver designed to effect a safe and efficient change of the formation lead with the least possible degradation to flight integrity. The lead change has to occur with relative ease so there is a crisp, instantaneous exchange of Lead and Wing roles and responsibilities. If at any time there is confusion by either aircrew about who is in the lead, utilize the radios to identify the leader (use aircraft characteristics to identify the Lead aircraft, i.e. "yellow RV-7, you have the lead").

Lead Change Signal

- While in Route, Lead will initiate the lead change with either a radio call or hand signals. If hand signals are used, Lead will indicate a lead change by pointing once to the Wingman (who will be the new lead), then pointing straight ahead repeatedly in a chopping motion.
- Wing will accept the Lead by tapping his head and pointing forward in a single chopping motion . If Wing 'shakes off' the signal or does not acknowledge the signal, Lead will maintain the lead position and repeat the lead change signal.
- After the Lead change signal is accepted, the new Lead will **maintain heading and altitude**, and may smoothly move forward to facilitate the previous Lead dropping back into position.
- The previous Lead, now Wingman, will reduce power slightly, and move to a Route position on the new lead.
- If the Lead change takes place over the radio, the communication will be as follows: "Two (or Three or callsign, etc), you have the lead", followed by the Wingman stating "Two (or Three or callsign, etc) has the lead"
- After the lead change is verbally accepted, the new Lead will **maintain heading and altitude**, and may smoothly move forward to facilitate the previous lead dropping back into position.
- The actual lead change occurs upon the Wingman accepting the lead change via hand signals or radio call.

After a multi-element lead change, it is common for lead to conduct a 'check-in' over the radio.

Example: "Gringo flight check". Lead then listens to make sure Wingmen check in correctly with their new positions.

"OPS CHECKS"

Every 30 minutes during a flight, Lead should find time either in Route or Extended Trail, to call for an "Ops Check". It should be acknowledged by each wingman in sequence "twoop", "threep", "fourp". Each member should check his (her) instruments and switch fuel tanks as appropriate.

RETURN TO BASE (RTB)

To return to base as a flight, pattern entry can be from an extended initial to the Overhead Pattern, or directly into a normal VFR pattern. If a VFR pattern is used, the aircraft can land as an element / section, or separation can be taken on the base turn by each wingman. These options are discussed below.

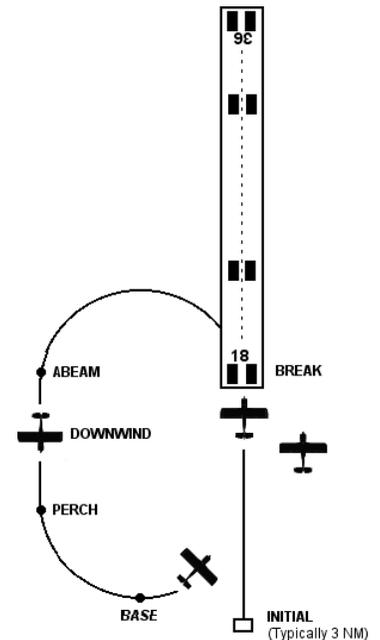
OVERHEAD PATTERN (BREAK / PITCHOUT)

- Field entry will be conducted in accordance with local Airport Traffic Area rules. Aircraft in the normal pattern have the right of way.
- Be conscious of the traffic pattern direction to ensure the flight is properly positioned for the overhead pattern (i.e., wingmen on the side opposite the direction of the break).
- Be aware of the reduced maneuverability inherent in a formation flight. This requires increased vigilance when operating in and around the airport traffic area.
- Lead will position the flight so as to arrive at an initial position approximately 3-5 miles prior to the approach end of the runway, aligned with the extended centerline of the runway, at pattern altitude (or above pattern altitude when conditions or local procedures dictate), in echelon. Lead should have the flight on the appropriate frequency well before arriving at the initial point, will follow all ATC instructions at towered airports, and will make appropriate radio advisory calls at non-towered airports.

THE BREAK When established over the numbers, or when practical after passing the numbers, Lead will pass the “break-up” signal, and 2 should acknowledge with a head nod (but should not pass the signal down the line). Lead will then pass the “kiss-off” signal, and commence the break / pitchout when traffic in the pattern allows. It is critical that Leads respect the right of way of traffic in the pattern, and conduct the break in a manner that is safe and courteous to pattern flow. The upwind leg may need to be extended to fit in with pattern flow, or the Lead may need to exit the pattern upwind, circle the field outside of the pattern, to re-enter at the initial, if pattern dynamics dictate. It is not acceptable to force a flight into a crowded pattern and disrupt normal traffic pattern flow.

- Once Lead breaks, #2 is now momentarily leading the remaining aircraft, so must maintain LEVEL flight and quickly begin a VFR scan, and will break as signaled or briefed, typically using a timed interval. It's an important concept to understand that #2 now sets the interval. When Lead breaks, everyone starts counting, when #2 breaks, **the onus is now on #3 and #4 to match that interval.**
- During the break / pitchout, it is critical for each Wingman to **keep the aircraft in front of them on the horizon**, DO NOT climb or descend during the break / pitchout OR on downwind leg.
- Each aircraft will roll to establish an angle of bank of approximately 60°, smoothly pulling approximately 2 Gs, THEN reducing power to idle (or as briefed), while making a 180° **LEVEL** turn to the downwind leg.

Fixed pitch aircraft should pull power smartly to idle, whereas constant speed aircraft should pull the power smoothly back so as not to “stop” in front of a fixed pitch. All aircraft should attempt to roll out at 87 KIAS / 100 MPH (flap speed) directly behind the aircraft in front, **at the same altitude**, approximately 800-1000 feet in trail, and begin to lower flaps immediately to control airspeed. It is not required, but common practice for flaps to be configured to FULL while on downwind, with power up to **maintain** 87 KIAS / 100 MPH until the Perch turn. **DO NOT GET SLOW!** In any case, each aircraft must **maintain 87 KIAS / 100 MPH and altitude** on downwind, until arriving at the Perch. Each wingman will follow Lead's ground track, maintaining **Lead's break altitude** until arriving at the Perch. **DO NOT DESCEND PRIOR TO THE PERCH!** Each wingman will **fly the same track** and airspeeds as Lead. Be prepared for wake turbulence and prop wash from the preceding aircraft.



THE PERCH Lead will adjust for winds and *maintain altitude* until beginning his (her) base turn. This turn point is called the Perch. At the Perch, Lead begins his / her base turn.

APPROACH TURN Leaving the Perch, Lead begins the base turn, reduces power, and extends flaps further as necessary to descend while slowing to 78 KIAS / 90 MPH on base.

Turning final, slow to 70 KIAS / 80 MPH. Each wingman should maintain interval on the aircraft ahead, follow Lead's ground track, and match Leads airspeed. Be prepared for wake turbulence and prop wash from the preceding aircraft.

- To maintain appropriate interval on the aircraft ahead, use lead or lag to maintain the appropriate distance.
- If a safe interval cannot be maintained, a go-around should be executed.
- The pattern should be flown to arrive at a nominal 1/4 mile final, traffic permitting.
- DO NOT allow the pattern to get strung out by extending past the preceding aircraft's turn point (the Perch).

RADIO COMMUNICATIONS DURING AN OVERHEAD PATTERN ENTRY Lead must communicate the flight's position and intentions when entering the pattern for an overhead entry. At towered airports, Lead should check the flight in, then contact tower with an initial position report, and a request for the overhead. Follow all ATC instructions with respect to initial distance, overhead altitude, and direction of the break turn. Tower may assign an altitude above the normal pattern altitude for the break, so Lead and all wingmen must be cognizant and compliant with instructions. At non-towered airports, it is critical that Lead communicate position and intentions in a concise manner that is clear to local traffic. Knowing that all pilots are not familiar with the terminology associated with overhead entries, the following is a list of *recommended* radio calls for use by FFI formations when entering the pattern via an overhead:

- First call: "XXX traffic, Red Flight of 4 RVs, 10 miles north, will enter straight-in Initial to the overhead pattern, left traffic, 26, XXX"
- At the 3-5 mile initial: "XXX traffic, Red Flight of 4 RVs, 5 mile initial, straight-in to the overhead pattern, left traffic 26, XXX"
- At the numbers: "XXX traffic, Red Flight of 4, over the 26 numbers for the overhead, left traffic 26, XXX"
- In the break: "XXX traffic, Red Flight of 4, in the break, left traffic 26, XXX"
- Downwind: "XXX traffic, Red Flight of 4, left downwind, full stop, 26, XXX"
- Base and Final: "XXX traffic, Red Flight of 4, left base and final, full stop, 26, XXX"
- Clear of Runway: "XXX traffic, Red Flight of 4, clear of 26, XXX"

Notes: XXX refers to the airport name. All calls should be clear and concise. Calls should be made as close to the above positions as possible, but timing and position may need to be modified if other traffic is transmitting on the frequency. Radio discipline and courtesy to other aircraft in the pattern is critical. Every flight is an ambassador for the formation community, so fly the aircraft, integrate into the pattern, and communicate in a manner that reflect well upon the formation community and FFI.

LANDING FROM THE BREAK (PITCHOUT)

After touchdown, it is important for the lead aircraft, (and subsequent Wingmen, if the flight consists of more than 2 aircraft), to avoid normal ground braking. Let the aircraft roll longer than the typical rollout to provide sufficient spacing for the aircraft following.

LANDING OPTIONS

Option 1: Centerline - Cold or Hot - Cold

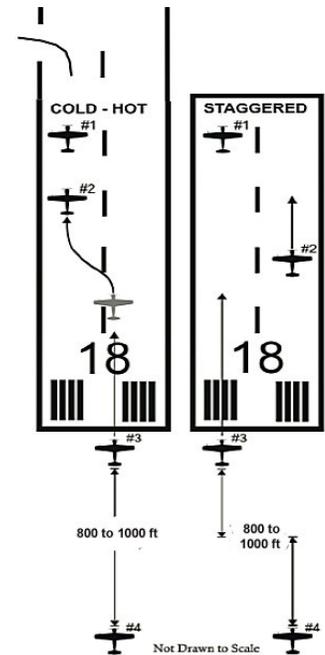
- Land on the centerline of the runway and, when “under control”, move to the **Cold Side**, which is the side of the runway the aircraft will exit from. This method provides for the **Hot Side** to be always available for passing or go-around, if necessary. This is the RV preferred method. It is also a valid technique to land on the hot side and transition or “fade” to the cold side when under control. Lead should brief the procedure to be used.

FLY YOUR AIRPLANE!

ALWAYS BE PREPARED FOR WAKE TURBULENCE

Option 2: Staggered

- All members land on alternate sides of the runway with a flight member on the Cold (Turn Off) Side calling “(Call Sign), **Cold**”, or “**3’s Cold**” to a member in front on the Hot Side when speed and closure is appropriate to cross over.
- The lead aircraft must NEVER turn to cross the path of the wingman as he (she) exits the runway, without being assured that the wingman has his (her) speed under control.



VFR PATTERN ENTRY - DOWNWIND BREAKUP

When a normal VFR pattern is required, Lead configures the flight in echelon away from the runway, maintaining an airspeed slightly above flap speed. A downwind entry is preferred, but a shallow 45 degree entry may be used. It is important to minimize any turns into the echelon. Lead will ‘kiss off’ the flight prior to the Perch, as he (she) prepares to turn to his (her) base leg. Each member then takes their own interval as they turn to base. Flaps will be lowered as each aircraft departs the Perch on the turn to base. Proper airspeed control is critical.

FORMATION LANDINGS - LANDING AS AN ELEMENT (SECTION)

Both aircraft will enter the pattern together as a flight of 2, in compliance with normal pattern rules. Lead should slow earlier than normal and configure the element / section sooner than normal. Plan to be at 87 KIAS / 100 MPH by mid-field downwind, with flaps extended.

- Extend Flaps to at least 10° on downwind. Flaps should be in their landing configuration prior to turning to base.
- Standard speeds to be flown:

Downwind	87 KIAS / 100 MPH
Base	78 KIAS / 90 MPH
Final	70 KIAS / 80 MPH
- Speeds other than those listed above may be briefed by Lead to suit the requirements of participating A/C.
- Lead may consider using less than full flaps, while Wingman uses full flaps, creating a drag advantage for Wing.
- Flap extension will be prefaced with a hand signal: **thumb and fingers together, opening and closing followed by a head nod to execute.**
- Approaches shall be flown wide and shallow and with power ON. Lead will limit angle of bank and rate of descent.

- It is desirable, but not mandatory, for Lead to position the Wingman to be on the OUTSIDE of the downwind, base and final turns in the landing pattern.
- When the Wingman is on the outside of the turns in the landing pattern, these turns should be flown as echelon turns (not as welded wing turns). This allows the Wingman a better power advantage as the aircraft slow, and as gear and flap transitions are made.
- Once on final, Lead should position Wingman on the upwind side of the runway, if a crosswind is present.
- All taildragger element / section landings will be "Wheel" landings. Tail low wheel landings preferred.
- On final, Wingman will fly a slightly higher than normal position, acute of the normal Fingertip Position, and will line up his (her) leading edge with Lead's trailing edge.
- Lead will line up on 1/2 of the runway.
- On short final, Wingman will increase lateral separation to line up on opposite half of runway. Wingman will also remove any stepdown, and fly level with Lead at this point.
- Lead will carry some power all the way through touchdown.
- After touchdown, Lead keeps the tail up and maintains a little power to allow Wingman a drag advantage. Once the rollout is stabilized, Wingman will pull power and fade to trail. If desired, Wingman can initiate gentle braking to establish more nose to tail separation.
- If the runway exit is on the Wingman's side, Wing calls "2's cold" when it is safe for Lead to fade across Wingman's path, to the cold side (exit side).
- Lead will not cross in front of Wing to make a turnoff until Wingman calls "Cold".
- Lead will taxi clear of the runway, and stop in a position to wait for the rest of the flight to clear before continuing.
- Wingman matches Lead's configuration for taxi in. (Flaps, canopy, etc)

TAXI BACK and SHUT DOWN

- **Taxi back** Lead will exit the runway onto an appropriate taxiway, and if feasible, make a 45° turn to wait for the remainder of the flight. Each Wingman, in succession, will pull up to within one plane width of Lead, and execute the same 45° turn to parallel Lead. When all Wingmen are aboard, Lead will make any radio calls as are appropriate, and taxi back to the parking area.
 - If Lead taxis on centerline, Wingmen follow close in trail, about 1 plane length clearance between planes.
 - If Lead staggers to the left or right of centerline, Wingmen will alternately taxi on opposite sides of the taxiway. #3 and #4 will line up centerlines of their aircraft with #1 and #2 in front of them.
 - Lead will use an elevator flutter, small porpoising, **to signal a move from stagger to trail**, if desired. Wingmen all need to pass this signal by rocking their elevators in the same manner.
 - Wingmen will match Lead's configuration for taxi back to the extent possible. (Canopy, flaps, etc)
- **Shutdown** Each aircraft turn into parking spots as appropriate. Lead may command a turn with a radio call such as "Gringo flight, right (or left) 90..... NOW". If pre-briefed, watch Lead for the shutdown signal, a large head nod, and shut down engines on that signal.

DEBRIEFING

- All formation flights will be thoroughly debriefed. This is a critical tool of the formation program. The Flight Lead will restate the objectives and review how the flight performed in all phases from planning and briefing to engine shut down, with emphasis on what occurred, why it occurred, and how to improve in the future. Each member of the flight will be given an opportunity to critique the flight, the self-critique being an important component of each debrief.

**WINGMEN!
DO NOT BE THE LAST ONE
INTO THE BRIEFING ROOM!**

EMERGENCY PROCEDURES

ABORTS

INDIVIDUAL ABORTS

The aborting aircraft (or element / section as the case may be) must maintain aircraft control, ensure separation from other aircraft and communicate their actions using the radio as soon as practical. "Falcon 2 is aborting". During a formation takeoff, there will be **no sympathetic aborts** by Wingman or Lead within the element after brake release. If one member of the element must abort the takeoff, the other flight member will add power and continue, provided it is safe to do so.

DUAL AIRCRAFT (ELEMENT / SECTION) ABORTS

If both aircraft in the element / section must abort, due to such conditions as a fouled runway or runway incursion, lead should transmit, "Falcon Flight, ABORT, ABORT, ABORT" Both aircraft must maintain their respective side of the runway.

TRAILING ELEMENT / SECTION ABORTS

In four ship, or mass formations, if the trailing (following) element / section has not released brakes when an abort is recognized or communicated, they will hold position. If they have released brakes, and someone in front of them has aborted, they will execute an immediate element / section abort.

ABORT PROCEDURES

The aborting aircraft will transmit "Falcon X aborting". If the aircraft are conducting staggered interval takeoffs (i.e. maintaining opposite sides of the runway throughout the takeoff roll), the aborting aircraft will maintain their side of the runway during the abort, to the extent possible.

AIRBORNE EMERGENCIES

During an airborne emergency a Chase aircraft will fly no closer than required to observe the mishap aircraft without becoming a distraction, or endangering their aircraft from the other aircraft's abrupt maneuvering due to loss of control, structural failure, etc. Avoid flying directly behind damaged aircraft. Chase should fly a position from which to observe the damaged aircraft, but otherwise remain silent unless absolutely required or requested by the damaged aircraft. **"Over-helping" may distract from performing critical steps in resolving the emergency.**

ENGINE / POWER PROBLEMS

Should a pilot of an aircraft experience engine/power problems, do not delay recovering the aircraft for landing, due to formation considerations. Immediately pitch up and out of the formation, as possible. Do not delay turning toward the nearest landing field. Announce intentions over the radio. A chase aircraft will be provided by the Lead or Alternate Lead. Chase should fly a safe position from which to observe the distressed aircraft, but otherwise remain silent unless assistance is requested.

AIRCRAFT MALFUNCTIONS

If any other aircraft malfunction occurs while in close (parade) formation, ensure aircraft separation before handling the emergency. The pilot of an aircraft experiencing an abnormal situation will advise the Flight Lead of the problem, intentions, and assistance required.

LEAD

If possible, move the flight to route formation first, then deal with the malfunction. If the pilot with the malfunction can transmit and navigate, offer him/her the lead so you can fly support. There are some emergencies where Lead should retain the lead.

WING

When an aircraft malfunction or emergency occurs, call "Knock It Off" and inform Lead of the problem. Normally, if the aircraft in distress is able to communicate with outside agencies and navigate, they should take the lead when offered. **As much as possible, avoid flying too close to an aircraft with an emergency. Fly no closer than route formation, and do not distract the pilot of the emergency aircraft.**

AIRBORNE EMERGENCIES (continued)

RADIO FAILURE / LOST COMM

If an aircraft experiences a partial or total radio failure (NORDO), either transmit and/or receive functions, the flight should be terminated and the no-radio (NORDO) aircraft will assume or retain the wing position and be led back to the field of intended landing, or to a divert field if pre-briefed. A formation approach to a drop-off on final should be performed - unless safety, pilot qualification, weather or other considerations dictate otherwise. The lead pilot will inform the tower or applicable controlling agency and coordinate. Once the flight is established on final with landing clearance received, the lead pilot will give the distressed pilot the "you've got the lead" hand signal, the distressed pilot will give the acceptance signal. The support pilot will then execute a single-ship go-around, thus allowing the NORDO aircraft to complete the landing as a single ship. In most cases the support pilot will accomplish the drop off at or above 300 feet AGL.

If the flight recovers using the overhead pattern, once the aircraft separate at the break, if Lead lands, all aircraft in the flight are assumed to have landing clearance, although the NORDO pilot must be cognizant of the possibility of tower-directed light signals for landing clearance.

RADIO FAILURE AS LEAD

Give the appropriate visual signal to pass the lead to either #2 or #3.

RADIO FAILURE AS WING

While in close or route formation, maneuver within close/route parameters to attract the attention of the flight or element lead and rock your wings to alert the flight/element lead you require assistance. If flying in any other formation, such as extended trail, approach your flight/element lead, but do not rejoin closer than two to four ship-widths. Rock your wings to gain your flight or element lead's attention and wait for him/her to pass the visual rejoin signal before proceeding. When signaled, rejoin and pass applicable NORDO visual signals. Expect to be led back to the briefed recovery field following the procedures contained in this section.

BREAK OUT PROCEDURE

The purpose of a Break Out is to ensure immediate separation and to avoid a mid-air collision. A Wingman **MUST** Break Out of a formation if:

- They lose sight of their formation reference aircraft.
- They are unable to rejoin or stay in formation without crossing directly under or in front of Lead.
- They feel their presence in the formation constitutes a hazard.
- When directed to do so by Lead.

LOST SIGHT (Break Out required)

If a Wingman loses sight of their formation reference aircraft while in a close formation, then a Break Out is required. To Break Out of a formation, immediately find a clear area, and maneuver towards the clear area. This clear area is the safest direction, away from the last known position or flight path of the Lead and other aircraft. In a dynamic situation, it is imperative that a Wingman that has lost sight (aka a "Blind" Wingman) not hunt for their reference aircraft; if a Wingman has lost sight, then an immediate Break Out is required. In most cases, the clear escape area is "above" the pilot, or along the aircraft's pitch axis or lift vector if the formation is not straight and level. Therefore, an "Up and Out" maneuver, away from the formation, would be appropriate. Situational awareness of where Lead and other aircraft are is critical, and formation pilots must always know where their "out" is. Be aware of Wingmen that may be affected by the Break Out; For example, if #3 in a 4-ship fingertip formation must Break Out, they must be mindful of aircraft on their wing.

Call the Break Out and direction, ***“Mustang 2, Breaking Out, up and to the right”***

If the Leader replies with ***“Visual”***, the Wingman will follow Lead’s instructions to rejoin the flight.

If the Leader does not have visual contact with the Wingman, the Leader will also call ***“Blind”***, and will ensure immediate altitude separation, by calling their altitude (***“Mustang Lead is Blind, 4500 feet”***). The Blind Wingman should echo the call with their altitude. Lead will cease maneuvering and put the remainder of the flight in a route position. At this point any aircraft that has the situational awareness to help the flight regain visual can make a call, i.e. ***“Mustang Lead, 2 (i.e., the Blind Wingman) is at left 10 o’clock, slightly high.”*** Once the Lead regains visual contact, they will direct the Blind Wingman as necessary to regain visual contact and rejoin the flight.

If the Flight and the Blind aircraft do not regain visual contact, they will then work towards a common reference point (ground reference point, Waypoint, or Radial/DME) until visual contact is regained. The Leader will be directive, and will ensure altitude separation is maintained until the visual contact is regained, or until RTB is directed.

LOST SIGHT (Break Out not required)

There may be situations where a Wingman momentarily loses sight of their formation reference aircraft while maneuvering, but a Break Out is not warranted. This occurs when spacing between aircraft is such that a mid air collision is not an immediate concern. Examples would be losing sight during or after rolling out from a pitch-out, during a rejoin, or during fluid maneuvering exercises, such as Extended Trail maneuvering.

In these situations, when proximity does not warrant an immediate Break Out, the Blind Wingman will call: ***“Mustang 2 Blind, 4500 feet”***, and lag the last known position of the reference aircraft. The Leader will be directive, as described above, to get the flight back together.

If there is any question to safety of flight then the proper call is: ***“Mustang 2 Knock It Off, Blind at 4500 feet”***. The flight in turn will cease maneuvering, mimic the KIO call, ensure altitude separation, and remain in a predictable flight path while using the techniques described above to regain visual contact. In all cases the Leader will be directive.

MIDAIR

The affected aircraft will immediately take separation and individually sort out the level of damage. Lead will ensure separation laterally and vertically, if possible. The non-mishap aircraft will provide chase duties. Do not delay recovery; turn toward the nearest divert field, if possible.

BIRD STRIKE

While in close formation, care must be taken ***not to cause a mid air collision*** attempting to avoid an imminent bird strike. If a bird strike does occur, gain separation before handling the emergency. The most critical conditions due to bird strike are engine or prop failure, airframe structural damage, or cockpit penetration. Consider being led back for a wing landing if forward visibility is severely restricted.

SEARCH AND RESCUE (SAR)

In the event an aircraft in the formation executes a forced landing, steps must be taken immediately to positively locate the downed aircrew and initiate rescue efforts.

The following are suggested specific SAR actions that should be made to assist in the location and recovery of a downed pilot/aircrew.

Respond

Immediately terminate maneuvering using appropriate Knock-It-Off procedures. Establish a SAR commander, normally the Flight Lead. Remain above the last known/observed position. De-conflict other aircraft and flight members assisting in the SAR effort by altitude to preclude mid-air collision.

Squawk

Squawk the emergency code to alert air traffic control.

Talk

Immediately communicate the emergency situation to the applicable air traffic control agency. Inform them of your intentions to provide airborne search and rescue support.

Mark

Mark the last known, or currently observed positions of the survivors or crash site using GPS or any other means available, such as radial/DME, ATC radar positioning or ground references. Communicate this information to ATC to assist in subsequent rescue efforts.

Assess

The Flight Lead should attempt to assess the survivors condition visually. This information should then be relayed to applicable controlling agencies/ATC to assist responding rescue assets.

Bingo

Revise bingo fuel and/or recovery bases as required to maintain coverage over survivors and/or crash site.

KNOCK-IT-OFF CALL

Initiation of a knock-it-off will begin with the flight call sign, and “knock-it-off.” If prudent, a short description of the hazard may be included, such as hard deck or traffic. This call will be followed by the flight acknowledging the call, in order. In the following example, Raven flight is flying an extended trail, fluid maneuvering exercise when Raven 3 realizes the flight is quickly approaching the briefed hard deck (lower altitude limit for maneuvering):

“Raven 3, knock-it-off, hard deck”

“Raven 1, knock it off” (Flight Lead)

“Raven 2, knock it off”

“Raven 3, knock it off”

“Raven 4, knock it off”

If a MAYDAY call is necessary, use it. The rest of the flight will check in with “knock it off”.

GLOSSARY of TERMS

~IMPORTANT NOTE~

In this, and other manuals, certain Air Force and Navy terms are used interchangeably. It is important to have a knowledge and understanding of both terms, and to realize that in some cases, different terms may be used to mean the same thing. In those cases, and throughout this manual, the Air Force term is listed first and the Navy term is listed second.

ABEAM: A line abreast position, either left or right, which is 90° off the longitudinal axis of the LEAD aircraft.

ACUTE: A condition in which the Wingman is incorrectly positioned forward of a designated bearing line. Opposite of SUCKED.

BEARING or BEARING LINE: An imaginary line drawn from the Lead to the Wing aircraft. Usually identified by selected visual checkpoints and referred to as an angle off the longitudinal axis of the lead aircraft.

BINGO FUEL: The fuel state at which the flight must return to base. A predetermined fuel remaining figure, which will allow the safe return to base plus sufficient reserves.

BLIND: A term used to communicate visual contact is lost with a member of the formation while maneuvering in VMC. Opposite of VISUAL.

BREAK: The breakup of the formation over the runway when a flight executes a 360° overhead entry into the traffic pattern. Also called PITCHOUT.

BREAK OUT: An immediate action maneuver where a pilot must rapidly devote full attention to clearing his / her aircraft from the formation or area.

BREAKUP: (Pitchout) A maneuver utilized to separate formation aircraft and establish them in trail.

CALL SIGN: The code word or words that designate a flight, usually selected by the Flight Leader.

CHECKPOINT: A selected point or set of points on the lead aircraft, which are utilized by the Wingman to determine line of position. (LOP)

CLOSE TRAIL: A formation position in which Wing is directly behind Lead. For RV to RV Close Trail the Wingman should fly below Lead's aircraft, placing the tailwheel on Lead's head, ½ to ¾ airplane length behind.

CLOSURE RATE: Overtake created by airspeed or angular advantage; can be positive or negative.

CROSSUNDER: A maneuver utilized to change the position of the Wing aircraft from one side of Lead to the other.

DASH TWO, DASH THREE, ETC.: A term used to refer to successive Wingmen in a formation.

DIAMOND: A 4-ship formation which places #2 and #3 on either side of Lead in Fingertip, and #4 in trail behind Lead, in the "slot".

ECHELON: Formation which places all Wingmen on one side of the leader. Normally, turns are away from the Wingmen, who fly a level turn with the leader.

ELEMENT / SECTION: A flight of two aircraft. The element / section is the basic fighting element and is self-supporting covering each other's six o'clock in combat (real or otherwise), and providing back-up on routine flights with radio or equipment malfunctions in addition to moral support and good company.

EXTENDED TRAIL: Trail formation flown with 500' - 1000' spacing between flight members.

FINGERTIP / PARADE: Close formation position on Lead's 45 degree bearing line. For RV to RV formation, line up the outside aileron hinge bolt on the prop spinner for the primary line of position (LOP), then look for a small amount of opposite side elevator tip behind the rudder to fix a point on that primary LOP. This reference establishes correct fore/aft (bearing), up / down (stepdown), and side to side spacing.

FINGERTIP FOUR / FINGER FOUR – A formation shape where #2 is on one side of Lead, and #3 and #4 are on the other side of lead.

FLIGHT / DIVISION: Four aircraft, consisting of two elements / sections, each with it's own leader, but under the command of the lead element's leader, who is designated "Flight Lead." The flight is usually led by the most experienced pilot, with the second element leader as his deputy Flight Lead.

FLIGHT INTEGRITY: The ability of the Wingmen to maintain the proper relative position while the formation is performing maneuvers.

FORMATION: A disciplined flight of two or more aircraft under the command of a fight leader using a standardized set of signals and commands to direct the Wingmen.

"GIMME ONE" or "GIMME SOME" Wingman call to Lead when he has insufficient power to keep up, asking Lead to reduce power by one inch or more of manifold pressure.

GO: Radio frequency change command from Lead, requiring response from Wingman.

HEFOE Signals: for Inflight Emergencies - If radio does not work, the following number (by raised fingers) indicate the nature of the emergency:

- 1- Hydraulic
- 2- Electrical
- 3- Fuel
- 4- Oxygen
- 5- Engine

INITIAL: Refers to the approach to the runway prior to performing a 360° overhead break. Usually a point 3 to 5 miles prior to the approach end of the runway, at pattern altitude, aligned with the extended centerline of the runway.

KISSOFF: Signal passed by Lead to the rest of the flight just before the Break or pitching out.

LAG PURSUIT: A maneuver used by Wing when Lead is in a turn to increase nose-to-tail separation and range. Wing maneuvers to the outside of Lead's turn by pointing the nose of the aircraft behind Lead's tail.

LEAD PURSUIT: A maneuver used by Wing when Lead is in a turn to decrease nose-to-tail separation and range. Wing maneuvers to the inside of Lead's turn by pointing the nose of the aircraft in front of Lead.

LOST SIGHT: Term used by the Wingman to communicate he has lost visual contact with the lead aircraft

NO JOY: Term used to indicate that you have not visually acquired your target or traffic. Opposite of TALLY-HO.

NOSE-TO-TAIL: The distance from the nose of the wing aircraft to the tail of the lead aircraft.

OVERSHOOT / UNDER-RUN: A maneuver utilized to allow the Wing aircraft to pass below, behind, and outside the Lead aircraft's flight path in the event the rejoin / rendezvous closure rate becomes excessive..

PLANE OF MOTION: An imaginary plane defined by the aircraft's flight path.

PURE PURSUIT: A maneuver used to follow Lead's flight path in a turn. Wing maneuvers by pointing the nose of the aircraft directly at Lead. Nose-to-tail separation and range will decrease slightly but with a slower closure rate than lead pursuit.

PUSH: Radio frequency change command from Lead, with NO response from Wingmen.

REJOIN / RENDEZVOUS: - A maneuver in which the formation aircraft are maneuvered into a position where a join-up is performed. To join the flight on the leader.

ROUTE / ENROUTE: A wider-spaced formation, usually used during cross country or transit flight, to reduce Wingman fatigue and improve lookout doctrine. Route formation is flown 2 to 4 ship widths wide, and forward of the normal reference, aligning the leading edge of the wingtip on the spinner. In turns, aircraft on the inside will maintain the approximate normal route reference and stack down far enough to keep Lead and other airplanes comfortably in sight. Aircraft on the outside of the turn will turn level with Lead by putting Lead on the horizon. (Similar to a slightly wide echelon turn).

SHAKE OFF: A visual signal given by the Wingman to indicate he does not understand the Lead's signal or is not prepared to execute the next maneuver or required action. Shake off is giving a head shake back and forth indicating "negative."

SMASH: Airspeed or Energy. Normally used to denote energy available.

STAGNATE: A condition during the rejoin where the wing aircraft ceases to continue closing on the Lead aircraft.

STEP DOWN or UP: The vertical distance of the Wingman below or above the Lead aircraft.

STRONG RIGHT or LEFT: Indicates the side of the 2nd Element / Section in a 4-ship formation.

SUCKED: A condition in which the Wingman is incorrectly positioned aft of a designated bearing line. Opposite of ACUTE.

TALLY HO: Term used to indicate that you have visually acquired your target or traffic. Oppose of NO JOY.

TERMINATE: A call used to cease the maneuvering of all aircraft in a flight when the learning objectives have been achieved, or are not achievable. "Terminate" is a directive call, sometimes used to cease maneuvering for reasons other than safety of flight. However, it is not expected, or desired, that Flight Leads use "Terminate" to end each maneuver during a training or evaluation flight.

TURN RADIUS: The distance between an aircraft's flight path and the center of the turn circle.

TURN RATE: The change in heading expressed in degrees per second at which an aircraft is turning.

VISUAL: A term used to communicate positive visual contact with an aircraft in the formation. Opposite of BLIND.

2020 Summary of Changes

Page 2: HAND SIGNALS

- Added FAST Formation Pilots' Knowledge Guide as reference for graphics of typical hand signals

Page 2: AIRCRAFT LIGHTING POLICY/PROCEDURES

- Added new subsection

Page 2: TRANSPONDER AND ADS-B POLICY/PROCEDURES

- Added new subsection
- Clarified FAA and FFI guidance for Lead to squawk transponder and ADS-B for the flight

Page 7: ECHELON AND ECHELON TURNS (2-ship)

- Retitled subsection
- Expanded verbiage on 2-ship echelon turns, added operations where 2-ship echelon turns should be performed, and clarified that sight picture is to hold bottom of the fuselage of the Lead aircraft on the horizon
- Replaced diagram with updated version showing the updated sight picture

Page 11: ECHELON

- Changed from three or more wingmen to two or wingmen on a single side of the lead (right or left).

Page 11: ECHELON TURNS

- Expanded verbiage and clarified that sight picture is to hold bottom of the fuselage of the aircraft ahead on the horizon.
- Replaced diagram with updated version showing the updated sight picture

Page 17: FORMATION LANDINGS - LANDING AS AN ELEMENT (SECTION)

- Re-ordered and updated verbiage in top 3 bullets on this page, to align with the echelon discussion on pages 7 and 11.