



# RV FORMATION GUIDELINES AND STANDARD PROCEDURES

February 2013 Rev 2.4

The ***RV Formation Guidelines and Standard Procedures*** 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. The sources include, but are not limited to, the T-34 Association Formation Flight Manual, 4th Edition, the FAST National Formation Manual, and the RV Supplement, 1st Edition. This Guideline reflects, as best possible, in a short format, the Formation Flying, Incorporated (FFI) standards.

## PRE-FLIGHT BRIEF

- All formation flights will be briefed thoroughly, without exception. If aircraft 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.

## RADIO PROCEDURES

- Frequency changes will be either thru 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.

### NOTE

The flight leader will include the number of aircraft in the flight and his/her tail number on initial contact with Air Traffic Control

## 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.
  - 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. Even tail-end Charlie rocks his (her) elevator for formation integrity.
  - Wingmen will match lead's configuration for 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

### SECTION / ELEMENT TAKEOFF

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 section takeoffs will be performed with the flaps UP.
- Lead should consider the crosswind component, as well as the makeup of his flight before opting for a section / element takeoff. Section / element 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 insure that his (her) prop wash does not affect the wingman during the takeoff roll. Lead must taxi down far enough to insure 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 "wing-abreast" 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 insure that each aircraft can clear the other in case of an abort or 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.

## **SECTION / ELEMENT TAKEOFF - (continued)**

- Lead signals run-up with a twirled finger above the head.
- Both aircraft firmly hold their brakes, and run up to 1700 RPM, 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. Both aircraft 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 build to the takeoff power setting, which is somewhat less than full takeoff power. Setting correct takeoff power will be difficult, and learned thru experience and practice.

- A smooth rotation should be at a slightly higher than normal speed, approximately 70 mph (60 knots).
- Once airborne, Lead will slowly accelerate to 115 MPH (100 KIAS) or as briefed.

If the power was set correctly on take off, no further reduction will be necessary to maintain 115 MPH (100 KIAS) in the climb. If Lead's power setting is too high, Wing can transmit "gimme some".

- Any aircraft aborting should announce "\_\_\_'s aborting" on the radio, i.e. "2's aborting". If multiple elements are operating on the same frequency, or if there are sub-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 section / element in front, has lifted (daylight under the wheels) before the wingman (or second section / element) starts his (her) takeoff roll.
- It is essential that Lead, or lead section, begin a power and/or RPM reduction as soon as practical after takeoff, to allow Wing, or the subsequent section, some power advantage.
- The lead will accelerate to and maintain 115 mph (100 knots), or as briefed. Lead will normally extend takeoff leg slightly before starting a shallow turn to facilitate the join-up.
- Following Wingmen / Element Leads should expect prop wash turbulence right after takeoff and offset slightly to avoid it, or to get themselves 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, 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 115 mph (100 knots). Lead will push the power up as high as possible once all wingmen are aboard. Wing will call "gimme some" if necessary. Climb out is normally conducted in either fingertip or route formation, or both.

## ROUTE

- Lead gives the ***fishtail signal by small movements of right and left rudder*** to move wingmen from any formation to Route. Route formation is flown at, and forward of the normal reference, ***aligning the leading edge of the wingtip on the spinner***. In turns, members on the inside will maintain the normal route reference (down), but members on the outside of the turn will turn level with Lead by putting Lead on the horizon. (Echelon turn).

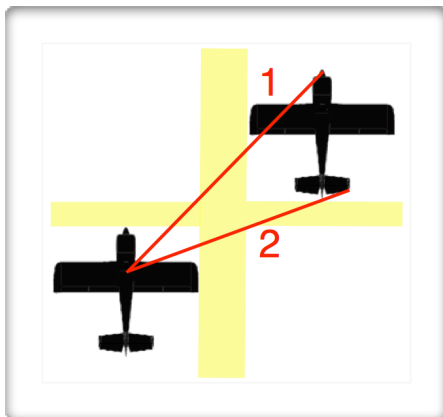
NOTE: Lead should give position changes, frequency changes, Ops checks (in-flight checks to include any prescribed checklists and periodic systems and fuel quantity checks) while in route position.

### 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.

## BASIC RV FORMATION POSITIONS

### FINGERTIP POSITION



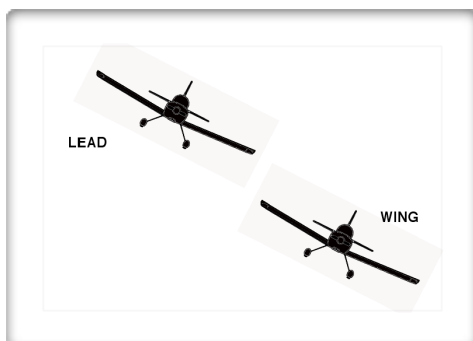
For RV to RV formation, **1** - line up the outside aileron hinge bolt on the prop spinner for the primary line of position (LOP), then **2** - look for a small amount of opposite side elevator tip behind the rudder to fix a point on that primary LOP. This reference establishes fore/aft (bearing), **3** - up / down (stepdown), and side to side. Clearance is provided in all 3 axis.

With a constant speed prop, maintain 2500 RPM or greater, within a range of 2500 to 2700 RPM.

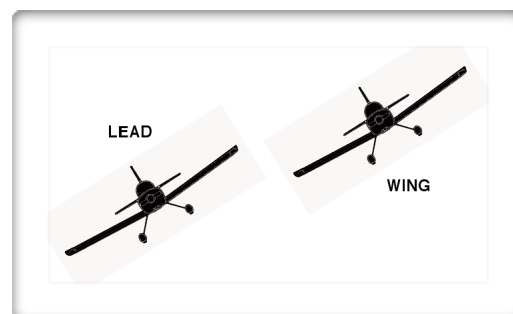


### FINGERTIP TURNS

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



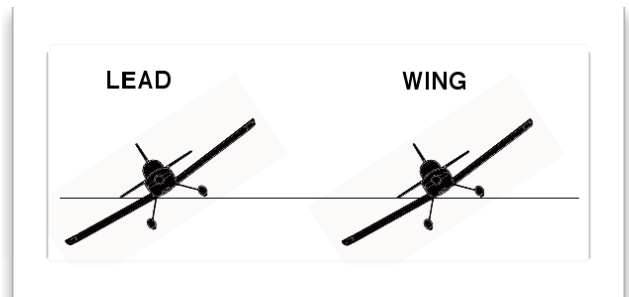
**FINGERTIP - TURN INTO**



**FINGERTIP - TURN AWAY**

## ECHELON TURN

Wingman maintains the same angle of bank as Lead but remains level with the horizon. The sight picture for Wing is to hold Lead on the horizon. 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 Wing should fly so as to be in the correct reference Line of Position when Lead rolls out of the turn.

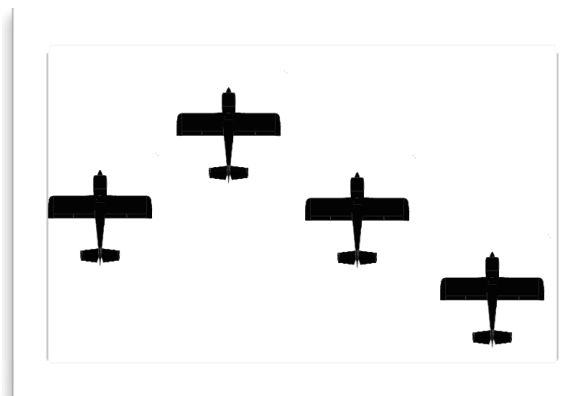


## 4-SHIP FORMATION

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 reference 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.

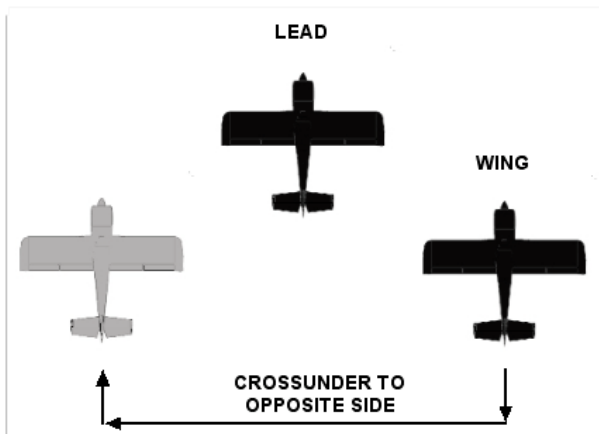


**FINGERTIP FOUR (STRONG RIGHT)**

## 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. #2 and #3 need to make eye contact, #3 will move the second section out, providing space for #2. 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 section (#3 and #4), Lead will signal with **arm bent at 90°, fist clenched, with two arm pumps**. When the 2nd section is moving across, below and behind the first section, the wingman in the 2nd section (#4) will also, simultaneously and automatically, without being signaled to do so, move further across his 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 (#2 and #3). #2 and #3 make eye contact, #2 waits as #3 moves his 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. #4 should fly very slightly stepped up to be able to see Lead's signals. If #4 does not move, Lead assumes he did not see the signal, and gives it again, in which case #3 relays 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 TRAIL** Lead gently porpoises his airplane several times. #2 slides back and behind lead, #3 moves behind #2, #4 moves behind #3.

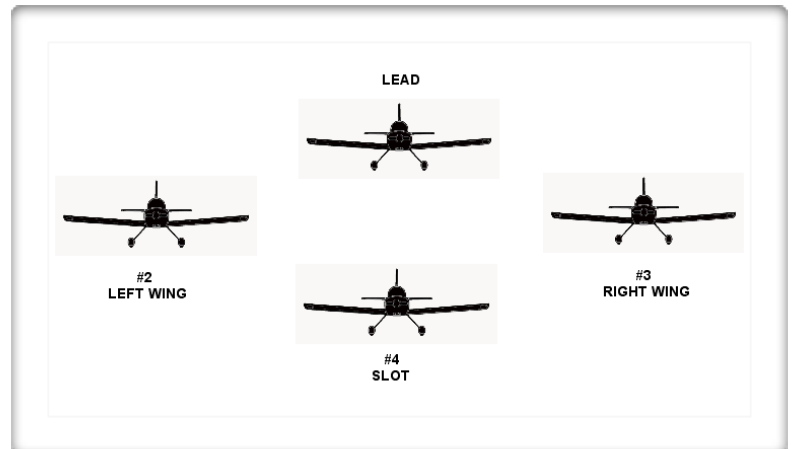
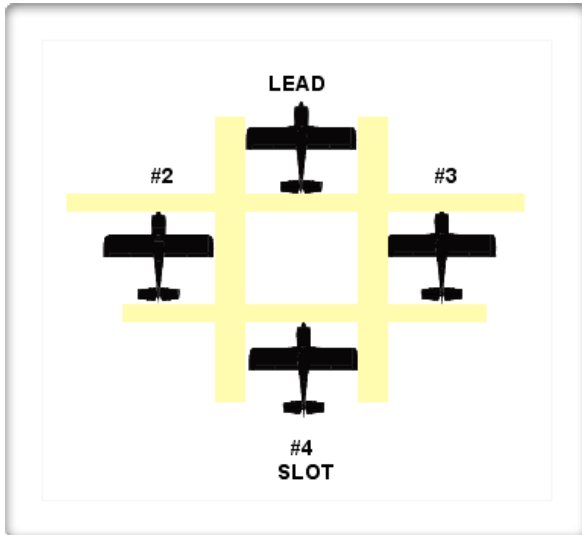
**TRAIL to FINGERTIP** Lead rocks his wings several times, then starts a shallow turn. #2 rejoins on Lead's inside wing, #3 and #4 rejoin on Lead's outside wing.

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

## DIAMOND

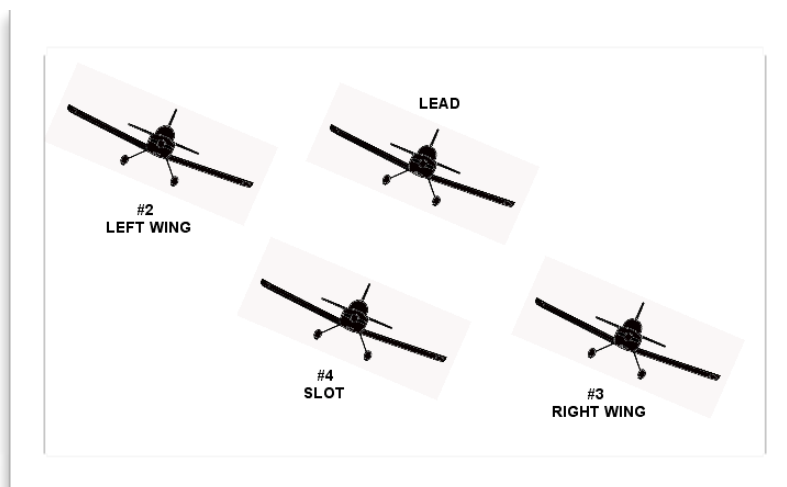
The formation enters Diamond from Fingertip. Lead signals #4 to the slot position with **arm bent at 90°, four fingers extended, then closed with thumb pointing rearward, motions aft**. #3 may need to relay this to #4. #4 call's "4's in" when established in position in the slot. Or, if briefed, #3 will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



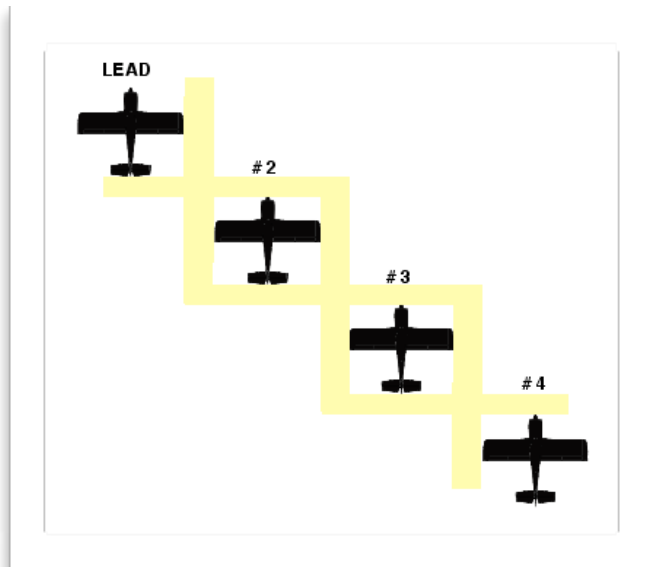
## DIAMOND TURN

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

Up to three wingmen on the bearing line (Line of Position), all positioned on one side or the other 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.**

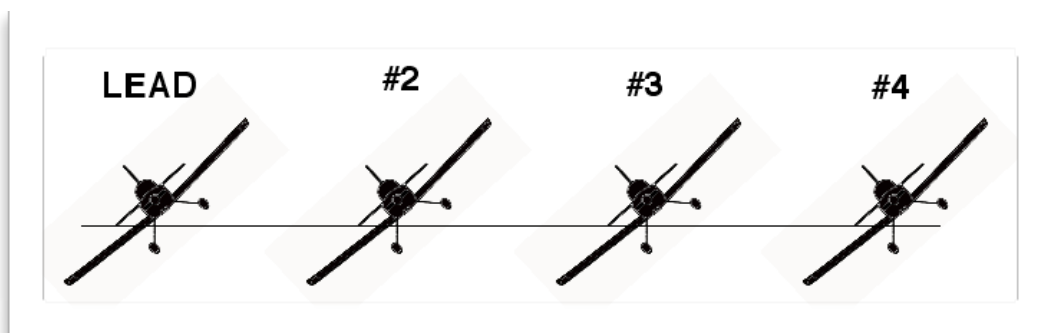


### NOTE

# 3 and #4 line up heads!

## ECHELON TURN

Echelon turns are only flown as turns away. 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 but remains level with the horizon. The sight picture for each Wing is to hold the aircraft in front of them on the horizon. 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.

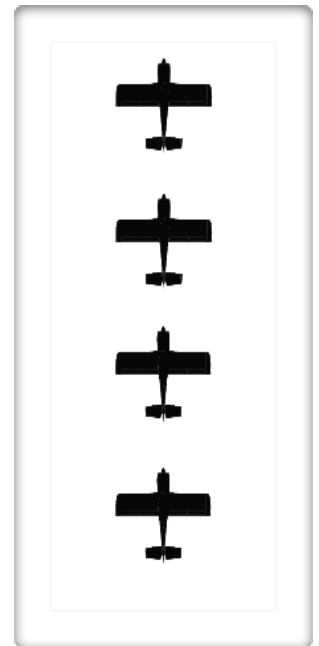
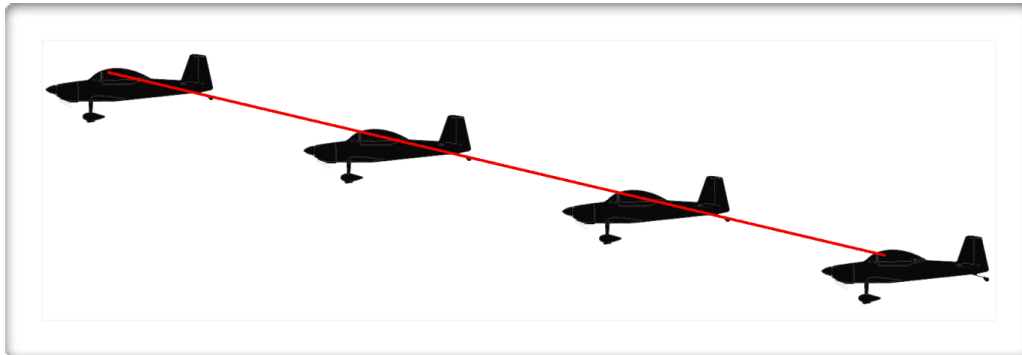


### NOTE

Turns into echelon are to be avoided

## TRAIL

Lead will signal the Trail formation with an ***elevator porpoise***. #2, #3, and #4 will drop back simultaneously and move into 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 pilots head (or looking straight into the exhaust stacks). Spacing between aircraft should be **1/2 to 3/4 ship length** from rudder to prop. Trail is a power anticipation exercise. Think about what is happening with Lead's airspeed and anticipate.



## EXTENDED TRAIL

Extended Trail is normally entered from Close Trail or from a Pitchout.

If entered from Close Trail, Lead signals Extended Trail by a radio call and gets an acknowledgement from Wingmen, i.e. "Mustang flight, go extended trail, 2 second left (or right) turn away, acknowledge", followed by "2, 3, 4". The breakup will be accomplished by Lead conducting a level, low energy turn away eventually achieving a maximum of 45° angle of bank after sufficient separation has occurred. Wingmen will follow, using a 2 second interval, each in a low energy lagging turn to achieve spacing on the aircraft in front. Lead will keep the level turn constant until proper spacing is achieved and the last aircraft calls "In".

If entered from a Pitchout, use a 2 second interval to achieve proper spacing, with the last aircraft calling "In" when spacing is achieved.

In either case, 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 the flight path of preceding aircraft. 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 to allow wingmen to stabilize in trail, or will establish a level turn to allow trailing aircraft to fall into the circle, then execute a large wingrock to signal a rejoin.

## "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.

## PITCHOUT (BREAKUP) AND REJOIN EXERCISE

The pitchout and rejoin exercise separates the formation to then 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 Wing is 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, followed by the kiss-off signal).

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'.

- Lead breaks away, rapidly rolling into 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.

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

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

Wing's 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 his 12 o'clock, slightly below the horizon.

- When the trailing Wingman is comfortably in position in trail, only he (she) will transmit "4's in", or as appropriate.
- Lead will then roll using an exaggerated wing rock and roll into a 25° to 30° AOB to begin the rejoin turn.

Lead maintains a constant 25° to 30° AOB while minimizing power changes.

- Wing 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 wing.**
- Up to 20 knots excess may be used for additional closure once proficiency is achieved.
- After arriving on the rejoin line, Wing 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 rejoin until the preceding aircraft is moving into position.

## UNDER RUN / OVERSHOOT

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

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

## Under run / Overshoot Procedure

Under run / overshoot by simultaneously executing the following steps:

- **LOWER** the nose slightly to obtain sufficient stepdown.
- **REDUCE ANGLE OF BANK and power** and move behind Lead to a position OUTSIDE the Lead's radius of turn.
- As you pass Lead's tail, begin to match Lead's angle of bank. When relative motion is controlled, as noted by an absence of closure with Lead, join in a Fingertip position.

NOTE  
Never go 'belly up' to the lead,  
resulting in lost sight

## 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

Lead will initiate the lead change by putting the flight in Route, then signal by pointing once to Wing (who will be the new lead), then pointing straight ahead twice 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.***

The previous lead, now wing, will reduce power, and fall back to a Fingertip Route position on the new lead.

Lead changes can also take place over the radio. "You have the lead", followed by "I have the lead".

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.

## 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 a section / element, 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., wing 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 at least 3 miles prior to the approach end of the runway, at pattern altitude, in echelon, on frequency, aligned with the extended centerline of the runway. Lead will make appropriate radio advisory calls at uncontrolled airports.

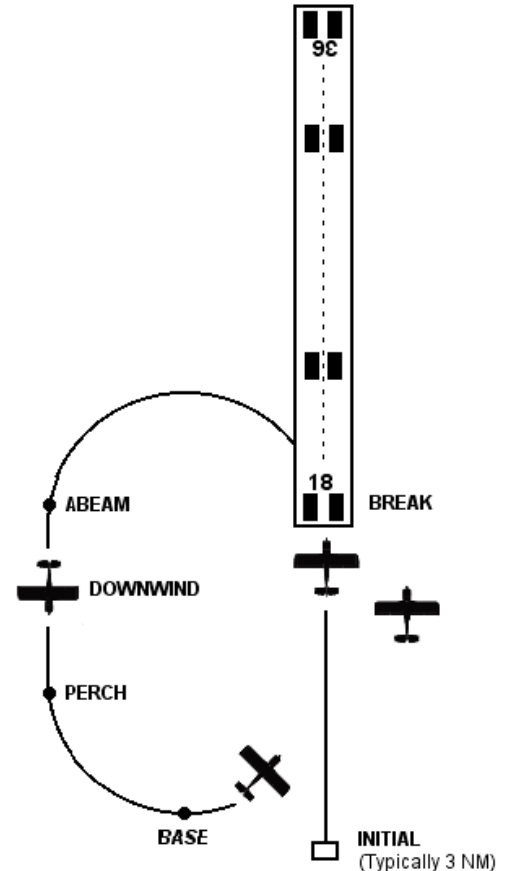
**THE BREAK** When established over the numbers, or as soon as practical after passing the numbers, Lead will pass Wing the “break-up” then the “kiss-off” signal just prior to commencing his (her) break / pitchout.

- Once Lead breaks, #2 is now the Flight Lead, so must maintain **LEVEL** flight and quickly begin a VFR scan, and will break as 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 100 mph / 87 knots (flap speed) directly behind the aircraft in front, **at the same altitude** 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 100 mph / 87 knots** until the Perch turn. **DO NOT GET SLOW!** In any case, each aircraft must **maintain 100 mph / 87 knots and altitude** on downwind, until arriving at the Perch.

**THE PERCH** Lead will adjust for winds and **maintain altitude** until beginning his (her) base turn. The turn point is called the Perch. At the Perch, Lead reduces power and extends flaps as necessary to descend and slow to 90 mph / 78 knots, holding that speed through the base turn and then slowing to 80 mph / 70 knots when rolling out on final. 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, slowing to 90 mph / 78 knots at the Perch, holding that speed through the base turn and then slowing to 80 mph / 70 knots when rolling out on final. Be prepared for wake turbulence and prop wash from the preceding aircraft.

- **DO NOT** allow the pattern to get strung out by extending past the preceding aircraft's turn point (the Perch).
- Use lead or lag on the aircraft in front (as in Extended Trail) to maintain 800' to 1000' spacing around the base turn.



## 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: Cold - Hot

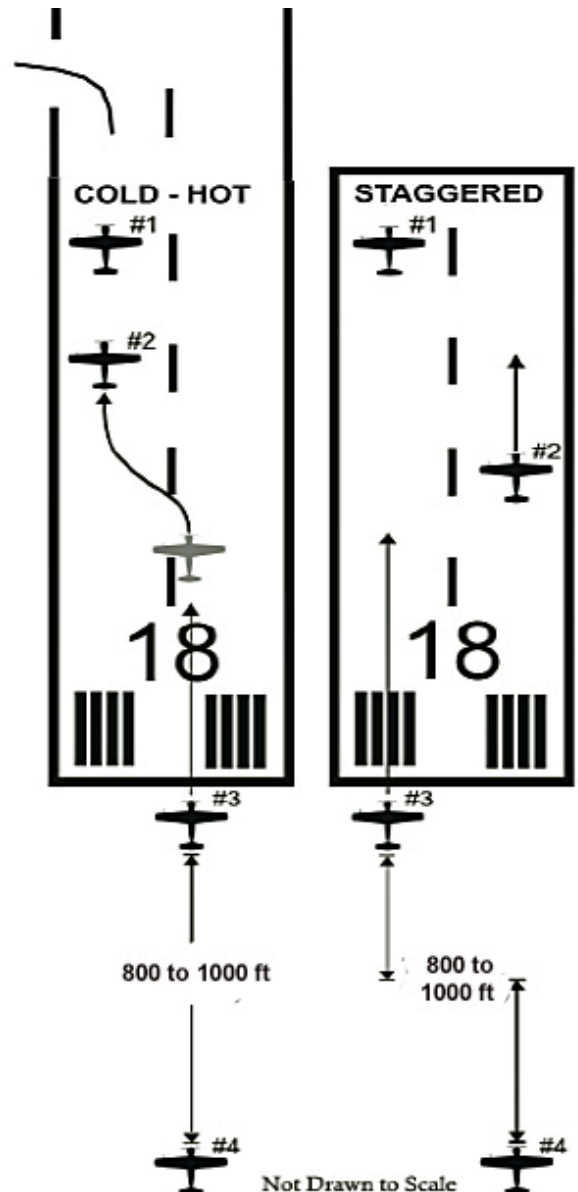
- Land on the centerline of the runway and, when “under control”, move to the **Cold Side**, which is the side of the runway the aircraft will exit from. This method provides for the **Hot Side** to be always available for passing or go-around, if necessary.

**THIS IS THE RV PREFERRED METHOD**

**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 “**2’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 A SECTION / ELEMENT

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 section / element sooner than normal. Plan to be at 100 mph / 87 knots 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:	100 mph / 87 knots
Base:	90 mph / 78 knots
Final:	80 mph / 70 knots
- Lead may consider using less than full flaps, while Wing 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.***
- Lead should position Wing on the upwind side of the runway. If wind is not a factor, it is desirable but not mandatory for Wing to be on the OUTSIDE of the turn on the base and final turns.
- Approaches shall be flown wide and shallow and with power ON. Lead will limit angle of bank and rate of descent.
- All taildragger section landings will be 'Wheelie' landings. Tail low wheel landings preferred.
- On final, Wing will fly a position acute of the normal Fingertip Position, line up his (her) leading edge with Lead's trailing edge.
- Lead will line up on 1/2 of the runway.
- On short final, Wing will increase lateral separation to line up on opposite half of runway. Wing will also remove any stepdown, and fly level with Lead at this point.
- Lead will carry some power all the way thru touchdown.
- After touchdown, Lead keeps the tail up and maintains a little power to allow Wing a drag advantage. Once the rollout is stabilized, Wing will pull power and fade to trail. If desired, Wing 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 Wing's path, to the cold side (exit side).
- Lead will not cross in front of Wing to make a turnoff until Wing 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.
- Wing matches Lead's configuration for taxi in. (Flaps, canopy, etc)

## TAXI BACK and SHUT DOWN

- **Taxi back** Lead will exit the runway on to 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 engine start to 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 section / element 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". 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 continue, provided it is safe to do so.

### DUAL AIRCRAFT (SECTION / ELEMENT) ABORTS

If both aircraft in the section / element 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 SECTION / ELEMENT ABORTS

In four ship, or mass formations, if the trailing (following) section / element 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 section / element 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

### ENGINE / POWER PROBLEMS

Should a pilot of an aircraft experience engine/power problems, do not delay recovering the aircraft due to formation considerations. Immediately pitch up and out of the formation, as is 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 the wing position with an emergency. If unavoidable, fly no closer than route formation.***

## **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.

### **LOST SIGHT PROCEDURES**

In the event any member of the flight loses sight of any other member, they will immediately announce "Gringo X, knock-it-off, lost sight", and turn away from last known position of Lead. All other aircraft in the flight will roll wings level and announce "Gringo X, knock it off", in sequence. Lead will attempt to regain situational awareness for the lost sight aircraft. Each aircraft in the flight can play a roll in this, depending on their perspective, thru radio communication.

### **MIDAIR**

The affected aircraft will immediately take separation and individually sort out the level of damage. Lead will insure 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. 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.**

## 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. Establish high and low SAR

### 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 SARCAP 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".

# HAND SIGNALS



*Cross Under (Motionless for wingman, double pump for element.)*



*#4 to Slot*



*Flap Actuation*



*Fuel State Inquiry*



*"Seven"*



*Climb*



*"Two"*



*Inflight Problem (To be followed by HEFOE code.)*

# 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 Fingertip-route, Diamond, or Trail. If joining from wings level 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 Fingertip-Route, each wingman closes to Fingertip spacing. If in Echelon-Route, 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, 2-3 ship widths wide.

**PORPOISE:** Lead gently porpoises his airplane several times using elevator inputs to move wingmen from Fingertip to 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.

## GLOSSARY of TERMS

**ABEAM:** A position, either port / left or starboard / right, which is 90° off the longitudinal axis of the aircraft.

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

**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 does a 360 overhead entry into the traffic pattern. Also call Pitchout.

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

**BEARING:** The horizontal angle off the lead as flown by the #2 aircraft.

**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

**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.

**DIVISION OR FLIGHT:** Four aircraft, consisting of two sections or elements, each with its 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.

**ENROUTE:** Same as Route. A much looser version of Fingertip. Usually used during cross country flight. It reduces fatigue on the wingmen. For RV formations, it is flown at 2-4 ship widths wide, and forward of the normal reference, aligning the leading edge of the wingtip on the spinner. In turns, members on the inside will maintain the normal route reference (down), but members on the outside of the turn will turn level with lead by putting lead on the horizon. (Echelon).

**FINGERTIP** (Air Force term. Navy uses the term Parade) 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 fore/aft (bearing), up / down (stepdown), and side to side.

**FLIGHT INTEGRITY:** The ability of the Wingman 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 flight leader using a standardized set of signals and commands to direct the wingmen. Not to be confused with a GAGGLE of aircraft.

**GAGGLE:** An undisciplined group of aircraft, milling about in roughly the same piece of sky, sometimes attempting to impersonate a FORMATION.

**GIB:** Guy in back

**"GIMME ONE" or "GIMME SOME"** What the wingman calls to Lead when he has insufficient power to keep up, asking Lead to reduce power by one inch or more of manifold pressure.

**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

**HUNG ON THE BEARING:** A condition during the rejoin where the wing aircraft ceases to continue closing on the Lead aircraft.

**INITIAL:** Refers to the approach to the runway when doing a 360° overhead break, usually considered to be a point at least 3 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:** Used to indicate that you have NOT visually acquired whatever it is you are looking for.

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

**OVERSHOOT:** 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..

**PARADE POSITION:** (Navy term) Formation configuration to be used when under observation by the public. Same as Fingertip. 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 fore/aft (bearing), up / down (stepdown), and side to side.

**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.

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

**REJOIN:** (Rendezvous) A maneuver in which the formation aircraft are maneuvered into a position where a join-up may be performed.

**RENDEZVOUS:** (Rejoin) A maneuver in which the formation aircraft are maneuvered into a position where a join-up is performed. To join the flight on to the leader.

**SECTION OR ELEMENT:** A flight of two aircraft. The 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.

**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.

**STEP DOWN:** The vertical distance between the Lead and Wing aircraft.

**STEP UP:** What the thinking wingman does when the leader's making low passes down the runway!

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

**TALLY HO:** Used to indicate that you have visually acquired whatever you are looking for.

**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.

**TRAIL:** A formation position in which Wing is directly behind Lead.

**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..

**VISUAL:** A term used to communicate positive visual contact with an aircraft in the formation (opposite of "Blind").

## LIST OF REVISIONS

### REVISION 2.4 CHANGES:

- page 3 - added bullet referencing prop wash turbulence on takeoff
- page 4 - added to FISHTAIL signal, to move wingmen from “any formation” to route
- page 5 - added comments about aileron pressure or rudder during crossunder
  - reworded last sentence in first paragraph under Crossunder
- page 6 - Standard Rules: removed all references to Lead’s LEFT or RIGHT arm
  - Removed “RIGHT” for FINGERTIP to DIAMOND section
  - Removed first reference to “clenched fist”
- page 7 - revised “four fingers extended, then closed with thumb pointing rearward, motions aft”, removed first reference to “fist clenched”.
- page 9 - changed wording when going from close trail to extended trail
- page 10 - added bullet referencing #3 and #4 will not pass or join aircraft in front
- page 20 - changed description to reflect same on page 3
  - added to FISHTAIL signal, to move wingmen from “any formation” to route
  - introduces “echelon route” special circumstances
- page 23 - added LIST OF REVISIONS section

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