



SPORT CLASS AIR RACING FORMATION GUIDELINES AND STANDARD PROCEDURES

December 1, 2017 Version 1.0

INTRODUCTION AND BACKGROUND

The *Sport Class Air Racing 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 Sport Class Air Racing Formation Warm-up periods, and as a standardization tool for Sport Class formation operations. The sources include, but are not limited to, the Formation Flying Incorporated (FFI) Formation Guidelines, the FAST Formation Manual Series, the Formation Pilot's Knowledge Guide, and the T-34 Association Formation Flight Manual. This manual reflects the Sport Class Air Racing Formation Standards and Standard Operating Procedures (SOP), and all attendees at Sport Class Formation Warm-up events, PRS and NCAR are tasked with full knowledge of it's contents.

MANUAL ORGANIZATION

This Formation Guideline document is organized to present an overview of basic formation concepts, followed by presentation of formation procedures and maneuvers in the approximate sequence of a typical flight. The manual builds from basic 2-ship material to 4-ship material, then to larger, race-sized formations. Contingencies and Abnormal Operations follow Normal Operations. A glossary of common terms is also included. This document is designed to present formation training reference material from a Sport Class Air Racing procedural perspective. For those pilots familiar with FFI or FAST procedures, where Sport Class Air Racing procedures differ from FFI or FAST procedures, only the Sport Class Air Racing procedures are presented in this document. Examples of this are radio procedures, the use of formation directive communication instead of aircraft or hand signals, and rejoin procedures. Additionally, this manual only discusses formations and maneuvers/procedures that are utilized in Sport Class Air Racing Formation Warm-up, PRS or Air Racing operations. Formations that are typical in FFI or FAST operations, such as Diamond and Close Trail, as well as procedures that are not conducted in Sport Class operations, such as Element/Section Formation Takeoffs and Landings, are not covered in this manual.

THE FORMATION CONTRACT

The Formation Contract is Sport Class Air Racing's definition of Flight Lead and Wingman responsibilities. It is the commitment of every pilot in a flight to those in their flight, and to Sport Class Air Racing.

Flight Leads will:

- Follow SOP at all times
- Brief and Debrief Flights
- Fly a stable platform
- Control the flight maneuvers
- Monitor the flight
- Terminate maneuvers if flight safety is compromised
- Navigate
- Communicate

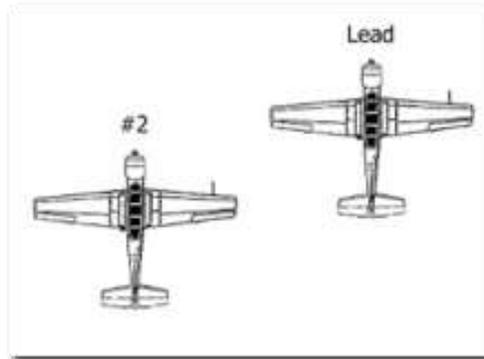
- Follow SOP at all times
- Attend and understand briefings (or will clarify with Lead)
- Always maintain visual contact
- Immediately advise lead if visual contact lost (blind)
- Don't hit Lead or other Wingmen
- Follow briefed formations/positions/maneuvers
- Have a formation exit plan ready
- Maintain a listening watch
- Advise Lead if traffic is observed

Wingmen will:

BASIC FORMATION POSITIONS

2-SHIP FORMATION BASIC POSITION AND SPACING

The fundamental 2-ship formation is known as an Element, or a Section. It consists of a Flight Lead and a Wingman.



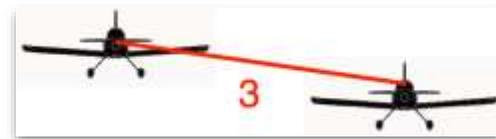
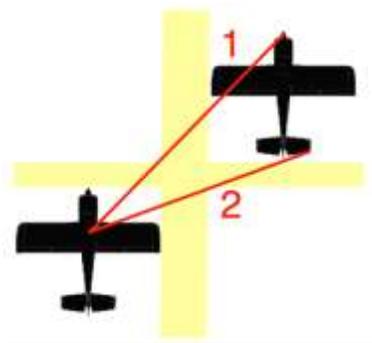
The basic position for a wingman is on a 45 degree bearing line, with approximately 10 feet of wingtip to wingtip clearance, approximately 10 feet of nose to tail clearance, and approximately 10 feet of positive step-down from the Lead. This close formation spacing is known as Fingertip spacing (Parade spacing in Navy terms). To maintain this position, there are visual references that assist the pilot that work well for most aircraft types. These are:

1 - Line up the center of the Lead's near wingtip with the spinner of the Lead's aircraft. This is the primary 45 degree bearing line position indicator. (RV FFI formation pilots use outboard aileron hinge on spinner, which is acceptable, but wingtip center to spinner is a good universal visual reference, and preferred for Sport Class formation operations).

2 - Fly along the 45 degree bearing line in a position from which you can see a slight bit of the Lead's opposite elevator behind the rudder of the Lead. This serves to fix your position along the bearing line in a position in which you have wingtip clearance.

3 - Establish appropriate positive step-down clearance by maintaining the above two reference points, while viewing the Lead's near-wing trailing edge from slightly below to edge-on. When step-down is correct, you should see a slight bit of the bottom surface of the Lead's wing, but should not see the upper surface of the Lead's wing.

Clearance in all three axes is provided with the above visual references. See the figures below for these references:

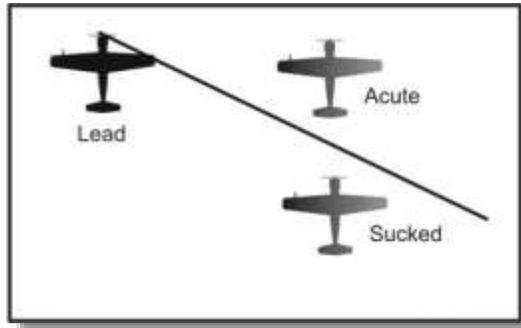


VISUAL LINES OF REFERENCE

STATION KEEPING

Station Keeping is the act of maintaining position while flying formation. The above presented position references are used as visual cues. Smooth, coordinated control pressures in all axes, and smooth power changes are used to keep the airplane in position. A high level of focus, and constant corrections, are required to correct for slight movements from the correct position. All relative motion between aircraft is considered movement on the part of the Wingman. While it is the responsibility of Leads to provide a stable, smooth platform for the Wingman to fly off, it is the responsibility of the Wingman to maintain sight of the Lead at all times, to maintain separation, maintain position, and control relative motion.

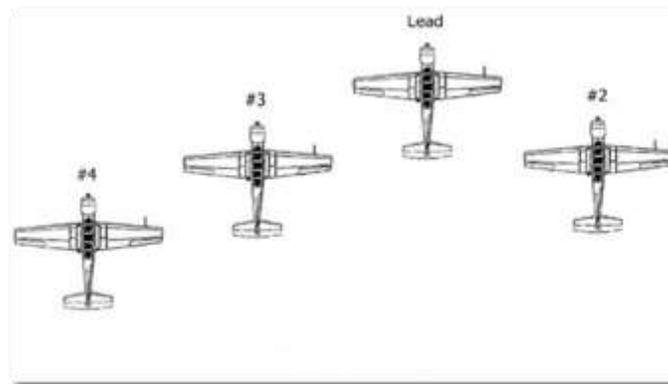
Flying forward of the 45 degree bearing line is termed "acute", while flying aft of the 45 degree bearing line is termed "sucked", as shown in the following figure:



BEARING LINE REFERENCE TERMINOLOGY

4-SHIP FORMATION BASIC POSITION AND SPACING

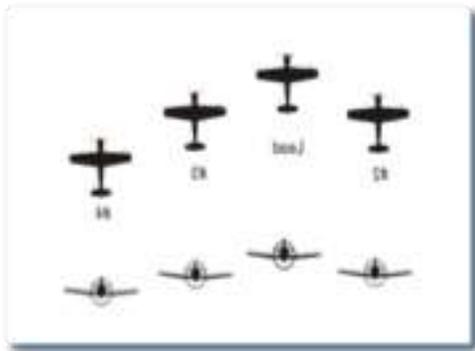
The basic 4-ship configuration for maneuvering and practice is the **FINGERTIP FOUR**. It derives this name from the shape of the formation, which resembles the shape of the fingertips of a hand when held vertically. Fingertip Four, or Finger Four, is a formation shape, not to be confused with Fingertip Spacing (close formation spacing). This formation is built with two 2-ship elements. The basic position and the visual references are the same as described in 2-ship formation above. Fingertip Four places one wingman to one side of the Lead, and two wingmen on the other side of the Lead. The Flight Lead is the #1 aircraft, and the single aircraft on one side is the Lead's Wingman. The Lead's Wingman is #2. #1 and #2 are known as the Lead Element of the flight. The second element is comprised of #3 and #4, the two Wingmen on the opposite side of the formation from #2. In many 4-ship formations, #3 is the second most senior member of the flight, and is often also a Flight Lead. However, that is not required. In Fingertip Four formation, #2 sets the position and spacing, and #3 dresses across the formation for symmetry.



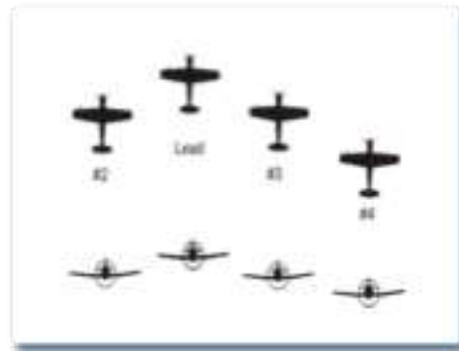
FINGERTIP FOUR

FINGERTIP STRONG LEFT or RIGHT

Fingertip Four may be either oriented with the second element on the right or the left side. The side of the formation on which the second element flies is known as the “Strong Side”. Therefore, “Fingertip Strong Right” places #3 and #4 on the right, and “Fingertip Strong Left” places #3 and #4 on the left side. See the diagrams below for examples of Fingertip Four formations:



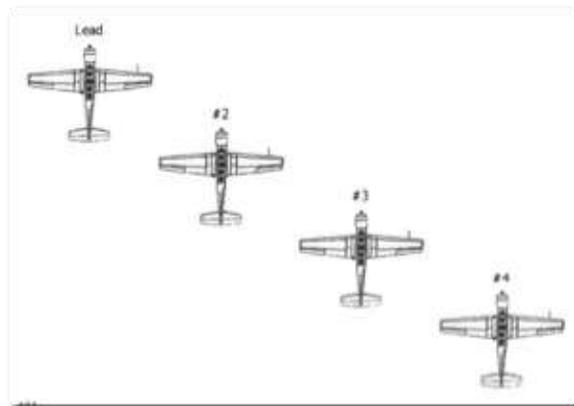
FINGERTIP FOUR (STRONG LEFT)



FINGERTIP FOUR (STRONG RIGHT)

ECHELON FORMATION

An Echelon formation is a formation of 3 or more aircraft, in which all wingmen are on one side of the Lead aircraft. An Echelon formation is less maneuverable than a Fingertip formation, thus takes more planning to lead. It is also more challenging for the Wingmen to fly, as movements of each Wingman tend to get amplified down the echelon. The Echelon positioning visual references for #2 are identical to those described in 2-ship formation and as #2 in a Fingertip formation. In an Echelon formation, #2 sets the spacing, and #3, 4 and beyond fly the standard references on the aircraft ahead, while also lining up the helmets of the pilots ahead. A good technique to use to stabilize your position and the entire formation is to maintain proper position and spacing from the aircraft immediately ahead, but also look through the formation to reference and fly off of the lead as a stable platform. Echelon formations are used during the initial takeoff rejoin, for practicing Echelon Turns, for entry to Pitchout and Rejoin practice, for entry to Extended Trail practice, for entering the Overhead Break to land, and during races, for maneuvering to the race start chute in preparation for moving to line abreast for the race start.

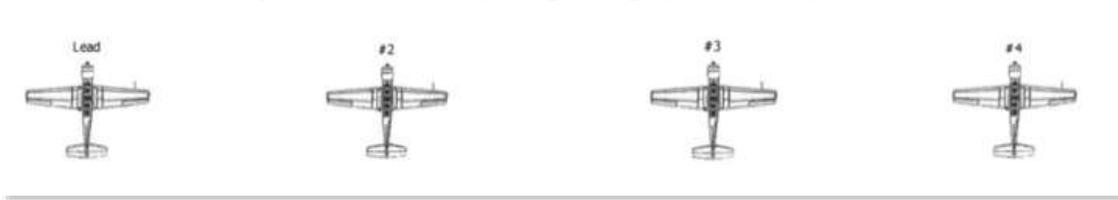


ECHELON RIGHT

LINE ABREAST FORMATION

Line Abreast formation is a specialty formation that is utilized by Sport Class for race starts. It is also practiced during Sport Class training flights. Line Abreast formation is flown in a position such that the wing-line (also known as the 3-9 line) of all aircraft in the formation are aligned. As with Echelon, movement of Wingmen tends to get transmitted and amplified down the line. Smooth technique is important, as is maintaining position on, and separation from, the aircraft to the left, but looking through the line of aircraft and flying off the Lead as a stable platform.

- Line Abreast is flown with the Lead to the left, and all Wingmen to the right, during Sport Class operations.
- Line Abreast is only moved into from Echelon Right during Sport Class operations, and is directed by Lead via a radio call, such as "Sport XX, move it up to Line Abreast".
- Line Abreast formation is *a/ways* flown in Route spacing during Sport Class operations.



LINE ABREAST FORMATION

ROUTE FORMATION SPACING

Route formation positioning is slightly wider than Fingertip spacing, which allows both greater maneuverability of a formation, as well as the ability to conduct Ops Checks, Frequency changes, Lead changes or conduct other formation management duties. It also allows Wingmen to relax a small amount during transits to and from the practice area.

- Route spacing is 2-4 ship widths wide, flying a position on, to slightly forward of the 45 degree bearing line, with positive step down and slight nose to tail separation.
- To move a formation from Fingertip spacing to Route spacing, the Flight Lead makes a radio call to direct the flight to Route ("Sport XX, Go Route").
- Wingmen move to Route from Fingertip by adjusting their position laterally out, using slight aileron and/or rudder pressure, until the leading edge of the Lead's (or aircraft ahead's) wingtip is on the spinner of the Lead aircraft (or that of the aircraft ahead).
- Wingmen should be cautious not to get complacent in position management while in Route, especially when checking gauges for an Ops Check, or changing frequencies on a radio.
- Route spacing may be utilized and flown in any formation shape or size. 2-ship, 4-ship, and larger race heat-sized formations all utilize Route spacing at times.

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.



ROUTE FORMATION SPACING

PRACTICAL APPLICATION - CORE FORMATION EVENTS AND MANEUVERS

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 mandatory. The Sport Class Air Racing formation/race briefing card is available for download at <http://www.sportclass.com/prs/>

RADIO PROCEDURES

Sport Class pilots will use their race number (Sport XX) as their call sign for all formation and racing operations. The Flight Lead's race number (Sport XX) will be used as the flight call sign, and the Wingmen will use race numbers (Sport XX) as their individual call signs for check-in and frequency changes, etc. If operating at a towered airport outside of the Reno NCAR/PRS waivers, and no prearrangement for special call signs has been made, the Flight Lead will utilize their registration number as the flight call sign.

- Frequency changes will be executed either over the radio (preferred), or through hand signals if required during a NORDO event or other communications irregularity (stuck mic, etc).
- The terms "Go" and "Push" are standard phraseology for frequency changes within the formation community. Sport Class Air Racing flights will use the "Go" methodology for all frequency changes, as described herein.
- When frequency changes are called over the radio by Lead using the term "Go", each flight member will respond in sequence to the call with their race number (Sport XX), prior to switching frequencies. If any flight member does not respond to the "Go" call, all flight members should remain on the current frequency until the lead contacts that pilot and gets a response. After the frequency change, the lead will check in the flight, and each flight member should respond to the check-in with their race number (Sport XX).

AIRCRAFT STAGING and ENGINE START

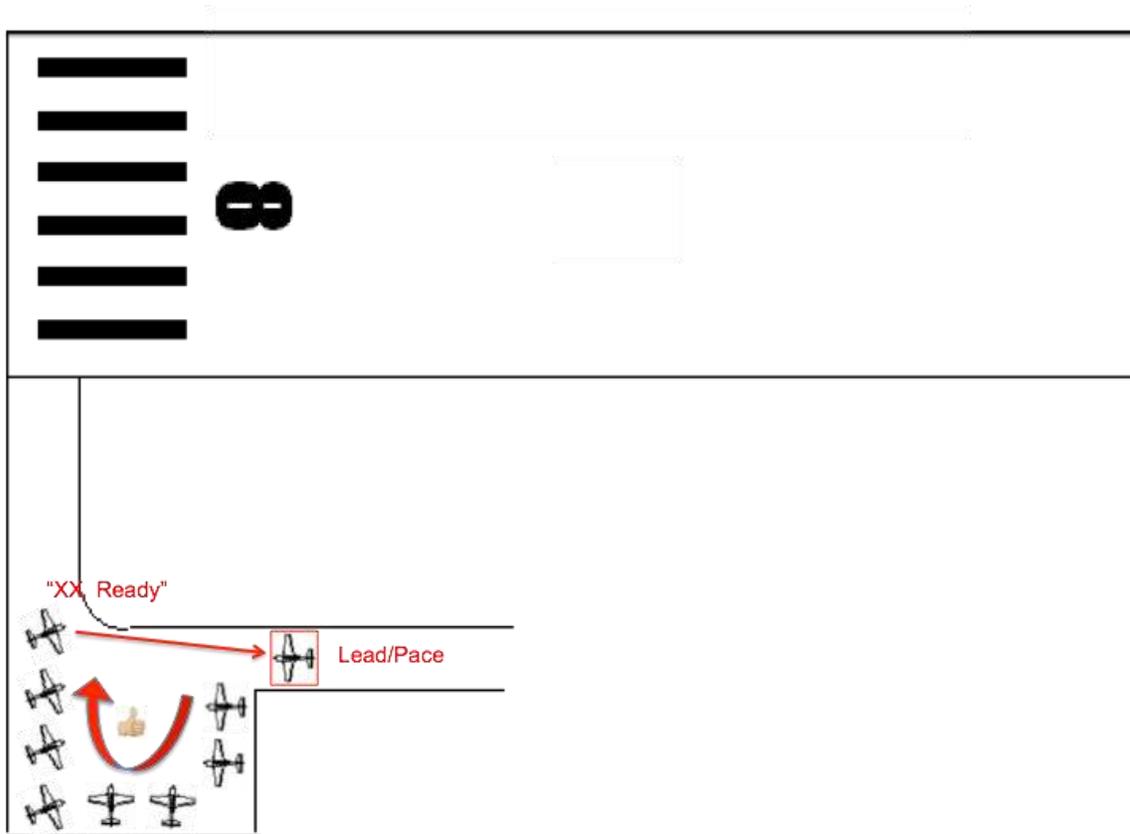
- It is preferable to position each aircraft so each pilot has a view of the others. Line abreast is preferred, or staged in a manner in which each pilot is able to see the lead aircraft. In situations where this is not possible, the Lead should brief this contingency, and the desired start procedures.
- All aircraft will start engines on Lead's startup signal, on Lead's engine start (prop turning), or on a time hack, as conditions require, and as briefed.
- After engines are running, each pilot will individually tune radios to the pre-briefed frequency.
- When ready for flight check-in, each pilot will pull their aircraft forward approximately 5 feet.
- Flight Lead will check the flight in on the pre-briefed frequency. Each flight member will respond with their race number (Sport XX).

TAXI

- After check-in, Lead will call for taxi clearance if at a Towered airport, or if at a non-towered airport, will direct the first wingman to begin his (her) taxi.
- Sport Class flights will taxi in flight order, with the first wingman taxiing first. The Lead follows the flight during taxi. The Lead may brief a Lead-first taxi when situations dictate (unfamiliar airport, unusual taxi requirements, etc).
- Standard taxi is staggered on alternating sides the taxiway centerline, with 1-2 plane lengths between aircraft. Additional spacing may be taken by tailwheel aircraft that need to do s-turns on the taxiway for forward visibility. This should be pre-briefed. Lead may also pre-brief, or call for, an on-centerline taxi if conditions warrant. Additional spacing should be allowed between each aircraft in this situation.
- As the aircraft enter the run-up area, the flight should fall into trail, and provide spacing needed for each aircraft to get into a run-up position in which they can see the pilot on either side of them for thumbs-up signals after run-up.

RUNUP

- When taxiing into the run-up area, each pilot should attempt to match the first aircraft's angle, and line up heads. Parking in an arc of aircraft may be the best way to accomplish this. The Lead will take a position at the entry of the run-up area, or at the back of the flight, and observe the flight's run-up.
- After completing his (her) run-up, each pilot checks over the aircraft to either side of them, looking for any out-of-the-ordinary conditions such as fluid leaks, open or unlatched doors/hatches/canopies, flaps or trim in an unexpected position, etc. If any are seen, the pilot must be notified.
- When ready, each pilot, starting with the last wingman, passes a thumbs up to the pilot ahead of them in flight sequence. Each pilot will pass the thumbs up forward, until it reaches the first wingman. The first wingman calls ready to the Flight Lead after receiving the last thumbs up, with their race number ("Sport XX, Ready").

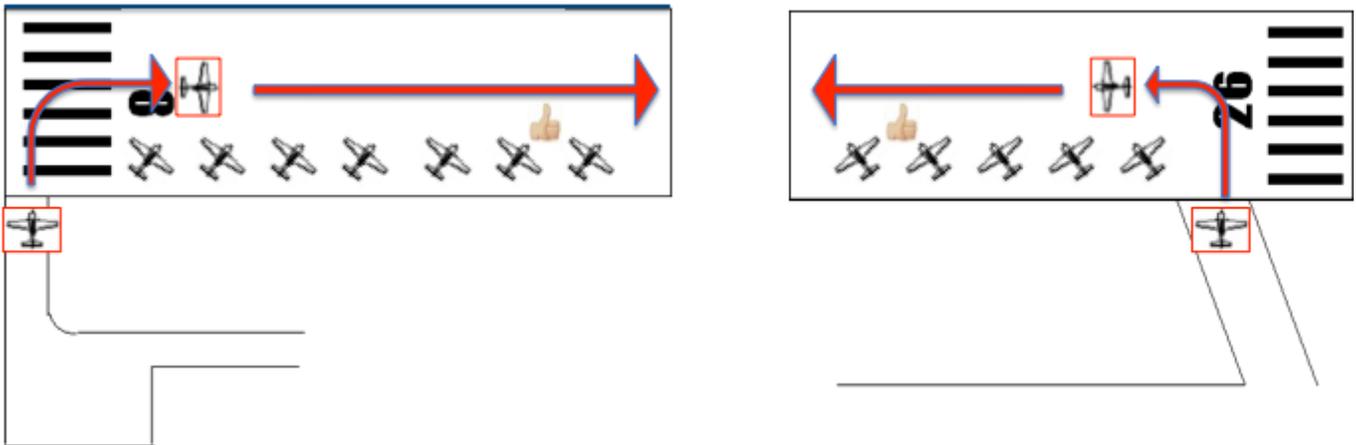


RUN-UP AREA PROCEDURES

TAKEOFF (Interval Takeoff)

Sport Class Air Racing uses a unique interval takeoff procedure. This procedure will be briefed on each flight.

- When cleared to line up and wait, or when cleared for takeoff (at a Towered airport), or at a non-towered airport, when pattern traffic will allow time for a Sport Class Line-up and interval takeoff, the Lead will direct the first wingman to lead the flight out onto the runway. The flight will taxi into position on the cold side (turnoff side) of the runway, at a 45 degree angle to the runway centerline and the departure end of the runway.
- The Flight Lead will follow the flight onto the runway, and taxi down the hot side of the runway (the side away from the turnoff side), and will receive thumbs up from each aircraft. Each pilot will give a thumbs up to the Lead as they taxi past, to signal ready for takeoff.
- After passing the final aircraft, the Lead will commence their takeoff roll, and call "Lead rolling" on the radio. The Lead will call "60 knots" when passing that speed on the takeoff roll.
- Each subsequent aircraft in the flight will taxi to the hot side, and will commence their takeoff roll approximately 1000 feet behind the aircraft ahead, or 5 seconds after the previous aircraft rolled.
- Takeoffs are conducted on the hot side of the runway, to allow for aborts on the cold side of the runway. Takeoff aborts are covered in the Emergency Procedures section of these guidelines.



RUNWAY LINE-UP AND TAKEOFF PROCEDURES

Note: In cases where operating at a towered field away from a race venue that has not approved these procedures, and expeditious takeoffs are desired, Lead may brief and lead a more conventional interval formation takeoff, as follows:

- Lead will lead the flight onto the runway in trail, and commence his/her takeoff as soon as cleared for takeoff. Takeoff will be on the hot side, and each wingman will follow in sequence, utilizing the standard 1000'/5 second standard spacing rule of thumb.

DEPARTURE REJOIN

- Departure rejoins will be flown at the pre-briefed airspeed. This speed will be selected by the Flight Lead based on the aircraft types that comprise the flight.
- Flight Leads will fly the pre-briefed airspeed, and will climb at 500 feet per minute, to allow all wingman a power advantage with which to effect the rejoin.
- Departure rejoins will be flown in the turning pattern briefed by the Flight Lead. This may be one of the standard Reno-Stead PRS/NCAR departure patterns, or may be briefed by lead for specific airport pattern requirements at other venues.
- Wingmen will utilize radius of turn, and a slight airspeed advantage (5-10 knots), to effect the departure rejoin. Power requirements for a climbing rejoin are higher than that of a level rejoin, so wingmen must be cognizant of, and control, their power setting, airspeed, and climb rate, to ensure the rejoin is conducted smoothly and safely.
- Wingmen must maintain sight of the Flight Lead and all aircraft ahead of them during the rejoin. If visual contact is lost, the pilot must make a "Blind" call, and must follow the Lead's directive calls to regain visual contact and join the flight. Blind calls and Lost Sight procedures are discussed in detail in the Emergency Procedures section of these guidelines.
- Wingmen must not fly so acute during a rejoin as to fly in front of the 3-9 line of the Flight Lead or the aircraft ahead.
- If an excessively acute position develops, or an excessively high closure rate develops, an overshoot/under-run is warranted. Overshoots/under-runs are discussed in detail in the Pitchout and Rejoin section of these guidelines.
- All aircraft will rejoin to the outside of the formation, in an echelon formation.
- If an aircraft ahead stagnates a small amount, it is best to slow your rejoin and allow them to complete their rejoin before completing your rejoin. Do not join on the aircraft ahead, or crowd/rush the pilot on their rejoin.
- If an aircraft ahead stagnates excessively, a following pilot may continue his/her rejoin by passing well behind that pilot, and leaving space for that pilot to join the echelon in their designated spot. Caution must be taken not to cut other aircraft off, and if there is any doubt that the aircraft ahead does not see you after you have passed and joined, a safety radio call is appropriate.
- If an aircraft ahead overshoots (under-runs) the flight, a following pilot must be cautious about joining the formation while the pilot ahead is correcting from the overshoot. Depending on the positioning of the overshooting pilot, the following pilot should consider slowing his rejoin to allow the pilot ahead to correct his position, or may join the formation if the overshooting pilot has stabilized well beyond the formation on the outside of the turn. The Lead should also make directive calls as appropriate to ensure the formation remains stable and maintains safe separation.

CLIMB

- Normal climb speed should be briefed for each flight, and should be commensurate with the performance of all aircraft in the flight.
- Once the flight is joined, the Lead may push the power up to expedite the climb and the transit to the practice area.
- If unable to stay with the formation after the power increase, Wingmen may call "gimme one" to inform the Lead. Climb out is normally conducted in either fingertip or route formation spacing, or both for practice.

TRANSIT TO THE WORKING AREA / BASIC MANEUVERING

- As the flight leaves the airport area, and transits to the practice/working area, Lead will configure the flight in route spacing, and execute a frequency change to the flight's discrete frequency ("company"/"tactical").
- Transit to the practice area is normally conducted in either fingertip or route formation spacing, or both, for practice.
- Formation maneuvers may be briefed and flown during the transit to the practice area, at Lead's discretion.
- Maneuvers, whether conducted in transit, or in the working area, are normally conducted at a pre-briefed baseline airspeed, based on the performance of the aircraft in the flight.

• OPS CHECKS

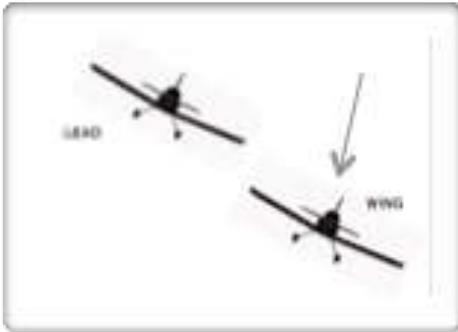
- Ops Checks are a method for Flight Leads to manage the flight, and ensure that all flight members are monitoring their aircraft systems and fuel states.
- Ops Checks should be conducted approximately every 30 minutes during a practice flight. Transit to and from the practice area or during a break in the maneuvering practice, are the recommended points in the flight to conduct Ops Checks.
- To conduct an Ops Check, the Lead will place the flight in Route spacing, and direct the Ops Check with a radio call, such as "Sport XX flight, Ops Check".
- All pilots will continue to fly Route formation, and will check critical systems and fuel state. Lead will begin the check-in for the Ops Check by calling, "Sport XX, Green, 60 minutes", signifying all aircraft systems/temperatures/pressures are good, and stating the current fuel state in minutes remaining.
- Wingmen will respond in flight order, with their race number ("Sport XX, Green, 90 minutes", as an example).

Even if the Lead has not called for an Ops Check, take other opportunities *when not in close formation*, to scan your aircraft systems and fuel state.

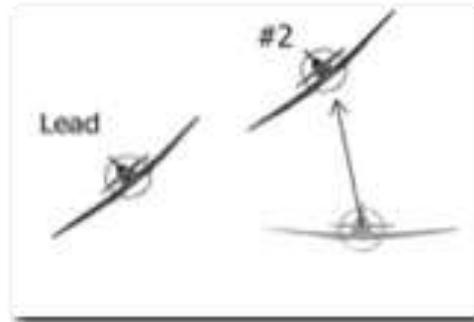
AREA WORK AND MANEUVERS PRACTICE

2-SHIP FINGERTIP TURNS

During 2-ship fingertip turns, Wingmen 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. Turns into the Wingman require a slight decrease in altitude and a slight reduction of power, while turns away from the Wingman require a slight increase in altitude, and a slight power addition. This is referred to as WELDED WING. See the diagrams below for examples of 2-ship Fingertip turns:



FINGERTIP - TURN INTO

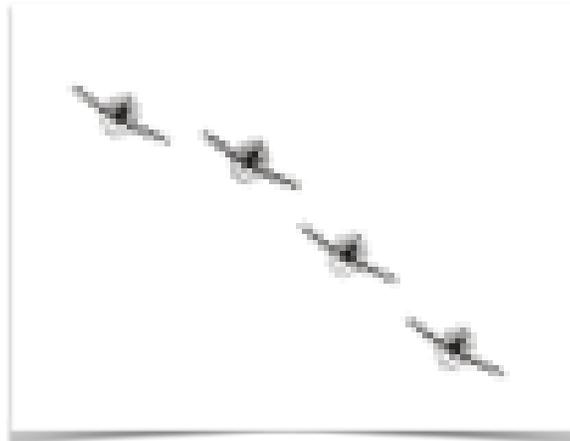


FINGERTIP - TURN AWAY



4-SHIP FINGERTIP TURNS

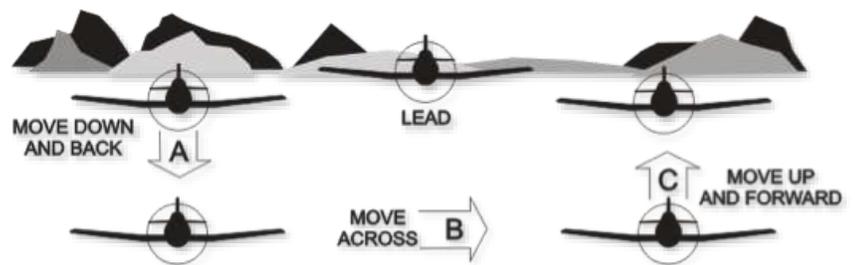
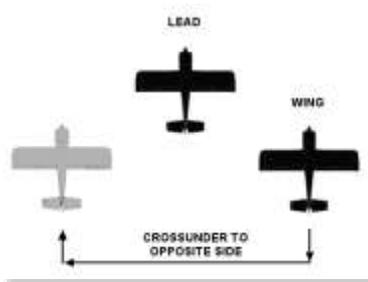
4-ship Fingertip turns are essentially performed in the same manner as 2-ship turns, in that all Wingmen fly Welded Wing throughout the turns. Wingmen will match Lead's angle of bank and maintain the same Fingertip reference as straight and level flight, either as a TURN INTO or a TURN AWAY. For #4, turns into the Wingman require a bit more of a decrease in altitude and power reduction, while turns away require a bit more of an increase in altitude, and a power addition. Anticipation of roll-ins and roll-outs, and the associated power and pitch requirements are key to maintaining position for #4. See the diagram below for an example of a 4-ship Fingertip turn:



CROSSUNDER

To move a Wingman from one side of the Lead to the other, the Flight Lead uses a Crossunder. A crossunder is initiated with a radio call, such as "Sport XX, crossunder". No verbal reply is required from the Wingman, as the movement of the Wingman is his indication that the command was received. A crossunder is accomplished in a fluid motion, with 3 subtly distinct parts. Those parts are "down and back", then "across", then "up and forward", as follows):

- Power is reduced slightly to move down and back, to the point where adequate nose-to-tail and step down exists to cross slightly below and slightly behind the Lead.
- This down and back motion is stopped with a slight power addition when in the appropriate position.
- Next, slight aileron and rudder pressure is used to create a very slight heading differential from the Lead (2-3 degrees), which initiates a smooth crossing rate.
- Once the crossing rate is established, aileron and rudder pressure should be neutralized, so that the crossing rate does not rapidly increase due to increasing angle of bank.
- Power is modulated during the cross as required to maintain consistent nose to tail spacing.
- When in position on the other side of the Lead, slight aileron and rudder pressure is used to realign with Lead and stop the crossing rate.
- Power is increased slightly to move forward and up into position, and then normal station keeping is conducted.



CROSSUNDER

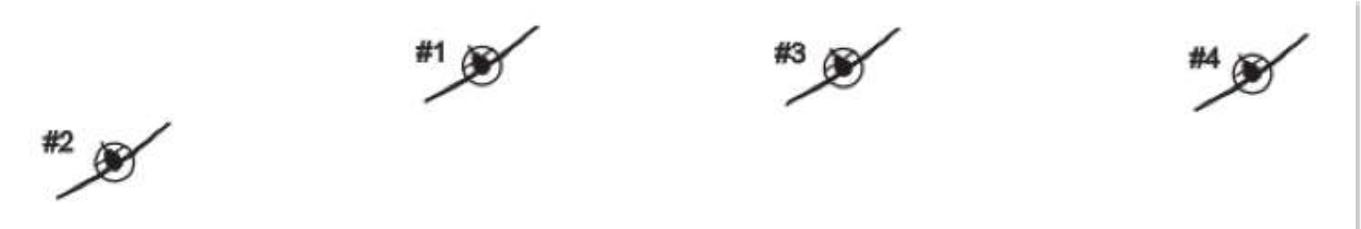
In 4-ship formations, when moving #2 into the opposite side of the formation (into the second element), Lead must direct #3 to move out and make room for #2 to crossunder. #2 must visually ensure the space has been opened by #3 before crossing under the Lead.

To cross the 2nd element (#3 and #4) in a 4-ship, Lead will direct the crossunder with a radio call. When the 2nd element is moving across, below and behind the Lead, the wingman in the 2nd element (#4) will also, simultaneously and automatically, without being signaled to do so, move further across his element Leader (#3), so as to assume the proper position on the new side.

Note: The directive radio call for a crossunder should indicate which Wingman/Wingmen, should move, and where they should move. It may reference a position (Sport XX, cross under to the right), or a formation configuration (Sport XX and YY, cross under into Echelon Right), or it may include both direction and configuration. The planned call should be briefed by the Lead.

ROUTE TURNS

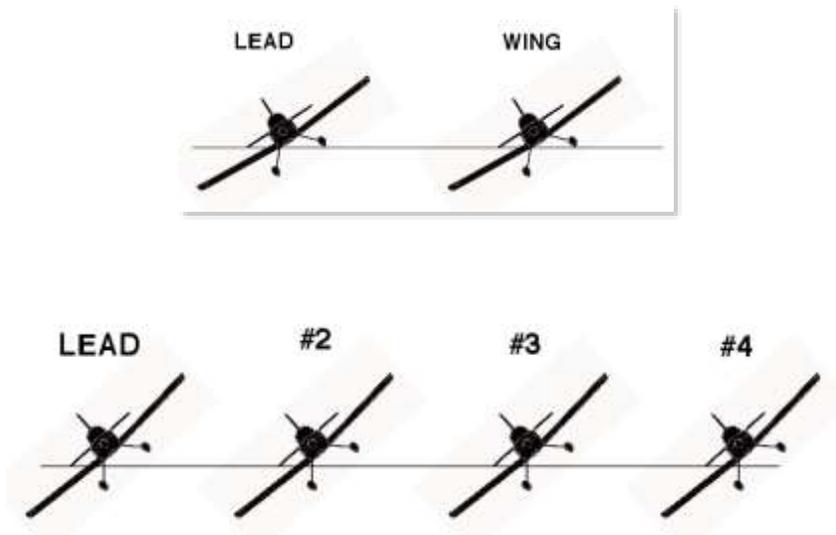
While in Route spacing, turns *into* the Wingman or the 2nd element are similar to Fingertip turns, in that the wingmen on the inside of the turn maintain the same visual cues, and the turn requires a slight descent and power reduction by the wingman. Route turns *away* from the wingman or 2nd element are performed in a slightly different manner than those in Fingertip spacing. Because of the additional lateral spacing of the wingmen in Route, during turns *away*, the Wingmen outside the turn will remain step-level (co-altitude) with the lead, and will not maintain the normal welded wing visual references, because it would require too much additional power to do so. See the diagram below for an example of a 4-ship Route turn:



ROUTE TURNS

ECHELON TURNS

Echelon turns are only flown as turns away. Leads should avoid turning into the Echelon, so flight path planning is critical when leading an Echelon. Leads will roll slowly and smoothly into and out of Echelon turns. 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 remain step-level (co-altitude) with Lead, by placing the Lead aircraft on the horizon. The sight picture for each Wingman is to hold the aircraft in front of them on the horizon, and match their angle of bank. Wingmen will require a significant power addition in the turn, because they are on the outside of the turn. Each Wingman will require progressively more power to hold position: #3 more than #2, and #4 more than #3, etc. See the figures below for examples of Echelon turns:



ECHELON TURNS

PITCHOUT AND REJOIN EXERCISE

The pitchout and rejoin exercise is a procedure to separate the formation, in order to then practice procedures to re-form the formation safely and efficiently. The concepts of radius of turn, bearing line, and pursuit curves are critical to controlling closure rates and executing proper rejoin procedures.

THE PITCHOUT

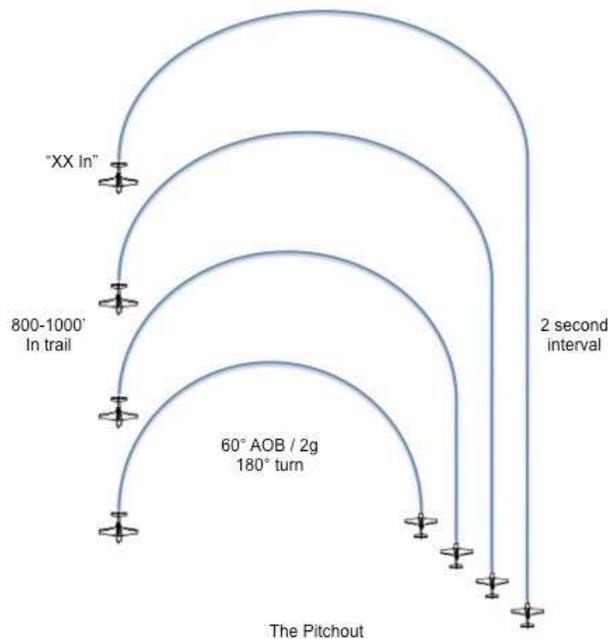
- Pitchout and Rejoins will always be entered from an echelon formation.
- Lead may conduct the pitchout in either direction based on weather, practice area management, etc.
- Prior to the the pitchout, Lead establishes the formation in straight and level, unaccelerated flight, in echelon formation away from the desired direction of the pitchout.
- Lead signals the pitchout with a radio call, such as “Sport XX flight, Pitchout Right (or Left), 2 second interval. (2 second interval is standard for Pitchout and Rejoin practice. Leads may brief and fly a different interval, if desired, but this must be clearly briefed). No Wingman radio acknowledgement is required.
- Lead should clear the area in the direction of the pitchout, then initiate the pitchout, smoothly rolling into a 60° AOB turn and smoothly increasing pull to 2 g’s.
- The turn will typically be 180° of turn. Slight adjustments for weather or terrain clearance may be used.
- 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 (or as briefed), then pitchout using the a 60° AOB / 2 g turn, for 180°.
- Each wingman should maintain constant power, and level altitude throughout the turn. Using slight power adjustments to maintain speed while correcting for altitude excursions is a good technique, if needed.
- A 2-3 second interval should yield approximately 800-1000 feet in trail, and slight lead/lag pursuit may be used to hold that distance during the turn, as required. Keep in mind, the target is a 60° AOB / 2 g turn.

IT IS IMPORTANT FOR EACH WINGMAN TO KEEP LEAD, AND ALL AIRCRAFT AHEAD, IN SIGHT, AND ON THE HORIZON

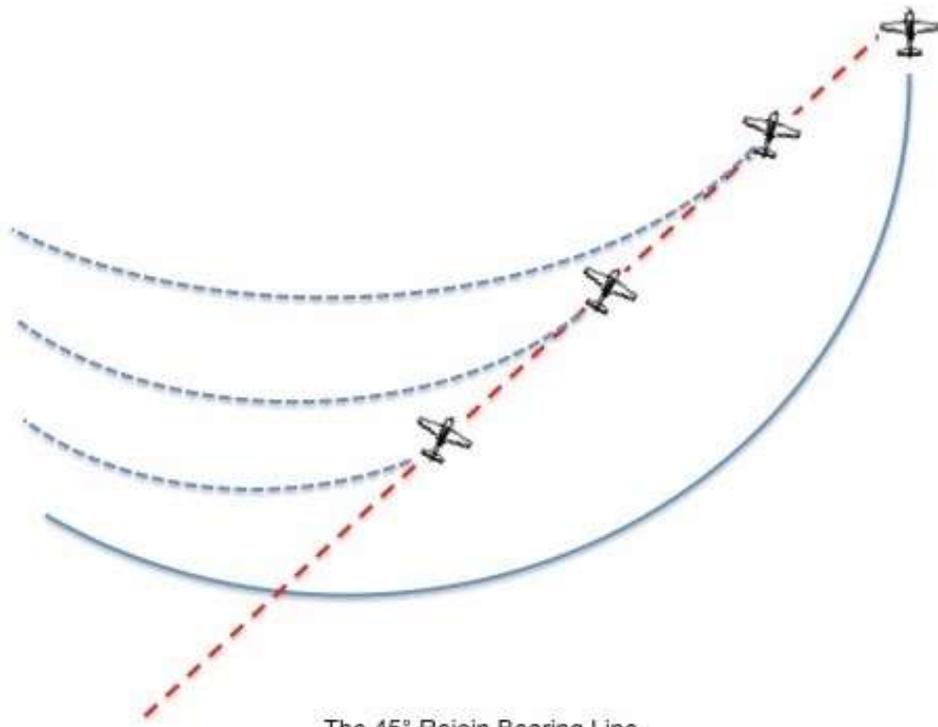
- As each Wingman rolls out of the 180° turn, they shall maneuver to place Lead and all other aircraft at their 12 o'clock, on the horizon.
- When the last Wingman is comfortably in position in trail, he (she) will transmit “XX in”, using their race number. A good technique to use is to ensure all wingmen have maneuvered into trail before making an “In” call. This prevents Lead from beginning a rejoin into a Wingman that is out of position. Be a good Wingman to all members of the flight!



PITCHOUT AND REJOIN EXERCISE (continued)

THE REJOIN

- Lead may conduct the rejoin in either direction based on weather, practice area management, etc.
- Lead signals with a radio call, such as "Sport XX, Rejoin Right (or Left)". At Lead's discretion, the pre-briefed rejoin airspeed may be added to the call. If an airspeed other than the pre-briefed speed will be used, that speed should be added to the radio call.
- Lead rolls into a 20° to 30° angle of bank level turn, and maintains altitude and airspeed until all Wingmen are aboard.
- Wingmen will initially use 30° (or more) of bank, as needed, to place their nose slightly in front of the Lead (lead pursuit), in order to maneuver inside Lead's radius of turn.
- As the Wingman approaches the 45° rejoin bearing line, the angle of bank should be decreased slightly to stop on the bearing line.
- The initial sight picture for the 45° bearing line during a rejoin is line up the vertical stabilizer on the outside (high) wingtip. Reference the diagram and photos on the next page.
- Angle of bank (AOB) should be modulated to maintain the bearing line throughout the rejoin. If acute, decrease AOB slightly. If sucked, increase AOB slightly.
- Acute rejoins tend to generate excessive closure rates, and Sucked rejoins tend to stagnate. Monitor the bearing line and make small corrections to stay on it, or correct back to it.
- Throughout the rejoin, airspeed must be managed to avoid too high or too low airspeed. High airspeed tends to generate excessive closure, while too low airspeed tends to create rejoin stagnation.
- Initially, Wingmen should learn to conduct rejoins with relatively fixed power, and no more than 5-10 knots of excess airspeed (over the briefed rejoin speed). As proficiency is achieved, airspeed management may be utilized for more expeditious rejoins. Up to 15-20 knots excess speed may be used for additional closure in the early phase of a rejoin. This excess speed should be reduced as the rejoin nears completion.
- Angle of bank and power corrections must be small. Control and safety in the rejoin are paramount.
- **NEVER GO BELLY-UP TO THE LEAD OR THE FORMATION AHEAD!**
- All Wingmen will rejoin to the outside of the formation, in an echelon formation.
- If an Wingman ahead stagnates a small amount, it is best to slow the rejoin and allow them to complete their rejoin before completing your rejoin. Do not join on the aircraft ahead, or crowd/rush the pilot on their rejoin.
- During Pitchout and Rejoin Practice in the working area, if a Wingman ahead stagnates excessively, do not pass them and complete your rejoin ahead of them (as is authorized during departure rejoins for race heats). In training, following Wingmen should stagnate their rejoin, stay behind the stagnating Wingman ahead, and allow the Lead to coach the Wingman ahead on proper rejoins.
- As the Wingman approaches the Lead, and as relative motion becomes more apparent, each Wingman will smoothly cross behind and slightly below the Lead, and fly to their position in the echelon. A good rule of thumb is to fly approximately 1-2 plane Lengths behind the Lead, or the Wingmen ahead.
- As the Wingman crosses behind the Lead and the Wingman in the echelon ahead, additional power is required, as the aircraft moves outside the Lead's radius of turn.
- Airspeed and closure must be controlled as the Wingmen cross into position. Excessive closure is cause for an Overshoot/Under-run.
- Crossing to far aft of the Lead the formation ahead causes a loss of closure, and position stagnation. A great deal of power is then required to move up into position while outside the Lead's radius of turn.
- When all Wingmen have joined in echelon, and the formation is stable, the Lead will smoothly roll out in preparation for the next maneuver.



The 45° Rejoin Bearing Line



ON THE BEARING LINE



ACUTE



SUCKED

OVERSHOOT / UNDER-RUN

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

- If a Wingman becomes **excessively acute** (well ahead of the desired bearing line / rejoin line, or approaching the abeam position of Lead).
- If a Wingman gets **acute when approaching the Lead**, and is too close to make angle of bank corrections.
- If a Wingman experiences an **excessive closure rate** that cannot be controlled with small angle of bank corrections and power.
- If a Wingman cannot control his position on the bearing line without going Belly-Up (NEVER GO BELLY-UP TO THE LEAD OR THE REST OF THE FORMATION!).
- Whenever a 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 "XX (Race Number) 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, the overshooting Wingman will join into the echelon 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 complete their rejoin, then follow him to the completion of the rejoin, in sequence.
- If required, the Flight Lead should make directive comm to direct the wingmen during an overshoot, to avoid potential conflicts.

EXTENDED TRAIL MANEUVERING

Extended Trail maneuvering is an exercise to develop Wingman skills in utilizing Lead Pursuit, Pure Pursuit and Lag Pursuit to maintain nose-to-tail spacing during Lazy 8 or other maneuvering. This exercise refines a Wingman's ability to recognize and manage distance and closure, while maneuvering their aircraft through a variety of attitudes and speed ranges. The following are definitions of the various Pursuit Curves and the Extended Trail Maneuvering Envelope:

Lead Pursuit

Definition: Maneuvering that points the nose of the Wingman's aircraft in front of the flight path of the Lead, or the aircraft ahead. In a turn, this moves the Wing aircraft from outside to inside (or further inside) the turn radius of the aircraft ahead.

Effect: Lead Pursuit generates closure and decreases nose-to-tail

Pure Pursuit

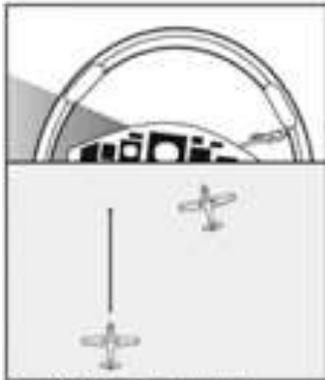
Definition: Maneuvering that points the nose of the Wingman's aircraft at the Lead aircraft, or the aircraft ahead. In a turn, this will move the Wing aircraft onto the turn radius of the aircraft ahead, and will then maintain that same radius.

Effect: Pure pursuit will not generate closure or opening, and will essentially maintain nose-to-tail distance in a turn. (Note: this is true once the two aircraft are flying the same radius of turn.)

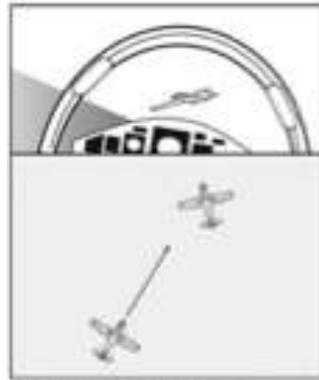
Lag Pursuit

Definition: Maneuvering that places the nose of the Wingman's aircraft behind the flight path of the Lead aircraft, or the aircraft ahead. In a turn, this moves the Wing aircraft from inside to outside (or further outside) the turn radius of the aircraft ahead.

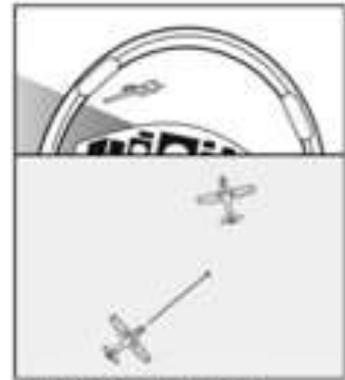
Effect: Lag Pursuit decreases closure and generates opening, and increases nose-to-tail.



LEAD PURSUIT



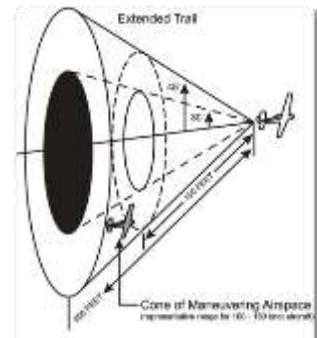
PURE PURSUIT



LAG PURSUIT

Extended Trail Maneuvering Envelope:

When maneuvering in Extended Trail, and utilizing Lead, Lag and Pure Pursuit, Wingman may maneuver within an envelope that can be visualized as a cone, as demonstrated in the diagram to the right

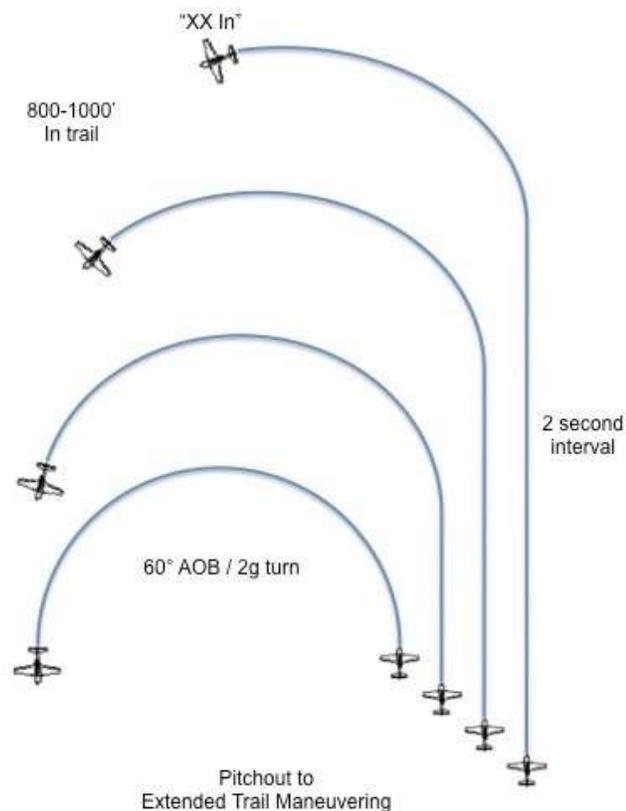


ENTERING EXTENDED TRAIL

- Extended Trail will always be entered from an echelon formation, via a pitchout.
- Lead may conduct the pitchout in either direction based on weather, practice area management, etc.
- Prior to the pitchout, Lead establishes the formation in straight and level, unaccelerated flight, in echelon formation away from the desired direction of the pitchout.
- Lead signals the pitchout to Extended Trail with a radio call, such as “Sport XX flight, Pitchout Right (or Left), to Extended Trail, 2 second interval, acknowledge. 2 seconds is standard for Extended Trail Maneuvering.

Note: This radio call, and the acknowledgement requirement, is what differentiates a Pitchout to Extended Trail from a Pitchout and Rejoin. It signals the Wingmen to expect maneuvering during the pitchout, once the last Wingman calls “In”, and signals the last Wingman to call in as soon as they have achieved Extended Trail separation (500-1000’) from the Wingman ahead.

- Lead should clear the area in the direction of the pitchout, then initiate the pitchout, smoothly rolling into a 60° AOB turn and smoothly increasing pull to 2 g’s.
- Each wingman will take a 2 second interval (or as briefed), then pitchout using the a 60° AOB / 2 g turn.
- When the last Wingman has achieved 500-1000’ spacing from the aircraft ahead, they call “Sport XX In”. This typically occurs shortly after the last Wingman’s pitchout.



- Lead will maintain a level turn until the last Wingman calls “in”, then is free to maneuver for the exercise.
- Lead will maneuver using a variety of turns and Lazy 8 maneuvers. The pitch and bank of these maneuvers are at Lead’s discretion, and should be tailored to the experience and comfort level of the Wingmen in the flight.
- Wingmen will use Lead, Pure and Lag Pursuit to maintain 500-1000’ nose-to-tail on the aircraft ahead, or

- to correct back to that spacing.
- Wingmen should keep power set, or use minimal power changes during the exercise. The objective is to use the various pursuit curves and radius of turn management to maintain spacing.
- The Lead must maintain visual contact on all aircraft in the flight throughout the maneuver, to ensure all Wingmen are maintaining proper spacing, and to act as a safety observer throughout the maneuver. Momentary loss of contact is permitted during turn reversals, but Lead must work to re-acquire and maintain situational awareness on all Wingmen during the exercise.
- Each Wingman must keep all aircraft ahead in sight at all times, and must know which aircraft is their interval. This prevents taking space on the incorrect Wingman (or Lead) ahead, and losing separation on the correct interval.
- If any Wingman loses sight of an aircraft ahead, or becomes confused as to who or where their interval is, a Blind call must be made. This may lead to a Knock-it-Off call, or to directive comm from Lead to help the Wingman maintain deconfliction and regain sight of the aircraft.

REJOINING THE FLIGHT AFTER EXTENDED TRAIL MANEUVERING

- When the Extended Trail Maneuvering Exercise is completed, the Lead will roll wings level and fly straight and level for a period of time (10-15 seconds).
- All wingman will fly to a position in trail of the Lead, still maintaining Extended Trail spacing. This will look similar to the positioning of all Wingmen after a pitchout for a normal rejoin.
- Lead signals a standard rejoin with a radio call, such as “Sport XX, Rejoin Right (or Left)”.
- The flight rejoins using the standard rejoin procedure, as described in the Pitchout and Rejoin section above.

Note: An “In” call is not required by the last Wingman when rolling out in trail of the flight. However, an “In” call is not prohibited, and may help expedite the rejoin of the flight. A good technique to use is to ensure all wingmen have maneuvered into trail before making an “In” call. This prevents Lead from beginning a rejoin into a Wingman that is out of position. Be a good Wingman to all members of the flight!

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 must occur in a manner in which a clear exchange of Lead and Wingman roles and responsibilities.

- While in Route, Lead will initiate the lead change with a radio call, such as “Sport XX, you have the lead on the left”.
- Wing will accept the Lead with a radio call, such as “Sport XX has the lead”.
- The actual lead change, and the shift in formation responsibilities, occurs upon the Wingman accepting the lead change.
- After the Lead change is accepted, the new Lead will **maintain heading and altitude**, and may smoothly and slowly move forward to facilitate the previous Lead dropping back into position.
- The previous Lead, now a Wingman, will reduce power slightly, and move to a Route position on the new lead. The new Wingman now has visual sight and separation responsibilities, per the Sport Class Formation Contract.

Note: After a multi-element lead change, it is common for lead to conduct a ‘check-in’ the flight over the radio.

Example: “Sport XX flight check”, followed by Wingmen checking in with their race numbers, in correct order.

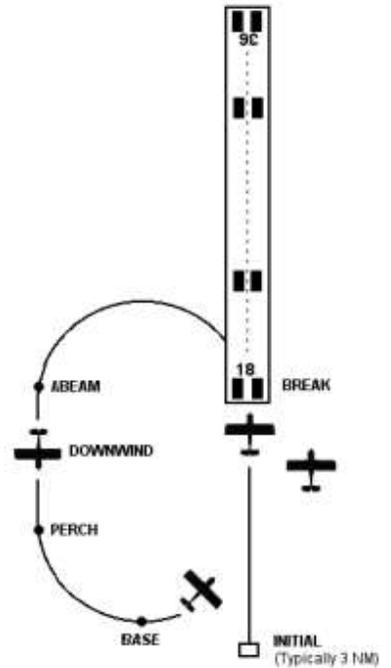
RETURN TO BASE (RTB)

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, separation will typically be taken by each Wingman on the turn from downwind to. These options are discussed below.

OVERHEAD PATTERN (PITCHOUT / BREAK)

GENERAL / APPROACHING THE INITIAL

- Field entry will be conducted in accordance with local Airport Traffic Area rules. Aircraft in the normal pattern have the right of way.
- 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 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.
- Lead will position the flight so as to arrive via 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),
- Be conscious of the traffic pattern direction to ensure the flight is properly positioned for the overhead pattern (i.e., Wingmen in echelon on the side opposite the direction of the pattern/break).



APPROACHING THE AIRPORT FOR THE PITCHOUT / BREAK

- The Lead's radio transmissions while entering the overhead pattern will signal the flight as to the direction and timing of the pitchout. These radio calls are described below.
- Lead may also use the standard hand signal for a pitchout and interval (twirling finger followed by number of fingers matching the pitchout interval) to supplement the radio calls.

Note: 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. If pattern dynamics dictate, 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 via the initial. It is not acceptable to force a flight into a crowded pattern and disrupt normal traffic pattern flow.

THE PITCHOUT / BREAK

- The Pitchout for landing is flown with the standard 60 degree, 2g level turn, as practiced in Pitchout and Rejoins. However, power is reduced smoothly towards idle to slow the aircraft to pattern speed during the break turn.
- Flights of higher speed, retractable-gear aircraft may brief and fly a climbing pitchout to facilitate rapidly slowing to gear extension speed in the break turn. The break altitude and pattern altitude should be clearly briefed.
- The Sport Class standard interval for an Overhead Pitchout/Break is 5 seconds. A flight of fixed gear (ex: RV) aircraft may brief and use a shorter interval, such as 2 seconds, at Lead's discretion. The interval must be briefed.
- Once Lead breaks, #2 is now momentarily "leading" the remaining aircraft, so must maintain LEVEL flight and quickly begin a VFR scan, then will pitchout at the briefed interval. This same method is true for each subsequent aircraft, as the aircraft ahead breaks.
- #2's timing sets the interval. When Lead breaks, everyone starts counting; when #2 breaks, the onus is now on #3 and #4 to match that interval.

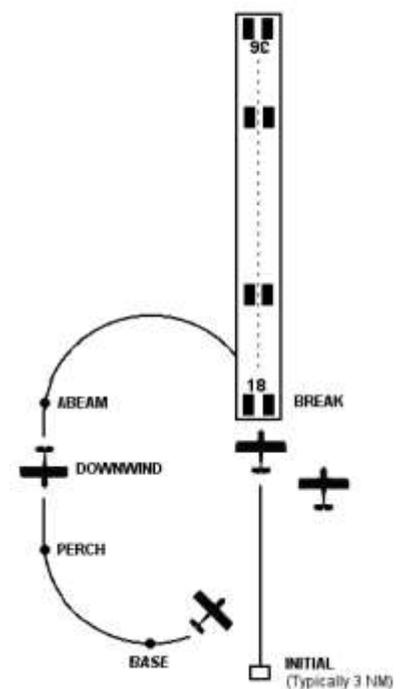
- Prior to each aircraft's break, care must be taken not to slowly roll, or "lean" into the turn, prior to pitching out.
- During the break / pitchout, it is critical for each Wingman to **keep the aircraft in front of them on the horizon**, DO NOT climb or descend during the break / pitchout, unless a climbing pitchout was briefed.
- During the break / pitchout, it is also critical for each Wingman to maintain situational awareness on the position of all members of the flight. As in Extended Trail Maneuvering, each aircraft must know which aircraft is there interval, to avoid cutting off aircraft in the break turn and the pattern.
- In a flight with aircraft that have both constant speed and fixed-pitch props, the power reduction towards idle should be managed to avoid aircraft over-runs in the break turn and the pattern. Constant speed prop aircraft tend to slow more rapidly at idle than fixed-pitch prop aircraft, so pilots of constant speed should not chop power quickly when in front of a fixed-pitch prop aircraft. Similarly, pilots of fixed pitch prop aircraft should be slightly more aggressive with their smooth power reduction, to avoid running up on the aircraft ahead.

DOWNWIND AND THE "PERCH"

- As each aircraft rolls out on downwind, airspeed should be managed to maintain pattern spacing while slowing to gear and flaps limit speeds. Heading should be managed to adjust abeam distance, and to remain in trail of the aircraft ahead.
- All aircraft must maintain pattern altitude, and must avoid the tendency to descend prior to the approach turn, especially as aircraft ahead descend on the base turn.
- The "Perch" or "180" is the point at which aircraft begin their base turn. Unless there are other aircraft on final that prevent a turn abeam the numbers, the Perch is abeam, to slightly beyond abeam, the numbers of the landing runway.
- Prior to leaving the Perch, ensure the final is clear, or ensure the interval ahead is in sight.
- Do not descend before reaching and leaving the Perch.

THE APPROACH TURN

- Traffic permitting, the lead will leave the Perch and start the descending approach turn when abeam, to slightly past abeam, the numbers.
- If traffic does not permit leaving the perch at the abeam point, Lead will extend the downwind, and maintain altitude until proper spacing exists on traffic ahead.
- Each Wingman will leave the Perch and begin their approach turn at approximately the same point as the Lead. Proper spacing exists when the aircraft in the flight ahead is 90 degrees through its base turn, and at about the 10 or 2 o'clock position.
- It is not necessary to wait for the aircraft ahead to pass abeam you and on final before beginning the approach turn. The goal is to follow the same ground track as the aircraft in the flight ahead.
- Do not allow the pattern to get strung out by extending past the preceding aircraft's turn point (the Perch).
- The pattern should be flown to arrive at a nominal 1/4 mile final, traffic permitting.
- 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.
- This spacing interval is appropriate when following any Sport Class aircraft, whether in the same flight, or behind a preceding Sport Class flight. The exception to this is when operating at a Towered airport, and ATC provides different spacing and/or landing instructions.



- Sport Class aircraft may utilize reduced formation landing separation, and may occupy the runway at the same time, as long as safe separation is maintained, and local airport or ATC rules or directions do not prohibit it.

LANDING AND ROLL-OUT

- During approach and landing, wake turbulence is often encountered, Be prepared to fly through it. If wake turbulence cannot be safely flown through and the approach continued safely, or If a safe interval cannot be maintained, a go-around should be executed.
- Sport Class uses a Hot side-Cold side landing procedure.
- Lead and each Wingman will land on the hot side of the runway (the side away from the runway turnoff or exit).
- When the aircraft is under control and slowing, each pilot will transition smoothly to the cold side of the runway (the exit or turnoff side), and make a radio call, such as "Sport XX, Cold". This allows a following aircraft to go around or pass in the event of a brake malfunction or other issue.
- The desired exit should be briefed on every flight.
- Pilots should not brake excessively and slow rapidly to make an early turnoff.
- As the aircraft clears the runway, configure the aircraft as required, but be vigilant for other aircraft that have exited in prior.

TAXI IN AND SHUT DOWN

- Lead may "collect" or reform all his Wingmen for a staggered taxi back to the ramp, or may direct all Wingmen to taxi-back single ship. This should be briefed.
- Standard taxi in is staggered on alternating sides the taxiway centerline, with 1-2 plane lengths between aircraft. Additional spacing may be taken by tailwheel aircraft that need to do s-turns on the taxiway for forward visibility. This should be pre-briefed. Lead may also pre-brief, or call for, an on-centerline taxi if conditions warrant. Additional spacing should be allowed between each aircraft in this situation.
- As the aircraft enter the ramp, all pilots must exercise extreme vigilance for other aircraft and people in the ramp area.
- All pilots must closely follow the directions of the Ramp Chief or other ramp taxi directors.
- Shutdown will be at each pilot's discretion, upon arriving at the shut-down or parking location. Formation shutdowns are not typical in Sport Class operations.

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, after flight check-in on tower frequency, Lead will contact tower with an initial position report, and a request for the overhead. Follow all ATC instructions with respect to initial position, overhead altitude, and direction of the pitchout/break turn. Tower may assign an altitude above the normal pattern altitude for the break, so Lead and all wingmen must listen up and comply with all instructions. At non-towered airports, it is critical that Lead communicate position and intentions in a concise manner that is clear to local traffic. Many local or non-formation pilots are not familiar with the terminology associated with overhead entries, so the following is a list of *recommended* radio calls for use by Sport Class formation Leads when entering the pattern via an overhead at a non-towered airport:

- First call: "Stead traffic, Sport XX, flight of 4, 10 west, will enter straight-in to the overhead, left traffic 8, Stead"
- At the 3-5 mile initial: "Stead traffic, Sport XX flight, 5 mile straight in initial for the overhead, left traffic 8, Stead"
- At the numbers: "Stead traffic, Sport XX flight over the 8 numbers for the overhead, left traffic 8, Stead"
- In the break: "XXX traffic, Sport XX flight in the break, left traffic 8, Stead"
- Downwind: Each aircraft in the flight calls "Sport XX downwind abeam" approaching the Perch
- Base: Each aircraft in the flight calls "Sport XX, base, gear"
- When moving to the cold side, each aircraft in the flight calls "Sport XX cold"
- Clear of Runway: The Lead may report the flight clear of the runway if desired.

Note: The actual timing and position of the above calls 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.

VFR PATTERN ENTRY - DOWNWIND BREAKUP

When a normal VFR pattern is required, or an overhead is not allowed or practical, Lead may bring the flight into the patter via a downwind or 45 entry.

- Approaching the downwind, Lead configures the flight in echelon away from the runway.
- Lead will maintain an airspeed that integrates with pattern traffic, and is appropriate for gear and flap extension for the flight members.
- The flight separates in the turn from downwind to base. Lead will start the turn, and each Wingman then takes their own interval as they turn to base. (A delay of 5-8 seconds, or when the aircraft ahead is approximately 90 degrees into the base turn is a good rule of thumb).

In a VFR pattern entry as described above, Lead will make all position reports for the flight throughout the pattern entry and downwind leg, until the flight separates on base. All aircraft will make the standard "Sport XX base, gear" and "Sport XX clear" calls

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 all the way through 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 provide feedback to the flight. Wingman must be open to the Lead's feedback and critique, as the goal of every debrief is to identify performance areas the met standards and were well flown, as well as areas that need improvement or did not meet standards. The overall objective is to assist all members of the flight to improve each and every flight. Self critique, and ownership of errors is an important component of each debrief. No unanswered questions or concerns should exist at the end of the debrief.

EMERGENCY AND CONTINGENCY PROCEDURES

TAKEOFF ABORTS

INDIVIDUAL AIRCRAFT ABORTS

The aborting aircraft must maintain aircraft control, ensure separation from other aircraft and communicate their actions using the radio as soon as practical. "XX 2 aborting". Once under control, the aborting aircraft should maneuver to the cold side of the runway, to clear a path for any aircraft that has begun its takeoff roll to continue takeoff on the hot side (if practical for that aircraft).

AIRCRAFT IN THE FLIGHT BEHIND THE ABORT

When an aircraft aborts ahead, following aircraft that have already begun their takeoff roll, may continue the takeoff, especially if already at significant speed, and aborting would create separation issues with the aborting aircraft. The decision to continue or abort will be based on speed and runway available (distance remaining and a clear path ahead). Any aircraft that has not started their takeoff roll at the time of the abort, shall maintain position. When the abort ahead is complete, following aircraft may continue the takeoff (runway clear), or may clear the runway (runway obstructed or debris/fluid present).

AIRBORNE EMERGENCIES AND CONTINGENCIES

CHASE AIRCRAFT - GENERAL

During an airborne emergency, a Chase aircraft will fly no closer than required to observe the emergency or damaged 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 a damaged aircraft. Chase should fly a position from which to observe the emergency/damaged aircraft, but otherwise remain silent unless absolutely required or requested by the emergency/damaged aircraft. **"Over-helping" may distract the other pilot from performing critical steps in resolving the emergency.**

AIRCRAFT MALFUNCTIONS WHILE IN FORMATION - MADAY versus Knock-it-Off

When flying formation, aircraft abnormalities and emergencies must be handled in a manner that ensures safety of the entire flight. These abnormalities and emergencies fall into two separate categories: Those that require immediate action, and those that require investigation and then action.

MAYDAY AND BREAKOUT

In the case of an immediate action emergency, a pilot must rapidly devote full attention to the emergency, but must clear his aircraft from the formation prior to taking further corrective action. This is done via a Breakout Maneuver, and is accompanied by a "MayDay" call.

BREAKOUT MANUEVER

To execute a Breakout, a pilot must visually clear a path, typically above (along the lift vector of) his aircraft, and maneuver rapidly to the clear area. The most common method is to pull to blue sky above. However, depending on the attitude of the formation, the clear area may not be up (in terms of the ground). In most cases, the clear area is along the lift vector of the aircraft. Situational awareness of where Lead and other aircraft are critical, and formation pilots must always know where their "out" is. A Breakout is also appropriate for Lost Sight/Blind situations, which are discussed in the Contingencies section.

"MAYDAY" CALL

When an aircraft with an immediate action emergency performs a Breakout, the pilot must make a MAYDAY call. This informs the Lead and the other Wingmen of the severity of the emergency, and that the emergency aircraft has exited the formation. Upon hearing a MAYDAY call, the Lead will take command of the situation, call a "Knock-it-Off" (discussed below), and smoothly cease maneuvering the flight. All flight members will smoothly move to Route spacing, and await Lead instructions. Lead will assess the situation, and assign a Chase aircraft to the emergency aircraft, if appropriate.

SITUATIONS APPROPRIATE FOR A BREAKOUT AND “MAYDAY” CALL

Situations that require immediate action depend on the aircraft operating manuals. Major emergencies common to all aircraft that justify a Breakout and MAYDAY call include: engine failure, major engine malfunctions or a rough running engine that is unable to sustain required power, major system malfunction warning indications, or a midair collision. In the case of a midair collision, great caution must be used in how the aircraft is maneuvered clear of the formation.

ENGINE / POWER PROBLEMS

Should a pilot of an aircraft experience engine/power problems, once clear of the formation and the MAYDAY has been called, do not delay recovering the aircraft for landing. Do not delay turning toward the nearest landing field. Announce intentions over the radio. A chase aircraft will be provided by the Lead.

MIDAIR

The affected aircraft will call a MAYDAY, immediately take separation, and individually sort out the level of damage. Lead will ensure separation laterally and vertically with directive calls, if possible. The non-mishap aircraft will provide chase duties as directed by Lead. 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 recovery if forward visibility is severely restricted.

KNOCK-IT-OFF

In the case of an abnormal situation that does not require immediate action, a “Knock-it-Off” call should be made. “XX knock-it-off”. Lead will echo the Knock-it-Off call, and smoothly cease maneuvering the flight. All flight members will smoothly move to Route spacing, and await Lead instructions. Lead will assess the situation, and the pilot of the aircraft experiencing an abnormal situation will advise the Lead of the problem, their intentions, and assistance required. Lead will direct further action as required.

SITUATIONS APPROPRIATE FOR A “KNOCK-IT-OFF” CALL

In terms of aircraft abnormal situations, a Knock-it-Off is appropriate in the case of aircraft system caution indications, abnormal sounds or odors of concern to the pilot, or any situation that a pilot wishes to investigate that will divert attention from flying formation.

LOST SIGHT / “BLIND” PROCEDURES

Losing sight of Lead, or any flight member ahead, is a serious threat to the safety of the formation. The actions required in a Lost Sight/Blind situation depend upon the current formation and maneuvering status of the formation.

BLIND IN CLOSE FORMATION

Should a pilot go lose visual contact and go blind on the formation when in close formation, a Breakout must be executed. Make a radio call, such as “XX Blind, Breaking Out”. Lead will call a Knock-it-Off and take command of the situation, and will assist the Blind Wingman in regaining visual contact, and rejoining the formation. The other Wingmen in the flight will follow the Knock-it-Off instructions from lead, and await further Lead guidance.

BLIND DURING A REJOIN

Should a pilot go lose visual contact and go blind on the formation during a rejoin, they should immediately call “XX Blind, Knock-it-Off”, cease maneuvering, and fly a predictable flight path. Lead will take command

of the situation, and will provide directive comm to the Blind Wingman to assist in regaining visual contact, or will direct a turn to clear the formation. Wingmen already joined will follow Lead's instructions. Wingmen behind the Blind Wingman will stagnate their rejoins and remain clear of the Blind Wingman as the Lead sorts out the formation.

BLIND DURING EXTENDED TRAIL MANEUVERING

Should a pilot go lose visual contact and go blind on the formation during Extended Trail Maneuvering, they should immediately call "XX Blind, Knock-it-Off", cease maneuvering, and fly a predictable flight path. Lead will take command of the situation, will cease maneuvering, and provide directive comm to the Blind Wingman to assist in regaining visual contact, or will direct a turn to clear other aircraft, if required. Wingmen will all cease maneuvering, will increase lookout doctrine, and will follow Lead direction as they sort out the formation.

RADIO FAILURE / LOST COMM

If an aircraft experiences a partial or total radio failure of either transmit and/or receive functions, the flight should be terminated. 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 required. A standard overhead approach and landing should be conducted, unless weather or other considerations dictate otherwise. The lead pilot will inform the tower or applicable controlling agency, and coordinate as required. 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

Pass the lead to either #2 or #3, and follow the above procedures.

RADIO FAILURE AS WING

Expect to be led back to the briefed recovery field following the procedures contained in this section.

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 SAR-specific actions that may be made to assist in the location and recovery of a downed pilot/aircrew.

Respond

Immediately terminate maneuvering using appropriate MAYDAY/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 if able.

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 if possible, and as required, to maintain SARCAP coverage over survivors and/or crash site. Do not allow SARCAP aircraft to fly below the briefed or adjusted BINGO fuel state.

GLOSSARY of TERMS

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, or a maneuver utilized to separate formation aircraft and establish them in trail. Also called PITCHOUT.

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

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.

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 SPACING: Close formation position on Lead's 45 degree bearing line.

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 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.

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 flight 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.

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

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: 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).

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. Opposite of NO JOY.

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.