



Team RV Formation Training Guide



A talking points guide to formation flight

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Purpose

The purpose of this document is **NOT** to teach the in's and out's of formation flying. Others before me have done a much better job than I ever could. I wrote this more as a training syllabus as I was being asked more and more to provide training in seminars and clinics. This is more a talking points guide to help me with discussion points when training RV'ers on formation flying. This does not cover every topic, nor will this alone provide you with the knowledge you need to be safe. What this will do is provide a list of talking points for a formation training clinic.

What is formation flying?

Formation: A disciplined flight of 2 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.

Why do we do this?

Formation flight is derived from the military with very practical uses, mostly tactical in nature for protection and strike capability. For civilian use, it is mostly for fun, convenience, safety, and more fun. I started Team RV after spending some time with a close friend 'Subaru Bob' Goodman, retired fighter jock, who introduced me to formation flying one day. I quickly found out that flying in tight formation with an RV buddy, was a whole lot more fun than just tooling around the patch. After getting more involved, I soon learned that there is much more to it than joining up and flying around. This is an art. A real discipline that requires attitude, focus, and practice, practice, practice. Ultimately I wanted a demonstration team to fly in local parades, air shows, and Oshkosh.

Standards

In order to facilitate consistency and safety, standards are necessary. To fly formation in an air show, what the FAA refers to as 'waivered' airspace, you must be certified by an FAA recognized organization. The only civilian general aviation group that does this currently is Formation Flying Inc. (FFI). FFI, along with other formation groups like the Warbirds of America, use the North American Training Association (NATA) (T-34) Formation Flying Manual, herein referred to as **Thuh Book** as a basis for their formation certification. ALL Team RV members and students are expected to own this inexpensive manual. A search on the web will provide you with a list of places to get it. The two-cassette video (VHS) (230 minutes) package 'Formation Flying: The Art', \$69.95, herein referred to as **Thuh Video** available from Sporty's Pilot Shop (catalog # 632A) is the best formation information material available. The video package includes the (T-34) Formation Flying Manual. Knowing these 2 training guides will get you 95% of what you need to know. The other 5 % comes with practice. Have I mentioned that this requires practice? Enough said on that.

Regulations:

There are few regulations to worry about. I won't quote the FAR's, but here is the gist:

- Formation flights are treated as one plane
- Lead is in charge
- Must be prearranged, with no passengers for hire
- Only lead squawks, others 'choke the parrot'

Pre-flight.... The Briefing

The FAA requires that in order to fly formation:

- The formation must have been prearranged by the pilots in command of the aircraft
- There must be no passengers for hire in the aircraft

Notice it does not say 'arranged on the fly.' **A briefing is essential.** A briefing should be just that, brief. Standards are standards, and should not be briefed. You are expected to know the standards. If you arrive at a briefing and do not know the standards, you will make the other flight members concerned for the flight, as others have prepared and you have not. You are expected to arrive at a briefing prepared with the knowledge of formation basics covered in *Thuh Book* and *Thuh Video*. Please, take this seriously by being prepared.

A briefing will cover many things, usually quickly, a list of which can be found in the appendix on the Team RV briefing sheet. Come to your briefing with a **briefing sheet and a pen**. Your lead will be impressed. Here are some items to consider during a briefing:

- A briefing is led by the flight lead. Do not argue with the flight lead. This is his flight. If you don't like what's going on, leave and get your own flight, but respect your flight lead if you stay. Leave your ego at home.
- Questions should generally be left until the end of the brief
- There are no Dumb ?'s in a briefing. Resolve any questions now. Nothing worse than, during the flight, having a question mark come over your plane and hover over you like a halo and sit there, requiring you to either risk other members in the flight by doing the wrong thing, or have to key up and ask.
- The most experienced pilot is always the lead, next is 3, 2, then 4

Terms

Like any specialized activity, there are specialized terms. Just some jargon to keep the 'regular people' confused and wondering what we are talking about. Most are defined in *Thuh Book*. I'll list some here. Also see the appendix for a glossary of terms.

Gaggle
Section
Flight

Sucked
Acute
Step Down/Up

Bearing
Rendezvous

The
Break/Initial/Pitchout
Kissoff
Gimmie One/Some

Call Sign
Parade
Enroute
Gib

Tally Ho
No Joy

Communications

Key to the art of formation flying, has nothing to do with flying at all, its communicating. There are four forms of communication in formation flight: Hand signals, plane signals, body language, and voice. Oddly enough, voice is used the least thanks to the old military guys. Turns out voice is not very practical in formation flight, particularly in larger formations. There is an old military saying that holds true today. There are two things lead wants to hear from 2. '2' and 'lead your on fire!' **A good formation is a quiet formation.**

Hand & Plane signals

Covered well in *Thuh Book* so I'm not gonna do it here. It suffices to say, know your hand & plane signals.

Body Language

This is simply the '**Head Nod**'. Lead gives a signal, wingman nod his head in an exaggerated way as if to say 'got it!' If you don't 'got it' don't nod your head. There is also the tap of your head to confirm that you have received the 'you have the lead' signal.

Voice

Voice is used in four areas of formation flight. Check-ins and Check-outs ('2'), position reports ('4's in'), Lead communication with the world, and in emergencies.

Check-in's and Out's

Used for frequency changes. What's important here is a positive cadence. 'Eagle flight, frequency change 122.75 go, 2, 3, 4.' You do not leave frequency w/o all flight members checking out.

When checking in on a controlled freq like a tower freq, flight lead WILL NOT check the flight in as this leads to ATC confusion. The flight waits for an appropriate time to do so on their own, initiated by 2. Example:

'Tower, experimental N686MS eagle flight of 4, 8 miles east, inbound for the initial with bravo.'

'Eagle flight continue, report the 3 mile initial runway 25, expect left break'

'Wilco 3 mile initial, expect left break, eagle flight'

'2,3,4'

Position Reports

When going into trail, '2's in, 3's in. 4's in'. When going into diamond, '4's in.' After a break, '2's in, 3's in, 4's in'

Emergencies

This is not the military so we certainly should just chime in an emergency or if there is a safety problem. HEFO works, voice is more effective and timely. Examples:

‘ 2’s aborting’, meaning takeoff, for a flat tire for example

‘Traffic 2 o-clock low’

‘Power lines, pull up’

Flight Positions

A flight, consisting of 2 sections, 4 planes, has 4 positions. Lead, known as lead or 1. Lead’s wing known as 2. Section two’s lead known as 3, and 3’s wing known as 4. Got that? Again: The leader is always number 1. Number 2 is on the left wing of the leader. In a three-airplane element number 3 is on the leader’s right wing. In a finger-tip (as the four fingers of your right hand) the number 4 aircraft flies on number three’s right wing. In right echelon, number 2 is on the leader’s right wing and number 3 is on number 2’s right wing. If there is a fourth aircraft it is on number 3’s right wing. In level flight when **a wingman is in the proper position**, the leader’s outboard aileron hinge that hangs underneath is lined up with the spinner. Otherwise called **‘aileron hinge to spinner’** when lead is not happy with his wing’s position. This gives a vertical spacing for safety. If leads engine quits, he will immediately slow down and the flight will not have time to react. He will slide back and the flight will pass on by. Flights are always ‘stepped down’ unless lead requests otherwise with the proper signaling.

Responsibilities

Lead

Always, unless training, the most experienced formation pilot is the flight lead. He has ultimate responsibility of the flight and its members. A lead must be trusted by his members, and must fly to the skills of the weakest wingman. Here are some other responsibilities.

- Flight communications, navigation
- **Flight Safety, attitude, discipline**

Wingman

- Fly your position
- Communicate to others with hand signals
- Fly your position
- Watch occasionally for traffic
- Fly your position
- Instill confidence in your lead by flying smooth, safe, tight formation.
- Fly your position
- Acknowledge signals with your head nod

Flying

There is a saying in the formation world; **you are in formation from startup to shutdown**. This is so true. You see, when you are in formation, everyone is watching from startup, to taxi, to flying, to landing, to shutdown. Remember this is a discipline. So look to lead for startup and taxi at the briefed position. Stay tight, look good, drive sharp, fly straight and you will be rewarded with the feeling of a true formation flight. Now onto a sample flight.

Startup

OK you've been briefed, you've prepared, you jump in your plane and fire up. **BUT WAIT!!** Remember you are a wingman and you take ALL your cues from your section lead. You are not a lone pilot now, you are part of a team. Get in your plane and be ready to fire-up at the briefed time and look for the startup signal.

Look for the startup signal and fire up with the team in unison. Be ready for the freq check-in.

Taxi

Taxi at the briefed position, usually staggered. About 1 plane length clearance. Stay tight.

Run up

Pull in together, turn together, position staggered if possible. Make your run-up brief. Try to cover your checklist while taxiing. Pass the 'thumbs-up' ready signal up the line. 3 is looking at 4. When 4 is ready he thumbs-up to 3, 3 to 2, and 2 to 1. When lead receives the thumbs up signal from 2, lead knows the flight is ready. You should be on freq and ready for check-in

Position and hold

When given clearance for takeoff, lead will take a position and hold. 2 will line up nearly wing abreast with lead, 3 behind lead etc. 2 lines up forward of the flying position for safety in the case of a problem on take-off. If leads main blows on your side during take-off, if you were lined up aft of lead, he'd be into you, and you'd both be in trouble.

Lining up nearly **wing abreast** lead will allow you to pass on by with some clearance should there be a problem.

During a section take-off, lead will signal run-up. Set the brakes, power to mag check 2000rpm, wait for leads' head-back and drop to release brakes. 3 will depart at the briefed interval, usually at leads' wheels off point.

Formation/Section Takeoff

This is an extremely fun maneuver and very easy to fly. It is also the most dangerous part of the flight. Here are some tips:

- **Do Not** wingtip overlap
- Consider putting wingman upwind
- Almost line abreast for safety

- Pay attention to signals, run up and brakes release
- Last chance to check stuff during run-up. Gages, instruments etc. Look at your leads' plane for final inspection. Remember, your about to roll into the most dangerous part of the flight, take-off.
- Should take about 5 sec to get to takeoff power setting from brake release
- Lead should give wingman about 4" of power
- Leave together, then wingman takes position
- On aborts:
 - Key up 'call sign abort', the rest of the flight continues
 - Other planes do not abort
 - Only lead can call 'Flight abort'

Departure

3 will join with lead and you will be enroute to the maneuver area. Usually lead will enter a slight turn and allow either his wing to join, or the other section to join. 2 Always joins to the inside of 1, **always**. Be prepared for a freq change.

Station keeping

This is the essence of formation flight. Two simple words, but not easy to do. It is just practice, practice, practice. Here are some tips:

- Don't delay in positioning, **anticipate** is the key, and do it now!
- Understand the dynamics and physics of motion
- With a c/s prop, keep rpms at 2550 or better. You will need the power.
- Maintain the same relative position, always small rapid changes
- Never stack up, especially in a turn unless told to do so
- **Use your rudder** for position movement
- Fore and aft movement is the most difficult to control
- You are always making corrections to stay in position
- Lead is always working in a tighter envelope w/ speed, power and position
- The more power you give your wing, the better you will look
- Lead should lead turns, meaning a gradual increase in turn rate
- Line up your points on the lead, cross reference w/ other planes
- Stay in trim
- It is more difficult and more dangerous to fly loose

Enroute

Lead will position the team for the enroute formation and spacing. Be on the lookout for a signal to spread.

Maneuvering

The standard formations are left and right fingertip, left and right echelon, diamond and trail. *Thuh Book* does not cover these signals well. The biggest confusion comes from the fist and double pump. If a fist, lead is talking to his wing for a cross-under. If a double pump, lead is talking to the second element for a cross under. 3 should always pass the

signal to 4 to keep him in the loop. The rest is straight forward. Here are some general tips:

- **Relax and fly the position**
- Small, smooth, rapid movements
- Anticipate required throttle changes
- **Never** pass lead
- All members fly off lead
- Practice practice practice
- Lead holds a constant briefed power/speed
- Look at other members as a cross reference to your position
- Never belly up to your lead.

Standard Formations

Finger Four

By far the most common formation. Typically strong right is your briefed 'standard' formation. Meaning this is the one you will return to before going to another formation. In this formation remember:

- Wingtip clearance
- Turn as one ship, as opposed to an echelon turn
- Remain stepped down
- 'aileron hinge to spinner'

Echelon

Typically used for an arrival to perform an initial or break. Remember this:

- Never turn inside an echelon
- This is not a very maneuverable formation
- Keep your lead on the horizon in a turn, as opposed to a fingertip turn

Trail

Trail, close or extended is fun and easy to fly since the guy in front of you is a giant ADI. Just match his wings and you are good to go. As you progress this can move to a 'tail chase' and the beginning of formation aerobatics. Remember this:

- Keep your nose/tip clearance
- Stack down for safety and clearance

Other Formations

Cross Unders

- Maintain your nose to tail clearance
- A smooth fluid motion
- Don't pull too much power in sliding back
- It's a down, back, over, up maneuver

- Take additional step down
- Control your relative motion

Close Trail

- Does not have many practical or tactical uses
- Easy to fly, and the guy in front of you is your ADI
- ½ ship back, low enough to clear turbulence

Cruise/Free cruise

- 2-4 ships out
- wing is free to maneuver in turns

Extended trail

- Excellent training tool for geometry
- 2-4 ships back
- Wingman holds power, only angle changes to cut off
- Free to maneuver 60° radius, very maneuverable formation
- Fun and can get progressively more radical in maneuvers with practice
- Lead should see wing cutting off his turns

The Break/Initial

Practiced for fun, practical for landing. The break is the fastest way to break up the formation for landing. *Thuh Book & Thuh Videos* do a good job of explaining this. Here are some notable tips:

- Don't pull up during the 2+g pull on the break, exit altitude is the same as the entry, unless briefed differently. Navy guys do the vertical pull up and away, air force jocks begin the initial at pattern and pull out level.
- If doing a break in the air, don't forget to call '2's in.'
- Watch your spacing, 180 ° turn, ¼ mile spacing
- Land alternate sides of the runway

The Rejoin

Without out a doubt, the most difficult task in formation flying, easy to understand, difficult to master. You need to see and do this maneuver in order to get it right. Again *Thuh Book & Thuh Videos* do a good job of explaining this. Here are some notable tips:

- Keep the lead in the same spot on your windshield, maintaining the 45 ° intercept
- Parallel leads' course as you approach the last 20 yards
- Think smooth, don't make lead nervous as you approach
- If your closure rate is too high, just go under, stabilize, and rejoin
- Come ***up the line*** as you rejoin
- Know where ALL the flight members are during the rejoin
- Never *belly-up* to lead
- 2 always joins inside
- Add 10knt speed to your join

- Point your nose slightly ahead of lead during lead pursuit
- Lead will just grow on your screen
- Typical problems:
 - Too fast and overshoot, which is not the end of the world, just go under, stabilize, and rejoin
 - Too much bank in close and going belly up. Expect lead to chew you out, or throw you out, if this happens
 - May end up in a tail chase

Formation Landings

Now this is a real challenge, and mostly relies on lead to be smooth, and gentle. Fly a larger pattern, take more time to do things. Here are some more tips:

- Same wind considerations for wingman as takeoffs
- Wingman likes the outside, but will settle for inside
- Do not rush, take longer stabilized approaches
- Stack line abreast and level, don't stack low
- Touch wheels simultaneously with lead, flying leads' wing all the way in
- Stay on your side of the runway all the way to the end

Emergencies

There are a few emergencies to consider and they will happen in 3 places; Take-off, flying, and landing

Take-off

If you line up on the runway correctly, most emergencies will not result in a collision. Remember to line up almost line abreast, meaning spars almost lined up. Should either plane have a problem, **the other plane keeps on going.**

Flying

There are just too many possibilities to consider while flying, with virtually all of them not affecting the flight as long as **everyone has taken the proper position.** Discuss any possibilities you are unsure of with your flight lead during the briefing. Remember these few points

- **Maintaining your proper position, stepped down** is the single most important thing you can do to prevent a catastrophe
- Typically the plane with the trouble takes the lead to work the problem
- **If a mid-air is imminent**, the pilot seeing the midair coming calls 'break (*direction*)' and the flight immediately breaks and performs a max G pull. This is a one time only, 'save your ass' maneuver and not to be practiced under any circumstances.

Landing

The same issues apply for landing as for take-off. A smooth lead will keep the flight stable as the transition is made from cruise to touchdown.

- Fly your lead ‘acute’, well forward and **again, almost line abreast**. As you touchdown, be very watchful for trouble as this is when it will occur. A collapsed gear, blown tire, & wind gust can be compensated for if you are nearly line abreast with the wingman upwind, the working airplane should slide right on by.

Summary

If you have read *Thuh Book*, watched *Thuh Videos*, and been given this training seminar, you are well prepared to begin formation training. Be safe, have fun, learn from each other, practice often, keep your attitude and discipline in check, and you will be rewarded with one of the most fun and challenging experiences of flying; You and your buds flying around the patch, looking good, feeling great. Enjoy and be safe!

Appendix

Sample Briefing Sheet

Flight Call Sign _____ Date _____
 Weather: Wind _____ Atl. Setting _____ Cloud Layer _____



Position	N-#(last 3)	Name (first)
Lead		
2		
3		
4		

Frequencies:

Time Hack:

Outbound

Inbound

Atis		Atis		Start	
Ground		Ground		Takeoff	
Tower		Tower		Rendezvous	
Departure		Departure		Overhead	
Enroute		Enroute		Other ()	
Airshow Ctl		Airshow Ctl		Other ()	

Enroute Alt. _____ Enroute Airspeed _____
 Rendezvous Point _____ Orbit Alt/Speed _____

Planned Maneuver Sequence:

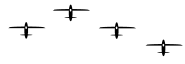
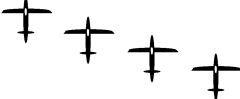
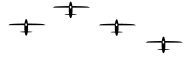
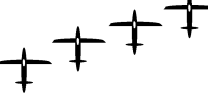
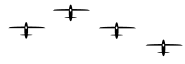

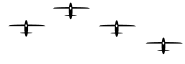
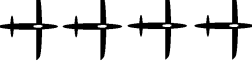

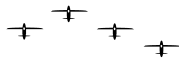
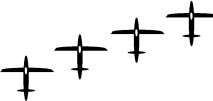
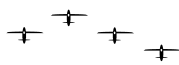
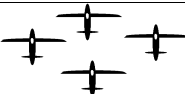
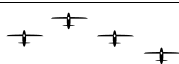
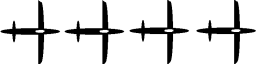
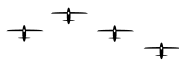
Landing:

Notes:

Pattern		
Alt.		
Formation		
Pitchout Interval		
Airspeeds		

Bingo Fuel _____

Little Cheat Sheet For Formation Changes

From	To	Signal
		Fist
		Double Pump
		Four To Slot 3 sgnl 4
		Pitch Up Down
		Fist 2 sgnl 3
		Double left Pump
		Rock Wings
		Rock Wings Shlw turn 2 join insd

Glossary of Terms *Snagged from the Blackjack Squadron*

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.

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.

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

SUCKED: To fall behind the lead, or be too far out on the position bearing to be able to join up with available engine power.

ACUTE: The opposite of "sucked." To be in a position too far forward in the formation or on a bearing (angle) that would place the aircraft too far forward during rendezvous, creating an uncomfortable closure rate and angle for the joining aircraft; vis. an "acute" rendezvous bearing as compared to a "sucked" rendezvous bearing.

NOSE TO TAIL OVERLAP: As viewed from above, the nose of the #2 aircraft is farther forward than the tail of the #1. Naturally, as long as there is lateral separation between aircraft, no danger exists.

WINGTIP OVERLAP: No lateral separation exists. A time to be smooth and concentrate if you also have nose to tail overlap.

STEP DOWN: The #2 aircraft is a couple of feet or more lower than the lead. This allows room to maneuver in case of turns into the wingman.

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

BEARING: The horizontal angle on the lead as flown by the #2 aircraft. (If the wingman were to overrun his leader and fly too far forward of a proper position, he would be on an "acute bearing." If he is too far aft of his proper position, he is on a "sucked bearing."

RENDEZVOUS: To join the flight onto the leader, as after takeoff.

THE BREAK: The breakup of the formation over the runway when a flight does a **360 OVERHEAD**. Also called "**pitchout**." A fighter maneuver indicating an abrupt bank and yank to accomplish a change of direction and/or altitude.

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

CALL SIGN: The code word or words that designate a flight, usually selected by the flight leader for that particular mission. The flight then would be designated (In the case of a call sign of "Red Flight") as: "Red Lead," "Red Two," "Red Three", and "Red Four." In the case of large formations divided into flights, the flights might be divided as follows, Red. Blue, Yellow, etc or Alpha. Bravo, etc. Any combination of names can be used, depending upon the imagination and audacity of the flight leader.

BINGO FUEL: The fuel state at which the flight must return to base. A predetermined fuel figure remaining in gallons, pounds, or minutes which will allow safe return to base plus sufficient overhead reserve. When the wingman signals bingo fuel, the leader acknowledges and heads for base.

PARADE: Formation configuration to be used when under observation by the public, as in an airshow appearance. Parade formation is demanding, since the aircraft are in close physical proximity to each other. It requires absolute concentration on the part of the wingmen and smooth leadership by the flight lead.

ENROUTE: A much looser version of the above, applied to any formation during cross-country flight. It allows the leader to control the flight, and reduces fatigue on the wingmen. Wingmen maintain the same relative bearing on the leader but move out to allow nose to tail and wingtip separation.

SMASH: Airspeed or Energy. Normally used to denote energy available to accomplish a snappy fighter-type maneuver, such as a pitchup to landing.

INITIAL: As in initial approach. Refers to the approach on runway heading used when doing a 360 overhead break.

TALLY HO: Used to indicate that you have visually acquired whatever it is you were looking for.

NO JOY: Used to indicate that you have not visually acquired whatever it is you are looking for.