

Formation Flying

by Alan Newton



Alan Newton is head of training for On-Track Aviation Ltd, a flight training school based at Wellesbourne Mountford Airfield, UK, that provides instructor and examiner training for UK/JAA ratings as well as other advanced training courses such as aerobatics and formation flying. Alan spent 18 years in the Royal Air Force where he saw operational tours on the Victor during the Falklands Conflict and the VC10 during the Gulf War. He also spent many years as a flying instructor on the Tucano and Jet Provost teaching both ab-initio and qualified pilots gaining an A2 instructor category. After leaving the Royal Air Force Alan joined Cathay Pacific Airways where he has flown the Boeing 747 classic and now flies the Boeing 747-400. He is an RTF Examiner and Flight Instructor Examiner on both land and seaplanes.

The Victor formation

The day started bright and clear and I felt relaxed as I drove to the airfield, looking forward to the formation flight I would be leading towards the end of the day.

We were planning to fly a Diamond Nine formation of light aircraft for the first time. Since we began teaching close formation flying we had always hoped we would one day be able to put up such a large formation. In the past this has been limited by the supply of suitably qualified pilots as opposed to aircraft, but today should see our aim achieved – fingers crossed!

After my usual morning coffee and chat with the operations staff at On-Track Aviation, it became clear this wasn't going to be the day for a Diamond Nine; it would more likely be a Diamond Seven – ugh!

A combination of aircraft un-serviceability and lack of pilots, due mainly to work commitments, had necessitated the downgrading of the formation from a nine ship to a seven ship. This was not what I had hoped for. It also meant that I had to redraw the formation and re-assign the pilots to different positions. Well, as they say, if you can't take a joke then you shouldn't have joined!

The number of formation qualified pilots we have at On-Track Aviation has increased greatly over the years by training a number of enthusiastic PPL holders. The most prolific comment made by pilots who have completed the course with us has been: "What shall we do with this new talent?" Our answer is to encourage them to pair up and go places as a formation. It is fun to arrive at a new airfield and maybe land as a pair. It may even result in a single landing fee! In addition, we ask them to take part in large formation flights organised and lead by instructors of On-Track Aviation, such as the one I had planned for this afternoon.

In the words of Gary Salter, one such PPL

who trained with us a few years ago, "I really enjoy the flying. It is very challenging and great fun. I always come down with a big grin on my face".

The close formation flying course is run out of Wellesbourne Mountford Airfield, in Warwickshire. The students who sign up for the close formation courses come from a variety of backgrounds and experience levels. They have included accountants, hoteliers and businessmen and women of all ages, but they all have one thing in common - they want to fly formation and have fun doing it.

The instructors who teach the formation flying course at On-Track Aviation have all come from the military with many years of teaching this discipline in a variety of jets and piston engine aircraft such as the Bulldog, Chipmunk and Jet Provost. Some of these instructors have been involved in formation aerobatics and formation displays.

It is an art form and a skill that any pilot can learn and it is both fun and sociable. It can also be a useful skill that could be used to help another pilot in trouble.

But is it legal?

Yes. There isn't anything to stop pilots flying in formation with each other. The Air Navigation Order (ANO) spells out the rules under which pilots may do this.

ANO Section 4, General Flight Rules, Avoiding Aerial Collisions

1. Notwithstanding that a flight is being made with air traffic control clearance it shall remain the duty of the commander of an aircraft to take all possible measures to ensure that his aircraft does not collide with any other aircraft.
2. An aircraft shall not be flown in such proximity to other aircraft as to create a danger of

collision.

3. Subject to sub-paragraph (7), aircraft shall not fly in formation unless the commanders of the aircraft have agreed to do so.
4. An aircraft which is obliged by this Section to give way to another aircraft shall avoid passing over or under the other aircraft, or crossing ahead of it, unless passing well clear of it.
5. Subject to sub-paragraph (7), an aircraft which has the right-of-way under this rule shall maintain its course and speed.
6. For the purposes of this rule a glider and a flying machine which is towing it shall be considered to be a single aircraft under the command of the commander of the flying machine.
7. Sub-paragraphs (3) and (5) shall not apply to an aircraft flying under and in accordance with the terms of a police air operator's certificate.

The close formation training, based on what military pilots are taught from early on in their flight training, provides pilots with a sound knowledge of ground and flight techniques, meaning that on successful completion of the course the pilot will be capable of flying close formation safely and accurately.

The course can be done on a part or full time basis as the candidate prefers, although we do recommend that the course is undertaken full time as it's easy to 'go off the boil' if there is too big a gap between training flights.

The course consists of five hours ground instruction and five hours 45 minutes of flight training, including a solo flight. These are the minimum training hours requirement and some candidates tend to require a little more flight instruction. (See table overleaf).

The emphasis throughout the course is

always on flight safety. Have fun but do it within the confines of your own ability safely.

Back to our Diamond Seven and it's time to gather the briefing material together and formulate a plan of action. All formation flying must be briefed and this briefing must be attended by all participating pilots. On-Track Aviation has a proud safety record when it comes to formation flights and the safe conduct of the flight starts with a thorough pre-flight briefing.

As leader it is my job to check all the necessary items, such as weather, NOTAMS, aircraft, exercise to be flown, emergency drills and so on. All aspects must be briefed and understood by all pilots before getting airborne. To help with this process the leader uses a set of slides (figure 1) which are preformatted with appropriate headings.

FORMATION BRIEFING SLIDE 2

FORMATION BRIEFING SLIDE 1

Time check	Weather	Airfield
Formation call sign _____		
Crew	Aircraft	Deputy Leader
Radio Frequencies _____		
Collector Frequency _____	Check-in _____	
Taxi _____		
Power / Take-Off Checks _____		
Take-Off _____		
Join Up _____		
Departure _____		

Figure 1

Ground Syllabus	Tuition	Private Study
Sections and formation positions	0.5	-
Joining formation and station keeping	0.5	0.5
Formation changes	0.5	-
Communications	0.5	-
Emergencies	0.5	0.5
Take-off and landing	0.5	-
Pre-flight briefing	0.5	-
Formation leading	0.5	-
Total (5 hours)	4.00	1.0

Flight Syllabus	Dual	Solo
Introduction and basic formation part 1	1.00	-
Pre-flight briefing	-	-
Start-up and taxiing	-	-
Stream take-off - Demo	-	-
Join up in straight and level flight	-	-
Manoeuvres in echelon and line astern	-	-
Formation changes	-	-
Lost leader procedure	-	-
Run-in and break and stream landing	-	-
Basic formation part 2	1.00	-
Stream take-off	-	-
Manoeuvres in echelon and line astern	-	-
Formation changes	-	-
Join up in straight and level and turning flight	-	-
Airmanship checks - bingo and chicken fuel	-	-
Changing the leader	-	-
Run-in and break and stream landing	-	-
Advanced formation	1.00	-
Formation take-off	-	-
Formation changes	-	-
Manoeuvres in echelon, line astern and line abreast	-	-
Changing the leader	-	-
Emergencies	-	-
Formation landing	-	-
Revision	1.00	-
Pre-solo check	1.00	-
Solo	-	0.45
Total (5 hours 45 min)	5.00	0.45

Planning the formation also requires knowledge of the pilots' abilities as a great many of the positions are flown by PPL holders we have taught over the years and they are not all as current and experienced as the On-Track Aviation instructors. Consequently, we always work to the lowest denominator to ensure the safety of the formation and its pilots.

In addition, we encourage each pilot to carry passengers as this provides a great source of photographs and a possible source of new trainees. As the leader I try and take a passenger to help monitor the aircraft around me as well as giving me another set of eyes to scan the horizon for possible conflicts.

Leading large formations around the sky, especially during the summer months, can be fraught with all sorts of challenges and threats which sometimes can be sorted out at the planning stage but most of the times are unplanned. A large formation of aircraft flying close together is not easy to manoeuvre out of the way of any potential threat so one has to always think well ahead and plan the outcome of any manoeuvre thoroughly.

As the briefing time approaches all the pilots assemble in the main briefing room. Today we will be flying a seven-ship formation lasting about 30-45 minutes, as much longer than that and fatigue sets in due to the amount of concentration required and expected of each pilot. I always finish the briefing in the same way: "We will walk at 20 past for engine start at 30, time check 17:00, any questions?"

There is a general buzz around the room as each pilot prepares him or herself for the forthcoming event. There is an atmosphere of anticipation mixed with nervous tension and excitement as each of the pilots and their passengers chat together before making their way to the aircraft.

"On-Track formation check in"
"On-Track One... Two... Three... Four... Five... Six... Seven"

"Loud and clear, engine start, go"
As the aircraft are parked at different locations around the airfield it is not possible to see each individual pilot and communicate the

engine start sequence visually, so we plan to use the radio. At this time of day the airfield traffic pattern is fairly quiet and soon the ATC will close down.

"On-Track formation check in"
"On-Track One... Two... Three... Four... Five... Six... Seven"

"On-Track formation, seven aircraft taxiing for runway 18, QNH 1005"

I apply power, moving off the grass parking area and taxi to the holding point for runway 18. The aircraft taxi either side of the taxiway centerline so as to reduce the slipstream affect and the possibility of throwing any stones into the numerical order behind me. At the holding point I turn my aircraft into wind, ready to complete the power and take-off checks. Each following pilot does the same. It's an impressive sight to look along the line of aircraft, but there isn't any time to take in the view as I have a job to do.

After completing my power and take-off checks I look left to await the thumbs up from my number Two, which tells me all the pilots are now ready for take-off. We work a cascade system of acknowledgement from the last pilot (number seven) to the leader with each giving the pilot next him/her the thumbs up as they become ready for take-off.

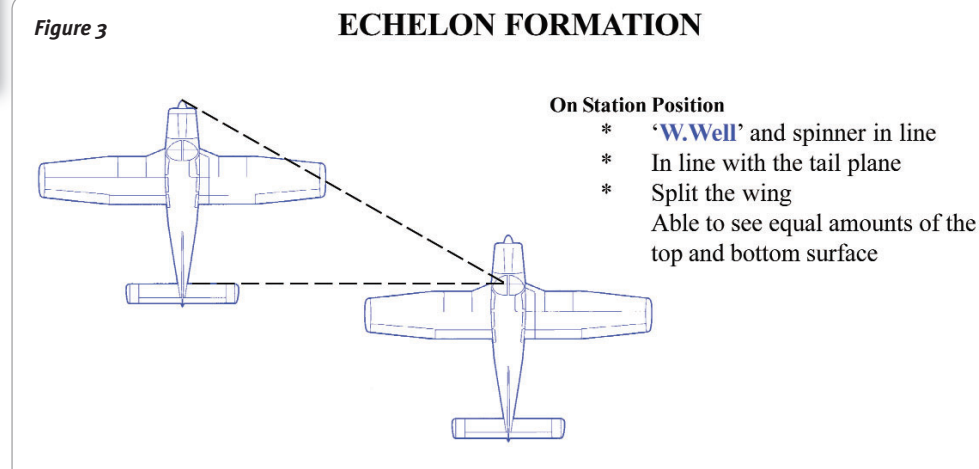
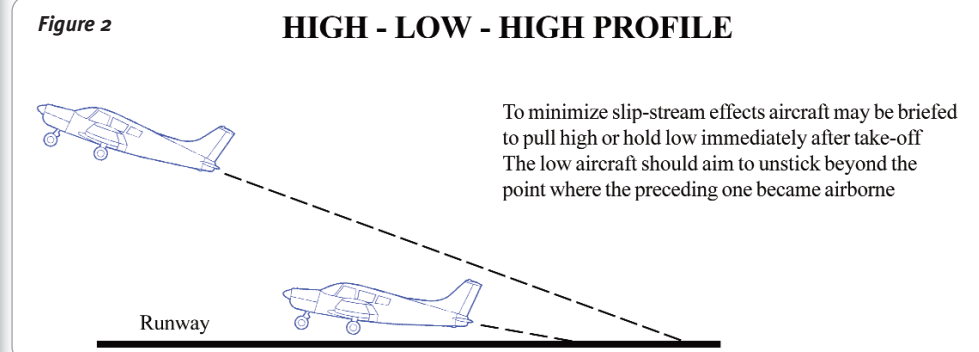
"On-Track formation ready for departure"
After a good look around, giving particular attention to the final approach, I taxi onto the runway ready for a stream take-off.

The stream take-off is the first type of formation take-off we teach the trainees. It isn't really a take-off in formation; more of a line-up in formation which then becomes an individual take-off. The major difference from a singleton take-off is that there will be other aircraft both ahead and behind on the runway conducting their own take-offs at a time interval of five seconds.

In order to ensure safety and avoid any wake turbulence the formation lines up in echelon into wind and operates a 'high-low-high' (figure 2) policy after take-off. Echelon into wind position allows any crosswind to blow the slipstream away from the adjacent aircraft. After



The seven-ship formation



take-off the preceding aircraft will fly a slightly higher climb profile than the following one for the same reason.

Echelon is when an aircraft flies slightly behind and on the left or right side of another. The pilot uses aircraft references to maintain the position (figure 3). These references will vary depending on what type of aircraft the pilot is flying echelon formation on.

I get a thumbs up from my number two, indicating that everyone is ready to go. I nod my head, which is the sign I am taking-off and apply power. Five seconds later number Two begins her take-off, and so on. On-Track formation takes to the sky.

Safely airborne I throttle back the engine and maintain the briefed climb speed to allow the following aircraft to catch up. As I am flying the least powerful of the aircraft in today's formation it will not be long before all the others join in their respective positions.

I glance over my right shoulder and see number Two moving quickly and accurately into place on my right echelon followed by the number Three on my left echelon.

"On-Track turning right 270 degrees. Rolling in, now"

By turning I will allow the pilots at the back of the formation to join quicker as they can cut the corner.

"On-Track Seven in"
After this call I know all pilots are in position and ready for the briefed exercise. It is an important call as I cannot see directly behind me. We continue the climb into the local training area to the briefed altitude ready for the exercise.

Today number Seven will act as a 'whip', which means he will break out of the formation and sit above us to organize the positions of each of the formation aircraft into a symmetrical pattern. It is important to do this as we have a variety of different aircraft flying in formation

and not all the pilots have had experience formatting on these new types. As leader I will retain the formation lead but delegate the positioning of each aircraft to the whip. He will ask individual pilots to move in order to achieve a symmetrical formation about number One.

"On-Track Four move forward one aeroplane length"

"On-Track Four"
"On-Track Two and Three hold your positions"
"On-Track Two... Three"
Each formatting pilot shall acknowledge the commands in the same way pilots acknowledge ATC instructions.

The formation of seven aircraft is made up of a 'Vic' and 'Box' formation, which is a series of echelon and line astern positions (figure 4). The line astern position is two or more aircraft lined up behind each other and stepped down slightly (figure 5).

After the whip has done his job he returns to

the formation and calls in. I begin a slow turn around back towards the airfield to position for a circuit and landing.

"On-Track Two out"
"On-Track formation heading 080 degrees, 90 knots, altitude 2,000 feet"

I look to my right and see number Two breaking away from the formation. She has got out of position and to ensure the safety of the rest of the pilots she has executed the 'Lost Leader' manoeuvre. This manoeuvre is taught early on to all pilots as it is the ultimate safety gate, in a similar way that a pilot is taught to go-around if the approach to land isn't stable and correct.

Lost Leader Procedure

- Climbing break using 45° AOB away from the leader
- Apply full power
- Hold for three seconds then reverse onto

STANDARD SECTION FORMATIONS AND POSITIONS

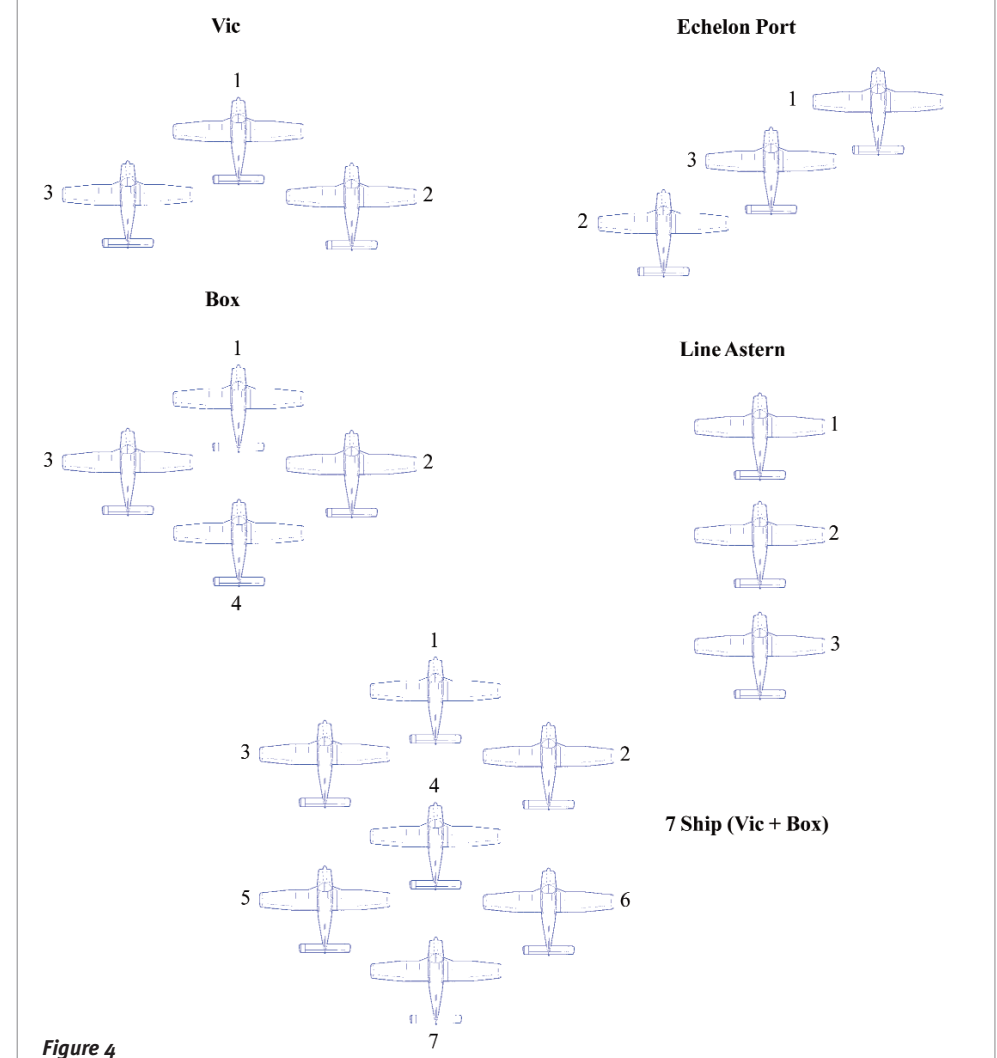
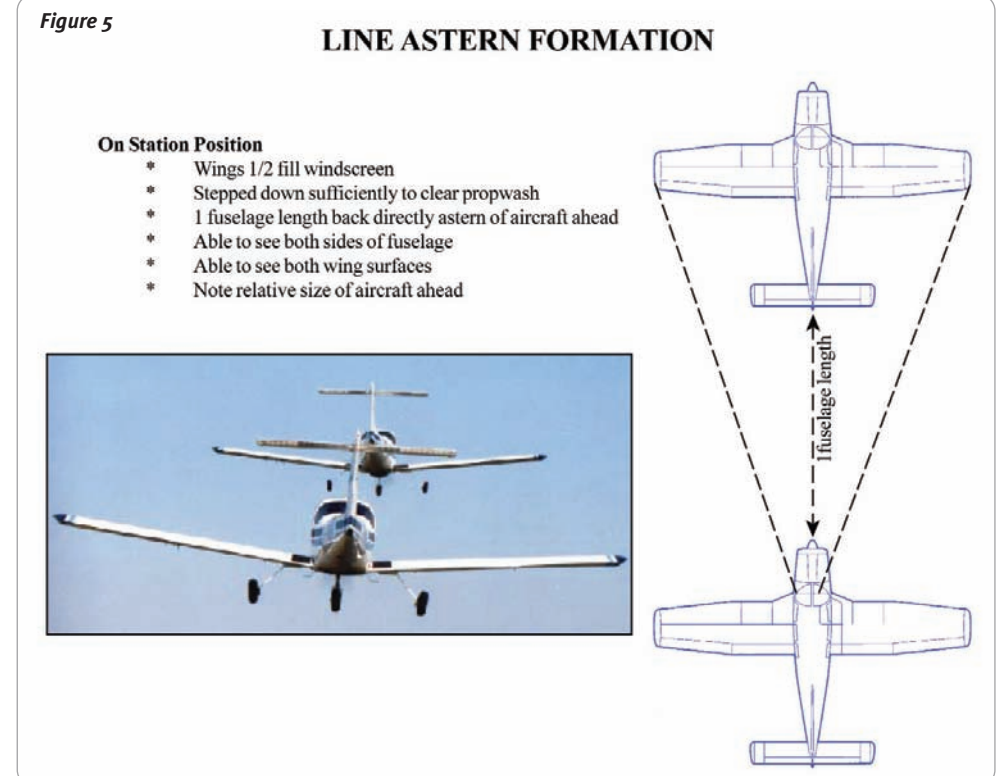


Figure 4



- leader's heading
- Call 'On-Track (?) out'
- Leader will respond with heading, speed and altitude
- Manoeuvre to locate formation and put leader on horizon
- Call 'On-Track (?) visual'
- Re-join formation only when cleared by the leader

I begin a gentle roll out of the turn onto a heading of 080 degrees and await a call from the number Two that she is visual and ready to rejoin the formation.

"On-Track Two visual"
"On-Track Two rejoin echelon starboard on the leader"

"On-Track Two"
It doesn't take long for her to re-join the formation and then I can continue positioning the formation for a rejoin at the airfield.

I make a radio call on the airfield frequency advises any traffic that we are rejoining the visual circuit.

"On-Track Four bingo"
"On-Track One roger"

Each pilot in the formation must carry out his/her own regular airmanship checks so as to monitor important items such as fuel level, engine health, etc. During the formation briefing, two fuel levels are nominated by the leader and called 'Bingo' and 'Chicken'. These are set figures based on either time or amount and when each member of the formation reaches either of these values they must tell the leader at the earliest opportunity.

Fuel Levels

- **Bingo**
This fuel state can be any amount of fuel and will be briefed by the leader e.g. less than one hour remaining. More than one Bingo fuel may be nominated.
- **Chicken**
This fuel state generally indicates that a wing-man has reached the fuel required for immediate recovery home or to a nominated diversion airfield.

With such a large formation with such a variety of pilot experience levels it is not safe to do a formation landing so I briefed a run and break followed by a stream landing. A run and break is a manoeuvre where the leader positions the formation for a straight-in approach to the runway and changes the formation into echelon. The leader continues towards the airfield and when he decides it is safe to do so breaks away from the other aircraft into the visual circuit. This may be a level or climbing manoeuvre. At the briefed time interval each of the other pilots follows suit. The leader makes all the radio calls for the formation. The run and break is then followed by a stream landing where each pilot positions his/her aeroplane behind the preceding one and makes an individual landing on the runway centre line. After landing and when it is safe to do so each pilot will move his/her aircraft over to the side of the runway from which they will vacate.

Additionally to keep the formation changes simple the seven ship will break up into two formation elements comprising a Vic (three aircraft) under my leadership and a Box (four aircraft) lead by On-Track Four. As formation leader I am still responsible for the overall safety and positioning of the formation into the visual circuit but On-Track Four takes it on himself to position his element in trail by a few hundred yards.

The look on everyone's face said it all - happy, smiling and well and truly knackered. "It's great to be able to do a job with such variety and have so much fun as well," commented one of the instructors.

If you wish to have a go at formation flying contact On-Track Aviation Limited. Tel: 01789 842777 or visit www.ontrackaviation.com for details.

The visual circuit on runway 18 is a right hand pattern and therefore to complete the run and break each element (Vic and Box) must now change formation into echelon port.
"On-Track Two echelon port, go"
"On-Track Two"

All formation changes are initiated by the leader or deputy if briefed. Each pilot who is required to move acknowledges first and then moves safely into position. When moving around the formation pilots are taught to move

in 'squares' one side of a square at a time. So to move from echelon starboard to echelon port the pilot, after acknowledging the command, will move down, then back and then across to the opposite side. Then move forward, then up and into position. Pilots never move diagonally for safety reasons and must always consider an escape route should things go wrong.
"On-Track Seven echelon port, go"
"On-Track Seven"
"On-Track Six echelon port, go"
"On-Track Six"

After hearing the command for On-Track Six to move and allowing a few moments for him to move into position, the formation is ready for the run and break. I begin a slow descent towards the briefed height for the break while at the same time allowing the aeroplane to slowly accelerate without increasing the power.

The circuit is clear and I have reached the start point for the break. Looking quickly right to check it's clear I rapidly roll the aircraft to the right and apply full power whilst transmitting on the radio.
"On-Track formation, seven aircraft on the break to land"
Three seconds later number Three breaks followed by number Two, followed by numbers Four, Five, Seven and finally number Six. I keep the turn very tight to give the following aeroplanes plenty of room to manoeuvre behind me. Almost as soon as I have applied full power I am reducing it again to bring the speed back within the flap limit. First stage of flap is lowered and I continue to tighten the turn on to final approach. The crosswind is having an effect on my ground track now. I lower the final stage of flap and line up with the runway at 150ft on approach speed.

"On-Track formation final"

I land the aircraft on the runway centre line and allow it to decelerate before moving across the right hand edge from where I will vacate the runway at the penultimate taxiway and wait for the rest of the formation to land and re-form ready for the taxi back to parking.

I now have a chance to view the last two aeroplanes positioning on final and making a smooth touchdown.
"On-Track formation vacated"

The last aircraft is clear of the runway and ready to taxi back to parking. We taxi back in the same way we taxied out, left and right of the centre line. On our return we are able to park next to each other and complete the shutdown checks.

"On-Track formation cut"

One final call to shutdown the engines and the formation flying is over, but not the exercise. After every flight there is a full debrief under the guidance of the leader. It is sometimes just a few words but on other occasions it can be quite heated.

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The Echelon formation