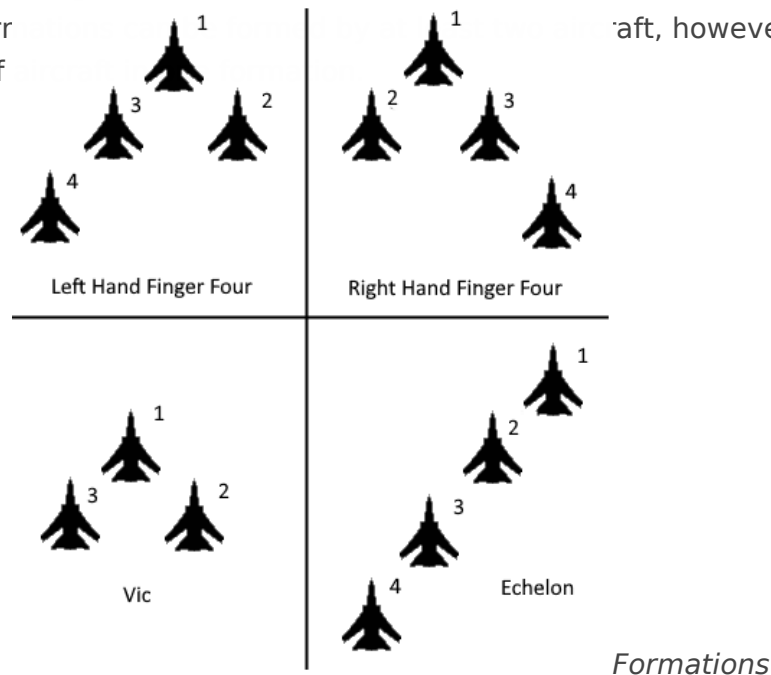


# Formation Flights

It is very common for military jets (e.g. F-16, F-18) to engage in formation flying. In these formations the responsibility for separation lies with the pilots. Some notable examples of formations are the Four Finger Formation, the Echelon Formation and the Vic Formation depicted on the right. These formations have no upper limit for the amount of aircraft, however, there is no upper



All aircraft in a formation usually have similar callsigns. If the military aircraft are using airforce callsigns then the flight leader will be numbered GAF123A and all other aircraft GAF123B, GAF123C etc. The flight leader will use the callsign GAF123 Formation when talking to ATC. If military aircraft are using tactical callsigns they will be numbered SABRE1, SABRE2, SABRE3 etc. The flight leader will use the callsign SABRE Formation when talking to ATC. No matter which callsign is in use, inside the formation the pilots will only refer to each other by using numbers as depicted on the right.

For ATC formations are handled like a single aircraft. Only the flight leader will have the transponder turned on and only he will communicate. You as ATC can disregard all other aircraft inside the formation. However, due to the fact that formations take up more space than single aircraft, we have to increase the horizontal separation from other aircraft to formations by one additional mile.

All Approaches and Departures can be flown by formations. That means that it is possible for formations to depart or land as a formation. In that case the runway needs to have a width of 45m for departure and 120m for landing. During the previously mentioned "Overhead Approach Maneuver" the formation will split automatically without any need to interfere by ATC.

Although only the flight leader will communicate with ATC, all elements of the formation have to listen on the active frequency. That means when the formation switches the frequency, there will be a short check by the formation when switching frequency as shown in the example below.

Station	Phraseology during frequency change
<b>EDGG_GIN_CTR</b>	GAF123, Contact Bremen Radar on 123.125
<b>GAF123A</b>	GAF123 Formation, Contact Bremen Radar on 123.125
<i>After frequency change on frequency 123.125</i>	
<b>GAF123A</b>	GAF123 Formation, check
<b>GAF123B</b>	Two
<b>GAF123C</b>	Three
<b>GAF123D</b>	Four
<b>GAF123A</b>	Bremen Radar, GAF123 Formation FL220

## Formation Splits

Reasons for formation splits can be operational reasons, weather or because formation landings are not possible. Especially in case of weather it is possible that elements of the formation lose visual contact with their wingmen. This is an emergency situation and must be resolved immediately. Most of the time the pilot will initiate the split and announce the emergency on frequency.

Plainly said: To split a formation one only needs to assign any instruction that will separate an aircraft from the formation. In case there are multiple aircraft, the split has to be performed one aircraft at a time! Methods to split the formation are

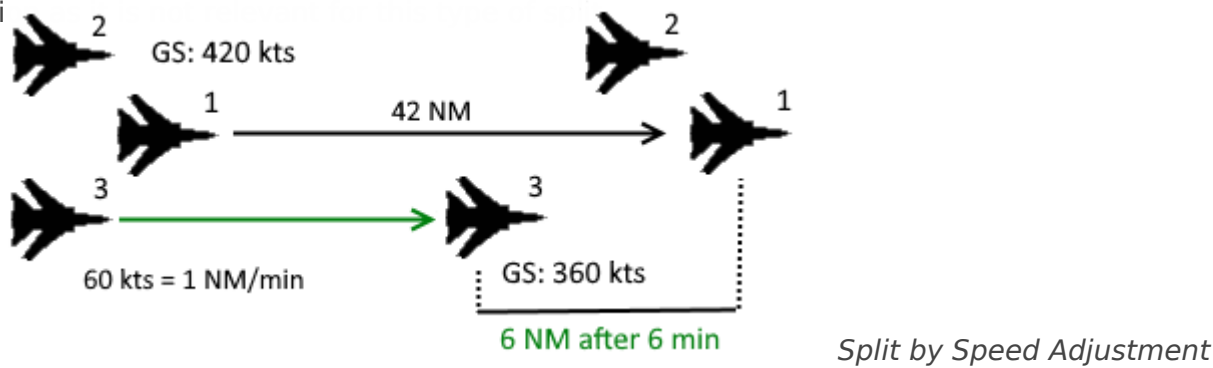
- Longitudinal split by using speed adjustment
- Vertical split by using climbs/descends
- Lateral split by assigning different vectors
- Combinations of the above.

Formations are only performed on request of the pilot(s). In IMC the split should not be performed in turn or descent unless requested so by the pilots. For ATC it is very important to know if the aircraft, that needs to be split from the formation, is able for a certain type of split. You do not need to know where every aircraft in the formation is but you need to ask whether the formation is able for a split turn or any other split. For example, when the splitting aircraft is on the right side of the formation, a left turn split will not be possible unless the pilot is given enough time and warning to move to the left side of the split. Especially when requesting a split by turning, the pilot should report which direction they are able to turn to.

The Formation split is considered accomplished when the pilot reports having passed or reached a level that is sufficient to provide vertical separation. The identification of the aircraft that is split from the formation should be done as soon as possible and before radar separation is established. Below you find examples and explanations for the three ways a formation split can be performed

## Longitudinal Formation Split by Speed Adjustment

For a Formation Split by speed adjustment you have to know the indicated airspeed of the formation. You can then assign a speed to the aircraft that needs to be split from the formation. Make sure that it is a significant speed different (e.g. 60 kts) because otherwise the split takes unnecessarily long. In this case you do not need to know the positions of the aircraft within the formation



As you can see in the picture, the number three, GAF123C, is assigned a 60kts speed difference. With 60 kts it takes 6 minutes to reach the required 6NM horizontal separation (5NM plus 1 NM because it is horizontal separation to a formation). This takes 42 NM without taking the deceleration period into consideration. As you can see, this should only be performed if enough flying distance is available. Especially when another split needs to be performed between one and two, this will take another 42NM. Below you can find an example for the phraseology with three aircraft in the split, GAF123A, GAF123B and GAF123C.

Station	Longitudinal Split by Speed Adjustment
GAF123	GAF123 Formation, request split for individual approaches, C is number one
ATC	GAF123 Formation, report indicated airspeed and ready for split by speed
GAF123	GAF123 Formation, speed 300kts indicated, ready for split
ATC	GAF123 Formation, for split maintain speed 300 kts, GAF123C, reduce speed 240 kts
GAF123	GAF123 Formation maintaining speed 300 kts, GAF123C reducing speed 240 kts
ATC	GAF123C squawk 2114

This may be repeated for GAF123B in order to complete the split.

# Vertical Formation Split

This is generally the fastest way to achieve the formation split. It takes only about 5 NM to achieve radar separation in this case. However, it also results in two aircraft on top of each other that will need to get individual approaches which can unnecessarily complicate the traffic situation in an approach airspace. In this case you do not need to know the positions of the aircraft within the formation as it is not relevant for this type of split. The Phraseology example is again given for a formation with three aircraft, GAF123A, GAF123B and GAF123C. This time we will also split GAF123B. The formation is flying on FL170.

Station	Vertical Split
<b>GAF123</b>	GAF123 Formation, request split for individual approaches, C is number one
<b>ATC</b>	GAF123 Formation, report ready for split by descent
<b>GAF123</b>	GAF123 Formation, ready
<b>ATC</b>	GAF123C for split descend FL150, report passing FL 160
<b>GAF123C</b>	GAF123C descending FL150, report passing FL160
<b>ATC</b>	GAF123C squawk 2114
<b>GAF123C</b>	GAF123C squawk 2114
<b>ATC</b>	GAF123C identified
<b>GAF123C</b>	GAF123C passing FL160
<b>ATC</b>	GAF123C Roger, GAF123 Formation, report ready for split by descent
<b>GAF123</b>	GAF123 Formation, ready
<b>ATC</b>	GAF123B for split descend FL160, report reaching FL 160
<b>GAF123B</b>	GAF123B descending FL160, report reaching FL160
<b>ATC</b>	GAF123B squawk 2115

# Lateral Formation Split

In this case the time it takes to split the formation depends on the angle between the aircraft that is split from the formation and the formation. Generally a 20-40° angle between formation and

splitting aircraft is advisable. In this case it takes 16 NM to reach 6NM horizontal separation with a 20° angle, 11 NM with a 30° angle and 8NM with a 40° angle. Any angle above 40° does not significantly increase the distance it takes to perform the split and achieve the required spacing. Again the previously mentioned example is given below. This time it is very important that ATC knows where the aircraft are inside the formation. Of course it is also possible to use orbits and "three-sixties" to accomplish a split but that is not recommended at high speed or high levels.

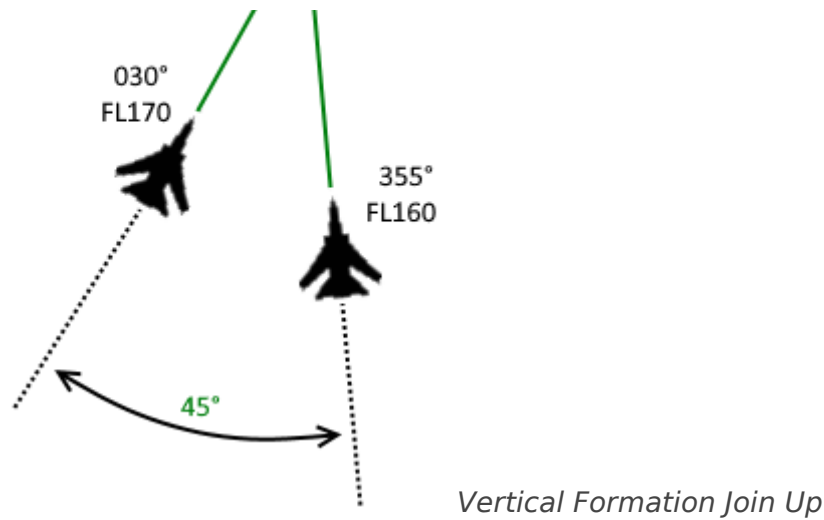
Station	Lateral Split
<b>GAF123</b>	GAF123 Formation, request split for individual approaches, C is number one
<b>ATC</b>	GAF123 Formation, report position of C
<b>GAF123</b>	GAF123 Formation, C is on the right hand side
<b>ATC</b>	GAF123 Formation, report ready for (right turn) split
<b>GAF123</b>	GAF123 Formation ready
<b>ATC</b>	GAF123C for split turn right by 30°
<b>GAF123C</b>	GAF123C for split turn right by 30°
<b>ATC</b>	GAF123C squawk 2114

Another example when a right turn split is not possible but C is on the right hand side.

Station	Lateral Split
<b>GAF123</b>	GAF123 Formation, request split for individual approaches, C is number one
<b>ATC</b>	GAF123 Formation, report ready for left turn split
<i>Give time for C to position on the left hand side</i>	
<b>GAF123</b>	GAF123 Formation ready
<b>ATC</b>	GAF123C for split turn left by 30°
<b>GAF123C</b>	GAF123C for split turn left by 30°
<b>ATC</b>	GAF123C squawk 2114

## Formation Join Up

In some cases aircraft will start individually and form a formation later. This is also necessary when a Jet aircraft joins a tanker formation to perform air to air refueling.



The following general guidelines need to be considered for a join up:

- the Join Up should be performed in VMC
- especially with limited visibility the join up should be performed vertically. Avoid cleared conflicts at all times!
- The intercept angle between both aircraft should not be greater than 45°
- ATC is required to maintain radar separation until the pilot reports the other aircraft in sight and the join up is approved. From that point onward the pilot is responsible for separation to the aircraft that he is joining up to.
- The formation may only be handled as a formation (handled as if it were one aircraft) when the flight leader has reported "FORMATION TIGHT"
- Before the formation is tight HDG and level changes should be avoided and if necessary only made with the consent of both pilots.

As you can see in the picture on the right, all guidelines are obeyed. The Join up is performed vertically with an intercept angle of a maximum of 45°. There is no cleared conflict. Both aircraft should be vectored to a distance of roughly 3NM before initiating the visual join up to make it easier for the trailing pilot to visually spot the preceding aircraft. Below you find a phraseology example for the formation join up.

Station	Formation Join Up
<b>GAF123B</b>	GAF123B request to join GAF123A
<b>ATC</b>	Roger, GAF123A report flight conditions and heading
<b>GAF123A</b>	GAF123A HDG030, VMC
<b>ATC</b>	GAF123B Fly Heading 355, climb FL 160
<b>GAF123B</b>	GAF123B Fly Heading 355, climb FL 160
<i>When close to 3NM</i>	

ATC	GAF123B Alpha is 10 o'clock, 3NM converging, FL170, report in sight
GAF123B	GAF123B Alpha in sight
ATC	GAF123B approved to join visually, report formation tight
GAF123B	GAF123B joining visually, wilco
After the formation has been formed	
GAF123	Langen Radar, GAF123 Formation, Formation Tight
ATC	GAF123B squawk standby

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