



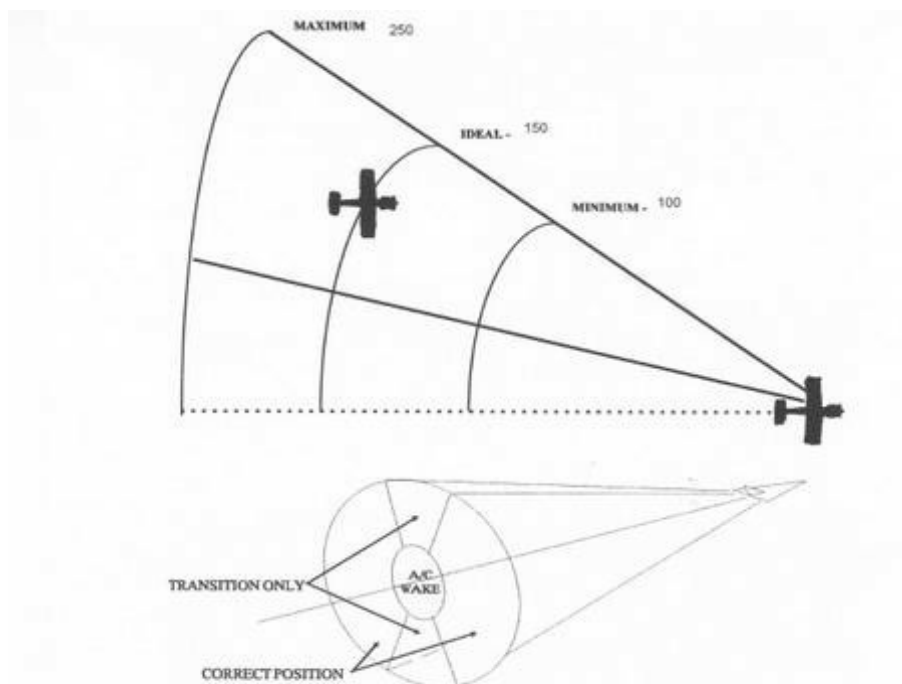
RED RADIAL'S
COMBAT & TACTICAL FORMATION
BRIEF

COMBAT FORMATION

Combat is a flexible formation that can be used by the leader to utilise the full manoeuvrability and performance of the aircraft. Domestically it can be used to allow the wingman to help with lookout and for more relaxed transits. It is also employed whenever the leader needs to manoeuvre more aggressively. The wingman positions their aircraft within a maximum performance cone behind the leader, at a comfortable range.

Combat Position

The maximum performance cone (Figure 1) is referenced with the leader's head as the apex and the lead aircraft's extended fuselage reference line as the axis of the cone. The cone subtends 60 degrees and the wingman flies approximately 150m from the leader (however their actual range to lead may increase or decrease slightly depending on the manoeuvres being flown), ideally on the edge of the cone so that both the leader and the wingman can see each other. The position of the leader from the wingman's cockpit is with the lead aircraft in the left 11 o'clock or right 1 o'clock, slightly high, so that the leader is clearly visible.



In the correct position the wingman positions between the following two cues :

- approximately half way along the trailing edge of the leaders wing (the aileron gap) lined up with the lead aircraft cowl, and
- the line from the leader's head to the outboard edge of the tailplane.

The wingman may transition through the leader's six o'clock, in fact it may be necessary during random, harsh manoeuvring to position close to the leader's six. However, once manoeuvring ceases, the wingman must re-establish a combat position whereby the wingman can see the leaders head (hence the leader can see him).

Basic Principals of Combat Formation

Whilst flying combat formation both the leader and the wingman have approximately the same power set resulting in both aircraft having the same energy. Once the wingman has achieved the correct combat position and sets the power they wait for the leader to manoeuvre in order to make adjustments to their position. To decrease spacing the wingman must fly less miles than the leader by using "lead" to cut inside the leader's turn. If the wingman wants to increase spacing he uses "lag" to fly more miles than the leader by flying on the outside of a turn.

Air Exercise

The leader will call "Vodka Two combat go" or give the appropriate hand signal. The wingman will move to combat formation via either of the following methods:

- a) Ease to combat. Wingman simply reduces power and eases out to the combat position, or
- b) Breakaway. The wingman breaks as for a normal rejoin. After about two seconds they will reverse the turn and establish the combat position.

Once established in position and ready to conduct aerobatic manoeuvring, the wingman will call 'Vodka Two in' and both aircraft will set the same power. If the formation is not conducting aerobatic manoeuvring, for example on RTB or transit, then there is no requirement to call 'In'. Simply slide back into position and stick with the leader.

Rejoining

When the combat exercise is complete, the leader will signal for a rejoin by rocking the wings. This is the signal for the wingman to rejoin echelon right. The leader should reduce their power to assist the rejoin. The leader should be visual with the wingman prior to reducing power for the rejoin to ensure a rapid closure conflict does not occur. The leader may enter a turn as a turning rejoin is usually more expeditious. The wingman should manoeuvre to establish on the rejoin line rather than just pointing at lead.

Terminate

Due to the high workload placed on both formation members during combat manoeuvring, it is possible for one or both members to suffer a degradation in situational awareness. As reducing situational awareness has serious flight safety ramifications, set Terminate criteria are established. Any time the criteria are reached, the member of the formation initiating the termination will transmit the 'Terminate' call and the reason. e.g. 'Vodka Terminate – hard deck'. The other aircraft will respond with 'Vodka XX Terminate'. Whatever the reason, the lead aircraft will continue the manoeuvre to its logical conclusion to achieve straight and level, in an expeditious manner. The exercise may be resumed once under control straight and level at the leaders discretion and direction.

The Terminate criteria are:

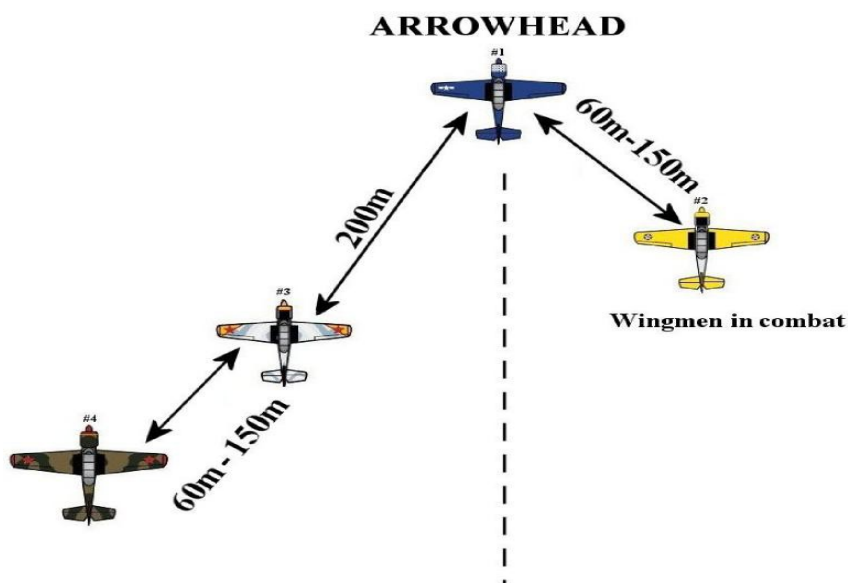
- a) 3/9 line overshoot by wingman
- b) Traffic conflicts occurring with other aircraft
- c) The wingman loses sight of lead or is forced to 'bug out'
- d) A predetermined minimum altitude is violated
- e) If IMC is encountered
- f) Wing cannot maintain station safely
- g) Pilots in either aircraft lose situational awareness

Blind /Bug Out Call

Should a dangerous situation develop or a loss of contact with the leader occur, bug out in the safest direction calling immediately: "Vodka Two Terminate (blind - if applicable) bugging out.....left/right/high/low". When safely clear and visual with the leader, rejoin the formation. Following a 'Bug out' call, the leader should continue though their manoeuvre in a predictable manner, whilst trying to acquire and maintain visual on the wingman (if not already visual).

3 - 4 Aircraft Combat Manoeuvring

The Arrowhead formation is used for 3 - 4 Aircraft Combat Manoeuvring



Last aircraft calls "IN", when in position.

- Remember 4 avoids 3, who avoids 2, who avoids 1.
- Each aircraft can manoeuvre to near the lead's 6 o'clock if necessary, but must remain on their side and return to position as soon as possible.
- 3 can tell 2 to change sides if required.
- 4 stays on the same side as 3.

Lead should keep manoeuvres to a more moderate level and mostly horizontal.

Combat Airmanship Items

Manoeuvring close to the Ground

The Combat position can be flown at lower levels. The basics of position maintenance and the position don't change at low level, however due to the close proximity of the ground the wingman must obey a few basic rules. At low levels the wingman should NEVER go below the level of the leader; keep the leader below the horizon. In turns 'towards', the wingman should match the leads manoeuvre by copying leads turns, and flying to the point lead turned at before initiating their own turn, whilst keeping the leader on or slightly below the horizon at all times.

Altimetry

Conduct of this type of dynamic manoeuvring demands good situational awareness. Pilots must maintain a situational awareness of the formation as a whole and of their own aircraft. This includes monitoring terrain, cloud, height restrictions, aircraft performance, hard deck, and other aircraft. You should be regularly checking your altimeter 'over the top' of manoeuvres to maintain SA and monitor your hard deck.

Collision Avoidance

In all formation flying 2 avoids 1. There is no excuse for getting yourself into a position where you lose sight of the leader as a wingman. You should NEVER accept a momentary loss of visual in order to correct spacing or angles. If you inadvertently do go 'blind' call 'Terminate' and regain Situational Awareness before trying to estimate the leader's position.

Leadership

Combat formation can be extremely rewarding when flown correctly. However, it has more potential than most other exercises to catch you out. Whether you are the leader or wingman you must be vigilant at all times. In particular, take note of the following points:

- α) combat manoeuvring must be thoroughly briefed before flight,
- β) as leader, you must ensure you remain well inside the limits for manoeuvring, the aim is not to lose your wingman, but to fly so as to make their job easier, and
- χ) as a wingman, despite all else, it is your job to manoeuvre according to the leader's actions and ensure adequate separation from the leader. That is 2 avoids 1 at all times.

Energy Management

It is very easy to lose energy in this type of aircraft. When manoeuvring close to the ground, an increased performance margin must be maintained.

TACTICAL FORMATION (TACFORM)

Tactical formation (TACFORM) is designed to allow a number of aircraft to fly together with the aim to provide good lookout capability and freedom to manoeuvre both defensively and offensively within a battle environment. TACFORM originates from military fighter operations devised by the German Condor legion during the Spanish civil war. These concepts are still used to this day.

TACFORM is based on an element pair philosophy. Element pairs operating in a 'Spread' or 'Battle' formation form the basis of TACFORM. The element pair is the building block to larger formation operations whilst still maintaining good lookout and mutual support between aircraft operating in a battle environment.

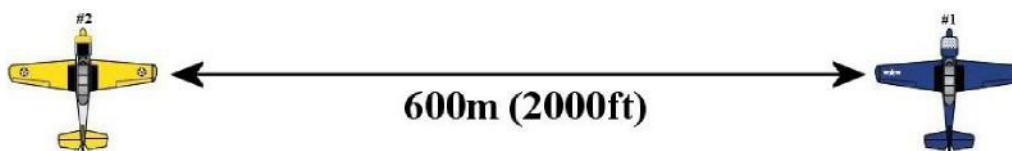
Larger formations are built from the basic Element Pair. In general terms the largest single formation flown is a Battle 4, made up of 4 aircraft or 2 Element Pairs. If more aircraft are used then they become part of a second Battle 4. A three aircraft formation (3 ship Spread) may become necessary where an aircraft is lost or becomes unserviceable. This formation is not desirable as it is more difficult to maneuver, and is not the subject of this brief. For the purposes of this brief, a Battle 4 with a missing man formation should be adopted in lieu of the Spread 3.

COLLISION AVOIDANCE

No matter what the responsibilities are : 4 avoids 3 who avoids 2 who avoids 1

Basic Pairs Formation - 'Spread'

The basic element pair's formation is used for 'Patrolling' or for 'Transiting'. This Pairs formation is referred to as 'Spread' or 'Battle' formation. The Wingman aims to fly abeam his lead at a distance of 600metres/2000feet. The lead sets the datum altitude and the wingman operates within a band either side of the datum. Altitude splits should not exceed 200 feet in a radar controlled environment during transits. Any altitude split should also never compromise the formations ability to check 6. If it's too hard to see your opposite wingman, then reduce the altitude split.



During low level operations the wingman should never be below the leads altitude. This is easily achieved by the wingman ensuring the lead is below the horizon.

Spread or Battle Formations can also be used during recovery to an airfield. When used for recovery to base (RTB) then the spread spacing is reduced to 500 feet just prior to the Initial Point.

Responsibilities and purpose of the basic 'Pairs Spread' formation

The basic element pair is designed to ensure mutual support which provides both defensive and offensive opportunities. The element pair ensures against intruders which might place either aircraft at risk, as well as facilitate operational goals.

The most basic of intentions of the element pair is to ensure mutual lookout against an intruder.

Each pilot has specific Zones or arcs of lookout responsibility, being an arc from their respective 11 or 1 O'clock (depending on the side of the formation they are on ie L or R) through the other aircraft in the formation to as far back as is possible. The rearmost limit should be the 6 o'clock position, but may be limited as a function of seating position and cockpit geometry. The intersection of the aft position lines determines the formation's Blind Zone. More advanced operations require individual aircraft to maneuver (within the formation) to clear the 6 o'clock position. It should be noted that the closer you fly a spread formation the closer in is the blind zone. The 600metre/2000feet spacing is chosen as a compromise between good 6 O'clock coverage and (notional) offensive positioning. Where an intruder approaches say the left hand aircraft and is within 600m or with rapid closure then the formation could execute a 'hard' or 'break' turn towards the left to defend or maintain an offensive position.

Keeping formation position becomes relatively easy after a little practice. The Lead should maintain a constant heading, speed and power settings that allow both power and maneuvering margins for the wingman. Once in position the wingman should be able to maintain a reasonably constant power setting, using minor altitude changes (ATC dependant) to vary speed to stay abeam the lead aircraft. Be aware that if you start dropping back you are compromising your 6 O'clock protection.

TACFORM TURNS

TACFORM turns are flown as follows unless noted or briefed differently;

Delayed, inplace and cross turns :	Cruise Pwr & 1.5 - 2G
Hard turns :	100% power and 3G, and
Break turns :	100% power onto the buffet.

CHECK TURNS

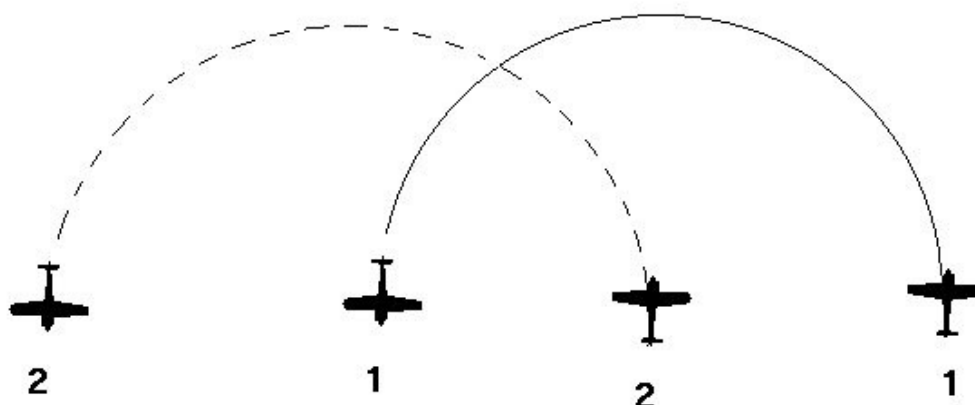
If the wingman ends too far back then the lead can call a "Check turn". The Check turn is used to get the formation abeam ASAP. For example let's say the wingman has drifted 20degrees back from the abeam. If both aircraft turn 20degrees towards the lagging aircraft the formation would immediately be abeam and cross cover restored. The call to initiate this would be something like "Red 2 check 20 left".

IN PLACE TURNS (2G)

The “In Place” turn is similar to the check turn but is usually performed to effect a formation change or 180 degree heading change. If both aircraft turn 90 degrees “Reds in Place 90 Left”, the formation goes from Abeam to trail.

If we wished to perform a 180 degree heading change and still end up abeam the lead simply calls the direction of turn. e.g. “Reds In Place Left”. At this call both aircraft perform a 180 degree turn to the left. During the turn the trailing man (in the example No 1) “Plays” the turn to control roll out timing. “Playing the turn” means varying the G to make sure he goes through the other aircraft’s 6 O’clock after 90 degrees of turn, i.e ensuring equal turn rates. A disadvantage of the in place turn is that the trailing fighter has no 6 O’clock cover through most of the turn.

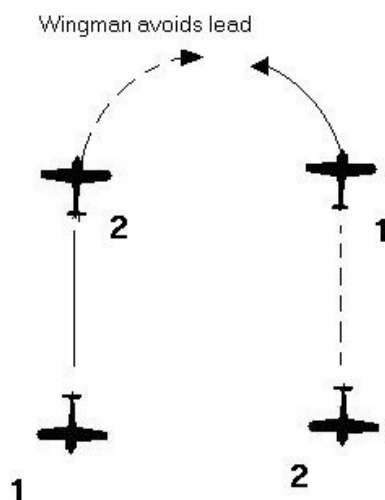
If the lead desires to turn in place through less than 180 degrees it must be called e.g. “Reds in place 40 right”.



IN PLACE TURN

CROSS TURNS (2G)

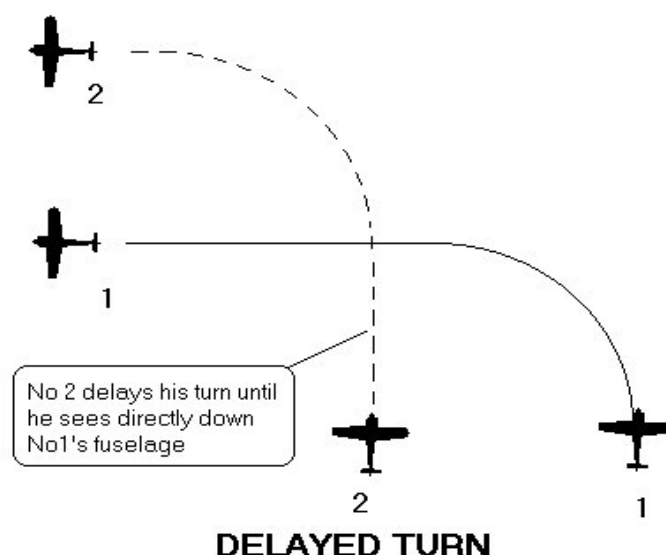
The cross turn is another turn to effect a 180degree heading change. In the cross turn both aircraft turn towards each other through 180degrees, their flight paths cross over hence the name. It is the wingman's responsibility to avoid the lead. The cross turn is initiated by the lead calling "Reds Cross turn". The cross turn provides both fighter protection of each other's 6 until the point of the cross. Cross cover is momentarily lost but soon regained after the cross.



CROSS TURN

DELAYED TURNS (2G)

The delayed turn is the standard or default tactical formation turn. The Delayed turn allows the formation to turn on to a heading whilst maintaining cross cover through out the turn and the formation rolling out of the turn in Spread. The essence of the turn is the "delay" hence the name. Let's first consider the 90degree Delayed turn. The formation is in Pairs and wants to turn 90 degrees and end up in Spread. If the wingman is the left hand man and the turn is a "90 Left". The lead simply turns towards the wingman. The wingman maintains his heading until such time as he sees the leads nose pointing directly at him (i.e. looking down the leads fuselage). (This is the delay). At that point the wingmen then commences a turn through 90 degrees, as soon as roles out he should see the lead on his left hand side on the new heading. This turn can be performed "No comm." Or by the lead calling "Reds 90 Left". (For the purists the delay is actually the number of seconds at the current TAS that it would take you to cover the formations spacing distance i.e. in our case 600m/2000feet).



If the turn is away from the wingman, in our case again the Wingman is on the left and the lead wants to complete a 90 right. The lead calls "Reds 90 right). The wingman immediately initiates the turn to the new heading. The lead aircraft performs the delay and subsequently the formation is restored on the new heading. All tactical turns are flown at 2 G Power to maintain IAS.

This can also be performed "No comm.". To initiate a Turn the lead aircraft "Wing Flashes" by rolling the aircraft to 60 or 90 degrees of bank away from the wingman and back to level using high roll rates. This flash signals the wingman to turn 90 degrees towards the lead.

Delayed turns can also be performed through any number of degrees. By default turns of 30 degrees or less are performed as in place turns/check turns. For heading changes of greater than 30 degrees are flown as delayed turns.

If the lead desires to turn through "X" degrees towards the wingman he simply turns on to the new heading (or calls "white X left). In this case the wingman maintains his heading again until he is looking down the leads fuselage and then commences his turn on to the new heading.

If the lead desires to turn "X" degrees away from the wingman he calls "White X left". The wingman commences the turn towards the lead and rolls out on the required heading, the lead performs the delay.

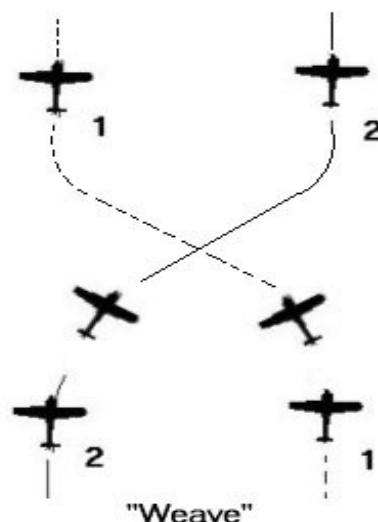
Turns away from the wingman of less than 90 degrees can also be performed No Comm. Again the lead simply performs a wing flash. The wingman assumes the turn is a 90 degree turn, and commences the turn. The lead watches the wingman and as he sees the wingman approaching the desired heading he again "flashes" towards the wingman. This signals the wingman to stop the turn on his present heading. Again the lead performs the delay.

No Comm turns should only be performed when the formation is proficient at called turns. The aim should be to work up to the point that all delayed turns are performed no comm.

THE WEAVE

The weave is used by the lead to swap sides of the formation. It can also be used to correct formation spacing and or assist a lagging aeroplane get back into position. The Weave is flown by each aircraft turning in 20 degrees. As the aircraft cross each aircraft resumes the original heading, playing the turn to achieve the correct spacing.

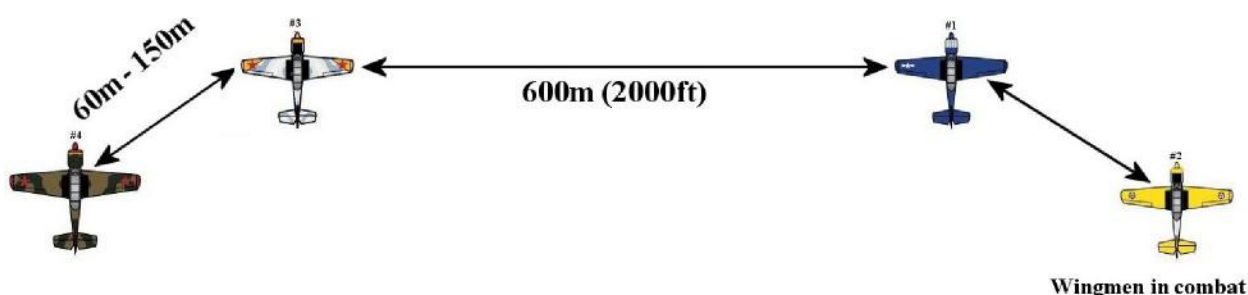
The weave is a gentle fluid manoeuvre using only 20 degrees of bank to achieve the heading change. Wingmen are responsible for collision avoidance. The weave is initiated by the lead command e.g. "Reds Weave"



If the weave is flown as a Battle 4 the wingmen switch to the outside of the formation at the crossover.

Battle 4

4 aircraft can operate in a tactical formation by combining the spread formation between elements and combat formation within the elements. Wingmen position to the outside of the formation so that they are looking past their lead to the opposite element.



Turns are performed as elements in the same way that individual aircraft do in Pairs Spread

Collision avoidance is standard: 4 avoids 3, who avoids 2, who avoids 1

NOCOM TACFORM

Most TACFORM ("Delay") turns can be initiated and carried out using NOCOM procedures.

The benefit of this is to reduce the amount radio "chatter", reserving it for more important purposes. Having said that, the radio should be used for time critical manoeuvres, where precision is of importance or there is some confusion.

Lead always initiates the turn.

There are two executive signals/manoeuvres used to initiate a delay turn:

1. Wing Flash. (WF) A rapid roll to at least 60°AOB followed by a return to wings level. Following a Wing Flash, the wingman begins a standard positive turn towards the lead.
2. Turn Toward. (TT) A standard positive turn by the lead towards the wingman.

After ensuring the wingman has begun to turn, one of the following signals, by the lead, will indicate the type of turn required:

1. Wing Flash
2. Turn Toward
3. Turn Away. (TA)

The table below summarises the various options.

For leads:

1. Allow extra distance/space in case the wingman misses the turn signal.
2. Ensure that the wingman is doing what you want him to do.
3. If there is no reaction to the Wing Flash, do another "Double Flash".
3. If there is no reaction to the Wing Flash, do another "Double Flash".
4. Still no reaction – prompt on the radio.

Other Situations.

- "Check" turns to regain abeam position – lead does a positive turn as appropriate.
- Heading changes < 30° - lead turns to new heading.

Exceptions.

- On RTB and on the offset initial, if the wingman is on the side away from the airfield he turns automatically to take up the runway track and spacing. Situation Awareness required!

RED RADIAL NOCOM TAC FORMATION BRIEF

TYPE of TURN	Executive Signal	Second Signal	Description	Diagram
Delay 90° Turn (Wingman on outside)	WF		Wingman turns through 90° Lead then does appropriate turn	
Delay <90° (Wingman on outside)	WF	WF	Wingman turns until second WF, then rolls wings level. Lead then does appropriate turn.	
Delay Turn (Wingman on inside)	TT		Lead turns to desired heading. Wingman does appropriate turn	
Cross-Turn	WF	TT	After the wingman begins his turn, the lead turns towards and both aircraft complete a 180° Cross-turn	
In-Place 180 (Lead turning away from wingman)	WF	TA	After the wingman begins his turn, the lead turns away from him and both aircraft complete a 180° In-place turn.	
Weave	WF	TT	After the wingman begins his turn, the lead turns towards through 20° then rolls wings level. Both aircraft complete a Weave	

RED RADIAL COMBAT AND TACTICAL FORMATION BRIEF

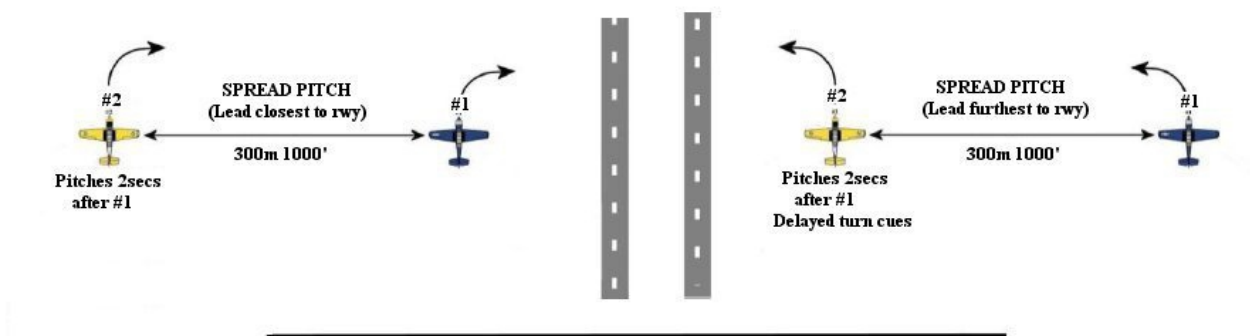
TACFORM PITCHES

Pairs and 3 ships will pitch from spread.

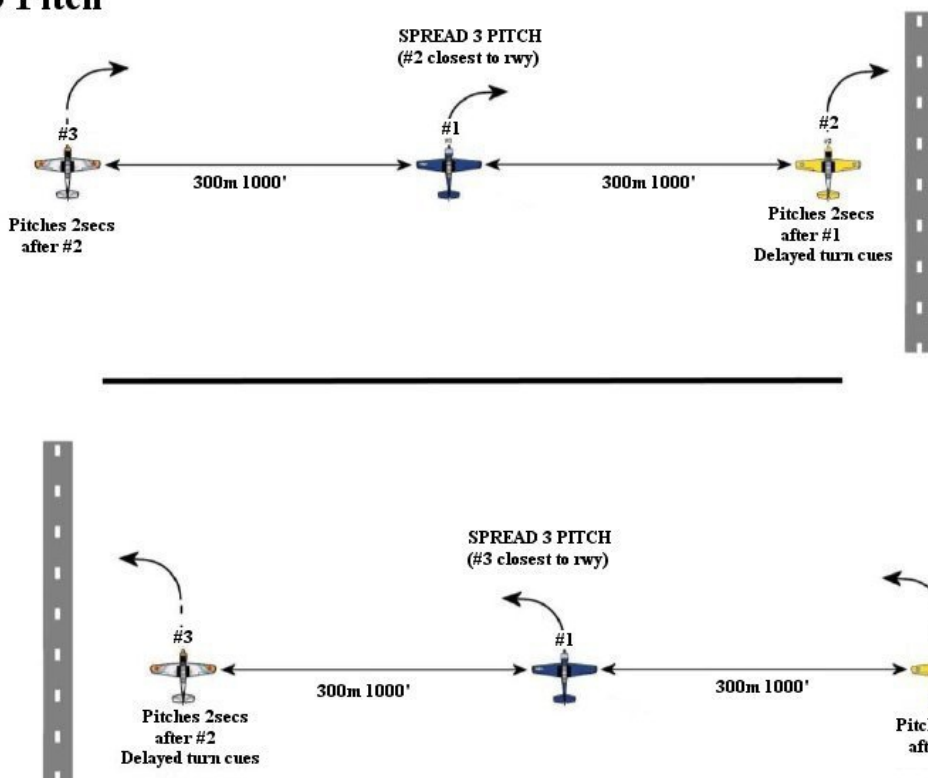
Spread Pitches

Approaching initial the formation closes up to spread distance of 300m or 1000ft separation.

Spread Pair Pitch



Spread 3 Pitch



RED RADIAL COMBAT AND TACTICAL FORMATION BRIEF

Battle 4 Pitches

Four ships will pitch from Battle 4.

Approaching initial the formation closes up to spread distance of 300m or 1000ft separation, with #2 and #4 closing to 60m. The wingman closest to the runway also steps down 20' to allow his lead to pitch over him. Pitch timing is 4 seconds, 2 seconds and 4 seconds “4--2---4”

Battle 4 Pitch

