



Formation Training

STANDARD OPERATING PROCEDURES

FORMATION SCHOOL SOPs

1. These SOPs are to be used as guidance for all formation flying in YAK 52 aircraft. The annexes provide differences when applicable for use in other aircraft variants.

BRIEFING

2. A briefing is to be given before every formation flight. All participants are to attend. The following points are to be covered where relevant:
 - a. Composition of the formation: leader, deputy leader and wingmen.
 - b. Callsigns and aircraft allocation.
 - c. Weather at base, diversions and in the operating area.
 - d. Flying phase.
 - e. Fuel calls.
 - f. R/T procedures.
 - g. Starting and taxiing procedure.
 - h. Pre take-off checks.
 - i. Take-off procedure.
 - j. Climb procedure.
 - k. Sortie profile.
 - (1) Formations and formation changes.
 - (2) Planned changes of leader.
 - (3) Routine checks.
 - (4) Use of hand signals.
 - l. Tailchase limitations.
 - m. Recovery procedures.
 - n. Emergency procedures:
 - (1) Aborting take-off.
 - (2) Aircraft unserviceabilities on the ground and in the air.
 - (3) R/T.
 - (4) PEFOM code.
 - (5) Lost leader in VMC and IMC.

The following paragraphs expand on these points.

R/T PROCEDURES

3. The R/T briefing should include the following points:
 - a. Frequencies to be used.
 - b. Collector frequencies.
 - c. Action to be taken in the event of loss of R/T contact.

4. Before start up, pilots are to make individual checks of the aircraft and then listen out on the designated air-to-air frequency (normally the frequency that will be used in the air). The leader is to check in the formation and then call them to start. Alternatively, a hot check in may be required in which case the pilots start the aircraft so that they are ready to taxi at the notified check in time. All checks-ins are to be initiated by the leader in the format "CALLSIGN CHECK". The second aircraft is to check in, in the format "CALLSIGN 2". Further aircraft are to check in with their number only.
5. Only the lead aircraft will squawk, other formation members should squawk stand-by.
6. If R/T contact is not re-established after a frequency change, proceed as follows after waiting for a suitable period of time, notionally 30 seconds:
 - a. Listen out on the previous frequency for up to 30 seconds.
 - b. If contact is not re-established on the previous frequency, change to the briefed collector frequency. The leader may signal the change to the briefed collector frequency by holding up one finger.
 - c. If contact is not re-established on the collector frequency, attempt to establish contact on the emergency frequency if appropriate. The leader may signal the change to VHF Guard by holding up 2 fingers.
7. Orders on R/T are to be in the form of a 4-section transmission, e.g.:
"CALLSIGN MANUAL 2 MANUAL 2 GO".
8. Calls given for information may be given in a simplified form, e.g.:
"CALLSIGN, TURNING LEFT".
9. The leader is to use the callsign "CALLSIGN ONE".

START UP

10. The start up may be briefed to be initiated by R/T, by hand signal, or at a pre-briefed time. Pilots experiencing unserviceabilities should inform the leader.

TAXIING

11. Aircraft are to taxi on the centreline with a minimum spacing of 50 metres between aircraft. If it is necessary to hold at the holding point awaiting take-off clearance, wingmen should close up but should take care to avoid the propwash from the aircraft ahead. The leader should position on the downwind side of the taxiway to assist wingmen to remain clear. Pre take-off checks are to be completed at the holding point, or on the Operational Readiness Platform (ORP). The sequence of events for these checks is as follows:
 - a. The highest number formation member gives a thumbs up to the adjacent aircraft that he is ready for checks (if not ready he gives a T signal for temperatures).
 - b. This signal is passed all the way along the line to the leader.
 - c. Leader then gives a wind up signal which is passed along the line lowest to highest.
 - d. When the highest number is ready to take the runway, i.e. checks complete, he signals a thumbs up to the next aircraft as before.
 - e. When all are ready the leader will inform the tower and line up ready for take-off.

TAKE-OFF

12. Stream Take-Off.

- a. Aircraft are to line up in echelon into any crosswind, using the standard formation references.
- b. When the wingmen are in position, the leader is to give the wind-up signal, having checked the nose-wheel is straight on all wingmen. No 2 is responsible for checking leader's nose-wheel. Wingmen are to acknowledge the wind up and then increase power to 70% rpm. When wingmen indicate they are ready, by a thumbs up, the leader simply begins his take-off roll with no other signal. Wingmen should roll at the briefed interval. The minimum stream interval is 5 seconds.
- c. ALL A/C TO USE MAX POWER. When safely airborne with the after take-off checks complete, the leader should reduce power to give 80% and 8 and climb straight ahead to 500 ft above airfield elevation before turning either level or climbing to allow wingmen to catch up.
- d. Wingmen are to climb straight ahead after take-off to at least 500 ft above airfield elevation before turning. At this point, they too set 80% and 8. The last aircraft should call "CALLSIGN AIRBORNE". Once at 1000 ft on departure, leader will set 70% and 7.
- e. In calm or very light wind conditions, a high-low-high profile should be flown to avoid wake turbulence.

13. Formation Take-Off.

- a. The maximum crosswind component for a formation take-off is 10 kts for a vic, 15 kts for a pair.
- b. Aircraft should line up in vic or in echelon into any crosswind if taking off as a pair plus a singleton, in the standard formation position. For a 2-ship formation carrying out a pairs take-off, the leader should line up in the centre of his half of the runway.
- c. When all aircraft are in position, the leader gives the wind up signal, which wingmen acknowledge, and increase power to 70% rpm checking the engine indicators and wheelbrakes.
- d. Wingmen indicate they are ready to roll with a thumbs up and the leader taps his head 3 times and releases the brakes on an exaggerated head-nod. After brake release, power is smoothly increased to 90% rpm. Wingmen are to maintain the normal lateral spacing throughout the take-off.
- e. If taking off as a pair plus a singleton, the singleton should roll at an interval of not less than 5 seconds, using full power.
- f. Once safely airborne, landing gear should be raised. Once the aircraft are clear, the leader should adjust power to 80% and 8.

CLIMB

14. **Standard Climb.** The standard formation climb is at 200 kph, with the leader adjusting power to maintain 80% rpm & 8. When weather conditions permit, the climb should be made in VMC. At 1000 ft power is reduced to 70% and 7.

15. **Snake Climb**. If weather and pilot qualifications preclude a standard formation climb, the snake climb technique is to be used using the following procedures:
- a. Where possible, the take-off should be carried out on the departure frequency.
 - b. Aircraft are to take-off in stream at 30-second intervals, using full power and normal IFR climb procedures.
 - c. The leader calls all turns in the format "CALLSIGN, TURNING RIGHT 355 NOW".
 - d. The No 2 turns 30 seconds after the leader and the No 3 turns after 60 seconds.
 - e. The leader should, ideally, allow a minimum of 60 seconds between turns and, after the initial turn onto the departure heading, should not normally turn through more than 90 degrees.
 - f. Wingmen should call when VMC on top and the leader levels off when all aircraft are VMC, calling his flight level and speed. Wingmen should level off stepped down by 500 ft from the aircraft ahead and maintain the leader's speed. The leader should then call a turn to facilitate visual acquisition and should look for the wingmen in the turn and pass his position to assist visual sighting. The wingmen should call when visual with the leader and join up in the normal way. If a turn is inappropriate (e.g. transit sortie) the leader should continue the climb to the planned cruising level. Wingmen should close up after the leader has levelled off and reduce power for the cruise.

FORMATION POSITIONS - STANDARD CRUISE SETTING 70% AND 7

16. Formation positions are shown at Reference a. and b. below. When changing from vic to echelon left before breaking into a right hand circuit, aircraft will be in the order 1, 3, 2 and not 1, 2, 3. Terminology for lateral positions is to be LEFT and RIGHT.

The references to be used for station keeping are:

- a. **Echelon**. **NB**. These references give ½ span lateral separation.
 - (1) Diagonal: the aircraft tie-down ring lined up with the top of the exhaust outlet.
 - (2) Vertical: split the wing.
 - (3) Fore and Aft: pilot's eye in line with the elevator hinge.
- b. **Line Astern**.
 - (1) Fill the half moon screen with the lead a/c.
 - (2) Put the undercarriage of the a/c in front on the crossbar at the bottom of the half moon.
 - (3) Ensure in line with a/c (all of them) in front.

BREAK AND REJOIN

17. **Break and Rejoin in Straight Flight**. Wingmen should obtain clearance from the leader before practising break and rejoin. Only one aircraft at a time may be cleared to break and rejoin. The following procedure should be used:
- a. Initiate a climbing break away from the leader, using full power, at 50 to 60 degrees of bank for 3 seconds and call "CALLSIGN OUT".
 - b. After 3 seconds, reverse back onto the leader's heading, calling "CALLSIGN VISUAL" once the leader is sighted.
 - c. The leader is to clear breaking aircraft to rejoin the formation, calling his airspeed.

- d. Rejoining aircraft should then enter a gentle diving turn towards the leader, reversing the turn to position just offset to their own side of the leader's 6 o'clock, adjusting power as required to maintain 20 to 30 kph overtake.
 - e. The initial approach must be made on a flight path parallel to and below the leader. Excess closing speed may be reduced by converting speed to height but some vertical separation must be maintained until stabilised. Power should be used to stabilise position 2 spans out, slightly low on the fore and aft reference, before climbing onto the split wing reference and then closing slowly to achieve the diagonal.
18. **Break and Rejoin in Turning Flight.** The turning rejoin may be practised from echelon, or used at other times (e.g. to join up after a tailchase) as appropriate. To set up a practice turning rejoin, the leader should call "CALLSIGN, TURNING JOIN GO". The leader should then break away using 60 degrees of bank through 90 to 120 degrees and then reduce to 30 degrees of bank, maintaining 210 kph throughout. Wingmen should follow at 2-second intervals and rejoin using the following technique:
- a. Wingmen should dive towards the centre of the leader's turn to position on the diagonal through the trailing edge of the leader's tail and outside wingtip, below the leader. Power should be adjusted to maintain a 10 to 20 kph overtake.
 - b. Approaching the leader, wingmen should descend to deep echelon - to allow a view of the underside of the lead aircraft.
 - c. If joining on the outside echelon, reduce bank to pass below and behind the leader and stabilise position in a wide outside echelon. This is known as the waiting position.
 - d. If joining on the inside echelon, power is used to stabilise position 2 spans out below the leader's plane. This is known as the waiting position.
 - e. Once stabilised in the waiting position, join up as for a join in straight flight.
 - f. If 2 aircraft are rejoining, the rearmost aircraft must keep the remainder of the formation in sight at all times and is to maintain a minimum of 100 metres separation behind the aircraft joining ahead, until cleared to join by the leader. The leader is only to give the rearmost aircraft clearance to join once he is satisfied that the first joining aircraft has achieved the stabilised waiting position.
 - g. If the first joining aircraft is joining to the outside echelon, it may re-cross to the inside if the pilot misjudges the join. No 3 will remain 100 metres astern until cleared to join by lead. No 3 has collision avoidance responsibilities in respect of No 2.

CHANGING FORMATION

19. Formation changes are to be initiated by the leader and acknowledged by all aircraft required to move. Formation changes are made by wingmen moving behind and below the leader. Movements are to be square and the standard lateral or longitudinal separation is to be maintained at all times. A change of formation to reverse vic is only to be performed through line astern or when rejoining close formation after a tailchase. The detailed procedures for changing formation are as follows:
- a. **From Vic to Line Astern.**
 - (1) No 3 drops back and down and calls "CALLSIGN CLEAR". He maintains a minimum of 1 length nose/tail separation on No 2.
 - (2) No 2 initially maintains position until No 3 is clear. Once No 3 calls "CALLSIGN CLEAR", No 2 moves back and down to stabilise 1 length aft of the leader and then moves across into position.
 - (3) No 3 moves in when he sees No 2 stabilised in position and is to call "CALLSIGN IN" when stabilised in position.

b. **From Line Astern to Vic.**

- (1) No 3 moves back 1 aircraft length and left, stabilises position and calls "CALLSIGN CLEAR".
- (2) No 2 maintains position until he hears No 3 call "CALLSIGN CLEAR". He then moves right, up and forward into position.
- (3) No 3 moves up and forward when he sees No 2 moving into position.

c. **From Line Astern to Reverse Vic.**

- (1) No 3 moves back one aircraft length and right, stabilises position, and calls "CALLSIGN CLEAR".
- (2) No 2 maintains position until he hears No 3 call "CALLSIGN CLEAR". He then moves left, up and forward into position.
- (3) No 3 moves up and forward when he sees No 2 moving into position.
- (4) After the change, the leader is to call the formation to renumber.

d. **From Vic to Echelon.**

- (1) Only the moving wingman acknowledges. He then moves back and down to stabilise position with one length nose/tail separation on the other wingman.
- (2) He then moves across, passing behind and below the formation and stabilises position before moving up and into position to join on the outside of the formation. He must never attempt to join between the leader and the other aircraft.
- (3) When changing from vic to echelon left, the formation will be in the sequence 1, 3, 2.

ROUTINE CHECKS

20. Standard altimeter settings are to be used throughout or as briefed by the leader. Pilots are responsible for completing regular FREDAs checks. During initial sorties, aircraft are to move out to at least 2 spans spacing before carrying out cockpit checks or changing radio frequencies. Once proficient, pilots may remain in close formation for checks. Fuel states are to be given in relation to the briefed Fuel figure. The first member of the formation to reach the briefed Fuel or Bingo figure is to inform the leader. On hearing one of these calls, other pilots should check their fuel but should only report their fuel state if it is lower. The meaning of the fuel calls are:

- a. **Fuel 1.** Normally briefed as an information fuel check made early in the sortie to ensure that all aircraft are using fuel at the normal rate.
- b. **Fuel 2.** Can be an extra fuel consumption check, or an action fuel state at which the leader wishes to commence a particular phase of the sortie as briefed. It is not always necessary to have 2 Fuel calls.
- c. **Bingo.** Bingo is the minimum fuel to commence recovery in order to land with the minimum fuel required.

TAILCHASE

21. Tailchasing is defined as a 'follow the leader' exercise. At no time is a tailchase to be allowed to develop into a 'dog fight'. The leader is to nominate a base height below which none of the formation is to descend: this height may be briefed on the ground or in the air, dependent upon the prevailing weather conditions. Members of the formation are not to allow their spacing to reduce to such an extent that the safety of any aircraft in the formation is prejudiced.

22. The following limits are to be applied to tailchasing:
 - a. The leader is to maintain VMC at all times.
 - b. Minimum height 1000 ft agl for experienced pilots, higher limits for ab initios.
 - c. Minimum vertical clearance from cloud - 500 ft.
 - d. Minimum spacing - 100 metres.
 - e. Minimum speed - 150 kph.
 - f. Leader is to pre-brief min/max G to be used in the tailchase (normally 0-4g).
23. The tailchase should normally be started from echelon right for a 3-ship. The leader is to warn the formation in sufficient time for each pilot to complete the relevant HASELL checks. Normally 80% and 8 is the set power for the tailchase. The leader is to begin the tailchase by calling e.g.: "CALLSIGN FORMATION BASE ALTITUDE TAILCHASE, FOLLOW ME, GO". He is then to turn sharply away from the formation, through at least 90 degrees, with the pre-briefed power set. Wingmen follow at 2-second intervals aiming for a spacing of 100-200 metres. If a tailchasing aircraft is coming within 100 metres of the preceding aircraft, or is likely to come forward of the 3/9 o'clock line, the pilot is to call "CALLSIGN OUT" and may add for example "BREAKING RIGHT/LEFT" as applicable. If No 2 breaks away, No 3 must follow him.

Pilots experiencing difficulty in regaining their position are also to call "CALLSIGN OUT". In either case, the leader is to decrease the complexity of his manoeuvres and, if necessary, direct the rejoin. The tailchase may be continued when the aircraft that broke out indicates that he is in a suitable position to do so by calling "CALLSIGN IN". If visual contact with the preceding aircraft is lost, the pilot is to call "CALLSIGN OUT BLIND".
24. Following a call of "CALLSIGN OUT BLIND", the leader is to level off, calling his height or altitude, and the aircraft which broke out is to establish at least 500 ft separation without flying through the leader's level. Subsequent aircraft are to maintain contact with the aircraft ahead. The leader is to pass the instructions to the joining aircraft to effect a join up. When he regains visual with the leader, he should call "CALLSIGN VISUAL" and the tailchase may be continued when the joining aircraft indicates that he is in a suitable position to do so by calling "CALLSIGN IN".
25. Any member of the formation may terminate the tailchase by calling "CALLSIGN, TERMINATE" three times. A pilot faced with an aircraft emergency necessitating the immediate cessation of the exercise is to call "CALLSIGN, KNOCK IT OFF" three times. These calls are immediately acknowledged by all formation members. The leader will then call the formation into an appropriate formation position.
26. When the tailchase is over, the leader is to call "CALLSIGN, TERMINATE" three times and call the formation into the appropriate formation position. Crews are to ensure that instruments are erect and synchronised either during the join-up or as soon as practical prior to continuing. The formation is not to re-form in line astern.

RECOVERY

27. The leader should remind wingmen to carry out routine checks before recovery.
28. The leader should use a minimum power setting of 60% and 6 in the descent.

RUN IN AND BREAK

29. **Rejoin**. The leader should give the formation a straight run of 1 to 2.5 nm and, once lined up on the deadside, the leader is to order the formation to the appropriate echelon. The minimum altitude for breaking is 500 ft agl. The move to echelon may be executed at the discretion of the moving aircraft if briefed.
30. **Break and Landing**. The leader should run in on the deadside and, at the appropriate position, call "CALLSIGN BREAKING". He should initiate a positive break by rolling to about 60 degrees of bank, pulling into the break, setting full power and 100% rpm as appropriate to achieve 190 kph on reaching normal circuit altitude if breaking from below this. The speed is then reduced, downwind, to achieve 160 kph prior to the final turn. This turn is flown with flap down and at 160 kph. The formation may fly level 500 ft above airfield elevation breaks. The minimum time interval between breaking aircraft is 3 seconds. When the leader breaks, the No 2 is to assume responsibility for the lookout of the formation and maintain contact with the leader while flying straight ahead for the briefed interval. The No 3 is to follow in turn using the same technique as No 2. The leader is to call downwind for the formation but final calls are to be made individually. Wingmen should avoid flying below the flightpath of the aircraft ahead to avoid wake turbulence. To this end, the leader should fly a slightly flatter than normal approach, the No 2 a normal approach, and the No 3 a slightly steeper approach. The minimum spacing on landing is to be 500 metres. All aircraft should land on the centreline and move to the exit side of the runway when down to a fast taxi speed. The last aircraft is to call "CALLSIGN RUNWAY VACATED" for the formation.
31. Formation leaders should emphasise the following points:
- The need to go around immediately if a pilot experiences wake turbulence or has any doubt that his spacing on final approach or landing is less than the briefed minimum.
 - The importance of achieving the correct threshold speed and the need to go around from a poorly judged approach.
32. **Formation Circuits**. The circuit should be joined using standard joining procedures with the downwind leg being flown slightly wider than normal. Individual landing gear checks are to be made when directed by the leader either by radio or by hand signal. The leader should bear in mind the effect of bank on the airspeed of, and power required by, the wingmen. The final turn is flown with flap down and at 160 kph.

FORMATION LANDINGS

33. The following limitations apply to formation landings.
- The maximum crosswind component is 15 kts for a pair, 10 kts for a vic. If the crosswind exceeds 10 kts, the pairs approach should be flown echelon into the crosswind.
 - Formation roller landings are prohibited.
34. The following techniques and procedures are to be used for a pairs landing:
- The leader should fly a slightly flatter than normal approach, aiming to land slightly further up the runway than normal. The leader should call "CALLSIGN CUT" after crossing the threshold when it is safe for the wingman to do so. He is to delay his own cut.
 - The leader should land in the centre of his own half of the runway.

- c. The No 2 should land in the centre of his own half of the runway. Once lined up on the final approach on a visual circuit or visual and below about 300 ft agl on an instrument approach, the No 2 should adjust position to line up in the centre of his half of the runway by easing out along the diagonal reference line. Vertical position should be the same height as the leader. This appears slightly higher than the normal position and is achieved by putting the leader's head on the horizon. The landing is flown individually. Thus, the No 2 should not wait for the leader's cut call, but should treat it as a reminder to select Flt Idle if he has not already done so. After touchdown, the No 2 should lower the nosewheel.
 - d. When down to a fast taxi speed, the No 2 should call the leader with clearance to cross to the exit side of the runway if appropriate. The No 2 should call "RUNWAY VACATED" for the formation if appropriate.
35. If landing as a vic, procedures are similar to those for a pair, except that the leader should land on the centreline. Wingmen should maintain their standard lateral separation. To achieve this on a 150 ft wide runway, they must land close to their side, about $\frac{2}{3}$ across. Wingmen should drop back very slightly on final approach to achieve nose/tail separation. After touchdown, the No 2 and the No 3 should lower their nosewheels when safe to do so. If either No 2 or No 3 has a problem with braking, they are to remain straight and maintain wing-tip to wing-tip separation.

LEADING

36. The leader is responsible for the safety of the formation. He must therefore pay close attention to lookout navigation, weather and fuel, in addition to making decisions in the event of emergencies.
37. All changes of altitude are to be made smoothly and the leader must remember that his flexibility of manoeuvre is limited by the experience of the students. The power settings used must allow tolerance for the pilots in formation. Manoeuvres should avoid unnecessary exposure to sun glare. **INFO:** In IMC the angle of bank is to be limited to 30 degrees.
38. Changes of lead are made on the orders of the formation leader and are normally to be made from echelon right, with the lead passing to the No 2. On changeover, the leader is to pass the formation's position to the new leader in the following format:
"CALLSIGN, POSITION 10 MILES WEST OF SCAMPTON, CALLSIGN 2 ON MY BREAK/
EASE YOU HAVE THE LEAD"
- No 2 is to acknowledge and the change of lead occurs on acknowledgement. The ex-leader is to move clear of the formation and squawk stand-by. The new leader is to renumber the formation, nominating the position the ex-leader is to join in.
39. **Signals.** R/T may be used as required to pass instructions to the formation for manoeuvring and changes of aircraft configuration. In the early stages of formation training, R/T may be used freely to call turns etc., but this should be dispensed with progressively and replaced by hand signals if necessary.

EMERGENCIES

40. **Aborted Take-Off.**

- a. **Formation Take-Off.** If a wingman needs to abort take-off, the other aircraft in the formation should continue. If the leader aborts, the entire formation should follow the briefed procedure. This will normally entail going to full power to get airborne diverging from each other. A wingman aborting should action the abort and then call "CALLSIGN ABORTING". If it becomes necessary for the whole formation to abort take-off, and if time and circumstances permit, the leader should call "ABORT ABORT CALLSIGN FORMATION ABORT", before he takes abort action.
- b. **Stream Take-Off.** If an aircraft aborts a stream take-off, he should call "CALLSIGN ABORTING". All aircraft behind him should also abort. The aircraft aborting should maintain its line down the runway.

41. **In Flight.** A pilot with an emergency in flight is to inform the other aircraft by R/T and carry out individual action. The crews of the serviceable aircraft are to assist the aircraft in emergency as necessary.

42. **Radio Failure.**

- a. **Radio Failure.** The leader or deputy should lead the unserviceable aircraft back to base using the pre-briefed recovery procedure.
- b. **Total Radio Failure.**
 - (1) **Wingmen.** A wingman should indicate total radio failure by moving forward and attracting the leader's attention by rocking the wings. The unserviceability is to be indicated in accordance with the PEFOM code below. The leader will then lead the unserviceable aircraft back to base using the pre-briefed recovery procedure.
 - (2) **Leader.** The leader should indicate a total radio failure by gently rocking his wings. If the formation is in line astern, this is the signal to change to vic. The leader will use visual signals to indicate the extent of his unserviceability. He will then point to the deputy leader and then point forward to indicate that he is handing over the lead. The new leader should then lead the unserviceable aircraft back to base, using the pre-briefed recovery procedure.

43. **PEFOM Code.** In the event of an aircraft with total radio failure experiencing a further emergency, the following procedure is to be used:

- a. A wingman or leader should move forward and rock his wings to attract the leader's or deputy leader's attention.
- b. He should then raise a clenched fist to the top of the canopy to indicate his intention to use the PEFOM code. The leader or deputy should acknowledge this signal by repeating it back.
- c. The pilot should then indicate the unserviceability by holding up the required number of fingers to denote the nature of the emergency as follows:
 - (1) PNEUMATICS 1 Finger.
 - (2) ELECTRICS 2 Fingers.
 - (3) FUEL 3 Fingers.
 - (4) OIL 4 Fingers.
 - (5) MOTOR 5 Fingers.

The leader or deputy should acknowledge by repeating the signal.

44. **Loss of Leader in IMC.** The leader is to use a maximum of 30 degrees of bank in IMC. A wingman losing sight of the leader in IMC is to transfer immediately to instruments and break away as follows:
- a. **In Straight Flight.**
 - (1) Turn 20 degrees away from the leader, using 20 degrees of bank, and maintain the heading for 20 seconds.
 - (2) Inform the leader.
 - (3) If climbing, continue. If descending, level off.
 - (4) After 20 seconds, resume the leader's original heading and proceed as instructed.
 - b. **Outside Wingman in a Turn.**
 - (1) Roll wings level for a minimum of 20 seconds.
 - (2) Inform the leader.
 - (3) If climbing, continue. If descending, level off.
 - (4) Proceed as instructed.
 - c. **Inside Wingman in a Turn.**
 - (1) Increase bank to 45 degrees.
 - (2) Inform the leader.
 - (3) If climbing, continue. If descending, level off.
 - (4) The leader will roll out of his turn immediately and pass instructions. Leaders are to pass instructions to wingmen losing contact, to ensure they maintain safe separation initially, and are then to order either a join-up or an individual recovery as appropriate. Both leader and wingmen should be mindful of safety altitude.
45. **Loss of Leader in VMC.** If a wingman loses sight of his leader in VMC, he should proceed as follows:
- a. Inform the leader immediately, and call his height.
 - b. Enter a turn. The leader will maintain vertical separation, enter a turn and effect a join up using either GPS, VOR, DME or a visual fix.

ADVANCED FORMATION - FIGHTING WING

46. **Airmanship.**
- a. **Lookout.** In fighting wing lookout is the responsibility of both leader and No 2.
 - b. **Reporting.** Pilots should report the other aircraft using the clock code relative to the leader.
 - c. **Hand Signals.** The leader may use a pushing motion of the hand to signal the No 2 to move into the fighting wing.
 - d. **R/T.** The leader will not call turns when in fighting wing.
 - e. **Collision Avoidance.** It is the No 2's responsibility to ensure collision avoidance by manoeuvring within the fighting wing 'box'.
47. **Fighting Wing Position.** The 'ideal' fighting wing position is between 100 and 300 metres and between 30 and 60 degrees swept from the leader. However, the whole 'box' is available and the wingman may cross to the other side.

48. **Fighting Wing Manoeuvring**. This exercise is not a tailchase and the leader is to ensure that the No 2 has adequate performance in hand to maintain position. Manoeuvres are to be limited to turns and wingovers. The leader is to use a maximum of 4g and a minimum of -2g.
49. **Recovery in Fighting Wing**. The formation may recover and join the visual circuit in fighting wing for a run in and break as follows:
- The break is to be in numerical order.
 - The leader is to arrange the formation so that his break is away from the No 2.
 - The No 2 should break after 5 sec.

4-SHIP FORMATIONS

50. The following formations may normally be flown:
- Box. The No 4 position is slightly further aft and down from a normal line astern position. He should be directly behind the leader, positioned such that he has the correct echelon references on Nos 2 and 3.
 - Line Astern.
 - Finger Four.
 - Swan.
 - Echelon.
51. **4-Ship Take-Off**. For a 4-ship, take-off is normally to be as 2 pairs at a minimum interval of 5 seconds. If the wind is outside pairs limits, an individual stream take-off should be used with a minimum interval of 3 seconds. Aircraft should be lined up on the runway in 2 echelons into wind. No 2 should have the wheel nearest the leader on the runway centre line. Alternatively, take-off may be as a vic and a singleton, with the No 4 rolling at not less than 10 seconds, using full power.
- NOTE:** If taking off with the crosswind from the left, the line up should be a mirror image of that shown above, i.e. Nos 1 and 3 remain element leaders with Nos 2 and 4 lining up in the echelon left position on their element lead. After take-off, the element leaders should individually call their wingmen into the required echelon before the formation joins up.
52. **Join Up**. The join up is to be made to box or finger 4 formation as briefed. Nos 3 and 4 may be briefed to join the formation either individually or as a pair.
53. **Climb**. Formations of more than 3 aircraft are not to penetrate cloud. If an IMC climb is required, the snake climb technique is to be used either as 2 pairs or individually.
54. **Formation Changes**. All formation changes, except from finger 4 to echelon on the same side and swan to line stern, are to be made through box as follows:
- Box to Finger 4**. No 4 moves back and across into echelon on the appropriate side.
 - Finger 4 to Box 4**. No 4 moves back, down and across into the box position.
 - Finger 4 to Echelon**. The No 2 (for echelon left) or the No 3 (for echelon right) moves back and down until he can see the other 3 aircraft and then moves across into position on the outside of the echelon. This move only commences once No 4 is in position.

d. **Box to Echelon.**

- (1) No 4 moves back and across into echelon on the appropriate side and calls "CALLSIGN IN".
- (2) When the No 2 (echelon left) or No 3 (echelon right) hears No 4 call "IN", he moves back and down until he can see all 3 aircraft, and moves across into position on the outside of the echelon.

Note: 4-ships in echelon left will be in the sequence 1, 3, 4, 2.

4-ships in echelon right will be in the sequence 1, 2, 4, 3.

e. **Echelon to Box.**

- (1) The pilot on the outside of the echelon moves back, down and across into position on the opposite side, and calls "IN".
- (2) On hearing the "CALLSIGN IN" call, the No 4 moves back and down until he can see all 3 aircraft and moves across into the box position.

f. **Box to Line Astern.**

- (1) No 3 moves back and down and calls "CALLSIGN CLEAR".
- (2) On hearing No 3 call clear, No 2 moves back, down and across into position behind No 4, who smoothly adjusts to a line astern position.
- (3) When he sees No 2 in position, No 3 moves across into position behind No 2 and calls "CALLSIGN IN".

Note: 4-ships in line astern will be in the sequence 1, 4, 2, 3.

g. **Line Astern to Box.**

- (1) No 3 moves back and left and calls "CALLSIGN CLEAR".
- (2) No 2 moves right, up and forward into position.
- (3) No 3 moves up and forward into position when he sees No 2 moving in.
- (4) No 4 smoothly drops back to his box position.

h. **Box to Swan.**

- (1) No 4 ducks 6 feet and then moves forward.
- (2) Nos 2 and 3 slide back co-plane with lead until they see No 4 when they drop down together. No 3 takes his tempo from No 2.

i. **Swan to Box.**

- (1) Nos 2 and 3 climb together until co-plane with lead and then slide forward.
- (2) No 4 moves down and back into his box position.

j. **From Swan to Line Astern.**

- (1) No 3 drops back and down and calls "CLEAR".
- (2) No 2 initially maintains position and waits to see No 3 moving away. On hearing No 3 call "CLEAR", No 2 moves back, down and across into position.
- (3) No 3 moves in when he sees No 2 stabilised in position and is to call "IN" when stabilised in position.
- (4) No 4 smoothly adjusts his line astern position as briefed.

- k. **From Line Astern to Swan.**
 - (1) No 3 moves back and left and calls "CLEAR".
 - (2) No 2 moves right, up and forward.
 - (3) No 3 moves up and forward when he sees No 2 moving in.
 - (4) No 4 smoothly adjusts his line astern position as briefed.

55. **Tailchasing.** 4-ship tailchases are permitted but looping manoeuvres are to be excluded.

56. **Recovering and Normal Break.** 4-ship formations are to recover VFR normally for a run in and break from echelon. (Formations of more than 3 aircraft are not to penetrate cloud in the descent. If an IFR recovery is necessary, a 4-ship is to split into 2 pairs, a vic and a singleton, or 4 individual aircraft. Once VMC below cloud they may either continue individually, or join up again, as briefed).

OPPOSITION BREAK

57. An opposition break may be flown from box provided that it has been specifically briefed, the circuit is clear and the crosswind is less than 15 kts. The procedure to be used is as follows:

- a. The leader is to call the break:
"CALLSIGN BREAK BREAK GO - (2 SECOND PAUSE) - BREAK BREAK GO".
- b. On the first "GO", Nos 2 and 3 break right and left respectively.
- c. On the second "GO", Nos 1 and 4 break left and right respectively.
- d. The leader calls downwind for the formation:
"CALLSIGN FORMATION, 4 AIRCRAFT LEFT AND RIGHT DOWNWIND TO LAND".
- e. No 2 turns finals first, right hand. No 3 turns in left hand as No 2 is halfway round the turn. No 4 turns right hand when No 3 is halfway round the turn, and No 1 turns finals left hand as No 4 is halfway round the turn. Individual aircraft call finals in the sequence 2, 3, 4, 1.
- f. Pilots should maintain the minimum spacing on landing as laid down in para 31.

INSTRUCTOR'S AIDE-MEMOIRE

58. There are 2 important "Gotchas" for people not familiar with YAK-52s:

- a. **On the Ground.** The brakes can fade if overused: typically, this happens in a confined space!
- b. **In the Air.** If the gill friction nut comes loose, the gills rattle shut and the engine overheats in about 2 min: therefore, pay attention to the CHT.

59. The fuel capacity of the aircraft is 120 lit, of which 108 lit are usable: this gives around 120 minutes at 60% and 6.

60. When on the wing in formation, you typically need 80% for novices. It is not possible to overboost the engine with 82% or more on the RPM.

61. The YAK 52 has a V_{ne} of 420 kph, V_{mnvr} of 360 kph, a clean stalling speed of 110 kph and flap stalling speed of 100 kph.

62. On take-off, when leading, aim to use 90% and about 4/5 throttle, rotate at 90 kph, accelerating to a climb out speed of 170 kph where the leader should set 80% and 8 manifold.
63. The gear limiting speed is 200 kph and the flap limiting speed is 170 kph. Downwind speed should be 190 kph, to achieve 160 kph in the finals turn, decreasing to 150 kph at the threshold.
64. Downwind checks are RPM to MAX, CARB to ON, Check fuel, Ts and Ps, harness and hatches and, finally, gear down and brakes catch OFF.
65. For novices, formation looping can be achieved from 330 kph (ideally in 2-span echelon) and formation barrel rolls can be achieved from 300 kph (ideally in extended line astern).

ANNEX A –NANCHANG CJ-6A DIFFERENCES

Nanchang CJ-6A (Non-) Differences Guide

Précis ‘Differences’ are surprisingly minor, even negligible. 3 ‘highlights’ are:

1. Use ‘5½’ as Power setting for most events.
2. As Leader, NB speed on VRIAB, if you exceed 280kph Yak-52s will get left behind.
3. Nanchang proved difficult / impossible to keep in as #3 in Flat Turns.

	CJ-6A Nanchang	Yak-52
Wind Up RPM	1800	70%
Cruise Power ~220kph	2200RPM 5.4 MAP	70% + 7
VRIAB	(No issue getting 280kph, do not increase e.g. to ‘6’ since will exceed 300kph and leave Yak-52s behind ☺) On Break <u>leave</u> set Power	80% + ~7 for 280kph On Break Set Full Power
Fuel Capacity	155L For Fuel Awareness, aim to refuel to 120L	120L
Fuel Consumption	Likely a little less than Yak-52 doing same profile?	Lead 60 Lph (wingman 80 Lph)
Rotate (gently)	100kph flies off ~130kph	110kph flies off ~130kph
Stall	108kph (only 4kph difference Clean/Dirty)	110kph
V_{NE}	340kph (CAA – was 370kph in Service)	450kph
V_{FE}	160kph	170kph
U/C Limit	200kph	200kph
Engine	285HP	[P] 360HP [PF] 400HP
Form TO – Leader	‘7’ (700mm Hg) [NB Full Power on TO is ~‘8’]	90%
Tailchase	‘5.5’ (550mm Hg?) / 2200	80% + 7¼
Canopy Open	Don’t use ‘Bobble’ above your head, it is Canopy Jettison! Use side lever... Open/Close knob bottom left of Canopy	‘Bobble’ above your head to release, latch bottom left of Canopy
Intercom	Hot Mic	Bottom PTT switch on Throttle
Flat Turns	Cannot keep up as #3, fine as #2	Can only do as #3 if entry held back ~200kph and limit to 45°AoB
‘g’ Limits	+6 / -3	+7/-5 (+5/-3 post life extension)
Inverted Systems	No Fuel / Oil 4 Point Harness	Yes – Fuel & Oil 5 Point ‘Ratchet’ Harness
Brakes	Cannot be latched. Seem to take a little longer than Yak-52 to release e.g. for Formation Takeoffs	Can be latched ‘on’ NB for Formation Takeoff

ANNEX B –ACKNOWLEDGMENTS

These SOPs would not have been possible without the help of:

Anthony & Samantha Hutton, Chris Heames, Sam Whatmough and Andy Hill

ANNEX C – R/T AIDE-MEMOIRE

The following R/T calls are intended as a *guide* to a typical early formation sortie. This aide-memoire is not intended to substitute for the SOPs, but rather just extract and summarise the R/T calls. The SOPs must be referred to in order to understand the significance and/or requirements of each specific R/T call. As a general principle, keep R/T calls to minimum number and length to comply with SOPs and mutual understanding. In this aide-memoire, the briefed Formation callsign ('C/S') is **Viper**.

Checking In / Frequency change:

#1	#2	#3 (#4...)	Notes
<i>Viper Check (Loud and Clear)</i>	<i>Viper 2</i>	<i>3 (4)</i>	NB Use of Formation C/S by #1 and 1 st to Ack Can use if no follow up executive / ATC call
<i>Viper Start Up, Start Up, Go</i>			'Executive' – action on Word 'Go'
<i>Viper Manual 2, Manual 2, Go</i>			NB may want hand signals / R/T call to ensure all ready to taxi before this freq change...
<i>Viper Check</i>	<i>Viper 2</i>	<i>3 (4)</i>	
<i>XYZ Radio, Viper Formation (details as passed) for Taxi</i>			Standard R/T calls to ATC. Use 'Formation' ideally only on 1 st call to an ATC unit.

Break & Join:

<i>Viper 3 Clear Break</i>		<i>Viper 3</i>	NB Leader clears airspace #3 will break into...
		<i>Viper 3 Out Blind</i>	"Blind" = Lost Visual so appropriate here until:
<i>Viper Lead 1800' Heading 180</i>			
		<i>Viper 3 Visual</i>	
<i>Viper 3 Clear Rejoin Vic xxx kts/kph</i>		<i>Viper 3</i>	

Vic (Echelon for 2 ship) ⇨ Line Astern:

<i>Viper Line Astern, Line Astern, Go</i>	<i>Viper 2</i>	<i>3</i>	
		<i>Viper 3 Clear</i>	
		<i>Viper 3 In</i>	

Line Astern ⇨ Vic (Echelon for 2 ship):

<i>Viper Vic, Vic, Go</i>	<i>Viper 2</i>	<i>3</i>	
		<i>Viper 3 Clear</i>	NB No "In" call since all visual...

Vic ⇨ Echelon (3 ship):

<i>Viper Echelon Right, Echelon, Go</i>		<i>Viper 3</i>	NB Only "movers" acknowledge
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Typical incorrect R/T reply and #1 appropriate response:

<i>Viper Echelon Right, Echelon, Go</i>	<i>Viper 2</i>	<i>3</i>	Erroneous call from 2 ("non-mover"), so nobody move:
<i>Viper Stop, Stop, Acknowledge</i>	<i>Viper 2</i>	<i>3</i>	#1 Rebrief by R/T as required...

Fuel Call:

		<i>Viper 3 Fuel 1 (-5)</i>	NB Leader does not initiate Fuel/Bingo calls
<i>Viper 3 Fuel 1 (-5) Acknowledged</i>			
	<i>Viper 2 Fuel 1 (-10)</i>		#2 Call (and response) here only made if #2 less Fuel than previous call
<i>Viper 2 Fuel 1 (-10) Acknowledged</i>			

Tailchase:

#1	#2	#3 (#4...)	Notes
<i>Viper 30 seconds to Tailchase</i>	<i>Viper 2</i>	3	Cue for HASELL checks etc.
<i>Viper Formation Base Ht 1500' Tailchase Follow me Go</i>			
	<i>Viper 2 Out (Breaking L/R)</i>	(follow #2)	e.g. (likely) breaking 50m / 3/9 line limits or Stretched – Leader will relax Manoeuvres:
	<i>Viper 2 In</i>		Correct position regained – Tailchase continues
	<i>Viper 2 Out BLIND</i>	(follow #2)	
<i>Viper 1 3000'</i>			#2 establish 500' separation
	<i>Viper Visual Viper 2 In</i>		Position regained – Tailchase continues
<i>Viper Knock It Off (x3)</i>	<i>Viper 2</i>	3	Emergency – can be called by any aircraft
<i>Viper Terminate (x3)</i> (Rejoin call a/r)	<i>Viper 2</i>	3	End Tailchase – can be called by any aircraft

Change Lead (from Echelon Right here):

<i>Viper 2, on my Break (Ease), you have the Lead</i>	<i>Viper 2</i>		#1 Breaks (Eases) to left...
#1 (prev #2)	#2 (prev #3)	#3 (prev #1)	
<i>Viper Renumber</i>	<i>Viper 2</i>	3	
<i>Viper 3 Clear Rejoin Vic xxx kts/kph</i>		<i>Viper 3</i>	(Speed call not necessary if via 'Ease')

Recovery via VRIAB ('Visual Run-In and Break'):

#1	#2	#3 (#4...)	Notes
<i>xxx Viper Formation 3 minutes to the Break</i>			Will be made with/after initial rejoin calls etc.
<i>Viper Initials / Left Base for Break</i>			NB Civil v Mil airfield etc. and if 'Initials' call is appropriate / will be understood
<i>Viper Breaking</i>			Not used in practice, usually substituted by:
<i>Viper 3 aircraft on the Break to Land</i>			Takes place of <i>Downwind</i> R/T call, 1 call for whole Formation...
<i>Viper 1 Finals</i>			Standard Individual Finals calls
	<i>Viper 2 Finals</i>		"
		<i>Viper 3 Finals</i>	"
		<i>Viper Runway Vacated</i>	If R/T shutdown required by Ldr:
<i>Viper Manual 1, Manual 1, Go</i>			Leave M1 call as late as possible. Alternative (better?) is to stay on ATC Freq and use Hand Signals.
<i>Viper Idle, Idle, Go</i>			
<i>Viper Cut, Cut Go</i>			

REVISION STATUS

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