

**BY ORDER OF THE
COMMANDING OFFICER OF
THE 185th RESERVOIR DOGS
VFS**

**185th VFS INSTRUCTION 14-4
30 APRIL 2005**

Advanced Flying Operations



TACTICAL FORMATION FLYING

NOTICE: This publication is available on the 185th WWW site at:
<http://185th.co.uk>.

Office of Primary Responsibility:
Training Officer

Certified by: CO 185th Reservoir Dogs
Pages: **15**
Distribution: A

This document is the part of the Advanced Flying Operations series, designed to teach regular Squadron pilots more advanced flying techniques. Pilots should have completed Basic Formation Flying Training prior to undertaking these Lessons.



TRAINING PACKAGE



Commanding Officer: Tracer

Executive Officer: PJC

TABLE OF CONTENTS

TABLE OF CONTENTS	2
LIST OF FIGURES	2
1 LESSON 1 - INTRODUCTION TO TACTICAL FORMATION FLYING	3
1.1 INTRODUCTION	3
1.2 LEAD TECHNIQUES	3
1.3 WINGMAN TECHNIQUES	4
1.4 COMBAT SPREAD FORMATION	5
1.5 BOX FORMATION	6
1.6 ENGAGING TURNS	7
2 LESSON 2 - TACTICAL TURNS	8
2.1 INTRODUCTION	8
2.2 BREVITY CODE WORDS	9
2.3 EXAMPLE 1	9
2.4 EXAMPLE 2	9
2.5 PROBLEMS WITH THE TURN	10
3 LESSON 3 - OTHER TURNS	11
3.1 INTRODUCTION	11
3.2 CHECK TURNS	11
3.3 IN-PLACE/HOOK TURNS	12
3.4 SHACKLE TURNS	13
3.5 CROSS TURNS	14
3.6 SUMMARY	14
3.7 CREDITS	14
3.8 PRACTICE FLIGHT TE	15

List of figures

Figure 1 - Spread Formation	5
Figure 2 - Spread Formation on the MFD	5
Figure 3 - Box Formation	6
Figure 4 - Box Formation on the MFD	7
Figure 5 - Left and Right Tac Turns	8
Figure 6 - 45 Degree Tac Turns	8
Figure 7 - Right Tac Turn	9
Figure 8 - Left Tac Turn	9
Figure 9 - Hook Turn	12
Figure 10 - Shackle Turn	13
Figure 11 - Cross Turn	14



Commanding Officer: Tracer

Executive Officer: PJC

1 Lesson 1 - Introduction To Tactical Formation Flying

1.1 INTRODUCTION

In order to maintain flight integrity, one of the most critical aspects of a combat mission, formation flying remains the most fundamental principal. Not only does it provide much needed Situational Awareness, but also gives the pilot a feeling of being part of something that transcends his lonesome cockpit. He is part of a tight unit, and constantly has his attention on remaining an effective piece of the overall tool called a flight.

It's just not acceptable to jump into a mission and spend ten minutes trying to find the other guy in your flight. How many times have you called out your bull position, searching your radar high and low, only to find out that your wingman is 500 ft directly above you dangerously blind feet?

It is a basic building block skill of any tactical pilot and must be mastered to the point of second nature to allow a combat pilot to concentrate on his first priority, achieving the mission. It is a critical tool for anyone who wants to keep their flight together and coordinated to maintain mutual support.

This series of 3 lessons is designed for use by regular 185th Squadron pilots who want to improve their ability to maintain Tactical Formations throughout the flight. Prior to completing these lessons all pilots should have completed the introduction to formation flying.

1.2 LEAD TECHNIQUES

The lead is critical to ensuring the formation is maintainable. He must be smooth, fly accurately, and inform his flight of critical information such as changes in headings, airspeeds and altitudes. The onus is on the lead to call the turns and changes in heading, but wing can do it if the tactical situation dictates. **Communication is key**, otherwise section mutual support will disintegrate.

The most important thing is to always fly the correct heading and airspeed. Note your power setting when at the appropriate airspeed. After each manoeuvre, establish the agreed upon tactical airspeed if you've strayed, then set the previously noted power setting and fly the agreed upon heading. Just cruising along, lead should strive for no more than about 2-3 degrees of variation in heading and less than 10-15 knots in airspeed. You may see larger airspeed deviations during some manoeuvres but strive to keep them less than 20 knots.

Some basic information about leading a flight needs to be understood. Lead must always give his wingmen "some." This means not going to full AB and leaving his wingman sucking jet wash 5,000' in trail.

A wingman will require 1-4% reduced power from lead during takeoffs, climbs, and in cruise while in any formation, tactical or otherwise. If the lead is at Military power (%100 or MIL), the wingman will likely not be able to maintain formation for long, as any error or deviation that requires a correction will leave him no room to do so without use of AB. Where possible, AB should be avoided as a formation-keeping tool due to fuel conservation issues. So, for example, lead briefs that after separate 15-second interval takeoffs, he will accelerate to 350K IAS for the climb. Once he reaches 350, he'd need to pull the power back. Just pulling power to MIL would likely require AB from the wingmen, so lead must give him "some" and pull his power to, say, 97%. He then adjusts his nose to maintain 350Kias. In general, any time lead is at or near MIL, he'll force the wingman to use AB. Similarly, in a descent, lead should avoid going to Idle to keep from forcing the wingman out in front. Give him a couple the other way by adding 2 - 4 %. A smooth and predictable lead is critical.

1.3 WINGMAN TECHNIQUES

Formation flying begins on the tarmac when the wingman rolls into fingertip position on his lead. From that point on, the wingman's main responsibility is the stay in position throughout the flight. The wingman must remember this: **BDA** (Bearing Distance Altitude). This means prioritise the bearing first, ie your clock position relative to lead. Use pitch attitude and throttle to hold or get back to the correct bearing relative to lead as soon as a deviation is noted. Allowing Distance and or Altitude to change in order to expedite this is acceptable and often useful. This means get your nose down and go to MIL if you are aft of the correct bearing, referred to as being "sucked." It's preferable to go nose low and MIL power, trading altitude for airspeed and burning a little gas than to get sucked or take an undue amount of time correcting to bearing. If you are sucked, **get your nose down** (zero g is best), power to MIL and accelerate the jet back onto bearing. About 50-150 knots excess should be used to quickly correct back to bearing. Do it yesterday! As the correct bearing approaches, convert your excess airspeed back to altitude, *match airspeeds and set the throttle as noted* and continue. Wingmen want to try to avoid using AB in most cases, but do what's required to get and stay in position.

If the wingman is ahead of the bearing, referred to as "acute", use S-turns to get back to the correct bearing. Slowing down significantly is not advisable (tactically unsound). A hard turn away from lead (and the agreed upon heading) of about 30-60 degrees heading change, followed by a hard turn back to original heading, will decrease your down range travel relative to lead, who continues straight ahead. This will allow lead to move forward as your S-Turn decreases your downrange travel and acts to move you back towards the correct bearing. Adjusting the magnitude of the turn in degrees away, and the amount of delay before turning back, will allow lead to drive further forward as needed to put you back on the bearing. It's OK to lose some airspeed, but don't get much slower than tactical airspeed (about 400-450 KIAS in F4). Some will note that the wingman will now be wide and that's true, but the bearing must be fixed first. If still acute, do another S-turn but this time *into* the lead and that should fix the distance. If on the proper bearing and still wide, then on the turn back into lead, just continue and turn 10-15 degrees more *into* lead from the agreed upon heading and you'll close the distance. Once the distance is correct, match up

headings, set the throttle, and get building SA and killing bad guys. A slight climb while S-turning can help as well. All this for straight and level flight!

Now we need to be able to manoeuvre the formation.

1.4 COMBAT SPREAD FORMATION

All of the turns described in this series of lessons use Spread (or line abreast) as their starting formation. It is an excellent balance between offensive firepower, ease of manoeuvre, and defensive properties. It allows both elements of the section to check each others blind spots equally and get their nose on a threat quickly, while still allowing both fighters unobstructed ability to launch at targets. The correct position is 6000-9000 ft or slightly more away from lead at lead's 3 or 9 o'clock position. Figure 1 shows the spread formation along with allowable variation while Figure 2 shows the HSD view in spread formation.

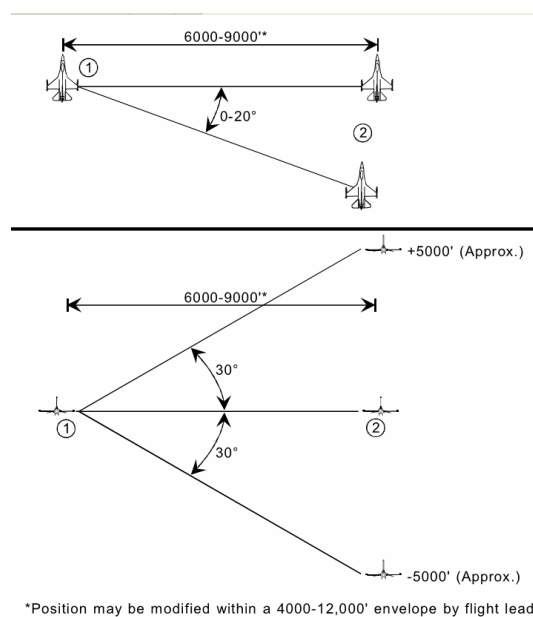


Figure 1 - Spread Formation

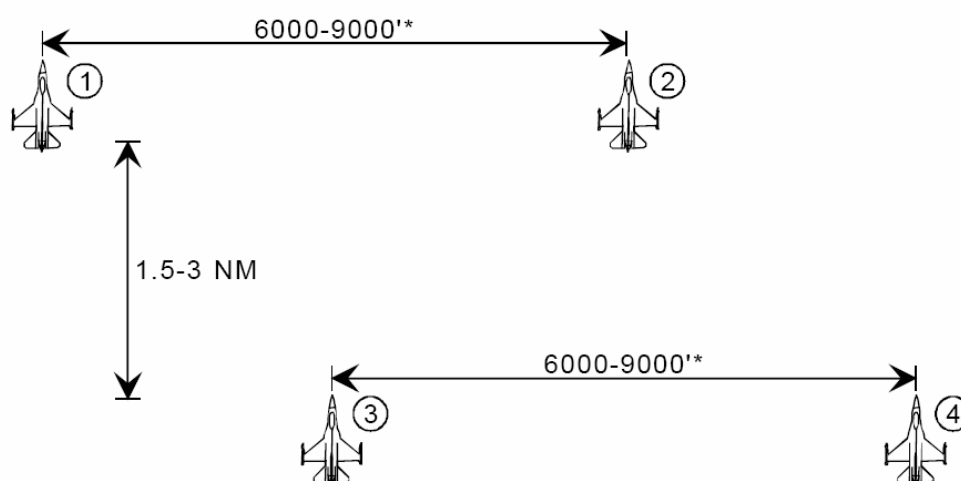


Figure 2 - Spread Formation on the MFD

The higher or faster your formation is, the wider it should be because true airspeed is greater and sustained g lower, resulting in larger turn radii. Typically it's about .75 - 1.5 miles, but variations abound. The correct bearing of 90 degrees is directly abeam lead and is easy to see by noting the location on the canopy of a wingman when he's in spread. A wingman altitude advantage is desirable to allow him more energy than lead; 1,000-3,000' is fine but may be disregarded as it's tough to do in simulators and still maintain sight. When flying you should be checking visually (using padlock and virtual cockpits) your wingman's six and your side of the formation often. Pan around in virtual cockpit and hit the padlock key to see if anyone is sneaking in on you. After any turn, both pilots will normally check each other's six on the new heading and report **"Six clear"**

1.5 BOX FORMATION

Spread is designed primarily for use in 2-ship operations. It can be used by a 4-ship but it makes manoeuvring unwieldy and time consuming. A better option, in most tactical situations, is to adopt the Box formation. Here elements use the spread manoeuvring principles and the trailing element takes 1.5 to 3 NM separation, depending on terrain and weather. The objective of the spacing is to give maximum separation to avoid easy visual detection of the whole formation, while positioning the rear element in a good position to immediately engage an enemy converting on the lead element. As the F-16 is difficult to see from a direct trail position, a slight offset will facilitate keeping sight of the lead element. In Box formation, all manoeuvres are initiated by the element leaders with number three manoeuvring to achieve the agreed spacing on the lead element. Figure 3 shows a diagram of the formation, while Figure 4 shows how the HSD should look in Box.



*Position may be modified within a 4000-12,000' envelope by flight lead.

Figure 3 - Box Formation



Figure 4 - Box Formation on the MFD

1.6 ENGAGING TURNS

TACTICAL turns, along with IN PLACE, CHECK and SHACKLE turns are **engaging** type turns, which means they are **sustained energy type turns, done without airspeed or significant altitude loss by the section**. If cruising in spread at tactical speeds you normally will not be at 100% power. **Engaging turns are normally made at 100% (MIL) power, avoiding AB**. Once at MIL power, the airspeed is maintained by the *amount of pull or g you apply*; climbs and descents are typically avoided. Each pilot will turn at MIL and use g to maintain airspeed and then will roll out, reduce power to hold briefed airspeed, and continue along. If he finds himself getting fast, he must increase his pull (g) to decelerate to target speed and conversely getting slow means he pulled too hard, as the throttle is fixed at MIL during the turn.

This is difficult at first and you'll find staying within 50 knots is tough, but soon enough you'll find you can do it within 10 – 20 knots easily. Practice offline doing 360-degree turns until you can do this readily plus or minus 10-20 knots. Use the cues provided in F4 like the sound of the wind, glance forward (if not in 2D view), and Shift 3 to get your instruments in padlock mode. You eventually want to be able to do it without just staring at the front cockpit for airspeed, g, and heading, but doing just that initially is not a bad way to learn.

NOTE: If at high altitudes or in a very heavy/draggy configuration, lead may brief Afterburner TACFORM and Afterburner may be used by aircraft during turns.

Included in the zip file for this lesson is an ACMI showing engaging turns with an F-16 at medium altitude (16000ft), doing a 360° turn without significant speed or altitude loss. Tactical speeds in the F-16 are typically 400-450 KIAS. For this example the pilot is trying to maintain 450 knots. The file is called "Engaging Turn.vhs".



Commanding Officer: Tracer

Executive Officer: PJC

2 Lesson 2 - Tactical Turns

2.1 INTRODUCTION

Tactical Turns (Tac Turns) are used in the spread/line abreast formation and are designed to maintain formation integrity when making turns. The end result of this manoeuvre is that you should still in line abreast formation at the end of turn. Figure 5 shows an overhead view of a left and right Tac Turn.

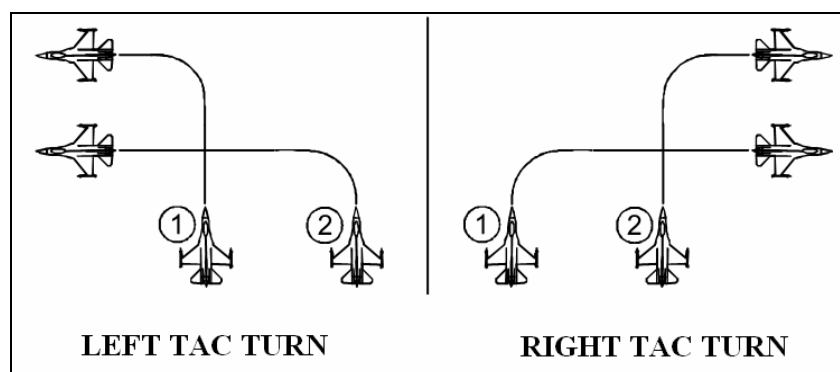


Figure 5 - Left and Right Tac Turns

There are two types of Tac turns, turns **into** the wingman and turns **away** from the wingman. In the configuration shown in Figure 5 you can see that a left Tac Turn would be away from the wingman and the right Tac Turn into the wingman.

The aircraft on the **outside of the turn will always turn first** but the move is **always initiated by Lead**.

Turns are normally 90 degrees left or right but can be 90 degrees and up to +/- 60 degrees. For turns under 30-40 degrees a Check Turn should be used and for angles over 150 degrees a Hook Turn is used, refer to the Lesson 3 for more information. Figure 6 below shows an example of left and right 45 degree TAC Turns.

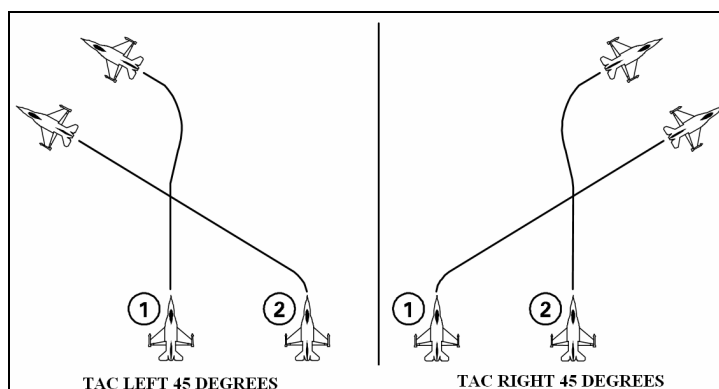


Figure 6 - 45 Degree Tac Turns

2.2 BREVITY CODE WORDS

If the turn is 90 degrees lead will call "**Tac Left/Right**", if any other angle is required then include that in the call eg "**Tac Left/Right 30**". You can also reference a know point eg "**Tac Left/Right Steerpoint 8**". The move does not begin until the wingman responds eg "**Two**".

2.3 EXAMPLE 1

You are in a 2 ship flying north. The wingman is in spread formation to the left of Lead and the flight needs to make a 90 degree turn to the right, which is a turn away from the wingman (see Figure 7). This puts the wingman on the outside of the turn and means he needs to turn first. Lead calls "**Tac Right**", the wingman responds "**Two**", applies full military power and begins his turn to the right, using g to maintain the same airspeed and altitude. A 4g turn is normally sufficient for this. When the wingman's nose passes through his lead (+/- 3 seconds) he will call "**One Turn**". Lead then begin his turn to the right. Both aircraft roll out on a heading of 90 degrees and still in spread formation.

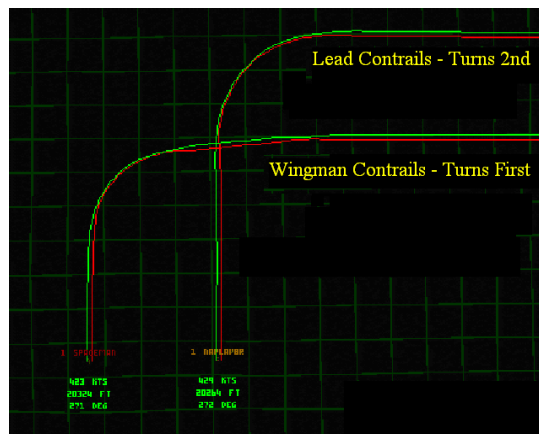


Figure 7 - Right Tac Turn

2.4 EXAMPLE 2

If lead had called "**Tac Left**" he would be on the outside and therefore need to turn first. The wingman would still answer "**Two**" and on hearing the response lead would turn into the wingman calling "**Two Turn**" as his nose passes through his Wingman. This is shown graphically in Figure 8 below. The rest of the procedure is as per Example 1 except the final heading is 270 degrees.

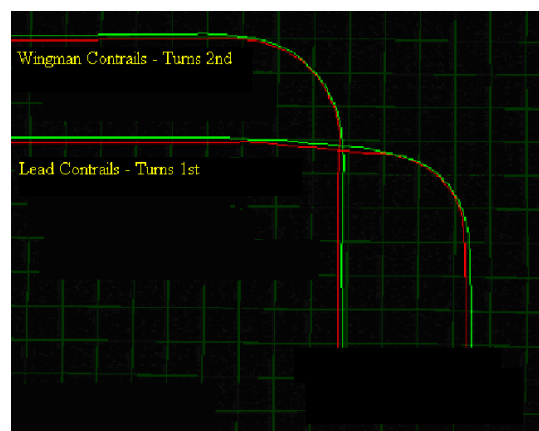


Figure 8 - Left Tac Turn

Tip: As the 2nd aircraft to turn you can use the HSD Expanded mode to watch the other aircraft's movement and help judge when to start your turn. When Lead and Wingman become proficient in these turns and get a good feel for the timings, the cue for the second aircraft to begin its turn eg "**Two Turn**" can be dropped.

2.5 PROBLEMS WITH THE TURN

If the inside or second fighter to turn continually rolls out in front of the other aircraft then he should delay longer next time before beginning his turn. If he's often sucked (rolls out aft of the other aircraft) then he's waiting too long or not pulling as he should during the turn and getting too slow.

Once on the new heading the wingman manoeuvres to regain the correct position, if he's not perfect, while lead goes about his duties.

The ACMI file "TAC_TURNS.vhs" gives an example of several TAC Turns.



Commanding Officer: Tracer

Executive Officer: PJC

3 Lesson 3 – Other Turns

3.1 INTRODUCTION

Lesson 3 in the series looks at several types of Turns that are used to stay in formation. Pilot should adopt the spread or box formations for these turns.

3.2 CHECK TURNS

Generally turns of 1-30 degrees (sometimes up to 40 degrees) are known as Check Turns. All Lead does is turn to a new heading, maintaining airspeed and altitude, while the wingman must jump through hoops to stay in or regain position.

If the turn is *into* a wingman, the wingman will tend to get acute (ahead of the 3-9 line) and must S-turn hard away for 45-60 degrees more than the new heading, followed by a turn back into the lead and adjust as necessary for correct bearing, followed by distance and then altitude.

Check Turns *away* from the wingman will normally put him sucked (behind the 3-9 line), so without delay the wingman should get his nose down, go to MIL, and turn to the new heading while accelerating (getting 50-150 knots excess) and drive back to the bearing, trading the excess airspeed for altitude as he reaches it. This will often put him tight and once on bearing, he can make a 10-15 degree turn away to get the distance.

In Check Turns the wingman will be doing a good deal of manoeuvring to stay in position; don't delay, as the sooner you get turning and compensating, the quicker you'll be back in position and the less work it will be. Think ahead and get correcting immediately.

As for comms, a heading is normally called out eg "**Cowboy 22, check left 210**". Any turn done greater than 30-40 degrees should be a modified TAC Turn as described in Lesson 3.

3.3 IN-PLACE/HOOK TURNS

In-Place Turns are engaging type turns of 180 degrees (+/- 30 degrees). They are often referred to as hook turns.

It is very similar to the Tac turn (See Lesson 2), except but both fighters turn **simultaneously** and in the **same direction** for 180 degrees. At the end of the manoeuvre they will be in the correct position if both do the right thing and fly the numbers. Both must maintain the briefed airspeed and altitude using MIL power and g to avoid airspeed changes. The wingman must regain a tally on lead early on and correct for any incorrect position he sees. The manoeuvre would be initiated by the call "**Cowboy 2, Hook/In Place left.**" The reply is the execute command "**Two**". If the turn is not 180 degrees, the heading must be added to the call by Lead. Figure 9 shows a Hook Turn.

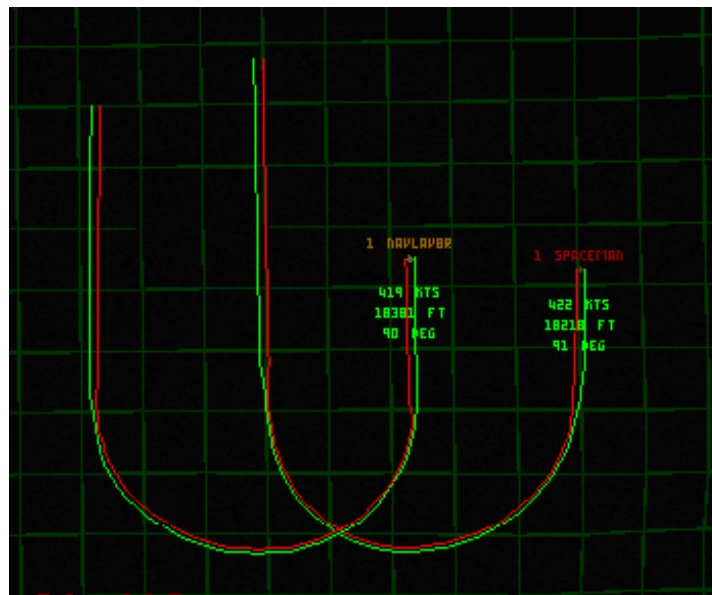


Figure 9 - Hook Turn

The ACMI file "Hook_Turns.vhs", included with this document, demonstrates several Hook Turns.

3.4 SHACKLE TURNS

Shackle Turns are so called because they look like a shackle on a chain. The manoeuvre is used to swap sides, check sixes, or more commonly, to correct the formation if the wingman is excessively acute or sucked. It can be used to change heading as well. Figure 10 shows a picture.

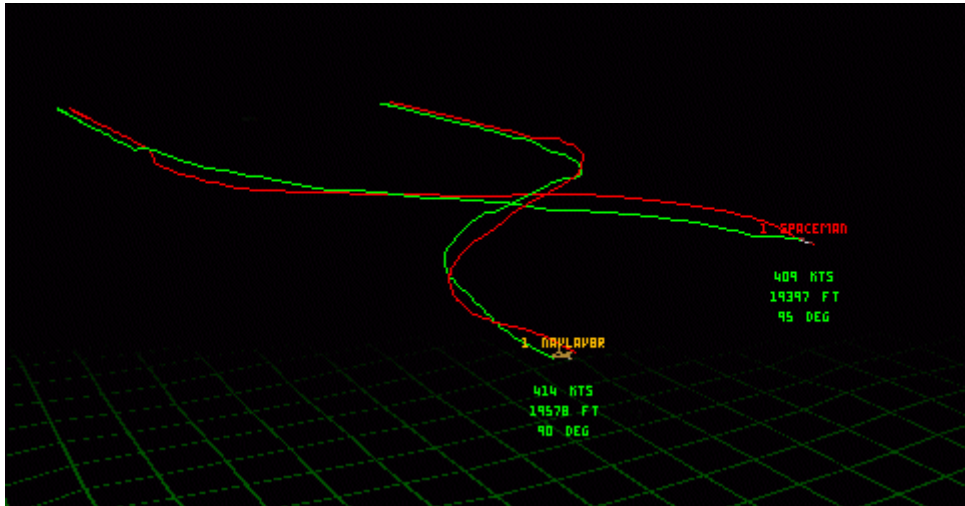


Figure 10 - Shackle Turn

In a typical Shackle Turn both fighters start an engaging type turn into each other for 45 degrees of turn and go wings level. They should pass right over each other (note how long from going wings level to the pass and delay the turn back to original heading for that amount of time, usually about 1-3 seconds), and then turn back to original heading. A swap of sides has been completed. Be careful to maintain agreed airspeed throughout the manoeuvre. If the wingman is sucked and Lead can call for a shackle, Lead will then do most of the turning while the wingman flies almost straight ahead, going down range and making up for being sucked. The guy out in front turns more than normal (50-70 degrees), the guy in back not at all or just enough to get on the other side of the guy out in front (10-20 degrees).

If the wingman is acute, then lead will help him out by turning only enough to swap sides while the wingman turns more than 45 degrees in an aggressive S-turn to stop his downrange travel and try to get back aft to the bearing. When it's finished, the formation is corrected, sides swapped, sixes checked, and both aircraft are ready to press on. It can be used in heading changes of up to 30 degrees but more often, back onto the original heading. It is used more often to redress formation. Comms calls are **"Two shackle"** if you intend to return to the original heading or **"Two shackle 210"** if you intend to change the final heading. Once again the reply **"Two"** is the execute command.

The ACMI, "Shackles.vhs" that came with this document shows several examples of the Shackle manoeuvre.

3.5 CROSS TURNS

Cross Turns are turns of 180 degrees, but are not an engaging type of turn. They are used when an immediate threat is found in the rear quadrant to get the element turned around more quickly. **Afterburner is used** and the *nose is placed above or below the horizon* to maintain tactical airspeed for best the turn rate (normally nose low). Figure 11 shows an example.

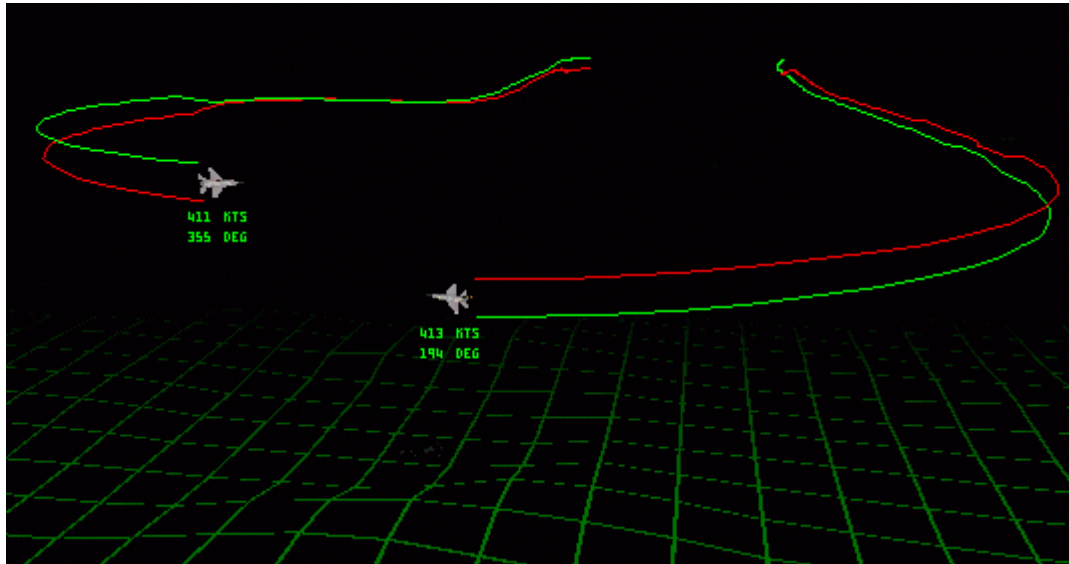


Figure 11 - Cross Turn

In the Cross Turn, both fighters turn at the same time and maintain airspeed with pitch attitude while holding max 'g' (9 g's in F4). The turn is made **into each other**, with the wingman normally passing over the top of lead and both rolling out on a reciprocal heading in spread. Comms are "**Two Cross turn**". If a turn other than 180 degrees is desired, the heading is added to the call. Remember to maintain airspeed by putting the nose down if required, and it often is.

3.6 SUMMARY

Reading these lessons in conjunction with the Introduction to Formation Flying will give you all the information you need to manage and keep your formation during a flight. If you practice these skills on a regular basis you will find you teamwork, mutual support and SA all drastically improve and you can devote more of your time to achieving the mission rather than trying to find your wingman.

3.7 CREDITS

Thanks go to John "NavIAV8R" Simon for the original article at:
http://www.simhq.com/simhq3/sims/air_combat/tacform

and to Merlin for his information, pictures and ACMI files. His web-site is here:
<http://members.westnet.com.au/web/merlin01/tacform.htm>

Thanks also to Pinbeck for helping to produce Lesson 2 and the Training TE.

3.8 PRACTICE FLIGHT TE

TE Name: TAC TURNS TRAINING.TAC

Aim: Training Flight to Practice Formation Turns.

Flights: **Lobo1**-4x F16C-52 **Panther1** -4x F16C-52 **Camel1** – 1x KC-10

Remember: **Entry parameters for turns will be 400 knots, Angels 15 and full military power. It is vital to maintain the same speed and altitude through the turn by controlling g.**

You can depart from the waypoints at any point in order to practice the turns from Lesson 3. When done return to the waypoint and resume the TAC Turns flight plan.

There is a tanker between Stp 10 and 11 so you can practice re-fuelling.

BRIEFING

- a. Line up on the runway and **start the flight recorder**.
- b. Take off and climb towards Stp 2. You can put smoke on to help identify aircraft positions if you wish.
- c. Be in **spread**/line abreast, **400 knots** and **Angels 15** before Stp 2.
- d. At **Stp 2 - TAC RIGHT**. New Heading (NH)=0.
- e. At **Stp 3 - TAC LEFT** NH=270.
- f. At **Stp 4 - TAC RIGHT 45** NH=315.
- g. At **Stp 5 - TAC RIGHT 45** NH=0.
- h. At **Stp 6 - TAC LEFT 45** NH=315.
- i. At **Stp 7 - TAC RIGHT 135** NH=90.
- j. At **Stp 8 - TAC RIGHT** NH=180.
- k. At **Stp 9 - TAC LEFT 135** NH=45.
- l. At **Stp 10 - TAC RIGHT** NH=135.
- m. At **Stp 11 - TAC LEFT 45** NH=90.
- n. At **Stp 12 - TAC RIGHT 45** NH=135.
- o. At **Stp 13 - TAC RIGHT** NH=225.
- p. Proceed to the landing pattern or fly the course in reverse.
- q. Review the ACMI tape and identify good turns and areas for improvement then re-fly the mission, acting on the de-brief points.