ANNEX E

GENERIC TACTICAL FIGHTER EMPLOYMENT

This brief exposé will attempt to put supersonic events in perspective as they apply to fighter tactics.

Fighters typically come in two forms, or configurations: they are either configured for Air-to-Air missions (A/A), or they are configured for Air-to-Surface attack missions (A/G, the "G" indicating "ground", but includes sea targets). The A/A configuration tends to be a "clean" configuration in that the fighter will not have a lot of pylons and pods hanging from the wings and fuselage; consequently, the A/A configuration allows the fighter to fly high and fast, and to accelerate quickly. Conversely, the A/G configuration is a "dirty" configuration in that the fighter will have several pylons hanging from the wings, and it will have bulky ordnance and pods hanging from the wing pylons and the fuselage. Thus, the higher drag A/G configuration reduces acceleration capability and requires the aircrew to fly at lower altitudes and slower speeds.

Tactical missions are planned with "packages" of A/A and A/G fighters. In a generic scenario, a package would typically consist of 25% A/A fighters and 75% A/G fighters. The A/A fighters will "sweep" into the battle area first, clean out enemy fighters in predetermined areas, and then establish "CAPs" ("Combat Air Patrol", which resemble holding patterns) to protect the A/G fighters as they execute their Air-to-Ground mission. Once the last of the A/G fighters have left the battle area, the A/A fighters flow out of their protective CAPs and return to their bases also.

It is highly unlikely that A/G fighters would experience a supersonic event during a training sortie. The drag associated with the bulky configuration of A/G fighters is so high that the fighter would probably have to be in a maximum afterburner descent to achieve Mach 1. Afterburner is an engine condition where the engine RPM is placed at maximum and then jet fuel is sprayed into the hot jet engine exhaust. This fuel then ignites and increases the thrust of the engine by approximately 30% - 40%. The use of maximum afterburner increases jet fuel flow about 60% above the fuel burn rate of maximum RPM thrust. Jet fuel is extremely precious to fighter aircrew because their targets are typically hundreds of miles from their home bases and from the air refuelling tankers (which are large airplanes that provide jet fuel to the fighters while airborne). Therefore, A/G fighter pilots are loath to using afterburner because this burns a tremendous amount of fuel: the result is a negligible increase in airspeed because of the drag associated with the A/G configuration, and they may not be left with enough fuel to get into their targets and then return to their home bases. Further, there are specific airframe and weapon speed limitations published for various configurations; A/G speed limitations tend to be restrictive and are often set below Mach 1. Most weapon deliveries (i.e. the dropping of bombs and the firing of A/G missiles) are currently made from the sub-sonic regime. Lastly, most A/G fighters that operate in the low environment (e.g. below 10,000 ft) simply can't produce the thrust required for level-attitude supersonic flight. Most later generation A/G fighters, such as Canada's CF-18, fly much higher than 10,000 ft during their mission profiles because this allows the fighter engines to burn less fuel and the high-altitude profile allows the fighter pilots to spatially distance themselves from many of the surface-to-air threat systems that an enemy air defence unit will attempt to employ against them; regardless, these A/G fighters maintain subsonic profiles. The only case where an

A/G fighter might attain Mach 1 would be a situation where an enemy fighter snuck through the A/A fighter “sweep”, evaded the protective CAPs, and attacked an A/G fighter: depending on the geometry of the attack, the A/G fighter might opt to jettison its ordnance, and then either turn into the adversary to fight or turn away and dash for 15-30 seconds. If the choice is made to dash away, the A/G fighter might be able to attain Mach 1 once the ordnance has been jettisoned (depending on the remaining drag of the aircraft and the thrust output of the engines). The jettisoning of ordnance is not practiced during peacetime training missions; therefore, it is highly unlikely that an A/G fighter would ever be able to attain Mach 1 during a peacetime training mission.

Air-to-Air fighters do have the ability to enter supersonic flight and may briefly use a supersonic dash to ensure success during a specific tactic. Currently, A/A fighters do not “super cruise”, or cruise for extended periods above Mach 1, because they also cannot afford to burn the fuel associated with afterburner use. The USAF statistics on supersonic flight for the F-15C, their premiere A/A fighter, represents 7.5% of its tactical flying time[1]. The following is a classic example of where and how A/A fighters will use supersonic flight during a mission.

When the A/A fighters first push out from their side of the front lines, they will typically be flying between 30,000 ft - 50,000 ft. If they do not have adversary aircraft in front of them, they will cruise into enemy territory sub sonically at a very high altitude to save fuel. If the A/A fighters have a known airborne adversary that is clearly setting geometry towards them, the A/A “sweep” fighters will set geometry and potentially attain supersonic speed (use of afterburner will likely be required) to ensure that their intercept tactic achieves a superior result to that of the adversary’s. Following this, the A/A fighters will reset geometry and will typically come out of afterburner to save fuel. Thus, the supersonic event associated with an intercept tends to be seconds in length, vice minutes, and tends to be well above 20,000 ft (see Table 1). In fact, during a recent study of CF-18 supersonic activity, the average CF-18 supersonic event lasted 24 seconds (see Table 2). At these high intercept altitudes, many sonic booms are bent sufficiently upward that they never reach the ground.

The fact that supersonic events are generally restricted to higher altitudes is not unique to the CF-18. Table 3 clearly demonstrates that two of the premier Air-to-Air fighters in the USAF inventory have the great majority of their supersonic events in the higher altitudes also.

If the situation develops such that the A/A fighters must “merge” with the adversary fighters, the A/A fighters will definitely not be supersonic because fighters cannot turn quickly at supersonic speeds; and, the adversary’s heat-seeking missiles easily target the engine heat associated with supersonic flight. Once a turning fight starts (i.e. a “dog fight”), the fight tends to spiral down into the lower altitudes quickly and the speeds remain subsonic. The only case where a supersonic event might happen following the commencement of a turning fight is where one fighter perceives that he can turn away from the adversary and dash to a safe distance: this is an extremely rare event. Generally, the fight spirals down to the “Hard Deck”, which is an artificial floor set at 5000 ft AGL (above ground level), where the fight ends, the fighters disengage, and then continue with the rest of their training mission

[1] Environmental Impact Statement, Initial F-22 Operational Wing Beddown, Headquarters Air Combat Command, Langley AFB, April 2001

(provided they have enough fuel to continue). Supersonic events below 15,000 ft are rare: for a supersonic event to transpire below 15,000 ft in the training environment, a critical tactical error will usually have been made by either the attacker or the defender. This error would cause the local engagement to be terminated quickly, with appropriate lessons drawn out for the mission debrief.

Finally, all combat aircrew must be given the opportunity to train the way they will fight. Because fighter aircrew employ supersonic flight during combat, they must be afforded the opportunity to train in the supersonic environment during training. Artificial restrictions placed on training opportunity will impart “negative training” (i.e. procedures and muscle memory movements that will not be used in battle): this may ultimately result in the unnecessary loss of life and precious resources during conflict.

In summary,

- The great majority of fighter jets today must use afterburners to attain Mach 1 or greater. This uses a lot of fuel; therefore, fighter pilots attempt to refrain from using afterburner unless absolutely necessary.

- A/G fighters (representing about 75% of a typical mission) general do not get to supersonic speeds because they cannot produce the thrust required to overcome the drag associated with the ordnance and pods that they carry. This situation generally applies to A/G fighters that fly both high level and low level.

- A/A fighters (representing about 25% of a typical mission) may attempt to attain Mach 1 during the early stages of an intercept, before they merge with the adversary. Once initial intercept geometry and speed have been attained, afterburners will usually be deselected and the A/A fighters will typically slow below Mach 1.

- The great majority of supersonic events last for a few seconds and take place above 20,000 ft. Often, the sonic boom does not reach the ground because the associated shock wave is bent upward.

- Supersonic events below 20,000 ft are uncommon. A supersonic event below 15,000 ft is quite rare and usually provides an important learning opportunity for the correction of a tactical error that could prove fatal in battle.

- Combat aircrew must be provided with the opportunity to train the way they will fight.

Table 1. Comparison of minimum altitudes to supersonic events during a CF-18 Squadron's Air-to-Air Combat training phase, June to August 2004.

MINIMUM ALTITUDE PER CF-18 SUPERSONIC EVENT		
ALTITUDE BLOCK	**NUMBER OF EVENTS**	**PERCENT BY ALTITUDE**
ABOVE 40,000 FT	0	0%
39,999 TO 30,000 FT	13	29%
29,999 TO 20,000 FT	25	56%
19,999 TO 15,000 FT	6	13%
14,999 TO 10,000 FT	1	2%
9,999 TO 5000 FT	0	0%

Table 2. Average Time per Supersonic Event, during a CF-18 Squadron's Air-to-Air combat training phase, June to August 2004.

Duration of Supersonic Events			
CF-18 Tail Number	**Number of Sorties by Airframe**	**Number of Supersonic Events**	**Cumulative Supersonic Duration (Seconds)**
740	8	1	40
751	18	8	95
753	10	7	200
754	30	3	45
757	18	9	110
761	4	0	0
766	8	0	0
777	26	9	375
784	19	6	70
795	7	2	120
Total	**148**	**45**	**1055**
Average Time per Supersonic Event (seconds)			**23.4**

Table 3. A Comparison of supersonic event altitudes by Air-to-Air Fighter type.

PERCENT OF SUPERSONIC ACTIVITY			
	F-15C	**CF-18**	**F-22**
ABOVE 30,000 ft	15%	29%	60%
10,000 TO 30,000 ft	84%	71%	39%
BELOW 10,000 ft	< 2%	< 1%	< 1%