28 February 2002

MEMORANDUM

TO: MR. David Wartofsky, Owner Potomac (VKX) Airport

FROM: Dr. Kenneth Nolde (USAF Ret), Senior Analyst, Defense Intelligence Agency

RE: Conversations September 2001 to February 2002 concerning General Aviation security perceptions.

SUBJECT: Conversations Concerning General Aviation (GA) Security Risk

Dave: I have been thinking about our conversation and what the risks are involving GA aircraft with Chemical and Biological activity, Nuclear Weapons, and Conventional (non-nuclear) Explosives. The subject is complex and not well understood by those unfamiliar with aviation. I will, in the following pages, attempt to provide a "layman's primer" on GA capabilities and their application to delivery of deadly cargo or weapons of mass destruction (WMD). I will limit scientific and technological concepts to a minimum within a methodology of straightforward description of the GA aircraft most common in the fleet. These descriptions will to include; weight carrying capabilities, limitations; speed; vulnerability to detection in a non-transponder environment; a discussion of the possible WMDs and facility of use; and conclusions.

Types of GA Aircraft:

General Aviation in the United States consists of 250,000+ licensed aircraft, not including another 150,000 mainly experimental, ultralights, historical, and others on display or not flying. For the purposes of this analysis, I plan to use three categories or generic types of aircraft that encompass 90-95 percent of the GA licensed fleet.

The Categories

1. Single engine, fixed landing gear. These aircraft are the most popular because of their low operating costs, modest capabilities, and reasonable purchase price. Specifically, these aircraft would be Piper Cherokees, Cessna 172s at the low end and Piper Saratoga, Cessna 182/206 at the high end. The aircraft in this category are four place (at the lower end, only nominal 4 place) with airspeeds of between 110 KTAS to 150 KTAS. The gross weights (GW) in this class run from 2100 pounds to about 3000 pounds. The fuel used is 100 octane Low Lead (100LL) gas and between 50 and 100 gallons are carried, with the fuel burned at the rate of 7 to 14 gallons per hour.

2. Single engine, retractable landing gear. These aircraft have higher performance, to include a few that will exceed 200 Knots true airspeed (KTAS), but the normal range is between 135 and 170 KTAS. The gross weights in this category range from 2500 pounds to 3500 pounds in this category and these are 4 to 6 place aircraft. These aircraft would include such aircraft as Piper Arrows to Mooney Bravos, Piper Malibu, and Bonanza 35s. In addition, the newer composite aircraft are somewhat faster, with the same weights. The fuel used is 100 octane Low Lead (100LL) gas and between 50 and 140 gallons are carried, with the fuel burned at the rate of 9 to 16 gallons per hour. There are a few aircraft in this category that are turbine powered and they use Jet A1, Kerosene.

3. Twin (two) engine, retractable landing gear. Planes in this category have the highest performance and are larger than the previous groups. The speed of these aircraft is from 130 to 240 KTAS, with gross weights ranging from 2700 to 6000 pounds, and 4 to 8 passengers are carried. The fuel used is 100 octane Low Lead (100LL) gas and between 100 and 250 gallons are carried, with the fuel burned at the rate of 15 to 30 gallons per hour. There are a few aircraft in this category that are turbine powered and they us Jet A1, Kerosene.

The categories selected are in order of performance with 1 having less than 2 or 3, and 3 having the most capabilities.

** **Weapons of Mass Destruction** WMD threats considered include chemical or biological agents (anthrax, VX nerve gas in liquid and solid/powder form, etc), conventional explosives, and nuclear weapons. The chemical and biological agents in liquid form will weigh an average of 6 pounds per gallon, this is the same general figure used for a gallon of aircraft fuel.

Defining Characteristics:
** **Payload** is important as it defines for how much actual "cargo" may be carried. Thus for a 2100 pound aircraft the payload is about 850 pounds, and for the 6000 pound aircraft it is about 2300 pounds. The payload consists of the weight of fuel, the pilot, baggage, and equipment added; the gross weight of an aircraft is sum of the basic weight of the airplane and everything else, up to the limit the manufacturer stipulates. Payload is emphasized because it is applicable to all aircraft categories and is a critical aspect of analysis.

The gross weight, as noted, is what the manufacturer determined is the maximum safe limit for a particular aircraft. However, more important than the simple gross weight, is how the weight is distributed. In actuality it means that for safe flying in any particular aircraft, the weigh must be distributed evenly ahead and behind the aircraft's center of gravity (balance point), in aviation this is called a "weight and balance" calculation. This is a critical measure because even modest imbalances can have catastrophic consequences for aircraft control. In all aircraft, too much weight forward or to the rear (aft) would cause the pilot to lose control of the plane and crash.

** **Payload/WMD Threat** relative to payload is here that a calculation can be made of how much deadly cargo may be carried by any particular aircraft. It should be noted that from the payloads vary for 850 pounds at the low end of Category one to 2300 at the high end of Category 3 and will be used for all calculations. In addition, a dedicated terrorist likely would try to maximize the interior space of the aircraft by removing all but the pilot's seat, so that would add 50 and 150 pound respectively. The payload is now considered to be 900 and 2450 pounds.

** Determining the amount of WMD weight available at takeoff. With the inside clear, the pilot must determine how much fuel to carry, three calculations will be considered, 1 hour, half-full, and full.

Aircaft One: Low-end single engine, fixed landing gear.

Aircraft Maximum Gross Weigh:	2100 lbs.	2100 lbs.	2100 lbs.
Aircraft Empty Weight:	1200 lbs.	1200 lbs.	1200 lbs.
Pilot weight:	170 lbs.	170 lbs.	170 lbs.
Fuel: 1 Hour	60 lbs. (10 gals);	Half full 175 lbs. (25 gals);	Full 300 lbs. (50 gals)
Operating Weight	1430 lbs.	1545 lbs.	1670 lbs.
Interim Cargo Weight	670 lbs.	555 lbs.	430 lbs.
10 Percent Reduction	67 lbs.	55 lbs.	43 lbs.
Potential Deadly Cargo Weight	603 lbs. (100 gals)	500 lbs. (83 gals)	387 lbs. (65 gals)

Aircraft two: High-end twin engine, retractable landing gear.

Aircraft Maximum Gross Weigh:	6000 lbs.	6000 lbs.	6000 lbs.
Aircraft Empty Weight:	3600 lbs.	3600 lbs.	3600 lbs.
Pilot weight:	170 lbs.	170 lbs.	170 lbs.
Fuel: 1 Hour	245 lbs. (35 gals);	Half full 875 lbs. (125 gals);	Full 1750 lbs. (250 gals)
Operating Weight	4015 lbs.	4645 lbs.	5520 lbs.
Interim Cargo Weight	1985 lbs.	1355 lbs.	480 lbs.
10 Percent Reduction	199 lbs.	136 lbs.	48 lbs.
Potential Deadly Cargo Weight	1786 lbs. (298 gals)	1219 lbs. (203 gals)	332 lbs. (55 gals)

The storage of chemical or biological weapons would require tanks for liquid or bins for dry substances and a mechanism for adequate dispersal of the material selected. Discussion:

The entry doors of all GA aircraft smaller than those in a car, mostly about 30-35 inches wide and 45-50 inches high, which severely restricts the type of containers that can be installed.

The dispersing mechanism (nozzles) must be external to the cabin of the aircraft and most probably it would have to be installed in flight to reduce ground detection.

The installation of a system to disperse the materials is technically very difficult and would be hard to hide during the build up phase.

The terrorist also must calculate the weight of the dispensing mechanism and subtract it from the weight of the deadly materials.

The amount of weight of the potential deadly cargo is considerable in terms of a GA aircraft and without very accurate weight and balance calculations it is likely that some of the potential deadly cargo could not be carried.

An assumed reduction of 10% of deadly cargo would be reasonable to compensate for installation and weight and balance requirements.

The above shows that in GA aircraft payload is as range (fuel) is carried, but 100LL fuel would add to a crash and this calculation would have to be based on terrorist considerations for the event planned. Similarly, the absolute amount of materials is limited, even with minimal fuel carried.

Conventional explosives of all types can be carried internally, with the same weight and placements restrictions as other materials. Explosives such as bombs could be jury-rigged to attach externally, but these weapons would, aside from attracting immediate notice, would adversely affect the GA aircraft's flying characteristics and reliable flight is improbable.

Using explosives in a GA aircraft also is a complex engineering issue, if the idea is to penetrate a target (a building is assumed) before the explosion occurs. Given the relative fragility of GA aircraft in a high speed crash, delaying the detonation, as the plane is consumed in a crash and the pilot dies, assumes some hardening of the explosives and a sophisticated, protected fusing mechanism.

** **Speed** is a relative characteristic, but the faster one can go, the more difficult it is to intercept once detected. However, the differences in GA aircraft speeds and those of military fighters are overwhelming and greatly favor the interceptor. For example: the fastest GA aircraft at low altitude is slightly over 200 KTAS, for a military jet 600 to 700 KTAS in the same flight regime is routine.

** **Detection** of GA aircraft in a non-transponder environment is assumed, This because, it is highly unlikely that a terrorist would use a position marking device (transponder, IFF) that would facilitate discovery. Without using a transponder, GA aircraft must be detected by radar, this called "skin painting" by controllers and GA aircraft are readily seen by radar. The metal construction, metal propellers, metal engines, and flat reflecting sides means that GA aircraft are not stealthy. In the Washington, D.C. area GA aircraft can be seen as low as 350 feet.

Hiding by flying low is feasible, but navigation is difficult, requiring "ups and downs" to avoid buildings or terrain. Moreover, low altitude make accurate, adequate dispersing of chemical or biological weapons almost impossible. Radar detection of GA is highly probable whether at low or high altitude.

Detection by an interceptor with radar or infra red (IR) missiles is enhanced by how GA aircraft are constructed and that all have hot, exposed exhausts to attract IR missiles. While a GA aircraft can stay low and out maneuver an interceptor, modern "look down, shoot down" armament systems are not fooled and missiles can readily be used.

Conclusions:

-- GA aircraft could, with significant effort be used by terrorists for a variety of activities involving WMDs.
-- GA aircraft are not even marginally suitable for the delivery of Chemical or biological weapons and the use of non-nuclear explosives. Weight and equipment limitations are severe.
-- GA aircraft are readily detectable in flight with current technologies, and will be more so in the future as better radars and detection systems come on line.
-- GA aircraft can be used to deliver a "suitcase" or small sized nuclear weapon/device. However, because of the vulnerability to detection and interception, using a GA aircraft is a very poor choice of delivery vehicle.
-- Given of their limitations as vehicles of destruction, security risks from GA aircraft are negligible. Moreover, given the choice between GA planes and ground vehicles as delivery platforms, ground is the clear winner.