FACTS ABOUT THE SAFETY OF F-35 BASING IN BURLINGTON

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1. **All new fighters have high accident rates, much higher than mature fighters and much, much higher than scheduled airliners.**
2. **Basing a new fighter with significantly less than 1 million fleet hours of safety experience in an urban area is likely to expose the residents to accident probabilities that are irresponsibly high.**

Discussion:

The F-16 at 100,000 fleet hours had a cumulative major accident rate (i.e., officially termed Class A Mishap Rate) of 17 per 100,000 hours. By 1 million hours (almost exactly the point when F-16s started operating from Burlington) its cumulative rate was down to 7 and the current cumulative rate at 12,000,000 fleet hours is 3.55. (Note that the current F-16 fleet major accident rate, that is, the non-cumulative rate, is actually running about 1.59, as averaged over the last 5 years).

Statistically speaking, there is not much point in looking at the accident rates of fighters with less than 100,000 fleet hours, simply because with such small accident sample sizes, the estimated rates bounce around too much, rendering the estimates too uncertain to be useful.

Thus, with only 4500 cumulative fleet hours for the F-35A (10,000 hours for all three variants), no useful direct estimate of the F-35A accident rate can be projected. **Note that only F-35A fleet hours are germane to estimating the accident probabilities for Burlington**; the accident experience of the F-35B and C is irrelevant because they only have 20% commonality with the F-35A. The fact that, so far, the F-35A has had zero Class A Mishaps is certainly commendable but uninformative. And the zero major accident score is certainly offset by having more early fleet-wide groundings to cure safety problems than any other fighter of the last 50 years.

The Air Force's EIS agrees that the F-35 accident rate can't be directly estimated because of the fighter's newness. Reasoning by analogy, the USAF does go on to say that the F-35 major accident rate may be similar to that of the F-22 because the size and technology are roughly comparable. This reasoning overlooks two relevant facts, both of which would increase the likely accident rate relative to the F-22. First, the F-35 has only one engine while the F-22 has two. Second, the F-35 flight computer, weapons system, cockpit/helmet display, control system, and cooling system are significantly more complex than the F-22 (for instance, 9 million lines of computer code versus 1.7 million for the F-22).

The F-22 cumulative accident rate, whether germane or not, is now running at about 7.34 major accidents per 100,000 hours with a fleet total of about 130,000 hours. At 16 years since first flight, these fleet total hours are remarkably low (at 16 years after first flight, the F-16 had 4 million hours). The F-35A will have similarly low total hours by 2020 for similar reasons: first, because both airplanes are so complex, they spend so much time in maintenance that they fly less than 12 hours per month; secondly, both are so expensive that the DoD budget can only afford to produce them at a slow rate (20 per year maximum for the F-22 at 11 years after first flight and only19 F-35As per year for the USAF out through at least 2014, with probably no production increase for 3 years longer under sequestration).

From the point of view of Burlington area residents, the real issue is the probability of a major accident in any given year. That, of course, depends on the fighter's actual accident rate and how often it flies per year.

The current VtANG F-16s fly 2550 sorties per year (same as 5100 flight operations/yr) from Burlington at 1.3 hours per sortie and have a current (not cumulative) major fleetwide accident rate of 1.59 per 100,00 hours over the last 5 years. That yields a .051 probability of at least one major accident per year (Poisson probability calculation)—or roughly 1 accident every 20 years.

Just as an illustrative comparison, a guesstimate for the F-35A accident rate could assign it the same major accident rate as the F-16, since the F-16 is the single engine fighter that is closest in size and performance to the F-35. When it came to Burlington in early1986 with 1 million hours of worldwide fleet flight time, the F-16 non-cumulative rate was about 7 per 100,000 hours, based on accidents experienced during the next million worldwide flight hours. Assuming this rate for the F-35A and with the F-35A flying 2250 sorties per year (according to the USAF's EIS Scenario 1) and about 1.54 hours per sortie (current average), the probability of at least one major accident per year would be .215—or nearly one accident every 4 years.

For scheduled airliners (no smaller than 10 passengers), the official NTSB Major + Serious accident rate (the rough equivalent of the military Class A Mishap) is .1217 accidents per 1 million hours over the last 5 years reported (2007 to 2011), about 132 times less than the F-16 hourly rate. These scheduled airliners flew 5681 flights (landing + departure) out of Burlington in 2012, averaging 1.53 hours per flight. That yields a .0011 probability of a major accident in a year—or roughly 1 accident every 945 years.

There are, of course, large numbers of flights out of Burlington by much smaller airplanes: air taxis (most of them well under 9 seats) flew 8862 flights (landing + takeoff) and private airplanes (most under 4 seats) flew 18522 flights in 2012, according to Sky Vector. These smaller planes need to be considered separately because their major accidents represent far less of an urban area disaster potential than the much larger scheduled airliners or fighters. Just to give a rough indication of accident likelihood for these smaller aircraft, the air taxi accident rate per flying hour is about 8 times that of scheduled airliners, so air taxis would still have a considerably lower major accident probability than F-16 fighters. Small private airplanes, however, have an accident rate about 40 times greater than scheduled airliners and fly 8 times as many flights out of Burlington, so their accident probability would significantly exceed that of the F-16s.

3. The VtANG claims that by 2020 the F-35 fleet will have accumulated 750,000 hours of safety experience and that will be adequate maturity to a) provide a good estimate of the fighter's accident rate and b) ensure acceptably safe accident probabilities for basing in Burlington. Statistically speaking, 750,000 fleet hours is marginally adequate for purpose a). Purpose b) would be served if and only if the F-35A fleet demonstrated less than 10 Class A Mishaps in the interval between 250,000 and 750,000 hours.

4. The arithmetic that led to the claim of 750,000 F-35 fleet hours by 2020 is wildly in error. In truth, a decision to base F-35As in Burlington in 2020 would be exposing the Burlington area to a fighter with only about 90,000 to 110,000 fleet hours of safety experience.

Discussion:

Given that current F-16 operations in Burlington are exposing the area to a Class A Mishap risk of about 1 every 20 years, it would be hard to argue that it is acceptable for a new F-35 fighter to significantly increase that risk, say by a factor of 2 or 3 or more—most particularly if that new fighter also adds the risk of a major toxicity disaster to any crash in a residential area (as will be discussed below). The success of the F-16 basing in Burlington—arriving with 1 million hours of fleet experience and demonstrating steady and satisfying accident rate reductions thereafter—sets a convincing precedent for a conservative approach to the fleet hours needed to estimate and mitigate the risk to area residents. Thus, 750,000 hours of fleet experience is marginally acceptable.

To keep the risk of the new F-35A fighter close to the 1.59 accident rate of the currently flying F-16s means that the new fighter needs to demonstrate less than 2 Class A Mishaps per 100,000 hours during an adequately long period before the date the F-35 is to be based in Burlington. From a statistical viewpoint, a sample of 10 accidents is barely acceptable for forming an adequately accurate estimate of the true accident rate. Thus, to ensure with adequate confidence an accident rate of no more than 2 per 100,000, it is essential to set a threshold of no more than 10 F-35A accidents in the 500,000 hours before the decision date for basing in Burlington.

With regards to correctly estimating the number of F-35 fleet hours accumulated by 2020, the arithmetic is quite simple. Our starting point is the 10,000 hours reported this October 13 by Lockheed for all three variants; the F-35A comprises 42% of the 63 F-35A/B/Cs flying in October and about 45% of the hours or 4500 hours. For those in-service 27 F-35As--plus for every newly produced F-35A delivered thereafter--we calculate that 10 hours per month (present fleet average) gets added to the 4500 hour starting point. The delivery schedule is fixed out to 2017 by the existing LRIP (Low Rate Initial Production) contracts. LRIP-5 delivers 22 F-35As (includes export planes) by second quarter 2014, LRIP-6 delivers 23 by second quarter 2015, LRIP-7 delivers 24 by 2Q 2016 and LRIP-8 delivers 21 by 2Q 2017 (these deliveries may well get cut back by the exigencies of sequestration). For our arithmetic, we assume a slight increase to 25 F-35As per year for the following years, 2018, 2019 and 2020 (even this slight increase may not materialize due to continuing budget pressures and large competing programs in USAF procurement plans). The total F-35A fleet hours by second quarter 2020 therefore total 89,460 hours. Should the monthly F-35 hours improve to 12, the 2020 total would be 107,352 hours. Note that only a quarter of the factor of 8 error in the 750,000 hour calculation is due to the VtANG's mistake of counting all three F-35 variants as providing relevant accident experience.

5. All largely composite-based (that is, laminated plastic and carbon fiber cloth) aircraft—whether new generation airliners or fighters—release large volumes of extremely toxic gases and fibers when the flammable plastic burns unextinguishably in a crash. These gases and fibers can blanket an entire neighborhood or can touch down in "hot spots" as far away as 10 to 50 miles, depending on atmospheric conditions.

Discussion:

There is a large and growing body of research and technical papers on the fire dangers of composite airplanes, authored by engineers, toxicologists, chemists and combustion scientists. Based on both laboratory experiments plus the real world experience of the 2013 Dreamliner fire in London and the disastrous 2008 B-2 crash on Guam (which burned for two days despite massive fire fighting efforts), there is direct evidence of the flammability of composite fuselages and wings, and of the dangerous toxicity of the clouds of resulting combustion products.

The aircraft that pose this new crash danger are the latest generation airliners (Boeing 787 and Airbus A350) and military aircraft (F-22, F-35, B-2 and almost all current drones), all with 30% to 60% or more of composite structure. Many older planes (F-16, F-18) have small composite parts—wing and tail tips, fairings and housings--comprising 2% to 5% of the structure; these planes are not at issue here.

The composite fire problem is simple: the plastic adhesives that glue the carbon fiber cloth layers together (mostly related to epoxies or polyurethanes), unlike aluminum structure, can be ignited at well below the temperature of burning fuel. And once ignited, the inner layers continue to smolder (sometimes for 24 to 48 hours) even after firefighters have extinguished the external fires. Epoxies and polyurethanes and their solvents are high on OSHA's list of dangerously toxic industrial chemicals, even at room temperature; after burning, the combustion products of these same chemicals can become significantly more toxic and corrosive to the lungs and other organs, as well as more carcinogenic. A further risk comes from the clouds of tiny carbon fibers, breathable like asbestosis fibers and laden with adsorbed toxic combustion products.

Viewing a video of any crashed airliner or military aircraft burning immediately establishes that there are towering clouds of smoke from the burning fuel that can easily blanket dozens or even hundreds of blocks of residential neighborhoods—particularly in still weather or, even worse, during an inversion. Then consider the effect of mixing in the toxic fumes of 12,300 pounds of burnt F-35 plastic composites (42% of the 29,300 pound empty weight of the F-35 is composites). Just the prompt evacuation problem for residents downwind of such a crash is a nightmare, not to mention the subsequent disastrous load on local medical facilities.

Less obvious is the problem of "hot spots"; these are touchdowns of the crash site's smoke plume that create locally toxic concentrations many, many miles downwind. Such hot spots have been widely observed in situations as diverse as toxic releases from incinerators or smelters, radioactive plumes from Fukushima and toxic smoke from the Twin Towers of 9/11.

At this early point in the history of composite aircraft crashes, the health consequences for people exposed to these toxic gases and fibers are, needless to say, poorly understood or quantified. But the OSHA and toxicological literature do establish some rough safety thresholds for some of the toxins involved, with respect to effects such as pulmonary tissue damage, neurotoxicity and cognitive dysfunction, liver damage, asthmatic crises, kidney damage and/or carcinogenicity.

6. All stealth coatings are highly toxic during manufacture and even more so when they burn, much more so than the already dangerous toxicity of standard composite fires.

Discussion:

There is a long history, dating back to before 1988, of stealth production line workers sickened and sometimes permanently disabled after breathing the toxic fumes of assembly line stealth materials. Some of this history is documented in dozens of lawsuits brought by afflicted workers, most of them unsuccessful because the defendant companies and government agencies invoked national security classification to withhold evidence. The 1980s open pit burning of failed F-117 stealth coating panels at the then-secret Area 51 airbase in Nevada killed two of the pit workers and permanently disabled at least five more who were working at the pits or downwind. This turned into a high profile lawsuit that won a favorable federal court ruling, ultimately blocked by a secrecy directive issued by President Clinton.

After the disastrous F-117 experience, the USAF started taking somewhat more responsible health precautions for mechanics repairing B-2 and, subsequently, F-22 coatings. Stealth aircraft manufacturers, however, varied greatly in taking responsible precautions. According to whistleblowers working there, Lockheed was notably irresponsible in exposing F-22 workers, engineers and even office workers to alarmingly toxic fumes from stealth constituents. As is to be expected, the exact toxic constituents are kept secret by high classification levels. However, it is known that di-isocyanates and mercury at particularly dangerous levels were involved in the F-22 stealth coatings. Di-isocyanates are one of the most important OSHA listed toxins in the plastics and fiberglass industries, with known long term pulmonary, asthmatic and neurotoxic/cognitive function effects at concentrations so minute that their usually acrid odor can't even be detected. The F-35 uses yet another generation of stealth coatings, different than the F-22 but known to be very toxic—even though, once again, the constituents are classified.

The classification/secrecy problem, in itself, considerably increases the already seriously elevated risks and health consequences of a crash involving the F-35's stealth coatings. Doctors treating people exposed to known toxins from an unclassified aircraft crash can focus on therapies for specific chemical pathways, particularly as toxicological and medical research in this area continues to make progress. But when a classified aircraft crashes, the doctor is denied knowledge of the toxins released and thus can only treat victims with generic, all-purpose therapies.