Study of

DETRIMENTAL IMPACT OF AIRCRAFT FUEL SAMPLING OPERATIONS IN 1998

Within the Contiguous 48 United States of America

And

YEAR 2000 FOLLOWUP ADDENDUM

BIBLIOGRAPHY

This original study was done in 1990 to identify the potential dangers inherent in the practice of throwing fuel samples on the ground by pilots conducting preflight checks on piston powered aircraft. It does not include inadvertently spilled AVGAS, nor does it include anything involving jet fuel. The statistics used throughout the original part of this paper are from 1989 and derived from figures publicly available then from the FAA, (Federal Aviation Administration) the AOPA, (Airplane Owners and Pilots Association) and NTSB (National Transportation and Safety Board).

DEFINITION OF THE PROBLEM

The problem is pollution of soil, air, and ground water with petroleum distillates and organic lead because of preflight sampling leaded AViation GASoline by pilots of gasoline engine powered aircraft. The first thing that must be done is determine the scope and magnitude of the problem that exists, because it seems insignificant when taken as a single and individual act.

Each time pilots prepare to fly an aircraft, as part of the preflight checks, they remove fuel samples from each of the fuel tanks, and other low points in the fuel system. Because they may extract fuel contaminants during this check, they throw the samples on the ground instead of putting the fuel back into the aircraft fuel tank, from which they came. Each time they perform this check they discard from 6 to 12 ounces of AVGAS. The most common grade of AVGAS is 100LL. 100 designates the octane rating and LL designates it as Low Lead. The Low Lead designation is in reference, and comparison to a previous grade of AVGAS, which contained a much higher lead content. On a broader comparison, 100LL AVGAS still contains roughly four times the lead that was found in regular leaded automotive fuel before it was banned. The lead additive used in AVGAS is an organic tetraethyl lead, the same one used previously in automotive gasoline. This form of lead additive is highly, and aggressively toxic to all complex forms of life.

To appreciate the dangers created by this practice, it is necessary to determine how much of these toxic substances are introduced into the soil, air, and wastewater eco systems immediately surrounding airport facilities. The following will determine how much of this highly toxic leaded fuel is deliberately discarded within the contiguous 48 United States on a yearly basis as a result of pilot preflight operations. The following statistics do not reflect inadvertent, or accidental fuel discharges, which can be substantial during summer months.

AVIATION SECTOR BREAKDOWN

The aviation industry is divided into two major categories:

(1) Air Carrier - Comprised of scheduled and unscheduled operations conducted under parts 121 and 135 of the Federal Aviation Regulations. Which are primarily Commercial Airlines and Air Cargo operators. Consequently, those aircraft are primarily jet engine powered and are not considered as part of this analysis because jet fuel does not contain the lead anti-knock additives, and no definitive statistics are easily available.

(2) General Aviation - Comprised of private aviators either for personal or business purposes. The main concern of this report is the private aircraft with a piston engine(s) using aviation gasoline (AVGAS) either single or twin engine. Therefore, all results will be confined to that portion of the General Aviation category.

NUMERICAL BASIS STATEMENTS (All numbers are 1989 statistics)

Of the total aircraft registered and active in the United States which number: 225,179
97% are General Aviation category: 219,401.
Of the total General Aviation aircraft:
88% are piston engine planes: 193,479
Of the total General Aviation, piston engine planes:
88% are single engine planes: 170,035
12% are multiengine planes: 23,331

Conservatively, the fuel quantity drained from an airplane for each preflight is 8 ounces for a single engine plane. This is based on a 4 second (equaling 4 ounces) purge of the fuel line to the engine, (per most manufacturers recommendations) Also, a 2 ounce sample taken from the wing tanks, of which there are two, or 8 ounces from a single sump at the lowest point in the fuel system. These figures assume only two fuel tanks, and one additional fuel line extraction point. Some aircraft have more tanks, and more fuel lines checkpoints as found with the most recent Cessna model 172, which has a total of 13 such checkpoints, all of which are required to be checked before every flight by extracting at least 2 ounces per checkpoint.

4 oz. from the engine.
Plus
4 oz. 2 oz. from each of two wing tanks.
8 oz. total
The amount of fuel drained as a sample from a twin-engine plane is 12 Ounces, or 8 ounces from a single, common drain.

8 oz. 4 oz. from each of two engines.
Plus
4 oz. 2 oz from each of two wing tanks.
12 oz. total

The average fuel sample quantity based on number of single and twin planes is as follows:
Single engine: 88% @ 8 oz.
Multi-engine: 12% @ 12 oz.
8.5 oz. Factored average total of all samples taken.

Some of the figures that will be used herein must be derived, from the reference statistics given on the AOPA fact sheet, and are based on some basic assumptions. It should be observed that there is a high degree of correlation between all of the given and derived figures despite using different data sets and approaches used to arrive at the results. Every correlation will not be specifically explained, but are self-evident to those familiar with the subject matter.

The first derived figure sought, which will be used in following calculations, is the average number of miles flown between departures. The basic assumption is that the aircraft will undergo a preflight inspection before each departure, as required by FAA regulations. Because of the average miles between departures it is assumed that there would probably be a refueling operation to top the tanks after each operation. This would be true even if the plane were going to sit waiting to be flown again, since it is a common practice to fill the idle fuel tanks after a flight to avoid condensation, or the formation of water in a large air cavity.

Total annual General Aviation miles flown.. 4,557,800,000 miles
Piston engine factor... 88%
Total piston engine miles flown... 4,010,864,000. miles
Total General Aviation departures... 40,200,000.
Piston engine factor... 88%
Total piston engine plane departures... 35,376,000.departures
Factored miles flown.. 4,010,864,000. miles
Factored departures... / 35,376,000. departures
Miles flown per departure... 113.4 Miles/departure

The next figure to be determined is the average number of gallons used, and therefore necessarily replaced in a refueling operation per departure, thus identifying a different interval between preflight checks and consequently, each fuel sampling operation.
Total factored piston engine miles flown... 4,010,864,000. miles
Average miles flown per departure... x 113.4 miles
Annual number of preflight operations or refuels.. 35,369,171.
Total annual gallons of AVGAS consumed... 377,000,000. gallons Annual number of preflight operations or refuels... /35,369,171. refueling operations
Average gallons per refuel operation... 10.7 gallons

To validate this figure, it can also be arrived at another way.
Total annual gallons of AVGAS consumed... 377,000,000. gallons
Total factored piston engine departures... /35,376,000. departures
Average gallons per preflight operation... 10.7 gallons

METHODOLOGY STATEMENT

In an effort to extrapolate a meaningful figure regarding the total amount of fuel being poured out onto the ground, four different sets of data will be resolved and then averaged to try to render a number that is a high confidence expression or at least fair in it's representation.

DERIVATION #1 Based on annual number of departures…
Total annual General Aviation departures... 40,200,000.
Piston engine factor... 88% = 35,376,000
One preflight inspection with fuel sampled x8.5 oz.
per departure… 300,696,000. oz.
128 ounces per gallon... 300,696,000 oz./128 oz.
AMOUNT OF FUEL POURED ONTO THE GROUND 2,349,188 Gallons ANNUALLY WITHIN THE UNITED STATES.

DERIVATION #2 Based on annual fuel consumed.
Total annual gallons of AVGAS consumed... 377,000,000. Gals.
Average estimated refueling quantity... /10.7 Gals.
(assume a fuel test following refueling operations, 35,233,645. Refuels or before next flight after refueling)
Average Sample Quantity... X 8.5 oz.
Total ounces... 299,485,931. oz.
128 ounces per gallon... 299,485,931/128 oz.
GALLONS OF FUEL POURED ONTO THE GROUND... 2,339,734 Gallons

DERIVATION #3 Based on annual miles flown.
Total annual General Aviation miles flown... 4,557,800,000. miles
Piston engine factor... 88%
Total piston engine miles flown... 4,010,364,000 miles
Average estimated distance traveled between departures/preflight operations/refuels... /113.4 miles
Number of preflight operations/refuels... 35,369,171 intervals
Average sample quantity...
(Assume one sample x8.5 oz. per refueling operation, or after refueled and before next flight) Total ounces... 300,637,954 oz.
128 ounces per gallon... 300,637,954 oz./128 oz.
GALLONS OF FUEL ANNUALLY POURED ONTO THE GROUND... 2,348,734 Gallons.

It may be argued that a preflight inspection and consequently fuel sampling is only done once a day per flying aircraft. Therefore, the following approach may prove enlightening.

DERIVATION #4 Based on one preflight per day per flying aircraft.
Annual factored departures... 35,376,000. departures
Number of General Aviation piston planes... 193,366. aircraft
Number of departures/plane/yr... 182.9

Number of days in a year... /365 days/year
Number of departures or preflight operations/plane/day... 0.5
* This factor could represent that half of the category planes fly each day, or half a preflight sample is taken each day for each plane. Numerically it makes no difference to the outcome.
Number of General Aviation piston planes... 193,366 aircraft
Factored preflight fuel sample quantity... x4.25 ounces
Number of ounces of fuel poured out/day 821,806. ounces/day
128 ounces per gallon... 821,806 oz/day/128 oz.
Gallons per day... 6,420. gallons
Days in a year... 6,420x365 days/year
TOTAL ANNUAL AMOUNT OF FUEL BEING DUMPED... 2,343,431. GALLONS
COMBINED RESULTS

In an effort to derive a meaningful figure, which fairly represents the amount of fuel deliberately poured out onto the ground by pilots in the contiguous United States in the period of one year, four different approaches have been used to determine the final number. Different assumptions have been made in conjunction with different sets of data. To be fair and to avoid any exaggerations inherent in the different sets of data, the four results are averaged. This should result in a number with a higher degree of confidence and believability. Averaging is reasonable because all four results are of the same general magnitude and if anything will render a conservative if not accurate final result.
DERIVATION #1 RESULT… 2,349,188 GALLONS/YR.
DERIVATION #2 RESULT… 2,339,734 GALLONS/YR.
DERIVATION #3 RESULT… 2,348,734 GALLONS/YR.
DERIVATION #4 RESULT… 2,343,431 GALLONS/YR.
TOTAL... 9,381,087. GALLONS

NUMBER OF RESULTS 9,381,087 gallons/ 4 = 2,345,272. AVERAGE GALLONS /YEAR
APPROXIMATELY 2 MILLION, 345 THOUSAND, 272. GALLONS OF LEADED AVIATION FUEL ARE BEING POURED ONTO THE GROUND AROUND OUR AIRPORTS ANNUALLY.

These figures only represent fuel purposefully sampled, and discarded by pilots performing preflight inspections. It does not include the fuel that drips, or in many cases run out of the fuel tank vent tube when a plane is either over-filled with fuel, or has been topped off in the cool of the evening and then experiences the heat of the following day, thereby expanding the fuel, which then runs out of the fuel tank vent tube. These circumstances amount to a significant quantity of fuel as is attested by the stains on every parking ramp across the country and could add half again the amount of fuel reaching the ground. Additionally, the calculated figure does not include any accidental spills of aviation fuel, nor does it include any jet fuel.

STATISTICAL CONCLUSION
Amazingly and unequivocally this one operation of sampling the fuel in an airplane to detect water

and debris contamination and then throwing the sample on the ground amounts to 2.3 MILLION GALLONS of fuel being deliberately poured out onto the ground of the United States EACH AND EVERY YEAR. Over the past decade since the activity levels have remained about the same, this amounts to a staggering 23 MILLION GALLONS of fuel contaminating our ground and air with petroleum distillates and highly toxic lead additives.
In terms of wasted resources, consider the barrels of oil that must be refined to render this amount of aviation fuel and the money spent for the wasted fuel.

TOXICITY

The damage to the atmospheric air quality, local soil, and wastewater is immeasurable, but based on the significance of the quantities involved; they surely must be significant also. In terms of biological toxicity and toxic pollution to the soil and ground water supplies consider this, beyond the obvious contamination of petroleum distillates, the main additive to aviation fuel is tetraethyl lead. It's the same organo-metalic anti-knock compound formerly found in banned regular leaded automotive gasoline only in much greater concentrations. It is highly toxic, easily absorbed biologically because it is already organic in its basic nature, and already in solution form, presenting a considerable health risk because of the serious physiological effects possible, which include, but is not limited to brain damage, birth deformities and eventually premature death. This represents enough of a hazard that because of this threat alone leaded gasoline has been banned in automotive use, and the practice of spilling AVGAS should be halted, especially in light of the quantities with which we are dealing.
Many studies, and historical evidence show that airborne exposure, and skin contact to tetra-ethyl lead has caused extremely high incidences of death. Ingestion of minute quantities only speed the inevitable results.

THE SOLUTION

Now that an awareness of the problem and its size and gravity exists, attention can now be turned to the solution. This problem is easily and quickly solved with the issuance and enforcement of federal regulations coming out of the EPA and the FAA to be imposed on all airport authorities, FBO's, Flight Schools, and pilots. The Regulation would specifically stipulate three things:
(1) The practice of throwing fuel samples on the ground is prohibited.
(2) Fuel samples must be either returned to the aircraft's fuel tank, or deposited in a suitable waste fuel collection container away from the aircraft.
(3) Fuel tank may not be filled above the fuel tank limit tabs.
As it stands currently, there are some EPA regulations that can be used to prohibit the offending activity, but only if the local EPA officials wish to use them to attack this particular problem. As yet, very little is being done to discourage the deliberate throwing of AVGAS onto the ground by pilots. Most state EPA officials, and state legislators completely ignore this hazardous practice, which puts the health of all complex life forms in proximity to airports in jeopardy because of the environmental hazards posed.

THE COMPLIANCE QUESTION

Legislation would solve one problem and create one more. The problem created is one of

compliance. What do the pilots that are now throwing the fuel samples on the ground do to stop polluting the environment and to comply with the law? There are alternatives, some of which are reasonable, and others that are not. First, pilots could be required to return all samples taken to the aircraft fuel tanks from which they came. Pilots and the FAA would consider this an unsafe practice potentially re-contaminating the plane's fuel supply, and negate the purpose of the preflight fuel inspection. Secondly, small collection containers could be supplied by the airport authority and stationed adjacent to each aircraft parking space where fuel samples could be collected. This would contain some of the heavier additives, but the lighter toxins and lead, which is bound to the petroleum distillates, would easily evaporate into the air. This might also necessitate routine inspections and draining of the numerous collection canisters. Third, an area collection container could be employed that would service several aircraft. The distance from the aircraft would be great enough to all but the adjacent planes, that it is unlikely pilots would actually use them. The fourth, and best alternative is the use of fuel testers, which now are available, that allow pilots to return their fuel samples to the aircraft fuel tanks by removing any contaminants before the samples are re-introduced into the aircraft.
There are three reasonable alternatives to throwing AVGAS onto the ground, so there is no valid excuse to allow this dangerous and detrimental practice to continue.

WHAT CAN BE DONE
Like most solutions, once the problem is understood the answer is simple. The solution to this problem requires all citizens of conscience and intellect, to raise this issue to their legislative representatives, state EPA officials, and the FAA, requiring them to take the appropriate steps to halt this deadly, wasteful, and irresponsible practice.

YEAR 2000 ADDENDUM

INTRODUCTION
Based on comparison with the statistics in the 1989 report there has been some interesting changes in the complexion of the aviation field for the year 2000. Although there have been shifts in the types, and number of active aircraft in the general aviation category, the number of piston engine aircraft has remained fairly constant. There has however, been an increase in the number of the offending preflight operations, and consequently in the amount of fuel thrown onto the ground.
Active US Aircraft in the year 2000

Of the total active aircraft in the United States which now number: 233,533 92% are General Aviation category: 214,388
Of the total General Aviation aircraft: 93% are piston engine planes: 199,320
Of the total General Aviation, piston engine planes: 86.5% are single engine planes: 172,420
13.5% are multiengine planes: 26,900
Total General Aviation departures, and therefore preflight inspections: 48,700,000

METHODOLOGY For comparison purposes, only one derivation will be shown.

DERIVATION #1 Based on annual number of departures…
Total annual General Aviation departures… 48,700,000
Piston engine factor… 93% 45,291,000
One preflight fuel inspection per departure… x8.5 oz.
Total ounces sampled and discarded… 384,973,500
128 ounces per gallon… 384,973,500 oz./128 AMOUNT OF FUEL PURED ON THE GROUND… 3,007,605 GALLONS
SUMMARY STATEMENT

This 3 MILLION plus gallons once again represent only the fuel deliberately extracted from aircraft fuel tanks and then discarded on the ground in a single year. Aviation gasoline still contains the same amount of tetraethyl lead. Over 1989 this amounts to an increase in dangerous pollution of 22% in 11 years. That amounts to an average increase of 2% per year. Over the years from 1989 to 2000, a total of over 32 MILLION GALLONS of lead laced gasoline has been deliberately, and irresponsibly poured onto the ground by the single act of private pilots sampling fuel during preflight inspections. In the decade preceding 1989 an estimated 23 MILLION GALLONS were poured out. Roughly, 55 MILLION GALLONS have polluted airport soils and waste water resources over the past 21 years.
In recent years there has been some discussion about removing the lead additive from aviation fuel, but nothing ever seems to be done. Even if the lead additives were removed from AVGAS there would still be the same amounts of petroleum distillates being poured onto the ground. What must happen to solve the total problem is the discontinuation of the practice of pouring fuel samples onto the ground. The makeup of the number of piston-powered aircraft has shifted somewhat over the past decade. There are fewer production aircraft being sold, but ever increasing numbers of home-built planes, which keeps the small general aviation numbers stable and growing slightly each year. Another trend is more closely related to the problem focused on in this report, and more of a concern. There is a trend toward maintaining fewer publicly funded airports across the United States. At the same time there are more private airports and landing areas being built, which increases the overall number of aviation facilities. The most easily supervised and controlled facilities are public airports. If the practice of not dumping fuel is not soon incorporated into the habits of pilots, there will be less control over the contamination of ever increasing real estate across the nation, with that pollution making its way into more and more soil and water systems. The time is long overdue to insist that this practice be stopped.