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COMMENTS OF THE EXPERIMENTAL AIRCRAFT ASSOCIATION

PROPOSED DESIGNATION OF ETHYLENE DIBROMIDE (CASRN 106-93-4) AS A HIGH-PRIORITY SUBSTANCE FOR RISK EVALUATION

EPA DOCKET NO. EPA-HQ-OPPT-2018-0488

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I. INTRODUCTION

On August 22, 2019, the Environmental Protection Agency (EPA) published “Proposed Designation of Ethylene Dibromide (CASRN 106-93-4) as a High-Priority Substance for Risk Evaluation” under the authority of the Toxic Substances Control Act (TSCA), Docket Number EPA-HQ-OPPT-2018-0488. The Experimental Aircraft Association (EAA) respectfully submits the following comments on the proposed designation.

The Experimental Aircraft Association is a non-profit individual membership organization of 240,000 pilots and aircraft owners with a wide range of aviation interests and backgrounds. EAA’s mission is dedicated to ensuring safe and enjoyable aviation access to all who wish to participate. EAA is committed to protecting the right to fly and own recreational aircraft, promoting opportunities to experience and enjoy aviation, preserving aviation history and heritage, while providing leadership and resources to promote and advance aviation safety. EAA has chartered approximately 1,000 Chapters which promote local aviation activities in their communities and regions.

EAA has been a strong advocate and resource in the development and evolution of aviation gasolines and nearly 40 years ago pioneered the Federal Aviation Administration (FAA) approval for the use of unleaded automotive gasoline in certain aircraft. Since the passage of the Clean Air Act Amendments of 1990, EAA has played a key role in working to advance the research, development, and eventual FAA authorization of an unleaded aviation gasoline to replace the high octane leaded gasoline upon which much of the piston powered general aviation fleet is currently reliant.

For aviation purposes, ethylene dibromide is solely used in the United States as part of a lead additive package in aviation gasoline that yields its superior octane performance that many aircraft cannot safely operate without. The additive, commonly known as TEL-B, contains tetraethyl lead (TEL) and ethylene dibromide (EDB). It is solely produced by Innospec in the United Kingdom and shipped to the United States as a finished product to petroleum refineries for blending in the production of 100 octane low-lead (100LL) aviation gasoline. TEL is necessary for the high anti-knock (octane) qualities of the fuel for which many aircraft are dependent. However, lead deposits in the combustion chamber and on spark plugs as a byproduct of burning leaded fuels result in intermittent combustion, partial and eventual total engine power loss. Ethylene dibromide (EDB) contained in the TEL-B package serves as a scavenger for lead in the combustion chamber and thus is a vital and irreplaceable safety component in existing leaded aviation gasoline. For that reason, EAA is making comment to this proposal.

II. AVIATION GASOLINE AND ITS USE

To our knowledge, the sole aviation use of ethylene dibromide in the United States is as part of the leaded fuel additive TEL-B which is used predominantly in aviation gasoline but also to a much lesser extent in specialty automotive racing fuels. EAA cannot speak to any other potential industrial uses of EDB and will confine its comments to aviation use and the aviation gasoline marketplace.

Aircraft piston engine development largely reached its zenith in the 1940’s during and immediately after World War II. The need to achieve extremely high power output with a minimum of engine weight resulted in the ubiquitous design characteristics of large cylinder bore, slow turning, high-power output, air-cooled engines. However, this combination of characteristics presents the worst case for combustion chamber knock and detonation that can rapidly lead to the destruction of the engine. Achievement of the high power-to-weight ratios of the most successful aircraft piston engines only became possible with the development of leaded aviation gasoline having anti-knock ratings equal to and sometimes greatly in excess of 100 motor octane. Note that 100 motor or aviation octane is approximately equivalent to 106 octane using the automotive scale of (R+M)/2, an average of the research and motor octane numbers.

At the period of peak commercial and military aviation gasoline use, the most common leaded fuels had ratings of 100/130 and 115/145 where the first number represents the lean motor octane rating and the second number the rich or supercharge rating. These are measurements, obtained by two differing test methods, that represent the performance of a fuel at opposite ends of the fuel-to-air mixture spectrum and at high power settings. These anti-knock parameters of the fuel become the boundaries around which aircraft engines are designed and built. Nearly the entire general aviation piston aircraft fleet of approximately 165,000 aircraft in the United States, including operational restored military aircraft from the World War II and Korean War era, were designed and built to use 100 octane leaded fuel.

That said, it is estimated that between 60-70% of the existing general aviation piston aircraft fleet is capable of burning a lower octane fuel. Indeed, EAA sought to accommodate some percentage of that lower octane fleet through the development the EAA Autogas STC (supplemental type certificate) program in the late 1970's and early 1980's. This testing and certification program resulted in the authorization of more than 30,000 aircraft to use lower octane automotive gasoline. However, due in part to a variety of commercial and liability reasons, automotive gasoline was rarely available on airports and the widespread adoption of autogas use was never fully realized (see the discussion on the limitations of dual fuel alternatives later in these comments).

It is important to note that the approval to use lower octane automotive gasoline only applied to certain low octane engines when combined with airframe fuel systems that could tolerate the higher vapor pressure of motor gasoline without risk of vapor lock and resulting engine power loss. It is also vital to note that this approval to use autogas was for the pure distillate gasolines of that era prior to the widespread inclusion of oxygenates and other blending chemicals. EAA revisited these STC approvals in the 1990's when mogas began to be blended with ethers such as MTBE, ETBE and TAME and did achieve acceptance by the FAA for the use of mogas blended with ethers under the existing STC program at the time. However, for a host of unrelated reasons, ethers were eliminated in mogas and replaced with ethanol. Ethanol blended motor gasoline is not considered safe for aircraft use and is prohibited under the STC program. Today there is very little automotive gasoline available that is not blended with ethanol rendering the EAA Autogas STC program largely unusable in a practical sense.

In the intervening years, considerable work has been undertaken to develop lower octane unleaded aviation gasoline grades, and indeed some standards and specifications have been approved for avgas with lean motor octane ratings in the 91 to 94 range. However, production and use of these lower octane fuels has never been widely adopted in the United States because of a crucial reality of the aviation gasoline marketplace that is often overlooked by those studying the general aviation piston aircraft fleet and its fuel/octane requirements.

While it is estimated that as much as 60 to 70 percent of the general aviation fleet in the U.S. could operate on a lower octane fuel of perhaps 94 motor octane, these low-compression aircraft engines and their associated aircraft do not represent the actual fuel marketplace. Indeed, it is well-established that the minority of the aircraft fleet that ***require*** a 100 octane fuel to operate safely consume the vast majority of the fuel; as much as 70 to 80 percent. This is because the high-power aircraft tend to serve commercial and business needs as opposed to the predominant use of low-power aircraft for recreational pursuits and flight training. These high-power aircraft operating in commerce and government applications conduct the vast majority of flight hours in the general aviation (GA) fleet and burn significantly more fuel per hour. As the general aviation industry has sought to develop unleaded alternatives to 100LL avgas, this marketplace dynamic has been studied repeatedly and in essence, the aircraft fleet requiring 100 octane fuel ***is*** the aviation gasoline marketplace from a volume standpoint.

This is why the majority of effort toward research and development of unleaded aviation gasoline over the past decades has sought to find a safe alternative to leaded 100 octane aviation gasoline. The aircraft that require this high octane fuel represent by far the greatest fleet hull value, the most significant commercial, economic, and societal operational impact, consume the vast majority of the fuel, and cannot be replaced either economically or in terms of operational capability by other technologies (notably turbine engine aircraft) to accomplish the same mission. It is also vital to note that, unlike the automotive industry, there is virtually no turnover in the general aviation aircraft fleet, so any new fuel has to satisfy the existing fleet of piston powered aircraft.

Accordingly, decades of effort have gone into research, development, and evaluation of unleaded alternatives to 100LL avgas which has proven to be a far more vexing technological barrier than anyone ever imagined. However, concerted and coordinated work continues to develop a safe, economically viable, and operationally capable high octane unleaded fuel that will satisfy the needs of the existing piston aircraft fleet. This joint industry/government effort known as the Piston Aviation Fuels Initiative (PAFI), combines the intellectual and technological resources of the aviation and petroleum industries, academia, and federal aviation regulators, and is funded by a combination of the FAA general budget, specific congressionally authorized funds, and industry in-kind investment and support. The program was designed from its outset to stimulate fuel research and development investment, draw out best possible fuel technologies, develop testing and evaluation methods and criteria to determine impact on the existing fleet of aircraft and engines under all operating conditions, and above all, provide a path to market for a successful fuel through a novel and creative FAA fleet authorization versus the traditional one-off approval by engine and aircraft make an model, a project that could never be undertaken for its sheer scope and cost.

Above all, the PAFI program was necessitated after two decades of research showed that there was no known off-the-shelf fuel technology that would operationally and safely satisfy the existing aircraft fleet as a “drop-in” fuel. Once the realization that a drop-in unleaded replacement for 100LL was not available and that any unleaded alternative would have potentially significant performance, operational, and safety implications for the existing fleet, the magnitude of the project became untenable for any individual company or group of companies for technological, cost, and liability reasons. The only path forward was to integrate the challenge into a coordinated government/industry effort with the Federal Aviation Administration at the core. It is this initiative that is underway today aggressively seeking a high-octane unleaded aviation gasoline that would allow for the elimination of the use of lead and, as a result, ethylene dibromide. Further information on PAFI can be located at https://www.faa.gov/about/initiatives/avgas/ or by directly contacting the Federal Aviation Administration Office of Environment and Energy. As a member of the PAFI Steering Group, the managerial oversight body of this initiative, EAA stands ready to further inform the EPA of the work and progress of this group as well.

For a variety of reasons, the aviation gasoline marketplace in the United States has been steadily shrinking over the past four decades. The consumption of avgas in the U.S. has decreased by more than 60 percent from a level well in excess of one million gallons per day in 1980 to around four hundred thousand gallons per day in 2019. That number will surely be dramatically lower this year as general aviation flight activity in 2020 has at least temporarily declined by an estimated 70 percent as a result of the coronavirus pandemic.

In addition to the dramatic long-term reduction in fuel consumption by volume, the lead content of 100 octane avgas has also steadily decreased as the permissible lead in 100/130 was reduced by half with the introduction of 100LL (100 octane low-lead) in the 1980's and further reductions of roughly another 20 percent from that point were realized with the introduction of a 100VLL (100 octane very low-lead) standard in ASTM D910 that governs leaded aviation gasoline production. While most fuel today is still marketed as 100LL, an estimated half to two thirds of the avgas being produced and delivered in the U.S. today meets the 100VLL lead content. This represents the minimum lead content possible without losing the octane and performance parameters of the fuel necessary to continue to safely operate the existing general aviation fleet in the absence of some heretofore unknown or unproven fuel technology without the use of lead. Thus, the 60 percent reduction in aviation gasoline consumption over the past four decades combined with the 60 percent or more reduction in lead content per unit volume of that fuel, has resulted in a significant reduction in the use of TEL-B and thus ethylene dibromide. At the point that the petroleum industry is able to develop a suitable and safe alternative to leaded avgas that can be successfully tested and evaluated by the Piston Aviation Fuel Initiative (PAFI) and authorized for use by the FAA, it is hoped that the need for lead, and thus ethylene dibromide, can be eliminated entirely.

III. ETHYLENE DIBROMIDE IN AVIATION GASOLINE PRODUCTION

Ethylene dibromide is a colorless heavy liquid with a boiling point of 131-132°C and density of 2.17 g/ml. For aviation purposes it is blended with tetraethyl lead at a rate of about 35.6% by weight to make up the octane enhancing lead additive package TEL-B necessary for the manufacture of 100LL and 100VLL aviation gasoline per ASTM D910. EDB is present in the additive package as a scavenger for lead deposits in the combustion chamber and on spark plugs. Without this scavenger, lead and lead oxide deposits result in intermittent combustion, reduced power, and eventual total power loss. There is no known alternative to EDB for this purpose.

The only product that contains TEL-B and thus ethylene dibromide is high octane leaded aviation gasoline and a very limited quantity of specialty automotive racing fuels. To our knowledge, no other aviation, motor, heating or industrial fuels contain EDB.

The only source for TEL-B for the purposes of avgas refining and blending in the world is Innospec, who manufactures TEL in the United Kingdom and blends it with EDB produced by a separate source, also located outside the U.S., to make TEL-B. To be clear, there is no production of EDB in the U.S. for aviation use and no handling or storage of neat EDB in the U.S. for aviation purposes as it is already blended in the finished TEL-B package at 35.6% by weight when imported in dedicated ISO tanks and delivered directly to the refinery or blending facility. Beyond this point, there is no distribution, point of sale, or consumer contact with pure TEL, EDB, or TEL-B as it is vastly diluted by blending it in small quantities into finished aviation gasoline at the refinery or blend facility.

According to information provided to EAA by Innospec and Ethyl Corporation (who serves as the U.S. importer and distributor of TEL-B), there is approximately 700,000 pounds of EDB imported into the United States annually contained within TEL-B. This is significantly lower than the one million to ten-million-pound threshold cited in the Draft Scope of the Risk Evaluation for Ethylene Dibromide put forth by EPA. The only other known use of TEL-B for aviation purposes is for refinery and contract laboratory-developed fuels produced in small batch quantities for specialty reference fuels and quality assurance testing. The quantity of EDB in laboratory TEL-B usage is estimated by Innospec to be less than 50 pounds per year.

TEL-B is blended with other base and bulk components of aviation gasoline at the refinery or blender as a sealed operation and from that point the finished leaded avgas moves to the end consumer/aircraft through a dedicated distribution network that, for quality assurance end environmental reasons, is not comingled with other products. Because of the low quantities of avgas consumed relative to the overall production of motor fuels by refineries, 100LL is produced only periodically and in comparatively small batches. Once the TEL-B is blended into the finished avgas, EDB is held in solution at an approximate weight of 0.07% and remains that way from the refinery to the aircraft. The TEL and EDB cannot be extracted, isolated, or settled out of the finished fuel and no professional or consumer contact with undiluted TEL or EDB is possible after the point of refining or blending. Finally, the vast majority of tanks for avgas storage and distribution at airports are above ground facilities with catchment enclosures. EAA estimates that more than 90 percent of avgas tankage at general aviation airports are above ground, limiting the risk of leakage or groundwater contamination of the fuel let alone the small fraction of that fuel by weight that is made up of EDB.

IV. AVIATION IMPACT OF REGULATORY AUTHORITY

In section 6(b)(1)(B) of the Toxic Substances Control Act (TSCA), as amended, and in the U.S. Environmental Protection Agency's (EPA) implementing regulations (40 CFR 702.3), a high-priority substance for risk evaluation is defined as a chemical substance that EPA determines, without consideration of costs or other non-risk factors, may present an unreasonable risk of injury to health or the environment because of a potential hazard and a potential route of exposure under the conditions of use, including an unreasonable risk to potentially exposed or susceptible subpopulations identified as relevant by EPA. Ethylene dibromide is one of the 40 chemical substances initiated for prioritization as referenced in a March 21, 2019 notice (84 FR 10491).

EAA understands clearly that the risk evaluation EPA is undertaking with regard to EDB is specifically seeking input on the quantities, kinds of use, and human health exposure of ethylene dibromide. We will endeavor to provide greater insight in these comments to that. However, given that the only known aviation use of ethylene dibromide is as part of TEL-B, the octane enhancing additive necessary for the production of 100LL aviation gasoline, the exposure and use of EDB is intrinsically tied to that of tetraethyl lead. Therefore, any discussion of EDB must of necessity be predicated on a deeper understanding of TEL, the role it plays in aviation fuel, the efforts that are underway to reduce and eliminate it from aviation gasoline over the long term, and the very serious safety and economic consequences of any premature control or elimination of TEL-B in aviation fuel. The aviation safety implications and risk to human life of eliminating or restricting TEL-B as a result of limitation or control of EDB before a suitable unleaded high octane avgas can be developed and approved for use by the FAA is likely as or more severe than the very limited human exposure to EDB itself.

TEL-B that contains EDB is produced overseas, shipped directly to refiners in the U.S. by means of sealed double wall ISO containers, and is blended with bulk fuel components in closed systems at a very small number of facilities down to 0.07% EDB by weight in the finished avgas product prior to distribution. Consequently, there is very little exposure risk to EDB in any meaningful concentration among any population. This very tightly controlled transportation and handling process is a byproduct of the environmental and occupational health and safety regulatory history surrounding tetraethyl lead, the other major component of TEL-B. The careful handling of EDB has benefitted from its association with TEL in the sense that TEL has been tightly and appropriately controlled in such a manner that there is limited to no exposure to the chemicals in their pure form. This is by design and it works. Furthermore, the limited quantities of EDB contained in finished aviation gasoline is fully burned in the combustion cycle of piston engine aircraft so what remains are highly dispersed and minimal emissions byproducts of EDB combustion, not exposure to EDB itself.

The European Chemical Agency has studied ethylene dibromide under its Registration, Evaluation, Authorization, and Restriction of Chemicals process (REACH) and found the risk of exposure to be below the stringent thresholds of the European Union. While there is no question that there is greater general aviation flight activity in the United States and thus far more aviation gasoline consumed, the underlying exposure routes, toxicology, and risk modeling are largely the same. EAA does not believe that it is necessary for the EPA to prioritize further risk evaluations of EDB, require further testing, or undertake further regulatory action at this time under TSCA. The health risks of EDB are well-documented as are those of TEL to which it is inextricably linked in an aviation application. There is no debate or argument about the toxicology of the substances which is why its use is so tightly controlled from the point of manufacture to fuel blending ensuring that the possibility of human contact with the pure chemical is minimized to every degree possible before it is diluted to de minimis quantities in finished avgas.

While this risk evaluation of EDB is being conducted under the Toxic Substances Control Act (TSCA), given that EDB is only used in an aviation application for leaded avgas, it is important to understand existing statute, and the shared roles and responsibilities that the EPA and FAA play in the control and regulation of aircraft fuels. Under Section 231 of the Clean Air Act (CAA), the EPA has the authority to regulate aircraft emissions and has for some time been actively exploring doing so for the purposes of setting standards for the control of lead emissions. However, EDB itself is not an emissions byproduct of aviation gasoline because it is completely burned in the combustion process. It is important to note though that the EPA can set standards for a given chemical emission but does not have the authority to directly regulate the composition of aviation fuels. That authority is granted by Congress solely to the Federal Aviation Administration. So, while the EPA can set emissions standards for aviation fuel, only the FAA can implement those emissions standards provided that there is a safe path to doing so.

This is relevant because all of the safety and economic impact data associated with the potential control of lead emissions from aircraft that has been gathered and developed by the EPA is identical to that for the evaluation of EDB since the two products are inextricably linked in their use. Any control of EDB, whether under the CAA as an emission standard or as a result of TSCA risk evaluation of production, handling, and use, bears the same outcome on aviation fuel formulation and commensurate aviation safety implications as that for lead. And ultimately, the FAA plays an important role in determining the safety impact of implementing any such standard.

Since the establishment of the first National Ambient Air Quality Standard (“NAAQS”) for lead in 1978, the general aviation and petroleum industries have been committed to safely reducing lead emissions from piston powered aircraft. 100LL aviation gasoline contains 50 percent of the lead (TEL-B) than 100/130 avgas did when the lead NAAQS were first introduced. This combined with a 60 percent decrease in aviation gasoline consumption over that period has dramatically reduced lead emissions, and thus EDB use in aviation. In addition, the general aviation industry more recently worked to further reduce the lead content of avgas by an additional 20 percent from the already reduced 100LL standard through the creation and evaluation of the 100VLL (very low lead) specification in ASTM D910. Today it is estimated that half to two-thirds of the avgas produced meets those lowered 100VLL standards even if not marketed that way.

Ultimately, the general aviation community and industry is committed to an unleaded future and has engaged in extensive research seeking a feasible unleaded alternative to today’s leaded aviation gasoline. However, the technical challenges of removing lead from aviation gasoline are formidable. Despite extensive efforts, no unleaded replacement has been found and approved that provides adequate and comparable safety and performance to 100LL and 100VLL for the existing fleet of aircraft. But work on this important issue continues and is accelerating under the Piston Aviation Fuels Initiative (PAFI). Success in the elimination of lead from aviation gasoline will also mean elimination of EDB as part of the TEL-B lead additive package, all of which is a desirable outcome from our perspective. For a deeper discussion of the extensive work that has been performed over recent decades to develop a suitable and safe unleaded alternative to high octane leaded aviation gasoline, EAA would commend the EPA to the comments of the General Aviation Avgas Coalition on the Advance Notice of Proposed Rulemaking on Lead Emissions from Piston-Engine Aircraft Using Leaded Aviation Gasoline contained in EPA Docket No. EPA-HQ-OAR-2007-0294. Further information on the extensive work that has subsequently been performed by the Piston Aviation Fuels Initiative (PAFI) since those comments were submitted is available at https://www.faa.gov/about/initiatives/avgas/ or by contacting the Federal Aviation Administration Office of Environment and Energy.

It is important to note that as part of the EPA’s efforts to evaluate and quantify the emissions of lead from piston engine aircraft, extensive studies have been conducted to determine whether public exposure to lead is present in excess of the current ambient air quality standards. These studies resulted in limited exceedances at only the very busiest general aviation airports and only in close proximity to specific areas of maximum potential emission such as preflight runup areas at the end of runways where access by the public is generally otherwise restricted due to safety and security considerations. Again, this is relevant because EDB use is directly tied and proportional to TEL use in aviation gasoline and studies have repeatedly shown that low activity levels, remote proximity to the public, and wide area dispersion tend to limit the effect of piston aircraft emissions. While there may not be specific data for aircraft emissions targeting EDB or its combustion byproducts, the EPA is in possession of extensive fuel use and emissions data from its lead studies that would be very applicable and instructive.

V. SOCIETAL AND ECONOMIC IMPACTS OF GENERAL AVIATION

General aviation is a key component of our nation’s transportation infrastructure and economy. There are more than 5,000 public-use airports that can be directly accessed by general aviation aircraft—more than ten times the number of airports served by scheduled airlines. These public use airports are the only available option for fast, reliable, flexible air transportation to small and rural communities in every corner of the country. General aviation directly supports jobs in these communities, provides a lifeline for small to mid-sized businesses, and provides critical services to remote cities and towns, particularly in time of disaster or crisis. As a result, general aviation is uniquely situated to serve some of the public's most crucial transportation needs.

The economic impact of general aviation is also significant. General aviation contributes to the U.S. economy by creating output, employment, and earnings that would not otherwise occur. Direct impacts, such as the purchase of a new aircraft, multiply as they trigger transactions and create jobs elsewhere in the economy (*e.g.*, sales of materials, electronics, and a wide range of other components required to make and operate an airplane). Indirect effects accrue as general aviation supports other facets of the economy, such as small business, rural economies, and tourism. Directly or indirectly, general aviation accounts for over 1.25 million jobs (with collective earnings exceeding $53 billion) and contributes over $150 billion to the U.S. economy.

Any future regulatory action by the EPA related to EDB would have the same impact as those from any contemplated control of lead emissions and will directly affect general aviation. Any control of EDB use would effectively force the elimination of leaded avgas. Without appropriate consideration of aviation safety, technical feasibility, and economic impact, premature forced transition to an unleaded fuel that does not meet the performance requirements for 100LL would have a significant impact upon the viability, safety, and long-term health of the general aviation industry.

An assessment by aircraft engine and airframe manufacturers to determine the effects of any forced transition to currently available lower-octane unleaded fuels indicates that approximately 57,000 aircraft would be unable to operate on a lower-octane unleaded avgas. This represents 34 percent of the fleet, including most twin-engine airplanes. Importantly, a large portion of these aircraft are operated in business or commercial service with high utilization rates. As a result, aircraft unable to operate on the lower-octane unleaded avgas represent a high proportion of total general aviation flight hours. This translates directly to a significant economic impact upon general aviation and other related sectors, such as airport operations, sales of fuel, maintenance, parts, and services to these aircraft operators not to mention the commercial operators themselves and their associated industries.

VI. SAFETY AND OTHER CONSIDERATIONS RELATED TO AVGAS REFORMULATION AND REPLACEMENT OF 100LL

Currently, there is no demonstrated unleaded replacement for 100LL avgas that meets the safety and operational requirements of the existing fleet. Unlike the transition away from leaded gas in automobiles, performance issues in aircraft have serious consequences for the safety of pilots, passengers, and persons or property on the ground. While the general health risks associated with lead have been well documented, we must also ensure the safe operation of approximately 165,000 general aviation aircraft.

There have been significant historical and current efforts to develop an unleaded high-octane aviation gasoline that maintains the properties necessary for the safe operation of aircraft engines. TEL-B is a lead compound that raises octane, reducing gasoline's tendency to suddenly and instantaneously ignite from compression (also known as detonation or knocking) during a reciprocating engine's combustion cycle. Sustained detonation can cause catastrophic engine failure. There is a direct relationship between the amount of horsepower a high-performance aircraft engine can produce, and the octane level of the fuel required to operate safely. The current avgas specification, ASTM D910, defines the acceptable limits for physical, performance, and fit-for-purpose properties necessary for an aviation gasoline to ensure safe operation of aircraft across a broad range of demanding conditions. Replacement of the TEL-B additive and the high-octane rating it provides is just one of many safety and performance parameters that must be addressed when developing an unleaded alternative to 100LL.

Avgas formulation and performance properties have a significant impact upon aviation engine performance and must be suitable for aircraft use under a wide variety of operating conditions. Aircraft/engines are designed and tested for operation using a specific avgas specification/grade and are type certificated by the FAA as meeting all applicable minimum airworthiness safety standards. In addition to octane, there are many safety and other considerations that must be met related to an unleaded avgas replacement for 100LL, particularly if there is any reformulation affecting the composition and properties of avgas to which the entire in-use fleet of aircraft/engines have been certificated by the FAA.

A. Safety Considerations Related to Avgas Reformulation

ASTM D910, *Standard Specification for Leaded Aviation Gasolines* defines the composition and properties of the following specific types of aviation gasoline for civil use: Grade 100; Grade 100LL, and Grade 100VLL. 100LL is predominantly the only avgas available at airports today in the U.S. though much of it meets the reduced lead content of 100VLL. The following issues are a few of the many challenges faced when developing and evaluating a new avgas formulation. Each parameter represents a critical safety of flight characteristic that must be considered in the operation of general aviation aircraft.

1. Octane

Octane is a measure of the anti-detonation (also known as anti-knock) properties of gasoline which is its resistance to sudden and uncontrolled ignition during a reciprocating engine’s combustion cycle. Sustained detonation can cause catastrophic mechanical engine failure. A high-performance engine has a higher compression ratio among other things and requires higher-octane fuel. The advantage of a high-performance aircraft engine is that it develops higher horsepower output for a given engine weight.

Most initial research on potential replacements for leaded (EDB containing) avgas to-date has focused on attaining the 100 motor octane requirement to satisfy the fleet of existing general aviation aircraft without the use of lead, specifically TEL-B. As an octane enhancer, TEL-B is many orders of magnitude more effective than other known octane boosting agents so removal of the small amounts of TEL-B results in the need to make wholesale volumetric changes to the underlying fuel in order to accommodate the large quantities of octane enhancers necessary to replace the anti-knock capability of lead. A fuel octane rating has a direct correlation to a given engine's ability to produce its maximum rated power, which in turn affects a number of aircraft safety factors including take-off distance, climb rate, hot weather performance, and load carrying capability. Any forced reduction in power brought about by a change in the octane rating of a new fuel reduces the utility, performance, and safety margins of the aircraft, perhaps to the point of rendering it useless. Any reduction in octane also triggers a requirement for re-certification of the aircraft and engine by the FAA; a tremendously expensive and labor-intensive activity for which neither government nor industry has the capability or resources to complete.

As noted above, removing lead from avgas requires that it be replaced with large fractions of other octane enhancers to replicate the anti-knock characteristics of leaded avgas. But this dramatic change in the underlying chemistry of the fuel to achieve octane levels in the absence of lead results in wholesale changes to other important performance characteristics of the fuel. So, while octane is a critical underlying consideration, it is only one of many fuel characteristics that must be met and evaluated in the development of a safe and viable unleaded replacement for 100LL avgas.

2. Distillation Curve

One of the most important and informative properties for engines operating on complex fluid mixtures is the distillation (or boiling) curve of the fuel. Simply stated, the distillation curve is a graphical depiction of the boiling temperature of a fluid mixture plotted against the volume fraction distilled. Distillation curves are used commonly in the design, operation and specification of liquid fuels such as gasoline, diesel fuel, rocket propellant, and gas turbine fuel to ensure proper vaporization of the fuel and good air/fuel mixing prior to combustion. Measurement of the initial temperatures and the examination of the distillation curves can serve as methods to evaluate the operational parameters of fuels, such as cold/hot/altitude start capabilities, fuel system icing, dynamics of acceleration, vapor pressure/susceptibility to vapor lock, carburetor icing, and deposit formation to name a few.

3. Vapor Pressure

Vapor pressure is a measure of a fuel’s volatility, or how readily the fuel will vaporize. Vapor lock occurs when the fuel changes state from liquid to gas while still in the fuel delivery system. This interrupts fuel flow as a result of gaseous bubbles in fuel lines or disrupts the operation of the fuel pump due to cavitation, and loss of feed pressure to the carburetor or fuel injection system resulting in transient or complete loss of engine power. Restarting the engine from this state may be difficult or impossible. The fuel can vaporize due to being heated by the engine, by the local climate and atmospheric conditions, or due to a lower boiling point at high altitude. The higher the volatility of the fuel, the more likely it is that vapor lock will occur. Avgas has a lower and constant vapor pressure compared to automotive gasoline, which keeps avgas in the liquid state in high temperatures and at high-altitude, preventing vapor lock.

4. Water Separation and Freeze Point

Water solubility in hydrocarbon fuels is a function of their composition and temperature. For a given composition lower temperatures reduce the solubility of water in the fuel. Current avgas dissolves only a very small amount of water at ambient temperatures. Therefore, there is relatively little water to separate and freeze as the fuel cools at altitude.

Freeze point and water shedding are characteristics that depend largely on the composition of the fuel. Solids that form from water or fuel freezing can impede flow of fuel through filters and screens, starving the engine and reducing its power or in extreme cases stalling an engine.

Because avgas is a mixture rather than a pure substance, there is not a temperature at which the entire fuel turns from a liquid to a solid. Freeze point for an aviation fuel is the temperature at which crystals begin to form, actually at which the last crystal melts as the fuel is warmed, to avoid super cooling phenomena. Freeze point for avgas should be below the temperature where an aircraft will operate long enough for fuel flow to be impacted by crystal formation from the dry fuel.

Water separation is a particularly important trait in aviation gasolines because the fuel systems are vented to the atmosphere and significant changes in altitude and temperature promotes condensation of water in the fuel tanks which must settle out of suspension readily so that it can be drained prior to flight to prevent loss of power due to water and/or ice contamination..

5. Energy Density / Weight

Energy is the ability to do work. Per kilogram of mass or volume, different substances release different amounts of energy when combusted. In other words, they have different energy contents. Energy density can be defined by the amount of energy per gallon or per pound of fuel. The higher the energy density, the more energy may be stored or transported for the same amount of volume or weight. Because aircraft have fixed volume fuel tanks and are limited in total weight for takeoff, both volumetric and gravimetric energy density are important parameters of any new fuel. A lower energy density fuel directly translates to either reduced range, reduced power, or a combination of the two. Increased fuel weight equates to reduced load carrying capability, decreased rate of climb at a given loading or reduced range of the aircraft.

In addition, relatively small changes in the weight or density of the fuel itself alters the amount of fuel passing through existing fuel metering systems in carburetors and fuel injection systems dramatically altering the combustion characteristics, mixture ratio, and levels of deposition of carbon and other substances in combustion chambers. Experience with the evaluation of high-density unleaded fuels in development has shown that this tendency toward carbon deposition can lead to premature engine failure at relatively low hours of operation.

6. Stability

Stability of a fuel can be defined as the resistance or the degree of resistance to chemical change or degradation. When gasoline is not stored correctly over a period of time, gums and varnishes may build up and precipitate from the gasoline. Gums and sediment may build up in the fuel tank, lines, and carburetor or fuel injection components making it harder to start the engine and cause rough operation of the engine. This could be a problem for aircraft as some are typically parked without use for long periods of time. Additionally, because aviation gasoline is not produced and sold in large quantities, fuel is often stored for extremely long periods of time before being delivered to the aircraft for use.

7. Corrosiveness

A fuel’s corrosiveness directly relates to the material compatibility issues that such a fuel would have on metal fuel system components including aircraft fuel tanks, fuel lines, and internal engine components.

8. Conductivity

The conductivity of a fuel is a measure of the ability of a fuel to dissipate static electric charge. Conductivity is important because in a low conductivity fuel electrical charges can accumulate and ultimately lead to dissipation in the form of a spark. This in turn presents a fire or explosive safety hazard. Aircraft naturally build up static charges by virtue of the friction involved in their passage through the atmosphere and the fuel needs to be able to equalize the electrical charges between aircraft components so as to prevent sparking.

Conductivity is also relevant because some aircraft use a capacitance means of measuring onboard fuel quantity in aircraft fuel tanks. Change in the conductivity of the fuel results in incorrect fuel quantity indications for systems that were designed and calibrated for 100LL. Inaccurate fuel quantity readings can lead to fuel starvation accidents.

9. Toxicity

All hydrocarbon fuels are toxic to one degree or another, but any future unleaded aviation fuel cannot exhibit any unusual or significantly increased toxicity traits that could affect persons handling the fuel, maintaining the aircraft, or impair flight crews in flight through inhalation of harmful vapors.

10. Composition

Specifications define the composition of aviation gasoline to limit maximum content of certain chemicals in order maintain desired properties and ensure it is suitable for civil aircraft use under a wide variety of operating conditions. For example, D910 limits the total aromatic content which relates to material compatibility issues of certain aircraft fuel system components made from natural rubbers and some polymeric substances

B. Safety Considerations Related to Aircraft/Engine and FAA Certification

As just discussed, a variety of physical and performance properties necessary for an aviation gasoline must be considered. However, fuel properties are only the beginning of the considerations necessary to ensure the safe operation of general aviation aircraft. General aviation engines and aircraft are specifically designed, built, and tested for safe and durable operation using a designated avgas specification. Aviation products are then certified by the FAA as meeting all applicable minimum airworthiness safety standards in 14 C.F.R. Federal Aviation Regulations (FAR).

FAR part 33 prescribes airworthiness standards for aircraft engines including the establishment of engine ratings and operating limitations relating to horsepower, temperatures, pressures, component life, and fuel grade or specification. The engine design and construction must minimize the development of an unsafe condition of the engine between overhaul periods which must be demonstrated through rigorous block tests. This includes operation throughout the full envelope of extreme conditions the engine is expected to encounter in service and demonstration of the engine's ability to start in extreme cold/hot temperatures and altitudes. Fuel properties such as vapor pressure, freeze point and distillation curve directly affect these engine performance envelopes. The most important performance range for an engine is horsepower and the safety critical limiting factor to power output is detonation. The octane level of avgas is a measure of protection against the onset of detonation so the higher the octane the higher the power output that is possible from a particular engine without the onset of detonation. FAR section 33.47 requires a test program to ensure that an aircraft engine can operate without destructive detonation throughout its full range of operation. In addition, each engine is subject to a prescriptive endurance test and inspection to ensure reliability and continued airworthiness necessary for safety. FAA issuance of an engine Type Certificate identifying a fuel grade or specification as a limitation constitutes approval of the fuel for that particular make and model of engine.

FAR parts 23 and 27 prescribe minimum airworthiness standards for normal category airplanes and normal category rotorcraft, respectively (which are the aircraft typically powered by piston-engines). This includes demonstration of minimum aircraft performance requirements such as takeoff runway length, climb, speeds and distance over a range of conditions such as maximum weight/payload, maximum outdoor temperatures and airport altitudes up to 10,000 feet. The critical performance envelopes and operational safety limitations for an aircraft established by these tests are directly dependent upon the installed engine and particularly the rated horsepower it produces. The FAA Type Certificate for an airplane or rotorcraft specifies the approved engine installation and identifies the fuel grade or specification as a limitation which constitutes approval of the fuel for that particular make and model of aircraft.

In addition, FAR parts 33, 23 and 27 require materials compatibility testing to substantiate that the fuel is compatible with all engine and aircraft materials to ensure that there are no safety and airworthiness impacts upon components and parts such as pistons, valves, turbochargers, carburetors, pumps, hoses, gaskets, seals, fuel tanks, bladders, structure, sealants, etc.

Each new make and model of engine and aircraft introduced into the fleet was specifically designed, tested and FAA certificated using 100LL (or equivalent ASTM D910 leaded avgas). Aviation fuel has a direct and significant impact upon both the engine and aircraft performance and compliance with the applicable FAA safety standards. Therefore, the range of safety considerations for a viable unleaded fuel to replace 100LL is a much greater challenge due to the broad range of in-use engines and aircraft that have already been certified. An alternative fuel that has any difference in physical, chemical, or performance properties from 100LL raises potentially significant safety implications that must be carefully evaluated with respect to both the engine and aircraft. FAA Advisory Circular AC 20-24 and ASTM Standard D7826 describe the procedures for evaluation and qualification of new fuels for in-use certificated aircraft engines. It essentially requires re-certification through the same engine tests and inspections discussed above for those airworthiness and performance requirements affected by fuel properties and chemistry that are different from existing 100LL.

C. Other Considerations Related to an Unleaded Avgas Replacement

Although safety is paramount, there are many other considerations for a viable unleaded avgas replacement for 100LL. Any new unleaded avgas must be more environmentally acceptable than the fuel it is intended to replace and cannot introduce new environmental concerns today or in the foreseeable future. Some of the most promising early research into high octane unleaded avgas centered on the use of ethers such as ETBE, MTBE and TAME as octane enhancers to partially replace lead. These chemicals were being widely used at the time in automotive gasoline but have been all but banned from automotive use in the U.S. due to concerns about ground water contamination issues. Work is restarting, however, examining the octane enhancing qualities of ethers for aviation use. Aircraft emissions must also be environmentally acceptable, so due consideration needs to be made regarding CO_2, NOx, VOCs, carcinogens, and any other potential areas of interest. In addition, consideration of potential human health impact of unleaded avgas will need to be made regarding matters such as handling, storage, venting, toxicity and water solubility.

Another key consideration for a viable unleaded avgas replacement for 100LL is the economic impact. This includes both the upfront costs to transition to an unleaded avgas as well as the long-term cost impact of operating on a new fuel. The EPA has previously recognized that converting in-use aircraft/engines to operate on unleaded aviation gasoline would be a significant logistical challenge, and in some cases, a technical challenge as well. As discussed previously, a change to the approved avgas or modifications to engines and aircraft require FAA certification to ensure compliance with applicable airworthiness standards necessary for safety. The FAA certification process is comprehensive and requires significant investment of resources, expertise, and time to complete. The cost and resource impact upon both industry and government can be extremely significant depending upon the level of effort and number of modifications that may be necessary to support a transition of the in-use fleet to an unleaded avgas. However, the closer the physical and performance properties of an unleaded avgas to 100LL, the less upfront economic impact there would be, particularly with respect to octane rating since it is a crucial fuel property for engines to schieve rated horsepower critical for maintaining operational safety limitations.

Another potentially significant upfront cost for an unleaded avgas is the impact upon the fuel production and distribution infrastructure and level of modifications/investment that may be necessary. Of vital importance is whether the components (often specialty chemicals) of a new fuel can be manufactured in quantities sufficient to feed a fuel marketplace and at a cost that is compatible with large quantity use in fuels. In some instances, significant investment in specialty chemical production facilities could be necessitated to meet the quantitative demands of a fuel marketplace. Long-term economic impacts that must be considered are the cost of unleaded avgas per gallon and any potential impact on aircraft/engine operating and maintenance costs. These are ongoing costs incurred by entire in-use fleet for the foreseeable future.

An unleaded avgas that works in aircraft is not a viable replacement for 100LL if it poses environmental and health concerns; would not be produced and made available where and when needed; or imposes significant economic impact that threatens the long-term viability or sustainability of general aviation in the U.S. Due to the relatively small size of the avgas market and the need for a dedicated distribution system for quality assurance and safety purposes, it is likely that there can only be one avgas and that any future unleaded replacement must accommodate the entire fleet.

VII. CHALLENGES OF A DUAL LEADED/UNLEADED FUEL APPROACH

On January 10, 1973, the EPA required that unleaded fuel for automotive uses be made available by mid-year 1974. This requirement began a process that ended in 1996 when the EPA finalized rules for a complete ban on the use of lead in automotive fuels. The 1973 requirement created a dual availability of leaded and unleaded automotive fuel, a strategy that has been suggested as a solution to reduce the amount of lead and thus EDB used in general aviation. While the introduction of additional grades of fuel was a sound strategy for the reduction of lead use in the automotive industry, there are serious challenges to and concerns with the application of that strategy to aviation. Increased costs, lowered availability, and decreased safety combine to make a dual fuel solution, even as a transitional solution, to the issue of lead and EDB use in aviation unworkable.

The challenges facing the production, transportation and distribution of aviation gasoline in a dual fuel environment were summarized in the Aviation Gasoline Survey – Summary Report released in June of 2010 by the American Petroleum Institute (API):

> "A key result from the survey indicated that no company [current avgas producer] would provide both 100LL and an unleaded avgas at the same time. The survey asked what infrastructure issues might become a problem in selling a dual fuel (that is, 100LL and unleaded avgas). All of the respondents indicated problems in maintaining duplicate distribution systems during the phase in, having to add new tanks to handle two fuels and cross contamination issues."

The first point that must be noted when understanding the challenges of a dual fuel solution for aviation is the very low volume of avgas produced, and therefore used, in comparison to overall transportation fuel for which resources compete. According to the U.S. Energy Information Administration, avgas production accounts for only 0.1 percent of overall transportation fuel production.

Proposal of dual fuel solutions seem to be a repeatedly attractive alternative to those desiring to realize near-term reductions in lead use in avgas and thus also ethylene dibromide. There is an ongoing attraction to the idea that perhaps as much as 70 percent of the existing aircraft fleet could use a lower octane unleaded fuel resulting in a supposed precipitous drop in lead and consequently EDB use. But that ignores the fact that the remaining 30 percent of the aircraft consume nearly 70 to 80 percent of the fuel. So, any dual fuel solution involving a lower octane unleaded fuel and existing 100LL, were it to be entirely ubiquitous and available at every airport (which it would not for the reasons we will outline below), would result in at best a 20 percent decrease in lead and EDB consumption. The general aviation industry has already yielded a 60 percent reduction in the lead content of aviation gasoline on top of a 60 percent decrease in avgas use over the past four decades. A dual fuel solution yields a barely measurable result when held against those improvements and at a cost that is deemed to be unworkable.

A. Production, Transportation and Distribution

In most cases, avgas is currently delivered to distribution terminals from manufacturers then shipped via over-the-road trailer to on-airport fuel service providers. Significant difficulties exist today, in a single-grade avgas environment, in finding space for avgas storage at delivery terminals. Fuel storage capacity at terminals is limited and due to the very specific quality requirements of aviation fuels, as opposed to automotive and other fuels, dedicated tankage is required meaning terminals must make a business decision as to whether to supply avgas. Many terminals, due to the very low throughput of avgas in comparison to other products, have chosen not to supply avgas at all. The limited number of terminals that do supply avgas are serving an ever-increasing geographic area, leading to increasing shipping costs to the final user.

The existing challenges of avgas distribution would be exacerbated by the introduction of a second grade of avgas as the current throughput is split into two distinct products. The limited tankage available at supply terminals would become more problematic as terminals would be required to segregate both leaded and unleaded avgas from other products. Terminals would be required to evaluate their existing storage availability, apply the lowered throughput per tank, and make a determination if a business case exists to supply avgas. Some terminals would be expected to exit the supply chain while some may, due to limited storage availability, choose to supply only one of the available grades. Terminals that chose to continue to supply avgas, either one or both grades, would see reduced revenue per storage tank due to the reduced throughput per tank, leading to possible higher storage and delivery rates for downstream customers.

Over-the-road trucking companies that handle delivery of avgas from supply terminals to airport facilities would also be affected in a dual grade avgas environment. Due to the strict segregation requirements for aviation fuels in general and leaded and unleaded fuels in particular, tanker trailers would need to be avgas grade dedicated or trailers would need to be steam cleaned every time a grade change occurred. The cost of additional tanker trailer dedication for very low volumes or ongoing steam cleaning would add even more cost to the delivery of avgas.

B. On-Airport Fuel Service Providers

In a dual grade avgas environment, on-airport fuel service providers, known as fixed base operators (FBOs), would experience significant negative effects in addition to the possible higher cost from supply terminals. FBOs currently have storage capabilities for one grade of avgas and would be required, due to the need to segregate different grades of aviation fuel, to construct or purchase additional infrastructure to handle additional grades in very limited volumes. This additional infrastructure would include storage tanks, filtration systems, associated piping, and fuel delivery vehicles. Many existing airport and FBO storage facilities have been designed for current needs and would not have room for additional storage tanks. These facilities would need to be completely redesigned or separate facilities for the new grade of avgas would need to be built.

In addition to infrastructure costs, FBOs would also face additional manpower costs. Unlike its automotive counterparts, aviation fuel and the equipment used to store and handle it must undergo a continuous regimen of quality control testing and inspection. Each storage tank, or fuel delivery vehicle, must undergo specific daily, monthly, quarterly, and annual inspections to maintain compliance with industry standards. A single tank or fuel delivery vehicle can require up to 214 man-hours or more per year to maintain quality standards.

Faced with a dual grade avgas environment, FBOs would be forced to make a business decision as to whether to supply both grades or only one of the two possible grades. The low overall volume of avgas throughput combined with the higher per gallon manpower cost of on-wing delivery (a typical avgas fuel sale tends to be a tenth or less, in gallons, than that of jet fuel) would likely lead to many FBOs choosing to supply only one of the possible grades of avgas likely choosing the one with the greatest market demand, 100LL. Further complicating the decision would be the long-term strategy relating to dual grade use. If the introduction of a second grade of avgas is envisioned to be a transition strategy, as it was in the automotive world, FBOs would be forced to amortize the cost of the additional infrastructure over a far shorter period of time than most other large-scale capital investments.

While it is expected that many FBOs would choose not to carry additional grades of avgas, some would more than likely not have a choice. The airport sponsor (owner) could require, through amended minimum standards or other mechanisms, that FBOs supply both grades of avgas to ensure that the airport attracts a wide class of users. FBOs at these airports would be required to carry both grades regardless of whether it is profitable to do so.

FBOs carrying both grades of avgas would experience significant changes in inventory management as their overall avgas throughput is split between two distinct products. The delivery of avgas by tanker trailer severely limits the ability of FBOs to modify shipping amounts. FBOs choosing to receive avgas in smaller quantities would still pay the same shipping charge as a full load. The end result is either that avgas at FBOs would spend more time in storage, tying up more capital in inventory, or the FBO would accept smaller quantities of avgas, incurring increased shipping and delivery costs.

C. Safety and Operational Considerations

The introduction of multiple grades of avgas also presents significant operational and safety issues. As airports, supply terminals, and FBOs make business decisions as to whether to carry both grades of fuels, the result could likely be reduced availability of certain grades of avgas at specific airports. This patchwork of fuel availability stands to impose significant burdens on aircraft operators, as those operators eliminate from use airports not carrying the correct grade of fuel. There is also the risk of landing at an airport in need of fuel only to find that the appropriate grade for the aircraft in unavailable.

From an FBO perspective, a leading safety concern is misfuelling. Misfuelling refers to the delivery of the incorrect type, grade, or quantity of fuel to an aircraft. Misfuelling is a serious safety concern and has led to aircraft accidents, even in large commercial airliners. The industry has worked hard to eliminate misfuelling through the use of selective spouts and aircraft filler ports to segregate avgas and jet fuel and even with these mitigations and significant FBO staff training and safety programs, errors still occur. The introduction of a second grade of avgas would exacerbate the serious dangers of misfuelling. Aircraft requiring lead or high octane could be subject to serious engine damage or failure in the event that the aircraft was inadvertently fueled with unleaded and/or lower octane avgas.

VIII. CONCLUSION

For the general aviation community, any regulation or limitation of components that make up aviation gasoline is a safety of flight issue. Evaluation of proposed unleaded alternative fuels over the past decade has shown that small changes to composition or performance characteristics of aviation fuel can have dramatic consequences for the safety, operability, and durability of aircraft engines and the aircraft themselves. The EPA has historically recognized that safety is paramount when addressing aviation fuel composition and aircraft emissions, and that safety emphasis has been upheld under challenge by the D.C. Circuit in National Association of Clean Air Agencies vs. EPA, 489 F.3d 1221(2007). The prominence of safety reinforces the need to proceed carefully with the potential control or limitation on the use of ethylene dibromide, and to make any determination only when such action is well supported by overwhelming data and careful analysis.

The aviation and petroleum industries are working aggressively with the Federal Aviation Administration and through standards setting bodies such as ASTM International in a coordinated manner to seek new fuel technologies that could allow for an unleaded future for aviation. This has been a strategic imperative for the aviation industry for a long time. General aviation manufacturers have long known that it is a strategic risk to produce aircraft whose expected service life can be well in excess of fifty years that are certified to operate on a leaded fuel whose future is in question and under constant threat by market forces and environmental concerns. One cannot build an industry on such a shaky foundation. Consequently, there has been a strong desire to find a suitable alternative to high octane leaded aviation gasoline that will satisfy the existing fleet and permit the development and manufacture of future aircraft that still have the useful load carrying capability and other performance parameters afforded by high octane fuel. Success in this endeavor not only eliminates lead from aviation fuels but also any need to use ethylene dibromide whatsoever.

In conclusion, EAA does not believe there is a need to prioritize further risk evaluations of EDB, undertake further testing, or develop further regulatory action at this time for the following reasons:

1) The sole use of EDB in aviation is as part of the lead fuel additive TEL-B which is necessary for the safe operation of piston powered aircraft. Any control or limitation on the use of EDB would effectively eliminate high octane avgas with profound safety of flight and economic implications.
2) Quantities of EDB used in aviation fuel are far less than projected in the *Draft Scope of the Risk Evaluation for Ethylene Dibromide* proposal document.
3) There has been a 60 percent reduction in the TEL and EDB content of aviation gasoline in recent decades that, when combined with a 60 percent decrease in the volume of fuel consumption over that same timeframe, has resulted in a greater than 80 percent overall reduction in EDB use in aviation gasoline.
4) EDB is not manufactured in the U.S. for aviation use and is only imported as part of the finished octane enhancing TEL-B additive package from a single source global supplier.
5) TEL-B containing EDB is imported and transported in sealed ISO containers and only delivered to a limited number of industrial users of the TEL-B additive, specifically the very few refiners and blenders of aviation gasoline.
6) There is no consumer or fuel distribution level contact with the TEL-B additive containing EDB in other than its highly diluted form in finished aviation gasoline; approximately 0.07% EDB by weight.
7) There is minimal risk to soil, air, and water sources because EDB is shipped and blended with bulk fuel components in sealed containers and blending systems at a very select few industrial facilities. An estimated 90 percent of the airport storage and distribution tankage is made up of above ground tanks with safety catchment containers.
8) EDB is only used for aviation purposes in combination with tetraethyl lead, meaning that existing environmental and occupational health and safety statutes and regulations governing the strict control and handling of TEL also already apply to EDB.
9) The petroleum and aviation industries, in collaboration with the Federal Aviation Administration are already undertaking significant investments in aggressive research, development, evaluation, and eventual authorization to use a replacement high octane unleaded aviation gasoline negating the future need for tetraethyl lead or the lead scavenger, ethylene dibromide.

EAA appreciates the dialogue we have had with the EPA to date on this matter and the opportunity to comment on the *Draft Scope of the Risk Evaluation for Ethylene Dibromide.* We stand ready to answer any additional questions the EPA may have with respect to aviation uses of ethylene dibromide and the effect any control or limitation on its use in aviation gasoline might have. As a member of the Piston Aviation Fuels Initiative Steering Group (PAFI-PSG), we also welcome any dialogue with the EPA regarding ongoing efforts to entirely eliminate tetraethyl lead and ethylene dibromide from future aviation gasoline.

Thank you, we appreciate your time and attention to this matter.