



February 12, 2019
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Submitted via www.regulations.gov

Document Control Office (7407M)
Office of Pollution Prevention and Toxics (OPPT)
Environmental Protection Agency (EPA)
1200 Pennsylvania Avenue NW
Washington, DC 20460-0001

Re: Information Supporting a Critical Use Exemption Request for phenol, isopropylated, phosphate (3:1) in Aerospace Uses (Docket ID Number: EPA-HQ-OPPT-2016-0730)

To Whom It May Concern:

I write on behalf of The Boeing Company (Boeing) to provide information supporting an aerospace critical use exemption for phenol, isopropylated, phosphate (3:1) (PIP (3:1)) Docket Identification Number EPA-HQ-OPPT-2016-0730. We appreciate this opportunity to enhance EPA's understanding of the uses of products containing PIP (3:1) as the agency drafts its proposed regulation. We request an exemption for the aerospace uses described below, for which we provide detailed information..

Boeing is the world's largest manufacturer of commercial jetliners and defense, space, and security systems. Boeing products and tailored services include commercial and military aircraft, satellites, weapons, electronic and defense systems, launch systems, advanced information and communications systems, and performance-based logistics and training. Boeing employs approximately 150,000 people across the United States, with major manufacturing operations in eight states. As a top exporter, Boeing has customers in more than 150 countries across the world, and supports airlines and U.S. allied government customers in more than 90 countries.

PIP (3:1) is an important component of hydraulic fluids, engine oils (including oils for auxiliary power units (APUs)), and landing gear fluids used on Boeing products. These are all critical for proper functioning of engines and aircraft. If these products are not available, aircraft will not be able to operate, potentially grounding commercial and military operations. The process for developing, qualifying, certifying and deploying alternate fluid formulations in aerospace products is one which requires collaboration and coordination with multiple entities. At the end of this often iterative evaluation process, there is no guarantee that a technically equivalent alternative can be developed. Therefore, to ensure continuity of production, operation and maintenance of aircraft, we request EPA provide a critical use exemption under Section 6(g) of TSCA for aerospace uses of PIP (3:1).

Chemical Properties and Conditions of Use

The aerospace and defense industry relies upon the material formulators' expertise to select constituents to develop aerospace materials that can meet demanding technical performance requirements for specific functions in the application operating environment. Based upon research performed by EPA¹ and comments²

¹ Preliminary Information on Manufacturing, Processing, Distribution, Use, and Disposal: Phenol, isopropylated, phosphate (3:1), Office of Chemical Safety and Pollution Prevention US EPA, August[. 2017

² EPA-HQ-OPPT-2016-0730, Comments submitted by ExxonMobil Fuels & Lubricants Company

in the docket, PIP (3:1) is used in the critical use applications for its flame retardance, anti-wear, and, in some formulations, enhancement of load carrying capability of materials and resistance to compressibility. These performance and functional requirements of these critical use materials are tested in controlled laboratory environments to evaluate material performance under simulated use conditions and then validated in aircraft in service. Some issues caused by the use of a new substance may not be known until an aircraft has been in service for a number of years leading to unforeseen technical challenges in developing a replacement formulation for the critical uses.

Phosphate ester based hydraulic fluids are used for commercial aircraft and military derivatives. Trialkyl phosphates make up 50% to 90% of these fluids whereas the PIP (3:1) is a significantly smaller percentage component added as a flame retardant and/or compressibility modifier. PIP (3:1) is also used as a component for similar reasons in engine oils and Boeing specified landing gear fluids (hydraulic and anti-wear strut shock) and greases. In some cases, the engine oil also acts as a hydraulic fluid for certain engine controls. Many of the critical use materials have been optimized for specific applications that required adjustments based upon extensive in-service performance over a number of years. As applications evolve (i.e. higher pressure hydraulic systems), performance issues such as increased wear, degradation, or deposit accumulation could require additional adjustments to the material as issues are identified in the fleet.

Impacts to Public and Specific Business Sector of the Chemical

Ceasing use of PIP (3:1) for aerospace critical uses without validated alternatives will be disruptive to both the military and civilian aerospace operations. As an important constituent of several fire-resistant hydraulic fluids, engine oils, and landing gear fluids, some aerospace products may become inoperable or suffer from premature degradation due to use of alternatives that may not be equivalent in performance, durability, or safety.

The lack of fire resistant oils and fluids for commercial aircraft would eventually disrupt commercial transportation of people and goods around the globe. Use of an alternate fluid could create additional wear or degradation of aircraft systems which could create need for more frequent replacement of components. For this reason, material specifications for commercial aircraft require hydraulic fluid resistance. In the case of landing gear, improper function of shock struts, which act as shock absorbers upon landing, can lead to bounce and potential loss of control. Inability to properly cushion during landing also increases the transmission of stresses into the aircraft structure which can impact the lifetime of the aircraft. As Boeing does not manufacture engines for our aircraft, engine oils for optimal performance are determined by the engine's original equipment manufacturer (OEM). While qualified alternatives may exist in some cases, it is necessary to consider the operating conditions of aircraft and use qualified materials that can function in a wide range of temperatures – both extreme heat and subzero conditions encountered during take-off and flight. Any increased repair required from use of unequal replacement materials would increase the non-operational time for aircraft that are currently highly utilized, impeding travel and trade.

Since engine oil requirements for larger engines are similar, in addition to commercial aircraft, Department of Defense (DoD) passenger and cargo aircraft would also be impacted. Similar concerns also exist for landing gear and hydraulic fluids in military applications. Therefore, adoption of a restriction without a qualified and certified replacement for products containing PIP (3:1) would cause concern in operation and maintenance,

³ Sniederma, D (2018), Commercial aviation lubrication, *Tribology & Lubrication Technology*, July 2018, 44-50

especially in theater, and would have a significant impact on military readiness in training and conflict. In addition to operation and readiness of the aircraft itself, the storage of aircraft maintenance and operation products is an important consideration for DoD. Inventories of these fluids are stored aboard naval aircraft carriers, and mitigating any ignition event in a storage area is of high importance, which the PIP (3:1) additive achieves by elevating the flash point of the material.

Compliance with Other Agencies' Requirements

The essential technical performance requirements of critical use materials used in the aerospace industry are documented in numerous federal, industry, military and company proprietary specifications. Over time, the requirements and specifications evolve to meet the needs of new technology³. Formulations that meet these requirements are developed, evaluated and qualified to these specifications. However, it is the application and/or use of these materials to perform specific functions as part of the product that is certified to meet airworthiness requirements by certifying authorities – Federal Aviation Administration (FAA) and DoD. Boeing and standards developing organizations (SAE, ISO) create and maintain specifications which list technical material requirements and qualified products. Additionally, DoD (through the Defense Standardization Program) developed performance specifications (MIL-PRF) which also defines the functional requirements. Below is a non-exhaustive list of specifications that contain qualified products containing PIP (3:1).

Sample list of Military and Industry Specifications (non-exhaustive):

Hydraulic fluids:

- Boeing Material Specification (BMS)3-11: Hydraulic Fluid, Fire Resistant
- MIL-PRF-83282, HYDRAULIC FLUID, FIRE RESISTANT, SYNTHETIC HYDROCARBON BASE, METRIC, NATO CODE NUMBER H-537
- MIL-PRF-87257, HYDRAULIC FLUID, FIRE RESISTANT, LOW TEMPERATURE, SYNTHETIC HYDROCARBON BASE, AIRCRAFT AND MISSILE
- SAE AS1241 Fire-Resistant Phosphate Ester Aviation Hydraulic Fluid

Landing Gear Fluids:

- BMS3-32 LANDING GEAR SHOCK STRUT FLUID, ANTI-WEAR
- SAE AIR5358 Landing Gear Shock Strut Hydraulic Fluid

Engine Oils:

- ISO 9940 Aerospace series - Fluid, hydraulic, phosphate ester-base, fire resistant - Technical specification - First Edition
- MIL-PRF-5606, HYDRAULIC FLUID, PETROLEUM BASE; AIRCRAFT, MISSILE, AND ORDNANCE
- MIL-PRF-7808 Grade 4 Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Number O-156;
- MIL-PRF-23699 Lubricating Oil, Aircraft Turbine Engine, Synthetic Base, NATO Code Numbers: O-152, O-154, O-156, and O-167

³ Sniederma, D (2018), Commercial aviation lubrication, *Tribology & Lubrication Technology*, July 2018, 44-50



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- SAE AS5780 Specification for Aero and Aero-Derived Gas Turbine Engine Lubricants
- SAE J1899 (formerly MIL-L-22851D LUBRICATING OIL, AIRCRAFT PISTON ENGINE (ASHLESS DISPERSANT))

Grease:

- BMS3-43 GREASE, AIRCRAFT, LANDING GEAR
- MIL-PRF-32014 GREASE, WATER RESISTANT, HIGH SPEED, AIRCRAFT AND MISSILE

Availabilities of Alternatives

Materials qualified to the specifications listed above have demonstrated reliable performance in a myriad of applications and uses that cover a range of technical requirements. The need to develop, test, qualify, certify and distribute alternative fluids and materials throughout an extensive and diverse user base could take years with no guarantee of success for all applications and uses. There are also component, vehicle design and maintenance standards that are based upon use and/or compatibility of these numerous formulations. The numerous specifications and organizations involved would require additional coordination to ensure that the qualifications are coordinated, timely and consistent. Alternatives would require equivalent performance in order to not require extensive re-design, validation testing and potential re-certification for specific applications.

Qualified Product Lists, or QPLs, provide lists of products that are available as options for specific applications. However, alternatives could be listed on a QPL and be suitable for certain uses, but may not cover the full range of conditions an aircraft may be subjected to in its lifetime. For example, a DoD fighter jet may meet optimal performance standards using a PIP (3:1)-containing Grade 4 high performance turbine engine oil Turbonycil 400 (4cSt) engine oil qualified to MIL-STD-7808. The Grade 4 requires higher viscosity oils with greater thermal stability and has only one qualified product. While other engine oils may be qualified to that specification, the Turbonycil 400 is the only Grade 4.

There are a limited number of qualified material formulations and formulators for landing gear greases (2) and fluids (4). The landing gear grease has two materials manufactured by two suppliers – both contain PIP (3:1). While there appears to be three qualified PIP (3:1)-free strut shock fluids qualified to the specification, we need to investigate whether there are other product limitations based upon certification requirements and in-service use that require the PIP (3:1) containing material.

The global commercial aviation hydraulic fluids are manufactured by two suppliers and used by Boeing, and based on information from the manufacturer, also by Airbus, Bombardier, British Aerospace, Cessna, Commercial Aircraft Corporation of China (COMAC), Embraer, Fokker, Gulfstream, and Mitsubishi.⁴ As we have shared with EPA in previous discussions, there are six materials qualified to BMS3-11 with the three PIP (3:1) containing materials representing the most recently qualified, latest developments in fluid performance. Two of these products have been certified for use in our higher pressure, 5000 psi system. In-service performance issues resulted in recommendations to use only the PIP (3:1) containing fluid. Extensive testing would need to be conducted to formulate and qualify a hydraulic fluid without PIP (3:1) for both 3000 and

⁴ExxonMobile (nd) list obtained from: <https://www.exxonmobil.com/en/aviation/products-and-services/products/categories/hydraulic-fluids>
Eastman (nd) list obtained from: <https://www.eastman.com/Brands/EAS/Skydrol/Pages/Industry-Approvals.aspx>



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5000 psi systems.

Efforts to Transition

Transitioning to new materials often requires extensive redesign. In the case of hydraulic fluids, flammability considerations led the industry to move from mineral oil to phosphate esters. However, the use of phosphate esters created compatibility issues that required hydraulic system design changes (hose and seal material changes), along with modifications to surfaces in the area, and added the need for potentially exposed aircraft materials to be phosphate ester resistant. This is a unique requirement that has driven the need for phosphate-ester resistance in commercial material specifications.

Formulations containing PIP (3:1) have been reliably performing in aerospace applications for several decades. Given the extensive effort, time, cooperation and coordination required from the formulator, OEMs (including engine and APU manufacturers) and airworthiness authorities to develop, qualify and in some cases certify products using these materials, there has been no impetus to develop alternatives and potentially disrupt operations to cease using products that have and continue to perform.

Safety Measures Used

The primary concerns when handling these materials are to protect from skin and eye contact. Accordingly, we call for use of gloves (SilverShield, Nitrile, Neoprene), eye protection (safety glasses w/side shields, chemical safety goggles for splash/overhead/pressurized systems), and protective clothing (coveralls, lab coats). Employees are instructed to wash any skin that has come in contact with oils and fluids and emergency eyewashes or showers are provided as appropriate. Respiratory protection is identified for those areas where there may be exposure to mist from fluids. This is typically P100 (HEPA) filters for a half-face (w/goggles) or full-face air purifying respirator.

Future Plans to Find Substitutes

Research on substitutes would normally take place in collaboration with formulators of the products containing PIP (3:1). In the case of engine oils, as OEMs, Boeing's engine manufacturers provide requirements, specifications, and substantiation of compliance for products under their design control as the type certificate holder. These OEMs also specify the requirements for maintenance and adherence to these procedures is a requirement for airlines and DoD for continued airworthiness. Boeing is unaware of any current or future efforts by manufacturers of hydraulic fluids, engine oils, or landing gear fluids to incorporate substitutes that can be qualified to current specifications.

Pending New Chemical Program Review for Substitutes

Boeing is not aware of any substances pending new chemical review as substitutes for PIP (3:1).



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Boeing appreciates this opportunity to provide this information to EPA as they prepare to propose regulation on PBT substances. As mentioned above, PIP (3:1) has critical uses in the aerospace industry for which there are few or no qualified alternatives. Qualified engine oils and landing gear fluids may not cover the full range of necessary conditions. Hydraulic fluids containing PIP (3:1) are necessary for all commercial aircraft and military derivative systems where it is present in small concentrations. While we work with our formulators to address our technical requirements and identify, test, and qualify alternatives, we request that EPA provide a critical use exemption for aerospace uses. Please do not hesitate to contact me, or Peter Pagano at (703) 414-6486 should you have any questions.

Sincerely,

A handwritten signature in black ink that reads "Steve Shestak".

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