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From the
Chemical & Material Risk Management Program
Office of the Assistant Secretary of Defense (Energy, Installations & Environment)

Chemical & Material Emerging Risk Alert

Tetrabromobisphenol-A (TBBPA)

The Environmental Protection Agency (EPA) has identified TBBPA (CAS No. 79-94-7) for assessment under the Toxic Substances Control Act (TSCA) Work Plan effort. This may lead to increased regulation and/or production bans, which could pose risk to DoD supply chains and require actions to identify and qualify suitable alternatives.

What is TBBPA?

TBBPA is the most widely used brominated flame retardant,¹ and is considered a substitute for certain polybrominated diphenyl ethers (PBDEs). The main application (~90%)² of TBBPA is in the epoxy resin used for printed circuit boards or laminates, where it contributes to the fire safety of consumer electronics, and civilian and defense communication equipment requiring FR-4 protection and V0 requirements of the UL-94 Standard. TBBPA is also used in many polymeric materials and epoxy adhesives. Its role has become increasingly important towards the miniaturization of electronics in which the use of loaded and condensed laminates produce more heat within smaller devices.

How is TBBPA used in the DoD?

Printed circuit board technologies are critical components to nearly every DoD weapon system. Combined DoD electronics, information technology, and electro-optics are estimated to account for roughly 15% of the total DoD budget. Fundamental to military operations, high-density ruggedized and reliable printed circuit boards are incorporated into all navigation, guidance, surveillance, and communication systems, including severe-service items used in extreme conditions (temperatures, high impact/vibrations, or submerged).

TBBPA may be used as an additive flame retardant in acrylonitrile-butadiene-styrene (ABS) plastics, high-

impact polystyrene (HIP) foams and phenolic resins. ABS resins containing TBBPA are used in automotive parts, pipes and fittings, refrigerators and various commercial-off-the-shelf (COTS) items employed by DoD.

TBBPA is incorporated into products in two-ways (1) reactively – where its molecularly bonded into the matrix of the treated polymer, and (2) additively – where it is physically combined with the material being treated, rather than chemically bonded. Additive flame retardants are considered more likely to leach from the polymer matrix.

What are the emerging health concerns?

TBBPA reactively incorporated into printed circuit boards is not expected to release into the environment. However, trace amounts of unreacted TBBPA may result in a release to the environment through waste streams. The primary environmental hazard for TBBPA is high-aquatic toxicity, with a moderate potential for bioaccumulation.³

Human exposure to TBBPA is possible from inhalation of ambient air and from dermal contact or ingestion of compound dusts from containing products. In both human and animal studies, TBBPA was not a sensitizer.⁴ Other animal studies, in vivo and in vitro, exhibited thyroid hormone activity,⁵ estrogenic activity,⁶ and increased weight of testes and pituitary glands in male offspring.⁵



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In neurotoxicity studies, TBBPA was found to inhibit neurotransmitter uptake, affecting dopamine, GABA and glutamate.⁷ TBBPA is absorbed from the gastrointestinal tract and extensively metabolized to glucuronide and sulfate conjugates.⁸ Additional information regarding chronic toxicity, synergistic/antagonistic effects, cytotoxicity, or carcinogenicity is available from the National Toxicology Program.⁹

How is TBBPA regulated?

In recent years, flame retardant chemicals have experienced increased regulatory attention due to their environmental persistence and bioaccumulation, human health hazards, and wide use in consumer products.¹⁰ TBBPA is listed under the Emergency Planning and Community Right-to-Know Act (EPCRA), but is not regulated by the Occupational Safety and Health Administration (OSHA), nor has NIOSH developed recommended exposure limits or has ACGIH established a threshold limit value. The reporting threshold for TBBPA for the Toxic Release Inventory is 100 pounds.¹¹

What is the emerging risk?

In 2013, the EPA identified 20 flame retardant chemicals for assessment under the TSCA. Four of the flame retardants (TBB, TBPH, TCEP, HBCD), representing three structurally distinct chemical groups, are slated for a full risk assessment. A fourth structure-based flame retardant chemical group (TBBPA) has been studied under the DfE Program since 2006¹² and was added to the TSCA Work Plan in 2014.¹³ This creates an increased likelihood of Toxicity Value/Regulatory Change.

Similar flame retardants (e.g., decaBDE) have been removed from the marketplace. If TBBPA were removed from the market due to increasing regulatory scrutiny, critical applications would be compromised. Currently, severe-service-printed circuit boards (those used in extreme temperature conditions, high impact/vibration, or submerged) are all TBBPA-based with no equivalent substitute.

What should you do in response to this Alert?

Be aware of the risk of unavailability and the potential need for a substitute. Identify operations that use TBBPA

and check specifications for flame retardant requirements, especially severe-service printed circuit boards. Determine if TBBPA is used and report the uses and relevant specifications to ODUSD(I&E) at:

osd.pentagon.ousd-atl.mbx.cmrmp@mail.mil

Knowledge of uses will inform our risk analysis.

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References:

- ¹ Law et al. 2006. Levels and Trends of Brominated Flame Retardants in the European Environment. *Chemosphere* 64:187–208.
- ² European Union Risk assessment Report (TBBP-A). European Chemicals Bureau. 4th Priority List, Volume 63 (2006).
- ³ *Flame Retardants in Printed Circuit Boards (Updated Draft Report)*. U.S. EPA. December 2014.
- ⁴ "Review of Toxicological Literature." National Institute of Environmental Health Sciences. 2002.
- ⁵ Van der Ven et al. (2008). *Endocrine Effects of Tetrabromobisphenol A (TBBPA) in Wistar Rats as Tested in a One-Generation Reproductive Study and a Subacute Toxicity Study*. *Toxicology* 245:76-89.
- ⁶ Kitamura et al. (2005). *Comparative Study of the Endocrine-Disrupting Activity of Bisphenol A and 19 Related Compounds*. *Toxicological Sciences* 84:2005.
- ⁷ Mariussen E and Fonum F (2003). *The Effect of Brominated Flame Retardants on Neurotransmitter Uptake into Rat Brain Synaptosomes and Vesicles*. *Neurochemistry International* 43:533-42.
- ⁸ *Brominated and Chlorinated Organic Chemical Compounds Used as Flame Retardants*. Meeting of the California Environmental Contaminant Biomonitoring Program Scientific Guidance Panel. December 2008.
- ⁹ <http://ntp.niehs.nih.gov/testing/status/agents/ts-m200033.html>
- ¹⁰ *Phase 1 Impact Assessment for Flame Retardants*. U.S. Army Public Health Command Army Institute of Public Health. May 30, 2014.
- ¹¹ 64 FR 58666, October 29, 1999; EPCRA Section 313
- ¹² <http://epa.gov/dfe/pubs/projects/pcb/>
- ¹³ *TSCA Work Plan for Chemical Assessments: 2014 Update*. U.S. EPA. October 23, 2014.



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