pinfa
Phosphorus, Inorganic & Nitrogen Flame Retardants Association

Your newsletter for non-halogen fire safety solutions n° 153 October 2023

SAVE THE DATE

Fire safety in strategic industry sectors

As part of the 5th European Fire Safety Week, pinfa webinar Wed. 15th November, 11h – 13h CET (Paris-Brussels time) on fire safety and sustainability in strategic industry sectors. This will centre on "Strategic Technologies" (as defined by the EU: renewable energies & batteries, data & electronics) and will cover impacts of fire on societal acceptance, resilience, and for the environment; specific new or accentuated fire risks in these sectors; fire risks of new materials and new production processes (3D printing).

The European Fire Safety Week is organised by the Dutch Burns Federation and EuroFSA (European Fire Safety Alliance).

Registration soon: https://www.europeanfiresafetyalliance.org/events/5th-european-fire-safety-week/

pinfa-NA online Lunch & Learn webinar

pinfa North America free webinar 'From flame retardant R&D to commercial product" Wed 25 October, 11h30-12h30 EST (17h30-18h30 CET). This continues pinfa-NA's 2023 Free Lunch & Learn Webinar series. Dr. Anteneh Worku, FR Adviser LLC, will discuss how to overcome challenges from customer need-based ideas, to chemical lab synthesis, to scale up and commercialisation.

Free webinar 'From flame retardant R&D to commercial product" Wed 25th October, 11h30-12h30 EST (17h30-18h30 CET) Registration here.

Webinar: selection of flame retardants

pinfa-NA, CAMX provided a dynamic one hour webinar on FR additive selection for fire safety on 18th October 2023. For material and product developers, R&D professionals, product designers, and sales and marketing teams.

Access the webinar at www.pinfa-na.org

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REGULATION AND POLICY

Fire safety missed in Batteries Regulation

The revised EU Batteries Regulation does little to address battery fire safety, despite other ongoing EU actions. The newly revised Batteries Regulation 2023/1542 (12th July 2023) aims to ensure that batteries are safer and greener (carbon footprint, raw materials, recycling). pinfa proposed amendments to include fire risks, smoke toxicity and extinction water toxicity (all highly relevant for environmental impact) were not taken onboard. The Regulation as adopted mentions fire only in requiring information on fire protection and mitigation instructions, fire protection of waste batteries, testing of fire risk in case of short circuit and testing of explosion risk in case of battery exposure to fire.

The Sustainable Transport Forum Expert Group has carried out a survey to collect information on guidelines and codes regulating fire safety for electric vehicle charging infrastructures.

EU survey "Mapping of legislation/guidelines/codes relating to fire safety for recharging infrastructure and electric vehicles in underground/above ground covered parking areas" closed 20th July 2023 but still online https://ec.europa.eu/eusurvey/runner/2023-parking-areas-legislation

EU revised Battery Regulation 2023/1542 "New law on more sustainable, circular and safe batteries enters into force" https://environment.ec.europa.eu/news/new-law-more-sustainable-circular-and-safe-batteries-enters-force-2023-08-17_en and Regulation text https://eur-lex.europa.eu/eli/reg/2023/1542/oj

US EPA proposes SNURs for three FR

The US has proposed Significant New Use Rules (SNUR under TSCA section 6) for TCEP, TBBPA and TPP: tris(2-chloroethyl) phosphate, 4,4'-(1-methylethylidene)bis[2, 6-dibromophenol], triphenyl phosphate. This requires notification of proposed new uses, whilst EPA carries out ongoing risk assessments of the three substances based on known existing uses.

"EPA Proposes Significant New Use Rules for Flame Retardants In Support of Risk Evaluations", 21 June 2023 https://www.epa.gov/chemicals-under-tsca/epa-proposes-significant-new-use-rules-flame-retardants-support-risk and proposed ruling.

Call for fire safety in EU buildings directive

Associations say fire safety, especially for new energy systems, should be better integrated into the EU EPBD (Energy Performance of Buildings Directive). The call comes from EuroFSA (European Fire Safety Alliance, of which pinfa is a partner), FEEDs (Forum for European Electrical Domestic Safety), Fire Safe Europe and the Federation of European Fire Officers. The association supports the European Parliament position (adopted 14th March 2023, see pinfa Newsletter n°148) which reinforces requirements for actions on fire safety in the proposed EPBD recast, and which adds reference to "fire safety of solar energy installations in buildings, including in combination with technical building systems such as domestic batteries or heat pumps", establishment of fire safety standards for roofed garages, fire safety compliance inspections, including fire safety in a "bill of materials" used in building and renovation.

European Parliament position (amendments adopted) on EPBD, 14th March 2023 https://www.europarl.europa.eu/doceo/document/TA-9-2023-0068_EN.html

"EPBD revision: Addressing fire safety will boost the safe decarbonisation of European buildings", EuroFSA, 29th August 2023 https://www.euractiv.com/section/energy-environment/opinion/epbd-revision-addressing-fire-safety-will-boost-the-safe-decarbonisation-of-european-buildings/

UK consults on Furniture Fire Regulations

Public consultation on recast of UK's 1988 Furniture Fire Safety Regulations open to 24th October 2023. The consultation includes a draft regulatory text "to illustrate the approach".

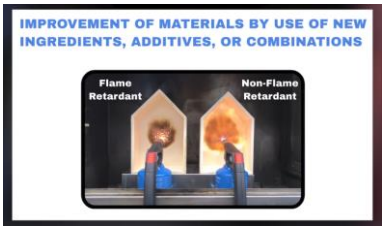
UK public consultation on recast of the 1988 Furniture Fire Safety Regulations, open to 24th October 2023 (midnight, UK time). "Smarter Regulation: Fire safety of domestic upholstered furniture". Includes: public consultation document (19 questions), Impact Assessment, draft regulations ("Draft legislation for illustrative purposes only"). https://www.gov.uk/government/consultations/smarter-regulation-fire-safety-of-domestic-upholstered-furniture

Summary

We are seeking views on a proposed new approach to the fire safety of domestic upholstered furniture and furnishings.

This consultation closes at
11:59pm on 24 October 2023

FIRE SAFETY



pinfa-NA explainer video series – n°4

4th educational video on passive fire safety shows success of residential building fire risk mitigation. The 3 minute video explains how US fire deaths have been reduced by 70% since the 1970's, from 55 per year per million population of which 84% in residential buildings. This has been achieved by making materials fire-safer using flame retardants, passive fire protection, modern extinguishing systems, new testing, building codes and public education. pinfa-NA's short learning videos aim to inform the public on public fire safety, flame retardant technology and human & environmental health topics. A series of ten videos is under production by pinfa-NA.

www.pinfa-na.org/learnfrmaterials

Tests show fire danger of materials in buses

Bus seat, floor and interior trim materials as used in buses and coaches were tested for fire behaviour and smoke emission, concluding that they "lead to very limited times for escape and rescue in case of fire in a bus cabin". Materials tested, supplied by manufacturers, were as used in public and commercial buses and coaches: four textiles and a polyurethane foam*. Cone calorimeter, FTIR (Fourier-transform infrared spectroscopy) and DIN tube furnace tests analysed heat release, smoke release and toxic gases, including carbon monoxide, HCN (hydrogen cyanamide), acrolein, SO_2, HF, acetylene, formaldehyde, ammonia … Results show high heat release and smoke emission within five minutes, with IDLH (Immediately Dangerous to Life and Health) values exceeded for all materials, in particular for HCN. Polyurethane foam shows the highest heat release of materials tested and polyester textile the highest total smoke production. PUR shows acrolein 130x higher than IDLH. The authors conclude that, despite all materials tested fulfilling the most recent regulatory requirements for bus interiors (UNECE R 118 Annex B, see pinfa Newsletter n°64), results are not significantly better than previous tests (Hofmann et al. 2014). They recommend that to improve bus passenger safety, heat release, smoke production and smoke toxicity requirements should be introduced for bus interior materials, for example those already applicable for railways in Europe (EN 45545-2).

** Textiles: RC 70% polyester 30% wool, CD = 65% polyester 28% wool 6% viscose, MB = 100% polyester, LW = polyester/polyamide. PUR Green = green-coloured polyurethane foam.*

"Reaction-to-fire testing of bus interior materials: Assessing burning behaviour and smoke gas toxicity", Fire and Materials. 2023;47:665–680 https://dx.doi.org/10.1002/fam.3108

EuroNews on battery fire risks

Are we prepared to tackle the fire risks of batteries? Calls for action and initiatives on electric vehicle and battery fire safety. EuroNews notes that fires in electric vehicles occur less often than in internal combustion engine cars (pinfa notes that this may be because fire performance requirements for materials in EVs are generally more demanding). But battery fires are more difficult to extinguish, tend to reignite and require considerably more firefighting water. Electric vehicle fires pose new risks for maritime transport (see pinfa Newsletter n°152). With e-bike battery fires now London's fastest growing fire risk (over 120 fires in the first eight months of 2023, resulting in three deaths and over 50 injuries), a coroner has called on the UK regulator to tighten safety standards.

"Sales of EVs are booming in Europe but are we equipped to tackle blazes caused by batteries?", EuroNews, 20 September 2023
https://www.euronews.com/next/2023/09/20/sales-of-evs-are-booming-in-europe-but-are-we-equipped-to-tackle-blazes-caused-by-batterie

Concerns about battery storage fire safety

New York launches taskforce to investigate energy storage fire risks after solar farm fire. Rotterdam puts moratorium on new facilities.

A fire at a Convergent solar farm, Jefferson County, New York State, involving a General Electric battery storage system caused residents in a mile radius to be told to confine and continued to burn for hours. Following this and two other battery storage fires, the State Governor has launched a task force to investigate energy storage facilities fire safety.

Rotterdam city, The Netherlands, has prohibited construction of battery storage or wind energy systems for six months, to give time to define codes. A member of the Energy Advisory Committee raised concerns about "the potential for large fires at battery energy storage facilities that burn for hours" and concerns that local fire departments are not equipped to handle such incidents. This follows a similar moratorium on solar farms.

Recharge News 31 July 2023 https://www.rechargenews.com/energy-transition/after-three-fires-and-a-solar-plant-toxic-fumes-scare-new-york-launches-safety-probe-into-battery-energy-storage/2-1-1493418

Wind Watch News 24 September 2023 (from Daily Gazette)
https://www.wind-watch.org/news/2023/09/24/rotterdam-approves-moratoriums-on-wind-battery-storage-systems/

Absence of fire standards for wind turbines

There are today over twenty wind turbine fires annually worldwide, causing up to 5 million € economic loss per fire. Causes include lightening, mechanical / gear / rotor breakage, bearing friction, overheating, sparks from mechanical problems or from braking, electrical failures (short circuits, arcing, batteries, overheating). Fires are often exacerbated by combustible materials. Access for firefighters is generally difficult or impossible (site, height of nacelle). Costs of fire include removal and replacement of destroyed turbine and equipment (often at inaccessible sites), loss of electricity generation revenue and image damage to the industry. Fire protection measures cited include heat and fire detection systems, monitoring systems, automatic extinguishing systems, lightening protection, electrical fuses and circuit breakers and fire protective coatings and fire safety treated materials. The authors note that there are nearly no fire safety standards for wind turbines, only EU Directive 2006/42 defining standards for machines in general, US NFPA 850 for electricity generation, some Spanish standards for turbine maintenance practices.

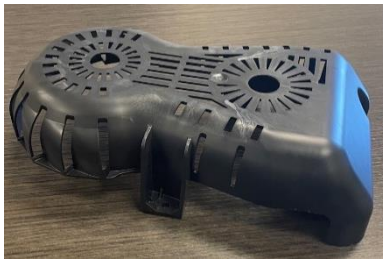
"Fire risk assessments and fire protection measures for wind turbines: A review", F. You et al., Heliyon 9 (2023) e19664
https://doi.org/10.1016/j.heliyon.2023.e19664

Fire risks of lithium ion battery electrolytes

Lithium ion batteries use highly flammable liquid organic electrolytes. Solutions include flame retardants. Current state-of-the-art lithium ion batteries use $LiPF_6$ as electrolyte salt in an organic carbonate solvent, a system which is flammable and thermally unstable. Flame retardants are included into the electrolyte to improve fire resistance and thermal stability. This paper details different FR solutions. FRs used can be based on phosphorus, fluorine or both. Phosphorus-based FRs used include alkyl phosphate esters (e.g. trimethyl phosphate TM), triethyl phosphate TEP, dimethyl methyl phosphonate DMMP), phenyl phosphate esters (e.g. triphenyl phosphates TPPs, diphenyl octyl phosphates DPOF, and diphenyl methyl phosphates CDP), phosphorus-nitrogen compounds (e.g. phosphazenes). The PFRs have the disadvantage of requiring significant loadings which reduce electrical performance. Fluorine FRs also deteriorate electrical performance somewhat and pose problems by generating toxic HF gas in fires or decomposing to toxic organic fluoride compounds. Composite FRs including both F and P can offer improved performance. Other possible future solutions to reduce lithium ion electrolyte fire risk include solid electrolytes, high concentrated liquid electrolytes or ionic liquids (organic molten salts).

"Nonflammable Liquid Electrolytes for Safe Lithium Batteries", X. Mu et al., Small Struct. 2023, 2300179 https://doi.org/10.1002/sstr.202300179

RESEARCH AND INNOVATION



PIN FR polypropylene (PP) for fire safety

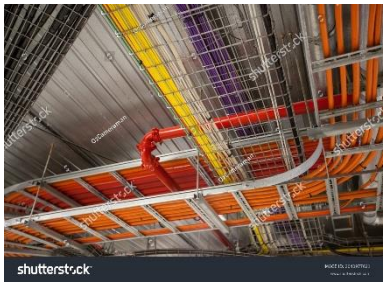
Sirmax (US) offers PP compounds to UL 94 V-0 (0.8 mm) for EV, consumer & industry applications where fire safety is essential. The non-halogenated flame retardant grades are low-toxicity and include copolymers, talc-filled, glass fibre reinforced or based on mechanically recycled post-industrial or post-consumer polymers. PIN FR PP copolymer compounds can reach UL 94 V-0 (0.8 mm) / 5VA (1.5 mm) or self-extinguishing. Applications include structural elements for electric vehicle batteries, or parts for fire-sensitive parts consumer appliances or industrial items, including for household cooking appliances or washing machines, power tools, parts susceptible to come into contact with electric motors or electronics (which are potential sources of heat or fire ignition).

"Sirmax accelerates the production of its self-extinguishing compound, a fully dedicated line in the U.S. Extremely high technology, low toxicity and customized colors." 25 July 2023 *https://www.sirmax.com/en/news/sirmax-accelerates-the-production-of-flame-retardant-compounds*

PIN FR cables show lower smoke toxicity

Tests on 89 different cables analysed how different cable structures and materials influence behaviour, including sheath materials, bedding, number and configuration of conductors, different conductor metals. Cone calorimeter test data is compared to real-scale fire tests. 18 of the cables were halogenated and over sixty were PIN FR. The authors underline the influence of cable structure which can protect against fire penetration and amounts of combustible materials and metal barriers. Non-halogenated cables show considerably lower smoke release and smoke toxicity. The conclusions note that PIN FR cables (LS0H Low Smoke Zero Halogen) "generate less heat, smoke and toxic gases" than halogenated polymer cables (peakHRR_{av} >17 times higher for halogenated cables),

"Fire properties of cables used in buildings", K. Kaczorek-Chrobak, 157 pages, Instytut Techniki Budowlanej Warsaw 2023, ISBN 978-83-249-8660-6; 978-83-249-8661-3
https://fachowa.pl/pl/p/file/c7149c854b675c34b11dc57f42bdb3dd/K.-Kaczorek-Chrobak%2C-Fire-properties-of-electric-cables-used-in-buildings_e-book.pdf



PIN FR cables prevent fire spread

Tests with full scale table trays show halogenated cables spread fire whereas PIN flame retardant cable do not. Four tests looked at spread between electrical cabinets, through the cabinet wall and via floor or ceiling trays of cables close to the cabinets. Poorly fire rated PVC cables (IEC/EN 60332-1-2) were compared to non-halogenated flame retardant cables (meeting IEC/EN 60332-3 -22, -23, -24 and also smoke density and acidity IEC/EN 61034-2 and IEC/EN 60752-2). Fire spread via the cable trays, leading to ignition of components in adjacent cabinets, occurred when the cables were halogenated with poor fire rating, but not when the cables were PIN FR, for cable trays both above and below the cabinets. Fire showed to also spread directly from one cabinet to another if temperatures in the second cabinet reached 600°C, despite metal cabinet walls separated by an airgap.

"spread between adjacent electrical cabinets connected by cable trays", P. Zavaleta, S. Suard, Fire Safety Journal 140 (2023) 103872
https://doi.org/10.1016/j.firesaf.2023.103872

Intense fire resistant PIN polyamide for EVs

Ascend Performance Materials' PIN FR PA66 resistant to 1100°C flame for 15 minutes for electric vehicle battery safety. The non-halogenated flame retardant performance polymer offers fire protection performance to SAE AS5127 (aerospace specification), better than aluminium, and will contribute to ensuring passenger safety in case of battery failure and thermal runaway. The PIN polyamide also offers mechanical integrity at 350°C, improved abrasion resistance, ultrasonic weld line strength, UL 94 V-0 @ 0.8 mm, glow wire GWFI 960°C and EN 45545 (railway specifications) rating R22: HL3. The material can be glass-fibre reinforced, brightly coloured and can be injection moulded using standard polyamide processing equipment. In June 2023, Ascend indicated that with its fire performance and vibration damping compounds, the company sells 25-30% more material into electric vehicles than internal combustion vehicles.

"New materials create safer, quieter EVs", PRN 13/10/2022
https://www.prnewswire.com/news-releases/new-materials-create-safer-quieter-evs-301647886.html and Ascend Starflam-X pages
https://www.ascendmaterials.com/products/our-brands/starflam/starflam-x-protect/ and June 2023
https://www.icis.com/explore/resources/news/2023/06/05/10893165/ascend-performance-materials-sharpens-focus-on-ev-transition-carbon-footprint-ceo/

PIN FRs for fire safety of recycled textiles

Insulation panels produced from of end-of-life textiles must be fire safety treated for safe use in buildings. In this study, an insulating panel material made from recycled automotive textiles (seats, ceiling upholstery, foot pads, anti-noise …) with polyurethane binding were tested with three commercial PIN flame retardants (from Tüchler & Bühnen, Isonem and HolzProf) by spraying and by dipping and compared to control (no FR treatment). All three PIN FRs showed to be effective, with dipping ensuring no ignition and reduction in heat release of 25 – 40%, suggesting that EU CPR construction products fire class B - D could be achieved (but this would need to be validated by SBI testing).

"The effect of flame retardants on the fire technical characteristics of recycled textiles", A. Danihelova et al. J. Industrial Textiles 2023
https://doi.org/10.1177/15280837231202526

OTHER NEWS

"Substitute" brominated flame retardants (BFRs) found in US breast milk. Milk from 50 mothers in or around Seattle was analysed for 66 BFRs: 37 PBDES or metabolites (a class of BFRs which has been largely phased out), 8 bromophenols and 8 other substitute BFRs. PBDEs were found in 100% of women's breast milk at median 15 parts per billion (ppb = ng/g), confirming a decline over the last decade (corresponding to phase-out). Bromophenols were found in 88% of samples (median c. 1 ppb). The other BFRs were found only in a few samples, except PBBZ (a pentabromobenzene) in 88%. Exposure estimates for breastfed infants suggest exceedance of EPA risk reference doses for PBDEs in c. 10% (5/50 women). To date, reference doses are not defined for the substitute BFRs. The authors note that the results show that "legacy" BFRs and new "substitute" BFRs are both now found in US mothers' breast milk.

"Brominated flame retardants in breast milk from the United States: First detection of bromophenols in U.S. breast milk", E. Schreder et al., Environmental Pollution 334 (2023) 122028
https://doi.org/10.1016/j.envpol.2023.122028

Possible release of brominated FRs from microplastics. Simulations using synthetic sweat and sebum and microplastics (polyethylene, polypropylene and polystyrene) containing PBDEs or HBCD suggested that 1 – 2% of the brominated FR could be dermally bioaccessible. Bioaccessibility was around twice as high in <0.45 mm diameter microplastics compared to 3 – 4 mm pellets. Addition of cosmetics (antiperspirant, foundation, moisturiser, sunscreen) increased bioaccessibility in some cases. The authors estimate that dermal exposure to brominated FRs in household dust microplastics could be as significant as from FR-containing materials.

"Novel Insights into the Dermal Bioaccessibility and Human Exposure to Brominated Flame Retardant Additives in Microplastics", O. Abafe et al., Environ. Sci. Technol. 2023, 57, 10554−10562, https://doi.org/10.1021/acs.est.3c01894

Review of toxicity of organo-phosphorus (OPFRs) and currently used halogenated FRs (HFRs) and of their metabolites. 69 studies were analysed , covering four alkyl OPFRs, five aryl OPFRs and fifteen chlorinated or brominated FRs. Principal metabolites of OPFRs are identified as di-alkyl phosphates (DAPs) and hydroxylated OPFRs. These are concluded to have low bioaccumulation potential but possible developmental toxicity and endocrine effects. The metabolites of the current brominated FRs are considered to have high stability in animal bodies and possible cytotoxicity, neurotoxicity, genotoxicity and hormone or endocrine effects. The authors conclude that more research is needed on the metabolism of recent FRs in different organisms and across food webs, and on effects of co-exposure to FRs and to their metabolites.

FRs considered:
- alkyl-OPFRs :tributyl phosphate (TNBP), tris(2-butoxyethyl) phosphate (TBOEP), tri(2-ethylhexyl) phosphate (TEHP), and tripropyl phosphate (TPRP)
- aryl-OPFRs [tripheny phosphate (TPHP), tricresyl phosphate (or so-called tris(methylphenyl) phosphate) (TCP or so-called TMPP), cresyl diphenyl phosphate (CDP), 2-ethylhexyl diphenyl phosphate (EHDPHP), and bisphenol A bis (diphenylphosphate) (BPA-BDP)
- halogenated FRs: TBB, tis(2-ethylhexyl)-2,3,4,5-tetrabromophtalate (TBPH), pentabromotoluene (PBT), pentabromophenol (PBP), hexabromobenzene (HBB), pentabromoethylbenzene (PBEB), 2,3,4,5-tetrabromo-6-chlorotoluene (TBCT), tribromophenol (TBP), 2,4,6-tribromophenyl allyl ether (ATE), and pentabromobenzyl acrylate (PBBA), DBDPE, BTBPE, tetrabromobisphenol A-bis(2,3-dibromopropylether) (TBBPADBPE), tetrabromoethylcyclohexane (TBECH), dechlorane plus, tris(2-chloroethyl) phosphate (TCEP), tris(2-chloroiso-propyl) phosphate (TCPP), and tris(2-chlorol-chloromethy) phosphate (TDCPP).

"The metabolism of novel flame retardants and the internal exposure and toxicity of their major metabolites in fauna - a review", R. Hou et al., Environ Expo Assess 2023;2:10 https://dx.doi.org/10.20517/jeea.2023.08

PBDE brominated FRs correlated to oxidative stress markers. Data for 8028 persons from the NHANES cohort (US National Health and Nutrition Examination Survey) were analysed for correlations between serum PBDE (nine PBDEs, tri- to deca-BDE) and metabolic indicators of oxidative stress (bilirubin, CGT). After controlling for covariables, all except one of the PBDEs (a penta congener) and total PBDE were associated to bilirubin. The authors note that this apparent correlation requires verification by a larger cohort study but that it corresponds to evidence from in vitro and in vivo animal studies.

"Association between brominated flame retardants exposure and markers of oxidative stress in US adults: An analysis based on the National Health and Nutrition Examination Survey 2007–2016", L. Han, Q. Wang, Ecotoxicology and Environmental Safety 263 (2023) 115253 https://doi.org/10.1016/j.ecoenv.2023.115253

Prenatal organophosphate ester metabolite (OPEm) exposure and preschool cognitive processes. Levels of four OPEms (list below) in one sample of 340 mothers' urine at 17 weeks pregnancy were compared to EF (Executive Function = attention span, vocabulary, assertiveness) of offspring 6 – 36 months. The main sources of these OPEms may not be FRs. Attempts were made to correlate out cofactors such as fish consumption or income. BBOEP and BDCIPP were above LOD in less than half of the urine samples. DnBP was generally associated with worse EF. DPhP, BBOEP and BDCIPP did not show consistent associations. These results are partly consistent with nine other identified studies looking at OPEms and neurodevelopment. The authors conclude that data is largely inadequate.

OPEms analysed: DPhP = Diphenyl-phosphate, DnBP = di-n-butyl-phosphate, BBOEP = bis(2-butoxyethyl) phosphate, BDCIPP = bis(1,3-dichloro-2-propyl) phosphate.

"Prenatal organophosphate ester exposure and executive function in Norwegian preschoolers", A. Hall et al., Environ Epidemiol. 2023 Jun 5;7(3):e251, https://doi.org/10.1097/ee9.0000000000000251

PUBLISHER INFORMATION

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