

Additional information relating to the draft risk management evaluation on Dechlorane Plus

Table of contents

| | |
|---|----|
| Table 1. The chemical identity of Dechlorane Plus, with its <i>syn</i> - and <i>anti</i> -isomers..... | 2 |
| Table 2. Overview of selected physicochemical properties of Dechlorane Plus, with its <i>syn</i> - and <i>anti</i> -isomers | 3 |
| Table 3. National regulatory processes and other related information for Dechlorane Plus and its isomers | 4 |
| Table 4. Global production volumes for DP, in tonnes/year..... | 5 |
| Table 5. Global trade volumes of DP, t/y (Eftec 2021; Annex E and F Republic of Korea and UK) | 6 |
| Table 6. Summary of uses of DP found in open literature as identified in ECHA (2022) | 7 |
| Table 7. Uses according to REACH registrations (ECHA, 2022b) | 8 |
| Table 8. Information on use from stakeholders (ECHA, 2022b,c) | 9 |
| Table 9. Information on use from Annex F information..... | 11 |
| Table 10. Table 1 Use of DP in the automotive industry (from Eftec, 2021)..... | 13 |
| Table 11. Concentration of DP in thermoplastics and thermosets, based on information from 2007 and 2009 as identified in ECHA (2022b)..... | 13 |
| Table 12. Use of DP in specific polymer types | 14 |
| Table 13. Use of DP in materials other than polymers (ECHA, 2022) | 17 |
| Table 14. Concentration of DP in components in cars, motorcycles and explosives as reported by stakeholders (Eftec, 2021)..... | 19 |
| Table 15. Global emissions of DP after wastewater treatment, by primary emission source (Eftec, 2021)..... | 20 |
| Table 16. Estimated total global releases for DP after wastewater treatment (Eftec, 2021)..... | 20 |
| Table 17. Emission reduction under each of the three restriction scenarios presented in tonnes per year as presented in the Annex to the EU restriction proposal | 21 |
| Table 18. Shortlist of potential alternatives to DP (adopted from ECHA, 2022,b)..... | 21 |
| Table 19. Identified alternatives to DP in its function as both a flame retardant and as an extreme pressure additive in grease/lubricant (adopted from ECHA, 2022,b) | 24 |
| Table 20. Available information on the most likely alternatives to DP as a flame retardant | 25 |
| Table 21. Available information on the most common alternatives to DP used in lubricants..... | 25 |
| Figure 1. Continued emissions (t/y) under the baseline (central estimate) and the three restrict options (ROs) over the period 2023-2042..... | 26 |

Table 1. The chemical identity of Dechlorane Plus, with its syn- and anti-isomers

| | |
|--------------------|--|
| CAS number: | 13560-89-9 (Dechlorane Plus TM), 135821-03-3 (<i>syn</i> -DP), 135821-74-8 (<i>anti</i> -DP) |
| IUPAC name: | 1,6,7,8,9,14,15,16,17,17,18,18-dodecachloropentacyclo-[12.2.1.1 ^{6,9} .0 ^{2,13} .0 ^{5,10}] octadeca-7,15-diene (Dechlorane Plus TM), (1S,2S,5R,6R,9S,10S,13R,14R)-1,6,7,8,9,14,15,16,17,17,18,18-dodecachloropentacyclo[12.2.1.1 ^{6,9} .0 ^{2,13} .0 ^{5,10}]octadeca-7,15-diene (<i>syn</i> -DP), (1R,2R,5R,6R,9S,10S,13S,14S)-1,6,7,8,9,14,15,16,17,17,18,18-dodecachloropentacyclo[12.2.1.1 ^{6,9} .0 ^{2,13} .0 ^{5,10}]octadeca-7,15-diene (<i>anti</i> -DP) |
| EC number: | 236-948-9 |
| EC name: | 1,6,7,8,9,14,15,16,17,17,18,18-Dodecachloropentacyclo[12.2.1.16,9.02,13.05,10] octadeca-7,15-diene |
| Molecular formula: | C ₁₈ H ₁₂ Cl ₁₂ |
| Molecular weight: | 653.73 g/mol |
| Synonyms: | Bis(hexachlorocyclopentadieno)cyclooctane; 1,2,3,4,7,8,9,10,13,13,14,14-Dodecachloro-1,4,4a,5,6,6a,7,10,10a,11,12,12a-dodecahydro-1,4:7,10-dimethanodibenzo[<i>a,e</i>]cyclooctene; 1,4:7,10-Dimethanodibenzo[<i>a,e</i>]cyclooctene 1,2,3,4,7,8,9,10,13,13,14,14-dodecachloro-1,4,4a,5,6,6a,7,10,10a,11,12,12a-dodecahydro-; Dodecachlorodimethanodibenzocyclooctane; Dodecachlorododecahydrodimethanodibenzocyclooctane; Dodecachlorododecahydrodimethanodibenzocyclooctene; DDCDiMeDiBzcOb |
| Trade names | Dechlorane Plus; Dechlorane Plus 25 (Dech Plus); Dechlorane Plus 35 (Dech Plus-2); Dechlorane Plus 515; Dechlorane 605; Dechlorane Plus 1000; Dechlorane Plus 2520; Dechlorane A; DP; Escapeflam DK-15 (China); PyroVex SG (grade 515, 25 and 35) |

Table 2. Overview of selected physicochemical properties of Dechlorane Plus, with its *syn*- and *anti*-isomers

| Property | Value | Reference |
|---|---|-------------------------------|
| Physical state at 20 °C and at 101.3 kPa | Solid white powder | ECHA, 2017b |
| Melting/freezing point | 340-382 °C 350 °C | ECHA, 2017b OxyChem, 2004b |
| Vapour pressure | 0.006 mm Hg \cong 0.8 Pa (at 200 °C) | OxyChem, 2004b |
| Water solubility* | <1.67 ng/L (20 – 25 °C) 0.044 – 249 μ g/L (insoluble) | ECHA, 2017b OxyChem, 2004b |
| n-Octanol/water partition coefficient, K_{ow} (log value) | 9.3 | OxyChem, 2004b |
| n-Octanol-air partition coefficient K_{oa} (log value) | 12.26 | OxyChem, 2004b |
| Sediment/water partition coefficient K_p (log value) | 6.65 | OxyChem, 2004b |
| Air-water partition coefficient K_{aw} (log value) | The following log K_{AW} values are estimated at 25 °C -3.2 (from measured water solubility and estimated vapour pressure) 0.44 (from measured water solubility and vapour pressure) -2.8 (from EPIWIN **predicted water solubility using log K_{OW} of 9 and vapour pressure) -3.5 (from HENRYWIN***v.3.20, predicted from structure using Bond Method). | ECHA, 2017b |

* There is some uncertainty in the precise value for water solubility (Chou et al. (1979a)). However, all available measurements and predictions agree that the substance is very poorly water soluble.

The following modelling programs are individual models in EPI Suite™:

** Estimation Program Interface Suite for Windows

*** Calculates the Henry's Law constant (air/water partition coefficient) using both the group contribution and the bond contribution methods. Since the group contribution method is not applicable to DP due to fragments missing in the database, only the result of the bond contribution method is shown.

Table 3. National regulatory processes and other related information for Dechlorane Plus and its isomers

| Country/ organisation | Regulatory process |
|--------------------------|--|
| Canada | <p>DP is listed on Canada’s Domestic Substances List (DSL) (ECCC, 2019). A final screening assessment of DP was published by Environment and Climate Change Canada (ECCC) and Health Canada in spring 2019 (Canada, 2019a). The assessment concludes that DP meets the criteria for toxicity to the environment, as it is entering or may enter the environment in a quantity or concentration or under conditions that have or may have an immediate or long-term harmful effect on the environment or its biological diversity. The proposed regulatory approach is to amend the <i>Prohibition of Certain Toxic Substances Regulations, 2012</i> to prohibit the manufacture, import, use, sale or offer for sale of DP and all products containing the substance (Canada, 2019b). A cost benefit analysis will be available following the publication of the Regulatory Impact Analysis Statement (RIAS), which will be published concurrent to proposed changes to the Prohibition of Certain Toxic Substances Regulations, 2012. The publication is targeted to take place in 2022 (Annex F, Canada).</p> |
| Egypt | <p>DP is banned by Decree No. 55 year 1996 of the Minister of Trade (Annex E, 2021). DP is banned as a pesticide with decree no.719 in 2005. (Annex F, 2022).</p> |
| European Union | <p>The ECHA online Classification & Labelling (C&L) Inventory database, which was checked on 8 March 2021, reports a joint submission (consisting of 151 notifiers) indicating no classification according to the CLP criteria. In addition, 99 notifiers have classified the substance as Acute Toxicity Category 4, H332 Harmful if inhaled (ECHA, 2021).</p> <p>In 2018, based on an Annex XV dossier and Risk Management Options Analysis prepared by the United Kingdom, DP (including its <i>syn</i>- and <i>anti</i>-isomers) were identified as SVHC and added to the REACH Candidate List as they are considered to be very persistent and very bioaccumulative substances (ECHA, 2017a). Suppliers of articles containing a SVHC in a concentration above 0.1% (weight by weight) have to provide recipients of the article with sufficient information to allow the safe use of the article. As a minimum, the name of the substance in question has to be communicated. Upon request from a consumer, the supplier has to provide safety data sheet, within 45 days.</p> <p>Based on its intrinsic properties in combination with high volume and widespread use, ECHA recommended in October 2019 to include DP in Annex XIV of the REACH Regulation (List of Substances Subject to Authorization). However, to align risk management activities within the EU with the evaluation process under the Stockholm Convention, an Annex XV REACH restriction dossier for DP has been prepared. Norway was responsible for developing the restriction proposal (ECHA 2021). The restriction process in the EU is still ongoing (https://echa.europa.eu/da/registry-of-restriction-intentions/-/dislist/details/0b0236e184a168c4)</p> |
| New Zealand | <p>DP is listed on New Zealand’s Inventory of Chemicals but does not have its own approval under the Hazardous Substances and New Organisms Act. This means it can only be used as a component of products that are covered by group standards (Annex E information, New Zealand).</p> |
| Norway | <p>In Norway, DP was added to the list of priority substances in January 2019 with a national goal to phase out the use by 2020 (Norwegian Environment Agency, 2019b).</p> |
| Thailand | <p>DP is not yet classified under the Hazardous Substance Act B.E. 2535 (1992). However, DP is regulated under the notification of the Ministry of Industry, Thailand on Account no 5.6. Manufacturers and importers are required to report imports of chemicals/products with tonnage above 1000 kg/year. At present, there is no data on available import volumes and usage in Thailand (Annex E information, Thailand)</p> |

| Country/ organisation | Regulatory process |
|------------------------------------|---|
| Russian Federation | The presence of this substance in the "Unified List" is evidence of the fact of its circulation on the Russian Federation national territory, but not of its production of the Russian manufacturers. This substance supplied to the Russia by Importers or Only representatives of import manufacturers and not produced in the Russian Federation (Annex E Russian Federation, Federal State Autonomous Institute Research Institution 'Environmental Industrial Policy Center' (EIPC) (Update to Annex E information in January 2022). |
| United States of America | DP is listed under the Toxic Substances Control Act (inventory and is subject to the Chemical Data Reporting Rule, which requires manufacturers and importers to provide the United States Environmental Protection Agency with production, import and use volumes, as well as other relevant information (US EPA, 2020). |
| International Chemical Secretariat | DP has been listed on the International Chemical Secretariat's ChemSec Substitute It Now (SIN) List since 2014 (SIN List, 2020). The SIN List consisting of chemicals that have been identified by ChemSec as being SVHC, based on the criteria defined within REACH, the EU chemicals legislation. |

Table 4. Global production volumes for DP, in tonnes/year (Eftec, 2021)

| Region | 1986 - 2002 | 2003 - 2008 | 2008 - 2010 | > 2011 |
|---------------|--------------------------|--------------------------|----------------------------------|-----------------------|
| USA | 450 – 4 500 ¹ | 450 – 4 500 ² | n/a | withheld ² |
| China | 0 | 300 – 1 000 ³ | 300 – 1 000 ³ | n/a |
| Global | 450 – 4 500 | 750 – 5 500 | 4 500 – 5 000⁴ | n/a |

Note: Global production volumes between 1986-2008 are calculated from production volumes in the USA and China.

¹ ECHA (2020b); Qiu et al. (2007)

² US EPA (2016)

³ Canada (2019); ECHA (2020b); Wang et al. (2010b)

⁴ Wang et al. (2010b); Feo et al. (2012); Ren et al. (2009)

Note: These references can be found in the original report (Eftec, 2021).

Table 5. Global trade volumes of DP, t/y (Eftec 2021; Annex E and F information from Republic of Korea and UK)

| Region | 2000 | 2003-2006 | 2008 | 2011 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---------------------|------------------|---------------------|--|--------------------|------|------|--------------------|----------------------------|-----------------------------|--------------------|-----------------------|
| Sweden | | 4 - 11 ⁵ | 0 ⁶ | | | | | | | | |
| Finland | | | 0 | | | | | | | | |
| Norway | | | 0 ⁶ | | | | | | | | |
| UK* | | | | | | | | 14-40 | 14-40 | 14-40 | |
| EU/EEA | 800 ⁶ | | 200 ⁷ – 5,000 ⁸ | | | | | 100- 1,000 ⁹ | 100- 1,000 ¹⁰ | <300 ¹¹ | 10- 100 ¹² |
| Canada | | | 1-10 ¹³ | 1-10 ¹³ | | | 1-10 ¹³ | | | | |
| Republic of Korea** | | | | | 10 | | 10 | | 0.63 | | |

Note: - Only years for which data was available are included.

- Blank cells indicate that no data on import volumes was found for the country/region in the specific year.

* Annex F information DP used per annum in the UK have been estimated based on extrapolated data from the EU registration and the estimation of imports of dechlorane plus into the UK.

** Annex E and F information

⁵ IVL, 2010; ECHA, 2020a

⁶ IVL, 2010

⁷ EA, 2018

⁸ ECHA, 2021

⁹ ECHA, 2017a

¹⁰ ECHA, 2019a

¹¹ ComRef, 2019C

¹² ECHA, 2020c

¹³ ECCC, 2019

Note: These references can be found in the original report (Eftec, 2021).

Table 6. Summary of uses of DP found in open literature as identified in ECHA (2022b)

| Industry | Sector | Article / Component |
|-------------------------------------|-------------------------------------|--|
| Automotive | Electrical and electronic equipment | Wires and cable plastic coatings, coil bobbins, ¹⁴ cable straps |
| | | Switches, and small electronic appliances including cameras, computers (motherboards, chargers and hard-plastic connectors) |
| | Engines | 2-part epoxy-void fillers |
| | Other | Bodywork parts |
| Aviation | Electrical and electronic equipment | Wires and cable plastic coatings, coil bobbins, cable straps |
| | | Switches, and small electronic appliances including cameras, computers (motherboards, chargers and hard-plastic connectors) |
| | Engines | 2-part epoxy-void fillers |
| Electrical and electronic equipment | Wire and cables | Wire and cable plastic coatings not used in the automotive or aviation industry, including cable insulation and nuclear power plant control cables |
| | Electronic devices | Electronic devices not used in the automotive or aviation industry, including mobile phones, lamps refrigerators, computer and washing machines |
| Building / manufacturing materials | Plastic products | Plastic roofing materials, wallpaper, paint, pipes, flooring, power tool housing and wall plates |
| Other consumer products | Plastic products | (Plastic) toys |
| | | Food packaging |
| | Textiles | Clothing, mattresses, curtains, carpets and (textile) toys |
| | Adhesives | Adhesives and binding agents, syntactic foams and potting compounds |

¹⁴ A coil bobbin refers to the plastic containers used to keep wire enabling it to retain shape and rigidity. Additionally, coil bobbins are used to ease assembly of the windings into or onto a magnetic core.

Table 7. Uses according to REACH registrations (ECHA, 2022b)

| Registered uses | End use/final product and articles (according to use descriptions explicitly listed in registration dossiers) |
|--------------------------|--|
| Formulation | Relevant chemical product categories for which Dechlorane Plus is used in pure form: PC 1: Adhesives, sealants PC 32: Polymer preparations and compounds PC 33: Semiconductors |
| Uses at industrial sites | Relevant sectors of end use for which Dechlorane Plus is used, whereby subsequent service life is not relevant for this use: SU 10: Formulation [mixing] of preparations and/or re-packaging (excluding alloys) SU 12: Manufacture of plastics products, including compounding and conversion SU 16: Manufacture of computer, electronic and optical products, electrical equipment |
| Article service life | Article category related to subsequent service life of articles at consumer use stage: AC 1: Vehicles AC 2: Machinery, mechanical appliances, electrical/electronic articles AC 3: Electrical batteries and accumulators AC 5: Fabrics, textiles and apparel AC 13: Plastic articles Article category related to subsequent service life of articles at industrial sites (by workers): AC 1: Vehicles AC 2: Machinery, mechanical appliances, electrical/electronic articles |

Table 8. Information on use from stakeholders (ECHA, 2022b,c)

| Sector / industry group | Use | Quantity | Reference | |
|-------------------------------|---|---|---|--|
| Aerospace and defence | Estimates of use in European Economic Area (EEA) based on preliminary responses | EEA Production | 200 kg/y | Industries Association of Europe |
| | | EEA Repair | 600 kg/y | |
| | | EEA Imported and premanufactured articles | 800 kg/y | |
| Automotive | Vehicle including automobile, construction, machinery, agriculture etc. | Wire harness, adhesive, tape and ‘diallyl phthalate prepolymer’ | - 140 tons per year of the production volume of DP is used in Automobile Industries - Concentrations of DP in final products are < 0.1% - 200 g DP per vehicle in average | Japan Auto Parts Industries Association (JAPIA) |
| | | <u>The main materials and its purpose:</u> - Polymers used in parts that require flame retardance - Greases used in parts that require seizure resistance | | |
| | | PDAP resin | | |
| | | Spare parts | | |
| Automotive | Motorcycle | Legacy spare parts | | ACEM - The Motorcycle Industry in Europe |
| Automotive | Vehicle | Legacy spare parts | | All-Terrain Vehicle Industry European Association |
| Agricultural machinery | Long-lived agricultural machinery used by farmers | Flame retardance and seizure resistance used in agricultural machinery for components such as harnesses, polymers, greases | | Japan Agricultural Machinery Manufacturers Association |
| | | Repair and spare parts | | |
| Marine leisure | | Flame retardant and anti-seize compound in products used in engines/powertrains in the marine leisure industry, including wire harnesses, adhesives, tape and grease for marine power equipment | Typical concentrations in products used are 13-20%w/w in coating of electric wires, 20-25%w/w in grease | The Marine Engine Committee (IMEC) of the International Council of Marine Industry Associations (ICOMIA) |

| Sector / industry group | Use | Quantity | Reference |
|--|--|--|---|
| Electrical and electronic equipment | Electric and electronic equipment including products with longer design cycle, such as production machinery and infrastructure equipment | Spare parts, repaired or refurbished products | Japan Electronics and Information Technology Industries Association (JEITA) |
| Electrical and electronic equipment | Electrical and electronic equipment | Spare parts, refurbishment and resale of older products | DIGITALEUROPE - The association representing the digital technology industry in Europe |
| Electrical and electronic equipment | Electrical and electronic equipment | Additive in thermoset plastic, thermoset plastic mixtures and articles made from Dechlorane-bearing thermoset plastic mixtures | Typical concentration about 8% |
| | | Coil forms and coil assembly mounts, such as bobbins, bases, and headers, and inductors, transformers, and other passive electromagnetic components | |
| Medical | Medical imaging including X-ray equipment, CT-equipment, PET/SPECT MRI-equipment, LINACs, Particle Therapy, Brachytherapy, Stereotactic body radiosurgery, Ultrasound equipment etc. | Electrical cables & ductwork, plastic in electrical wire coatings, hard plastic electrical connectors, Printed Circuit Board items, monitor/display interfaces, other plastic electronic parts | European Trade Association representing the medical imaging, radiotherapy, health ICT and electromedical industries (COCIR) |

Table 9. Information on use from Annex F information

| Sector / industry group | Use | Reference | |
|--------------------------------|--|--|--|
| Aerospace and defence | Aero engine manufacture and repair | Flame retardant in fillers; Affected parts include aircraft jet engine fan blade abradable rub strips and the use of DP includes the related void filling abradable compound for manufacturing and repair | International Coordinating Council of Aerospace Industries Associations (ICCAIA) |
| | Missile rocket motors | Flame retardant | |
| | Electrical items | Connectors, wires, cables, switches, tapes, films, power supplies, gaskets, transceivers, monitors, inductors, printed circuit boards and transformers | |
| | Structural panels | Epoxy adhesives, syntactic foams, potting compounds; Adhesives containing DP are used to fill honeycomb edges in panels, liners, partitions and stowage | |
| | Naval systems | Fire retardant in polymeric components of articles used for the manufacture and maintenance of some naval systems | |
| | Aircraft cabin interiors | Adhesives, syntactic foams, honeycomb core edge fillers/potting compounds | |
| Automotive | Automobile | Legacy spare parts | European Automobile Manufacturers' Association (ACEA) |
| Automotive | Automobile including motorcycles, agricultural machinery, and construction machinery | Flame retarded resins including Polydiarylpthalate (PDAP) resin, Flame retarded/Insulating/Heat resistant; Adhesive tape, Adhesive, Filler, Grease, Electric and electronic parts (Wire harness, Connector, Cable, Cable protection tube, Coil, Solenoid, Bobbin, Case, Motor, Transformer, Substrate, Sensor, Inductor, Inverter, Converter, Alternator, Thermostat, Thermistor, Noise filter, Electronic Control Unit, Gateway device, Communication terminal, Electric fan, Lump, Display, Touch panel, Power supply, Lighting device, Charger, Switch, Electromagnetic valve, IC), Gear lever, Hose/Tube, Steering | Japan |
| Railway | | | |
| Industrial machinery | Semiconductor manufacturing equipment, Automatic vending machinery, hydraulic equipment, Bearing, Machine tool, Electric equipment, Sewing machinery, Air-conditioning and Refrigerating | | |

| Sector / industry group | Use | Reference |
|--|--|--|
| | equipment, Forming machinery, Die-casting machinery etc. | shaft, Oil filter, Clutch, Starter, Antenna, Hot wire film, Car audio, Air conditioner, Heat exchanger, Scale, Water absorption sheet, USB |
| Medical | Medical instrument | |
| Electrical and electronic equipment | Analytical, Measuring, Testing, Monitoring Controlling equipment, Battery, Information and communication network equipment, Electronic information system, Lighting equipment, Home electronic appliance | |
| Construction | Housing, Construction, | |
| Material | Chemical and related materials | |
| Financial | | |
| Aerospace and defence | | |
| Other | Infrastructure equipment including Wiring system, Gas alarming equipment, Gas and oil equipment, Heavy electric machinery etc. | |

Table 10. Table 1 Use of DP in the automotive industry (from Eftec, 2021)

| Use/application | Share of total volume |
|--|-----------------------|
| Electric wire (with wire harnesses being specifically mentioned) | 80% |
| Plastic and rubber parts | 8% |
| Tapes and adhesives | 10% |
| Greases (extreme pressure agent) | 2% |

Table 11. Concentration of DP in thermoplastics and thermosets, based on information from 2007 and 2009 as identified in ECHA (2022b)

| Type of polymeric system | Product type | Concentration of Dechlorane Plus | Reference |
|--------------------------|-------------------------------|----------------------------------|---|
| Thermoplastic | ABS | 16.9% | OxyChem (2007) |
| | Natural rubber | 18.7% | |
| | Nylon | 0–35% | KemI (2007) and Weil and Levchik (2015) |
| | Polybutylene terephthalate | 8–18% | OxyChem (2007) |
| | Polyester | 0–16% | KemI (2007) |
| | Polypropylene | 20–35% | OxyChem (2007) |
| | SBR block copolymer | 30% | |
| Thermoset | Epoxy resins | 25.5% | OxyChem (2007) |
| | EPDM | 33% | |
| | Neoprene | 10% | |
| | Polyester resins, unsaturated | n/a | |
| | Polyethylene, cross-linked | 25.5% | |
| | Polyurethane foam | 17.5–35% | |
| | Polyurethane rubber | 20–30% | |
| | Silicon rubber | 18.8–40% | |

Note: Other relevant polymer systems for DP referred to in OxyChem product literature as of 2007 are: Chloroprene; DAP; EEA; Phenolics; EPR; EVA; Hypalon®; Hytrel®;Kraton; High Impact Polystyrene; and TPE (ECHA, 2022b).

Table 12. Use of DP in specific polymer types

| Polymer (or other substrate) | Application type | Notes on technical function, loading rate and synergist systems | Comments |
|---------------------------------------|---|--|--|
| Thermoplastic polymers | | | |
| Acrylonitrile butadiene styrene (ABS) | Resin | FR at 16.9% with antimony trioxide synergist (OxyChem, 2007) FR typical loading ~20% in ABS in appliances (ESD, OECD, 2004) | UV stability, high heat distortion temperature, and no blooming are particularly mentioned (OxyChem, 2007) |
| Natural rubber | Elastomers [Elastomer adhesives] | FR at 18.7% with antimony trioxide (OxyChem, 2007) | No further information found |
| Nylon | Fibre reinforced polymer | FR at 10-25% in presence of inorganic synergist (zinc, antimony, iron compounds) (OxyChem, 2007) | |
| Nylon | Connectors, switches, cable straps, power tool housing and wall plates | FR at 11-22% in presence of inorganic synergist (zinc, antimony, iron compounds) (OxyChem, 2007) | “The synergist selected is a very important factor in determining the physical and electrical properties of the final formulation.” (OxyChem, 2007) Confirmed and significant commercial use of DP |
| Nylon coating | Wire and cable / cable coatings; cable jackets | FR at 11-22% in presence of inorganic synergist (zinc, antimony, iron compounds) (OxyChem, 2007) For ‘high CTI’ fibre-reinforced nylon, important for electrical insulation function: 11.2% in presence of synergist (zinc, antimony, melamine compounds) (OxyChem, 2007) | “The synergist selected is a very important factor in determining the physical and electrical properties of the final formulation.” (OxyChem, 2007) |
| Polybutylene Terephthalate (PBT) | Connectors, switches, cable straps, power tool housing and wall plates | FR at 15.2-15.75% with antimony trioxide synergist (‘high CTI’) (OxyChem, 2007) | |
| Polybutylene Terephthalate (PBT) | Fibre reinforced polymer | FR at 8-18% with synergists (antimony trioxide) (OxyChem, 2007) | |
| Polyolefin Polyethylene | Wire and cable / cable coatings; cable jackets [Thermoplastic adhesives] | FR at ~25% in presence of inorganic synergist (antimony) (OxyChem, 2007) | Confirmed and significant commercial use of DP |
| Kraton | Elastomers | FR at 30% with antimony trioxide (OxyChem, 2007) | No further information found |

| Polymer (or other substrate) | Application type | Notes on technical function, loading rate and synergist systems | Comments |
|--|---|--|---|
| TPU, Thermoplastic urethanes | Elastomers | FR at 16% with antimony trioxide (OxyChem, 2007) | No further information found |
| TPU, Thermoplastic urethanes | Potting compounds | | No further information found |
| Ethylene vinyl acetate (EVA) | Wire and cable / cable coatings; cable jackets [Thermoplastic adhesives] | FR at 25% in presence of inorganic synergist (antimony) (OxyChem, 2007) | Electrical properties, thermal stability and colourability; char formation and non-dripping, low smoke (OxyChem, 2007) |
| Expanded polystyrene | Foams / sound-absorbing panels | | Relevance in EU is uncertain |
| Polyvinyl chloride (PVC) | PVC line pipes | | Relevance in EU is uncertain |
| Thermoset polymers | | | |
| Cross-linked PE (XLPE) | Wire and cable / cable coatings; cable jackets | FR at ~25.5% in presence of inorganic synergist (antimony) (OxyChem, 2007) | Electrical properties, thermal stability, and colourability; char formation and non-dripping, extremely low smoke (OxyChem, 2007) |
| Epoxy | 2-part Epoxy void filler / potting compound / syntactic foam [thermoset polymer adhesives] | FR at <15% | Exceptionally stringent qualification requirements apply in this sector (Rolls Royce PLC, comments received in 2019 to ECHA's Draft 9th Recommendation for DP [for inclusion of substances in Annex XIV of REACH]) Confirmed commercial use of DP |
| Epoxy resin | Resin | FR at 25.5% with synergists (antimony, zinc or iron compounds); Filler (OxyChem, 2007) | Choice of synergist can affect amount of smoke production (OxyChem, 2007) |
| Ethylene/propylene diene monomer elastomers (EPDM) | Wire and cable / cable coatings; cable jackets | FR at 33% in presence of inorganic synergist (antimony) (OxyChem, 2007) | Electrical properties, thermal stability, and colourability; char formation and non-dripping (OxyChem, 2007) |
| Ethylene/propylene diene monomer elastomers (EPDM) | Nuclear power plant control cable (Wire and cable / cable coatings; cable jackets) | FR at 33% in presence of inorganic synergist (antimony) (OxyChem, 2007) | Electrical properties and colourability; char formation and non-dripping (OxyChem, 2007) |
| Hypalon | Elastomers | FR at 5-6% with antimony trioxide (OxyChem, 2007) | No further information found |

| Polymer (or other substrate) | Application type | Notes on technical function, loading rate and synergist systems | Comments |
|-------------------------------------|--|--|---|
| Neoprene | Elastomers [Elastomer adhesives] | FR at 10% with antimony trioxide (OxyChem, 2007) | No further information found |
| Phenolic resin | Paper laminated resin [Structural adhesives] | FR at 12.9% with synergist (antimony oxide); Filler (OxyChem, 2007) | |
| Polypropylene Talc-reinforced PP | Moulded parts / other plastics / circuit board / motherboard & components / chargers / appliance parts | FR at 20-35% in presence of synergist (antimony, zinc compounds) (OxyChem, 2007) | Colourability and non-drip useful (OxyChem, 2007) |
| Polypropylene | Moulded / extruded parts / other plastics / hard plastics | FR at 20-35% in presence of synergist (antimony, zinc compounds) (OxyChem, 2007) | Colourability and non-drip useful (OxyChem, 2007) |
| Silicon rubber | Elastomers [Elastomer adhesives] | FR at 18.8-40% with antimony trioxide (OxyChem, 2007 manual) | No further information found |
| Silicon rubber | Potting compounds | | No further information found |
| Unsaturated polyester (UPE) resin | Resin [Thermoset polymer adhesives] | FR at 20% with synergists (antimony oxide); filler (OxyChem, 2007) | |
| Urethane foam | Elastomers | FR at 17.5-35% with antimony trioxide (OxyChem, 2007) | No further information found |
| Urethane rubber | Elastomers [elastomer adhesives] | FR at 20-30% with antimony trioxide (OxyChem, 2007) | No further information found |

Table 13. Use of DP in materials other than polymers (ECHA, 2022b)

| Material | Application type | Technical function, loading rate and synergist systems | Comments |
|-----------------------------------|--|--|---|
| Adhesives | Potting, encapsulating and bonding in electronics; cladding and flooring in building/construction; bonding composite panels, flooring and other fixtures and fittings; aircraft cabin interior | | Many polymer types can be used as adhesives. Where polymers for which DP may be used also have polymer uses this is noted in the rows above in square brackets. Confirmed commercial use of DP. |
| Caulk | Building materials | | Potential commercial use |
| Greases | | Dual function: FR and seizure resistance (pers comm – stakeholder consultation feedback) | Confirmed commercial use of DP |
| Cooling / coolant | | | No further information found. While some other polychlorinated FRs are reportedly used in coolants in electrical equipment, it is unknown whether this is a relevant use for DP in EU. |
| Flame resistant paint | Emulsions and coatings | | No further information found. Potential commercial use of DP, but relevance uncertain; the use is not confirmed in the registration dossier |
| Foam | Foams / sound-absorbing panels | | Confirmed commercial use of DP . |
| Foam or non-foam filling material | mattresses | | Textiles is a potential commercial use of DP but further information on the nature of the coating is not available). |
| Non-woven wallpaper | Wall papers | | Relevance in EU is uncertain |
| PVC/paper | Wall papers | | Relevance in EU is uncertain |
| Explosives | Fireworks | Colour intensifier additive in pyrotechnics (Impag, 2018, US Army, 1967). | The use in explosives is recommended against by REACH registrants in the ECHA disseminated dossier. Confirmed commercial use of DP in explosives and commercially available for the use in fireworks (Impag, 2018). |

| Material | Application type | Technical function, loading rate and synergist systems | Comments |
|--------------------------------------|--|--|--|
| Textiles | Textile coating (i.e. finishing product) / clothing / curtains | Application of auxiliary padding liquor at normally up to 50 kg/t textile (OECD textile ESD, 2004 ¹⁵). | Further information on the nature of the coating is not available (Coated and back-coated textiles are possible). |
| Textiles (toys) | Textile toys | | Textiles is a potential commercial use of DP but further information on the nature of the coating is not available |
| Textiles (military) | Military textiles | | Textiles is a potential commercial use of DP but further information on the nature of the coating is not available |
| Tile | Building materials (e.g. roofing materials, laminate flooring) | | No further information found |
| Wood | Building materials (e.g. panels, roofing materials, insulation board, laminate flooring) | | No further information found |
| Unknown (plastic toys) | | | No further information found |
| Unknown (food packaging and storage) | | | No further information found |

¹⁵ https://echa.europa.eu/documents/10162/16908203/pt9_oecd_esd_no_7_textile_finishing_industry_en.pdf/2d6bb902-83cc-4ff1-94ef-6e8fb2aab978

Table 14. Concentration of DP in components in cars, motorcycles and explosives as reported by stakeholders (Eftec, 2021)

| Stakeholder name | Product/Application | Concentration (%) | Comment |
|----------------------|--|-------------------|---|
| JAPIA | Wire coating | 13 - 20 % | < 0.1 % in final products |
| Rolls Royce | Individual component articles | < 0.1 - 6.5 % | - |
| ACEA | Wire coating and wire printed circuit board housing. Often but not exclusively used in PA 66 ¹⁶ . | 13 – 20 % | Average purchase price for the materials: € 6 - 11 per kg |
| | Plastic and rubber parts (connector, board, case, bobbin) | 13 – 20 % | Average purchase price for the materials: € 6 - 11 per kg |
| | Grease | 20 – 25 % | - |
| | Tape and adhesive | 5 – 30 % | - |
| ACEM | Electric wire, where DP is contained in the wire coating | 13 – 20 % | - |
| | Plastic and rubber parts | 13 – 20 % | - |
| | Grease | 20 – 25 % | - |
| | Tape and adhesive | 5 – 30 % | - |
| Explosives (unknown) | Explosives | 0.1 % | - |

¹⁶ PA 66 refers to a polyamide commonly known as Nylon 66.

Table 15. Global emissions of DP after wastewater treatment, by primary emission source (Eftec, 2021)

| Use | Total releases (kg/y) | | Share of total |
|--|-----------------------|-----------------|----------------|
| | Low | High | |
| Manufacture of substance | 33,029 | 110,097 | 52.6% |
| Formulation of sealants / adhesives | 4 | 292 | 0.1% |
| Industrial use of sealants / adhesives | 255 | 1,000 | 0.5% |
| Polymer raw materials handling, compounding and conversion | 1,825 | 6,156 | 2.9% |
| Formulation of greases | 15 | 50 | 0.02% |
| Widespread use of articles over their service life - indoor use | 265 | 882 | 0.4% |
| Widespread use of articles over their service life - outdoor use | 955 | 3,185 | 1.5% |
| Waste dismantling and recycling | 19,110 | 83,300 | 37.7% |
| Waste incineration | 30 | 100 | 0.05% |
| Landfill | 2,640 | 8,800 | 4.2% |
| TOTAL | ~58,000 | ~214,000 | 100% |

Table 16. Estimated total global releases for DP after wastewater treatment (Eftec, 2021)

| Releases to... | Lower estimate (kg/year) | Upper estimate (kg/year) | Share of total global releases |
|-------------------|--------------------------|--------------------------|--------------------------------|
| Air | 34,600 | 135,000 | 62% |
| Water | 6,020 | 20,200 | 10% |
| Agricultural soil | 17,300 | 57,900 | 28% |
| Industrial soil | 270 | 900 | 0.4% |
| Total | 58,100 | 214,000 | 100% |

Table 17. Emission reduction under each of the three restriction scenarios presented in tonnes per year as presented in the Annex to the EU restriction proposal

| Sector/use | Baseline emissions (t/y) | Annual reduction (t/y) | | |
|---|--------------------------|------------------------|-----------------|-------------------|
| | | RO1 | RO2 | RO3 |
| Automotive | 5.6 - 17.8 | 5.1 - 16.2 | 5 - 15.9 | 4.1 - 13 |
| Aviation | 0.9 - 2.9 | 0.8 - 2.6 | 0.6 - 2 | 0.4 - 1.3 |
| Other including imported articles | 2.6 - 8.1 | 2.3 - 7.4 | 2.3 - 7.4 | 2.3 - 7.4 |
| All uses | 9.1 - 28.8 | 8.3 - 26.2 | 8 - 25.3 | 6.8 - 21.7 |
| Scenario Emission reduction capacity | | 91% | 88% | 75% |

Note: Sums may not add up due to rounding.

Table 18. Shortlist of potential alternatives to DP (adopted from ECHA, 2022b)

| CAS No. | Alternative Substance | Plastics | Coatings | Literature source* |
|--------------|---------------------------------------|----------|----------|--|
| 115-27-5 | Chlorendic anhydride | X | | Velsicol (2020) |
| 1003300-73-9 | Mixtures of esters of phosphoric acid | X | | PINFA (2010b), PINFA (2010c), PINFA (2013) |
| 115-86-6 | Triphenyl phosphate | X | | KemI (2004, 2005, 2009), Lassen et al. (2006), Washington State (2006), PAKALIN ET AL. (2007), Illinois EPA (2007), Troitzsch (2011), UK HSE (2012), Lowell Center for Sustainable Production, (2005), PINFA (2010a), PINFA (2010b), PINFA (2010c), PINFA (2013) |

| CAS No. | Alternative Substance | Plastics | Coatings | Literature source* |
|--------------------------------------|--|----------|----------|---|
| 1309-42-8 13760-51-5 | Magnesium hydroxide | X | X | KemI (2004, 2005, 2009), Lassen et al. (2006), PAKALIN ET AL. (2007), US EPA (2012-2014), Illinois EPA (2007), UK HSE (2012), EFRA (2012a), EFRA (2012b), PINFA (2010a), PINFA (2010b), PINFA (2010c), PINFA (2013), Albemarle (2013), Chemtura (2011), ICL Industrial Products (2013); Stakeholder consultation |
| 13674-87-8 | Tris(1,3-dichloro-2-propyl) phosphate | X | | KemI (2004, 2005, 2009), Albemarle (2013) Chemtura (2011), ICL Industrial Products (2013) |
| 14728-39-9 68333-79-9 | Ammonium polyphosphate | X | X | KemI (2004, 2005, 2009), Lassen et al. (2006), PAKALIN ET AL. (2007), US EPA (2012-2014), Illinois EPA (2007), UK HSE (2012), EFRA (2012a), EFRA (2012b), PINFA (2010a), PINFA (2010b), PINFA (2010c), PINFA (2013) |
| 21645-51-2 8064-00-4 1318-23-7 | Aluminum hydroxide | X | X | KemI (2004, 2005, 2009), PAKALIN ET AL. (2007), US EPA (2012-2014), Illinois EPA (2007), UK HSE (2012), EFRA (2012a), EFRA (2012b), PINFA (2013, 2010a, 2010b, 2010c), ENFIRO, Albemarle (2013) Chemtura (2011) ICL Industrial Products (2013) |
| 21850-44-2 | Tetrabromobisphenol-A bis (2,3-dibromopropyl ether) | X | | KemI (2004, 2005, 2009), Lassen et al. (2006), Washington State (2006), PAKALIN ET AL. (2007), US EPA (2012-2014), Troitzsch (2011), UK HSE (2012), Albemarle (2013) Chemtura (2011), ICL Industrial Products (2013) |
| 218768-84-4 | Melamine polyphosphate | X | X | KemI (2004, 2005, 2009), Lassen et al. (2006), PAKALIN ET AL. (2007), US EPA (2012-2014), UK HSE (2012), EFRA (2012a), EFRA (2012b), PINFA (2010a), PINFA (2010b), PINFA (2010c), PINFA (2013) |
| 225789-38-8 | Organic phosphinates (Diethylphosphinic acid, aluminum salt) | X | | KemI (2004, 2005, 2009), Lassen et al. (2006), PAKALIN ET AL. (2007), US EPA (2012-2014), Illinois EPA (2007), Troitzsch (2011), UK HSE (2012), PINFA (2010a), PINFA (2010b), PINFA (2010c), PINFA (2013) |
| 26444-49-5 | Cresyl diphenyl phosphate | X | X | KemI (2004, 2005, 2009), Lassen et al. (2006), Washington State (2006), PAKALIN ET AL. (2007), Illinois EPA (2007), Troitzsch (2011), UK HSE (2012), Lowell Center for Sustainable Production, (2005), EFRA (2012a), EFRA (2012b), PINFA (2010a), PINFA (2010b), PINFA (2010c), PINFA (2013), Albemarle (2013) Chemtura (2011) ICL Industrial Products (2013) |
| 32588-76-4 | Ethylene bis(tetrabromophthalimide) | X | X | KemI (2004, 2005, 2009), Lassen et al. (2006), Washington State (2006), PAKALIN ET AL. (2007), US EPA (2012-2014), Troitzsch (2011), UK HSE (2012), EFRA (2012a), EFRA (2012b), Albemarle (2013) Chemtura (2011), ICL Industrial Products (2013) |
| 37853-59-1 | Bis(tribromophenoxy)ethane | X | | KemI (2004, 2005, 2009), Lassen et al. (2006), Washington State (2006), PAKALIN ET AL. (2007), UK HSE (2012), EFRA (2012a), EFRA (2012b) |

| CAS No. | Alternative Substance | Plastics | Coatings | Literature source* |
|---------------------------|---|----------|----------|---|
| 57583-54-7 125997-21-9 | Resorcinol bis(diphenylphosphate) (RDP) | X | | KemI (2004, 2005, 2009), Lassen et al. (2006), Washington State (2006), PAKALIN ET AL. (2007), Illinois EPA (2007), Troitzsch (2011), UK HSE (2012), Lowell Center for Sustainable Production, (2005), PINFA (2010a), PINFA (2010b), PINFA (2010c), PINFA (2013), (ENFIRO, 2014), Albemarle (2013), Chemtura (2011), ICL Industrial Products (2013) |
| 5945-33-5 181028-79-5 | Bisphenol-A bis (diphenyl phosphate) (BDP/BAPP) | X | | KemI (2004, 2005, 2009), Lassen et al. (2006), Washington State (2006), PAKALIN ET AL. (2007), Illinois EPA (2007), Troitzsch (2011), UK HSE (2012), Lowell Center for Sustainable Production, (2005), EFRA (2012a), EFRA (2012b), PINFA (2010a), PINFA (2010b), PINFA (2010c), PINFA (2013), ENFIRO, Albemarle (2013), Chemtura (2011), ICL Industrial Products (2013) |
| 66034-17-1 | Substituted amine phosphate mixture (P/N intumescent systems) | X | X | US EPA (2012-2014), Troitzsch (2011), UK HSE (2012), PINFA (2013, 2010a, 2010b, 2010c) |
| 7723-14-0 | Red phosphorous (encapsulated) | X | X | KemI (2004, 2005, 2009), Lassen et al. (2006), PAKALIN ET AL. (2007), US EPA (2012), US EPA (2014), Illinois EPA (2007), UK HSE (2012), EFRA (2012a), EFRA (2012b), PINFA (2013, 2010a, 2010b, 2010c), Albemarle (2013) Chemtura (2011) ICL Industrial Products (2013) |
| 79-94-7 | Tetrabromobisphenol-A | X | | KemI (2004, 2005, 2009), Lassen et al. (2006), Washington State (2006), PAKALIN ET AL. (2007), Troitzsch (2011), UK HSE (2012), Albemarle (2013) Chemtura (2011) ICL Industrial Products (2013) |
| 84852-53-9 | Ethane-1,2-bis(pentabromophenyl) | X | X | KemI (2004, 2005, 2009), Lassen et al. (2006), Washington State (2006), PAKALIN ET AL. (2007), US EPA (2012-2014), Troitzsch (2011), UK HSE (2012), EFRA (2012a), EFRA (2012b), Albemarle (2013) Chemtura (2011) ICL Industrial Products (2013); Stakeholder consultation |
| 88497-56-7 57137-10-7 | Brominated polystyrene | X | | KemI (2004, 2005, 2009), Lassen et al. (2006), PAKALIN ET AL. (2007), US EPA (2012-2014), Troitzsch (2011), UK HSE (2012), EFRA (2012a), EFRA (2012b), Albemarle (2013) Chemtura (2011) ICL Industrial Products (2013) |

Note: This list is generated from the RPA (2014) report on Support to an Annex XV Dossier on Bis-(pentabromophenyl) ether (DecaBDE) and represents alternatives to flame retardants presented in the literature.

* The references can be found in the original document (ECHA, 2022b).

Table 19. Identified alternatives to DP in its function as both a flame retardant and as an extreme pressure additive in grease/lubricant (adopted from ECHA, 2022b)

| Cas No. | EC No. | Alternative Substance | Commercial products and notes | Literature source* |
|--|------------------------|-----------------------------------|---|--|
| Flame Retardant | | | | |
| 115-27-5 | 204-077-3 | Chlorendic anhydride | | Velsicol (2020) |
| 14728-39-9. 68333-79-9 | 269-789-9 | Ammonium polyphosphate | Flame retardant in many applications such as paints and coatings, and in a variety of polymers | (KemI, 2004, KemI, 2005); Lassen et al. (2006); PAKALIN ET AL. (2007); US EPA (2012-2014); Illinois EPA (2007); UK HSE (2012); (EFRA, 2012a, EFRA, 2012b); PINFA (2013, 2010a, 2010b, 2010c); ENFIRO |
| 21645-51-2. 8064-00-4. 1318-23-7 | 244-492-7 | Aluminium hydroxide | Aluminium Hydroxide has a wide range of applications, including a variety of polymers, paints and coatings. | (KemI, 2004, KemI, 2005, KemI, 2009); PAKALIN ET AL. (2007); US EPA (2012-2014); Illinois EPA (2007); UK HSE (2012); (EFRA, 2012a, EFRA, 2012b); PINFA (2013, 2010a, 2010b, 2010c); ENFIRO; Albemarle (2013); Chemtura (2011); ICL Industrial Products (2013) |
| 84852-53-9 | 284-366-9 | Ethane-1,2-bis (pentabromophenyl) | | (KemI, 2004, KemI, 2005, KemI, 2009); Lassen et al. (2006); Washington State (2006); PAKALIN ET AL. (2007); US EPA (2012-2014); Troitzsch (2011); UK HSE (2012); (EFRA, 2012a, EFRA, 2012b); Albemarle (2013); Chemtura (2011); ICL Industrial Products (2013); Stakeholder consultation |
| Grease/Lubricant | | | | |
| 63449-39-8 | 264-150-0 | Long chain chlorinated paraffins | Cereclor 42 (example) | |
| 1330-78-5 | 215-548-8 809-930-9 | Tricresyl phosphate | Celluflex TPP®, Disflamoll TP®, Phosflex TPP®, Phosphoric acid, triphenyl ester, Pilabrac 521®, Reofos TPP®, Reomol TPP® and TPP. | As noted in Environment Agency (2009) Some of the tradenames and trademarks may refer to older products no longer supplied to the EU, or products produced outside the EU, but these are included in the report as they are sometimes referred to in the open literature. |
| 3232-62-0 | 221-775-3 | Diallyl chlorendate | Only REACH pre-registered | Indicated for use as an extreme pressure additive in silicone greases - in patents literature (Google patents). |

* The references can be found in the original document (ECHA, 2022b).

Table 20. Available information on the most likely alternatives to DP as a flame retardant

| Flame retardant | Share of DP substituted | Price €/tonne | Loading | Price x loading compared to DP |
|---|--------------------------------|----------------------|----------------|---------------------------------------|
| Dechlorane Plus | - | 6 000 - 10 000 | 17% | 100% |
| Aluminium hydroxide | 40% | 964 | 65% | 40% - 60% |
| Ammonium polyphosphate | 30% | 2 675 | 31% | 50% - 80% |
| Ethane-1,2-bis (pentabromophenyl) (EBP) | 30% | 5 782 | 17% | 60% - 100% |

Table 21. Available information on the most common alternatives to DP used in lubricants

| Flame retardant | Price €/tonnes |
|--|-----------------------|
| Dechlorane Plus | 6 000 – 10 000 |
| Long chain chlorinated paraffins (LCCPs) | 4 000 |
| Tricresylphosphate (TCP) | 9 000 |

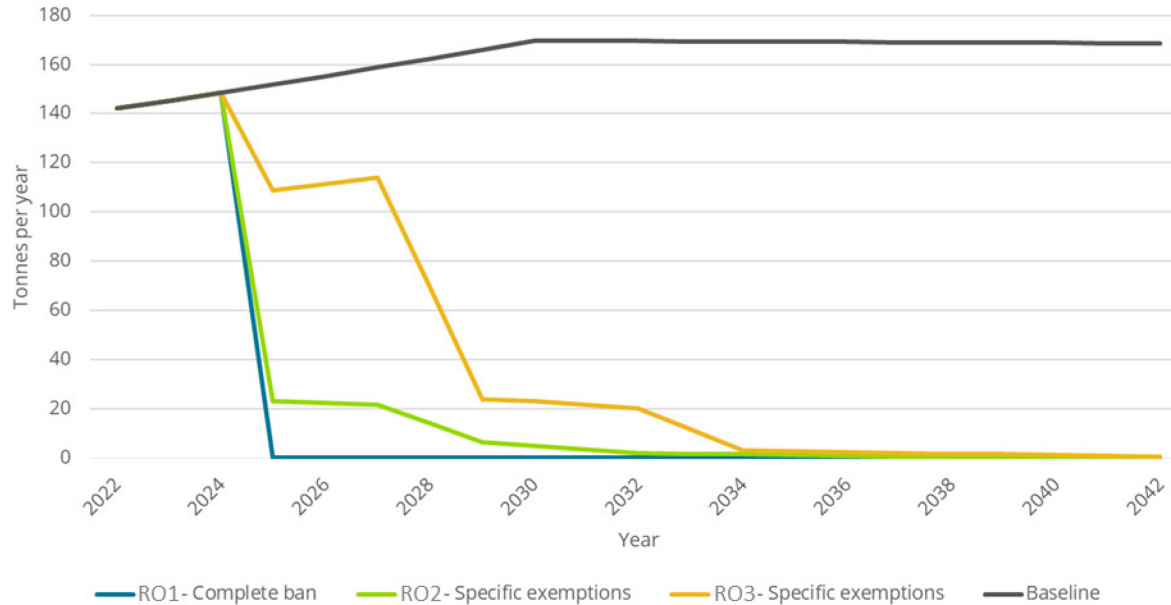


Figure 1. Continued emissions (t/y) under the baseline (central estimate) and the three restrict options (ROs) over the period 2023-2042. The figure shows the modelled emissions under the baseline (i.e. the scenario where no regulation of DP is implemented) and the three restriction options. The results show that all of the ROs will result in substantial emission reductions, and by proxy, large expected benefits, with the strictest option (RO1) achieving a 91% reduction in emissions of DP. The drivers behind the emission reductions associated with each restriction option are the entry into force of the ban and the specific exemptions (Eftec, 2021).

References

Annex E (2020). Comments on the draft risk profiles on Dechlorane Plus. 30 March 2020. Available at: <http://chm.pops.int/tabid/8366/Default.aspx>

Annex F (2022). Submissions of Annex F (Risk management) information on Dechlorane Plus 14 March 2022. Available at: <http://chm.pops.int/TheConvention/POPsReviewCommittee/Meetings/POPRC17/POPRC17Followup/AnnexFD PSubmission/tabid/9099/Default.aspx>

Canada (2019a). Dept. of the Environment. Dept. of Health. Screening Assessment Certain Organic Flame Retardants Grouping 1,4:7,10-Dimethanodibenzo[a,e]cyclooctene, 1,2,3,4,7,8,9,10,13,13,14,14-dodecachloro-1,4,4a,5,6,6a,7,10,10a,11,12,12 adodecahydro-Dechlorane Plus (DP), Chemical Abstracts Service Registry Number 13560-89- 9. Available at: <https://www.canada.ca/en/environment-climate-change/services/evaluating-existing-substances/screening-assessment-certain-organic-flame-retardants-substance-grouping-dimethanodibenzo-cyclooctene-dodecachloro-dodecahydro-dechlorane-plus-dp.html>

Canada (2019b). Dept. of the Environment. Dept. of Health. Certain Organic Flame Retardants Grouping Risk Management Approach For 1,4:7,10-Dimethanodibenzo[a,e]cyclooctene, 1,2,3,4,7,8,9,10,13,13,14,14-dodecachloro1,4,4a,5,6,6a,7,10,10a,11,12,12a-dodecahydro- Dechlorane Plus (DP), Chemical Abstracts Service Registry Number 13560-89- 9. Available at: <https://www.canada.ca/en/environment-climate-change/services/evaluating-existing-substances/certain-organic-flame-retardants-grouping-risk-management-approach-dimethanodibenzo-cyclooctene-dodecachloro-dodecahydro-dechlorane-plus-dp.html>

ECHA (2022b). RAC & SEAC (draft) Background document Annex to the Opinion on an Annex XV dossier proposing restrictions on 1,6,7,8,9,14,15,16,17,17,18,18-Dodecachloropentacyclo[12.2.1.16,9.02,13.05,10]octadeca-7,15-diene (Dechlorane Plus) [covering any of its individual anti- and synisomers or any combination thereof] - Revision 1 of 21/01/2022. <https://echa.europa.eu/documents/10162/cfbcfefd-c6ba-923a-72ff-b70b2786ff70>

ECHA (2022c). Response to comments submitted on the restriction report from 23/6/2021 to 03/01/2022. Submitted restrictions under consideration - ECHA (europa.eu) https://echa.europa.eu/documents/10162/17233/rest_dechlorane_plus_rcom_en.docx/5f0eb4ad-2bbc-e602-c49b-3488b78e4135?t=1647418105766&download=true

ECHA (2021). Annex XV Restriction Report. Proposal for a restriction. Substance name: 1,6,7,8,9,14,15,16,17,17,18,18- Dodecachloropentacyclo[12.2.1.16,9.02,13.05,10]octadeca-7,15-diene (“Dechlorane Plus”™) [covering any of its individual anti- and syn-isomers or any combination thereof]. Available at: <https://echa.europa.eu/restrictions-under-consideration/-/substance-rev/28201/term>

ECHA (2017a). Agreement of the Member State Committee in accordance with Article 59(8): 1,6,7,8,9,14,15,16,17,17,18,18-Dodecachloropentacyclo- [12.2.1.16,9.02,13.05,10]octadeca-7,15-diene (“Dechlorane Plus”™) [covering any of its individual anti- and syn-isomers or any combination thereof] is identified as a substance of very high concern because it meets the criteria of Article 57 (e) of Regulation (EC) 1907/2006 (REACH) as a substance which is very persistent and very bioaccumulative (vPvB), in accordance with the criteria and provisions set out in Annex XIII of REACH Regulation. Available at: <https://echa.europa.eu/documents/10162/15b88a69-2162-9385-4089-7c247cba4da6>

ECHA (2017b). Member State Committee support document for identification of 1,6,7,8,9,14,15,16,17,17,18,18-Dodecachloropentacyclo- [12.2.1.16,9.02,13.05,10]octadeca-7,15-diene (“Dechlorane Plus”™) [covering any of its individual anti- and syn-isomers or any combination thereof] as a substance of very high concern because it meets the criteria of Article 57 (e). Adopted on 30 November 2017. Available at: ECHA (2019a). European Chemicals Agency. Background document for 1,6,7,8,9,14,15,16,17,17,18,18-dodecachloropentacyclo[12.2.1.16,9.02,13.05,10]octadeca-7,15-diene1 (“Dechlorane Plus”™). 2019. Available at: https://echa.europa.eu/documents/10162/13640/9th_recom_final_backgdoc_dechlorane_plus_en.pdf

Eftec (2021). Economics for the Environment Consultancy Ltd (eftec). Socio-economic considerations of regulating Dechlorane Plus under the Stockholm Convention. Draft report for the Norwegian Environment Agency, April 2021. Available at: <https://www.miljodirektoratet.no/publikasjoner/2021/juni-2021/socio-economic-considerations-of-regulating-dechlorane-plus-under-the-stockholm-convention/>

Norwegian Environment Agency (2019b). Prioritetslisten. Published 18.01.2019. Available at: <http://www.miljostatus.no/prioritetslisten> (Accessed 27.03.2019).

OxyChem® Dechlorane Plus® Manual. 2007. Ver. 07-27-2007. Available from: https://www.oxy.com/OurBusinesses/Chemicals/Products/Documents/dechloraneplus/dechlorane_plus.pdf

OxyChem test-plan for Dechlorane plus (2004b). Available at: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.578.5473&rep=rep1&type=pdf>.

SIN List (2020). International Chemical Secretariat's (ChemSec) Substitute It Now (SIN) list since 2014. Available at: <https://sinsearch.chemsec.org/chemical/13560-89-9>

US EPA, US Environmental Protection Agency (2020). The Toxic Substances Control Act (TSCA) Chemical Substance Inventory. Available at: <https://www.epa.gov/tsca-inventory>