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Task Force on Persistent Organic Pollutants****Third meeting of the Task Force
Vienna, Austria
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II. Sufficiency and effectiveness review

1. Integrated [summary report](#) on the review

This draft document summarizes the chapters below and will be included in the report to the Group on Strategies and Review

2. Individual chapters

The chapters below were elaborated by the lead authors, based on the discussions at the info meeting of the Task Force in Rome (28 February - 1 March) and further comments received b March

- (a) [Effects of POPs deposition](#)

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- (b) [Assessment of technological developments, Alternatives to PCBs](#)

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- (c) New development in environmentally sound destruction of POPs
- (e) BAT for major stationary sources
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PEER REVIEWS OF THE DRAFT DOSSIER “PERFLUOROOCTANE SULFONATE (PFOS)”

(proposed for a nomination to the UN-ECE LRTAP Protocol)

REVIEWER A

Summary:

Introduction

Perfluorooctane sulfonate (PFOS) is a fully fluorinated anion which is used as such or incorporated into larger polymers. It is used in a variety of sectors such as the photographic industry, in photolithography and semiconductors, hydraulic fluids for the aviation industry, in metal plating and fire fighting foams. PFOS may be formed by the degradation of a large group of perfluoroalkylated substances (PFAS). Ninety-six of these PFOS-related substances are also part of the present nomination.

Methods

The dossier was examined and the scientific information presented evaluated against the requirements outlined in Executive Body decision 1998/2. Quoted papers and technical reports were examined, with special attention to the OECD Hazard Assessment. Because of the technical complexity of the present nomination which involves a large group of PFOS-related substances, a careful examination of papers and reports from open literature was carried out on both PFOS and its possible precursors.

Comments below refer to the fundamental contents of the dossier.

Two additional references have been indicated.

POP characteristics in terms of the guidance and indicative numerical values provided in Executive Body 98/2 for:

Potential for long-range atmospheric transport

Due to the measured low vapour pressure and low air-water partition coefficients, PFOS volatilisation is expected to be very low. No experimental data is available on PFOS behaviour and its presence in the atmosphere. Nevertheless, considering the estimated atmospheric half-life (more than 3.7 years at 25 ° in atmosphere) and presence in biota from remote areas, PFOS potential for long-range atmospheric transport cannot be excluded. Some of PFOS precursors are reported to be considerably more volatile than PFOS itself and could therefore significantly contribute to the overall PFOS contamination observed.

Toxicity

PFOS is toxic to aquatic organisms. This is on the basis of results from prolonged exposure studies on aquatic invertebrates (*Mysidopsis bahia*) and from other toxicity studies on different aquatic species.

Potential for human health effects are indicated by the outcomes of different animal studies indicating toxicity for mammalian species. The dossier reports some studies on rodents and primates considered critical to the assessment of PFOS toxicity. Subchronic exposure of monkeys resulted in gastrointestinal effects and mortality. Postnatal deaths and various developmental effects at low doses in offspring are resulted from a two-generation reproductive toxicity in rats.

Persistence

Data reported in the dossier indicates that PFOS is extremely persistent (estimated half-lives of years) with respect to both biotic and abiotic degradation routes in the environment.

Bioaccumulation

Due to its both hydrophobic and oleophobic nature, Kow cannot be determined.

Tests carried out on fish indicated BCF < 5000.

Potential for bioaccumulation and biomagnification is indirectly indicated by the high PFOS concentrations observed in predators (e.g. the polar bears) from remote regions, higher than concentrations detected in species at a lower level in the food webs of the same regions.

Monitoring or equivalent scientific information suggesting long-range transboundary atmospheric transport.

PFOS has been detected in different wildlife species from different remote regions of the Northern hemisphere. Animals (top predators in fish-based food chains) living in these regions show the highest levels of contamination so far observed in sampled biota. This data suggests long-range atmospheric transport as the most plausible cause of the presence of PFOS in these environments. In particular, this presence could be due, to an extent at present impossible to assess, to long-range atmospheric transport of PFOS precursors of reported higher volatility. Data is reported on increasing levels of PFOS in eggs of fish-eating birds in the last three decades, this indicating continuity of exposure.

PFOS has been detected in remote marine waters far from local sources (background areas): an investigation on PFOS presence in open ocean waters showed PFOS levels in central to western Pacific ocean in the range of 15 – 56 pg/L. Comparable concentrations were detected in the mid-Atlantic ocean.

Sufficiency of the information to suggest that the substance is likely to have significant adverse human and /or environmental effects resulting from its long-range transboundary atmospheric transport.

Adverse environmental effects

PFOS presence detected in remote regions could be associated to adverse environmental effects. This is because of the high levels observed in some biota species and the nature of the critical effects observed in laboratory mammals.

Adverse human effects

Food of animal origin is likely to be a source of human exposure to PFOS. For this reason, as well as the bioaccumulative nature of this compound, and its observed half-lives in humans¹, consumption of local contaminated biota in the above regions might be a matter of concern for some population sub-groups.

Conclusion on the technical content of the dossier

The information reported clearly indicates reasons for concern related to PFOS presence in the environment. Evidence is produced on PFOS persistence and toxicity. PFOS levels in biota from remote regions indicate long-range atmospheric transport as the most plausible source of contamination, although the mechanisms of environmental transport and partition of this compound (and its precursors) are still unclear. Data set on PFOS concentrations in biota of different trophic levels in food webs indicate bioaccumulation and biomagnification potentials, although the underlying mechanisms still need to be elucidated.

Ninety-six “PFOS-related substances” are also part of the nomination. For some of these, environmental occurrence and toxicity² data are available and metabolic and/or environmental degradation to PFOS has been shown to occur, or to be likely to occur. Nevertheless, for the majority of the group, PFOS formation is speculatively deemed possible but rates, extent and conditions of eventual PFOS formation are unknown. Furthermore, the environmental behaviour of these substances, and even more their potential for atmospheric long range transport is, on the whole, inadequately characterised, or unknown.

Disclaimer

The views expressed in this technical review are solely those of the reviewer and do not necessarily represent the views of any organization and/or government to which the reviewer is affiliated.

Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

- 1) 3M Company (2000). Determination of Serum half Lives of Several Fluorochemicals, June 8, 2000, 3M Company. FYI-0700-1378, 8(e) Supplemental Submission, 8EQ-0373/0374.
- 2) Health Canada (2004). Perfluorooctane Sulfonate, its Salts and its Precursor that Contain the C8F17SO2 or C8F17SO3 Moiety, Screening Assessment Report, March 5, 2004.

REVIEWER B

Summary

Perfluorooctane sulfonate (PFOS; $\text{CF}_3(\text{CF}_2)_7\text{SO}_3^-$) and 96 PFOS-related substances that degrade to PFOS have been proposed by Sweden for consideration as persistent organic pollutants (POPs) under the UNECE-LRTAP POPs Protocol. The LRTAP nomination process includes the preparation of a risk profile by the proponent Party, which, if considered acceptable by the LRTAP Executive Body, then undergoes one or more technical reviews, i.e., the genesis of this technical review. Because of their surface-active chemical properties and persistence, PFOS and related substances have been manufactured for a number of commercial uses, such as stain repellent and cleaning products, hydraulic fluids, fire fighting foams, and semiconductor chip manufacture. These chemical products degrade in the environment, leaving the resistant PFOS core. In contrast to currently listed POPs chemicals, PFOS does not accumulate in lipid, but rather can be measured in the protein fraction of serum and liver samples. Based on measurements of the widespread distribution of PFOS in biota, the principal global manufacturer

of PFOS began phasing out production in 2000, although other companies continue production and issues remain regarding the availability of suitable alternatives to replace some critical uses.

On the basis of the scientific information provided, I have reached the following conclusions regarding the risk profile provided by Sweden:

Beyond a few minor typographical errors, the Swedish proposal is a well-written and accurate compilation of the technical literature on PFOS. It is based on other well conducted assessments prepared by the OECD (2002) and United Kingdom, and incorporates additional, recently published literature.

The PFOS molecule, alone or as a portion of a larger PFOS-related chemical structure, satisfies the following indicative numerical values provided in Executive Body Decision 98/2 for:

- Persistence: PFOS is highly persistent in the environment, exceeding the LRTAP POPs guidance;
- Bioaccumulation: Although PFOS falls short of the indicative numerical criteria for the bioconcentration factor (BCF) and LogKow, its BCF combined with biomagnification in food chains, high levels in biota in remote locations, coupled with considerations of very high environmental persistence, indicate that PFOS satisfies the LRTAP POPs guidance for bioaccumulation;
- Long-range atmospheric transport: PFOS has the potential for long-range transboundary atmospheric transport either through entrainment on particles or as a component of more volatile PFOS-related molecules;
- Toxicity: PFOS has the potential to adversely affect human health and/or the environment.

Under LRTAP EB Decision 1998/2 (2), sufficient information is available to conclude that:

- (a) Monitoring data in the air and biota indicate that PFOS, either entrained on particles or as component of more volatile PFOS-related substances, is undergoing long-range transboundary atmospheric transport.
- (b) The combination of the potential for long-range atmospheric transport, measured atmospheric, environmental and biotic levels, temporal increases in these levels, and their relationship to toxic endpoints in humans and biota, indicate that PFOS exhibits similar reasons for concern as substances already listed as POPs under the LRTAP Protocol.

Introduction:

Perfluorooctane sulfonate (PFOS; $\text{CF}_3(\text{CF}_2)_7\text{SO}_3^-$) can best be considered as a core molecule upon which a number of other chemical structures are attached with different end chains to yield different properties for commercial use. These uses take advantage of the hydrophobic, degradation resistant, fully-fluorinated carbon chain, coupled with various, generally lipophobic, end chains. Due to these various structural configurations, PFOS and PFOS-related substances possess both lipid and water repellant properties, making them ideal for a number of commercial uses, principally those requiring surface-active properties. They have been used in stain repellant and cleaning products, hydraulic fluids, fire fighting foams, and semiconductor chip manufacture. It is important to note that the PFOS moiety is often not the chemical product that is distributed into the market, but rather the degradation resistant core of other chemical products that have been developed with different end chains. These complex molecules break down in the environment, but leave the resistant PFOS core.

Consistent with the text of the LRTAP POPs Protocol, Sweden has provided the Executive Body with a risk profile proposing that PFOS and 96 PFOS-related compounds be considered under the United Nations Economic Commission for Europe (UNECE), Long Range Transboundary Air Pollution (LRTAP) Persistent Organic Pollutant (POPs) Protocol. The risk profile must be subject to one or more technical reviews, hence this analysis of the proposal, limited to the Track A review of POPs characteristics. The issue contemplated under this proposal is whether the human health and environmental risks posed by the long-range transboundary atmospheric transport of PFOS and PFOS-related substances warrants their consideration under the POPs Protocol. While noting that the PFOS moiety is the end pollutant of concern, the Swedish risk profile proposes many (~96) separate PFOS-related molecules for regulatory action. These 96 substances are linked through possession of this common PFOS component in their structures, and the ability to break down in the environment to this pollutant.

Note should also be made of the differences between PFOS and PFOA, and the many different lengths of fluorinated carbon chains that can and have been created. PFOA, perfluorooctanoic acid, is basically the core, fluorinated, carbon chain of PFOS, absent the sulfonate group. It exhibits some different properties to PFOS, and is undergoing separate risk evaluation, most recently via the U.S. EPA draft risk assessment and review by U.S. EPA's Science Advisory Board. The issue of different chain lengths also needs to be kept in mind by the LRTAP Working Group on Strategies and Review in the broader context of perfluorinated molecules and their presence in the environment.

Method:

As requested, this review has been conducted in a similar manner to those routinely undertaken for peer reviewed journal articles or government document preparation. The basic instructions were for the review to be transparent, and to include critical evaluation of such aspects as, inter alia, availability, reliability, completeness and relevance of the information and references. Reviewers were instructed to only address

the information contained in the dossiers, to refrain from any elaboration of their content, and to avoid comments that could be considered to reflect policy. On clarification, it was agreed permissible to suggest additional citations and information as done for a normal peer review, but not to engage in any revision of the proposal. The Swedish proposal is sufficiently contemporary in nature to have incorporated much of the recent literature in this developing field, building as it does upon the risk assessment and risk management documents prepared by the OECD (2002) and United Kingdom (2004).

POP characteristics in terms of the guidance and indicative numerical values provided in Executive Body Decision 98/2 for

Persistence:

The risk profile accurately summarizes the results of the OECD, national, and 3M corporation testing of PFOS. The core PFOS component does not hydrolyse, photolyse, or biodegrade in the testing conditions used, as reported in considerable detail in OECD (2002).

Conclusion: PFOS is highly persistent in the environment, exceeding the LRTAP POPs guidance.

Bioaccumulation:

The EB Decision 1998(2) indicative guidance for “bioaccumulation” provides for two options 1) BCF, BAF, or log Kow information, or 2) alternatively, other factors that make the substance of concern within the scope of the protocol. The Swedish risk profile correctly notes that obtaining an octanol-water partition for PFOS is inappropriate, as the substance forms a third phase between the oil and water. The risk profile also summarizes how the bioaccumulation properties for PFOS differ from previously characterized LRTAP POPs, which accumulate in lipid, whereas PFOS binds to proteins principally in the serum and liver.

On a purely numerical basis, as noted in the Swedish proposal, the BCF values (generally calculated as the ratio of the tissue concentration, usually in a fish, divided by the free concentration in water) fall short of the indicative criterion of 5000. The OECD (2002) calculated kinetic BCF values were 1124 (edible), 4013 (inedible) and 2796 (whole body) in bluegill sunfish in a flow-through study. Martin et al. (2003) reported BAFs of 2900 and 3100 in liver and plasma, respectively, for juvenile rainbow trout fed a mixture of PFOS and related substances in their diets. Regarding the Martin et al. (2003) study, the risk profile reports this as a BCF value, which may be inappropriate given the method of exposure.

In the PFOS situation, as the risk profile notes, BCF values do not take fully into consideration the potential for bioaccumulation and biomagnification from the food supply and trophic pathways, which have also been demonstrated for PFOS. PFOS accumulation has been suggested as more apparent from sediment rather than water,

based on substantially higher PFOS levels in benthic species compared to pelagic feeders (Martin et al. 2004; ES&T 38:5379). The diet weighted BMF for trout in this study was calculated at 2.9 fold, and the trophic magnification factor for PFOS in this study may be up to 5.88 among fish in the mainly pelagic food web. It is important to note that this biomagnification information does not incorporate links to terrestrial food web species. Of particular interest in this regard are the high levels of PFOS in the livers of polar bears (mean 3100 ppb, min 1700 ppb, max >4000 ppb) and arctic fox (mean 250 ppb, min 6 ppb, max 1400 ppb) remote from any source (Martin et al., 2004; ES&T 38:373), appropriately highlighted by the risk profile. These levels are thought to result from numerous sources and source chemicals being transported to the Arctic and biodegraded to the common end-pollutant, PFOS. Overall, because the actual BCF value falls short of the indicative guidance, the risk profile should provide further numerical data on biomagnification studies and the extent of measured accumulation levels in food chains. In addition, the profile could be supplemented in its explanation of bioaccumulation through incorporating information on the very long half-lives of PFOS in monkeys (200 days) and humans (mean 8.67 years, with caveats that this value may be elevated through ongoing PFOS exposure and possibly metabolism of PFOS-related substances to PFOS in the subjects). These half-lives provide additional evidence of the potential for bioaccumulation in mammalian species, particularly humans.

Regarding the LRTAP consideration of alternative properties that warrant concern as a POP, the current proposal under-emphasizes the potential multiplicative nature of physical accumulation due to environmental persistence, coupled and magnified through bioaccumulation. The very high environmental persistence properties of PFOS warrant review under these alternative considerations.

Conclusion: Although PFOS falls short of the indicate numerical criteria for the bioconcentration factor (BCF) and LogKow, its BCF combined with biomagnification in food chains, high levels in biota in remote locations, coupled with considerations of very high environmental persistence, indicate that PFOS satisfies the LRTAP POPs guidance for bioaccumulation.

Potential for Long-Range Transboundary Atmospheric Transport:

The risk profile correctly notes the expected very long half-life of PFOS in the atmosphere and the levels found in remote locations, along with the apparent contrast to the essential involatility of PFOS. The profile suggests that atmospheric transport to remote locations might be through binding to entrained particles, or could relate to the more volatile nature of some of the precursor chemicals, such as EtFOSE alcohol, EtFOSA, etc. Citations are limited in the risk profile to a 3M (2000) report. This section should be enhanced through the addition of citations that have explored and begun to support the concept of atmospheric transport of more volatile PFOS-related substances. For instance, a number of PFOS-related substances have been confirmed in atmospheric sampling (Martin et al., 2002; Stock et al., 2004). Atmospheric half-lives have been estimated for the family of fluorotelomer alcohols at ~20 days from interaction with

hydroxyl radicals (Ellis et al., 2003). The biotransformation of N-EtPFOSA to PFOS has been demonstrated in rainbow trout (Tomy et al., 2004).

The monitoring data and time trends for PFOS in remote locations provided in the risk profile also support the potential for PFOS to be undergoing long-range transport, presumably atmospheric.

Conclusion: PFOS has the potential for long-range transboundary atmospheric transport either through entrainment on particles or as a component of more volatile PFOS-related molecules.

Toxicity:

The risk profile correctly cites the relevant animal and human toxicity testing data on PFOS. These data are conveyed in detail in the OECD (2002) report. To the extent that information of this type fulfills national or intergovernmental decrees on “toxicity”, PFOS fulfills these criteria as a low to moderately toxic substance. However, from a risk assessment science perspective, these toxicity classification criteria are unsatisfying, because ultimate determinations of risk should consider the relationship between the current or predicted environmental levels and the levels at which harm might occur. This concept is incorporated into the European PEC/PNEC approach, other national efforts at risk characterization, and the basic tenets of risk assessment. While recognizing the imprecision and uncertainty incorporated in many of these methods, with these caveats adequately communicated there remains considerable benefit in looking toward margin of exposure (MoE) relationships. This is especially important in a situation where it is possible that some important, low volume, residual uses of PFOS may need to continue because of a lack satisfactory alternatives at present, as noted in the risk profile, including some that may be protective of human health.

Information that would inform such MoE estimates was not adequately conveyed in the risk profile, although that information is available in the research publications, OECD (2002), United Kingdom regulatory proposals, and in regulatory submissions by 3M Corporation. The dose metric used in the risk profile was daily dose, generally in mg/kg/day. However, for persistent, bioaccumulative, toxins, the more appropriate metric is tissue dose (e.g., microgram per ml serum, or microgram per gram liver) or area under the curve/body burden. Use of these cumulative tissue dose metrics is essential when dealing with this type of chemical. With a PFOS half-life in rats of 7 days, monkeys 200 days, and humans 8.9 years, the same daily dose will give vastly different tissue dose measures. Presentation of daily dose measures in the toxicology section of the risk profile - especially when the dose was not administered long enough to reach steady state – is somewhat meaningless when trying to make a comparison to measured human or other mammalian exposure levels. A better comparison could be made of the potential risks to humans and wildlife through conveyance of this information. For example, non-occupationally exposed humans have PFOS serum levels of 0.030 - 0.053 µg/g (ppm) mean, ranging up to around 0.1 ppm with occasional outliers to 1.7 ppm (see OECD 2002 Table 1), and occupational workers have been measured up to low single

digit to 10 ppm levels. These tissue levels can be compared to effect levels for body weight and food consumption in rodents at around 18.9 ppm serum (female average, F0 generation, 2-gen repro study, 0.4 mg/kg/day dose; 5.28 ppm serum NOAEL; OECD 2002 p.46 summary table). Similar information and comparisons could be provided for liver concentrations in mammals, such as the polar bears and mink, recognizing again the scientific limitations on such comparisons and the mixed exposures occurring from other halogenated organics.

Conclusion: PFOS has the potential to adversely affect human health and/or the environment.

Monitoring or equivalent scientific information suggesting long-range transboundary atmospheric transport.

LRTAP EB Decision 1998/2 (2) and the guidance for this technical review state that the technical reviews shall evaluate (a) the monitoring or equivalent scientific information suggesting long-range transboundary atmospheric transport; and (b) whether sufficient information exists to suggest that the substance is likely to have significant adverse human and/or environmental effects resulting from its long-range transboundary atmospheric transport. There are two additional topics in EB 1998/2(2) that will presumably be evaluated under the Track B technical review. The Swedish risk profile for PFOS does not provide delineated sections covering these two considerations, although the necessary information is contained in various parts of the risk profile. It may be worthwhile noting this as a potential oversight that might be rectified in future risk profiles.

Regarding the specific question of monitoring information on LRAT, as noted above, the risk profile does adequately address the potential for long-range atmospheric transport. To reiterate, although PFOS itself may travel entrained with particles, it is unlikely to exist in the vapor phase. However, other molecules containing PFOS exhibit increased volatility, and have been measured in the atmosphere and in remote waters. Levels in biota in remote locations have also confirmed the ability for PFOS to undergo long-range transport, such as the low parts per million levels in polar bear and arctic fox livers (Martin et al., 2004) and the ppb levels in albatross from Midway Atoll in the Pacific Ocean (Kannan et al., 2001). Rising concentrations have also been measured in the environment, such as the Guillemot eggs graphed in the risk profile (see Holmstrom et al. 2005; 30 fold increase from 1968 - 2003).

Conclusion: Monitoring data in the air and biota indicate that PFOS, either entrained on particles or as component of more volatile PFOS-related substances, is undergoing long-range transboundary atmospheric transport.

Sufficiency of the information to suggest that the substance is likely to have significant adverse human and/or environmental effects resulting from its long-range transboundary atmospheric transport.

As noted above under “toxicity,” review of this EB1998(2) decision requirement would have been facilitated in the risk profile by 1) having a section conveying information pertinent to the EB requirement and 2) providing dose-response information in a metric more amenable to comparing laboratory data to measured environmental levels and across species, i.e., tissue concentration data rather than daily dose. That said, the risk profile does convey measurement data from the Arctic that demonstrate substantial increases in PFOS levels in the livers of Arctic mammals. As summarized in the risk profile, Martin et al. (2004) report that: “PFOS was the major contaminant detected in most samples and in polar bear liver was the most prominent organohalogen (mean PFOS = 3.1 microg/g wet weight) compared to individual polychlorinated biphenyl congeners, chlordane, or hexachlorocyclohexane-related chemicals in fat.” Thus, PFOS in at least some remote locations constitutes a problem of similar exposure magnitude to currently listed LRTAP POPs chemicals. Additional data are also provided in the risk profile demonstrating the presence of PFOS in remote ocean locations, as well as the presence of PFOS-related molecules in air.

Conclusion: The combination of the potential for long-range atmospheric transport, measured atmospheric, environmental and biotic levels, temporal increases in these levels, and their relationship to toxic endpoints in humans and biota, indicate that PFOS exhibits similar reasons for concern as substances already listed as POPs under the LRTAP Protocol.

Conclusions on the technical content of the dossier

Beyond a few minor typographical errors, this is a well-written and accurate compilation of the technical literature on PFOS, based on other assessments prepared by the OECD (2002), United Kingdom, and in the more recent published literature. The information provided is adequate to conclude that PFOS satisfies the UNECE LRTAP EB1998/2 POPs indicative or alternative criteria for persistence, bioaccumulation, toxicity and the potential for long-range atmospheric transport.

Disclaimer

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REVIEWER C

Summary:

Introduction

Perfluorooctane sulfonate (PFOS) is a sulfonate ion with a fully fluorinated alkyl chain. PFOS is used as such in some applications or incorporated into larger polymers. Due to its surface-active properties it is used in a wide variety of applications. PFOS can be

formed in the environment by degradation from a large group of related substances, referred to as PFOS-related substances. PFOS and 96 PFOS-related substances are part of the nomination. All these substances are members of a large family of perfluoroalkylated substances (PFAS), among which some are substitutes for PFOS.

In 2000, 3M (the major global producer of PFOS) decided to voluntarily phase out the production of PFOS, and the production ceased completely in the beginning of 2003. This has resulted in a significant reduction in the use of PFOS related substances. However, due to the end use of PFOS related substances in articles, emission control techniques cannot eliminate the diffuse sources, which are considerable. Environmental concentrations in the future are therefore hard to predict. Although fluorinated alkyl compounds were identified and quantified in various environmental compartments, little is known about their transport and behavior in the environment.

Methods

Firstly, the process of nomination was studied using documents from the UNECE website. Secondly, a number of related peer-reviewed articles on PFOS were read to get an overall impression of the compound. Subsequently, the dossier was read and the indicative values were reviewed carefully, and if necessary compared with that from open literature sources.

Potential for long-range atmospheric transport

The information provided in the dossier on long-range atmospheric transport is sufficient and in line with additional data provided in this review. PFOS meets the criteria for potential long-range atmospheric transport mentioned in EB 1998/2.

Toxicity and ecotoxicity

The dossier provides various references indicating that the substance is toxic or very toxic to aquatic organisms and may cause serious damage to health by prolonged exposure. This is confirmed by literature data. Significant effects on several liver endpoints in Wood mice were observed in a field site near a fluorochemical plant in Belgium recently.

Persistence

The dossier indicates that PFOS does not hydrolyze, photolyse or biodegrade under environmental conditions based on data from OECD and 3M. Experimental data are not provided in the dossier, which is due to the fact that analytical techniques for measuring the compound became available only recently. The information provided is sufficient and in line with the additional data provided in this review.

Bioaccumulation

The dossier concludes that PFOS fulfils the criteria for bioaccumulation, based on the biomagnification potential. Thus it meets with the EB decision 1998/2 criterion on bioaccumulation which states that other factors that make the substance of concern within the scope of the protocol, such as the high toxicity of the substance, may be put forward in case the substance does not meet with the numerical values. Besides the data on biomagnification it may also meet the bioaccumulation criterion of EB 1998/2 based on the toxicity data provided.

Monitoring or equivalent scientific information suggesting long-range transboundary atmospheric transport

The dossier on PFOS provides sufficient information on the long-range transport of PFOS in chapter B1. Additional information is given in the review report.

Sufficiency of the information to suggest that the substance is likely to have significant adverse human and/or environmental effects resulting from its long-range transboundary atmospheric transport (EB decision 1998/2-2b).

The dossier does not provide much information on the likelihood of PFOS having significant adverse human and/or environmental effects resulting from its long-range transboundary atmospheric transport. It is questionable if such information should be aimed at, as adverse effects will already appear in industrial and highly populated areas in a much earlier stage.

The dossier indicates that PFOS exhibits a global distribution, appears in remote areas, and is persistent in the environment. Furthermore PFOS shows an increase in concentrations in biota over subsequent years. These data suggest an increase in exposure in these areas. Emission control techniques cannot eliminate the diffuse sources, which are thought to be considerable and little is known about the transport and behavior of fluorinated alkyl compounds in the environment at present. Consequently, the change in PFOS concentrations in remote areas and their effects are hard to predict at this moment.

Conclusions on the technical content of the dossier

The dossier is written in a compact and easy readable style and the literature is up-to-date. Additional literature supporting the dossier can be added in some parts of the dossier. The dossier provides enough information for screening against the indicative values of the POP characteristics. Better estimated quantities of PFOS related compounds over the different uses would facilitate measures.

Introduction:

Perfluorooctane sulfonate (PFOS) is a sulfonate ion with a fully fluorinated alkyl chain. PFOS is used as such in some applications or incorporated into larger polymers. Due to its surface-active properties it is used in a wide variety of applications. PFOS can be formed in the environment by degradation from a large group of related substances, referred to as PFOS-related substances. PFOS and 96 PFOS-related substances are part of the nomination. All these substances are members of a large family of perfluoroalkylated substances (PFAS), among some of which are substitutes for PFOS.

Surface treatments constitute the largest volume of PFOS production: 5.1 million pounds in 2000. This category includes protection of clothing, upholstery, and carpets (2.4 million pounds). Applications are performed at textile mills, leather tanneries, finishers, and carpet manufacturing facilities (Renner, 2001).

In 2000, 3M (the major global producer of PFOS) decided to voluntarily phase out the production of PFOS, and the production ceased completely in the beginning of 2003. This has resulted in a significant reduction in the use of PFOS related substances. However, due to the end use of PFOS related substances in articles, emission control techniques cannot eliminate the diffuse sources, which are considerable. Environmental

concentrations in the future are therefore hard to predict. Although fluorinated alkyl compounds were identified and quantified in various environmental compartments, little is known about their transport and behavior in the environment (Schultz et al., 2004).

Three subjects interfered with/complicated the reviewing process:

1. Not a single compound is nominated, but a group of PFOS-related substances are nominated. Thus, not only the characteristics of the compound, but also of its precursors should be taken into account.
2. The amount of data before 2000 is limited. Improvements in the analytical methods have made measurements of individual compounds possible only since about 2000 (e.g. Hansen et al., 2001; Renner, 2001; Martin et al., 2002; Moody et al., 2002; Moody et al., 2003).
3. PFOS behaves differently than the usual POPs as it binds to proteins rather than to lipids. Therefore, some indicators which are used in the POP protocol as indicative values, such as the octanol-water partitioning (standard indicator for bioaccumulation), are meaningless.

Methods:

First, the explanation of the nomination process, and the backgrounds of the Protocol, the Task Force, the Working Group of Strategies and the Executive Body of the UNECE were downloaded from the UNECE website and were read to get a good impression of the reviewing process.

Secondly, the dossier on PFOS was examined as a whole to get an impression of the contents of the dossier. Then a number of related peer-reviewed articles on PFOS were retrieved from the literature to get an impression of the – related – compound(s) and the progress in studying the compound(s). Subsequently, the indicative values were reviewed carefully, and if necessary compared with that from open literature sources.

POP characteristics in terms of the guidance and indicative numerical values provided in Executive Body 98/2 for:

Potential for long-range atmospheric transport

In the EB decision 1998/2 the potential for long-range transboundary atmospheric transport is described as:

“Evidence that the substance has a vapor pressure below 1,000 Pa and an atmospheric half-life greater than two days. Alternatively, monitoring data showing that the substance is found in remote regions.”

The Swedish dossier on PFOS indicates that the vapor pressure is less than 1,000 Pa, but that PFOS itself is not expected to volatilize significantly. Atmospheric transport is therefore assumed to take place predominantly bound to particles rather than in the gaseous phase. The expected half life in air is greater than two days due to the persistence of PFOS mentioned in the literature. A reference for the indirect photolytic half life of

PFOS is included in the dossier. PFOS is found in remote areas, far distant from anthropogenic sources, which supports the potential for long-range transboundary atmospheric transport. The dossier indicates that the mechanisms of this transport are not yet known, but that long-range transport of volatile PFOS-related precursor or precursors of PFOS cannot be excluded.

Although the dossier refers only to the information from OECD (2002) and 3M (2000) the findings are consistent with recent literature data on global distribution of PFOS and related compounds in human blood samples and in biota (e.g. Giesy & Kannan, 2001; De Silva & Mabury, 2004).

Experiments on the atmospheric half life of PFOS and related compounds are scarce. However, various sources mention the persistence of these compounds and especially the perfluorinated alkyl chain (Moody et al., 2003). The atmospheric half life of one of the PFOS precursors, an electro-chemically produced polyfluorinated sulfonamidoethanol, was determined by its reaction with OH radicals and was estimated to be approximately 20 days. Other chemical processes were of minor importance (Ellis et al., 2003).

Conclusion: the information provided in the dossier is sufficient and in line with additional data provided here. PFOS meets the criteria mentioned in EB 1998/2.

Toxicity and ecotoxicity

Toxicity is described in the EB 1998/2 decision as:

“potential to adversely affect human health and/or the environment”.

No further criteria on toxicity are given in the EB 1998/2 decision”.

Environmental toxicity data for PFOS is predominantly found for aquatic organisms such as fish, invertebrates and algae. The lowest NOEC-values (No-Observed Effect Concentrations) mentioned in the dossier are 300 µg/L for the Fathead Minnow (*Pimephales promelas*) and 250 µg/L for the mysid shrimp (*Mysidopsis bahia*). Ecotoxicity data for soil and sediment organisms are lacking. Based on the toxicity to fish PFOS fulfils the EU criteria for the classifications “toxic to aquatic organisms” with the risk phrase R51 and the classification “May cause long-term adverse effects in the aquatic environment” and the risk phrase R53.

The results of a study by MacDonald et al. (2004) indicate that PFOS toxicity thresholds (EC50) for the aquatic midge (*Chironomus tentans*) are about 90 µg/L. Based on the toxicity to the midge PFOS also fulfils the EU criteria for R50 and R53. The Risk Reduction Report on PFOS by the UK indicates that PFOS is highly toxic to honeybees, hereby referring to the OECD report.

The dossier provides data on toxicity of PFOS and classifies the compound as R48: “danger of serious damage to health by prolonged exposure”. Comparable data are provided in the literature, which shows that salts of PFOS are known to cause significant

toxic effects, including mortality, in cynomolgus monkeys, rabbits, rats and zooplankton (Moody et al., 2003). Significant effects on several liver endpoints in Wood mice (*Apodemus sylvaticus*) were observed in a field site near a fluorochemical plant in Belgium recently (Hoff et al., 2004).

Conclusion: The dossier provides various references indicating that the substance is toxic or very toxic to aquatic organisms and may cause serious damage to health by prolonged exposure. This is further confirmed by additional literature data.

Persistence

Persistence is described in the EB 1998/2 decision as:

“Evidence that the substance's half-life in water is greater than two months, or that its half-life in soils is greater than six months, or that its half-life in sediments is greater than six months. Alternatively, evidence that the substance is otherwise sufficiently persistent to be of concern within the scope of the protocol may also fulfill this criterion.”

The data presented in the dossier on PFOS mainly originate from the OECD report (OECD, 2002) and from 3M (2003). These sources state that PFOS does not hydrolyze, photolyse or biodegrade under environmental conditions and that it is persistent in the environment. Experimental data from the open literature are scarce.

Additional data show that the PFOS anion, like many other perfluorinated chemical species, is very stable (Kissa, 2001). It is also indicated in the literature that the persistence of perfluorinated surfactants is consistent with the Aqueous Film Forming Foam (AFFF) product labeling (Moody et al., 2002).

Boudreau et al (2003) investigated the persistence of PFOS in a series of microcosms under natural conditions. The PFOS concentration showed no drastic reduction in any microcosm over 285 days, thus, confirming that PFOS undergoes little degradation in aquatic ecosystems. Moody et al (2003) suggested that the observations of perfluoroalkane sulfonates and perfluorocarboxylates in groundwater at some distance of a fire training site indicates a minimum life time of 5 years and a potential life time as long as 15 years. However, as the original amount of these compounds on the site of spilling is not given, a proper half life can not be drawn from these data. Additional field studies on persistence would help to elucidate the half life time of PFOS in different environmental media.

Conclusion: the dossier indicates that PFOS does not hydrolyse, photolyse or biodegrade under environmental conditions based on data from OECD and 3M. Experimental data are not provided in the dossier, which is due to the fact that analytical techniques for measuring the compound became available only recently. The information provided is sufficient and in line with the additional data provided in this review.

Bioaccumulation.

Bioaccumulation is described in the EB 1998/2 decision as:

- “(i) Evidence that the BCF or BAF for the substance is greater than 5,000 or the log Kow is greater than 5; or
(ii) Alternatively, if the bio-accumulative potential is significantly lower than (i) above, other factors, such as the high toxicity of the substance, that make it of concern within the scope of the protocol.”*

The PFOS dossier provides information on Log Kow and bioaccumulation, which are both indicators of the bioaccumulation potential. From Table 2 of the introduction of the dossier it becomes clear that the Log Kow is not measurable.

Bioconcentration factors for whole fish, fish liver and plasma are provided in section B1 of the dossier (up to 2796 L/kg, up to 2900 L/kg, and up to 3100 L/kg). The dossier indicates that these values do not meet with the indicative BCF values given in the EB decision, but also explains that the BCF may not adequately represent the bioaccumulation potential of PFOS. Therefore additional information on biomagnification of PFOS is provided in the dossier.

The literature mentions that PFOS behaves differently than the usual POPs as it binds to proteins rather than to lipids (Hu et al., 2002; Hu et al., 2003; Jones et al., 2003) and that indicators for bioaccumulation, such as the log Kow, are meaningless in the case of PFOS (Renner, 2001). Studies on bioaccumulation of PFOS are very limited.

Literature on PFOS provided lowest EC50's of 90 µg/L for aquatic midges and somewhat higher concentrations (LC50's: 250-300 µg/L) for other species (see dossier). Therefore PFOS fulfils the EU criteria for the classifications “toxic to aquatic organisms” with the risk phrase R51 and the classification “May cause long-term adverse effects in the aquatic environment” and the risk phrase R53.

Conclusion: the dossier concludes that PFOS fulfils the criteria for bioaccumulation, based on the biomagnification potential. Thus it meets with the EB decision 1998/2 criterion on bioaccumulation which states that other factors that make the substance of concern within the scope of the protocol, such as the high toxicity of the substance, may be put forward in case the substance does not meet with the numerical values. Besides the data on biomagnification it may also meet the bioaccumulation criterion of EB 1998/2 based on the toxicity data provided.

Monitoring or equivalent scientific information suggesting long-range transboundary atmospheric transport (EB decision 1998/2-2a).

The dossier on PFOS provides information on the long-range transport of PFOS in chapter B1. The paper of Martin et al (2004) is mentioned by name and deals with concentrations of PFOS in biota in arctic areas. Other sources (not mentioned in the dossier) providing information on long-range transport (concentrations measured in biota in Arctic or Baltic waters) are Giesy & Kannan (2001), Kannan et al., (2001) and Holmström et al. (2005). The dossier indicates that the mechanisms of the transport of

PFOS to these areas are not known, but it cannot be excluded that it is due to volatile PFOS-related substances that have been degraded to PFOS.

Sufficiency of the information to suggest that the substance is likely to have significant adverse human and/or environmental effects resulting from its long-range transboundary atmospheric transport (EB decision 1998/2-2b).

The dossier does not provide much information on the likelihood of PFOS having significant adverse human and/or environmental effects resulting from its long-range transboundary atmospheric transport. It is questionable if such information should be aimed at, as adverse effects will already appear in industrial and highly populated areas in a much earlier stage.

The literature reports that PFOS and PFOA concentrations are much lower for animals living in the Canadian Arctic than for the same species living in mid-latitude regions of the United States (Martin et al., 2004), which is to be expected because of the location of the main sources. However, PFOS exhibits a global distribution, appears in remote areas, is known to be persistent, and shows an increase in concentrations in biota over subsequent years from the limited data available (Martin et al., 2004; Holmström et al., 2005). These data suggest an increase in exposure in these areas. Giesy and Kannan (2001) provided data on the widely distribution, the persistence and the bioaccumulation of PFOS, however they concluded that the PFOS concentrations in wildlife were still below those required to cause significant effects in laboratory animals. Significant effects on several liver endpoints in Wood mice (*Apodemus sylvaticus*) were observed more recently in a field site near a fluorochemical plant in Belgium (Hoff et al., 2004).

Since surface treatments constitute the largest volume of PFOS production, scientists and regulators believe that they present the greatest potential for widespread human and environmental exposure (Renner, 2001). Due to the end use of PFOS related substances in articles, emission control techniques cannot eliminate the diffuse sources, which are thought to be considerable. Notwithstanding the above presented knowledge, little is known about the transport and behavior of fluorinated alkyl compounds in the environment (Moriwaki et al., 2003; Schultz et al., 2004). Consequently, the concentrations in these areas in the future and their effects are hard to predict at this moment.

Conclusions on the technical content of the dossier

1. The dossier is written in a compact and easy readable style.
2. The literature used in the dossier is up-to-date
3. Additional literature can be included in some parts of the dossier (e.g. 1st par. of chapter B1)
4. The dossier provides enough information for screening against the indicative values of the POP characteristics
5. Better estimated quantities of PFOS related compounds over the different uses would facilitate measures (chapter C2)

Disclaimer

The views expressed in this technical review are solely those of the reviewer and do not necessarily represent the views of any organization and/or government to which the reviewer is affiliated. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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SUMMARY OF PEER TECHNICAL REVIEW COMMENTS ON PENTABROMODIPHENYL ETHER AND PERFLUOROOCTANE SULFONATE DOSSIERS SUBMITTED UNDER THE UNECE-LRTAP POPS PROTOCOL

PENTABROMODIPHENYL ETHER

Introduction: Commercial pentabromodiphenyl ether (PeBDE) is a brominated flame retardant most commonly used in the production of polyurethane foam, although production for this use appears now to have ceased in North America and Europe. Commercial PeBDE is a mixture of polybrominated diphenylethers, particularly those with four bromines (tetrabromodiphenyl ethers; TeBDE), five bromines (pentabromodiphenyl ethers; PeBDE) and, to a lesser extent, six bromines (hexabromodiphenyl ethers; HxBDE). Within each of these groups there are different congener arrangements of the bromine atoms, which may exhibit different toxicities (e.g., BDE-47 in the TeBDE group, BDE-99 in the PeBDE group, etc). In 2004, Norway proposed commercial PeBDE for listing as persistent organic pollutant (POP) under the UNECE-LRTAP POPs Protocol. The LRTAP nomination process includes the submission of a risk profile by the proponent Party, which, if considered acceptable by the LRTAP Executive Body, then undergoes one or more technical reviews. The technical review process has been separated into Track A (POPs characteristics) and Track B (management options). This report is an abbreviated summary of four independent technical reviews of the risk profile undertaken under Track A of this process. The original technical reviews are appended and should be referred to should clarification be needed.

Methods: The technical reviews were conducted in a similar manner to those routinely undertaken for peer reviewed journal articles or government document preparation. Reviewers were instructed to be transparent, and to include critical evaluation of such aspects as, *inter alia*, availability, reliability, completeness and relevance of the information and references. Only information contained in the dossiers was to be addressed, and reviewers were to refrain from any elaboration of their content or comments that could be considered to reflect policy. Thus, the statements and conclusions made in the technical reviews address the sufficiency and veracity of the risk profile in making the case that a substance is a POP under the LRTAP POPs Protocol. Reviewers were at liberty to suggest additional citations and information, as routinely performed in peer reviews, based on the reviewer's knowledge of the subject and contemporary literature. Following an introductory teleconference to discuss the peer review charge, the reviewers acted independently and were instructed not to seek to obtain consensus on issues, although conversations between reviewers were permitted. Individual, independent, peer review reports were submitted by each reviewer. These reports are summarized here with the understanding that the purpose of this summary is to compile the independent findings, not to seek consensus on decisions or to provide any further interpretation. For brevity, the terms "concluded" or "agreed" are used in this following summary to refer to independent evaluations of whether the risk profile provides sufficient information to draw its stated conclusions, rather than a concurrence among reviewers or a *de novo* assessment of POPs characteristics.

POP characteristics in terms of the guidance and indicative numerical values provided in Executive Body Decision 98/2 for:

Persistence: All four technical reviewers concluded that the risk profile provides sufficient information that PeBDE is persistent in the environment, exceeding the LRTAP guidance.

Reviewers agreed that PeBDE was not readily biodegradable in the only available laboratory test. One reviewer noted difficulty in obtaining a copy of this report.

Three reviewers noted that the structure-activity relationship (SAR) analyses indicated PeBDE and certain congeners to exceed the LRTAP guidance. One of these reviewers noted that the citations were not readily obtainable.

One reviewer noted additional data on persistence available from EMEP, demonstrating half-lives in the environment of approximately 5.5 (BDE-47) and 6.1 (BDE-99) months. Another reviewer noted the prolonged stability of PBDE in sediment cores.

Bioaccumulation: All four reviewers concluded that the risk profile provides sufficient information that PeBDE satisfies the LRTAP guidance for bioaccumulation.

Reviewers agreed that PeBDE has a logKow >5; three reviewers noted the BCF >5000.

One reviewer noted substantial contemporary literature relating bioaccumulation potential to the sizes of the brominated molecules, along with changes in congener profiles in biota possibly related to reductive debromination.

Toxicity: All four reviewers agreed that the risk profile provides sufficient information that PeBDE has the potential to adversely affect human health and/or the environment.

Reviewers agreed that PeBDE satisfied a variety of national criteria for determining toxicity, particularly those of the European Union.

One reviewer noted the existence of more contemporary toxicity studies, particularly related to developmental neurotoxicity at potentially lower levels than were noted in the risk profile.

The same reviewer recommended inclusion of additional information comparing environmental levels to those potentially associated with adverse effects. This reviewer also recommended the inclusion of additional information explaining the cumulative dose-metric concept for persistent toxicants, coupled with the long half-life of PBDE in humans compared to many of the test species.

Potential for Long-Range Transboundary Atmospheric Transport: All four reviewers agreed that the risk profile provides sufficient information that PeBDE has the potential for long-range transboundary atmospheric transport.

Reviewers agreed that PeBDE has a vapour pressure <1000 Pascals and that it has been detected in the atmosphere and in remote locations. Three reviewers noted the half-life in air of greater than 2 days by SAR, one citing newer literature on half-lives of ~7 - 20 days. Two reviewers provided additional contemporary citations reporting atmospheric transport to remote locations.

One reviewer expressed concern that the SAR citations in the risk profile were difficult to obtain.

Monitoring or equivalent scientific information suggesting long-range transboundary atmospheric transport: All four reviewers agreed that there was monitoring data to indicate that PeBDE is undergoing long-range transboundary atmospheric transport.

Three reviewers noted the time trends for PeBDE levels in remote regions, in addition to recommending further contemporary citations.

Sufficiency of the information to suggest that the substance is likely to have significant adverse human and/or environmental effects resulting from its long-range transboundary atmospheric transport (LRAT): Executive Body Decision 1998/2(2) stipulates a technical evaluation of the sufficiency of the information that the substance is likely to have significant adverse effects resulting from its LRAT. The PeBDE risk profile includes a "Statement of the reasons for concern and need for global action," which is at least partially responsive to EB1998/2(2), albeit more geared to Stockholm Convention requirements. The conclusions of the technical reviewers on this issue are carefully worded and best conveyed verbatim. Please refer to the attached original documents for additional information and clarification.

Reviewer 1: Adverse environmental effects could result from PentaBDE presence in remote regions and its observed concentrations in some species of biota. PentaBDE may in fact cause long-term adverse effects in the aquatic environment, considering its intrinsic toxicity (EC50 for Daphnia), lack of biodegradation and the high bioaccumulation potential observed. Also, the high PentaBDE levels observed in marine predators as well as in predator birds (and their eggs) of the terrestrial food web, provide reasons for concern for both the aquatic and the terrestrial compartment ...

Reviewer 2: The combination of the potential for atmospheric transport, measured environmental and biotic levels, the exponential increases in these levels, and their relationship to toxic endpoints in humans and biota, indicate that PeBDE exhibits similar reasons for concern as substances already listed as POPs under the LRTAP Protocol.

Reviewer 3: The dossier does not provide much information on the likelihood of pentaBDE having significant adverse human and/or environmental effects resulting from its long-range transboundary atmospheric transport. However, the fact that pentaBDE is present in remote areas, and that their concentrations are increasing provide sufficient evidence that pentaBDE is likely to have significant adverse human and/or environmental effects.

Reviewer 4: Results indicate that the levels of Penta-BDE are on the rise in the Arctic. Considering its intrinsic toxicity and persistence in the environment pent-BDE congener will bioaccumulate in biota and will move up the food web. This causes concern among the predator birds and terrestrial animals at the top of the food web. Low level neurotoxicity would impair their ability to hunt, and would hinder their ability to survive. ...

Conclusions on the technical content of the dossier: Three reviewers emphasized that the risk

profile was out of date, referencing literature only until 2000. Newer references should be included and would strengthen the proposal, as they confirm earlier concerns. Otherwise, the reviewers considered the dossier to be well-written, with sufficient information for screening against the LRTAP indicative POPs guidance criteria.

Disclaimer: The views expressed in this technical review are solely those of the reviewers and do not necessarily represent the views of any organization and/or government to which the reviewers are affiliated. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

PERFLUOROOCTANE SULFONATE

Introduction: Perfluorooctane sulfonate (PFOS; $\text{CF}_3(\text{CF}_2)_7\text{SO}_3^-$) is a sulfonate ion with a fully fluorinated alkyl chain. PFOS is used as such in some applications or incorporated into larger molecules and polymers. Due to its surface-active properties, it is used in a wide variety of applications, such as stain repellent and cleaning products, hydraulic fluids, fire fighting foams, and semiconductor chip manufacture. PFOS can be formed in the environment by degradation from a large group of substances containing the core PFOS moiety, referred to as PFOS-related substances. Based on measurements of the widespread distribution of PFOS in biota, the principal global manufacturer of PFOS began phasing out production in 2000, although other companies continue production and issues remain regarding the availability of suitable alternatives to replace some critical uses. In 2004, Sweden proposed PFOS and 96 PFOS-related substances for listing as persistent organic pollutants (POPs) under the UNECE-LRTAP POPs Protocol. The LRTAP nomination process includes the submission of a risk profile by the proponent Party, which, if considered acceptable by the LRTAP Executive Body, then undergoes one or more technical reviews. The technical review process has been separated into Track A (POPs characteristics) and Track B (management options). This report is an abbreviated summary of three independent technical reviews of the risk profile undertaken under Track A of this process. The original technical reviews are appended and should be referred to should clarification be needed.

Methods: The technical reviews were conducted in a similar manner to those routinely undertaken for peer reviewed journal articles or government document preparation. Reviewers were instructed to be transparent, and to include critical evaluation of such aspects as, *inter alia*, availability, reliability, completeness and relevance of the information and references. Only information contained in the dossiers was to be addressed, and reviewers were to refrain from any elaboration of their content or comments that could be considered to reflect policy. Thus, the statements and conclusions made in the technical reviews address the sufficiency and veracity of the risk profile in making the case that a substance is a POP under the LRTAP POPs Protocol. Reviewers were at liberty to suggest additional citations and information, as routinely performed in peer reviews, based on the reviewer's knowledge of the subject and contemporary literature. Following an introductory teleconference to discuss the peer review charge, the reviewers acted independently and were instructed not to seek to obtain consensus on issues, although conversations between reviewers were permitted. Individual, independent, peer review reports were submitted by each reviewer. These reports are summarized here with the understanding that the purpose of this summary is to compile the independent findings, not to seek consensus on

decisions or to provide any further interpretation. For brevity, the terms “concluded” or “agreed” are used in this following summary to refer to independent evaluations of whether the risk profile provides sufficient information to draw its stated conclusions, rather than a concurrence among reviewers or a *de novo* assessment of POPs characteristics.

POP characteristics in terms of the guidance and indicative numerical values provided in Executive Body Decision 98/2 for:

Persistence: All three technical reviewers concluded that the risk profile provides sufficient information that PFOS is very persistent in the environment, exceeding the LRTAP guidance.

Bioaccumulation: All three reviewers concluded that the risk profile provides sufficient information that PFOS satisfies the LRTAP guidance for bioaccumulation.

Reviewers agreed that PFOS binds to proteins in the serum and liver, and that the octanol-water partition coefficient is an inappropriate measure in this situation.

Reviewers agreed that the BCF is less than 5000. The risk profile cites OECD (2002) at 2796.

Reviewers noted the evidence for biomagnification, with one reviewer providing additional citations.

Two reviewers emphasized the strong evidence of bioaccumulation/biomagnification in polar bears, the third reviewer also noted this in a subsequent point.

Two reviewers noted the LRTAP alternative consideration of “other factors that make the substance of concern within the scope of the protocol.” One reviewer highlighted toxicity, the other the potential multiplicative nature of physical accumulation due to environmental persistence, coupled and magnified through bioaccumulation.

Potential for Long-Range Transboundary Atmospheric Transport: All three reviewers agreed that the risk profile provides sufficient information that PFOS has the potential for long-range atmospheric transport either entrained on particles or as a component of more volatile PFOS-related molecules.

Reviewers agreed that PFOS, per se, has very low volatility and would be unlikely to undergo vapor phase atmospheric transport.

Reviewers agreed that the volatility of PFOS-related substances could be contributing to the long-range atmospheric transport of PFOS.

Reviewers noted the paucity of experimental information on PFOS behavior and presence in the atmosphere. Two reviewers provided additional citations to literature on the atmospheric persistence of PFOS-related substances (20+ days), atmospheric levels of PFOS-related substances, and evidence of conversion of PFOS-related substances to PFOS in the environment.

Reviewers emphasized the importance of measured, elevated, PFOS levels in remote regions, such as the Arctic.

Toxicity: All three reviewers agreed that the risk profile provides sufficient information that PFOS has the potential to adversely affect human health and/or the environment.

Reviewers agreed that PFOS satisfied a variety of national criteria for determining toxicity, particularly those of the European Union.

One reviewer emphasized that information to inform PEC/PNEC or margin of exposure (MoE) estimates was not adequately conveyed in the risk profile, nor were such procedures attempted, even though that information is available in research publications, OECD (2002), and United Kingdom regulatory proposals. Conducting such comparative scoping exercises was considered important by this reviewer to inform risk considerations, especially as the risk profile notes the existence of some residual uses that impact human safety and for which satisfactory alternatives are not currently available.

Monitoring or equivalent scientific information suggesting long-range transboundary atmospheric transport: All three reviewers agreed that there was monitoring data in the air and biota to indicate that PFOS, either entrained on particles or as component of more volatile PFOS-related substances, is undergoing long-range transboundary atmospheric transport.

Sufficiency of the information to suggest that the substance is likely to have significant adverse human and/or environmental effects resulting from its long-range transboundary atmospheric transport: The two considerations under Executive Body Decision 1998(2)(2a monitoring data on LRAT; 2b adverse effects from LRAT) were not specifically addressed in the Swedish PFOS risk profile. Although the three technical reviewers were generally supportive that the risk profile provided sufficient information to satisfy this decision requirement, their conclusions on this point are carefully worded and best conveyed verbatim. Please refer to the attached original documents for additional information and clarification.

Reviewer 1: PFOS presence detected in remote regions could be associated to adverse environmental effects. This is because of the high levels observed in some biota species and the nature of the critical effects observed in laboratory species. Food of animal origin is likely to be a source of human exposure to PFOS. For this reason, as well as the bioaccumulative nature of this compound, and its observed half-lives in humans, consumption of local contaminated biota in the above regions might be a matter of concern for some population sub-groups.

Reviewer 2: The combination of the potential for long-range atmospheric transport, measured atmospheric, environmental and biotic levels, temporal increases in these levels, and their relationship to toxic endpoints in humans and biota, indicate that PFOS exhibits similar reasons for concern as substances already listed as POPs under the LRTAP Protocol.

Reviewer 3: The dossier does not provide much information on the likelihood of PFOS having significant adverse human and/or environmental effects resulting from its long-range transboundary atmospheric transport. It is questionable if such information should be aimed at, as adverse effects will already appear in industrial and highly populated areas in a much earlier stage. The dossier indicates that PFOS exhibits a global distribution, appears in remote areas, and is persistent in the environment. Furthermore, PFOS shows an increase in concentrations in biota over subsequent years. These data suggest an increase in exposure in these areas. Emission

control techniques cannot eliminate the diffuse sources, which are thought to be considerable and little is known about the transport and behavior of fluorinated alkyl compounds in the environment at present. Consequently, the change in PFOS concentrations in remote areas and their effects are hard to predict at this moment.

Conclusions on the technical content of the dossier: The reviewers considered the risk profile to be well-written and the literature up-to-date, albeit with recommendations for adding several recent publications. The reviewers considered the dossier to provide sufficient information for screening against the LRTAP indicative values. The reviewers also noted the potential complexity and paucity of information on the 96 PFOS-related substances.

Disclaimer: The views expressed in this technical review are solely those of the reviewers and do not necessarily represent the views of any organization and/or government to which the reviewers are affiliated. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

THIRD MEETING OF THE TASK FORCE ON PERSISTENT ORGANIC POLLUTANTS 30 MAY - 2 JUNE 2005

Dear Task Force Colleagues:

Below you will find two papers which I have prepared in support of our work on the Track A review.

The first *Agenda item 2 Track A review. Personal notes from D Stone on how this item may be addressed* is self explanatory. They are my notes that I have prepared to help me guide us through the agenda. I thought you may like me to share them.

The second paper *Draft text options for dealing with Agenda item 2 Track A review*, considers options for the structure and nature of our report on this item for the Working Group on Strategies and Review. As one of these options will be a challenge to complete in the time available, I have prepared a draft text (based upon the work of the Track A peer reviews) which the Task Force may find helpful as a starting point.

Best wishes. David.

Agenda item 2 Track A review. Personal notes from D Stone on how this item may be addressed.

1) Recall what we have been asked to do.

i) EB Decision 2003/10 states that the Task Force will “prepare technical reviews on dossiers of new substances proposed by Parties for inclusion into annexes I, II or III, in accordance with the relevant provisions of the Protocol and paragraphs 1, 2 and 3 of Executive Body decision 1998/2, and present relevant documentation on the proposals to the Working Group on Strategies and Review”.

ii) At its 22nd session, the Executive Body requested that reviews be conducted on dossiers provided by Norway on Penta-BDE and by Sweden on PFOS.

2) Recall how have been asked to work

i) At its 22nd session, the Executive Body agreed that the generic guidelines for the technical review of new substance dossiers (as included in EB.AIR/WG.52004/1) be used for proposals for additions of substances to the annexes.

ii) In accordance with these guidelines, the Track A review is to examine those elements of the two dossiers and other material that may have been forwarded by the Executive Body) which are relevant to a decision being made by the Parties (at the EB) on whether or not the substances should be considered a POP. This review will focus upon those elements in paragraph 1 a-d of EB decision 1998/2 and be evaluated , inter alia, in accordance with its paragraph 2 a and b, taking note of paragraph 3.

3) Recall progress so far.

i) As allowed by the generic guidelines, four and three peer reviewers respectively have reviewed the

Penta-BDE dossier and the PFOS dossier.

ii) The Track A peer reviews worked alone after an initial coordination meeting. Upon completion of their work, they elected one of themselves to prepare a summary text for each dossier (based upon their individual reports). The two summaries were distributed to the reviewers for comment. No reviewers requested changes to these texts which were (with the original reviews) then distributed to the Task Force. The Track A reviews were organized by myself, but I provided no comment on the reviewers text, or on their summary. As far as possible, an independent peer review has taken took place. The Track A reviewers wished to be anonymous.

4) Outline what needs to be achieved in Vienna?

By the close of the meeting, we must have developed and agreed upon a text (2 pages or less per dossier) which will inform the Working Group on Strategies and Review of the result of our Track A technical reviews of the Penta-BDE and PFOS dossiers.

Bb5) How may we proceed in Vienna?

The following approach could be taken separately for each substance.

- i) Brief presentation on the peer reviews, focussing upon the summaries.
- ii) Discussion on the dossiers and the peer review reports. Brief presentations may be made. One presentation is anticipated from 3M, and the Netherlands may wish to speak to their distributed paper. Norway and Sweden may wish to provide comment.
- iii) Develop a text. Depending upon our preceding discussions, we may consider it possible to begin this task by using the peer review summaries. However, as noted in paragraph 7 of the generic guidelines, the responsibility for the Track A report belongs to the Task Force. The peer review reports and the Task Force technical review report are separate entities. *A possible draft text based upon the peer reports is provided below.*

6) Considerations.

The Task Force may find it helpful to recall (inter alia) the following:

- i) At the end of the meeting, the Task Force must approve those parts of our report to the Working Group on Strategies and Review that constitutes the key elements of our discussions relating to the Track A review and the report is to reflect the full range of views expressed.
- ii) There is no requirement for the Task Force to make recommendations, but we may of course reach conclusions.
- iii) The Task Force undertakes tasks specified in the annual work plan of the Executive Body. In the POPs Protocol process, it is the dossiers and any other information forwarded by the Executive Body that are the subject of the technical review. The Task Force is not requested to elaborate upon the dossiers, the responsibility for "making the case" resting with the proposing Parties. At its 22nd session, the Executive Body forwarded the two dossiers on Penta-BDE and PFOS, but did not include any other information.

iv) In implementing this approach, the Task Force is obviously considering dossiers in the context of the existing body of published scientific information. However, new information may be introduced for consideration, such as has occurred through the submission by 3M. In the present process, the approach for dealing with such material which has not been forwarded through the Executive Body could be for us to take note of the 3M material, and advise the WGSR that it has been received and of its general nature. In this way we may seek guidance, and the WGSR and EB may take into consideration such matters in their deliberations on the dossiers.

v) The Track A peer review reports and the summary reports were distributed to the Party focal points more than 60 days in advance of the Vienna meeting. In the case of any documents received after this time, our report must indicate that the relevant documents were not provided in sufficient time for consideration, unless the Task Force decides otherwise by consensus.

vi) Some discussion may focus upon the content of the two dossiers in respect to sub- paragraphs 1(a) to 1(d) of EB 1998/2. These sub-paragraphs are introduced in paragraph 1 by (“...following the guidance and indicative numerical values, which demonstrate: ...”). The negotiators consciously avoided setting up “red line criteria”.

CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION
THIRD MEETING OF THE TASK FORCE ON PERSISTENT ORGANIC POLLUTANTS
30 MAY - 2 JUNE 2005

Draft text options for dealing with Agenda item 2 Track A review.

Explanation: The purpose of this paper is to assist us in the preparation of the text for this part of our report to the Working Group on Strategies and Review. The first step may be to ascertain whether we are in general agreement with the work of the peer reviewers. If this is the case, then there seem to be two fundamental ways in which the Task Force may approach the task.

1) We could prepare a short conclusions text for the report, and refer the WGSR to the peer review reports and their summaries for any sense of the strength or weakness of those conclusions. This approach is attractive because it is simple and avoids the difficulty of attempting to summarize and agree upon how to present a complex body of information. The unsatisfactory aspects of this option include the lack of Task Force participation in the work, the "exposure" that it places upon the Track A reviewers who wished to be anonymous, and the fact that all of detail behind the conclusions will only be available in English.

2) We could prepare a brief summary technical text which will address all of the requirements of EB 98/2. This approach will fully engage the Task Force and would enable the summary to be available in all of the official languages. Because it would be more time consuming and complex, I have taken the liberty to prepare a draft which you may wish to consider as a starting point if this approach is chosen. This text (based upon the work of the Track A reviewers) is provided below.

PROGRESS ON THE WORK ON POPS (Key issues for the WGSR)

In accordance with the work-plan for the implementation of the Convention:

a) the Task Force has prepared reports for the Working Group on Strategies and Review (included below) on:

- i) the technical review of dossiers forwarded by the Executive Body on Pentabromodiphenyl ether (PeBDE) and Perfluorooctane sulfonate (PFOS; $\text{CF}_3(\text{CF}_2)_7\text{SO}_3^-$);
- ii) the technical elements of a review on sufficiency and effectiveness.

b) The Chair of the Working Group on Strategies and Review and the Co-Chairs of the Task Force on POPs have prepared an options paper on possibilities for dealing with amendments to the Protocol and with priority setting.

SUMMARY OF THE TECHNICAL REVIEWS OF THE DOSSIERS ON PeBDE AND PFOS

In accordance with the generic guidelines for the technical review of dossiers, the Task Force conducted for each dossier, a Track A technical review to examine those elements that are relevant to a decision being made by the Parties (at the EB) on whether or not the substances should be considered a POP, and a Track B review of those elements that are related to the development of a strategy for the substance.

Track A peer and technical reviews. To assist in its work, the Task Force arranged for a team of peer reviewers to examine the dossiers in a similar manner to those routinely undertaken for peer reviewed journal articles or government document preparation. Peer reviewers worked and reported independently. They were instructed to be transparent, and to include critical evaluation of such aspects as, *inter alia*, availability, reliability, completeness and relevance of the information and references. Only information contained in the dossiers was to be addressed, and reviewers were to refrain from any elaboration of their content or comments that could be considered to reflect policy. Statements and conclusions made in the peer reviews address the sufficiency and veracity of the risk profile in making the case that a substance is a POP under the LRTAP POPs Protocol.

The reviewers elected one of themselves to prepare a peer review summary text for each dossier (based upon their individual reports). The two summaries were distributed to the reviewers for comment. No reviewers requested changes and no comments were provided by the co-chair on the individual Track A reports or on the summary texts. The individual peer reviews submitted by each reviewer and the peer review summaries are available in a separate document.

At its third meeting, the Task Force reviewed the dossiers, the individual peer review reports, and the peer review summaries. The Task Force was in general agreement with the findings of the peer reviewers and decided to base its Track A technical review report to the Working Group on Strategies and Review upon the peer review reports, which may be consulted by Parties if necessary. In its report, the Task Force has followed the procedure used by the peer reviewers, and has employed the terms “concluded” or “agreed” to refer to their memberships evaluations of whether the risk profile provides sufficient information to draw its stated conclusions, rather than a Task Force concurrence or a *de novo* assessment of the POPs characteristics of the two substances.

PENTABROMODIPHENYL ETHER (PeBDE)

Conclusions. The Task Force concluded that the dossier contains sufficient information for screening in relation to the requirements of EB 98/2, and to support the dossiers conclusion that the PeBDE be considered as a POP in the context of the Protocol. It was generally felt that the risk profile was out of date, referencing literature only until 2000. Newer references would have strengthened the proposal.

Introduction: Commercial pentabromodiphenyl ether (PeBDE) is a brominated flame retardant most commonly used in the production of polyurethane foam, although production for this use appears now to have ceased in North America and Europe. Commercial PeBDE is a mixture of polybrominated diphenylethers, particularly those with four bromines (tetrabromodiphenyl ethers; TeBDE), five bromines (pentabromodiphenyl ethers; PeBDE) and, to a lesser extent, six

bromines (hexabromodiphenyl ethers; HxBDE). Within each of these groups there are different congener arrangements of the bromine atoms, which may exhibit different toxicities (e.g., BDE-47 in the TeBDE group, BDE-99 in the PeBDE group, etc).

POP characteristics in terms of the guidance and indicative numerical values provided in Executive Body Decision 98/2 for:

Persistence: The Task Force agreed that the risk profile provides sufficient information to support the dossier conclusion that PeBDE is persistent in the environment, exceeding the guidance and indicative values.

Bioaccumulation: The Task Force agreed that the risk profile provides sufficient information to support the dossier conclusion that PeBDE satisfies the guidance and indicative values for bioaccumulation and bioconcentration.

Toxicity: The Task Force agreed that the risk profile provides sufficient information to support the dossier conclusion that PeBDE has the potential to adversely affect human health and/or the environment. It was noted that PeBDE satisfied a variety of national criteria for determining toxicity, particularly those of the European Union, and that attention had been drawn to the existence of more contemporary toxicity studies, particularly related to developmental neurotoxicity at potentially lower levels than were noted in the risk profile.

Potential for Long-Range Transboundary Atmospheric Transport: The Task Force agreed that the risk profile provides sufficient information to support the dossier conclusion that PeBDE has the potential for long-range transboundary atmospheric transport by satisfying the guidance and indicative values for vapor pressure and atmospheric half life, and by the existence of monitoring data showing that the substance is present in remote regions.

Sufficiency of the information to suggest that the substance is likely to have significant adverse human and/or environmental effects resulting from its long-range transboundary atmospheric transport (LRAT): The Task Force noted that the dossier is partially responsive to this requirement. It was observed that (inter alia) although effects in wildlife and humans have not been documented, the combination of the potential for atmospheric transport, measured environmental and biotic levels, the exponential increases in these levels in some environments and their relationship to toxic endpoints, indicate that PeBDE exhibits similar reasons for concern as substances already listed as POPs under the LRTAP Protocol.

PERFLUOROOCTANE SULFONATE (PFOS)

Conclusions on the technical content of the dossier: The Task Force concluded that the dossier contains sufficient information for screening in relation to the requirements of EB 98/2, and to support the dossier's conclusion that PFOS be considered as a POP in the context of the Protocol. The Task Force observed that several recent publications could have been cited and noted the potential complexity and paucity of information on the 96 PFOS-related substances.

Introduction: Perfluorooctane sulfonate (PFOS; $\text{CF}_3(\text{CF}_2)_7\text{SO}_3^-$) is a sulfonate ion with a fully fluorinated alkyl chain. PFOS is used as such in some applications or incorporated into larger molecules and polymers. Due to its surface-active properties, it is used in a wide variety of applications, such as stain repellent and cleaning products, hydraulic fluids, fire fighting foams, and semiconductor chip manufacture. PFOS can be formed in the environment by degradation from a large group of substances containing the core PFOS moiety, referred to as PFOS-related substances. Based on measurements of the widespread distribution of PFOS in biota, the principal global manufacturer of PFOS began phasing out production in 2000, although other companies continue production and issues remain regarding the availability of suitable alternatives to replace some critical uses.

POP characteristics in terms of the guidance and indicative numerical values provided in Executive Body Decision 98/2 for:

Persistence: The Task Force agreed that the risk profile provides sufficient information to support the dossier conclusion that PFOS is persistent in the environment, exceeding the guidance and indicative values.

Bioaccumulation: It was noted that the BCF is lower than the indicative value of 5,000, but that since PFOS is thought to bind to proteins in the serum and liver, the octanol-water partition coefficient is an inappropriate measure of bioaccumulation. In this situation the Task Force took note of evidence of toxicity, and bioaccumulation / biomagnification, in polar bears, together with information on high environmental persistence, and agreed that the risk profile provides sufficient information to support the dossier conclusion that the guidance of EB 98/2 concerning bioaccumulation has been satisfied.

Potential for Long-Range Transboundary Atmospheric Transport: The Task Force noted the paucity of experimental information on PFOS behavior and presence in the atmosphere. It was agreed that low volatility of PFOS reported in the dossier suggests that vapor phase atmospheric transport is unlikely, and that the indicative values for vapor pressure are not met. However, the Task Force considered that monitoring information on PFOS presence in air and biota in remote areas and the possibility of entrainment on particles or of the transport of more volatile PFOS related substances is supportive of the dossiers conclusions that PFOS has the potential for long-range atmospheric transport.

Toxicity: It was noted that PFOS satisfied a variety of national criteria for determining toxicity, particularly those of the European Union, but at the same time information was not provided which considered the relationship between environmental levels and the levels at which harm may occur. The Task Force agreed that the risk profile provides sufficient information to support the dossier conclusion that PFOS has the potential to adversely affect human health and/or the environment.

Sufficiency of the information to suggest that the substance is likely to have significant adverse human and/or environmental effects resulting from its long-range transboundary atmospheric transport: It was noted that the dossier does not specifically address the requirements of paragraphs 2 (a) (monitoring data indicating long-range atmospheric transport), and 2(b) (adverse effects from long-range atmospheric transport). However, the Task Force was

generally supportive that the risk profile provides sufficient information to indicate that PFOS has the potential to adversely affect human health and/or the environment as a result of long-range atmospheric transport.

Other considerations *NOTE The Task Force may be presented with additional information in Vienna. The Task Force has a mandate only to review material provided to it by the EB. However, the Task Force may wish to inform the Working Group on Strategies and Review that it has received such information and at the same time provide some indication of its nature.*

PERFLUOROOCTANE SULFONATE (PFOS)

**Track B Review for the
UNECE LRTAP Task Force
on Persistent Organic Pollutants**

May 2005

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PERFLUOROOCTANE SULFONATE (PFOS)

**Track B Review for the
UNECE LRTAP Task Force
on Persistent Organic Pollutants**

May 2005

SUMMARY

Sweden prepared a dossier dated August 2004 to nominate Perfluorooctane Sulfonate (PFOS) and 96 PFOS-related substances to the UNECE LRTAP Protocol and the Stockholm Convention. The dossier contains only limited information on release and emission scenarios for PFOS, but generally reflects the best information available at the time it was prepared. The dossier recognizes that no alternatives to PFOS are currently available for certain specific uses, and notes that those uses are limited in volume and are amenable to emission control techniques. References in the dossier to risk management actions already taken or proposed in the United States (US) and the United Kingdom (UK) are suggestive of measures that could be undertaken throughout the UNECE countries to limit PFOS production, use, and emissions. Information is not provided concerning the legal authority for implementing such measures beyond the US and UK. The dossier notes that the health and environmental implications of fluorinated telomers, which substitute for PFOS in many applications, are not understood. Information is extremely limited on the volume of production and use, the specific nature of process and emission controls, and the costs and benefits of control actions.

INTRODUCTION

This document provides the Track B review of a dossier prepared by the Swedish Chemicals Inspectorate (KemI) and the Swedish EPA titled, *Perfluorooctane Sulfonate (PFOS): Dossier prepared in support for a nomination of PFOS to the UN-ECE LRTAP Protocol and the Stockholm Convention*, in August 2004. The purpose of this Track B review is to present a technical review of the information about release to the environment and socio-economic factors provided in the dossier. Such information will be relevant to developing a strategy for managing risks from PFOS, if it is decided to pursue such action. This review has been conducted in conformance with Executive Body Decision 1998/2 (EB 1998/2) and subsequent guidance to reviewers prepared under the auspices of the Task Force on Persistent Organic Pollutants.

Information from all reviewers has been utilized in the preparation of this review. It follows the format suggested in January 18, 2005, guidance provided to reviewers by the co-chairs of the UNECE LRTAP Convention Task Force on Persistent Organic Pollutants.

RELEASE TO THE ENVIRONMENT

The references in the dossier concerning production, use, and emissions are generally complete. The 13 Jan. 2005 OECD *Results Of Survey On Production And Use Of PFOS, PFAS And PFOA, Related Substances And Products/Mixtures Containing These Substances* (ENV/JM/MONO (2005)1), which was not available until after the date of the dossier, provides more recent data relevant to the development of risk-reducing strategies.

Production

The dossier provides limited production volume information. It describes 2000 PFOS production by 3M, the single, largest manufacturer at that time, and global capacity at the end of the 1990s for producing PFAS, a category of chemicals of which PFOS is one. It states correctly that 3M completely phased out of production of PFOS in the beginning of 2003. While these data provide an historic perspective, they are outdated. Following 3M's action, it is expected that global production dropped substantially and it would have been desirable for the dossier to provide some estimate of current or expected future production levels.

Use

The information on the use of PFOS and related substances is, in large part, based on one source. This source provides extensive information about the historical uses of PFOS in the United Kingdom (UK) and the European Union (EU). Very little information about uses is provided for UNECE countries, although there is mention of the significant new use rules (SNUR), put in place in the US after PFOS was taken off the market. These rules restrict PFOS from re-entering the market in the US without Environmental Protection Agency (EPA) review for uses identified in the rule. The description in the dossier left the reader with the mistaken impression that these rules prevented all uses in the future when, in fact, four low volume uses without substitutes in the semiconductor manufacture, aviation hydraulics and photography areas have been allowed to continue. Information about volumes of use is very limited. With the exception of one table identifying volumes for four uses in the UK, no volume information is provided. These volumes are identified as "current," without identifying the specific year to which they apply. In light of the phase out of PFOS production by 3M in 2003, it would be desirable to know if these data precede or come after the phase out.

Emissions

There are different stages in the life cycle of PFOS where emissions to the environment can occur - from manufacture through use, disposal and treatment. There are no measured data on emissions to air from production of PFOS, but there is strong evidence that air emissions must take place during PFOS production. However, most emissions of PFOS and related substances go to water and soil. No data are presented about the amount of air emissions but they are probably small compared to emissions to soil and water. The dossier recognizes that PFOS can be formed through the degradation of

PFOS-related substances, thus creating a major obstacle to estimating releases of PFOS to the environment.

SOCIO-ECONOMIC FACTORS

National and International Regulations

Although not specifically called for in EB 1998/2, the dossier provides information about regulatory status of PFOS in the EU and US. It also summarizes activity in the OECD and OSPAR. Other UNECE countries are not mentioned.

Alternatives/substitutes

The dossier provides information in some depth about the availability of substitutes for remaining uses. It recognizes that the alternatives to PFOS for many applications are fluorinated telomers, and that the health and environmental implications of these chemicals are not yet understood. The dossier indicates that alternatives to PFOS are not available for certain photographic, semiconductor manufacture, and aviation hydraulic fluid uses, and that alternatives to the use of PFOS in chemical mist suppression for hard chrome plating need to be explored in more detail. While generally the dossier addresses chemical substitutes, in the case of photography, it recognizes a substitute technology, digital photography. As a result of the rapid growth of digital photography in the marketplace there is a reduction in the use of chemicals, including PFOS, in the film development process. The discussion of alternatives is limited to the UK, EU and US. This discussion may apply to other areas of the world as well, but the question about global applicability is not answered for the reader. More information about markets, the opportunities for penetration by competing chemicals or technologies and comparative costs of the substitutes, along with comparative efficacy would be helpful in understanding the relative ease or difficulty of moving to substitute chemicals or technologies.

Emission Control Techniques

This section about pollution prevention opportunities is quite brief and seems to be suggesting that few opportunities for process change, better handling of chemicals or other pollution prevention approaches exist. The section fails to provide adequate information to be persuasive that the opportunities are so limited. More exploration of the pollution prevention possibilities is warranted.

Costs and Benefits of Control

This section does not provide very much information to decision makers wanting to consider a strategy for controlling the risks from PFOS and none for the 96 related substances. The dossier only provides two examples of costs and a qualitative naming of benefits. While, admittedly, a detailed cost-benefit analysis cannot be undertaken in the absence of a particular set of decision choices, considerably more information could have been provided to help frame the question about whether or not society will be better off if additional actions are taken to manage risks from the remaining manufacture and use of PFOS and related substances.

CONCLUSIONS

The dossier generally reflects the best available information concerning PFOS production, use, and emissions available at the time the dossier was prepared. The focus is clearly on PFOS, as virtually no release or socio-economic information about the 96 related chemicals is provided. The dossier does provide a good overview of the available information about the technical aspects of alternatives for PFOS. Yet it falls short of providing adequate information for understanding the current manufacture and use of PFOS since 2003, when 3M stopped production, or the likely success of various strategies that might be taken to manage risks from PFOS or the 96 related chemicals. Little information is provided about markets outside of the UK and EU and, to a lesser extent, the US. Benefit and cost information is especially inadequate for developing a strategy for action. Although one reviewer suggests that the information in the dossier is adequate to provide a basis to guide a strategy under either Annex II (restriction on uses) or Annex III (emission reduction) to the protocol, others are not so confident. In general, the reviewers felt that utilization of information that has become available more recently would be valuable as the decision process moves forward.

DISCLAIMER

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Both PFOS and PeBDE dossiers have been technical reviewed of the information about release to the environment and socio-economic factors provided. This is the first step in the Track B review. Once the EB decides that the substances are a POP more work will be needed to gather information (second step) to develop a management strategy. The technical reviews are therefore different in nature than the Track A peer reviews. The name technical review and not peer review as used in Track A reflects this.

PFOS

The information on the use and the production volume of PFOS and 96 PFOS-related substances is extremely limited. The dossier contains only limited information on PFOS release and emissions, but generally reflects the best information available at the time it was prepared. No data are presented about the amount of air emissions but they are probably small compared to emissions to soil and water. The dossier recognizes that PFOS can be formed through the degradation of PFOS-related substances, thus creating a major obstacle to estimating releases of PFOS to the environment. The dossier does provide a good overview of the available information about the technical aspects of alternatives for PFOS. The dossier recognizes that no alternatives to PFOS are currently available for certain photographic, semiconductor manufacture, and aviation hydraulic fluid uses, and that alternatives to the use of PFOS in chemical mist suppression for hard chrome plating need to be explored in more detail. It is noted that those uses are limited in volume and are amenable to emission control techniques. The dossier notes that the health and environmental implications of fluorinated telomers, which substitute for PFOS in many applications, are not understood. More information about markets, the opportunities for penetration by competing chemicals or technologies and comparative costs of the substitutes, along with comparative efficacy would be helpful in understanding the relative ease or difficulty of moving to substitute chemicals or technologies. The costs and benefit section does not provide very much information to decision makers wanting to consider a strategy for controlling the risks from PFOS and none for the 96 related substances. References in the dossier to risk management actions already taken or proposed in the United States (US), the European Union (EU) and the United Kingdom (UK) are suggestive of measures that could be undertaken throughout UNECE countries to limit PFOS production, use, and emissions. The dossier falls short of providing adequate information for understanding the current manufacture and use of PFOS since 2003, when 3M stopped production, or the likely success of various strategies that might be taken to manage risks from PFOS. Benefit and cost information is especially inadequate for developing a strategy for action. Utilization of information that has become available more recently such as the *OECD Results Of Survey On Production And Use Of PFOS, PFAS And PFOA, Related Substances And Products/Mixtures Containing These Substances* (ENV/JM/MONO (2005)1), would be valuable as the decision process moves forward.

PeBDE

The dossier on PeBDE was prepared over four years ago in 2000, and much relevant information has been published since that time. This gap is excessive in this situation. Although the dossier would benefit from updating with more contemporary citations, the information provided is accurate and begins to point towards possible risk management

actions that could be taken. The dossier provides information on production and market, as of 2000. Production and use of PeBDE will now be significantly lower due to the phase-out in US and EU. Even with the phase out of PeBDE, existing stock of products containing the chemical is still used in the applications described. Major potential emission routes were identified and release estimates provided. Available information on releases from products during the whole of their life cycle is not exhaustive, but the dossier states that most of the PeBDE is released as diffuse pollution during and after the service life of the articles, and as “small-scale point source pollution” from disposal and recycling. Challenges include how to address releases due to weathering and wearing of articles, disposal in sewage sludge, releases from landfills, incinerator emissions, and releases from recycling plants. The dossier does identify potential alternatives, chemical and non-chemical, to PeBDE. The dossier discusses flame retardants now used in furniture, noting TBBE and chlorinated phosphate esters (e.g., TCPP) as alternatives for PeBDE in particular. Costs are not addressed and benefits are only touched on. Costs and technical feasibility of control measures need to be more fully developed and actual emission data is needed. Utilization of information that has become available more recently, especially the US industry phase-out of PeBDE, followed by the US regulation under the Toxic Substances Control Act, proposed in December of 2004, would be valuable as the decision process moves forward.

Should a decision be made to move ahead with PeBDE clarification is needed on the chemistry and nomenclature of PeBDE. The Norwegian proposal is that commercial pentabromodiphenyl ether be listed as a POP. This commercial product is, however, comprised of a number of homologue groups of diphenylethers, particularly those with four bromines (tetrabromodiphenyl ethers; TeBDE) and five bromines (pentabromodiphenyl ethers; PeBDE) but also tri and hexa congeners. Consideration will need to be given to prevent a company merely relabelling a penta product as tetra, or slightly modifying the product to increase the proportion of the tetra homologue.

**Integrated Summary of the Components of Technical Input For Reviewing the
Protocol on Persistent Organic Pollutants
Review of the Sufficiency and Effectiveness**

1. The Task Force on POPs prepared technical elements of the review of the sufficiency and effectiveness of the obligations set out in the Protocol on POPs as requested by the Executive Body at its twenty-first session in December 2003 (Decision 2003/10)
2. Pursuant to Article 10 para. 3 of the Protocol: *The sufficiency and effectiveness review will take into account the best available scientific information on the effects of the deposition of persistent organic pollutants, assessments of technological developments, changing economic conditions and the fulfilment of the obligations on emission levels.*
3. This integrated summary report presents summaries of main reports prepared for the technical components of the Sufficiency and Effectiveness Review. These reports are appended to this summary report.

I. Best available scientific information on the effects of the deposition of POPs

The aim of this review is to provide a synthesis of the best available scientific information on atmospheric transport and deposition, levels in environmental media, and the potential toxicological effects that those levels may cause, using measured and modelled levels.

Advances in modeling of POP transport and deposition have improved the identification of chemicals that have the potential for long-range atmospheric transport (LRAT) based on their physical chemical properties. Current models demonstrate transportation and deposition of POPs on global, hemispheric and region scales. While these models demonstrate the importance of global POP sources, they indicate that the majority of POPs deposited in the UNECE originated within the region. Model simulations demonstrate how reduced emission levels in the UNECE have resulted in corresponding decreases in deposition.

The body of information on PCBs and DDTs is relatively extensive and permits the assessment of some spatial and temporal trends that can be attributed to changes in deposition from LRAT. Results suggest that levels of both substances have generally decreased over the past 15-30 years as indicated in natural depositional archives (e.g. sediment cores) and levels in biota. Over the past 10-15 years temporal data from atmospheric and biological monitoring suggest that environmental levels are still decreasing though at a much slower rate, particularly in remote environments such as the Arctic. Despite these trends a number of species continue to display Σ PCB levels, and to a lesser extent Σ DDT levels, that exceed various thresholds for toxic effects. Estimated daily intake of PCBs among the general human population can exceed reference levels set by the ASTDR and the USEPA. The risks are greater for newborns where exposure levels can exceed adult exposure by an order of magnitude. In general, levels of Σ DDT exposure among the general human population are well below exposure guidelines. Highly exposed groups, such as Inuit from Greenland and Canada, who regularly exceed

guidelines for PCB exposure, also exhibit levels of Σ DDT exposure that approach and occasionally exceed WHO guidelines.

The amount of information on environmental levels of PCDDs and PCDFs is not as extensive as it is for most other POPs. Models of current atmospheric levels and deposition suggest decreasing trends in industrial regions of the UNECE. Monitoring results from remote areas such as the Arctic generally show no discernible trends for PCDDs and PCDFs in abiotic media or biota. These data also suggest that some of the more highly exposed species of marine mammals and fish eating birds may exceed some toxicity thresholds. The probability of adverse effects is further increased when exposure to dioxin-like PCBs is considered. PCDDs and PCDFs are ubiquitous in human tissues and together with dioxin-like PCBs can contribute to levels of dioxin-like toxicity that regularly exceed WHO guidelines in the general population.

The accumulated information on environmental levels and trends of HCB, HCHs, chlordanes, toxaphene and to a lesser extent dieldrin and heptachlor epoxide allows for the assessment of some spatial and temporal trends that can be attributed to deposition from LRAT. Data suggests that environmental levels of HCBs, α -HCH, heptachlor epoxide, chlordanes and toxaphene have generally decreased over the past 30 years, however, the evidence for decreasing trends in dieldrin, lindane (γ -HCH) or β -HCH is not as clear. Similar findings are also expressed in Arctic atmospheric monitoring data collected over the past 10-15 years. Tissues concentrations in the most highly exposed marine species (birds and mammals) generally do not exceed applicable thresholds of toxicity, however, some effects in highly exposed species have been associated with toxaphene, HCB, HCHs, heptachlor epoxide and chlordanes. Levels of exposure to these POPs among the general human population and resulting from LRAT are well below applicable guidelines. Exposure among Arctic populations that consume marine mammals, however, can exceed USEPA and ASTDR guidelines.

Some modeling data has been generated for PAHs, particularly for more industrialized parts of the UNECE. Model results appear to compare well to atmospheric monitoring data and suggest that atmospheric levels and deposition of PAHs have decreased over the past 10-15 years. Since PAHs do not effectively accumulate or concentrate in food webs, levels measured in biota are relatively low. Consequently, human dietary exposure to PAHs as a result of LRAT is relatively minor and well below applicable guidelines. The greatest source of human exposure to PAHs results from their formation during food production.

Once released into the environment aldrin is readily degraded to dieldrin and is therefore rarely measured. Endrin and mirex are occasionally measured in environmental media, however, the existing data is insufficient for the assessment of temporal trends. A comparison of some recent results compared to results of 20-30 years ago suggests environmental levels have decreased. The limited data for biotic levels of endrin suggest relatively low levels of exposure and little risk of adverse effects resulting from LRAT. Levels of mirex, while higher than endrin levels, are lower than other POPs and there does not seem to be any documented risk of adverse effects related to exposure from

LRAT. Levels of exposure among the general human population are well below applicable guidelines. Mirex exposure among Inuit exceeded Health Canada guidelines in some individuals.

There is very little information about environmental levels of chlordecone and polybrominated biphenyls that is related to deposition from LRAT. What little information there is suggests that exposure to wildlife and humans is negligible.

A number of POP like substances have recently been measured in remote environments for which local sources do not exist. These include brominated flame retardants (PBDEs and HBCD), fluorinated organic compounds (PFOS and related compounds), chlorinated industrial chemicals (SCCPs and PCNs) and current use pesticides (endosulfan). Endosulfan is now one of the most abundant and ubiquitous organochlorine pesticide in the North American Atmosphere. Increasing temporal trends with doubling times of 4-5 years have been reported from some PBDE congeners and concentrations of PFOS have been measured in some species at levels that are among the highest for any POP. PBDEs and PFOS are also being measured in human tissues with increasing regularity and in the case of PBDEs, levels are increasing, particularly in North America.

II. Assessments of technical developments

A. Production and use, including exemptions, of substances listed in annexes I and II

The aim of this review is to provide a synthesis of available information on technological developments for the following substances: DDT, HCH (lindane), and PCBs. In addition, it provides information on requests for special exemptions to produce and/or use PCBs and HCB.

Requests for special exemptions. None of the three Parties with economies in transition has requested an exemption to produce or use HCB or to produce PCBs. The Secretariat does not have information about production and/or use of PCBs with regard to non-Parties.

DDT. The uses and availability of alternatives to DDT was reported upon by the Task Force in 2004. Recently long-lasting insecticide-treated bed nets have been developed where a synthetic pyrethroid insecticide is incorporated into the net fibers, extending the life of the net to 2- 5 years.

HCH including Lindane. The uses of HCH by Parties to the Convention and the Protocol were reported by the Task Force in 2004. Formerly isomers of technical HCH were also used to manufacture trichlorobenzene (TCB). HCH is no longer needed to manufacture TCB. No other chemical products are made with technical HCH.

PCBs. The uses of PCT and Ugilec were reviewed by Parties to the Convention and the Protocol and were reported by the Task Force in 2004.

Dielectric fluids represent a major historical application for PCBs. The most frequently used alternatives for use in transformers are mineral oils and silicone oils. Other alternatives may also be used, but they do not have similar commercial interest.

Alternative engineering designs such as encapsulated transformers equipped with air-cooling have been recommended for non-biodegradable PCB substitutes (DIVS 2000:825, Nordic Council of Ministers). Retrofitting technology to replace PCBs with alternatives in larger transformers is available. The time required to retrofit depends on the size and structure of the transformer and is longer when transformers contain materials, like wood which retain PCB-oil.

The Arctic Council initiated a project in 1998 to phase out PCBs in the Russian Federation. The project included a feasibility study with an evaluation of alternative dielectric fluids for use in larger capacitors and transformers. The combustibility of alternative liquid dielectrics required technologies for storage and filling of transformers to be slightly adjusted and fire safety measures to be intensified. The use of alternatives did not require an upgrade of production technology for capacitors and transformers. Capacitors and transformers using alternative dielectric fluids have electric properties and service lives comparable with units using PCBs and cost less to destroy.

B. Waste management

The aim of this review is to examine new developments on environmentally sound destruction/disposal of substances listed in Annexes I-II of the Protocol as considered under the Basel Convention and the Global Environment Facility (GEF)

At its seventh meeting in October 2004, the Conference of the Parties to the Basel Convention adopted *General Technical Guidelines¹ on the environmentally sound management of wastes consisting of, containing or contaminated with POPs*. They describe commercially available operations for the environmentally sound destruction and irreversible transformation of the POP content in wastes, including alkali metal reduction³³, base catalysed decomposition (BCD)⁴⁸, catalytic hydro-dechlorination, cement kiln co-incineration, gas phase chemical reduction (GPCR), hazardous waste incineration, plasma arc, potassium tert-Butoxide (t-BuOK) method, super- and sub-critical water oxidation. The document also provides guidance on reducing or eliminating releases to the environment from waste disposal and treatment processes.

A Review of Emerging, Innovative Technologies for the Destruction and Decontamination of POPs and the Identification of Promising Technologies for Use in Developing Countries², published by the GEF Scientific and Technical Advisory Panel (STAP) in 2004 identified the following five non-combustion technologies³ as promising, emerging and innovative: (i) Ball milling; (ii) GeoMeltTM Process; (iii) Mediated Electrochemical Oxidation (CerOx); (iv) Mediated Electrochemical Oxidation (AEA Silver II Process); (v) Catalytic hydrogenation. The report recommends that the five identified emerging and promising technologies be further evaluated for the purpose of

¹ The full text is available on the internet at: http://www.basel.int/techmatters/pops/pops_guid_final.doc

² The full text is available on the internet at: http://www.basel.int/techmatters/review_pop_feb04.pdf

³ The definition used for the purpose of the review includes processes which operate in a starved or ambient oxygen atmosphere. Such technologies may produce dioxins or furans but require less technology than an oxidised process such as a high temperature rotary kiln.

providing funding so that the technologies may become commercialized in the near future.

C. By- products

i) Technological Developments on Best Available Control Techniques (BAT)

The following overview of the most recent technological BAT developments in relation to Annex V of the Protocol covers both new and existing major stationary sources. Alternatives and emerging technologies are summarised for each category in the following table.

Category	Alternatives	Emerging Technologies
<i>Incineration, including co-incineration of municipal, hazardous, medical waste, or of sewage sludge waste</i>	<i>For municipal waste:</i> - Zero waste management strategies; Waste minimization, source separation and recycling; Sanitary landfill; Composting; Mechanical biological treatment; High-temperature melting <i>For hazardous waste:</i> - Waste minimization and source separation with final disposal by other techniques or to appropriate landfill; Gas phase chemical reduction; Base catalyzed decomposition; Sodium reduction; Supercritical water oxidation <i>For medical waste:</i> - Steam sterilization; Advanced steam sterilization; Microwave treatment; Dry heat sterilization; Alkaline hydrolysis (or heated alkali digestion); Biological treatment; Disposal to landfill <i>For sewage sludge:</i> - Disposal to landfill; Landspreading of sewage sludge	- Pyrolysis and gasification; Thermal depolymerization; Plasma technologies
<i>Sinter Plants</i>	- FASTMET process; Direct reduction processes; Direct smelting processes	- Selective catalytic reduction - Urea injection
<i>Primary and Secondary Production of Copper</i>	- Consideration should be given to hydrometallurgical processes, where technically feasible, for new smelting facilities or processes.	- Catalytic oxidation
<i>Production of Steel</i>	- There are no alternatives to the graphite electrode at the present time.	- Selective catalytic reduction.
<i>Smelting Plants in the Secondary Aluminum Industry</i>		- Catalytic oxidation - Catalytic filter bags
<i>Combustion of Fossil Fuels in Utility and Industrial Boilers with a Thermal Capacity Above 50 MW</i>	*(Annex V does not identify best available techniques for the specific purpose of PCDD/F removal. Studies in the U.S. have shown that sulfur concentrations in the flue gas inhibit dioxin formation.)	
<i>Residential Combustion</i>	- Replacing poorly designed stoves with improved stoves that burn fuel more efficiently.	- Heat Pumps
<i>Firing Installations for Wood with a Thermal Capacity below 50 MW</i>	- Downdraught boilers; Modern pellet boilers; Installation of accumulator tank	- Small scale Combined Heat and Power Units; Heat Pumps; Renewable technologies; Fuel Cells
<i>Coke Production</i>	- European Jumbo Coking Reactor (Single Chamber System); Non-recovery cokemaking; Antaeus	- Continuous cokemaking process; Calderon Cokemaking

Category	Alternatives	Emerging Technologies
	Continuous Coke™ process	Technology; Japanese SCOPE21 project
<i>Anode Production</i>	-Dry adsorption; Condensation with electrostatic precipitators	- Regenerative afterburner
<i>Aluminum Production using the Soederberg Process</i>	- Inert anodes; Wettable cathodes; Vertical electrodes low-temperature electrolysis (VELTE); Drained cell; Carbothermic technology; Kaolinite reduction technology	
<i>Wood Preservation Installations</i>	- Strict restrictions on the use of creosote and carbolineum for wood preservation.	

ii) Technical developments on limit values

Current international and national limit values for new and existing facilities in those sectors identified in annex IV were compiled for this review. As well, current limit values for both new and existing facilities in sectors identified in annex VIII not covered in annex IV were also considered. This review includes information from countries that are not Parties to the Convention.

For major stationary sources for PCDD/F identified in annex IV: municipal solid waste, medical solid waste and hazardous waste incineration, most countries have limit values below or equal to those set by the Protocol⁴. Limit values in use by most countries are usually set at 0.1ng TE/m³. The lowest limit value reported is 0.080 ng TE/m³ which applies to new and expanding facilities and will be applied to existing facilities in 2006.

Limit values for both PCDD/F and PAH have been adopted by many Parties to the Convention for sources identified in annex VIII. Several countries have emission limit values for PCDD/F for each of the sectors categories 1-5 identified in annex VIII and fewer for categories 6-11 and none for the wood preservation sector (category 12). A few countries have limit values for PAHs. Limit values exist for PAHs for most source categories identified in Annex VIII except for the incineration and wood preservation sectors. Emission limit values for CO in flue gas is being used by some countries to control PAH emissions in the residential combustion sector. Only one country has reported limit values for HCB and this is for category 6. No emission limit values for either PCDD/F, PAH and HCB were found for the wood preservation sector.

Information compiled on medical and hazardous waste incineration standards in this report indicate that the limit values in the UNECE POPs Protocol are generally higher than those established by many Parties. Annex IV of the Protocol only includes limits for incineration of municipal solid waste, medical solid waste and hazardous waste. The present compilation indicates that several Parties have established emission standards for sources identified in Annex VIII, most notably for PCDD/F for categories 1-5.

⁴ Limit values for dioxins and furans referred to in the Protocol are expressed in TEQ/m³ using TEQ suggested by the NATO/CCMS, while currently there is another classification of TEQ given by WHO;

iii) Technological Developments on Measures to Control Emissions from Mobile Sources

National and international emission standards which apply to mobile sources and their fuels, as well as technical developments with respects to Annex VII of the Protocol were reviewed as follows.

Regarding petrol engines, in the past alkyl-lead compounds were widely used in petrol to protect motors from "knocking" effects. Additives were used to avoid lead deposits. During combustion these halogenated scavengers resulted in PCDD/PCDF formation. Today electronic fuel injection and combustion controlling facilities (3-way catalytic converters) are routinely fitted to petrol vehicles to effectively eliminate PAH from exhaust. Since catalysts are intolerant to lead in exhaust, unleaded fuel was phased in. As a result, further addition of halogenated scavengers became obsolete. With leaded petrol phased out in most parts of the UNECE region, petrol cars stopped being a source of PCDD/PCDF.

Due to the heterogeneous nature of combustion, diesel-powered engines are one of the major sources of fine particulate matter (PM). The amount of PM formed depends primarily on the operating conditions and the fuel quality. A major fraction of low volatile hydrocarbons, including PAH gets associated with PM. However, all existing emission standards on diesel engines refer to PM rather than PAH. In recent years there has been improved design of these combustion systems resulting in substantial reduction of PM emissions. Further substantial PM cuts require particulate filter trap systems. Such devices proved to be the most efficient tailpipe reduction technology available, capable of reducing not only just the total amount of particulate in engine-out diesel exhaust but also for retaining effectively the full range of particle size down to nanoparticles of less than 100 nm.

Performance of catalysts and electronic control devices are severely affected by poor fuel quality. Hence, advanced exhaust aftertreatment systems require enhanced fuel standards, e.g. low sulphur content. Refinery processes have been developed producing petrol and diesel fuels of less than 10 ppm sulphur.

It can be concluded that advances in technology have resulted in the following conclusion. With the phasing out of leaded gasoline, petrol fuelled vehicles are no longer a relevant source of dioxins and furans. Diesel powered engines, formally a main source of fine particulate, of which PAH was a major component are undergoing stricter control for PM. Further tightening up of limit values, particularly for off-road machinery is envisaged to further curb PM emissions from diesel engines. Fiscal incentives have also been enacted in some countries to allow for accelerated phasing-in of cleaner technologies. In addition car makers steadily strive for better performance of control technologies in order to cope with tightening of emission standards. Considering the legislatively complex and technologically dynamically evolving issue of PM emission reduction from mobile sources, it is no longer relevant to include PM in one of the annexes to the POPs Protocol and may be better considered outside of the POPs Protocol.

III. Fulfilment of the obligations on emission levels

The required data from Parties to the Protocol are not available for the review as countries will not report 2004 emission data until 2006. As a result the scope of the review is limited. However, the Task Force on POPs invited MSC-E to prepare a synthesis document on the best available Country submitted Emission data, including 1990 and more recent years. A short overview of the emission data is presented below. The emission data submitted by countries in 2004 are available in [EB.AIR/GE.1/2004/10].

Substances included in Annex III. In 2004 the information on emissions of PCDD/Fs, PAHs and HCB for the period from 1990 to 2002 (for at least one year) was submitted by 31, 31 and 22 countries, respectively.

Dioxins and furans. PCDD/F emissions in most European countries showed a general decrease within the period indicated. The overall PCDD/F emissions in seventeen countries for 1990 and 2002 decreased by 68% (or 3.2 times) (Fig.1). The maximum decrease of the PCDD/F emissions was 15 times, whereas the maximum increase of the emissions was 1.5 times.

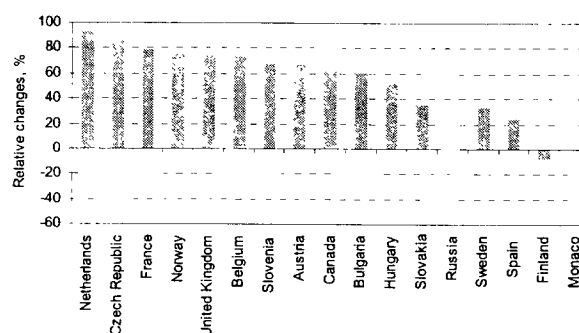


Fig.1. Relative changes of PCDD/F emissions for 1990-2002 in 17 countries

The data on PCDD/F emissions for each year (1990-2002) are available for 10 countries.

The information about the spatial distribution of PCDD/F emissions was submitted by 12 countries. The information on the NFR⁵ PCDD/F sector emissions is available for 20 countries for 2002. The maximum contribution to the total PCDD/F emissions in these countries was made by the residential source sector (31%).

Polycyclic aromatic hydrocarbons. “For the purposes of emission inventories of PAHs the following four indicator compounds were used: benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, and indeno[1,2,3-cd]pyrene”. Countries also submit other data on PAH emissions, data on different compounds.

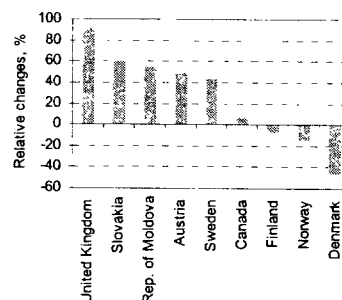


Fig.2. Relative changes of PAH emissions for 1990-2002 in 9 countries

⁵ NFR - Nomenclature For Reporting

The PAH emissions in nine countries, for both years 1990 and 2002, decreased by 29% (or 1.4 times) (Fig.2). The maximum decrease of the PAH emissions was 12 times, whereas the maximum increase of the emissions was 1.5 times.

The data on the PAH emissions for each year (1990-2002) are available for 8 countries.

The spatial distribution of PAH emissions was provided by 11 countries. The information on the PAH sector emissions was submitted by 13 countries for 2002. The maximum contribution to the total emission of PAHs is from the residential sector (63%).

Hexachlorobenzene. The total HCB emissions for eight countries for both years 1990 and 2002 decreased by 20% (or 1.3 times) (Fig.3). The maximum decrease of the HCB emissions was 14 times, whereas the maximum increase of the emissions was 15 times.

The information on HCB sector emissions is available for 12 countries for 2002. The maximum contribution to the total HCB emissions is for the manufacturing industries and construction sector (35%).

Due to limited available data, expert estimates still play a significant role in the evaluation of emission totals and spatial distribution. As a result, these estimates are based on both available official emission data and emission expert estimates.

To evaluate the quality of the estimates, emission data was compared with modelling results. For PCDD/Fs, such a comparison shows that over 60% of available measurements agree with modelling data within a factor of three. Normally the calculated values are lower than measured ones. The agreement between calculations and measurements of PAHs is mostly within factors of two or three depending on a compound. For HCB, the calculations underestimate the measured values considerably due to the global character of this pollutant. HCB emissions from at least the whole Northern Hemisphere should be taken into account. For substances included in Annex III, the comparison is not reliable due to the insufficient amount of measurement data obtained at EMEP monitoring network.

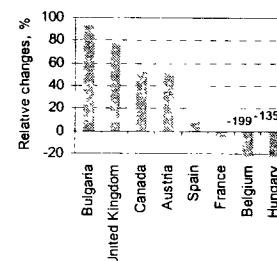


Fig.3. Relative changes of HCB emissions for 1990-2002 in 8 countries

Substances included in Annex II. In addition, the information on emissions of PCBs and HCH for the period from 1990 to 2002 (for at least one year) was submitted by 19 and 12 countries, respectively.

According to the data, the total PCB emissions decreased 4 times between 1990 and 2002. The maximum decrease of the PCB emissions was 9 times, whereas the maximum increase of the emissions was 1.5 times.

According to the information for 1990 and 2002, emissions of HCH decreased 6 times in one country and increased by 3% and 9% in two other countries respectively in 2002 as compared with 1990. HCH emissions in one country equal zero since 1998.

Substances included in Annex I. The emission data on Aldrin, Chlordane, Chlordecone, Dieldrin, Endrin, Heptachlor, Hexabromobiphenyl, Mirex, Toxaphene and DDT for the period from 1990 to 2002 (for at least one year) were also submitted by 11 countries. No use of these substances is reported by all countries but one country.

CONVENTION ON LONG-RANGE TRANSBOUNDARY AIR POLLUTION

**THIRD MEETING OF THE TASK FORCE ON
PERSISTENT ORGANIC POLLUTANTS**

30 MAY - 2 JUNE 2005

**VENUE: FEDERAL MINISTRY for AGRICULTURE, FORRESTRY, ENVIRONMENT
AND WATER MANAGEMENT, Stubenring 1, 1010 Vienna**

DETAILED AGENDA PROPOSAL and TENTATIVE TIMETABLE (Version: 12 May 2005)
All days start at 9.00 and end approximately 17.30

Monday 30th May

1) 09.00 Introduction from the host organization.

09.20 Introduction from the co-chairs and approval of the agenda.

2) 09.40 Track A peer reviews and Track B review reports for PeBDE and PFOS.

- Track A: Presentation of Track A peer reviews and of the peer reviews summary
Opportunity for provision of information. We expect a presentation from 3M.,
and comments have been circulated from the Netherlands. Please advise the co-
chairs if other presentations are expected.
Preparation of the Track A WGSR report (4 pages, each substance 2 pages)
- Track B: Presentation of Track B review reports
Summary for the WGSR report (2 pages, each substance 1 page)

N.B. If time allows we will start on the E&S review!!!!

Tuesday 31st May

3) The sufficiency and effectiveness review.

Part I - BEST AVAILABLE SCIENTIFIC INFORMATION ON EFFECTS OF DEPOSITION OF POPS

Presentation led by Jason Stow (Canada)
Summary for the WGSR report (2 pages)

Part II - ASSESSMENTS OF TECHNOLOGICAL DEVELOPMENTS

Section A - Production and use, incl. exemptions, of substances listed in annexes I and II
Presentation led by Janice Jensen (USA)
Summary for the WGSR report (1 page)

Section B - Waste Management
Presentation by the Secretariat.
Summary for the WGSR report (1/2 pages)

Section C - By-products
i. Technological Developments on Best Available Control Techniques (BAT)

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Presentation led by Paul Aldomovar (USA).

Summary for the WGSR report (1 page)

ii. Technical developments on limit values

Presentation led by Cheryl Heathwood/Michael Herrmann

Summary for the WGSR report (1 page)

iii. Technical developments on measures to control emissions from mobile sources

Presentation led by Michael Herrmann

Summary for the WGSR report (1 page)

Part IV - FULFILMENT OF THE OBLIGATIONS ON EMISSION LEVELS

Presentation by Elena Mantseva (MSC-E)

Summary for the WGSR report (2 pages)

Wednesday 1st June

3) The sufficiency and effectiveness review (cont.).

4) Options for priority setting and possible amendments to the 1998 Protocol on POPs

Presentation by Richard Ballaman (chair WGSR)

The report of the TF contains 2 pages for the WGSR report

Thursday 2nd June

5) Information on other activities of interest.

Reports from AMAP, Stockholm Convention etc. Please advise the co-chairs if other presentations are expected.

6) Report to the WGSR

7) Meeting wrap-up.

17.00 Closing of the meeting