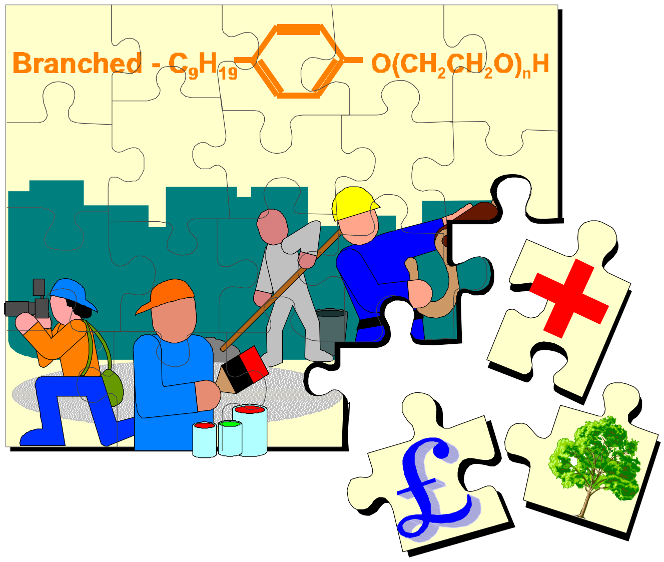
Nonylphenol Risk Reduction Strategy



Final Report

For the Department of the
Environment, Transport and the Regions

RPA

September 1999

Nonylphenol Risk Reduction Strategy

Final Report - September 1999

(Revised 17 September 1999)

prepared for

Department of the Environment, Transport and the Regions

by

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EXECUTIVE SUMMARY

1. Nature and Extent of the Risks

The environmental risk assessment for nonylphenols (NPs) and their ethoxylates (NPEs) indicates the need to reduce risks associated with their production, their formulation into other products and the end use of these products in a wide range of industries.

In particular, the risk assessment concluded that aquatic, terrestrial and secondary poisoning (e.g. bioaccumulation) risks were unacceptable. In terms of lowest observable effects levels (LOEL), the most sensitive of these 'endpoints' is the aquatic environment. Nevertheless, the risk reduction strategy must be designed to deal effectively with each of these endpoints.

The predicted environmental concentration for water (PEC_{water}) is calculated to be 0.6 microgrammes per litre (μg/l), while the predicted no effects concentration for water ($PNEC_{water}$) is calculated to be 0.33 μg/l. Thus, background concentration levels must be reduced significantly, while local concentrations must also be controlled.

2. Proposed Risk Reduction Measures

A mix of policy measures is recommended to address the environmental risks associated with NP and NPE (NP/E). Firstly, in order to reduce background regional concentrations to below the PNEC, it is recommended that comprehensive phase-outs under Directive 76/769/EEC are applied to those industries which contribute most to the regional concentration and/or for which alternatives to NP/E are known to be available. These are industrial, institutional and domestic cleaning (I&I), textiles, leathers, agriculture (veterinary medicines), metals, pulp and paper, and cosmetics. It is believed that this measure would eliminate some 70% of the NP burden, reducing the background regional concentrations to below 0.18 μg/l and thus below the PNEC (0.33 μg/l). For use of NPEs in pesticides (and pesticide adjuvants), introduction of mandatory separation zones between areas of pesticide spraying and water courses is recommended.

Secondly, for the remaining industries, it is recommended that an environmental quality standard (EQS) is established to ensure local concentrations are also below the PNEC. For all facilities which will be licensed under the Industrial Pollution Prevention and Control (IPPC) Directive 96/61, the EQS can be included in the IPPC operating licence, thereby minimising monitoring costs. Member States are required to have IPPC operational by October 1999, with individual permits being operative by 2007. For non-IPPC facilities, the EQS must be established through other regulatory means, either through national legislation or following the introduction of the Water Framework Directive. The risks associated with uses not covered by IPPC could be reduced in the short-term through voluntary agreements initiated by industry. Should such actions be sufficient, the need to introduce a more costly EQS regime may be negated.

Thirdly, for some specific applications, derogations are recommended. In particular, this applies to the use of NPE as the active ingredient in spermicides, where no substitute is available. Other potential uses which may require derogations include the following:

- certain technical applications in I&I;
- the use of emulsion polymers in the textiles industry (e.g. flocking) and the leather industry;
- certain specialist operations in the metalworking industry;
- certain specialist impregnated and emulsion coated papers;
- certain water-borne auto refinishing (paint) products, where these have been developed as an alternative to solvent-based paints which contain volatile organic compounds; and
- use in fuel and oil where NPs are employed in the production of detergents used to help meet vehicle emission standards.

3. Balancing Costs and Benefits

The risks associated with NP/Es are distributed over a wide range of industries. Some of these are responsible for a large proportion of the risk, while others contribute very little to the overall risk. By way of example, the risk assessment calculates that 45% of continental NP exposure is associated with I&I (industrial, institutional and domestic cleaning/detergent products), while only 0.002% is associated with emulsion polymerisation.

Costs provided by industry suggest that a complete ban on alkylphenols (APs) and their ethoxylates (APEs) would cost industry Euro 1.6 billion (roughly £1 billion), where this includes one-time reformulation costs plus the change in raw materials costs for one year resulting from the use of alternatives. According to these data, NP/Es make up 90% of all AP/Es, with the remainder being octylphenols (OPs) and their ethoxylates (OPEs). If the costs are similarly distributed, the costs associated with a ban on NP/Es would be just over Euro 1.4 billion (£0.9 billion).

Just as the risks are not evenly distributed across all sectors, nor are the costs. The costs to the I&I sector are estimated to be less than 10% of the above costs (representing some 0.13% of annual turnover), while costs to emulsion polymerisation would be approximately one-third of total costs. This type of consideration and quantification was undertaken in order to develop a balanced strategy. In addition, as required by the *Technical Guidance Document for Risk Reduction Strategies*, a number of risk reduction tools were identified and analysed for their effectiveness, practicality, economic impact and monitorability.

As described above, the resulting risk reduction strategy recommended in this report allows some industries to continue using NP/Es, with their impact on the environment being controlled through licensing and/or environmental limits. These industries will instead incur the costs of pollution minimisation, but it is expected that these will be significantly lower.

Those industries for which use restrictions are recommended are already moving toward the use of alternatives as a result of individual company decisions, various sector-wise voluntary agreements and/or legislation specific to certain Member States. Thus, the costs of eliminating the use of NPE in some sectors would not be entirely as a direct result of EU-mandated use restrictions.

Other means are also recommended to assure a balance of costs and benefits. For example, within the cosmetics sector, a derogation for the use of NPEs as an active ingredient in spermicidal products (e.g. condoms) is recommended, as there is currently no viable alternative. In other sectors, investigation into the use of derogations is recommended where the use of NPEs in certain 'closed loop' applications results in minimal environmental exposure and where a ban would be disproportionately expensive. Examples include the use of emulsion polymer coatings in the textiles, leather and paper industries, where no NPEs are discharged to water. Where pesticides are concerned, marketing and use restrictions are not recommended for the present time. This is due to the high costs relative to the marginal benefits of such restrictions owing to difficulties in reformulation, re-testing and re-licensing of pesticides in the immediate term.

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List of Abbreviations

AP	alkylphenol
APE	alkylphenol ethoxylate
BACS	British Association of Chemical Specialities
BAT	best available technology
BRE	Building Research Establishment
CBWT	Confederation of British Wool Textiles
CEFIC	European Chemical Industry Council
CESIO	European Committee of Surface Agents and Organic Intermediates
CIA	Chemical Industries Association
COLIPA	European Cosmetic, Toiletry and Perfumery Association
DETR	Department of the Environment, Transport and the Regions
DLO	Dutch Agricultural Research Department
EA	Environment Agency
EQS	environmental quality standard
EU	European Union
GCMS	gas chromatography - mass spectrometry
HSE	Health and Safety Executive
I&I	industrial and institutional (cleaning sector)
IFCS	Intergovernmental Forum on Chemical Safety
IKW	German soap and detergent association
IPC	integrated pollution control
IPPC	integrated pollution prevention and control
IWS	International Wool Secretariat
KOH	potassium hydroxide
kt	kilotonnes
LD	lethal dose
M&U	marketing and use
NDT	non-destructive testing chemicals
NOAEL	no observable adverse effects level
NP	nonylphenol
NPE	nonylphenol ethoxylate
NP/E	nonylphenol and/or nonylphenol ethoxylate
NVZ	Dutch Detergent Organisation
OP	octylphenol
OPE	octylphenol ethoxylate
OECD	Organisation for Economic Co-operation and Development
OEL	occupational exposure level
PARCOM	Paris Commission
PCB	printed circuit board
PEC	predicted environmental concentration
PFR	phenol/formaldehyde resins
PNEC	predicted no effect concentration
PVC	polyvinyl chloride
RBA	risk benefit analysis
RPA	Risk & Policy Analysts
SDIA	Soap and Detergents Industry Association

SME	small and medium enterprises
STP	sewage treatment plant
TEGEWA	German industry association for textiles, leathers and detergents
TNPP	tri (4-nonylphenol) phosphite
UK	United Kingdom
WWF	Worldwide Fund for Nature

1. BACKGROUND

1.1 Introduction

Nonylphenol (NP) is on the second priority list of substances drawn up under the European Union's Existing Substances Regulations (793/93/EEC). NP is on this list due to the large quantity produced and used annually, its toxicity to aquatic organisms, and concerns that it is not readily biodegradable. As rapporteur, the UK is responsible for assessing the risks associated with the use of NP and its derivatives and for developing a risk reduction strategy where the risks are determined to be unacceptable to human health and/or the environment. The UK Department of the Environment, Transport and the Regions (DETR) is the Competent Authority with respect to the environment, while the UK Health and Safety Executive (HSE) has this role with regard to human health.

The environmental portion of the risk assessment has been undertaken by the Environment Agency, using Building Research Establishment (BRE) as consultants, and this indicates the need for risk reduction across a range of applications. To this end, DETR contracted Risk & Policy Analysts (RPA) to develop an environmental risk reduction strategy, which is set out in this report[1].

1.2 Substances Under Consideration

'Nonylphenol' refers to a large number of isomeric compounds of the general formula $C_6H_4(OH)C_9H_{19}$. The type and extent of branching of the NP depend on the production process and the feedstock used in production. Although many NP isomers have discrete CAS numbers, the second priority list identifies only two; these were chosen by NP manufacturers because they are the most representative of the product as they make it, and it is agreed that those assessed represent all commercially available NP products.

NP is used almost exclusively as an intermediate in the production of various NP derivatives. Releases of NP from these production processes are very low. As a result, very little NP enters into the environment directly. Rather, the primary source of NP in the environment is considered to be nonylphenol ethoxylates (NPEs)[2], which can break down into NP after being released into the environment during their production, their formulation into various other products, and the use of such products. Therefore, the risk assessment and this risk reduction strategy also consider the risks arising from NPEs. (Other NP derivatives were not considered in the risk assessment and are therefore not covered by this strategy.)

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[1] It had been the intention to complete both the environmental and human heath risk reduction strategies in parallel. However, as the human health risk assesment is not yet complete, the human health risk reduction strategy will be issued separately, managed by the Health and Safety Executive (HSE).

[2] NPEs are also referred to as nonoxynol, ethononylphenol, polyoxyethylene nonylphenol ether and nonylphenoxypoly (ethyleneoxy) ethanol.

NPEs are part of the alkylphenol ethoxylate (APE) group of non-ionic surfactants and represent some 90% of APE in tonnage used[3]. The wetting properties of NPE surfactants are of particular importance for degreasing (i.e. cleaning), where the surface tension of the cleaning solution has to be low enough in order to wet the entire surface of the material to be degreased. Likewise, NPEs are important in situations where chemical or cleaning formulations need to be dispersed to every part of the component or product.

1.3 Use Pattern of Substances

As Figure 1.1 shows, nearly 80 kilotonnes (kt) of NP were used in Europe in 1997, with most of this also being manufactured in Europe. NP is used almost exclusively as an intermediate in the production of other chemicals, with some 60% used to make NPEs and the remainder to make other NP derivatives[4].

Depending on their precise make-up (i.e. chain length), NPEs may be used as emulsifiers, dispersive agents, surfactants and/or wetting agents. In certain applications, NPEs are also used for the other properties which they confer. Given their versatility, NPEs are used in a wide range of industry sectors. As shown in Figure 1.2 overleaf, the most significant of these is the industrial and institutional cleaning sector (I&I), which consumes some 30% of the NPE used in the EU[5]. Other sectors which use significant amounts of NPE include emulsion polymerisation (12%), textiles (10%), 'captive use' (use in the chemical industry, 9%) and leathers (8%). Table 1.1 (see page 5) provides an overview of the specific functions NPEs perform in the various sectors. Greater detail on how NPs and NPEs (NP/Es) are used in each sector is provided in Annex 1.

1.4 Approach to the Study

1.4.1 Overview

The approach adopted for this study was informed both by the European Commission's *Technical Guidance Document on Development of Risk Reduction Strategies* and by previous work undertaken by RPA on other substances (such as short-chain chlorinated paraffins).

1.4.2 Stage 1: Information Gathering

The EU approach to risk management of existing substances requires the risk reduction strategy to be based directly on the conclusions of the risk assessment. Thus, it is

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3 The remaining 10% are primarily octylphenol ethoxylates.

4 Very small quantities of NP are used directly in products such as fuel additives packages and some specialty paints.

5 It should be noted that the use of NPEs in domestic cleaning products is also included in I&I.

Figure 1.1: NP and NPE Market in Western Europe 1997
(figures expressed in kilotonnes)

NP

EU production	73.5
imports	8.5
exports	3.5
total NP	78.5

NP Derivatives

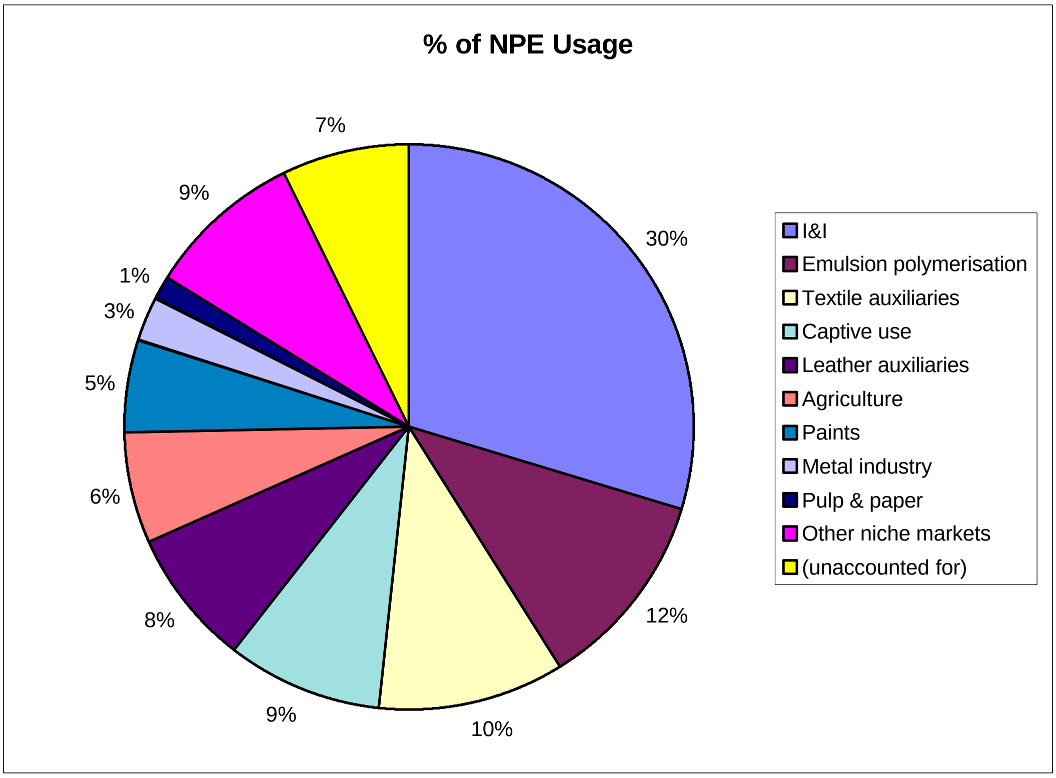
- 47.0 (60%) → NPE (EU production) 118.0
  - imports 5.6
  - exports 46.0
  - total NPE 77.6
- 22.5 (29%) → Phenol/formaldehyde resins
- 4.0 (5%) → TNPP
- 2.5 (3%) → Phenolic oximes
- 1.5 (2%) → Epoxy resins
- 1.0 (1%) → Production other plastic stabilisers

Allocation of NPE to Various Industries

- 23 (30%) → I&I
- 9 (12%) → Emulsion polymerisation
- 8 (10%) → Textile auxiliaries
- 7 (9%) → Captive use
- 6 (8%) → Leather auxiliaries
- 5 (6%) → Agriculture
- 4 (5%) → Paints
- 2 (3%) → Metal industry
- 1 (1%) → Pulp & paper
- 7 (9%) → Other niche markets
- 5.6 (7%) → unaccounted for

Based on data provided by Contensio

Figure 1.2: Use of NPE in Western Europe



Category	NPE Usage (tonnes)	% of NPE Usage
I&I	23000	29.64
Emulsion polymerisation	9000	11.60
Textile auxiliaries	8000	10.31
Captive use	7000	9.02
Leather auxiliaries	6000	7.73
Agriculture	5000	6.44
Paints	4000	5.15
Metal industry	2000	2.58
Pulp & paper	1000	1.29
Other niche markets	7000	9.02
(unaccounted for)	5600	7.22
Total	**77600**	**100.00**

Based on 1997 data provided by Contensio

Table 1.1: Function of NPEs on an Industry Basis (in decreasing order of annual NPE tonnage used)		
Industry	**Function of NPEs**	**Notes**
I&I	laundries; floor and surface cleaning in buildings; vehicle cleaners; anti-static cleaners; metal cleaning	includes 'industrial and institutional' cleaning *and* domestic products; also covers releases from NPE-based detergents used in other sectors (e.g. electronics/electrical engineering)
Emulsion Polymerisation	added to acrylic esters used for specialist coatings, adhesives and fibre bonding used as processing aids in formulation of emulsion polymers, including polyvinyl acetates and acrylic acids potentially used in polymerisation reactions to make polymer solutions that are used for wastewater treatment	act as dispersants and aid the stability of the formulation; present (see also 'civil & mechanical engineering' under 'other niche markets') end applications for polymer dispersions include paints, paper, inks, adhesives, carpet backings, textiles and leather finishing APEs used in wastewater treatment are thought to account for 3-4% APE exposure to the environment in the EU
Textile Auxiliaries	main use is wool scouring (removing natural oils from wool); also for fibre lubrication, dye levelling and flocking	being phased out of wool scouring in the UK
Captive Use (use by the chemical industry in synthesis of other chemicals)	(a) synthesis of nonylphenol ether sulphates (b) synthesis of nonylphenol ether phosphates	(a) used as an emulsifier for styrene and other monomers (probably low impact), as emulsifier in agrochemicals, and additive to special types of concrete (b) normally used as agrochemicals or in the emulsion polymerisation process; may also be used in I&I cleaning products
Leather Auxiliaries	thought to be used in the wet degreasing of hides in the leather industry	new information from the leather industry indicates that almost half of NPE usage attributed to them is exported for use outside the EU
Agriculture	(a) pesticides (b) veterinary medicines (principally in teat dips for treating mastitis; also in sheep dips)	used as wetting agents, dispersants and emulsifiers in pesticides; run-off from the soil surface and leaching are not significant sources of water contamination because NP/Es are strongly bound to soil; teat and sheep dips eventually applied to land as sewage sludge
Paints	used in the preparation of the paint resin (polyvinylacetate) and also as a paint mixture stabiliser	other possible uses of NPE in the coatings industry include the formulation of inks for laser jet printers and the formulation of 'blanket wash' chemicals for use with lithographic printers; NPEs used in water-based paints
Metal Industry	metal cleaning processes (iron and steel manufacture); steel phosphating, electronics cleaning (for metal contacts) and cleaning of metal products prior to storage; formulation and usage of cutting and drilling oils	use of detergents for cleaning in the metal working industry is considered under I&I cleaning

Table 1.1: Function of NPEs on an Industry Basis (in decreasing order of annual NPE tonnage used)

Industry	Function of NPEs	Notes
Pulp and Paper	felt conditioner/cleaner (woolen/ synthetic drying machine that needs periodic cleaning); defoamers (these are dripped into the wet end of paper manufacturing to reduce foaming); wire cleaner; descaler; system cleaner; retention aid; mould inhibitor; tissue softener; de-lignification of wood.	
Other niche markets:		
* Civil and Mechanical Engineering	possible uses include manufacture of wall construction materials, road surface materials, and also in cleaning of metals etc; may also be in some plastic materials used in construction, particularly if produced via emulsion polymerisation	may also be used as an air-entraining admixture in cement, but this is a small usage; releases from production of plastics and use of NP-based additives related to civil and mechanical engineering is considered elsewhere in the risk assessment
* Electronics/ Electrical Engineering	used in fluxes in the manufacture of printed circuit boards, in dyes to identify cracks in printed circuit boards and as a component of chemicals baths used in the etching of circuit boards	
* Mineral oil and Fuel Industry	nonylphenol ethoxylate phosphate esters used as additives in lubricating oil (used in military gearboxes); nonylphenol ethoxylate esters (prevent aggregation of metal fragments in engine boxes; reduce the impact of water contamination); NPE <u>and NP</u> used in blending of fuel additive packages; used either in a lubricant or in a fuel oil	the manufacture and blending of additives packages are thought to be main sources of environmental release for this industry, where the risk assessment indicates that NP/Es are mostly burnt off during end use in fuels, detergents are used to clean engines internally as a means of meeting vehicle emission targets
* Photographic Film	in products intended for home use by amateur photographers; for photo developers who develop film for amateur photographers; in some professional products; also reported to be used in x-ray film	regulations require that commercial photo developers do not discharge to sewer; largest users of photo chemicals pre-treat their waste, then discharge to sewers; small/medium scale users generally have waste removed from the site and incinerated, although some residue from wash tanks is discharged directly; home hobbyists discharge to sewer
** Personal Care	cosmetics, spermicides, shampoos, shower gels, shaving foams, etc.	used as a surfactant in cosmetics
** Public Domain	non-agricultural pesticides; vehicle and office cleaning products; correction fluids, inks and other office products	these products were part of the category ‘Public domain’ which was largely, but not entirely, replaced by the category ‘I&I’

* Tonnage for these sectors are aggregated as part of ‘other niche markets’ in industry usage data; however, for the purpose of calculating the sector-specific NP burden, they are treated independently in the risk assessment.
** These are also subsectors of ‘other niche markets’, but neither their tonnage nor the associated NP burden is treated independently.

important that information required for the former is considered by and incorporated into the latter, even where such information may not necessarily be required under the EU risk assessment protocol. The first stage of this study therefore involved information gathering prior to finalisation of the risk assessment, primarily through consultation with industry. The findings from this work were then integrated into the risk assessment as appropriate, but also formed the starting point for the development of the risk reduction strategy.

1.4.3 Stage 2: Qualitative Analysis

The second stage of this study focused on gathering qualitative information on the implications of adopting different risk reduction strategies. It primarily involved:

- reviewing the *Technical Guidance Document for Risk Reduction Strategies* to ensure that the full complement of potential measures was considered, and selecting from these the measures for more detailed examination; and

- further consultation with industry for input on the effectiveness, practicality, economic impact, and monitorability of the potential risk reduction measures.

Consultees included trade associations and individual companies, and care was taken to ensure that a mix of large and small industrial/commercial entities from all phases of the NP/E life cycle and all sectors identified in the Risk assessment was contacted. While the majority of consultees are UK-based, various EU-wide trade associations, industry groups, and international companies were also consulted to ensure a broader European scope.

Annex 2 provides a list of the organisations which were consulted during this second phase (and the other phases of the study). It must be noted that this list indicates all of the organisations contacted, although not all of those contacted provided data. The detailed description of NP/E use by the various industry sectors provided in Annex 1 gives an indication of the number of organisations contacted as part of data collection for each sector and the number responding to data requests.

1.4.4 Stage 3: Quantitative Analysis

The third stage of the study built upon the second stage, and involved a semi-quantitative analysis of the likely impacts of various risk reduction measures, in order to develop the most suitable strategy. The resulting strategy relies on a mix of risk reduction measures, reflecting the wide range of industry sectors which use NP/Es in an even wider range of processes and applications. The strategy seeks to account for the environmental exposure associated with the different sectors as determined by the risk assessment, which ranges from extremely small (e.g. 0.001% of the total continental exposure from electrical engineering) to very high (e.g. 45% of the total continental exposure from detergents and cleaners). The aim has been to achieve a balance between the costs which any one sector or specific application would face with the benefits arising from the associated level of risk reduction (taking into account any risks associated with substitutes).

This semi-quantitative analysis required that the costs of adopting the various risk reduction measures be estimated wherever possible. The Alkylphenol Ethoxylates Task Force of CESIO, the CEFIC sector group representing the surfactants industry for this study, provided data estimating the costs arising from a complete EU-wide ban on all APEs. These figures represent, therefore, the costs associated with the development, marketing and use of substitutes for NP/Es. Further details of these data are provided in Section 5. To verify this information and to supplement it with costs to sectors not specifically addressed by the CESIO data, a survey was distributed to over 90 companies/trade associations. The results of these surveys were also used in the quantitative analysis.

Using the two data sets, the quantitative analysis follows a cost-benefit analysis approach to the degree possible. In other words, the costs of risk reduction are compared to the benefits, taking into account the need to reduce risks to an acceptable level. However, the degree to which a fully quantified and monetary cost-benefit analysis can be undertaken is constrained by the nature of the risk characterisation provided by the risk assessment. The risk assessment indicates whether the 'predicted environmental concentration' (the PEC) is likely to be greater than the 'predicted no effect concentration' (the PNEC). It does not provide the additional information which would be required for quantification of the actual impacts on environmental receptors. This would require information on dose-response relationships, actual concentrations in the environment and the population of receptors at risk.

Without quantitative data on the actual consequences arising from current levels of NPEs in the environment or the workplace, economic valuation would be unreliable and misleading. It is only possible, therefore, to assess the change in risks in qualitative terms.

1.5 Quality Assurance

A number of approaches to quality assurance have been used in the development of the NP/E risk reduction strategy. First, a range of stakeholders has been involved in the process from the outset, by way of a Steering Group managed by DETR. Members of the group include representatives from industry, an international environmental interest group, individuals involved in preparation of the environmental risk assessment, and government authorities from Sweden and the Netherlands, the UK Environment Agency, as well as HSE. This Steering Group met at key stages of the study to provide input and ensure that the wide range of interests represented by the members received due consideration.

With regard to the data provided by industry, one of the aims of consulting a number of organisations within each of the sectors was to enable some comparison and validation of responses. For example, the use and comparison of cost data from two different sources were important in this regard (see Section 1.4.4). Finally, in preparation of this Final Report, a draft was distributed to members of the Steering Group and to industry reviewers for comment. These comments have been addressed and incorporated where appropriate into the text.

2. THE RISK ASSESSMENT

2.1 Overview

This chapter summarises the key findings of the environmental risk assessment. EU guidelines for undertaking risk assessments require that the risks are characterised such that one of three conclusions can be reached:

(i) there is a need for further information and/or testing;

(ii) there is at present no need for further information and/or testing and no need for risk reduction measures beyond those which are being applied already; or

(iii) there is a need for limiting the risks; risk reduction measures which are already being applied shall be taken into account.

The risk reduction strategy is aimed at reducing the risks stemming from those activities identified in the risk assessment as giving rise to Conclusion (iii).

2.2 Ecosystems of Concern

In the environmental risk assessment, the endpoints (ecosystems) considered are the primary environmental 'compartments' (aquatic, terrestrial and atmospheric), as well as effects relevant to the food chain (secondary poisoning[6]). Impacts on each of these four endpoints were assessed independently for each phase in the NP life-cycle. These phases are:

- NP production;
- production of NPE and other NP derivatives;
- formulation of NPE-based products; and
- use of these products in each of the identified industry sectors.

The conclusions reached for each phase are summarised in Table 2.1 overleaf, which shows that for the aquatic environment, Conclusion (iii) applies to all industry sectors which use NP/E with the exception of TNPP production. For the 'terrestrial' and 'secondary poisoning' endpoints, Conclusion (iii) applies to fewer sectors. For the atmospheric compartment, Conclusion (ii) applies to all sectors. Thus, some sectors require risk reduction for only one endpoint, while others require risk reduction for two or three endpoints.

Of all the endpoints, the aquatic is the most sensitive in that it has the lowest NP concentration threshold to trigger adverse effects.

6 This includes bioconcentration, bioaccumulation and biomagnification.

Table 2.1: Conclusions of the Environmental Risk Assessment*

Life Cycle Stage	Industry Sector	Risk to Aquatic Environment	Risk to Terrestrial Environment	Risk of Secondary Poisoning
NP Production	NP production	❖ **(iii)**	(ii)	(ii)
Production of NP Derivatives	NPE	**(iii)**	**(iii)**	**(iii)**
	Phenol/formaldehyde resins	**(iii)**	(ii)	(ii)
	TNPP	(ii)	(ii)	(ii)
	Phenolic oximes	❖ **(iii)**	(ii)	(ii)
	Epoxy resins	❖ **(iii)**	(ii)	(ii)
	Other plastic stabilisers	**(iii)**	(ii)	(ii)
Formulation of NPE-based Products	Formulation (excluding paints)	**(iii)**	**(iii)**	**(iii)**
	Paints	**(iii)**	**(iii)**	**(iii)**
Use of NPE-based Products	I&I	**(iii)**	**(iii)**	**(iii)**
	Emulsion polymerisation	**(iii)**	**(iii)**	(ii)
	Textile auxiliaries	**(iii)**	**(iii)**	**(iii)**
	Captive use	❖ **(iii)**	**(iii)**	**(iii)**
	Leather auxiliaries	**(iii)**	**(iii)**	**(iii)**
	Agriculture (pesticides)	❖ **(iii)**	(ii)	not given
	Agriculture (veterinary care)	**(iii)**	**(iii)**	not given
	Paints	❖ **(iii)**	(ii)	(ii)
	Metal industry (extraction)	**(iii)**	**(iii)**	**(iii)**
	Pulp and paper	**(iii)**	(ii)	**(iii)**
	Other niche markets			
	Civil and Mechanical Eng.	**(iii)**	**(iii)**	**(iii)**
	Electronics/Electrical Eng.	**(iii)**	**(iii)**	**(iii)**
	Mineral Oil and Fuel Industry	**(iii)**	not given	not given
	Photography (small scale)	❖ **(iii)**	(ii)	(ii)
	Photography (large scale)	**(iii)**	**(iii)**	(ii)
	Other	**(iii)**	not given	not given

* The table excludes assessment of the risk to the atmosphere as the risk assessment concluded (ii) overall for the atmospheric compartment.

❖ The risk assessment notes that Conclusion (iii) was reached for these sectors only because the background regional PEC was added to the local PEC.

2.3 Hazardous Effects and Routes of Exposure

2.3.1 Aquatic Compartment

The risk assessment reviewed standard toxic effects on the aquatic environment (fish, aquatic invertebrates and algae) as well as bioaccumulation of NP (see 'secondary poisoning' below). It was found that the standard toxicity effects occur at lower concentrations than significant effects associated with bioaccumulation, so standard toxic effects were used as the basis for deriving the 'predicted no effect concentration' for water ($PNEC_{water}$) of 0.33 μg/l. The regional 'predicted environmental concentration' (PEC_{water}) is 0.60 μg/l. Based on background regional concentrations alone, the PEC/PNEC ratio will always be greater than one. Thus, the production, formulation or use of any product containing NP or its derivatives will automatically result in Conclusion (iii). The only exception to this is TNPP production, as the risk assessment concludes that the two TNPP production sites in the EU contribute nothing to the local (nor, therefore, to the regional) concentrations.

2.3.2 Terrestrial Compartment

Toxicity tests of NP on terrestrial plants show effects on growth, while tests on terrestrial invertebrates show impacts on reproduction and mortality. The $PNEC_{soil}$ of 0.3 mg/kg is based on the most sensitive of these test subjects. The PEC varies according to industry sector, exceeding PNEC where discharges to sewer are particularly high.

According to the risk assessment, the PEC for soil is primarily a result of NP/E in sewage sludge applied to land. The quantity of NP/E in sewage sludge is a direct result of the many industrial uses of NPE-based products and, potentially, its use as a flocculant in sewage treatment processes.

2.3.3 Secondary Poisoning

The risk assessment also considers secondary poisoning, an effect on higher organisms (e.g. birds, fish-eating mammals) which can arise through their consumption of lower organisms containing the substance (e.g. fish, daphnia). This is assessed by comparing the concentrations in the food organisms with the effect concentrations on the higher organisms. Secondary poisoning risks occur almost exclusively as a result of concentrations in the terrestrial environment (they therefore affect terrestrial species). Since, in all of the relevant sectors, PEC/PNEC ratios are greater for risks to the terrestrial environment than for risks of secondary poisoning, any risk reduction measures which reduce the PEC/PNEC ratio to below 1 for the terrestrial environment will similarly reduce the risks of secondary poisoning.

2.4 Contribution of Each Industry to Risk Levels

Figure 2.1 and Table 2.2 (both based on Table 3.4 of the environmental risk assessment) show the contribution to the continental burden of NP attributed to the various industry sources of NP or NPE. From these, it can be seen that the I&I, textile, leather and NPE production industries alone contribute some 70% of the total burden.

Figure 2.1: Continental NP Burden Attributable to Various Industries

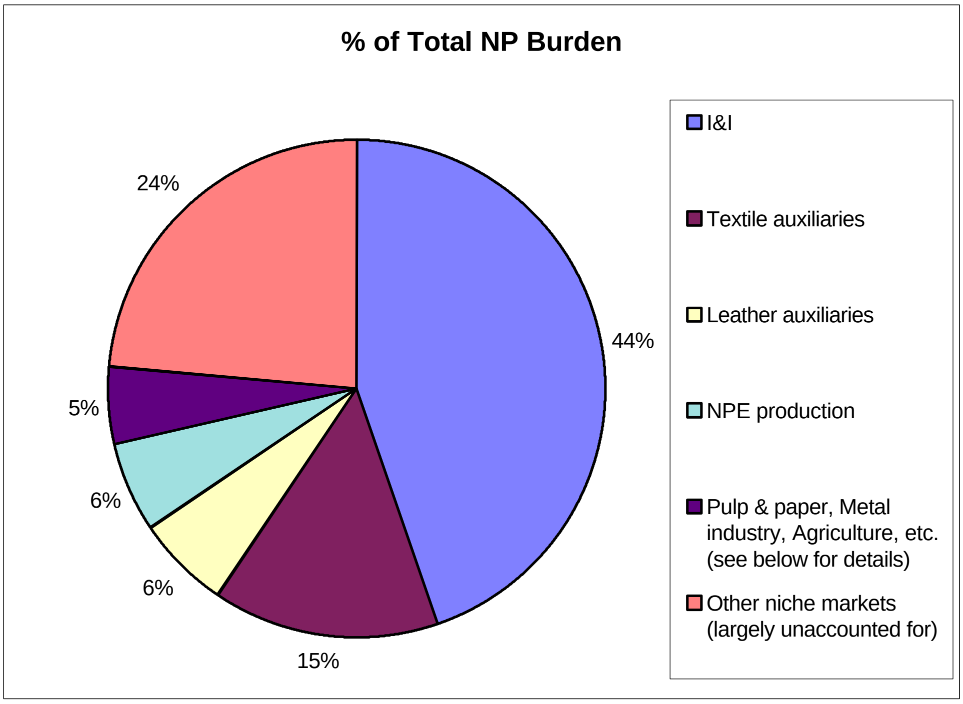


Table 2.2: Continental Burden Attributable to Various Industries

Category	% Total NP Burden
I&I	44.700
Textile auxiliaries	14.700
Leather auxiliaries	6.090
NPE production	5.820
Pulp & paper; Metal industry, Agriculture, etc. (see below for details)	5.000
Other niche markets (largely unaccounted for)	23.700
Total	**100**

Pulp & paper; Metal industry, Agriculture, etc. -- a detailed breakdown	
Pulp & paper	1.720
Metal industry	1.220
Agriculture	1.080
Formulation (other than paint; mineral oil/fuel)	0.470
Paints (includes formulation .04 and use .14)	0.180
Photographic film	0.160
Captive use	0.100
Production other plastic stabilisers	0.020
Civil & mechanical engineering	0.020
Mineral oil & fuel industry	0.008
Phenol/formaldehyde resins	0.007
Epoxy resins	0.004
NP production	0.003
Emulsion polymerisation	0.002
Electrical engineering	0.001
Phenolic oximes	0.000
TNPP production	0.000
Sub Total	**5.0**

The 24% of the total burden associated with 'other niche markets' is largely unaccounted for, although a small part of this is attributable to the civil and mechanical engineering, electronics/electrical engineering, mineral oil and fuel, and photographic sectors. The final 5% is distributed across the remaining industry sectors.

Figure 2.2 illustrates how each phase in the NP life cycle contributes to the total NP burden. More than 90% of the burden is associated with final use of NPE-based products. Figure 2.2 also highlights the six industries identified in the risk assessment as Conclusion (iii) only because the regional background concentration was added to the local concentration. These are: NP production; epoxy resin production; phenolic oxime production; use of agricultural pesticides (but not veterinary medicines); small photographic users (but not large users); and use of paints. This also applies to captive use, but only for the aquatic environment; risks to the terrestrial environment will not be eliminated through a reduction in background concentrations.

2.5 Imminence and Degree of Risks of Concern

The imminence and degree of risk of concern to the environment are partly discussed above in Sections 2.3 and 2.4. For the aquatic environment, the imminence of the risks can be demonstrated by the $PEC/PNEC_{water}$ ratio of 0.6/0.33 (where these are μg/l), or 1.8. This ratio is specific to the background regional concentration, indicating that the risks are widespread. In terms of local concentrations – ignoring the contribution from the general background concentration – the PEC/PNEC ratios vary significantly from one sector to another, ranging from a ratio of less than one in several sectors to ratios in the tens and hundreds for others.

2.6 Degree of Uncertainty in the Risk Assessment Results

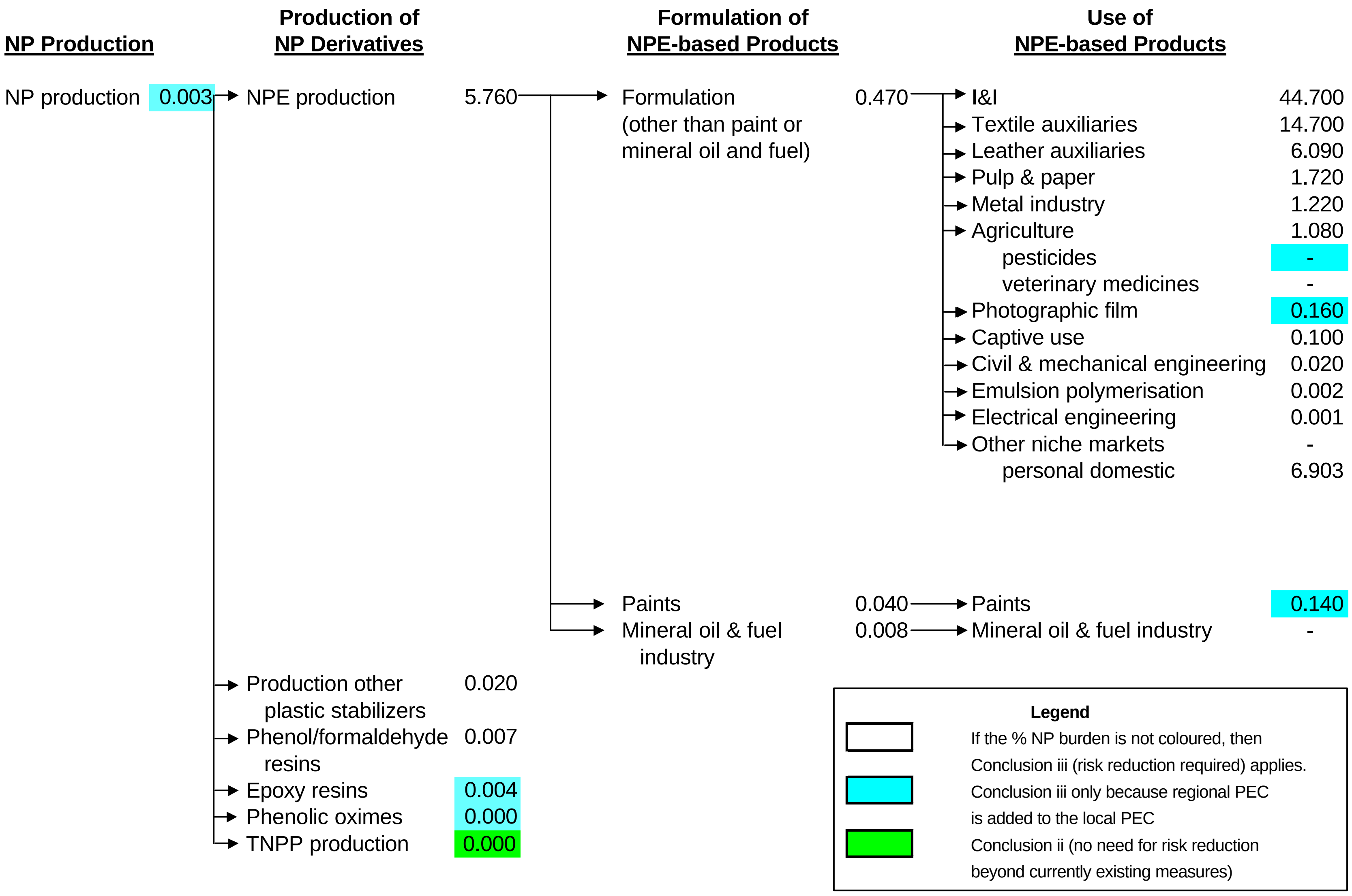
With regard to the development of a risk reduction strategy, there are two related areas of uncertainty which must be taken into account:

- the risk assessment is based on data provided by industry, which fails to account for the use of around 5,600 tpa NPE (representing nearly 5% of total NPE usage). Either the industry data underestimate the amounts used in the identified sectors and/or other significant uses of NPE remain unidentified; and

- a total of 12,000 tpa NPE (16% total usage) is allocated to 'other niche markets' (which includes the 5,600 tpa mentioned in the above bullet point). For some minor sub-sectors (engineering, photography, and mineral oil and fuel), the NP burden (exposure) is calculated individually. For the remaining usage, the burden is calculated using 'worst case' assumptions. Through this approach, 24% of the NP burden is allocated to 'other niche markets', for which there is little information on use.

Although these areas of uncertainty are acceptable within the risk assessment process, they have implications for the development of a risk reduction strategy. In developing the strategy, it is important that those activities giving rise to the risks are targeted, as this is the only means of ensuring that the costs placed on any one sector are outweighed by the risk reduction benefits; unless this is the case, the end strategy will not be cost-effective either. Both of these objectives are hard to achieve when a significant percentage of total use is unidentified.

Figure 2.2: Life Cycle Flow Diagram (with Indication of % Continental NP Burden)



On a separate note, the risk assessment itself indicates concern about the confidence that can be placed on the use and release of NP/E at the local scale.

2.7 Risks Associated with the Use of Substitutes

2.7.1 Background

In developing a risk reduction strategy, it is important not only to take into account the results of the risk assessment, but also to address to the extent possible any new risks which may result from the use of substitute chemicals and/or other changes (e.g. alternative processes or techniques) brought on by implementing the strategy. However, as the *Technical Guidance Document on Development of Risk Reduction Strategies* acknowledges, this can be a demanding task and should therefore be limited to demonstrating the likely risk of alternative substances. As such, it is not the intent of this report to provide a detailed risk profile of alternatives to NP/Es. This section, however, does cover some issues relating to the comparative hazards and potential risks associated with alternatives to NP/Es.

In the case of NPEs, many of the Contracting Parties to the PARCOM Recommendation noted that various alcohol ethoxylates are primary substitutes and that these pose a lesser risk to the environment than NPEs. This is indicative of a broad-based understanding that, in the main, the use of these compounds would be preferable from an environmental (and human health) risk perspective. Section 2.7.3 details some toxicity data for these alternatives to NPEs.

For the purposes of this strategy, the degree to which the risks associated with substitutes can be evaluated is limited by the following factors:

- for a number of sectors, the use of substitutes is still being tested and firm results are not yet available;
- where substitutes are already in use, consultees are often reluctant to give specific chemical names for reasons of commercial confidence; and
- the toxicity of both NP/Es and alcohol ethoxylates varies considerably. Since specific information regarding precisely which chemicals are used or could be used (in the case of alcohol ethoxylates) is not available, an accurate comparison cannot be made.

With regard to this last point, it must be recognised that the categories 'NP' and 'NPE' represent a significant number of possible different chemicals. NPs may be either branched or straight chain molecules. NPEs, in addition to these variations, have differing degrees of substitution by ethylene oxide. Furthermore, the extent of ethylene oxide polymerisation and nature of chain branching will vary between molecules within a particular formulation.

The term alcohol ethoxylates represents a yet wider group of chemicals. Not only may the degree of ethoxylation vary but the chain length of the parent alcohol may vary as well (although this is generally not significant *within* individual formulations).

In making a comparison between alcohol ethoxylates and NPEs, this variability in the chemicals has two important implications since subtle differences in molecular structure may considerably influence a molecule's properties:

- the properties relevant to a chemical's performance in use (e.g. degree of wetting, surface activity, etc.) will vary such that whilst one chemical will be suitable for use in a particular product, another very similar chemical may not; and

- the particular properties of a certain chemical may have profound effects upon that substance's toxicity which, in terms of associated risk, may influence the suitability of that material as a substitute.

2.7.2 Substitutes for NPs

During consultation with industry, few alternatives were identified for replacement of NPs where they are used as an intermediate in the formation of other products. The products in question include phenol/formaldehyde resins (PFR), tri (4-nonylphenol) phosphite, phenolic oximes, epoxy resins and other plastic stabilisers. These products generally owe their properties to the use of NP in their formulation and such characteristics may be more difficult to duplicate using alternatives than appears to be the case with NPEs.

The only alternatives which have been suggested as suitable at present are other alkylphenol compounds, particularly octylphenols. It is unlikely that these products would represent a suitable substitute because they are so structurally similar to NPs and toxic effects may be expected to be of a similar magnitude. It is not believed to be appropriate to recommend discontinuation of the use of NPs as chemical intermediates at present until further information on the comparative level of risks is available. If the level of risk is similar, prohibiting the use of NPs would result in ineffectual expenditure on the part of industry and the need for further risk reduction measures in the future.

2.7.3 Substitutes for NPEs

In terms of direct toxicity of NPEs as compared with the main suggested alternatives (alcohol ethoxylates), there is considerable variability both *between* the two classes and *within* the classes themselves. A linear alcohol ethoxylate with parent alcohol chain length C_{12-15} and 2-10 ethoxylate groups has been shown to have acute toxic effects in some species at below 1 mg/l whereas a branched C_{10} compound with 8 ethoxylate groups only exerts such effects at above 100 mg/l (CESIO classification of surfactant classes, obtained from Albright and Wilson). A similar variability can be observed amongst acute toxicity data for NPEs.

Differences in toxic effects may be due to a number of factors including: differences in metabolism and site(s) of toxic action amongst chemicals and differences in metabolism and site(s) of toxic action amongst species. These will both be influenced by molecular structure. Toxicity estimates derived using quantitative structure-activity relationships (QSARs), shown in Table 2.3, indicate that while one alcohol ethoxylate may be of lower toxicity than a particular NPE, another may be expected to have similar acute toxic effects.

Table 2.3: Comparison of Acute and Chronic Toxicity Values (mg/l)

Chemical	Fish Acute	Daphnid Acute	Algal Acute	Fish Chronic	Daphnid Chronic	Algal Chronic
Ethoxylated Nonylphenol*	2.0	2.0	2.0	0.2	0.2	0.2
Alcohols, C_8-C_{10}, Ethoxylated	24	24	24	2.4	2.4	2.4
Alcohols, C_{12}-C_{14}, Ethoxylated	2.2	2.2	2.2	0.22	0.22	0.22

Source: US EPA (1994)
***** The exact NPE for which the above results are given is not identified in the source document

Thus, these data are not intended to indicate that one chemical is more suitable, in environmental terms, but rather to illustrate that some alcohol ethoxylates can be estimated to have a lower toxicity than NPEs and thus *may* be a lower risk alternative. Obviously, a more detailed assessment of toxicity and potential risks should be conducted when making such a decision. This is only generally possible when considering *specific* chemicals in *specific* applications, due to the variability in properties discussed above.

Thus far, the discussion of the comparative toxicity of NPEs and alcohol ethoxylates has not revealed whether either type of chemical will have a greater risk associated with its presence in the environment. The ability of a chemical to exert its toxic effects upon specific environmental compartments and their biota is influenced by that chemical's behaviour within the environment in terms of the factors which are discussed below.

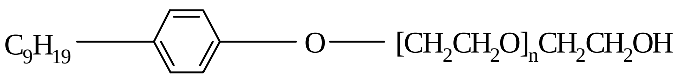
The environmental compartment(s), such as water or sediment, to which a chemical tends to partition is a vital factor in determining the bioavailability of compounds. For both NPEs and alcohol ethoxylates this will be influenced by factors such as solubility in water which, in turn, is dictated by molecular structure. A greater degree of ethylene oxide substitution will tend to make both types more soluble in water. The degree of carbon chain branching in both NPEs and alcohol ethoxylates will also exert an influence upon solubility, as will the chain length of the parent alcohol for the latter.

Degradation of the chemical, notably by biological activity but also by chemical reaction and by photolysis, is of vital importance to the risk associated with these chemicals in the environment. Degradation intermediates can have significant associated toxicity. This is the case for NPEs, which degrade rapidly in sewage treatment, etc. to form the parent NP. This NP is of high toxicity and, indeed, it is through this (partial) degradation to NPs that NPEs exert the majority of their toxic effects. Herein lies the significant advantage of the use of alcohol ethoxylates: whereas NPEs degrade to form NPs which degrade only slowly in the environment, alcohol ethoxylates tend to degrade fully within a relatively short timescale to form carbon dioxide and water. Although these will be the eventual degradation products of NPEs, the formation of NPs as an intermediate breakdown product make potential effects that much greater. It is due to this exposure, coupled with the relatively high toxicity of NPs, that NPEs pose more of a threat to the environment than alcohol ethoxylates. Box 2.1 further describes the implications of this degradation for the effects of environmental exposure.

Box 2.1: Degradation of NPEs and Alcohol Ethoxylates in the Environment

The chemical formulae below are those of an alcohol ethoxylate (top) and an NPE (bottom).

$$C_nH_{2n+1} — O — [CH_2CH_2O]_nCH_2CH_2OH$$



It can be seen that these two classes of chemical are relatively similar. In the environment, biodegradation of NPEs proceeds by stepwise removal of the ethylene oxide (CH_2CH_2O) groups until the nonylphenol (NP) remains[a]. This reaction has been demonstrated to occur in sewage treatment as well as in the wider environment. The NP will eventually degrade; however, the rate of this reaction will be relatively slow, allowing the NP a greater chance to cause toxic effects upon biota (especially in the aquatic environment).

For the alcohol ethoxylates, this mechanism of degradation (removal of ethylene oxide groups) also occurs. However, whereas with NPEs there is a degredation intermediate (NP) which is not readily biodegradable, this is not the case with alcohol ethoxylates. In this degradation process, the alkyl chain of the parent alcohol (C_nH_{2n+1}) is simultaneously oxidised, resulting in complete degradation of the substance to form carbon dioxide and water.

This difference in degradation rates and by-products is responsible for their observed behaviour in the environment. For example, in water treatment processes – as well as in the wider environment – NP/Es are not completely removed whereas the extent of removal of alcohol ethoxylates has been found to be effectively complete within a relatively short timescale[b].

[a] US EPA, 1995
[b] see e.g. Bielman, 1995

In relation to human health, harmful effects associated with exposure to alcohol ethoxylates are generally stated to include irritation of the eyes, the skin and the respiratory and gastrointestinal tracts[7]. Similar effects can be observed in a large number

[7] Surface Cleaning Association, 1999.

of chemicals, in particular NPEs. Material Safety Data Sheets[8] for NPEs state that the same effects may occur through the same exposure routes. A comparison of the acute effects resulting from direct human exposure does not appear to provide a basis for favouring either NPEs or alcohol ethoxylates. However, in terms of environmental effects, a greater contrast can be observed.

Ethylene oxide, used in the production of both NPEs and alcohol ethoxylates, is not deemed to pose a significant risk during manufacture and use of these chemicals although it is carcinogenic and a reproductive hazard of itself. This is because the process is generally well controlled due to the known hazardous nature of ethylene oxide. In addition, the presence of ethylene oxide in the products themselves is at such a low concentration as to be of negligible effect.

It appears that many companies intend to switch to alcohol ethoxylates or, indeed, already have done so. In general, this decision can be vindicated since the overall risks associated with their use may be expected to be lower than those associated with NPEs due to the fact that they degrade more rapidly in the environment and do not form a by-product as toxic as the NP formed from NPEs. In addition, concerns regarding potential endocrine disrupting effects of NPs are not mirrored in the use of alcohol ethoxylates; indeed one manufacturer appears to have developed a range of alcohol ethoxylates specifically in response to calls to replace NP/Es (Scott, 1998).

2.7.4 Conclusions

At present, known substitutes for NPs in the manufacture of derivatives other than NPEs are octylphenols, the use of which is not expected to yield a measurable reduction in risk over the use of NPs. Where substitutes of NPEs are concerned, alcohol ethoxylates were most frequently identified by the sectors/companies consulted for this study.

In terms of environmental risk, alcohol ethoxylates appear to present a clear advantage over NPEs, chiefly owing to issues of biodegradability. Specifically, alcohol ethoxylates biodegrade more readily than NPEs in the environment. Furthermore, alcohol ethoxylates tend to degrade fully to carbon dioxide and water in a relatively short timescale, while NPEs degrade to form NPs, the toxicity and slow biodegradability of which have been identified in the risk assessment and are thus the cause for this risk reduction strategy. In terms of human health risks, no data have been found which favour either alcohol ethoxylates or NPEs as a group. Nevertheless, when substituting an NPE with an alcohol ethoxylate, it is important to look at the toxicity of the specific chemicals under consideration, as toxicity may vary substantially depending on the alkyl chain lengths, chain branching and the degree of ethoxylation.

Although alcohol ethoxylates in general have been identified as suitable alternatives to NPEs, they are not currently applicable to all uses. For some specific uses, either no suitable alternative has been identified or significant issues arise over the environmental

[8] For example Cornell University Environmental Health and Safety Homepage contains MSDSs for both alcohol ethoxylates and NPEs (http://msds.pdc.cornell.edu).

impacts of the alternative. These issues may necessitate derogations from restrictions on NP/E use in the following applications:

- use of NPEs as spermicides, which provide considerable human health benefits and for which no viable alternatives are currently available;
- use of NPEs in some high performance water-based paints, which provide an alternative to VOC-containing solvent-based paints; and
- use in fuel and oil where NPs are employed in the production of detergents used to help meet vehicle emission standards.

3. CURRENT RISK REDUCTION MEASURES

3.1 Introduction

This section provides a summary of the actions which have been taken specifically to address the risks associated with NP/Es (and, more generally, APEs). It addresses actions which have been taken internationally, at the European level and at a national level, covering both legislative measures and voluntary agreements. Where actions are targeted at specific industry sectors, these are identified (with more detailed discussions provided in Annex 1).

3.2 International Initiatives

At the international level, several initiatives regarding NP/Es and their actual and potential environmental effects are underway, notably by the Paris Commission (PARCOM) and the North Sea Conference. The former is discussed in more detail below given its importance. The North Sea Conference's initiative consists of the *Ejsberg Declaration*. This involves[9] a commitment on the part of members to "*take concerted action within the framework of the competent international forums to substitute the use of the following substances (with the list including NPs, NPEs and related substances) by less hazardous or preferably non-hazardous substances where these alternatives are available*".

Further initiatives by the International Forum on Chemical Safety (IFCS) and the Organisation for Economic Cooperation and Development (OECD), whilst not targeted specifically at NP/Es, encompass these chemicals by virtue of their *suspected* potential for endocrine disruption. These entail (WWF, 1997b):

- recommendations by the IFCS to coordinate research into the hazards and risks associated with endocrine disrupting chemicals; and
- a review by the OECD into endocrine disrupting substances, and the questioning of Member States on national policies concerning these chemicals.

3.3 PARCOM

Under PARCOM Recommendation 92/8, contracting parties have agreed (WWF, 1997b):

- to study all uses of NPEs and similar substances, which lead to the discharge of these substances to sewer or to surface waters with a view to a reduction of such discharges;

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[9] Annex 2 of Ejsberg Declaration, Section 4: Urgent Measures to be Implemented by the Year 2000, para viii, cited in WWF (1997).

- that the use of NPEs as cleaning agents for domestic uses be phased out by the year 1995;

- that the use of NPEs as cleaning agents for industrial uses be phased out by the year 2000;

- that care shall be exercised to ensure that replacement materials for the current uses of NPEs are less damaging to the aquatic environment; and

- to report on the progress in the implementation of the Recommendation in 1994, 1997 and 2000 and to exchange information on acceptable substitutes.

Since 1992, some efforts have been made towards a binding Decision on NPEs (to replace the Recommendation) and towards NPEs being listed as endocrine disrupters. For example, in September 1996, Sweden called for the phase out of all uses of NP/Es as well as octylphenols and their ethoxylates (OP/Es) which result in contamination of the environment. The phase-out would take place in two stages[10]:

- all uses leading to direct discharge to sewers or to surface waters to be phased out by 31 December 1999; and

- all uses leading to releases to the environment to be phased out by 31 December 2004.

Work in this area has been delayed and any decision has been postponed to allow account to be taken of this work under the EC Existing Substances Regulation and by other international fora (WWF, 1997b).

In a report to PARCOM in March 1998, the Swedish EPA (1998) summarised actions being taken within member countries to phase-out the use of NPEs and other APEs in domestic and industrial cleaning products. Information was supplied by nine EU Member States[11]. This information indicates that virtually all domestic uses of NPE-based cleaning products have been phased out. In all cases, this has been as a result of an industry commitment, either a voluntary action or negotiated agreement.

3.4 European Union

Within the European Union, the main initiative on NPEs is this assessment under the Existing Substances Regulation. Insofar as NPEs are used as surfactants in detergents, they have been indirectly covered by EU detergents legislation since the 1970s. Also, the risks associated with NP/E production and use by certain sectors could be addressed by

10 *Sweden Pushes for Phase-out of Oestrogens in Pesticides*, ENDS 260, September 1996, p40.

11 Belgium, Denmark, Finland, Germany, the Netherlands, Norway, Sweden, Spain and the United Kingdom.

the Directive on integrated pollution prevention and control (IPPC), which has been adopted and will soon be in force.

With regard to EU detergents legislation (consisting of a Framework Directive, four amending Directives and a Commission Recommendation), this aims to restrict the sale of ‘hard detergents’ which are difficult to degrade. The legislation bans the marketing of any detergent where the ‘primary’ biodegradability level of the surfactant components is less than 90%, as determined by the tests specified in the legislation. Given that detergents continue to contain NPEs, this indicates that these surfactants have passed this criterion. As a result, the use of this Directive (in its present form) could not be relied upon as a means of achieving the necessary levels of risk reduction.

Consultation with industry has indicated that revisions to the detergents Directives are being developed which will address not only biodegradability, but also issues of mineralisation. However, it appears that any new legislation will not be designed to address the issues of aquatic toxicity specifically. Furthermore, no draft text is yet available and no formal Commission proposals exist to amend the legislation. Thus, it is not possible at this time to assess the impact which any future legislation might have.

The IPPC Directive (96/61/EEC) identifies substances that are persistent, bioaccumulative or may affect reproduction amongst those that need to be taken into account in establishing emission limits for industrial processes. The Directive is to be implemented by 1999. This is discussed more fully in subsequent sections of this report.

3.5 Country-Specific Actions

3.5.1 Austria

The Austrian detergent industry has indicated that APEs are not used.

3.5.2 Belgium

The Belgian manufacturers of detergents had phased out the use of NPEs in domestic cleaning products by 1995. Use of NPEs in industrial cleaning products has reduced and the industry is committed to a phase out of use by the year 2000. Although no official negotiated agreements have been made, the Government indicates that it may act if promises are not kept (Swedish EPA, 1998).

3.5.3 Denmark

In 1987, Denmark reached a voluntary agreement with the trade association SPT (Association of Danish Cosmetics, Toiletries, Soap and Detergent Industries) to phase out the use of NPEs in cleaning products. In 1998 it was reported that there was no consumption of NPEs among trade association members in Denmark. While a 1994 study indicated that between 100 and 250 tpa[12] of NPEs were still being used in washing and cleaning products by companies not covered by the voluntary agreement, the voluntary agreement has been seen as a success by the Danish Environmental Protection Agency (Danish EPA)[13].

In October 1995, the Danish Minister of Environment and Energy suggested a complete phasing out of alkylphenolic compounds in cleaning products. It was also suggested that an action programme be produced for the remaining uses of these compounds, with the goal of phasing out all APs before the year 2000 (NCM, 1996). In 1997, it was reported that the Danish EPA had included APEs on a list of 'undesirable substances' which pose a threat to health or the environment[14].

The Ministry for Energy and Environment Order No. 823 of 16 September 1996 lays down, *inter alia*, a cut-off value for NP in sewage sludge with effect from 1 July 1997. This maximum concentration must not be exceeded if sludge is to be used in agriculture (WWF, 1997b).

Finally, Denmark has proposed a water quality criterion of 1 μg/l for NP and NPE (EA, 1998c).

3.5.4 Finland

Finland has not yet implemented PARCOM Recommendation 92/8. The use of NPEs in household cleaning products has declined sharply in recent years. In 1994, use was estimated at 7.4t, declining to 0.6t in 1996. With respect to industrial and service products, an estimated 90t were used in 1994 as detergents and for degreasing (Swedish EPA, 1998).

3.5.5 Germany

NPEs are classified under the German classification system for 'water-endangering' chemicals/substances.

In 1986, a number of German manufacturers of APE-based detergents and cleaning agents committed themselves to phasing out the use of certain APEs. Organisations involved included IKW (German soap and detergent association), TEGEWA (association of surfactant manufacturers) and producers of textile and leather auxiliaries, anti-freezing agents and vehicle cleansers, etc. The voluntary commitments do not cover all fields of application, however, with drilling additives, additives to pesticides, flotation products

[12] The Swedish EPA (1998) and NCM (1996) indicates that 100 tpa were used while WWF (1997b) indicates that this figure is 250 tpa.

[13] Presentation by the Danish EPA at a joint workshop with the SPT on the LAS (linear alkanebenzene sulfonate) Risk Assessment for Sludge-Amended Soils held in Copenhagen, April 1999.

[14] ENDS 267, *Firms begin APE Phase-out*, April 1997.

and the photographic industry not covered. The target date was the end of 1986 for domestic products, 1988 for disinfectants and 1992 for industrial products.

By 1995, virtually all domestic use of APEs in detergents had been phased out. The situation remains unchanged at present. However, in 1997, there were still 650 cleaning products on the market which contained APEs, most of which were for industrial use. These products were marketed by 134 companies, and most (around 85%) contained <10% APEs weight for weight. Overall, the use of APEs in detergents and cleaning agents reduced by about 90% from around 11,000 tpa in 1986 to around 1,000 tpa in 1997 (UBA, 1999).

The phase out of NPE use in industrial products has not been achieved owing to a number of factors including (Swedish EPA, 1998):

- a large number of small and medium sized enterprises (SMEs) which either are not party to the voluntary agreement or continue to use APEs in spite of the agreement;
- manufacturers from other EU Member States continuing to sell APE-containing products in Germany;
- the lack of a commitment from APE producers to a phase out of their products; and
- some substitutes being more expensive and having poorer performance than APEs.

The UK-based International Wool Secretariat has also indicated that the German wool industry voluntarily phased out the use of NPEs in wool scouring around 1989-90. This involved a cessation in both the production and use of NPE-based products for such applications (WWF, 1997b). In addition, a voluntary agreement was drawn up in 1997 to phase out the use of NPEs as flocculants in wastewater purification before the year 2002.

3.5.6 Greece

Industry reports that APEs are not used in Greece as per an industry agreement. Other data would appear to contradict this suggestion and it may be the case that this refers to use by one sector, such as in cleaning agents, as opposed to use by all sectors and all potential applications.

3.5.7 Netherlands

In the Netherlands, NPEs have not been used in household cleaning agents since 1988, as a result of voluntary initiatives by the Dutch Detergent Industry Association and individual companies. The use of APEs in industrial cleaning has been substantially diminished in recent years due to voluntary moves by industry (Dutch Detergent Industry Association, 1998).

No agreements covering other sectors have been identified.

3.5.8 Spain

The Spanish Association of Detergent Manufacturers (ADTA) indicates that 500 tpa of NPEs are used in industrial cleaning products. Member companies are taking steps to replace NPEs with other surfactants, and substitution should be completed in 1998 (Swedish EPA, 1998).

3.5.9 Sweden

In Sweden, voluntary initiatives to phase out NPEs began in 1972, when their use ceased in household detergents (Swedish EPA, 1998). In the late 1980s, it was agreed that the use of NPEs in industrial and institutional cleaning products would be reduced by 90% between February 1989 and January 1991 (WWF, 1997b). In 1992, use of NPEs in other household cleaners was phased-out.

Between 1990 and 1995, total NPE use was reduced by about 70% to 80% as a result of both government initiatives and voluntary industry actions (Swedish EPA, 1998). Total marketed amounts were further reduced from 1,600 to 500 tonnes NP between 1994-97 and from 1,500 to 600 tonnes NPE during the same period[15]. The driver for these reductions was the Begränsningsuppdraget (the Risk Reduction Commission) which selected 13 chemical substances for risk reduction on the basis that these posed special threats to the environment. NPEs (as a group) were listed as one of these chemical substances. The Government Bill 1990/91:90 on environmental policy – A Living Environment (En god livsmiljö) – set out targets for achieving the necessary risk reduction. For NPEs, the target was for a 90% reduction in use by the year 2000, where this was to be achieved through voluntary actions by industry (KEMI, 1997).

Several actions have been taken to reduce remaining uses of NPEs, including a 90% reduction in NPE use in glue production by 1997. Use of NPE-based industrial cleaning agents has also drastically reduced so that these are no longer the largest use of NPEs; indeed, the detergent industry indicates that there is no consumption of APEs at this time. There is still a minor use of NPEs in cosmetics, but the trade association involved has encouraged its members to phase out use as soon as possible (Swedish EPA, 1998).

By way of example, the NPE content in sewage sludge is analysed before use in farming. The national association of farmers has agreed with the Swedish EPA and the national association of water companies and sewage treatment plants to use a voluntary guidance value of 100 mg NP per kilogram dry weight of sludge used in farming. This guidance value was lowered to 50 mg/kg as of 1997. As a result, over the period from 1992 to 1997, emissions of NPEs from sewage treatment works reduced by a factor of 10. For example, Stockholm Water Company reduced emissions from 1,000 to less than 100 mg/kg dry weight (KEMI, 1997). This has been helped by other actions such as the Industrial Control Program in Goteborg, which has been successful in reducing the

15 Swedish Products Registry – marketed amounts refers to production plus imports minus exports.

discharge of p-nonylphenol polyethoxylates from larger industries to the sewer system (Paxeus *et al*, 1995).

With respect to the longer term, efforts continue to phase out uses of NPEs which lead to direct emissions to the environment. As at present, the aim is that this should result from voluntary actions within industry. The Government is awaiting the results of this EU assessment before proposing further measures on NPE (KEMI, 1997).

3.5.10 United Kingdom

Legislative Action

The UK has not taken any legislative action specifically aimed at NP/Es. However, NP/Es are covered indirectly by current legislation on integrated pollution control (IPC – which has preceded the introduction of IPPC in the EU more generally). IPC sets out a system for controlling and recording the releases of hazardous substances from specified facilities. In this regard, the Chemical Release Inventory (CRI) was established to compile information on reported releases from IPC processes and contains information on releases from processes associated with metal production, textiles, and pulp and paper manufacturing.

Under IPC, releases are required to meet environmental quality standards (EQSs) and, while there is no EQS for NPEs, an operational EQS has been developed by the Environment Agency (EA) for NP, with this being 1μg/l. This was not developed on the basis of oestrogenic effects, as toxicity indicators (including suppression of growth rates in fish) were reported at lower concentrations of NP than the lowest known to cause oestrogenic effects (EA, 1998a).

In 1995, a National Rivers Authority[16] survey found that most sewage effluents contained between 1 μg/l and 5 μg/l of APEs (WRc, 1998). In September of that year, it was reported that discharges from wool processing appeared to be the most significant sources of APEs in rivers and estuaries in the UK[17]. Action has now been taken under IPC and, for example, all four of the largest scouring facilities – processing 50% of the UK's wool – comply with the EQS. Not all wool scouring companies qualify for regulation under IPC, but in January 1996 all members of the Confederation of British Wool Textiles had agreed to phase-out discharges within a year[18].

With respect to future actions, in January 1998, the EA issued a consultative report on endocrine disrupting substances which specifically identifies NP and NPE on this basis (EA, 1998a). The aim of the paper is to seek views on what actions should be taken

16 The NRA was the predecessor body to the Environment Agency with regard to water resource management.

17 *Wool Companies Stall on NRA Plea for Oestrogen Ban*, ENDS 248, September 1995.

18 *NRA Claims Success with Phase-out of Oestrogenic Detergents*, ENDS 252, January 1996.

concerning these and other endocrine disrupting substances. The EA's view is that the steps which should now be undertaken include:

- determining a list of priority endocrine-disrupting substances;
- developing pollution prevention and control plans for each priority substance aimed at reducing, or where possible eliminating, releases to the environment;
- developing a complete set of EQSs for priority substances;
- targeting specific sectors such as chemical manufacturing and working with them to identify specific actions for preventing or minimising releases of priority substances;
- carrying out targeted environmental monitoring programmes to improve information on the occurrence of priority chemicals; and
- developing alternative approaches for licensing of discharges, such as consents based on direct toxicity measurements.

More generally, the EA has issued the consultation paper with the aim of gaining a balanced perspective on which substances are implicated as endocrine disrupters, the relative risks they pose to the environment, and the potential costs and benefits of various pollution prevention and control options.

Voluntary Agreements

UK industry took one of the first voluntary actions on NPE in 1976 when it was agreed to phase out the use of NPEs in domestic cleaning products. This action is reported to be a negotiated agreement which covers all key manufacturers and all relevant companies in the UK which belong to a recognised trade association. It has resulted in an almost complete phase out of NPE-based domestic cleaning products.

In 1996-97, the British Association for Cleaning Specialities (BACS) and the Soap and Detergent Industry Association (SDIA) reached a voluntary agreement to remove all APEs from industrial and institutional detergents by 1998. Products not covered by the agreement include solvent degreasers (INFORM, 1997). Consultation has indicated that this agreement has been met by all member companies.

With respect to the actions of UK industry more generally, it appears that recent reports of the possible endocrine disrupting effects of NPEs may be influencing the commercial considerations of UK manufacturers and users of these substances. This is impacting on the use of NPE. Likewise, the Chemical Industries Association (CIA) has reported that sales of NPE in sectors such as detergents fell when the potential risks of endocrine disruption first became apparent. However, it is also reported that alternatives were found not to work as well and sales of NPE have begun to increase again (POST, 1998).

4. AVAILABLE RISK REDUCTION OPTIONS

4.1 Overview

There are numerous EU policy tools available to reduce chemical risks at a Community-wide level. For the risks posed by NP/Es to both human health and the environment, the following risk reduction measures were identified by the qualitative assessment as meriting consideration:

- marketing and use restrictions;
- IPPC licensing;
- limit values and/or environmental quality standards (EQSs);
- voluntary agreements;
- classification and labelling; and
- occupational exposure limits (OELs).

The regulatory underpinnings for each of these are outlined below.

4.2 Marketing and Use Restrictions

Restrictions on the marketing and/or use of NP/Es could be introduced under EC Directive 76/769/EEC. This Directive is very flexible, stating that "the substances and preparations listed in the Annex may only be placed on the market or used subject to the conditions specified therein". In theory, this provides for a wide range of possible restrictions, including:

- banning the use of NP/Es in all or specified products/sectors;
- phasing in restrictions;
- restricting the concentration of NP/Es in products; and
- derogating use in specified products or applications.

Thus, NP/Es could be totally or partially phased out and their concentration within some or all products restricted. With respect to restrictions by product type, the use of NP/Es could be eliminated in only some uses or in all uses. Certain processes or products which require NP/Es could be given derogations for a specified time in order for alternatives to be developed. In the extreme, a ban could be introduced immediately across all products containing NP and its derivatives.

4.3 Integrated Pollution Prevention and Control (IPPC)

The direct licensing of operators using NP/Es can provide a means of reducing emissions, with the key vehicle for such licensing being IPPC as set out under EC Council Directive 96/61/EC. This Directive was adopted in September 1996, and Member States must transpose it into domestic law by October 1999. The Directive aims to establish a Europe-wide authorisation system under which most medium-sized and large industrial installations whose processes are covered by this Directive will need to obtain an operating permit, which sets limit values for emissions to water, air and land under an integrated permitting regime. The IPPC system focuses on the use of 'best available technology' (BAT) for pollution prevention.

The IPPC Directive identifies persistent and bioaccumulative organic substances amongst those that need to be taken into account in establishing emission limits for industrial processes. It also identifies categories of industrial activities which should be licensed. From these categories, it can be seen that IPPC licensing could be used for controlling NP/E emissions from the following industry sectors:

- production of NP;
- production of NPE and other NP derivatives;
- emulsion polymerisation;
- captive use;
- textiles;
- leathers;
- metals; and
- pulp and paper.

It should be noted, however, that a definition of BAT is required in order to identify an achievable limit which may then be applied in licensing. No common definition of BAT applicable to the relevant industries has yet been agreed, either for production or for use, and there are no limits for NP/Es (or AP/Es) in existing Community legislation. However, the adoption of national guidance notes providing indicative standards for site-specific assessments of BAT for new and existing plants would lead to a reduction of NP/Es to the environment.

4.4 Limit Values and Environmental Quality Standards (EQS)

Limit values and EQSs can be used to place regulatory limits on the concentration of pollutants in effluent and/or surface waters. Limit values may be placed on industrial discharges to surface and groundwaters under a variety of legislative provisions currently used by Member States to control water pollution. These include permitting procedures under Member States' domestic legislation and, at an EU level, the authorisation regimes of the IPPC and the Dangerous Substances Directives. Limit values are commonly set with regard to polluting effects on the aquatic environment as predicted through monitoring and modelling work, and may be set at a common level over the whole of the territory of the Member State or at an individual plant level.

Limit values, therefore, control directly the composition of discharges to the environment without the necessity of referring to the quality of the receiving watercourse. In contrast, EQSs represent target values in the receiving watercourses, and act as quality specifications which are met by the setting of limit values on discharges at individual sites, where these are set to ensure that the targets are achieved.

Currently, such limits can only be established EU-wide via the Framework Directive (76/464/EEC) on pollution caused by certain dangerous substances in the aquatic environment. The Directive sets up two lists of dangerous substances, List I (the 'black list') and List II (the 'grey list'). It requires that discharges of listed substances are authorised and that emission standards for these discharges are established. Broadly speaking, List I substances are those considered to be toxic, persistent or bioaccumulative in the aquatic environment. However, NP/Es do not fit into any of the specified 'families and groups of substances' which define the current scope of List I and II. Therefore, in its current form, this Directive cannot be used to implement a limit value/EQS approach at a pan-EU level.

The new Water Framework Directive will significantly change the legislative system regulating the use and management of water resources. While the Commission is not proposing to repeal Directive 76/464/EEC, revisions to it are unlikely. Nevertheless, the new Directive may include provisions for adding certain pollutants or groups of pollutants to the 'black list' and/or for setting EQSs at an EU level. In addition, it will allow each Member State to adopt its own EQSs on the basis that waters must be capable of meeting the Drinking Water Directive standards after treatment. As yet, there are no standards for NP/Es in drinking water. However, the Directive aims to achieve 'good' surface water status, which is defined as including good ecological status. The observed effect of AP/Es is their impact on fish reproduction, and a deterioration in ecological status would be observed if they were allowed to accumulate. Under Article 13(3)(a) it would, therefore, be possible for Member states to set national EQSs. These would not become Community standards until their adoption under Article 21(d).

In lieu of an EU-wide mechanism for implementing limit values or EQSs, existing laws in individual Member States concerning discharges to the aquatic environment could be used. These are outlined in Box 4.1 overleaf. All countries considered have a means by which discharges to surface waters can be regulated either centrally or by local authorities. In Germany and the Netherlands, for example, discharges to surface waters are sometimes limited to those which are achievable using the 'best available technologies'. Although this approach is used in the UK, it tends to be associated only with certain processes (through IPC). The Netherlands also has a system of industry-specific covenants aimed at reducing industrial discharges.

4.5 Voluntary Agreements

Voluntary agreements arise when industry undertakes a commitment to limit environmental contamination resulting from a substance or to phase out its use in specified applications. Such agreements with industry represent a versatile instrument which can be used at regional, national, community and international levels. They allow industry to develop its own approach to risk reduction strategy, and are therefore considered to result in a highly cost-effective solution. However, they are non-binding, and the widespread use of such agreements to address the risks associated with NP/Es, as detailed in Section 3, has had varying success.

Box 4.1: The Control of Discharges to Sewers and Surface Waters (Source: Mumma, 1995)

Belgium: General quality standards have been established for public water. Quality standards and treatment requirements have been set by the federal authorities. More detailed (and restrictive) provisions have been established by the Flemish and Walloon Regions. Federal legislation imposes a general prohibition on discharging any object or substance into public water. However, permits can be obtained from communal authorities in Brussels (or the regional authorities) for discharges of sewage and waste water into public waterways. General and industry specific conditions are attached and further individual conditions may be imposed depending on local water quality and the presence of other polluting industries. The tendency has been to impose stricter individual conditions on industry and companies. Industries can either treat their own sewage or arrange for it to be treated by the water companies (in which case they must contribute to the cost of so doing).

Denmark: The Environmental Protection Act governs the pollution of water. There is a general prohibition against the discharge of substances which can pollute surface water. However, the regional council may permit the discharge of specified substances. As a result of the prohibition on discharges to surface waters, connection to the public sewerage system is obligatory.

Finland: The Water Act 1961 (as amended) provides for a permit procedure based on prohibitions against the pollution of waterways. Any activities which result in non-compliance with these prohibitions require a permit. Permits are only issued under certain conditions including a requirement that the activity will not cause perceptible and harmful changes in the environment. Sewage discharge permits, which may be revoked or revised, are normally issued for a specific period of time. The permit may include conditions or requirements on, for example, allowable waste load and required water treatment and the maintenance of treatment facilities.

France: Water pollution is regulated by the law of 16th December 1964 and by the New Water Act of 3rd January 1992. An *arrêté* dated 1st March 1993 regulates discharges by authorised classified facilities. The 1992 Act defines general objectives for the protection of water quality and institutes a system of authorisations and declarations. An authorisation is granted by a *préfet* and the duration of the permit and any technical prescriptions are specified.

Germany: The control of water pollution is governed by the Water Management Act. This is Federal law supplemented at *Land* level. Surface waters may be utilised to the extent customary in the relevant *Land.* The *Länder* are responsible for producing regulations as to water quality. Under the Water Management Act, discharges of solid or liquid substances into surface waters require a licence. This will be refused for liquid discharges if the toxic content is not maintained below levels set out in the relevant Regulations or as low as current technology allows. Those who release effluent above a given daily threshold are to appoint a water resources protection officer to see that regulations are adhered to. Under the 1976 Waste Water Contribution Act, contributions are set for the discharge of effluent into certain waters according to its nature. This economic instrument aims to protect the environment and encourage ‘cheaper’ disposal methods.

Ireland: The principal legislation consists of the Local Government (Water Pollution) Acts 1977 and 1990 and the 1978 Regulations. The local authority can grant an effluent discharge licence permitting discharges to waters and sewers. For processes associated with integrated pollution control, the licensing function has been transferred to the Agency. The Minister of the Environment is empowered, by implementation of several EC Directives, to prescribe various quality standards which are incorporated by Statutory Instrument into Irish legislation. A local authority uses these, WHO or other international standards in determining ‘safe’ contaminant levels.

Netherlands: The main legislation regulating discharges to surface waters is the Pollution of Surface Waters Act (1969) which distinguishes between direct discharges to surface waters and indirect discharges (usually to the municipal waste water system). 76/464/EEC has been implemented under the Act and Daughter Directives are implemented by decrees which set limit values for the substances concerned. In general, a licence is required for any discharge direct to surface waters; the Minister of Transport, Public Works and Water Management is the competent licensing and enforcement authority for major national waterways (major rivers,

Box 4.1: The Control of Discharges to Sewers and Surface Waters (continued)

Netherlands (cont.): canals and water bodies). For direct discharges to other waters, the water quality management agencies (the provinces of Groningen and Utrecht and 28 water boards) are the competent authorities. Licences may set limits on discharges of specific pollutants or prescribe specific techniques, technologies or materials which must or may not be used. In principle, discharges to sewer do not necessarily necessitate a licence under the Act and are normally regulated by municipal discharge ordinances. However, a licence under the Act is required for categories of establishment designated by decree, and decrees have designated some nineteen categories of establishment, including metalworking companies, for which licences are required from regional water quality management agencies.

An important policy instrument for reducing industrial emissions is the use of 'covenants' which are agreements between the authorities and industrial associations representing specific sectors. About a dozen covenants have been made including one with the 'metal and electrotechnical' industry. The covenant contains global reduction percentages for designated pollutants including oils for the metal sector. There are various mechanisms by which overall objectives are translated to specific reductions at company level. The sectoral organisations are expected to develop a 'work-book' elaborating how the objective is to be achieved and all companies are to develop a corporate environmental plan setting company level emission objectives and how these will be met. The intention is that covenants, although voluntary, should be made as binding as possible.

Italy: The protection of waters from pollution is provided for by the 'MERLI' Law of 1976 and subsequent amendments. Regulation of discharges is associated with two basic principles: the setting of limits for what are acceptable discharges; and a system of authorisation for all discharges to be granted by the authorities responsible for controlling water. The law states that discharging systems should be easily accessible for testing and monitoring purposes. The Regions are responsible for maintaining controls on discharges. The Provinces entrusted to the Municipalities control and grant authorisations in respect of all discharges.

Portugal: Qualitative and quantitative limits for discharge of waste water are set out in various annexes to Law 74/90. These limits take account of the type of activity producing the waste water and the quantity of waste produced. Those disposing of waste water must obtain a licence from the National Water Institute and from the relevant Regional Directorate for the Environment and Natural Resources. The licence sets out the disposal limits.

Spain: The main legal framework is the Water Law 29/1985 and the 1986 Regulation on Public Waters (as amended). The regulation sets limits for the disposal of certain substances. Water Authorities are responsible for authorising discharges to 'public waters'. The authorisation may have conditions attached to it. The granting of an authorisation is subject to a charge which is set according to how many 'Units of Contamination' the discharge represents (the Unit depends on the type and volume of the pollutant and other factors). The Water Law also provides for the formation of 'waste companies' to treat waste water produced by other industries.

Sweden: The Environmental Code, which entered into force on 1 January 1999, is amalgamated of 15 acts related to environmental and health conditions. The Code, in principle, applies to all human activities that may harm human health or the environment, e.g. hazardous activities. These activities include all use of land, buildings or fixed installations that involve an emission to land, the atmosphere or water. Under the Environmental Code, requirements for permits will be laid down. Hazardous activities that require a permit from the environmental Court will be scheduled on the A list; the B list will comprise those environmentally hazardous activities in respect of which permits will be considered instead by the county administrative boards or municipal board. Finally, the C list will include environmentally hazardous activities that are subject to duty to give notification. Such notification must be given to the county administrative board or municipality. An important new provision in the Environmental Code is the possibility to introduce environmental quality norms.

Box 4.1: The Control of Discharges to Sewers and Surface Waters (continued)

United Kingdom: The principal law in England and Wales is the Water Resources Act 1991, and in Scotland the Control of Pollution Act, 1974, both of which have been amended by the Environment Act of 1995. The Secretary of State (Minister) of the Department of Environment, Transport and Regions can classify waters and set environmental quality objectives and associated standards. It is an offence to allow polluting substances to enter water and any discharges must have the consent of the Environment Agency (or the Scottish Environmental Protection Agency). Consents may have conditions relating to quantity and effluent quality attached to the permit. Allowable concentrations of substances are usually related to the need to meet environmental quality standards in the receiving watercourse and are individually specified for each discharge, although the introduction of the EC Urban Wastewater Directive has introduced limit values for some parameters in effluents discharged from waste water treatment plants.

Under the Environmental Protection Act, 1990 a system of integrated pollution control applies to large polluting industries throughout the UK. Processes are authorised on the basis of best available techniques not entailing excessive cost (BATNEEC). Discharges to water from these industries must also meet any EQSs in the receiving watercourse. Discharges of trade effluents into sewers are controlled through a separate procedure under the Water Industry Act 1991, by issue of a consent and the application of charges by the sewerage operators. If the trade effluent contains substances which are prescribed by the IPC legislation (which include List I substances) the Environment Agency (or Scottish Environmental Protection Agency) issues the consent.

Guidelines for the development, implementation and monitoring of voluntary agreement are set out in the EC Council Resolution of 1997 (97/C 321/02), the Communication from the Commission of the European Communities to the Council and European Parliament of 1996 COM(96), and in the Commission Recommendation of December 1996 (96/733/EC).

The Commission's plan is for the environmental aims of a voluntary agreement to be set by legislation, leaving it to industry to work with the relevant national authorities to define the means of reaching those targets. In many agreements, the legalisation remains in the background as a deterrent, only being fully developed and enforced if the agreement is not seen to be working satisfactorily. This approach incorporates the possibility of enforcing the agreement which is vital to its success: without such enforcement mechanisms, non-compliance may be seen as an attractive option. Still, because voluntary agreements bind only those who have agreed to them, other companies may reap the rewards of non-compliance, by avoiding the costs which their competitors who are adhering to the agreement are incurring.

In order to ensure that any agreements are transparent and credible, the following will be sought when setting them up:

- quantified objectives;
- a clearly defined timetable;
- appropriate monitoring to develop objective results; and
- reporting to public bodies and the competent authority.

In some cases, an independent body may be established to monitor, evaluate and/or verify the results.

4.6 Classification and Labelling

NP/Es are not currently classified in accordance with EC Directive 67/548/EEC. The classification and labelling of a substance under this Directive is aimed at improving awareness of the 'proper' use, handling and disposal of the substance. To this end, the packaging of all classified substances must be labelled to show, *inter alia*:

- symbols indicating the danger involved in using the substance;
- symbols indicating the specific risks arising from use of the substance; and
- symbols relating to safe use of the substance.

There are risk and danger symbols that apply to both human health and the environment, with the risk assessment proposing classification and labelling of NP as outlined in Table 4.1.

Table 4.1: Proposed Classification and Labelling of NP

Xn	Harmful
R22	Harmful if swallowed
C	Corrosive
R34	Causes burns
S-36-37-38	Wear suitable protective clothing Wear suitable gloves Wear eye face protection
N R50-53	Dangerous for the environment
S61	Avoid release to the environment Refer to special instructions/Safety data sheets

It should be noted, however, that the proposed classification and labelling does not apply to NPEs; nor does the risk assessment propose separate classification and labelling for NPEs. Furthermore, where a classified substance forms part of a preparation, this falls within the remit of Directive 88/379/EEC (on the classification, packaging and labelling of dangerous preparations). This Directive can be used to require labelling of preparations which contain a classified substance, but only where the substance poses a risk to human health (as opposed to the environment). In other words, while substances themselves must be labelled as 'dangerous for the environment', preparations containing those substances need not display such labels. Whilst there is a draft Directive for preparations which would provide the basis for mandatory labelling as 'dangerous for the environment' of such preparations, the proposed timescale for its implementation is not known.

5. ASSESSMENT OF POSSIBLE FURTHER RISK REDUCTION MEASURES

5.1 Introduction

In line with the *Draft Technical Guidance Document on Development of Risk Reduction Strategies* (May 1997), the risk reduction options under consideration in this study have been evaluated against the following four criteria:

- **effectiveness:** the measure(s) must be targeted at those significant hazardous effects and routes of exposure where risks that need to be limited have been identified by the risk assessment, and must be capable of reducing the risks that need to be limited within and over a reasonable period of time;

- **practicality:** the measure(s) should be implementable, enforceable[19], and as simple as possible to manage (such that smaller enterprises are able to comply). Priority should, therefore, be given to consideration of commonly used measures that could be properly carried out within the existing infrastructure (though not to the exclusion of novel measures);

- **economic impact:** the rapporteur can make a rough qualitative estimate of the impact of the measure(s) on producers, processors, users and other parties on the basis of experience and judgement. However, regarding restrictions on marketing and use, the rapporteur should provide more detailed analysis of the advantages and drawbacks of the measures; and

- **monitorability:** monitoring possibilities should be available to ensure the measure(s) is (are) being carried out and to allow the success of the risk reduction measure(s) to be assessed.

To assist in the evaluation process, consultees were asked for their views on the performance of the risk reduction options against these criteria (see Section 1.4). Compared with the data provided on use of NP/Es, very few responses were received which addressed this issue. Where responses were received, these generally identified preferred options but provided little discussion as to why they were preferred.

The results of this evaluation are reported below for each risk reduction option in turn and are then summarised at the end of this section. Where appropriate, issues raised by the specific uses of NP/Es have been highlighted in the discussion. To the degree possible given the data available from industry, the performance of each risk reduction option has been considered at a sectoral level (see also Annex 1 for a more detailed discussion for each industry sector).

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19 The Guidance indicates that voluntary agreements are an exception to this criterion. However, the Guidance also states that the rapporteur should consider whether those undertaking voluntary commitments are likely to be able to secure compliance within the terms of the agreement.

5.2 Marketing and Use Restrictions

5.2.1 Effectiveness

Full marketing and use (M&U) restrictions would ensure that the environmental (and human health) risks posed by the release of NP/Es from production, formulation and end use would be eliminated from all industry sectors and sites affected[20]. However, it cannot be argued that banning the use of NP/Es across all industry sectors would necessarily be the most 'effective' approach: for those sectors where the use of alternatives would confer no reduction in risk, or indeed a net decrease in benefits, this will not be an appropriate measure.

By way of example, the substitutes for NPEs in emulsion polymerisation are other APEs, which will pose a similar level of risk while creating significant costs (see below, Section 5.2.3). In another example, NPEs are used in some water-based paints, which are being promoted as an environmentally preferable alternative to solvent-based paints which contain volatile organic compounds. Thus, while M&U restrictions can be effective in reducing the NP risk, this approach would not necessarily yield a net reduction in the environmental risks from paints; the appropriateness of M&U restrictions must, therefore, be considered in comparison to other possible options.

While some options can only be applied to point-sources, M&U can be used to reduce risks from both these and diffuse sources (e.g. I&I and personal care products). Similarly, for 'closed-loop' applications, other options may be as effective in reducing risks, yet may be ineffective in controlling widespread 'down the drain' applications. M&U restrictions are also effective for industry sectors in which lower risk substitutes are available. In the main, these are (or are likely to be) alcohol ethoxylates and fatty alcohol ethoxylates, which the various Contracting Parties to the PARCOM Recommendation have argued pose lower risks to the environment and human health than NPEs (for a more thorough discussion of alternatives, see Section 2.7).

5.2.2 Practicality

The implementation of M&U restrictions would be through an amendment to Directive 76/769/EEC. Where a ban is implemented, it is expected that this would result in a top-down response whereby production of NPE would decrease, formulation of products for specified uses would cease, and so the end products containing NPE would no longer be available. This has been a standard and effective approach to controlling the risks from a wide range of substances and it is expected that practical methods for implementation have been devised by Member States.

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20 However, theoretically, this goal might not be achieved if a given sector could illegally source NP/Es through means other than the traditional supplier. Consultation for another similar study has suggested that where a traditional supply route is interrupted, then supply may be sought illegally from non-traditional routes. For example, if NPEs were no longer directly supplied for use in I&I products but were supplied for use in pesticides, then an I&I formulator might buy NPE from a pesticide formulator instead. However, there would be risks attached to both buying and supplying the substance. For these reasons, it is expected that such a practice would not be widely undertaken.

One key issue of practicality is the availability of substitutes. In sectors such as I&I, textiles, leathers, metals, pulp and paper, and cosmetics, numerous alternatives are generally available and are, in many cases, already in use. The increasing use of alternatives in these sectors has been aided by a number of factors:

- the 1976 UK voluntary agreement to phase NPEs out of domestic cleaning products;
- a 1986 voluntary agreement by industry in Germany, in which the I&I, textiles, leathers, metals, and pulp and paper sectors undertook to phase out their use of NPEs (with target dates of 1986 for domestic products, 1988 for disinfectants and 1992 for industrial products);
- PARCOM Recommendation 92/8, which calls for the phase-out of NPE use both in domestic products (by 1995) and in industrial and institutional products (by 2000);
- the provision of information by the European Cosmetic, Toiletry and Perfumery Association (COLIPA) to its member associations and companies on the issues associated with APEs and advised them to "consider the possible adverse publicity surrounding APEs during their reviews of formulations"[21]. As a result, it is reported that the large volume uses of NPEs as surfactants and emulsifiers by the cosmetic industry have been rapidly replaced with alternative products; and
- a response within industry to general concerns about NP/Es, resulting in, for example: pressure from pulp and paper mills on their suppliers for NPE-free products; pressure from retailers for NPE-free products for cleaning their stores; and professional cleaning companies moving away from the use of products which contain NPE in the belief that NPE-free products may be required by certain customers (e.g. local authorities) in the future.

Thus, full M&U restrictions are much more practical for these sectors than for those where suitable alternatives may not be available for a number of years. For example, one formulator of waterborne paints and resins for auto finishing indicates that five to seven years will be needed to develop suitable alternatives for use in solvent-free formulations.

In some cases, however, alternatives may be available for most applications within a sector while not for certain specialist applications. In such instances, there may be a case for derogations. A prime example of this is the existence of substitutes for most applications within the cosmetics industry with the exception of the use of NPEs in spermicides used on condoms. To date, there are no known substitutes for NPEs within this application. The only other areas where the potential need for derogations have been raised are the use of NPEs in flocking textiles and in certain I&I applications. In both cases, however, inadequate information has been made available to substantiate these requests.

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21 COLIPA Recommendation No. 2 in Alkylphenol Ethoxylates.

With respect to other forms of risk reduction via the M&U Directive (see Section 4.2), restricting the concentration of NPEs in products is not thought to be practical in the vast majority of cases. This is because surfactant levels are thought to already be at a minimum as a result of the need to produce products which are as low cost as possible.

5.2.3 Economic Impact

Two approaches were taken to assess the economic impact of M&U restrictions on NP/Es. First, costs estimates for the introduction of a complete phase out were provided by the Alkylphenol Ethoxylates Task Force of CESIO, the CEFIC sector group representing the surfactants industry. These are reproduced here in Table 5.1 (with a comparable table quoting the UK£ equivalent given in Annex 3). In order to verify the CESIO data and to obtain cost data from sectors not specifically addressed by these data, RPA obtained cost data directly from a wide range of companies. Primarily, these data are the results of a survey distributed to over 90 companies during the quantitative stage of this study (see Section 1.4)[22]. Cost information obtained during other stages of this study has also been used as appropriate.

Cost Estimates from CESIO/CEFIC

CESIO data suggest that a complete ban on alkylphenols (APs) and their ethoxylates (APEs) would cost industry Euro 1.6 billion (£1.1 billion), where this includes both one-time reformulation costs plus the change in raw materials costs for one year resulting from the use of alternatives. According to these data, NP/Es make up 90% of all AP/Es, with the remainder being octylphenols (OPs) and their ethoxylates (OPEs). If the costs are similarly distributed (as the measures proposed here do not cover OP/Es), the costs associated with a ban on NP/Es would be just over Euro 1.4 billion (£1 billion).

However, these costs are significantly higher for some sectors than others and are not proportional to either the volume used or the contribution to the total NP burden of the various sectors. This is the case for the production of NP and its derivatives, as well as for captive use and emulsion polymerisation. Together, these sectors account for over half of the above costs, but less than 6% of environmental exposure.

Conversely, industry data suggest that the costs to I&I of a complete ban would amount to some 10% of the total costs, yet would reduce risks by almost 45%. Similarly, CESIO data suggest that the textile and leather sectors would incur some 5% of total costs, while M&U restrictions for these sectors would reduce the risks by 20%. These data highlight the importance of ensuring that a balance is achieved between the costs and the associated benefits of risk reduction, particularly where there may be other measures which could provide for the same level of risk reduction at lower cost.

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22 Each of the industry sectors identified in the environmental risk assessment were covered by the survey; some of the companies were producers and formulators, while others were end users.

Table 5.1: Nonylphenols, Octylphenols and their Ethoxylates: Estimate of Approximate Costs to EU Industry (Euro 1999*)						
Uses	**Estimated Consumption (1995) (kt)**	**Estimated Number of Formulations**	**Reformulation Cost per Formulation (Euro 000s)**	**Cost of Substitution (Euro million)**		**Total Cost to Industry (mill Euro)**
				Costlier Substitute**	**Reformulation & Commercialisation**	
NP/OP Chemical intermediate for resins & additives (excl. ethoxylates)	39	2,000	69	107	137	244
NPE/OPE Industrial Detergents	28	10,000	14	19	137	156
Emulsion Polymerisation	12	2,000	274	8	549	557
Textile & Leather Processing	18	2,000	34	12	69	81
Agrochemicals	6	1,000	206	4	206	210
Other Uses	16	10,000	34	11	343	354
Total		**27,000**		**162**	**1,441**	**1,603**

* Converted from 1995 ECUs
** Assumed at Euro 2.74/kg for NP/OP and Euro 0.68/kg for NPE/OPE

It must also be remembered that a number of sectors are already moving towards the use of alternatives as a result of individual company initiative, various voluntary agreements, environmental concerns expressed by customers and the general public, and/or legislation specific to certain Member States[23]. Thus, the costs reported above may not be entirely attributable to the introduction of EU-mandated marketing and use restrictions.

RPA Survey/Consultation

The RPA survey has provided detailed cost information for a number of individual players. While one must be cautious in aggregating these costs to a UK or EU level, the survey responses provide an additional picture of the nature and degree of costs that may be expected to arise from various risk reduction measures.

In the emulsion polymers sector, survey responses tend to confirm the high levels of cost suggested by the CESIO data under a ban. The high costs result from the complexity

[23] The trend toward using substitutes for NPEs has been seen in almost all sectors, particularly in I&I, textiles, leathers, veterinary medicines, metals, pulp and paper, personal care products.

involved in isolating suitable substitutes, as these must be carefully selected and/or developed to provide the desired properties in the polymers, which are used in a wide range of end-products.

However, these costs are significantly higher for some sectors than others and are not proportional to either the volume used or the contribution to the total NP burden of the various sectors. This is the case for the production of NP and its derivatives, as well as for captive use and emulsion polymerisation. Together, these sectors account for over half of the above costs, but less than 6% of environmental exposure.

In the textile sector, cost data were provided by the International Wool Secretariat (IWS) on the use of substitutes for wool scouring. IWS reports that with careful detergent selection and process optimisation, substitution of APEs should not result in increased costs to wool scourers. Although initial laboratory studies confirmed that alcohol ethoxylates are less effective at dirt and grease removal than APEs, more sophisticated studies allowed IWS to short-list the most promising products for mill trials. One such trial revealed that while alcohol ethoxylates were around 20% more expensive than APEs, the cost of scouring 15,000 tonnes of raw wool could be reduced from Euro 133,200 (£90,000) with APE detergents to Euro 101,750 (£68,750) with alcohol ethoxylates. This saving is due to increases in process efficiency which reduced detergent use from 0.8% to 0.5%[24]. These savings have been realised at one site at least in the UK which is party to the UK voluntary agreement to phase out the use of NPEs in wool scouring.

The responses for the leather sector are more mixed. One company reported that alcohol ethoxylate-based substitutes would cost around 10% more than NPEs, while another company indicated increased per unit costs for alcohol ethoxylate-based substitutes of 50% or more than the current NPE-based products. These figures relate to need to the development of new substitutes, where this will include application development, process development and marketing verification and promotion expenses and the higher costs of the base surfactant (e.g. the alcohol ethoxylate). No operational costs should arise, however, from the need to modify the processes in which the chemicals will be used. Furthermore, as the 1986 Germany voluntary agreement included the leather industry, some EU companies are expected to have already incurred reformulation costs.

For veterinary medicines, it appears that the main costs of concern to industry resulting from the mandatory use of alternatives are those related to licensing fees. According the UK Veterinary Medicines Directorate, however, a change in the surfactant would not require a new marketing authorisation, but rather a ‘variation’ to the marketing authorisation, the costs and requirements of which are significantly less. Although specific figures have not been provided by either industry or the regulator, industry-wide costs for obtaining license variations will be tied to the number of veterinary medicine products which contain NPEs. In December 1998, there were at most 24 such products registered in the UK. It is also worth noting that a number of applications for such

[24] Taking into account increases in process efficiency alone, APE detergent costs would have fallen from £90,000 to £56,250.

license variations have been made since early 1998, where NPEs were being replaced with alcohol ethoxylates.

In the metal sector, the costs of using alternatives to NP/Es relate mainly to the increased purchase cost of the substitute chemical, rather than to any changes in equipment, processing or waste disposal costs. That said, there are reformulation and re-registration costs to formulators of these fluids (with one respondent indicating these would correspond to a one-off cost equivalent to roughly Euro 0.006/litre (0.4 pence/litre). Increases in the purchase costs across a range of products are estimated at between Euro 0.015 and Euro 0.074 per litre (1 to 5 pence per litre) of product, with these translating to increases in product cost of between 3% and 13% (with the latter relating to solvent degreasers).

Where NPEs are included in crack detection chemicals (electronics, electrical, civil and mechanical engineering), survey responses indicate that full M&U restrictions may lead to per-unit cost increases of between 3% and 8% (see Annex 1 for further details).

In the cosmetics sector, one producer of skin cleansers and other personal hygiene products has indicated that the best alternatives to NPEs appear to be alcohol ethoxylates and that, depending on the type and volume of alcohol ethoxylate purchased, these can be between 40% and 100% more expensive than NPEs. However, these cost estimates are high when compared to figures given by another consultee who indicated that the increased costs associated with the substitutes to NPEs in skin toners, mascaras and shower/bath and hair care products would be low, at less than 1% higher than NPE-based substance in most cases. It has also been reported that there are technical difficulties in replacing NPEs in some very specific formulations. Examples of these are where NPE functions as a solubilising agent in some hair products and decorative cosmetics at low levels. For these products, replacement ingredients have not yet been identified (and thus the delayed introduction of restrictions may be merited for these applications).

As previously noted, NPEs are also a key ingredient in spermicides for which no replacement currently exists. Information on use has been provided by two manufacturers of condoms. In the last financial year, one company sold 3.5 million individual condoms, each containing approximately 22.75 mg of NPE. The total quantity used was almost 80kg. The company and its suppliers understand that there is currently no viable alternative to NO9 for this type of application. At this point in time, the result would be the removal of the spermicidal formulas which contain the NPEs from all products. This would make the product unviable. The risk to the environment from this application is very small, and the human health risk assessment has indicated there is no risk of concern; thus, banning the use of NPEs in this application would have considerable drawbacks and only minor benefits.

5.2.4 Monitorability

If the use of NP/Es in all applications is phased out across Europe, then checking imports would suffice to ensure that they are no longer used. However, if NP/Es continue to be used in some sectors (either as a result of derogations or the adoption of other measures to achieve an adequate level of risk reduction), then some degree of monitoring may be required. The need for monitoring would be limited by the following factors:

- there are only a few sites where NP/Es are produced, so output could be monitored with relative ease;
- a number of industry sectors are already phasing out the use of NPEs on a voluntary basis, in response either to existing voluntary agreements or to customer demand.

The greatest application of NPEs (I&I sector) will shortly be restricted, by virtue of the voluntary agreement to phase out their use by the year 2000. As NPEs become less abundant, it is expected that their price will increase. This should also help to curtail demand for unauthorised use.

5.3 Integrated Pollution Prevention and Control (IPPC)

5.3.1 Effectiveness

As indicated in Section 4, IPPC could not be used to control the risks associated with NP/E use from all sectors. The application of IPPC is limited to medium and large facilities within the following sectors:

- production of NP;
- production of NPE and other NP derivatives;
- emulsion polymerisation;
- captive use;
- textiles;
- leathers;
- metals; and
- pulp and paper.

For the facilities covered in these sectors, IPPC would not eliminate the risks associated with NP/Es, but could reduce them to acceptable levels. In this regard, it would help to reduce the continental burden while also effectively managing local concentrations. It should be effective in reducing risks for the aquatic endpoint. Where risks occur to the terrestrial environment (and subsequent secondary poisoning in some cases), these risks occur primarily through the deposition of sewage sludge containing NP/Es to land. Such deposition should, therefore, also be addressed through the IPPC licensing process.

Particularly in the case of emulsion polymerisation, where the most immediately available substitutes are other APEs with risks similar to NPEs, IPPC offers an effective approach to risk reduction. Similarly, in the production of NP and its derivatives, IPPC offers an appropriate mechanism for controlling risks while allowing for continued down-chain uses where these are not otherwise restricted. Given the contribution of NPE production to the continental burden (6%) and the few sites where NPE is produced, however, there remains a concern that risk reduction measures are implemented as early as possible.

In terms of the appropriateness of IPPC for captive use, textiles, leathers, metals and pulp and paper, the potential effectiveness of IPPC must be considered more carefully, with due regard to the contribution of these sectors to the continental NP burden and the degree to which IPPC can reduce this contribution given that it does not cover smaller facilities. In this regard, we have drawn the following conclusions:

- the contribution of captive use to the continental burden is very low, and local impacts upon the aquatic environment require risk reduction only because the background regional PEC must be added to the local PEC in the risk assessment (although this is not the case for the terrestrial environment). Since all such facilities should be covered by IPPC, this mechanism should be effective in minimising both aquatic and terrestrial risks from this sector;

- textiles are the second largest contributor to the continental burden (14.7%), but the degree to which IPPC can reduce this contribution is limited by the fact that smaller facilities (those processing under 10 tonnes per day) will not be covered by IPPC; it is expected that a significant proportion of textile processors would therefore be exempt (see also Annex 1);

- leather processors are the third largest contributor to the continental burden, accounting for roughly 6%. Again, smaller facilities (those processing under 12 tonnes per day) will not be covered by IPPC, with such facilities also expected to comprise a significant proportion of the industry (see also Annex 1);

- the metalworking sector contributes just over 1% of the total NP burden, but again many metalworking facilities are too small to be covered by IPPC (see also Annex 1); and

- the pulp and paper industry contributes just under 2% of the total NP burden. While some paper facilities are small (under 20 tonnes per day), it is understood that a good proportion are large and thus these and all pulp production would be covered by IPPC.

5.3.2 Practicality

Member States are required to have IPPC transposed by October 1999, with permits for existing facilities in place by 2007. As new facilities affected by the IPPC directive will soon be undergoing licensing anyway, it is expected that very little extra effort would be required by industry or the regulators to address NP/E emissions.

Under IPPC, BAT (best available technology) is based on a site-specific approach, taking into account the balance of costs and benefits. Guidance notes will be produced which will have indicative performance standards for both new and existing plants which inspectors will be required to use to set emission limits. In general, what is BAT for one site is likely to be BAT for a comparable site. Nevertheless, by using site-specific assessment, IPPC licensing will take into account variable factors such as local environmental conditions, which in turn could result in varying standards being imposed at different facilities.

In addition, there is an important distinction between new and existing facilities. New facilities will generally be expected to achieve emissions levels possible in a well designed, well maintained and well operated installation or process. For existing installations, the economic and technical viability of upgrading needs to be taken into account and this will influence the emission limits such installations are required to achieve.

Some concern has been expressed about the potential for a wide variety of different limits to exist across the EU. This is, to some degree, the nature of the approach, which attempts to achieve the lowest possible discharge level while taking into account local environmental conditions and site-specific financial costs. In this regard, however, it should be noted that in cases where the BAT limit is unacceptable for environmental reasons, recourse would have to be made to Article 9(3) where Member States must take account of the *nature* of substances (ref Annex III – water item 4). If it is necessary to adopt more stringent controls, Article 9(4) and Article 10 allow the adoption of additional measures which would be based on the environmental need rather than the BAT achievability criteria. In this case, specific limit values could be applied which were unrelated to BAT itself.

Under Article 9(7) other specified conditions could be applied. However, if a limit value or other requirement is added to the BAT specification (for example, a tighter standard than is actually achievable, or a specific requirement to extract and transport away NP/Es from a particularly sensitive location), the regulatory body could be subject to judicial review for applying restrictions to trade (under the EU Fifth Environmental Action Programme and Articles 130s and 130r of the Treaty of Rome such environmental protection action would be acceptable, of course.)

If the EU decides on common emission limit values (under Article 18), the question arises as to whether these would be based on a particular BAT or designed for EQS reasons. Either approach would overcome arguments often raised about equity. On the other hand, the development of such values is likely to take longer than implementation of BAT-based values.

5.3.3 Economic Impact

In general, industry has a number of possible responses to the introduction of IPPC BAT-based requirements in those facilities using NP/Es. The key responses are to implement BAT, change processes so that the NP/E-based product is no longer required, or adopt substitutes to the NP/E-based product. Assuming that industry is rational in its response, it can be expected to adopt the action which will minimise the costs it faces over the medium and longer term.

The current trend away from the use of NPEs in many of the sectors to which IPPC could be applied is therefore of note, as this suggests that switching to alternatives is considered by industry to be acceptable in cost terms. The industry sectors to which this argument would appear to apply include:

- textiles;

- leather processing;
- metalworking; and
- pulp and paper.

However, it should also be noted that some respondents to the RPA survey indicated that they would respond to the introduction of limits to discharges of NPEs with the introduction of further recycling of NPE-containing fluids and additional treatment as required. With regard to the former, the additional costs were indicated as being negligible and some also indicated that additional treatment costs should be low (particularly as they already treated much of their waste streams).

With regard to the other sectors, industry data suggest that the cost of switching to AP/E alternatives for use in chemical intermediates (excluding ethoxylates) and emulsion polymerisation would be around Euro 800 million (£540 million; see Table 5.1). This amounts to half of the costs expected to result from a complete ban. By managing exposure from these facilities via IPPC rather than via comprehensive use restrictions, these facilities will be free to adopt the least-cost response to meeting licensing requirements. As for the previous sectors, this may be through increased recycling and effluent treatment.

In addition, costs to competent authorities should be low as the additional requirements can be brought in as part of every day licensing activities.

5.3.4 Monitorability

The number of sites in the EU which would be covered by the introduction of IPPC across all the possible sectors identified above would be enormous. For example, in most EU countries over 30% of metalworking facilities employ less than 50 people and thus are likely to fall outside IPPC production requirements. The same conclusion holds for the textile and leather processing sectors in most countries.

If, instead, IPPC is limited to those facilities involved chemical production and formulation, covering:

- the production of NP derivatives,
- the formulation of NPE-based products,
- emulsion polymerisation, and
- other captive uses

then the costs number of facilities which would need to be monitored would be significantly reduced. In this case, the proposed licensing restrictions would cover in the order of 300-500 sites (based on figures in the risk assessment and elsewhere). As has already been discussed, if environmental quality objectives are used to ‘trigger’ the need for licences, this number could be expected to be reduced, as not all of the installations which are covered by IPPC will be releasing sufficient quantities of NP/E to result in concentration of NP/E above acceptable levels.

In terms of the physical measurement of concentrations of environmental NP/E for the purposes of monitoring and triggering IPPC, the EA has indicated that an 'NP equivalence' index may be required to be developed and applied much like the index used for the monitoring and measurement of dioxins. The reasons for this are that, as there are a number of different chain-length NPs and, generally, the toxicity increases as the chain length decreases, the release of a long-chain NPE will eventually degrade to a more toxic endpoint of NP.

However, the equipment needed as part of any monitoring and sampling requirements should be available to regulatory authorities. Gas-chromatography mass-spectrometry (GCMS) equipment can be used for some individual APs at concentrations of 0.1 to 1.0 μg/l. As the concentrations in effluents are likely to be significantly higher than these levels, then such equipment should be suitable. For the UK, it has been suggested that the costs for routine sampling would be negligible, while non-routine sampling undertaken to monitor compliance specific to NP/Es would cost in the range of Euro 75-150 (£50-£100) per sample.

5.4 Limit Values and Environmental Quality Standards (EQSs)

5.4.1 Effectiveness

An approached based on EQSs and/or limit values could be established to provide competent authorities with an enforcement tool to tackle aquatic and associated secondary poisoning risks. Although this type of approach could be used to control such risks across all sectors, its use as the primary instrument is likely to have logistical implications (as discussed further below). It would, however, be effective in minimising risks to these compartments if a significant proportion of the total continental burden was removed through the use of other measures. If an EQS/limit value approach was applied, the potential advantages over the other measures include that:

- only those facilities identified through a monitoring programme as leading to unacceptable levels of discharge and thus risks would be targeted for risk reduction. As such, individual operators would then have a choice as to how to go about reducing risks;

- the establishment of a monitoring and enforcement tool would provide the logistical framework for monitoring compliance with all of the other risk reduction measures proposed in the strategy;

- the enforcement tool would provide a means of tackling any uncertainties within the risk assessment with respect to individual operators who, although their sector is not otherwise targeted by the strategy by virtue of reduced background concentrations, may, in individual cases, still pose a local risk; and

- as the use of NP/E is widespread, there is always an uncertainty as to whether all uses and potential NP derivatives have been covered by the risk assessment process. As such, a monitoring and enforcement tool would provide a means of

> catching any unaccounted for applications in terms of usage. An obvious example of this is the potential use of NP/Es as de-watering aids and flocculants in sewage treatment, where this use was not clarified in time for inclusion in the risk assessment.

The potential advantages of an EQS/limit value approach in the above context are clear. However, there are a number of problems which serve to reduce its attractiveness. These are problems associated with its application, coverage and implementation. These are discussed in more detail below.

Nevertheless, it should also be noted that should the potential use of NP/Es in certain sectors continue, the development of new NP/E applications may also continue, with new uses arising after any risk reduction strategy is finalized within the EU. Although the regulation of such applications may require adaptation to and further development of the strategy, the adoption of an EQS for certain existing uses would help in protecting the aquatic environment from future applications.

Application

By definition, EQSs are concentration values of pollutants in the environment which will cause no harm; thus, the widespread adoption of an EQS approach to NP/Es should theoretically give rise to an effective means of preventing harm from these substances.

The adoption of EQSs would require enforcement of the values through measures taken at all sites which discharge to water, or the control of any uses which could give rise to emissions which would cause the EQS to be exceeded. All existing controls which enable Member States to regulate such discharges would be valid measures, and the conditions which apply to permits for the production and use of NPEs would have to include limits which enable the EQSs to be maintained. The individual limits placed on any discharge could vary from place to place depending upon such characteristics as dilution available in the receiving waters (see also Section 4.4).

The use of limit values would also give a measure of control, but the adoption of common limit values would mean that at some sites the controls might be over-stringent, and at others there might still remain some discernable environmental effect, unless the most stringent values are applied universally.

Coverage

Clearly, an EQS/limit value approach will apply only to water and will not deal *specifically* with the terrestrial risks identified by the risk assessment. It is possible that, because EQSs are usually applied at sewage treatment plants as a matter of course, the approach may indirectly control the terrestrial risks associated with NP/E-containing sewage sludge. The reasoning behind this is that, once an EQS is set and implemented, operators of sewage treatment plants will seek to identify who within their catchment area may be releasing levels of NP/E sufficient to cause a threat to the quality of water entering and leaving the plant. As such, they will seek to come to their own arrangement with such operators so as to reduce emissions of NP/Es to sewer. The knock-on effect of this is that less NP/E will be entering sewage treatment plants and, hence, less NP/E will be contained in sewage sludge disposed of to land.

It is perhaps more likely, however, that an EQS would be met by increasing the removal efficiency to sludge at treatment plants, with subsequent increases in trade effluent consent charges. This approach could then still leave problems for the terrestrial environment through sludge application, unless such sludge was classified as controlled waste or specific limits concerning the allowable concentration of NPEs in sludge spread on land were established (as in Sweden).

Either way, this issue does not apply to the use of NP/E in veterinary medicines such as teat dips and sheep dips. The terrestrial risks associated with this use category are associated with their direct disposal to (farm) land and, as such, could not be dealt with either directly or indirectly with an EQS approach.

5.4.2 Practicality

The legislative problems associated with the implementation of a pan-European EQS for NP/E were discussed in Section 4 where these problems revolve around the fact that a mechanism for applying EQSs will not exist until the adoption of the Water Framework Directive.

The Water Framework Directive will allow each Member State to adopt its own EQSs on the basis that waters must be capable of meeting the Drinking Water Directive standards after treatment. As yet there are no standards for these substances in drinking water. However, the Directive aims to achieve ‘good’ surface water status, which it defines as including good ecological status. As NP has been observed to have effects on algal growth, daphnia reproduction and fish survival at low concentrations, a deterioration in ecological status would be observed if they were allowed to accumulate. Under Article 13(3)(a), it is therefore possible for Member States to set national EQSs. These would not become Community standards until their adoption under Article 21(d).

The adoption of European-wide EQSs for NP/Es would also require the accurate prediction of environmental harm and the assessment of an appropriate safe level. At the present time, there is insufficient information to derive a formal no-effect level, although individual countries may have developed internal values. In the UK, for example, an operational (as opposed to statutory) EQS for NP/Es of 1 μg/l has been developed. The basis of setting limit values would rely on the same data.

In principle, EQSs would have to be set for individual substances, and this would lead to analytical complexity at a site which uses more than one substance. The use of ‘total’ NP/E (or APEs) would lead to the same difficulty that was experienced in developing a pesticide parameter for the Drinking Water Directive. This was solved by specifying individual pesticides in the new Directive. It appears that the use of the EQS approach would have to be introduced in stages – as data became available on the impact of individual NP/Es, EQSs would be set for these compounds.

In practice, the process could be introduced by setting EQSs at places where NP/Es were discharged, identifying the individual compounds, and where data are available, setting the EQS appropriately. Over a period of time (probably quite short), the remaining inputs would be brought under control. EQSs could generally be set on the basis of toxicity to aquatic biota using the now standard techniques of assessment regarding three types of target biota [algae, fish and (in)vertebrates] until more definitive data are available. This could lead to a generalised toxicity-based standard for a mixture of APEs, or to individual EQSs.

5.4.3 Economic Impact

The major impact of the introduction of this approach would be similar to the use of the IPPC regime in terms of controls on manufacture and uses. The introduction and enforcement of limits which do not apply at present would lead to changes in manufacturing processes, changes in levels of treatment and recycling, or the adoption of substitutes. In general, it can be expected that industry would adopt the least-cost method of meeting the EQS or limit values. The impact would therefore be similar to that of IPPC, although it would also fall on smaller facilities and on those sectors not covered by IPPC.

There would also be a significant increase in the frequency and amount of measurement of NP/Es in effluent streams and in the natural environment. Most countries already have sampling programmes for water and effluent monitoring, and existing programmes should be able to accommodate any new requirements for obtaining samples. For routine sampling of a range of products, costs would therefore be minimal. For non-routine sampling, where this is done to monitor compliance specific to NP/Es, costs would be associated primarily with staff time. For the UK, it has been suggested that these costs would be in the range of Euro 75-150 (£50-£100) per sample. The resulting costs at a national level would then relate to the number of water courses where such monitoring would be required.

5.4.4 Monitorability

The use of the EQS approach does require an analytical methodology to be developed to measure the concentrations at one-tenth of the EQS value. No methods are currently available which are used on a routine basis for such measurements. Development work is in process in the UK and detection limits using GCMS for some individual APs range from 0.1 to 1.0 μg/l. At present, the UK has a guideline EQS of 1 μg/l. This same level has been proposed in the Netherlands.

Generally the concentrations in effluents may be ten times or more than the EQS values, and the limit of detection used in the analysis may therefore be correspondingly higher. At present no routine analytical procedure is in use, although GCMS may be available for the levels expected to be required.

5.5 Voluntary Agreements

5.5.1 Effectiveness

The effectiveness of existing voluntary agreements must inform the assessment of the effectiveness of any further agreements. As noted elsewhere in this report, a number of voluntary agreements to eliminate the use of NPEs in domestic cleaning products exist in the various EU countries, both prior to and as a result of the PARCOM Recommendation, with phase out dates no later than 1995. These are understood to have been partially effective in that the large (and many medium-sized) manufacturers are reported to have moved away from NPEs. However, 1994 and 1997 data provided by industry on the use of NP/Es suggest that between 3,000 and 4,000 tpa NPEs are still used in the EU in the manufacture of domestic cleaning and detergent products. As longer term data were not available on the historical use of NPEs in this sector, it is not possible to indicate more clearly the degree to which these voluntary agreements have impacted on NPE use. It is understood that the on-going use in domestic products may be associated with smaller manufacturers, many of which are not members of the trade organisations which are party to the voluntary agreements.

With regard to the use of NPEs in industrial and institutional products, the situation is similar. There has been a number of voluntary agreements in this area, although the PARCOM Recommendation allows for continued use through 2000. It appears that NPE consumption in this sector remained stable across the EU between 1994 and 1997, and reductions since the earliest voluntary agreements cannot be assessed owing to a lack of historical data.

To be completely effective, a voluntary agreement in any given sector would have to extend to all products and all manufacturers within the sector, requiring the cooperation of facilities which are not affiliated with those industry bodies which may be party to an agreement. It appears that this would be difficult to accomplish. Thus, the suitability of voluntary agreements must be assessed by considering the level of risk reduction required in a given sector and a realistic assessment of the level of risk reduction such an agreement may confer.

5.5.2 Practicality

In the case of NP/Es, the large number of industry sectors and applications which give rise to unacceptable risks makes a strategy based on voluntary agreements less manageable as a primary risk reduction tool than for other substances where use is more confined. Consideration must be given to the following:

- whether all sectors would be given the opportunity to use voluntary agreements and why;
- for each sector, which industry bodies should be party to the agreement; and
- what proportion of each sector would be represented by those bodies.

The more sectors included, the more time and effort would be required by both industry and regulators to achieve the necessary agreements. Also, there appears to be no mechanism to include non-members of the industry bodies within any agreement.

Thus, given the complexity of the NP/E market, this measure must be considered an impractical and hence ineffective means of achieving primary risk reductions. However, it may be practical to use voluntary agreements in a limited way. For example, voluntary agreements may be practical for sectors with a small contribution to the continental NP burden, as a complement to the use of, for example, an EQS. Similarly, the use of voluntary agreements may provide a practical interim strategy for dealing with the risks associated with the use of NPEs by the IPPC sectors, as it may take a few years before IPPC permits are actively in operation.

5.5.3 Economic Impact

If a voluntary agreement is 100% effective, it will result in the same costs as would be incurred from a ban under the Marketing and Use Directive. Where it is partially effective, the costs are obviously lower. It is assumed that compliance with any voluntary agreement will be greater amongst companies where the associated costs are considered acceptable or where other pressures, such as the desire to demonstrate environmental performance/commitment, is the highest.

5.5.4 Monitorability

The monitoring of a voluntary agreement will be essential if its effectiveness is to be demonstrated. Monitoring and reporting mechanisms would therefore need to be developed and clearly stipulated in any agreement. To date, it appears that effective monitoring remains difficult. In Germany, however, industry and government have met regularly to discuss and report on progress with the 1986 voluntary agreement, indicating that effective monitoring can be achieved.

5.6 Classification and Labelling

5.6.1 Effectiveness

Firstly, it must be noted that the classification and labelling proposed in the risk assessment applies only to NPs, and not to NPEs. In addition, due to the lack of legislation enabling the establishment of requirements concerning the classification and labelling of preparations as being dangerous for the environment, this risk reduction measure would only be effective for those sectors associated with the first stages of the NP life cycle. The use of formulations, which is associated with more than 90% of NP/E exposure, would be unaffected.

For those sectors where classification and labelling would apply, in order for environmental risks to be reduced, users of NPs would have to respond either by reducing the use of NPs or by changing their operations so as to reduce the amount of NPs entering into the environment. The former is unlikely to happen unless additional pressures are placed on users, particularly given the cost and in some cases performance advantages conferred by NPE-based formulations.

5.6.2 Practicality

Classification and labelling of NPs would be implemented via Directive 67/548/EEC. This is a standard approach to risk reduction for a wide range of substances and it is understood that practical methods for implementation have been devised by Member States. However, as noted above, labelling of NPE-based preparations as dangerous for the environment would need to wait until the proposed enabling Directive is introduced.

5.6.3 Economic Impact

Industry has provided no information on the likely costs of additional labelling, although they are likely to be low. Experience with the classification and labelling of other substances indicates that any subsequent impacts with regard to changes in practice would also be low and, at the extreme, would be no higher than the costs associated with a switch to alternative formulations.

5.6.4 Monitorability

It is expected that monitoring would be straightforward, due to two factors. First, the labels would be clearly displayed on all NP containers. Second, those facilities which would be required to label containers are producers of NPs and such facilities currently number fewer than a dozen across the EU.

5.7 Summary of Relative Performance

The performance of each of the risk reduction options against the four criteria is summarised in Table 5.2 (overleaf). Within this table, marketing and use restrictions provide the standard against which the performance of the other options is compared. A comprehensive summary of option performance is then presented in Table 5.3. The findings presented in this table and discussed in more detail above underpin the risk reduction strategy for NP/Es developed in the next section.

Table 5.2: Performance of Options Against that of Marketing and Use Restrictions					
	Marketing and Use Restrictions	**IPPC**	**Limit Values/EQSs**	**Voluntary Agreement**	**Classification and Labelling**
Effectiveness: Timing	Year 2000	1999/2007	Year 2000+	dependent upon industry	Year 2000+
Coverage	all countries all uses all facilities	all countries some uses large/medium sized facilities	all countries all uses fewer facilities	some countries some uses few facilities	some countries some uses few facilities
Applicability	all sectors	some sectors	point sources non-point indirectly through sewage treatment plants	some users	fewest number of users
Level of NPE Reduction	can eliminate risks	reduces risks to acceptable levels	reduces risks to acceptable levels	reduces risk in ad hoc manner	reduces risk in ad hoc manner
Potential for Increased Risks	some potential depending on alternatives	if alternatives used instead of treatment, then some potential depending on alternatives	response specific, potential increase in risks to terrestrial environment	some potential depending on alternatives adopted	not likely
Practicality: Achievability	straightforward	less straightforward	less straightforward	difficult	not for environment
Flexibility	inflexible	flexible	most flexible	inflexible	inflexible
Economic Impact Costs	most costly to industry low cost to regulator	less costly to industry some cost to regulator	less costly to industry high cost to regulator	possibly lower cost	least costly to all
No. of Affected Organisations	potentially all producers and users	large and medium users in controlled sectors	most water companies and some users	producers and and some users	formulators and potentially users
Monitorability:	relatively simple costs proportional to number of uses	straightforward but some cost implications	more difficult and could be costly	could be difficult costs proportional to no. of affected uses	relatively simple not costly

Table 5.3: Performance of Possible Risk Reduction Options Against the Evaluation Criteria				
Option	**Effectiveness**	**Practicality**	**Economic Impact**	**Monitorability**
Marketing and Use Restrictions	**Instrument:** Amendment to the Marketing and Use Directive 76/769/EEC. **Timing:** year 2000 at the earliest. **Coverage:** addresses risks across the production, formulation and all uses, and across the EU. **Specificity:** Addresses aquatic, terrestrial, secondary poisoning and any human health risks associated with production, formulation and use of NP/Es. **Level of Risk Reduction:** eliminates risks associated with the use of NPE. **Potential for Increased Risks:** alternative substances may introduce new risks. However, most alternatives appear to be either less hazardous or give rise to no greater risks than NPEs.	**Achievability:** a ban on the use of NPEs should be straightforward in implementation. **Flexibility:** Inflexible, as users of NPEs are forced to adopt alternative substances.	**Numbers of Affected Organisations:** All producers and users of NPEs. **Costs:** some or all of the following costs would be incurred: reformulation costs; increased surfactant costs, reduced performance; and loss of business. Other, more flexible, options are likely to be less costly for particular sectors. Monitoring costs are proportional to the scale and number of uses, but would be lower than for standards based approaches.	Monitoring by Member States and the Commission would be required. Monitoring costs would be proportional to the scale and number of uses.

Table 5.3: Performance of Possible Risk Reduction Options Against the Evaluation Criteria (con't)

Option	**Effectiveness**	**Practicality**	**Economic Impact**	**Monitorability**
IPPC	**Instrument:** Integrated Pollution Prevention and Control Directive. **Timing:** IPPC Directive is due to be implemented in 1999 and fully operative by 2007. **Coverage:** addresses risks across the EU but not across all sectors of use. In addition, releases from smaller facilities would not be covered. **Specificity:** Not limited to aquatic risks; aims to minimise releases across all media. **Level of Risk Reduction:** achieves the required level of risk reduction for the aquatic environment and thus would reduce secondary poisoning risks. Also a requirement to minimise releases rather than simply meet any emission standard. **Potential for Increased Risks:** prevents the adoption of an option aimed at reducing risks to the aquatic environment if this resulted in unacceptable risks to other media.	**Achievability:** Emission standards may be as low as 0.33 µg/l of NP. **Flexibility:** Companies are able to choose the means of compliance as long as BAT or standards are met; options may include: improvements to storage, handling and use; process changes; installation of treatment systems; changes in disposal route; and/or the use of alternative products.	**Numbers of Affected Organisations:** All large and medium-sized facilities which fall under the IPPC licensing and which discharge NPEs would be affected. **Costs:** Only those costs which are additional to the costs arising from the implementation of the IPPC Directive in its current form are of relevance. This option gives companies the choice of compliance method, although it is likely to be more costly than EQS and limit values as BAT is specified. Monitoring costs are not known and could be high as the emission standard is close to the level of detection for NPEs.	Monitoring would be required by all controlled industrial facilities releasing NPEs. Monitoring costs would also be incurred by regulatory authorities. However, affected facilities are likely to be monitored regardless of NPE requirements; thus associated monitoring costs should be only incrementally higher.

Table 5.3: Performance of Possible Risk Reduction Options Against the Evaluation Criteria (con't)				
Option	**Effectiveness**	**Practicality**	**Economic Impact**	**Monitorability**
Limit Values/EQS	**Instrument:** Water Framework Directive **Timing:** Water Framework Directive is not yet in force. Establishing community wide controls could thus take time. National limits could be introduced in interim. **Coverage:** addresses the risks from all use categories across the EU. Releases from those industrial facilities which discharge direct to the aquatic environment and sewage treatment plants would be affected. **Specificity:** Specific to aquatic risks. Affects only those facilities which release 'unacceptable' levels of NPE. **Level of Risk Reduction:** could achieve the required level of risk reduction for the aquatic and secondary poisoning compartments. **Potential for Increased Risks:** where treatment is used to meet the option, levels of NP in sludge may increase. This may increase risks to the terrestrial environment.	**Achievability:** The EQS may be as low as 0.33 µg/l of NP, although operational values adopted have been higher at 1 µg/l. Some difficulties in monitoring at necessary limits and for individual substances may arise. **Flexibility:** Companies are able to choose the means of compliance from: improvements to storage, handling and use; process changes; installation of treatment systems; changes in disposal route; and/or the use of alternative products. Sewage treatment plants will be forced to install additional treatment where risks arise from effluents over which they have no control (e.g. domestic uses).	**Numbers of Affected Organisations:** Most sewage treatment plants would need to take action. Only those companies which discharge NPEs above a certain level would be affected. **Costs:** Only those with 'unacceptable' releases would be affected by this option. This option gives companies the choice of compliance method. It should therefore be the least cost option. However, monitoring costs are not known and could be high as the EQS is close to the level of detection for NPEs and the scale of monitoring required is at this time unknown.	Monitoring would be required at sewage treatment works and in surface waters. Monitoring may also be required by dischargers. The effectiveness of the option is heavily reliant on monitoring capabilities.

Table 5.3: Performance of Possible Risk Reduction Options Against the Evaluation Criteria (con't)				
Option	**Effectiveness**	**Practicality**	**Economic Impact**	**Monitorability**
Voluntary Agreement	**Instrument:** Targets would be set in line with Resolution 97/C 321/02 and Recommendation 96/733/EC. **Timing:** could be implemented more quickly than other options, although legislative back-up would take time. **Coverage:** depends on the actions of industry. With 100% involvement would address risks across the EU and all uses of NPE. Most likely to affect uses with simple replacements. **Specificity:** Not specific to aquatic risks. Not targeted at the greatest contributors to risks. Effect on users of NPE depends on the actions of industry. **Level of Risk Reduction:** depends on actions of industry. Without 100% industry involvement some degree of risks will remain. **Potential for Increased Risks:** alternative substances will introduce new risks. However, most appear to be either less hazardous or give rise to no greater risks than NPEs.	**Achievability:** a voluntary agreement which involves 100% of industry will be virtually impossible to achieve. **Flexibility:** Inflexible, as those which comply are forced to use alternative substances.	**Numbers of Affected Organisations:** Depends on the level of industry involvement. **Costs:** some or all of the following costs would be incurred: reformulation costs; increased surfactant costs, reduced performance; and loss of business. Other, more flexible, options are likely to be less costly. Monitoring costs will be proportional to the scale and number of affected uses.	Monitoring by industry and the Commission would be required. Monitoring costs would be proportional to the scale and number of uses.

Table 5.3: Performance of Possible Risk Reduction Options Against the Evaluation Criteria (con't)

Option	Effectiveness	Practicality	Economic Impact	Monitorability
Classification and Labelling	**Instrument:** New Preparations Directive. **Timing:** not known. Could be the year 2000 before the Directive is implemented and later when NPEs are then addressed. **Coverage:** depends on the actions of industry and other users. May vary according to country, use category, market pressures, and the nature of alternative products. **Specificity:** Not targeted at the greatest contributors to risks. Effect on industry and other users will be determined by their response. **Level of Risk Reduction:** depends on actions of industry and other users. Will vary by sector and country. **Potential for Increased Risks:** low if alternative substances are similarly and correctly labelled.	**Achievability:** involvement of 100% of industry is impossible to achieve. **Flexibility:** Inflexible, as those which comply are forced to use alternative substances.	**Numbers of Affected Organisations:** Depends on the level of industry involvement. Relatively few producers and formulators would incur costs from labelling and classification itself. **Costs:** costs of implementing the measure are low, but subsequent costs to industry will depend on response. Likely to be the lowest cost option for industry. Monitoring costs will be associated with surveys of industry and other users.	Monitoring by the Commission would be required. Monitoring costs would be proportional to the scale and number of uses.

6. THE RISK REDUCTION STRATEGY

6.1 Introduction

Clearly, while several (mainly voluntary) risk reduction measures are in place, there is a need to reduce risks further and to formalise voluntary arrangements within a regulatory strategy which will reduce the risks associated with NP/Es. When determining the structure and mechanism of such a risk reduction strategy, it is important to ensure all risks are dealt with effectively, while at the same time taking into account the need to balance overall costs and benefits.

As discussed in Sections 4 and 5, a number of risk reduction 'tools' can be applied to reduce the risks to the environment, yet each must be carefully assessed in terms of its potential application to the various sectors requiring risk reduction. This assessment must recognise that a significant amount of risk reduction is required to manage the risks associated with NP/Es, but also that the degree of risk posed by different uses varies considerably. As a result, the likely effectiveness, practicality, economic impact and monitorability of the tools also vary across the sectors (as described in detail in Section 5). Furthermore, while some of the tools are readily applicable, some (notably EQSs) may require further consideration at a European regulatory level before they could be applied.

Not only should a balance be achieved between the costs incurred by any one sector (and the facilities within it) and the resulting reduction in risk, but the strategy itself should also be cost-effective in the manner in which it achieves the necessary risk reduction. In developing the proposed strategy, a stepwise approach has been undertaken in order to ensure – sector by sector and overall – that the appropriate balance between costs and the benefits is struck.

6.2 Step 1 – Reduce the Continental Burden and Background Concentration

6.2.1 Introduction

As noted earlier, the regional aquatic concentration ($PEC_{regional}$) is nearly two times higher than the PNEC. The environmental risk assessment indicates that, of the 20 or so industry sectors identified, only a small number of these are responsible for the majority of the continental burden of NP (as shown earlier in Figure 2.1). In addition, for seven of the use categories covered by the risk assessment, Conclusion (iii) (aquatic environment) is only recorded because of the current (elevated) background concentration of NP. Of these seven, however, one use category (captive use) also displays risks to the terrestrial environment and related risks of secondary poisoning.

The first logical step in the risk reduction strategy must, therefore, be to consider the costs and benefits associated with reducing background concentrations. This requires:

- determining the relative costs and benefits of eliminating the risks associated with the major contributors to environmental loading of NP; and
- eliminating, where possible, the need for risk reduction in those sectors to which Conclusion (iii) would no longer apply.

The extent to which a given industry sector will affect background concentrations is a function of both the loading attributable to the associated uses of NP/Es and the ‘diffuseness’ of the emissions resulting from those uses. By way of example, NPE production can be characterised as giving rise to a relatively high continental loading, with this concentrated at only a few sites. In contrast, I&I has a high continental loading resulting from its extremely diffuse sources, raising the environmental concentration more generally over a wider area. Table 6.1 provides information on the likely effect on background concentrations of eliminating the continental loading from those uses responsible for over 1% of continental NP loading.

Table 6.1: Effect on Background Concentrations

Sector	% NP Load	Number of Sites	Likely Effect of Removal on Background Concentration
I&I (industrial, institutional and domestic cleaning)	44.7	>2,000	Significant effects on overall background concentrations
‘Other’ (including personal care products)	23.7	Unknown	Unknown
Textiles	14.7	1,000-2,000	Fairly large effects on overall background concentrations
Leathers	6.1	1,000	Fairly large effects on overall background concentrations
NPE production	5.8	7	Little effect on overall background concentrations but large potential effect in localised catchments
Pulp and Paper	1.7	1,300	Small/moderate effects on overall background concentrations
Metals	1.2	>3,050	Small/moderate effects on overall background concentrations
Agriculture	1.1	>20,000	Small/moderate effect over a very wide area

6.2.2 Implications for Various Sectors

I&I, Textiles and Leathers

As can be seen from Table 6.1, elimination of NPEs from I&I, textiles and leathers would have a significant effect on overall background concentrations (PEC_{water}) of NP, owing to the magnitude of their contribution to the total NP continental loading (over 65% of the total) and to the 'diffuseness' of the sources. At the same time, risks to the terrestrial environment and risks of secondary poisoning associated with these industries would be eliminated. Such benefits must, however, be compared with the costs to industry and regulators of eliminating these uses.

As is discussed more fully in previous sections, there have been various voluntary agreements within the EU to phase out the use of NPEs in these sectors. Partly as a result of these, suitable (less toxic) alternatives to NPEs are available[25]. For more technical applications, there may be some cases where reformulation with alternatives may be difficult. No firm evidence has been presented to us that would suggest that substitution would be impossible for any applications, although it is accepted that some applications may require either temporary or permanent derogation from the restrictions. Our own survey has revealed that, where substitution is not already planned, this could take less that one year in many cases and 5-7 years in others, depending on the application.

While the estimated costs associated with a ban may be considerable (see Table 5.1), these should be seen within the context of these sectors' total annual turnover in the EU. For I&I, the estimated costs associated with full M&U restrictions are estimated as equating to about 0.13% of annual turnover. For textiles and leathers, this figure is 0.18%. Furthermore, the current trend towards the adoption of substitutes would suggest that these figures are overestimates as some of the reformulation and marketing costs will already have been incurred. In addition, M&U restrictions should also present low monitoring and enforcement costs to the regulator.

PARCOM Recommendation 92/8 is aimed at the removal of NPEs in all cleaning products by the year 2000. As such, removing NPEs from such products by means of a M&U restriction under Directive 76/769/EEC represents further formalisation of these goals. Furthermore, for I&I there does not appear to be any other suitable risk reduction tool currently available.

For textiles and leathers, IPPC could be applied; however, given the magnitude of the overall NP burden associated with these sectors and the high number of smaller facilities to which IPPC would not apply, it is believed that this would not be an adequate approach to risk reduction. In addition, it is believed that risk reduction via the M&U Directive could be in operation before 2007, the latest year by which IPPC permits must be operable for existing facilities. Timing is particularly important for these sectors, given the proportion of the NP burden associated with them. Thus, it is proposed that M&U restrictions are placed on these sectors.

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[25] Although some substitutes may pose equal or greater risks – see also Section 6.2.3 below and Section 2.7.

The Pulp & Paper and Metal Sectors

In terms of other significant contributors to continental loading and background concentrations, the pulp and paper industry and the metals industry are also candidates for M&U restrictions. For both sectors, suitable (less toxic) substitutes appear to be fairly readily available, while some further reformulation will also be required. Evidence suggests that for most applications in the paper and pulp industry, few problems with substitution are foreseen and (certainly in the UK) paper manufacturers expect costs to be borne by suppliers of the raw materials (whilst apparently accepting that these costs may be passed on to them). However, it is conceivable that there may be some manufacturers who may find some difficulty in the interim with substitution in more technical applications such as the production of specialist impregnated and emulsion coated papers. Further investigation at an EU level is recommended to identify whether temporary or permanent derogations may be required.

In terms of the metal industry, evidence suggests that suitable alternative formulations are already available from formulators for most uses. The formulators themselves appear to have been, in the main, concerned by any restrictions on the use of NPEs in the production of fluids destined for markets overseas rather than restrictions on the use of such fluids in the EU. As such, the formulators' overseas market for products containing NPEs is preserved, even though, owing to the M&U restriction, their products are likely to carry a warning stating that the products are not permitted for use in the EU. Whilst this may affect their market, it can only promote the idea of restricting use in the destination countries overseas, where this would at least ensure that EU formulators developing NPE-free products were not at a competitive disadvantage (indeed, this could place them at a competitive advantage).

For the metal industry, the limited data provided by industry on costs indicated that the adoption of alcohol ethoxylate substitutes would add 1 to 5 pence per litre of fluid, equating to an increase of roughly 3% to 13% in the fluid costs. No comparable data was provided for the paper and pulp industry. Given that these sectors tend to be moving away from the use of NPEs, however, the implication is that the increase in costs is considered acceptable. Based on this conclusion and the reduction in environmental loadings which would result from phasing out use in these sectors (3% for the two sectors combined), M&U restrictions are considered the most appropriate risk reduction measure. This recommendation also reflects the difficulties and costs to regulators associated with the application of some of the other tools to these sectors (e.g. the application of IPPC to the metal industry given the large number of smaller facilities).

NPE Production

Although from Table 6.1 NPE production appears to be a significant contributor to continental loading, this category cannot be considered as a suitable candidate for M&U restrictions unless all uses of NPE in all sectors are eliminated. As a total ban on the use of NP/Es is not proposed within this strategy, this sector is examined in the next step (see Section 6.3).

Agriculture

Within the agricultural sector, it is important to distinguish as far as possible between veterinary medicines and pesticides in terms of risk. This is somewhat difficult, as no data have been provided to indicate what proportion of the 5000 tpa NPE used in agriculture is used in these two areas. Nevertheless, as shown in Figure 2.2, the risk assessment has concluded that the environmental risk resulting from the use of NPEs in pesticides is unacceptable largely because of the background regional concentrations. This is not the case for veterinary medicines, where the risk is unacceptable regardless of background concentrations.

From a review of the means by which environmental exposure occurs from the use of NPEs in veterinary medicines, it appears that mandatory removal of NPEs (via marketing and use restrictions) is the only regulatory mechanism currently available for reducing the associated environmental risk to an acceptable level. As discussed in Section 5.2.3 and in Annex 1, manufacturers of sheep and teat dips are already replacing NPEs in their products as a matter of course, and this appears to be through substitution with alcohol ethoxylates. Thus, suitable alternatives are available, and costs to industry are primarily associated with the need to obtain a 'variation' to the marketing authorisation. Total costs will depend on the number of veterinary medicines products which contain NPEs (no more than 24 in the UK). This approach should have limited cost impacts on regulators.

Restrictions on marketing and use are not recommended for the use of NP-based products in pesticides, at least not at the present time. Due to the low level of risks involved compared to the high costs of reformulation and re-licensing, alternative restrictions are proposed which it is believed would be more suitable for this specific application. These proposals are described in Section 6.2.4.

Other

In terms of the category of 'other' which appears in the risk assessment, this consists of a variety of different uses. It is perhaps useful to first discuss the use of NPEs in personal care products such as cosmetics and shampoos, as these are believed to comprise the most significant volume of NPEs of all applications considered under 'other'. As noted earlier, one EU company alone uses 1 kt/annum of NPEs in its range of personal care products. Were industry-wide usage across the EU to be four times this amount (which may be a reasonable estimate), then personal care products would be associated with over 7% of the total continental NP burden. The lack of more concrete sector-wide data (both on NPE consumption and industry-wide costs associated with substitution) makes it difficult to fully consider the costs and benefits of any risk reduction measure for these applications in quantitative terms. However, these questions can be addressed in qualitative terms.

In identifying appropriate risk reduction measures, it must first be remembered that the risks associated with these products arise generally from their end-use. In other words, they arise primarily from use by consumers as opposed to the disposal of effluent from production or processing. The options available for reducing environmental risks are, therefore, limited to M&U restrictions, limit values/EQS and voluntary agreements. The application of limit values/EQS to reduce these risks would place a heavy burden on sewage treatment works to reduce concentrations within their effluent discharges and would have high monitoring cost. M&U restrictions would provide greater assurance that the risks would be reduced and probably at lower cost. Also, given the large number of individual companies, products of concern and the potential contribution of this sector to the total continental NP burden, voluntary agreements could not be relied upon to deliver the necessary risk reductions.

The next question concerns whether or not the benefits of adopting M&U restrictions would outweigh the costs to this sector. The general trend within this sector is one of movement away from the use of NPEs, with some consultees indicating that they had already replaced all NPEs as part of their wish to have environmentally friendly products, and others indicating that replacement could take a maximum of 2 to 5 years for some of the more difficult products (e.g. the bath/shower and hair care products). These findings, together with the indication that the NPE-based additives account for a low percentage of end-product costs (i.e. less than 5%) and that the alternatives should, in general, not be of significantly higher cost than the NPE-based additives, suggest that the costs to industry would not be out of proportion to the significant level of risk reduction provided by M&U restrictions.

With respect to the safety of replacements, all individual ingredients employed in cosmetic products are systematically assessed for human safety as mandated by the 6th amendment (93/35/EEC) of the Cosmetics Directive (76/768/EEC). Similarly, formulations are also considered for environmental safety by most larger companies. Any alternatives to NPEs would also have to be assessed as part of this process. This suggests that the adoption of any restrictions should recognise that there will be a time lag resulting from the above procedures between identifying a substitute and its being marketable.

With regard to the remaining applications of NPEs considered under ‘other’, the risk assessment identifies the following: non-agricultural pesticides; vehicle and office cleaning products; correction fluids, inks and other office products. In terms of cleaning products, it appears that these would be covered under any controls placed on the I&I sector. Where correction fluids, inks and other office products are concerned, it is believed that these would be associated with negligible environmental exposure. It is thought feasible that the continental loading calculated for this ‘other’ category may simply apply the ‘worst of the worst’ case assumptions to quantities of NP/E that are unaccounted for elsewhere in the assessment. As such, it is possible that the level of continental loading attributed to ‘other’ may be higher than, in reality, is the case. By inference, this means that the continental loading calculated for the other uses may be proportionately higher. This will serve to further increase the reductions in continental loading provided by the M&U restrictions proposed above. Given the absence of any data on NPE usage and the expected exposure associated with these applications, it is recommended that M&U restrictions are not placed on these uses.

6.2.3 Risks of Substitutes

As noted in Section 2.7, most of the above users of NPEs have indicated that they would switch to alcohol ethoxylates (or have already done so) should a ban be placed on the use of NPEs. In general, the toxicity values for these substitutes are (on the whole) lower than for NP/Es, although there are certain alcohol ethoxylates which are of similar toxicity to NP/Es. The substitution of these for NP/Es may, therefore, confer little environmental benefit. In their favour, the greater biodegradation rates of the alcohol ethoxylates together with the fact that they raise no questions concerning potential endocrine disputing effects would indicate that they are overall preferable to NP/Es. However, further effort should be put into clarifying the comparative toxicity of the longer chain mixtures.

6.2.4 Borderline Conclusion (ii)/Conclusion (iii) Sectors

In addressing the uncertainties resulting from the methodology used, the risk assessment notes that Conclusion (iii) was reached for a number of sectors only because the background regional concentration is added to the local concentration. These sectors and their associated local PECs are listed in Table 6.2 (overleaf). If the risk reduction strategy could eliminate some 70% of the total continental NP burden, this would reduce the background regional concentrations to 0.18 μg/l (compared to the existing background regional concentration of 0.60 μg/l and the PNEC of 0.33 μg/l). The final column of the table shows how the PEC/PNEC ratio for these sectors would change as a result of such a reduction in the continental NP loading (where a ratio of less than one indicates that risk reduction is no longer required).

As Table 6.2 shows, a strategy eliminating 70% of the continental NP burden would result in Conclusion (ii) for the production of NPs, epoxy resins and phenolic oximes, as well as for the use of paints. As such, for the purposes of risk reduction, these categories (and the costs that might have been incurred by control measures) need no further consideration within this strategy. Requiring these sectors to undertake action would place costs in excess of the likely benefits. That said, where added assurance of risk reduction is required and facilities using NPE are required to undergo IPPC licensing in any case, then measures could be taken to ensure that risks at the local level do not exceed unacceptable levels (i.e. PEC/PNEC greater than one). It should be noted that the above applies to the aquatic environment only. Risks associated with captive use would also become Conclusion (ii) for the aquatic environment following a reduction in background concentrations but this would not address terrestrial risks and associated secondary poisoning; this is considered in the following section.

For the photographic industry and pesticides, the PEC/PNEC ratio ranges from below 1 (Conclusion ii) to above 1 (Conclusion iii). The risks from the photographic sector are considered more fully in Section 6.3 and those from pesticides are considered below.

Table 6.2: Borderline Conclusion (ii)/Conclusion (iii) Sectors[a]

Sector	**Local PEC_{water}**	**Local $PEC/PNEC_{water}$[b] (current)**	**Total $PEC/PNEC_{water}$ including regional concentration (current)***	**Total $PEC/PNEC_{water}$ including regional concentration (post RRS)****
NP production	0.019	0.058	1.88	0.60
Epoxy resin production	0.050	0.152	1.97	0.70
Phenolic oxime production	0.004	0.012	1.83	0.56
Pesticides	0.08-0.33	0.24-1.00	2.06-2.82	0.79-1.55
Photographic	0.009-1.54	0.03-4.67	1.85-6.48	0.57-5.21
Paint (use)	0.01-0.012	0.03-0.04	1.85	0.58

[a] As identified in the environmental risk assessment
[b] $PNEC_{water}$ = 0.33 μg/l
* Determined by adding together local PEC and current regional PEC (0.60 μg/l)
** Determined by adding together local PEC and regional PEC reduced by 70% (i.e. 0.18 μg/l)

Pesticides

In comparison to veterinary medicines, it is believed that restrictions on the marketing and use of pesticides would raise significant issues in relation to cost-effectiveness and practicality. The costs of immediate substitution are expected to be great due to the need for reformulation, re-licensing and re-testing (veterinary medicines would require a variation to the marketing authorisation rather than a new authorisation, as discussed in Annex 1). In addition, the assumptions used in the risk assessment have indicated a concern only where especially pessimistic assumptions have been used and only for a limited number of applications.

Given that potentially significant risks may arise in a few situations, there remains the need for the implementation of some form of risk reduction, where this relates to use of NPEs in both commercial pesticide formulations and also as adjuvants which are mixed with pesticides in order to increase surface wetting properties.

In order to limit input to the aquatic environment, it is recommended that a mandatory separation zone ('buffer zone') be introduced for pesticides containing NPEs. In terms of the adjuvants, this requirement could be included in Member States' conditions of use (e.g. placed on the list of approved adjuvants such as the Pesticides Monitor published in the UK).

It is anticipated that the introduction of separation zones, possibly coupled with recommendations to seek alternatives as part of re-licensing under Directive 91/414/EEC, will encourage some formulators to implement the use of alternatives as part of reformulation and re-licensing activities since farmers will seek pesticides and adjuvants with the fewest conditions on use. Consultation has indicated that replacement may take up to 15 years in the absence of such incentives (or indeed marketing and use restrictions). In any event, the resulting reductions in NPE input to water courses through the use of separation zones should have the desired effect of limiting risks.

In order to monitor the success of this proposed measure, it is suggested that the proposed marketing and use daughter directive should include a requirement for review of environmental concentrations resulting from pesticide use itself and also in relation to background concentrations. This review should also encompass any reduction in NPE use in the pesticides industry which results from the recommended measures.

6.3 Step 2 - Apply IPPC to Residual Risks (Regional and Local)

Having eliminated much of the background concentration, a number of sectors still require risk reduction by virtue of the levels of use, and associated emissions to the various environmental compartments. It next seems most sensible to consider which of these can be addressed through the use of IPPC given the effectiveness of this approach and the lower monitoring costs associated with it than with the adoption of a limit value/EQS- based approach. Table 6.3 provides a list of the remaining sectors and associated risks that could conceivably be covered by IPPC restrictions.

Despite the fact that the risk assessment has identified these sectors as requiring risk reduction, in reality all sites are unlikely to currently be exceeding the relevant PNECs for each environmental compartment. Rather, depending on the application, some sites will exceed the PNEC and some will not. As a result, because IPPC takes into account actual, measured releases, only those installations where impacts could not be demonstrated as being below the levels of concern would need to proceed with risk reduction.

As such, IPPC is proposed for all sectors listed in Table 6.3. This will include NPE production which, according to the risk assessment, is a significant contributor to background levels. Adopting this approach, therefore, will produce a further reduction in background levels over and above the reduction instigated by the proposals for M&U restrictions outlined above. This will effectively further justify the exclusion of those industry categories identified above where a Conclusion (iii) was only recorded because of the current (elevated) background levels.

Table 6.3: Industry Sectors Recommended for Control under the IPPC Directive				
% of Total NP Burden (Exposure)	**Industry Sector**	**Risk to Aquatic Environment**	**Risk to Terrestrial Environment**	**Risk of Secondary Poisoning**
5.820	NPE production	**(iii)**	**(iii)**	**(iii)**
0.100	Captive Use	❖ **(iii)**	**(iii)**	**(iii)**
0.020	Production other plastic stabilisers	**(iii)**	(ii)	(ii)
0.007	Phenol/formaldehyde resin prod.	**(iii)**	(ii)	(ii)
0.002	Emulsion polymerisation	**(iii)**	**(iii)**	(ii)
5.949	Total			

For the sectors listed in Table 6.3, the application of IPPC would not eliminate risks, but would reduce them to acceptable levels. The use of IPPC would help to reduce the continental burden while also effectively managing local concentrations. Similar to M&U restrictions, IPPC can be used to reduce risks to all environmental endpoints. Particularly in the case of emulsion polymerisation, where the substitutes effectively offer little (if any) reduction in risk, IPPC offers a more appropriate approach to risk reduction. It also enables the terrestrial risks to be managed in a manner more rigourous than the application of EQSs or limit values. Risks of secondary poisoning, which occur largely as a result of terrestrial concentrations, will be addressed through reductions in soil and water concentrations since the corresponding PEC/PNEC ratios are smaller.

Member States are required to have IPPC operational by October 1999. As the above-mentioned facilities affected by the IPPC Directive will soon be undergoing licensing anyway, very little extra effort will be required by industry or the regulators to address NP/E exposure in this process.

Industry cost data[26] suggest that, where adopting substitutes is an option for risk reduction (i.e. not NP/E production) the cost of switching to alternatives for those use categories where IPPC is proposed would be of the order of Euro 160 million (or roughly £100 million) per year. Given that this value does not include the costs of reducing risks from NPE production, it might be expected that costs could be higher than this value.

By managing exposure from these facilities via IPPC rather than via comprehensive M&U restrictions, costs can be minimised as individual companies will be free to adopt the least cost approach to meeting licensing requirements. In addition, costs to competent authorities should be low as the additional requirements can be brought in as part of every day licensing activities.

[26] Data provided by the Alkylphenol Ethoxylates Task Force of CESIO, the CEFIC sector group representing the surfactants industry and complemented by the Consultant’s own survey (see Section 5).

The number of sites in the EU covered by the proposed licensing restrictions is in the order of 300-500 sites (based on figures in the risk assessment and elsewhere). As has already been noted, if environmental quality objectives are used to 'trigger' the need for licences, this number could be expected to be reduced as not all of the installations which are covered by IPPC will be releasing sufficient quantities of NP/E to result in concentrations of NP/E above acceptable levels.

In terms of the physical measurement of concentrations of environmental NP/E for the purposes of monitoring and triggering IPPC, the Environment Agency has indicated that an 'NP equivalence' index may be required to be developed and applied much like the index used for the monitoring and measurement of dioxins. The reason for this is that, as there are a number of different chain length NPs and, generally, the toxicity increases with longer chain length, the release of a long chain NPE will (by degradation) eventually result in the (more toxic) endpoint of NP.

6.4 Step 3 - Options for Dealing with Remaining Use Categories

6.4.1 Introduction

Table 6.4 provides a list of the use categories and associated risks that are, as yet, not covered by proposals set out in the first two steps of this risk reduction strategy.

Table 6.4: Industry Sectors Not yet Covered by Risk Reduction Measures

Industry Sector	**Risk to Aquatic Environment**	**Risk to Terrestrial Environment**	**Risk of Secondary Poisoning**
Formulation (excluding paints)	**(iii)**	**(iii)**	**(iii)**
Formulation of paints	**(iii)**	**(iii)**	**(iii)**
Other niche markets:			
Photography (large scale)	**(iii)**	**(iii)**	(ii)
Civil and Mechanical Engineering	**(iii)**	**(iii)**	**(iii)**
Mineral Oil and Fuel Industry	**(iii)**	not given	not given
Electronics/Electrical Engineering	**(iii)**	**(iii)**	**(iii)**
Other	**(iii)**	not given	not given

Of the environmental risk reduction options discussed in Section 4, there are three that have, as yet, not been considered:

- environmental limits and standards (e.g. EQSs);
- voluntary agreements; and
- classification and labelling.

Classification and labelling is unlikely to provide an effective means of controlling risks unless coupled with other measures, such as those already proposed under M&U restrictions. As such it is not considered further here as a primary tool.

The remaining control measures are limit values/EQSs and voluntary agreements, both of which have their own potential to control risks in the remaining categories and both of which have their own associated drawbacks.

6.4.2 Potential Application of EQSs/Limit Values

A combined EQS/limit value approach could be established to provide competent authorities with an enforcement tool to tackle the remaining sources of water pollution identified in Table 6.4. This would provide both a targeted approach to reducing the risks arising from those facilities which are not covered by IPPC, and would aid in ensuring that the risks posed by disperse, unaccounted for uses of NPEs were also managed. In cost/benefit terms, it would also allow individual operators within the sectors of concern to choose how to go about reducing risks, allowing them to adopt the least-cost approach at a site level. As noted in Section 5, it would also provide a logistical framework for monitoring compliance with all of the other risk reduction measures proposed in the strategy.

Clearly, however, an EQS/limit value approach will apply only to water and will not deal **specifically** with the terrestrial risks identified by the risk assessment nor to the secondary poisoning risks which are predominantly associated with concentrations in the terrestrial environment. However, all of the remaining terrestrial and secondary poisoning risks identified in Table 6.4 relate primarily to the disposal of sewage sludge containing NPEs. This suggests that limits should also be placed on the concentration of NPEs in sludge applied to land where such concentrations might be high.

The main drawback to this approach is that its implementation would be through the Water Framework Directive which would take some time. In addition, the adoption of European-wide EQSs for NP/Es would require the accurate prediction of environmental harm and the assessment of an appropriate safe level (where, as already indicated, this would have to be based on 'NP equivalence'). As noted in Section 5, at the present time there is insufficient information to derive a formal no-effect level, although individual countries have developed internal values. In the UK, for example, work has been under way to determine a suitable operational guideline EQS (i.e. non-statutory), with this currently being set at 1 μg/l. Furthermore, there are significant monitoring implications.

In terms of the logistics and associated regulatory costs of a monitoring programme (for which the EQS approach is often criticised), the remaining sectors which could be covered by EQSs represent only ~0.7% of the total NP burden. Given that by the time an EQS could be in place, the rest of the risk reduction strategy (namely the M&U restrictions and IPPC) will have removed most of the NP loading, it is possible that very little action would be required to enforce an EQS for this remaining 0.7% NP burden. For example, sampling exercises may find that a risk as defined by the PEC/PNEC ratio may no longer exist.

However, should the reverse be found (i.e. that, despite M&U restrictions and IPPC related controls, NP/E concentrations were still, in practice, above the PNEC in certain river basins) then the necessary regulatory mechanism would be in place to address these elevated concentrations without delay.

Another option for (potentially) avoiding the regulatory costs of an EQS approach might be for industry to pursue voluntary agreements covering the remaining sectors in Table 6.4. As detailed in Section 4, there is a framework set out in EC legislation for pursuing such a course of action and, as noted there, in many agreements, full development of legislation can remain in the 'background' as a deterrent if the agreement is not seen to be working satisfactorily. In this case, the 'deterrent' might be the application of the full EQS monitoring and enforcement approach. The advantage of this is that the targets and timetable to be agreed on is not as encumbered by the 'rules' concerning the level and measurement of an EQS as already discussed. The 'timetable' could be related to the time it will take for a full EQS mechanism to be incorporated into the Water Framework Directive. However, it is up to industry to initiate such agreements.

In light of the above discussion, and although the likely balance between costs and benefits is more marginal, it is recommended that an EQS approach is pursued for addressing the following use categories:

- formulation (including paints);
- photography (large scale film processors);
- civil and mechanical engineering;
- mineral oil and fuel industry; and
- electronics/electrical engineering.

However, implementation should be determined by the results of monitoring activities, with EQSs only adopted should the results of monitoring indicate that risks to the environment remain.

6.5 Summary

6.5.1 Summary of Strategy

In pulling together the above risk reduction strategy, the aim has been to consider both the advantages and drawbacks associated with the use of NP/Es and associated with the introduction of different types of measures for controlling the identified risks. Table 6.5 (at the end of the section) summarises the proposed environmental risk reduction strategy for each industry sector covered by the environmental risk assessment.

The structure of this risk reduction strategy has been based on the consideration of several factors including:

- the conclusions of the September 1998 Draft of the Environmental Risk Assessment;

- the environmental loads attributable to each sector involved in production, formulation and use of NP/Es;

- the existing risk reduction measures which are in place for the sectors identified by the environmental risk assessment;

- the costs of developing suitable (safer) substitutes in each category, or of adopting other measures (such as recycling and treatment) to reduce or eliminate the risks associated with NP/Es;

- the balance between costs to industry and regulators/competent authorities of implementing the various measures as compared to what could be achieved in risk reduction terms;

- the suitability and justification of M&U restrictions requiring substitution of NP/Es (taking account of the uncertainties inherent in any environmental risk assessment); and

- the legislative and logistical practicalities associated with the proposed measures.

As can be seen from Table 6.5, the application of M&U restrictions is recommended to remove the use of NP/Es in those industry sectors responsible for the majority of environmental loads (with the exception of NPE production). As well as addressing the risks associated with use in these sectors to all environmental endpoints, these measures also eliminate the need to further address the 'local' risks associated with the use of NP/E in a number of sectors which are responsible for very low levels of environmental exposure.

Licensing under IPPC restrictions is applied to those remaining sectors to which it is applicable. The residual risks from the remaining sectors is addressed through the use of an EQS/limit value approach, with the option of reducing monitoring and enforcement costs through an industry-led voluntary agreement with the Commission. As well as providing a means of controlling the risks associated with the remaining sectors, the EQS approach would act as an effective 'safety net' to accommodate both those uncertainties identified in Section 2.6 and those uncertainties that are inherent within any assessment of the environmental risk of using chemical substances.

6.5.2 Outstanding Matters

The above text has highlighted, in a number of cases, the potential need for either temporary or permanent derogations from the proposed introduction of M&U restrictions. In particular, the following applications of NPEs were identified as potentially requiring temporary derogations:

- I&I: certain technical applications;
- textiles and leathers: flocked fabrics and other 'closed loop' applications of emulsion polymer coatings;
- pulp and paper: specialist impregnated and emulsion papers; and

- metals: specialist operations.

In addition, one key NPE application within the sector of 'cosmetics' is its use in spermicidal formulations. Consultation has indicated that, as yet, there are no substitutes the application of NPEs within these formulations. As such, banning the use of NPEs in this application may have severe adverse consequences for contraception in general (and also the spread of HIV). It is therefore recommended that this use should be derogated from the M&U restrictions indicated above. However, incentives should be given to the sector to develop safe alternatives to NPEs in spermicidal formulations.

Table 6.5: Environmental Risk Reduction Measures

Life Cycle Stage	Industry	% NP or NPE Usage	%Total NP Burden	M&U	IPPC	EQS	Derogat-ion	Voluntary Agreement	Other
NP production	NP production		0.003		*				
Production of NP derivatives	NPE	60	5.82		Yes				
	Phenol/formaldehyde resins	29	0.007		Yes				
	TNPP	5	0		*				
	Phenolic oximes	3	0		*				
	Epoxy resins	2	0.004		*				
	Other plastic stabilisers	1	0.02		Yes				
Formulation of NPE-based products	Formulation (including paints, fuels)		0.618			Yes		*	
Use of NPE-based products	I&I	30	44.7	Yes			*		
	Emulsion polymerisation	12	0.002		Yes				
	Textile auxiliaries	13	14.7	Yes			*		
	Captive use	9	0.1		Yes				
	Leather auxiliaries	8	6.09	Yes			*		
	Agriculture (pesticides)	6	1.08			*			Yes[a]
	Agriculture (veterinary care)			Yes					
	Paints	5	0.04			*	*		
	Metal industry (extraction)	3	1.22	Yes			*		
	Pulp and paper	1	1.72	Yes					

Table 6.5: Environmental Risk Reduction Measures									
Life Cycle Stage	**Industry**	**% NP or NPE Usage**	**%Total NP Burden**	**M&U**	**IPPC**	**EQS**	**Derogat-ion**	**Voluntary Agreement**	**Other**
Use of NPE-based products (cont.)	Other niche markets	-37	23.7						
	Civil and Mechanical Engineering	<1	0.02			Yes		*	
	Electronics/Electrical Engineering	<1	0.001			Yes		*	
	Mineral Oil and Fuel Industry	<1	0.008			Yes		*	
	Photography (small scale)	<1	0.16			*			
	Photography (large scale)					Yes		*	
	Personal Domestic	6	8.801	Yes					
	Personal Domestic (spermicides)						Yes		
	Miscellaneous Other (inc.unallocated tonnage)	10	14.899			Yes			

* denotes an optional application
[a] introduction of separation zones for spraying is proposed for pesticide use, rather than any of the standard measures specified in this table

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

Nonylphenols and their ethoxylates pose unacceptable risks to the environment, where these arise from their use across a wide range of industry sectors. However, the degree of exposure from these sectors varies significantly. Similarly, the costs and benefits expected to result from managing NP/E exposure varies widely both across sectors and according to the risk reduction tool. In order to achieve a balanced strategy, a number of risk reduction tools were analysed in accordance with the *Technical Guidance Document for Risk Reduction Strategies*. Through this process, it has been concluded that no single tool is the most appropriate for all sectors, but that a mix of tools is required in order to adequately balance the costs and benefits associated with risk reduction.

7.2 Recommendations

7.2.1 Recommendation 1: Marketing and Use Restrictions

Under EC Directive 76/769/EEC, the marketing and use of NPEs should be banned for the following sectors:

- I&I (where this includes industrial and institutional cleaning/detergent, as well as domestic cleaning/detergent products);
- textiles;
- leathers;
- agriculture;
- metals;
- pulp and paper; and
- cosmetics (where this also includes shampoos and other personal care products).

In relation to agriculture, marketing and use restrictions are recommended for use of NPEs in veterinary medicines though not – at least in the interim – for use in pesticides. Instead, as described in Section 6.2.4 and Annex 1, introduction of mandatory no-spray zones is recommended with provisions for review possibly being included in the proposed marketing and use directive.

7.2.2 Recommendation 2: Integrated Pollution Prevention and Control

Under EC Council Directive 96/61/EC, the following sectors should be required to operate under integrated pollution prevention and control (IPPC) licenses:

- production of NPE;
- captive use;
- production of phenol/formaldehyde resins;
- production of other plastic stabilisers; and
- emulsion polymerisation.

7.2.3 Recommendation 3: EQS/Limit Values

Using the new Water Framework Directive, or through other national measures, EQSs or limit values should be developed to deal with the remaining risks associated with NP/Es (although the balance between costs and benefits is more marginal). This could be used for targeted monitoring of the following:

- formulation (in sectors where NP/E use will continue);
- civil and mechanical engineering;
- electronics/electrical engineering;
- mineral oil and fuel; and
- the photographic industry (large facilities).

This approach will also be useful for protecting against unacceptable environmental risk associated with continued use of NPEs in paints, by small photographic users and for the 'miscellaneous other' uses which were not specifically addressed in the risk assessment.

It is understood that this tool is not immediately available and that a considerable amount of work will be required to develop appropriate EQSs or limit values. However, such work is already underway in some Member States, and 'operational' values have already been established. Moreover, the other risk reduction tools are expected to address the large majority of the risks associated with NP/Es, with EQSs and/or limit values providing a pollution prevention incentive – backed up with enforcement and monitoring – to those sectors where the risk is relatively small. To address these risks in the short-term, consideration should also be given to voluntary agreements across these remaining sectors.

7.2.4 Recommendation 4: Derogations

In some select cases, the potential need for derogations has been indicated. The need is most clear for spermicidal products, where no suitable alternatives have been identified to date. It is expected that a derogation would be needed to cover the short- to medium-term, until a viable alternative has been found.

The need for derogations in other applications has been suggested, but is less clear. These are:

- certain technical applications in I&I;
- the use of emulsion polymers in the textile industry (e.g. flocking) and leather industry;
- certain specialist operations in the metalworking industry;
- certain specialist impregnated and emulsion coated papers;

The justification for any derogations and the specific applications requiring them need to be investigated further. Should the case for derogations be made, these would nevertheless be for a limited time, as it is assumed that suitable alternatives will be developed eventually.

7.2.5 Recommendation 5: Final Notes

In closing, it is worth noting that there are some uses of NP/Es which confer an environmental benefit over the current alternatives in sectors where an environmental limit value/EQS has been recommended. These include:

- certain water-borne auto refinishing (paint) products, which have been developed to replace solvent-based paints which contain VOCs in response to the Montreal Protocol; and

- use in fuel and oil where NPs are employed in the production of detergents used to help meet vehicle emission standards.

Although these uses have developed as a result of other environmental regulations, it is understood that there is no reason why formulators and end-users of these NP/E products could not be expected to meet a limit value/EQS.

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ANNEX 1:

SECTOR-BY-SECTOR BASE CASE

FOR THE ASSESSMENT

A1.1 Introduction

This appendix sets out a base case for the analysis contained in the main report. All of the relevant sectors in the life-cycle of NP/Es are covered and are presented in such an order. Within each life-cycle stage, sectors are ordered according to usage of NP/Es.

The following points are covered within the description of each sector:

- a description of how and why NP/Es are used in the particular sector under consideration;
- trends in the use of NP/Es within the sector including any relevant initiatives on the part of industry, governments, etc; and
- consideration of issues pertaining to the replacement of NP/Es for the sector, including a description of the relevant risks, the ease with which NP/Es could be replaced by substitutes in terms of performance and costs, and also practical considerations for the adoption of different risk reduction measures.

A1.2 Production of NP-Based Derivatives

A1.2.1 Introduction

Derivatives of nonylphenol (NP) include the following:

- nonylphenol ethoxylates (NPEs - 47 kt/annum);
- phenol/formaldehyde resins (PFR - 22.5 kt/annum);
- tri (4-nonylphenol) phosphite (TNPP - 4 kt/annum);
- phenolic oximes (2.5 kt/annum);
- epoxy resins (1.5 kt/annum); and
- other plastic stabilisers (1 kt/annum).

With the exception of NPEs, use of these NP derivatives is not considered to result in NP exposure to the environment. Thus, their use was not addressed in the risk assessment. It should also be noted that the quantities given above indicate the amounts of NP used in producing these derivatives, not the total amount of derivatives produced.

A1.2.2 The Nature of Products and Their Use

NPEs

These are produced from NP through heating with a KOH (potassium hydroxide) catalyst. Ethylene oxide is added which reacts with the free NP and then with ethoxylated NP to form ethoxylate chains of the desired length, which are determined by the ratios of the two chemicals or by the length of the reaction time. This reaction is carried out using a batch process. No residual NP is expected since NP is more reactive than the partially ethoxylated product and will be consumed preferentially.

Phenol/Formaldehyde Resins (PFR)

PFR resins are thermosets formed by reaction of NP in this case (though the majority of processes use other phenols) with formaldehyde. Often used as a co-monomer, NP can reduce the polymer's reactivity, hardness and colour formation. NP also aids solubility in non-polar solvents and flexibility.

It is estimated that NP is used for PFR production at around 25 sites in the EU. Uses for these resins include carbonless copy paper, tyres, contact adhesives, coatings, electrically insulating varnishes and printing inks.

TNPP

Tri (4-nonylphenol) phosphite is used as a secondary antioxidant in a wide variety of polymer formulations such as polyolefins (e.g. polyethylene, polypropylene), PVC, polystyrene and polyurethanes. The primary use is in food packaging though concentrations are thought to be very low.

Phenolic Oximes

These are used in the extraction and purification of copper and are produced at just one site in the EU (though all of this is thought to be exported).

Epoxy Resins

A number of epoxy resins utilise NP as an accelerator or curing agent. NP is present as a nonylphenol amine salt which is permanently contained within the resin.

A1.2.3 Issues in Risk Reduction

In terms of current availability of substitutes for these applications, a response has only been obtained from one manufacturer of PFRs and for none of the other categories. This manufacturer stated that only other alkylphenols were suitable replacements.

Given the different applications covered here and the fact that they are used in a number of different end uses, it is important to consider the nature of the facilities involved, the number of sites, in addition to the relative contribution to environmental risks associated with each application.

To start with, the risk assessment indicates that TNPP manufacture has essentially zero associated emissions to the environment and, thus, that no risk reduction is required for this application.

Although epoxy resins and phenolic oximes have been classified as requiring action, the risk assessment states that this is primarily due to the magnitude of the background regional aquatic concentrations of NP/E in the environment (see Table 6.2); the contribution of these sectors to the *local* aquatic concentrations alone yield a PEC/PNEC < 1 (i.e. risk reduction not required). Implementation of the proposed risk reduction strategy for NP/Es would reduce the background regional concentrations by some 70%, such that the resulting lower background regional concentration added together with the local concentrations from these sectors still yields a PEC/PNEC <1. Risks from captive use to the terrestrial environment and the associated secondary poisoning effects will not be reduced to acceptable levels through a reduction in background concentrations since these are relatively low as compared to the soil PNEC value and local terrestrial concentrations. Therefore, captive use is addressed separately.

Emissions are released to both air and water from PFR production, although liquid effluent wastes will be treated either on or off-site and emissions to air are not expected to pose any risk. The resins produced also typically contain up to 3% free NP, but due to the insoluble nature of the resin, its use is not thought to represent a concern as regards migration into the environment. The risk assessment does indicate, however, that production presents risks to the aquatic environment.

The risk assessment also concludes that the production of NPE itself from NP presents risks to the aquatic and terrestrial environment and also a risk of secondary poisoning. It accounts for roughly 6% of the total continental NP burden and thus must be subject to some form of risk reduction.

A ban on the marketing and use (M&U) of NP derivatives would end the use of many products which are not deemed to pose a risk to the environment. These types of chemical production facilities are covered by IPPC and it appears that this approach would be the most effective in ensuring that those sites and processes which result in environmental risks are effectively controlled. It should also provide flexibility in that sites which have already invested in best available technology (BAT) and which do not lead to NPE concentrations exceeding the PNEC are not further penalised, while those identified as causing environmental risks are controlled.

A1.3 Formulation

A1.3.1 Introduction

The risk assessment considers the risks arising from the formulation of NPE-containing products across all uses, with this being related to some 40,000 tpa of NPE.

In collecting data on the use of NPEs in the various industry sectors discussed above, as well as information on formulation processes themselves, consultation was held with a number of key formulators of NPE products and their trade associations were also consulted.

A1.3.2 Trends in NPE Use

As has become clear from the consultation, trends in use by the individual industry sectors are such that formulators are in some cases responding themselves to concerns over NPEs by developing substitute products or are being pressured to do so by their customers (e.g. the pulp and paper industry). The overall trend is therefore likely to be one of moving away from the use of NPEs.

During consultation, a number of key issues arose with regard to formulation activities. These are as follows and are illustrated by the company case studies given below:

- not all formulators currently release NPEs to the aquatic environment (Companies A and D;
- often, formulation is by batch process; releases are therefore intermittent, and concentrations of NPE can be small compared with total effluent (Companies B and E);
- those companies which have environmental management systems are likely to be reducing emissions of NPEs or eliminating use of NPEs (Company C); and
- manufacturers in some sub-sectors have low levels of releases (Company F).

Company A uses almost 55 tpa of NPE at two sites in the UK and a total of about 250 tpa NPE across the EU as a whole. The company is involved in the manufacture of NPE-based products used in six industry sectors. It has a policy to reformulate where possible using alternatives to NPE, and does not use NPE in new products. The company estimates that it could replace NPEs within about 12 months, and reduce use to at least 5 tpa (i.e. by 90%) within 6 months. The company has identified a range of alcohol ethoxylates as the main alternatives across their entire product range. With respect to releases of NPE to the water environment, the company claims that "it puts back cleaner water than it takes in". This is achievable due to the nature of the waste stream; the company produces both industrial cleaners and products based on mineral oils, and wastes in the effluent stream from the associated processes agglomerate and are easily removed.

Company B supplies NPE-based chemicals to the leather industry and indicates that manufacture of such products will have virtually no release of NPEs in effluent. These are produced in batches which give washings of between 1 and 3 kg per batch. Effluent is diluted and biologically treated with the company making only around 5 batches (of 5 tonnes) per year.

Company C produces a range of cleaning products including those used in vehicle cleaning, hand cleansers, graffiti removers and floor care. It also produces acid descalers for use in metal treatment and metalworking fluids. The company is credited to ISO14001 environmental management systems and has a target to remove NPEs by June 1998. The NPEs are to be replaced with alcohol ethoxylates.

Company D uses NPE in the production of metalworking fluids. The company has no effluent discharge to sewer with all trade effluent being contained and collected for disposal off-site.

Company E produces alkaline and acid cleaners for the metal processing industry. It formulates cleaners in batches of 500-2000 litres. Waste water per batch is perhaps 5 litres of this compared with total effluent of around 3000 litres per hour. Products contain between 0.2% and 5% - 8% NPE.

Company F produces cosmetic and beauty care products. By the middle to end of 1998, it aimed to have none of its products containing direct additions of NPEs. More generally, an EC study of the manufacture of cosmetic and beauty care products has indicated that there are generally low product loss rates from such facilities (CEC, 1993).

A1.3.3 Issues in Risk Reduction

As marketing and use restrictions are not recommended across all of the other end-uses of NPEs, other measures need to be found for minimising the risks associated with formulation. The above discussion indicates that there is potential for reducing environmental risks associated with this sector through the use of site-specific controls.

In determining which type of site-specific measure may be appropriate, the nature of formulation activities needs to be taken into account. In particular it should be recognised that this stage in the NP/E life-cycle will comprise a wide range of enterprises, from small to large companies. For example, there are around 700 sites across the EC which are involved in the manufacture of industrial and decorative coatings. Similarly, there are over 100 formulators of metalworking fluids and 45 sites involved in the manufacture of chemicals for use by the paper industry in the UK alone. Some sectors are not covered by IPPC at all, while a number of facilities in sectors which are covered are likely to fall below IPPC thresholds, the use of IPPC may not be effective in dealing with the localised risks to the aquatic environment and of secondary poisoning highlighted by the risk assessment.

The use of limit values and associated EQSs, however, which are specific to site and receiving waters should ensure that controls are only required at those formulation facilities which give rise to environment risks associated with the aquatic compartment and with secondary poisoning. The risk assessment has also identified risks to the terrestrial environment and of secondary poisoning occurring as a result of terrestrial concentrations. These risks are associated with NPEs in sewage sludge and the application of such sludge to land. For limit values and EQSs to be effective, therefore, there will be a need to also place restrictions on the concentration of NPEs in trade effluent discharges to sewer or on the application of NPE-containing sludge to land. As EQSs would usually be applied at sewage treatment plants, one would expect operators of these facilities to place such restrictions on the volume of NPEs in trade effluent discharges.

Overall, it is believed that a limit value approach should provide an appropriate balance between costs and benefits (in terms of risk reduction), given that this sector is estimated to account for less than 0.5% of the total continental NP burden.

A1.4 Institutional and Industrial Products

A1.4.1 Introduction

As indicated in the risk assessment, the I&I sector used some 23,000t in 1997. It is important to note that this is based on data provided by industry and includes some 3,600t NPE used in the production of domestic detergents. Thus, both these sub-sectors are discussed below.

The discussion provided in this section is based on consultation with six trade associations and 27 companies, 18 of which provided data for the study. In addition, some trade associations have surveyed their member trade associations and companies on our behalf. Thus, the total numbers of organisations contacted and responding is in excess of the figures given above.

A1.4.2 The Nature of Products and Their Use

Overview

There is a vast range of products which can be classified as being 'institutional and industrial' (I&I) cleaning products including:

- janitorial products such as hard surface cleaners, cream cleansers, hand gels and cleaners, floor cleaners and strippers, bactericidal cleaners, disinfectants, manual dishwashing liquids, carpet cleaners and acid toilet cleaners;
- automotive products such as traffic film remover, wash & wax, car shampoos, windscreen washes, pressure cleaners, chrome cleaners, rinse formulations, engine degreasers and upholstery cleaners;
- products for the food, dairy and catering industries such as machine dishwashing products, rinse aids, bottle washing, steam cleaners, cleaning-in-place and iodophors;
- industrial laundry detergents, both powder and liquid products;
- products for metal cleaning and preparation including immersion cleaners, spray cleaners, solvent degreasers, electrolytic cleaners and rinsing formulations;
- specialist cleaners such as oil spill dispersants, rig wash, quick-break emulsifiers, abattoir cleaners, general foam cleaners, micro-emulsion cleaners, concrete cleaners/graffiti removers, paint stripper/brush cleaners; and

- domestic detergents.

With respect to the levels of NPEs in these formulations, these can vary typically between 1% and 10% depending on end use. Further details of the types of products used in some of these applications are given below. The vast majority of information is for the Netherlands and is summarised from Westra and Vollebregt (nd) which provides a comprehensive review of APE use in I&I products.

Car-Related Products

APEs may be present in products used to remove protective coatings from new cars and in heavy duty hand cleaning agents. In contrast, research in the Netherlands has indicated that APEs are not present in the detergents used in car washes. Similarly, although APEs could be present in the detergents used to clean buses, trains, trams, subways and aircraft, no actual use of APEs was identified (Westra and Vollebregt, nd). The situation appears to be different in the UK, with the EA indicating that NPEs are used as surfactants in car washing products (EA, 1998b).

New cars imported to the Netherlands are usually protected with a paraffin or polymer coating (although the trend is away from the use of such protection). While the paraffin-based coatings are removed with pure solvents, special detergents which may contain APEs are used to remove polymer coatings. Assuming that APEs are used in all such products, it is estimated that between 1 and 2 tonnes of APEs are used each year by importers (mostly) and some car dealerships[1]. With respect to the fate of APEs, waste water is discharged to sewer or surface water following neutralisation, with the removal of solid waste following settling. Some NPEs will be discharged to water, therefore, with the remainder treated as chemical waste (Westra and Vollebregt, nd).

APEs are present in some heavy duty hand cleaning products sold in the Netherlands, although 20% of the market is known to be APE-free. It was estimated that half the products contain APEs with 20 tpa of APEs used in 1995[2]. However, the company with 60% of the market was planning to replace APEs with (fatty) alcohol ethoxylates at the beginning of 1996. Thus, APE usage could now be less than 8 tpa. Some companies may chose to continue using APEs as they are less costly than other non-ionic surfactants and are odourless. That said, the unpleasant odour which characterises alcohol ethoxylates can be avoided by using products of a higher purity. With respect to fate of APEs in such uses, these will be discharged to sewer (Westra and Vollebregt, nd).

[1] 450,000 new cars of which 20% are coated with co-polymers. These are removed using 0.2 litres of product which contains 5% to 10% non-ionic surfactant, all of which is assumed to be APEs.

[2] 500 tpa of heavy duty hand cleaning agents containing 15% to 20% ionic and non-ionic surfactants, of which around 50% are APEs.

Tank Cleaning

Research indicates that APEs are present in the products used to clean chemical tankers employed for road transport. In contrast, detergents tend not to be used in cleaning the tanks of oil tanker ships. Similarly, the use of APEs in cleaning oil tankers for road transport or chemical tanker ships is not reported (Westra and Vollebregt, nd).

It is estimated that between 20 and 40 tonnes of APEs are used as cleaning agents and degreasers for the cleaning of chemical tankers each year[3]. With respect to the fate of APEs, large companies use a three-stage system to purify waste water by gravitational, physico-chemical and biological means. Smaller companies use temporary storage to allow solid material to settle. Following treatment, some waste water may be disposed of as chemical waste along with any solids. Some less toxic waste water is discharged to sewer. Some NPEs will thus be treated as chemical waste with the remainder being discharged to water (Westra and Vollebregt, nd).

Other Degreasing Applications

In addition to use in metal processing, electroplating[4] and tank cleaning, APEs may also be present in the degreasing agents used on motor and machinery parts. Degreasers may be either water- or solvent-based[5]. APEs may be used as emulsifiers in the former and as wetting agents in the latter. In both cases, APEs will be present in concentrations in the range 5% to 10% (Westra and Vollebregt, nd).

There is a general trend away from the use of these chemicals as degreasers, with some producers phasing out their use completely (e.g. members of NVZ). The main substitutes are (fatty) alcohol ethoxylates but these perform less well. In particular, the surface tension decreases less than with APEs and wetting time increases. In addition, (fatty) alcohol ethoxylates are more costly than APEs (Westra and Vollebregt, nd).

With respect to the fate of APEs, waste treatment will vary according to the type of use and degreaser. For example, roto-cleaning machines are used for the cleaning of small engine parts. The solvent-based waste is collected and treated as chemical waste (Westra and Vollebregt, nd).

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3 200,000 cleaning activities in the Netherlands each year using 1 to 2 litres of cleaning agent per activity. All non-ionic surfactants are APEs and these make up 5% of cleaning agents.

4 Use in metal processing is considered in section A1.10.

5 Some report that the majority of degreasers are solvent-based while others report that water-based and solvent-based products have equal market shares (Westra and Vollebregt, nd).

Food Industry

APEs could be present in the products used to clean the bottles, in production systems and in filling systems involved in the production of beverages[6]. In addition, they may be present in cleaning products used in the production of dairy products, meat, and canned, frozen and dried food. In the Netherlands, APE use in these sectors is low as most companies are members of the NVZ.

Domestic Detergents

These products include domestic laundry products and other cleaners. Use of NPEs in this sector is thought to be very limited.

A1.4.3 Trends in Use (I&I)

Under PARCOM Recommendation 92/8, the use of NPEs in industrial cleaning agents is to be phased out by the year 2000. As indicated in the main report, actions have been taken by trade associations at both European and national levels to meet this Recommendation and use is reported to have declined as a result. These actions and their impacts on usage are recorded in Table A1(a). With respect to tonnages used, these are not in the same base year and thus cannot be easily compared.

The deadline for the phase out of NPEs in institutional and industrial cleaning products has not yet been reached and this, combined with the later start of many voluntary actions in this sector means that NPE usage is higher than for the domestic sector. Furthermore, it appears that NPE usage in this sector is stable.

The level of NPE use will also be influenced by the nature of the market place. While 80% of the domestic market is dominated by just four companies, two large companies share 20% of the I&I market, with the remainder divided between thousands of smaller businesses. In addition, neither of these major players is reported to have phased out NPEs completely:

- one has indicated that the manufacture of detergent products using NPEs ceased at the end of March 1988. In contrast, many disinfectants and other specialist products will continue to use APEs indefinitely; and

- the other has indicated that its use of NPE has declined from 1,000t in 1995 to 450t in 1997. The expectation is, however, that NPE use will be phased out by the year 2000.

The withdrawal pattern adopted by the first company mirrors the agreement between industrial members of the UK's British Association of Chemical Specialities (BACS) and

6 In the case of alcoholic beverages, almost no detergents are used in the production of spirits and alcohol. Similarly, no surface active agents are used in the production of beer due to concerns over impacts on foaming.

Soap and Detergent Industries Association (SDIA) to phase out NPEs by the beginning of 1998. While all detergent products are covered by this agreement, products such as disinfectants and floor polishes are not. As a result of the agreement, large numbers of products have been reformulated and some removed from the market altogether. One major company alone is reported to have reformulated several hundred and removed around six.

In an attempt to remove NPEs from all UK detergent products, BACS and SDIA have agreed to encourage non-member companies to comply with this agreement. Approximately 20% of all formulators are not members of the trade associations and it is expected that, at present, the majority of these still use NPEs.

Table A1(a): Effects of PARCOM Recommendation 92/8 on I&I Sector

Country	Industrial Cleaning Agents	Comment
Austria	none	detergent industry indicates APEs not used
Belgium	reducing	no official agreement with manufacturers to phase out NPEs, but government can act if promises are not kept
Denmark	100-125 tpa (1994)	voluntary agreement with SPT to phase out NPEs, but NPEs were still used by those outside SPT in 1994 (although usage assumed for domestic products). Now a draft order to eliminate APEs in cleaning products
Finland	90 tpa (1994)	PARCOM Recommendation not implemented. Industrial tonnages are for 1994
Germany	1,500 tpa (1997)	voluntary agreement including a number of trade associations. Industrial tonnages are for 1997, at which time there were 650 NPE-containing products on the market. Producers have now strengthened commitment to phase out APEs
Greece	none	industry indicates that no APES are used as per an industry agreement
Netherlands	60 tpa (1995)	industrial usage is 1995 data, although industrial use is reported to have ceased due to a voluntary agreement
Spain	500 tpa	Association of Detergent Manufacturers are taking steps to replace NPEs. Substitution should be completed in 1998
Sweden	163 tpa (1996)	agreement to phase out use of NPEs in industrial and institutional products in the late 1980s. Industrial usage is for cleaning products including those for cars
UK	8,000 tpa (1993)	1996 agreement to phase out use in industrial and institutional products by the year 2000

Source: Consultation meeting with industry

As a result of the BACS/SDIA agreement and the PARCOM initiative, it is reported that usage of NPEs in the I&I sector has decreased significantly in the UK. Examples of the actions taken by companies are:

- a producer of hard surface cleansers (for use in vehicle cleaning, floor and wall cleaning, disinfectants and heavy duty hand cleaners) is reducing its use of NPEs in line with PARCOM's target phase-out date of the year 2000. 350 tpa of NPEs are used in 17,000 litres of finished product at present, typically at concentrations of between 3% and 15% w/w NPEs;

- one large producer has a policy which states that the use of APEs is prohibited, and that where these products enter the group's line through acquisition, these should be formulated out; and

- another producer of NPE-containing products for use in vehicle cleaning, hand cleaning and floor care has an objective to eliminate the use of NPEs by June 1999 and to replace them with alcohol ethoxylates. This is due to the BACS initiative.

Continental usage of NPE in this sector will be affected by the fact that the major player has withdrawn NPE from use in I&I detergents intended for the EU market. However, companies in all locations may choose to remain with NPEs due to their low cost, and the competitive advantage this gives them may act as a brake to wider removal of NPEs from the market place.

The notoriety given to NPEs by initiatives such as PARCOM also has had an effect on demand for products containing these chemicals. For example, it has been reported that some retailers are asking that the products used to clean stores are free from NPE. Professional cleaning companies are also moving away from the use of products containing NPE in the belief that NPE-free products may be required by local authorities, for example, in the future.

A1.4.4 Trends in Use (Domestic Detergents)

Under PARCOM Recommendation 92/8, the use of NPEs in domestic cleaning agents (such as laundry detergents) was to be phased out by the year 1995. As indicated in the main report (Section 3), actions have been taken by trade associations at both European and national levels to meet this Recommendation and use is reported to have declined as a result.

These actions and their impacts on usage are recorded in Table A1(b). With respect to tonnages used, these are not in the same base year and thus cannot be easily compared.

Table A1(b) reveals that in many EU Member States, use of NPEs in domestic cleaning products has been phased out. This finding is confirmed by the European Federation of Trade Associations which reports that voluntary measures have resulted in the phase-out of NPEs in such products (WWF, 1997b).

The household consumer sector is reported to be dominated by four companies which account for 80% of the market. It is understood that these large and many medium-sized companies have moved away from NPEs (and other APEs). Thus, any remaining usage of NPEs in domestic products is likely to be associated with mainly smaller companies which choose NPEs due to their price advantage over other products. Such companies are also less likely to be members of trade associations.

Table A1(b): Effects of PARCOM Recommendation 92/8 on Domestic Cleaning Sector

Country	Use of NPEs in Domestic Cleaning Agents	Comment
Austria	none	detergent industry indicates APEs not used
Belgium	none	no official agreement with manufacturers to phase out NPEs, but government can act if promises are not kept
Denmark	small	voluntary agreement with SPT to phase out NPEs. In 1994, NPEs were used by those outside SPT (small usage assumed for domestic products). Now a draft order to eliminate APEs in washing and cleaning products
Finland	0.6 tpa (1996)	PARCOM Recommendation not implemented, but NPE use reducing
Germany	virtually none	voluntary agreement including a number of trade associations
Greece	none	industry indicates no APES are used as per industry agreement
Netherlands	none	NPEs have not been used in domestic detergents since 1988 due to voluntary agreement of the Dutch Detergent Industry Association
Spain	nd	Association of Detergent Manufacturers are taking steps to replace NPEs. Substitution should be completed in 1998
Sweden	none	use in household detergents voluntarily ceased in 1972
UK	virtually none	voluntary agreement in 1976 to phase out use of NPEs in domestic products

Source: Consultation meeting with industry

A1.4.5 Issues in Risk Reduction (I&I)

Relative Performance and Time Required for Substitution

Our survey has revealed that substitution of NP/Es, where not already planned, could take between less than one year to a maximum of five to seven years depending on the application. In most cases, substitution could probably be achieved in around two years.

NPEs continue to be used in I&I for a number of reasons including that:

- they are the most cost-effective non-ionic surfactants available over a wide range of formulations and applications;

- they usually exhibit superior wetting and emulsifying properties; and

- they are extremely versatile.

With respect to the first of these, replacement products are reported by some as being less cost-effective than NPEs in terms of delivering the desired performance from a product. Thus, in some cases, manufacturers may need to accept inferior performance coupled with additional costs. However, other companies surveyed as part of this study have indicated that the performance of products based on the substitutes will be comparable and that there will be no effective loss of quality.

With respect to the third point, it is reported that no single product can replace NPEs; thus, more than one replacement is likely to be needed by a company seeking to replace NPEs across an entire cleaning range. As a result, it has been suggested that replacement will complicate production processes.

In most cases, however, NPEs can be replaced with alternative substances, many of which have been known for some time but not chosen due to their higher costs and lower formulation versatility. Now, improved formulation techniques are allowing companies to utilise these alternatives which are almost exclusively alcohol ethoxylates, generally either:

- C_{9-11} linear alcohol ethoxylates;
- C_{13-15} linear alcohol ethoxylates; or
- C_{13-15} isotridecanol ethoxylates (branched).

Alcohol ethoxylates have the general chemical formula $R-(OCH_2CH_2)_n-OH$. In the I&I sector, a typical substitute is *Synperonic 13/9* (trade name) in which the parent alcohol is branched tri-decanol (i.e. R is $C_{13}H_{27}$) and the value n – representing the number of ethylene oxide units – is nine.

Although industry has indicated that there may be some cases where an NPE is used for its technical specificity, because it gives the right performance when combined with other ingredients, insufficient data has been provided to allow this argument to be rigorously examined in this study in terms of recommending derogations. The question of whether or not there are adequate reasons for derogations allowing continued NPE use in some applications, therefore, remains.

Alcohol ethoxylates are believed to be substantially removed from water during biological sewage treatment. They are biodegradable in the environment [as defined by OECD 301C – see Ellis and Everar (1999)]. The 48 EC_{50} values for *Daphnia* magna immobilisation are 2-10 mg/l compared with 0.085 mg/l for NP/Es (Brook, 1993 cited in the risk assessment) and 96h LC_{50} values for fish are of the order of 4-10 mg/l compared with 0.128 mg/l for NPEs (Brook, 1993 cited in the risk assessment).

These toxicity data appear to suggest that alcohol ethoxylates are environmentally less damaging than NP/Es. No evidence was found to suggest a potential for secondary poisoning effects through the use of these chemicals. It would appear that their use as replacement for NPEs can thus be justified on environmental grounds. However, as described in Section 2.7, some alcohol ethoxylates are of similar potency to NP/Es in terms of some toxic effects and the particular product used as a substitute should be evaluated individually.

Costs of Substitution

Owing to concerns over the confidentiality of data in this highly competitive sector, companies completing our survey were unwilling to provide data on the change in costs arising from the move to substitutes. Data provided by CEFIC/CESIO must, therefore, be relied upon for these purposes. These data indicate that of an estimated total Euro 1,600m (£1,080m) required to substitute APs and APEs (of which at least 90% comprises NPEs) some Euro 156m (£106m) would be required to eliminate use in I&I. Thus, the costs of reducing the use of NPEs in this sector would constitute some 9 to 10% of the total costs of substitution across all uses, while the use of NPEs by this sector contributes over 44% of the total continental burden associated with NPs. This suggests that restricting use by this sector would be more cost-effective than restricting use in some of the other sectors.

Issues in Risk Reduction (Domestic Detergents)

Given that most of the larger manufacturers in this sector have moved away from the use of NPEs, it would appear that substitution is not a problem. No consultee identified difficulties in adopting substitutes as a problem. The substitutes which are being adopted are reported to be alcohol ethoxylates, with the specific type varying according to application (see also the discussion on substitutes for I&I).

Environmental concerns associated with this sector relate to the fact that use in the household leads to widespread releases either to sewer or the environment of NPEs. This leads to risks to both the aquatic and terrestrial environment (through NPEs in sewage sludge subsequently spread on land). The only effective way of minimising such risks is likely to be through some form of use restrictions, given that voluntary agreements do not cover all manufacturers and have not been effective across all EU countries.

A1.5 Emulsion Polymerisation

A1.5.1 Introduction

NPEs as well as OPEs (octylphenol ethoxylates) are used in the manufacture of latices and polymer dispersions. They are employed to aid polymerisation and are usually present at concentrations of around 3-4% of the product. It is estimated that use in the EU for this purpose is around 9000 tpa spread between about 70 sites of various sizes.

It is estimated in the risk assessment that some 2000 polymer dispersions are used in the EU. NP ether sulphates are often used to disperse monomer droplets in water in order to aid the polymerisation reaction. They also have the effect of adding stability to the end product. The primary uses for polymers which employ NPEs include production of paints and of concrete blocks.

A1.5.2 Issues in Risk Reduction

Emulsion polymers are generally produced using a batch process. However, sometimes a continuous process is used which would typically operate for around 300 days per year. Emissions to air are reported as zero since these wastes are incinerated. Effluent wastes are usually treated on site using combinations of flocculation, filtration and biological treatment processes. Contamination of water released has been stated to be between 0.001% (0.01 kg/tonne) and 0.1 kg/tonne (0.01%).

Although it has been reported that 1-1.5% of the polymer ends up as waste, this does not represent the quantity passing out of a site provided the above treatment processes are employed.

Industry has stated that substitution of NPEs would be very problematic and also very costly. Substitute materials cannot simply be used in the process as it currently exists since additives are carefully selected to provide the desired properties in the polymer. The only viable alternative to NPEs at present is OPEs. Other substitutes would require significant development.

Furthermore, industry has indicated that the costs of developing alternatives and making the necessary changes to manufacturing processes would cost an estimated €280,000[7] (roughly £190,000) to replace NPEs in each formulation. As there are an estimated 2000 formulations in use in the EU, the costs would be very high should M&U restrictions come into force. These costs relate to research and development, performance testing, marketing, etc. In addition, downstream users would be expected to incur costs of 3-10 times this figure.

The risk assessment has, however, identified unacceptable risks to both the aquatic and terrestrial environment from emulsion polymerisation processes. Given that the number of sites of concern is relatively few (i.e. 70) and that these sites are covered by IPPC, this would appear to provide an appropriate risk reduction option. The IPPC approach would be able to take into account differences in measured releases from different sites as part of the licensing procedure. It would also be more certain to use this instrument rather than relying solely on an environmental limit value or EQS, which is particularly important given the large volume of NPEs used at a limited number of sites.

[7] Euro and Sterling quantities derived from 1995 ECUs and adjusted for inflation.

A1.6 Textiles

A1.6.1 Introduction

The risk assessment estimates that some 8,000 tpa of NPEs are used within the textile industry with most of this being used for wool scouring. Consultation has indicated that there are also other a range of other uses which may be covered by this usage figure.

For the purposes of defining a risk reduction strategy, consultations have been held with two trade associations and two individual companies, all of which provided data for this study.

A1.6.2 The Nature of NPE Usage

Processes Using NPEs

The textiles industry is one of the largest users of NPEs. The primary use of NPE in textiles is in wool scouring, which takes place in several stages of wool processing, from straight off the sheep, to yarn, to sewn pieces.

To a lesser extent, NPEs are also used in some textile dyeing and finishing processes. For example, they are used as emulsifying agents in certain textile treatments, in order to get the treatments in the right phase to interact with the textile. In moth proofing agents for carpets, synthetic pyrethroid insecticides are dissolved in odourless paraffin and surfactants (which may include NPEs) so that they can be emulsified in water.

Other processes that may contain APEs include (Westra and Vollebregt, nd):

- chemicals for the pre-treatment of fabrics; and
- additives for bleaching with hydrogen peroxide; and
- vinyl acetate-ethylene copolymer emulsions (VAE) used as binders in non-woven fabrics, for example towels and baby wipes (FOA, 1997)[8].

Industry estimates that 40% of the 8000 tpa used in textile processing is exported outside of the EU.

Structure of Industry

Industry has also estimated that there are approximately 1000 to 2000 textile processing sites within the EU, with this relating to an average amount of NP/NPE/APE use per site as 8 tpa (BRE, 1998). This figure should be considered within the context of the structure of this sector.

[8] In this regard, there is an overlap with the pulp and paper sector.

Data are generally not available specific to textile processing alone, with some 47,000 sites in the EU classified as falling under the more general heading of 'textile industry' [as defined by the *NACE 43* classification which covers the preparation, spinning, weaving and knitting of a number of natural (wool, cotton, silk, linen, flax, ramie, jute) and man-made fibres]. However, these more general data are useful in providing some context as to the likely profile of the sector.

For example, Italy, Germany, France and the UK accounted for nearly 80% of textile production in 1993, with Italy alone accounting for 32% of production (in value added terms). With regard to company size, some 72% of firms employ less than 20 people; however, these smaller companies employ only 18% of the total workforce and generate only 15% of total turnover. In terms of turnover, the ten largest textile companies account for about 11% of the EU textile industry's total turnover.

A1.6.3 Trends in Use

In 1995, discharges from wool processing in the UK were reported as being the most significant source of APEs in rivers and estuaries in the country[9]. For example, a five kilometre stretch of the river downstream of the Keighley sewage works contained APEs at up to 180 μg/l, with wool industry discharges via Huddersfield and Dewsbury sewage treatment plant (STP) raising APE levels in the river to 123 μ/gl and 80 μ/gl respectively.

As a result of these problems, the former National Rivers Authority (now the Environment Agency) secured a voluntary agreement with the textile manufacturing industry for the use of APEs in wool scouring to be discontinued by 1996 (ENDS 266). UK scourers voluntarily undertook to eliminate discharges of APEs by the end of 1996, using alcohol ethoxylates as a replacement. The Confederation of British Wool Textiles (CBWT) representing most wool processors in West Yorkshire indicated that there would be no problem phasing out APEs in the vast majority of applications.

The voluntary agreement is supported by IPC authorisations issued in September 1996 which require the elimination of APE emissions for those industries under its control. By March 1997, it was reported that all major scourers covered by IPC had stopped discharging APEs. In 1995, the four largest scouring companies used APEs in the processing of 50% of all UK raw wool; by 1997, two had switched to alcohol ethoxylates, one had installed a novel treatment process and the other had ceased trading.

However, some formulations for difficult wools still contain NPEs for cost reasons. One of the major scouring companies in the UK has not, however, moved away from the use of NPs. Instead it relies on a waste water treatment system to minimise the risks to associated with NP releases to the environment. The company has installed an ultrafiltration plant and a two-stage evaporation plant. The ultrafiltration facility allows water reuse, while the evaporation plant reduces scouring effluent to a concentrated

9 Wool Companies Stall on NRA Plea for Oestrogen Ban, ENDS 248, September 1995.

sludge suitable for landfilling. The plants have decreased effluent generation by 90% and left only one treatment bath discharging to sewer.

A1.6.4 Issues in Risk Reduction

Relative Performance, Time Required for Substitution and Costs

It is now argued that suitable replacements for the majority of textile uses exist and it is expected that the use of NPEs will be phased out of most applications over the next six years (CES, 1993 in WWF, 1997b).

Initially scourers believed that APE substitutes would perform poorly on difficult wools (such as coarser wools) and would be more quickly exhausted. In addition, most alternatives based on alcohol ethoxylates are slightly more expensive than APEs and companies feared that this combined with higher usage rates would add significantly to costs. However, the International Wool Secretariat (IWS) reports that with careful detergent selection and process optimisation, substitution of APEs should not result in increased costs to wool scourers.

The International Wool Secretariat (IWS) has been conducting research into alternatives for APEs since 1990. Although initial laboratory studies confirmed that alcohol ethoxylates are less effective at dirt and grease removal than APEs, more sophisticated studies allowed IWS to short-list the most promising products for mill trials. One such trial revealed that while alcohol ethoxylates were around 20% more expensive than APEs, the cost of scouring 15,000 tonnes of raw wool could be reduced from £90,000 with APE detergents to £68,750 with alcohol ethoxylates. This saving is due to increases in process efficiency which reduced detergent use from 0.8% to 0.5%[10]. These savings have been realised at one site (at least) in the UK which is party to the voluntary agreement referred to above.

When trying to identify the specific chemicals which would act as substitutes it became clear that much of this information was proprietary in nature. Indeed this was confirmed by the IWS, who indicated that they were provided with a formulation for testing purposes but were not given details of its composition.

Risk Reduction Considerations

The above discussion suggests that eliminating the use of NPEs across most applications should be possible, although it has been suggested by an industry source that there may be some applications for which cost-effective substitutes do not exist. In particular, it has been suggested that substitutes do not exist for the production of flocked fabrics, although the data necessary to draw firm recommendations on the need for a derogation have not yet been provided.

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[10] Taking into account increases in process efficiency alone, APE detergent costs would have fallen from £90,000 to £56,250.

A second consideration relates to the profile of this sector, which comprises a large number of small operators who may be subject to regulation through the use of measures such as IPPC (as noted above). Given the high number of small companies, significant risks to the environment could remain under the adoption of this approach. Similarly, it may be difficult to implement and monitor the introduction of a limit value approach given the number of facilities which may be affected.

Although voluntary agreements exist in a few countries, notably Germany and the UK, they do not exist across the EU and are only effective in so far that they cover all the relevant facilities. As noted in the above concerning the discussion on the voluntary agreement in the UK, a number of smaller companies fall outside the agreement and continue to use NPEs.

A1.7 Leather Processing Industry

A1.7.1 Introduction

The risk assessment identified usage of NP/Es within the leather processing industry as being 6,000 tpa, with this use being as auxiliaries in the wet degreasing of hides. Further consultation indicates that NPEs may also be used in a number of other aspects of leather processing (see below). The industry has indicated that a significant proportion of products formulated for this sector are exported out of the EU.

The consultation undertaken as part of this study involved two trade associations and a numbers of companies, many of which provided data for the study. The total number of companies contacted and responding is not known as most were contacted by the trade associations.

A1.7.2 The Nature of NPE-Containing Products

NPEs are used in a number of leather processing chemicals:

- surfactants used in the soaking and liming of hides and skins;
- surfactants used in the scouring and aqueous degreasing of sheepskins;
- fatliquors;
- fungicides; and
- auxiliaries such as dye levelling agents.

The majority of NPEs are used as the non-ionic surfactants in the first two applications. The range of surfactants is well known and there are thought to be four main producers/suppliers of NPE-based surfactants. In contrast, it is not known which fatliquors, fungicides and auxiliaries contain NPEs as most formulations are confidential. However, ten companies producing these products have been identified and one chemical supplier has indicated that fat liquors could contain up to 10% NPEs.

NPE Surfactant Use in the UK

Data from the International Leather Guide indicates that there are 126 tanners in the UK, with over 58% of these being small enterprises of less than 50 employees and 36% having between 50 and 250 employees.

Total NPE surfactant use by the UK leather industry can be estimated by consideration of bovine and ovine leather processing. In the **bovine sector**, it is assumed that 0.2% surfactant (by weight) is added during soaking and liming. With an installed capacity of approximately 2.5 million hides per annum, and an average weight of 25 kg per hide, this results in a total surfactant consumption of approximately 125 tonnes. A survey carried out among those tanneries making up 90% of UK production capacity revealed that only a small amount of NPE-based surfactants are being used, possibly in the order of 10 tpa (i.e. around 12.5% of total surfactant use). Most UK bovine processors are not using NPEs or are in the process of substituting for these chemicals.

The **ovine sector** generally uses surfactants in soaking, liming, scouring (wool-on) and degreasing. The UK processes some 8 million skins per annum up to the pickled stage (i.e. no degreasing takes place). In addition, some 6 million are processed into wool – on skins, plain leather, and chamois. During felmongering[11], it is estimated that approximately 0.05% of surfactants are added. With an average weight of 6 kg per skin, this results in about 24 tpa of surfactants being used in this process. For further processing, the surfactant consumption depends on the degreasing method. Where solvent degreasing is employed, no significant amount of surfactant is used. However, where aqueous degreasing is used, up to 3% of the weight of pickled pelts (typically 1.5 kg/pelt) can be used. Several tanneries are currently considering employing aqueous degreasing systems, however, in order to move away from solvents.

With regard to the UK sheepskin processors, only a few are still using NPEs. Most have already changed to alternative surfactants. Those tanneries which are still using NPEs are generally not aware of the environmental problems associated with the use of this chemical. It is estimated that the use of NPEs in this industry is at most 10 tonnes per annum.

Overall, the survey of tanneries and fellmongeries suggests that between five and ten UK-based facilities are using around 20 tpa of NPE-based surfactants. Comparison with data provided by a manufacturer of products containing NPE surfactants for ovine processors indicates that this tonnage could be an underestimate. Twenty-four months ago, the company (which does not supply fellmongerers) sold products containing 14 tonnes of NPEs at an average concentration of 50% NPEs (with some products containing fewer NPEs and some containing 100% NPEs). The company is actively replacing NPEs, however, with only 10 tonnes of NPE in products sold this year. Furthermore, it is estimated that by the end of the year, NPE use will be down to zero.

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[11] Processing of raw skins from sheep.

Use of NPE Surfactants by EU-based Processors

Within other EU countries, there are estimated to be another 1425 tanneries, with Spain and Italy dominating the market. As in the UK, most tanneries are small enterprises, employing less than 50 people, with there being very few large operations employing over 250 people, as indicated in Table A1(c).

Use of NPEs in mainland Europe varies considerably. For example, in a 1986 voluntary agreement in Germany, industry agreed to phase out the use of NPEs in a number of sectors, including leathers, by 1992. In Austria, use has decreased significantly in the last few years with large tanneries substituting NPEs with fatty alcohol ethoxylates. However, in Portugal, it is estimated that some 140 tonnes of NPEs-based surfactants are still being used. As Italy and Spain have by far the largest tanning industries (65% of total output in Europe), it is expected that the use of NPE-based surfactants is greatest in these countries.

With respect to other EU Member States, there was reported to be some use of APEs by Dutch producers of chemicals for the leather industry in 1995 (Westra and Vollebregt, nd).

A1.7.3 Issues in Replacing NPEs

Relative Performance and Time Required for Substitution

NPEs are used because they are cheap and effective. However, most of the UK-based tanneries and fellmongeries are aware of the environmental problems associated with NPEs and, as a result, many have adopted substitutes for NPE-based surfactants. Similarly, the industry states that the voluntary agreement in Germany has been quite successful, indicating that suitable substitutes would now be in use. The following alternative surfactants have been adopted with different degrees of success:

- alcohol ethoxylates (also called alkyl polyglycol ethers) and blends thereof; and
- mixtures of non-ionic (alcohol ethoxylates) and anionic surfactants.

New products in each of the above categories are being launched, with the range of available alternatives being expanded. However, at this stage it may be too early to say whether alternatives can be found for all NPE-based products. Generally, substitution of NPEs surfactants is not a technical problem except for the aqueous degreasing of sheepskins. For this use, further research and development is needed to find an effective substitute. It is important to remove fats from skins as these can degrade and cause staining. In addition, fats can migrate to the surface of leather and affect its aesthetic and physical properties.

With regard to the use of NPEs in fungicides, fatliquors and auxiliaries, these may be more difficult to replace as formulations are the result of extensive research programmes.

Research is being undertaken to identify further alternatives where solutions are not yet satisfactory. For example, the Dutch Government's research institute DLO is examining the proteins in leather waste in order to produce alternative surfactants (WWF, 1997b).

Table A1(c): Number and Size of Tanners in Each Member State					
Member State	**Number of Tanners**	**Proportion of Total in EU**	**Distribution of Small, Medium and Large Tanners by Member State in terms of Employee Numbers[A]**		
			Small: <50	**Medium: 50-250**	**Large: >250**
Austria	15	0.97	50%	17%	33%
Belgium	14	0.90	70%	30%	-
Denmark	2	0.13	-	100%	-
Finland	14	0.90	75%	25%	-
France	179	11.54	75%	23%	2%
Germany	139	8.96	64%	30%	6%
Greece	25	1.61	60%	30%	10%
Ireland	9	0.58	60%	40%	-
Italy[B]	572	36.88	77%	20%	3%
The Netherlands	44	2.84	78%	22%	-
Norway	5	0.32	34%	66%	-
Portugal[B]	115	7.41	47%	43%	10%
Spain	285	18.38	69%	24%	7%
Sweden	7	0.45	100%	-	-
UK	126	8.12	58%	36%	6%
TOTAL for EU	1551	*100%*			

Notes: A Not all entries in the source document indicated their number of employees; the presented data accounts for the size of between 50% and 80% of tanners (varying by country).

B A considerable number of tanners did not indicate number of employees, the majority of these having company names which appeared to be the names of people. This may mean that small companies are not adequately represented.

Source: Miller Freeman plc (1997): **International Leather Guide - 1998**

Costs of Substitution

With respect to cost, alcohol ethoxylates are reported to cost 10% more than NPEs, while another respondent has indicated that alcohol ethoxylate-based substitutes would be favoured with the costs per unit of such substitutes being 50% or more than the current NPE-based products. Cost impacts will relate to need to the development of new substitutes, where this will include application development, process development and marketing verification and promotion expenses and the higher costs of the base surfactant (e.g. the alcohol ethoxylate). No operational costs should arise from the need to modify the processes in which the chemicals will be used.

Risk Considerations

The effluent from leather processes in larger facilities in the Netherlands is generally treated (which may involve both biological and physico-chemical treatment) before discharge to sewer (Westra and Vollebregt, nd). No data exist, however, to allow any determination of whether the same is true for other European countries and for smaller facilities.

It must be noted that an estimated 30% of all industrial facilities in the EU are not connected to sewer and thus discharge directly to the environment. Thus, for a limit value or EQS option to be effective, all unconnected facilities would need to be identified and their discharges of NPEs restricted.

The application of IPPC to minimise risks is also constrained given the high percentage of small enterprises within this sector [as indicated in Table A1(c)]. In order to be covered by IPPC restrictions, plants for the tanning of hides and skins must have a treatment capacity exceeding 12 tonnes of finished product per day. Given that most leather processing facilities are small- or medium-sized, they will not be reaching this level of productivity. As a result, IPPC will only be applicable to the larger enterprises, which are also more likely to be those with some form of treatment prior to discharge. The problem of unconnected facilities continuing to discharge effluent containing NPEs direct to the aquatic environment remains, as does the potential for terrestrial risks arising from the application of sewage sludge which contains NPEs arising from leather processing.

Given the significant contribution of this sector to the total environmental burden of NPEs, the above discussion suggests that marketing and use restrictions are likely to be the most appropriate risk reduction measure.

A1.8 Agriculture

A1.8.1 Overview of Products

It has been estimated that some 5000 tpa of NP/Es are used in agricultural applications, with these contributing just over 1% to the total continental burden of NPEs (see Table 2.2). The two products in which NPEs are used include:

- veterinary medicines (such as teat dips and sheep dips); and
- pesticides.

In developing appropriate risk reduction measures, consultation was held with government departments responsible for the licensing of pesticides and veterinary medicines as well as with those involved in producing the relevant products.

A1.8.2 The Nature of the Products and Trends in Use

Veterinary Medicines

The key use of NPEs in veterinary medicines is in teat dips and sheep dips. In teat dip formulations, fairly high concentrations (~5% wt/volume) are used to ensure that the active ingredients of the teat dip (typically iodine or chlorohexane) are spread evenly around the teat to prevent mastitis infection. Dips are typically applied after milking (rather than before). NPEs are also used as wetting agents in some sheep dip formulations for the prevention and cure of sheep scab, etc.

While industry has expressed a reluctance to phase out the use of NPEs, it nevertheless appears that companies have begun to substitute these with other compounds.

Pesticides

NPEs are used in some pesticide formulations as adjuvants (spreaders/wetters). These adjuvants are either part of the pesticide formulation or can be purchased separately for mixing with other pesticide products. The former use is believed to be significantly greater than the latter.

NPEs are used to reduce surface tension of spray mists, allowing better coverage of the target crops or associated weeds. As such, they enable some reduction of the concentration of active ingredients in pesticide formulations and applications. The rate of application of NPE during the spraying process is reported in the risk assessment as being between 48 and 192 g/ha (4.8-19.2 mg/m^2).

At least 20% of all adjuvants marketed in the UK contain alkylphenol ethoxylates (APEs). The proportion of adjuvants used as spreading/wetting agents is greater still (UK Pesticide Guide, 1999). There are, however, a number of these substances which are not based upon APEs which indicates that alternatives are available for use as wetting agents, some of which are based upon alcohol ethoxylates. The actual extent to which NPEs are used in 'ready to use' pesticide formulations is not known. However, given the availability of non-APE based adjuvants, it is probable that there are also a number of similar alternative products available for use in pesticide formulations.

A1.8.3 Issues in Risk Reduction

Veterinary Medicines

With regard to the teat dips, the risk assessment has considered two routes of exposure to the terrestrial environment, with these being containment within parlour washings applied to land using either a tanker sprayer or constant irrigation. It has assumed that a single plot of land is subject to an annual dose of parlour washings, resulting in unacceptable levels of NP building up in agricultural soil. Under UK legislation implementing the 1980 Groundwater Directive, it appears that this is a likely scenario.

While rotating the piece of land to which parlour washings are applied could sufficiently reduce the risk, it appears that this is not feasible within the current regulatory structure.

Consultation has indicated that manufacturers of these dips are beginning to replace NP/Es in their products as a matter of course. One manufacturer provided specific details of the substitutes, stating that alcohol ethoxylates are being used. Furthermore, UK Veterinary Medicines Directorate has indicated that a number of companies within the last 18 months have replaced NPEs with alcohol ethoxylates. As discussed in Section 2.7, these are more readily biodegradable than NPEs and do not result in more toxic degradation intermediates.

Given that substitutes are readily available, that companies are already beginning to phase out NPEs, and that the use of substitutes is expected to result in lower levels of environmental risk, the mandatory removal of NPEs from veterinary medicines appears to be a sound policy option. In terms of costs, it is understood that obtaining marketing authorisation for new veterinary medicine products is an expensive process. However, a change in the surfactant would not require a new marketing authorisation, but rather a 'variation' to the marketing authorisation. Although no data have been provided, it is understood that this is a much simpler, much less expensive process. It is therefore believed that a balance would be struck between the costs and benefits resulting from a ban on the use of NPEs in veterinary medicines.

Pesticides

The risk assessment has considered the concentrations in the terrestrial environment resulting from the direct application of pesticides to crops, and hence soil. This has assumed one application per year over a period of ten years and total/instantaneous degradation of NPE to NP, providing a PEC/PNEC ratio of 0.13. As such, the risk assessment does not identify the terrestrial risks of NPE use in pesticides as requiring risk reduction.

Aquatic risks have been calculated by applying a distance-drift function to the applied rates and deriving concentrations in adjacent waters by consideration of dilution effects, etc. The method used is the same as that use by the UK Pesticide Safety Directorate in their assessments of aquatic risks and the need for buffer (separation) zones between applications and adjacent water. Depending on the background concentration in receiving waters, the calculated PEC/PNEC ratios are between 0.03 and 4.67. Reduction in background concentrations, as envisaged through implementation of restrictions on the major uses of NP/Es, will reduce these risks. However, a need for risk reduction measures remains for values at the higher end of the scale.

In terms of measures to reduce the risks associated with NPE use in pesticides, it is arguable that the provision of a separation zone ('buffer zone') between spray application and water course would suffice in reducing the risk to acceptable levels. Such separation zones are already applied to certain pesticides and pesticide active ingredients in the UK and this could be extended to cover those pesticides containing NPE or any applications using a NPE based adjuvant purchased 'off the shelf'. As described in the main text

(Section 6.2.4), it is recommended that a mandatory separation zone be introduced for the use of both pesticides and adjuvants containing NPEs. This should be supplemented with encouragement to formulators to move away from NPEs as part of re-licensing under Directive 91/414/EEC and with a requirement for review after a set period to assess continued use of these substances and also the success of the proposed risk reduction measures.

Whilst alternatives are available, as pesticide approvals are based on a toxicity and risk assessment of the formulation (as opposed to the active ingredient), any changes in the pesticide formulation will thus require the whole formulation to be re-tested and re-licensed. This point, coupled with the lower associated risks, provides the justification for implementing the proposed measures in preference to marketing and use restrictions which are recommended for veterinary medicines.

At least for the interim, the complete removal of NPE use from pesticides through marketing and use restrictions should be avoided owing to the costs associated with re-formulation, re-testing and re-licensing. In the longer-term, marketing and use restrictions may become more cost-effective. Such an assessment could be made when the aforementioned review is conducted.

A1.9 Coatings and Paints

A1.9.1 Introduction

The risk assessment estimates that some 4000 tpa of NPEs are used by this sector within the EU. In the collection of data for this study, three trade associations and three individual companies were consulted, with three of these providing detailed information.

A1.9.2 Nature of Products

NPEs are used in the manufacture of water-borne emulsions and solution resins for use in coatings. They may also be added directly to water-borne decorative coatings, industrial coatings, brush cleaners and paint strippers. Their prime functions are as stabilisers and/or emulsifiers.

With respect to paints, NPEs are mainly used in decorative emulsions and in other applications such as water-based refinishing paints, and cleaners and ancillaries for vehicle re-coating. Within these products, NP-containing emulsion polymers act as binders. NPEs may also be used directly as emulsifiers and dispersants (with this use stemming from manufacturers moving away from solvent-based paints due to concerns over volatile organic compounds).

Dispersants are similar to stabilisers and are used to prevent the paints from flocculating and to keep colours dispersed. As a result, it has been indicated that NPEs are mostly used in coloured emulsion paints (with white paints able to use simpler chemicals). The quantities of NPEs used in paint formulations are small, at between 0.5% to 2% of the emulsion paint. However, quantities will vary across products, with consultees also indicating that they may comprise up to 10% of the cleaners. In general, it has been indicated that NPEs are likely to account for less than 5% of the total costs of the end products.

A1.9.3 Trends in Use

Consultation has indicated that NPEs are a priority issue for the industry which has been exploring how to reduce their use for some time. Some paint manufacturers have indicated that in the past they have been unable to establish whether or not NPEs are used in the emulsion polymers and dispersants provided by suppliers. Furthermore, it must be recognised that not all emulsion paints contain NPEs, with some companies already removing these from their brands, as well as from brush cleaners and paint strippers.[12]

Although one consultee indicated that the company is already phasing out NPEs in two of their products – the decorative emulsions and waterborne cleaners and ancillaries – they have also indicated that it will take up to four years before full substitution is complete for these two products (four and two years respectively). With regard to the other two product lines, this consultee also indicated that between five and seven years would be required for substitution to take place. The replacement of NP/Es in these products is still under evaluation, with no adequate substitutes identified to date.

The other consultee indicated that it would take between two and three years before substitution was complete within the company's products.

A1.9.4 Issues in Risk Reduction

The main chemicals providing the basis for the substitutes are alcohol ethoxylates. For those products which the first company is already phasing out, the estimated costs of substitution are as follows:

- the substitute costs 10% more per unit than the NP based additive, increasing the total product cost by less than 1% (i.e. a 10% increase in less than 5% of end product costs);
- a one-off cost of £7 million is expected for the reformulation and changing of materials for decorative emulsions, with these relating to per unit costs of £0.10/litre of product; and
- the costs of developing substitutes for the other three applications are currently unknown, although these are expected to be significantly higher than those quoted above in the case of waterborne cleaners (on a per unit basis).

In contrast, the second company has indicated that the substitute alcohol ethoxylates are roughly 50% more costly, with this implying a 2.5% increase in end-product costs.

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[12] Firms Begin APE Phase-Out, Ends 267, April 1997.

The key issue identified for this sector with regard to the replacement of NPEs concerns the potential conflict between such requirements and other environmental legislation. In particular, it has been noted that the use of NPEs in various water-based automotive refinishing products aimed at professional/industrial users is a direct result of legislation aimed at reducing emissions of volatile organic compounds (VOCs) from the previous line of solvent-based products.

One of the consultees indicated that they would seek a derogation from any restrictions on the use of NPEs on this basis. This consultee, who is a paint formulator, adds that all waste produced by the company itself is treated or recycled prior to disposal to sewer. This respondent also indicated that as part of professional use, the waste from the application of these finishing products would be classified as 'controlled' wastes disposed of by licensed contractors and, thus, that environmental risks associated with such uses should already be minimised. This claim is not supported by other consultees who have indicated that it is likely that wastes will be discharged to sewer, as assumed by the risk assessment.

A1.10 Metal Processing

A1.10.1 Introduction

The risk assessment indicates that around 2,000 tpa of NP/Es is used in the metal processing industry. The main uses are as:

- emulsifiable metalworking fluids;
- in neat metalworking oils required to be water washable; and
- in alkaline and acid cleaners.

Use of NPEs in cleaners is covered in Section A1.4 on institutional and industrial cleaners, with only use in metalworking fluids considered below. In gathering data for this study, four trade associations were consulted and eleven companies. Eight companies provided data for this study.

A1.10.2 Use in Metalworking Fluids

Overview

NPEs are used in industrial lubricants such as metalworking fluids. They form part of the ready-made additives packages supplied to the formulators of industrial lubricants and are reported to be widely applied throughout the whole of the industry.

The main use of NPEs is as supplementary emulsifiers in water-extendable (water-miscible) metalworking fluids where they are used to achieve stable emulsions. For example, one company has been identified which uses NPEs in grinding fluids.

There is also limited application of non-ionic emulsifiers such as NPEs in some neat oils, where they are required to be water-washable, for example in quenching oils. NPEs are also present in system cleaning fluids (i.e. those used to clean the metalworking fluid system when replacing fluids).

The main reasons for using NPEs in metalworking fluids are that they:

- have been readily available;
- are easy to incorporate into the product to give the desired result; and
- have been cost-effective.

In metalworking fluid concentrates, where NPEs act as supplementary emulsifiers, they will be a minor component at a concentration in the order of 1% to 5%. One company using NPEs has indicated that nearly half its formulations contain <1% NPEs, while another indicates that the maximum concentration in its products is 2% to 3%. Concentrates are then diluted in the ratio of around 20:1 (water to concentrate), although dilution can be as high as 50:1.

Use in Metal Cleaners

NPEs are used in metal cleaning during iron and steel manufacture, steel phosphating, electronics cleaning and metal cleaning prior to storage (CES, 1993). With respect to the types of products containing NPEs, these are mainly alkaline and acid cleaners.

Whilst the metal finishing industry is relatively small, it supplies products to many other sectors including aerospace, automotive, electronics, white electrical goods, printing, shop fittings and trolleys, petrochemicals and architectural finishes.

(i) ***Alkaline Cleaners***

Alkaline cleaning occurs as a part of both metal processing and electroplating to prepare metal surfaces for further applications. Alkaline cleaners can be both solvent-based and water-based. The cleaner chosen depends on the nature of the finishing process and associated requirements. For example, solvent-based cleaners are not suitable for use with hot processes such as electroplating, while water-soluble cleaners are; however, water-soluble cleaners should not be used with finishing processes which require dry metal.

The main use of NPEs in the UK metal industry is reported to be in alkaline cleaners which represent between 80% and 90% of NPE use. One large manufacturer of these products has indicated that perhaps 25% of all alkaline cleaners used in the UK will contain NPEs. (One class of alkaline cleaner is not suitable for the use of NPE[13], and this makes up perhaps 50% of the market; of the remainder, perhaps half contain NPE). In general, the concentration of NPE in alkaline cleaners is <5%, perhaps in of the order of

[13] Assumed to be solvent-based cleaners.

1% to 2%. Cleaners are generally purchased in concentrate form and diluted at the point of use.

In the Netherlands, about 70% to 80% of alkaline cleaners[14] are water-based with the remaining 20% to 30% consisting of pure solvents (Westra and Vollebregt, nd). APEs may be present in water-based agents as emulsifiers which are used along with other additives such as anti-foaming agents and corrosion inhibitors to improve performance (Westra and Vollebregt, nd). In the Netherlands, at least 60% of cleaners do not contain APEs as this portion of the market is supplied by one company which stopped using APEs at the beginning of 1995. The reason for this move was German legislation (Umweltbundesamt) which bans APEs in cleaning products.

Information gathered from formulators of alkaline cleaners suggests that there is more than one class of water-based cleaner. These include:

- spray cleaners used in the engineering industry;
- cleaners used mainly prior to electroplating; and
- electrolytic cleaners.

A major use appears to be alkaline spray cleaners used in the engineering industry, although no data has been forthcoming on this use.

Electrolytic cleaners are specialist types of cleaner in which the electrical properties of the solution are important. The cleaner performs when a current is passed across a cell. This produces hydrogen and oxygen which scours the metal. At the same time, chemicals in the cleaner dissolve the surface of the metal to be cleaned. A producer of such cleaners has indicated that its products contain <5% NPEs and are used at a concentration of 50 - 75 g/litre.

(ii) ***Acid Cleaners***

Acid cleaners have a very limited use in metal processing with one of the main applications being in the production of Printed Circuit Boards (PBS, see Section 5.2). Acid cleaners are used to activate metal prior to plating with other metals (i.e. they are used after cleaning but prior to electroplating). The choice of surfactant is critical as it is important that none are left behind on the surface after water rinsing. Concentrations of NPEs in acid cleaners are reported to be <15% in general.

(iii) ***Other Uses***

NPES are also used in the acid de-scalers used in metal treatment, for example, in the acid baths used for cleaning engine blocks.

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14 The reference refers to degreasing which is assumed to equate to alkaline cleaning.

A1.10.3 Quantities of NPE Used

A survey of producers of water-based metalworking fluids in the Netherlands estimated that 65 tpa of APEs may be used in this application each year (note, however, that the survey did not consider oil-based metalworking fluids). It was estimated that 15 tpa of APEs are used in fluids for cutting and drilling[15] and between 20 tpa and 50 tpa in fluids for rolling[16] (Westra and Vollebregt, nd).

Data in the UK indicate that consumption here could be of the same order as for the Netherlands. A large UK-based producer of metalworking fluids and metalworking fluid additives has indicated that 10% to 15% of its formulations contain NPEs[17], and that they consume 21 tpa of NPEs[18]. Around 65% of their products are used in the UK, and a further 15% to 20% in the rest of the EU. The company estimates that its products are associated with 20% to 25% of the metalworking fluid market in the UK. Assuming that this company's use of NPEs is typical of other additive manufacturers and fluid formulators suggests that UK usage of NPEs in metalworking fluids and other industrial lubricants could be 55 to 70 tpa[19]. With respect to this assumption, the company is taking steps to reduce levels of NPE use and, therefore, may use proportionally fewer NPEs than other companies.

With respect to usage of NPE-containing metalworking fluids, it is estimated that there are some 50,000 companies in the UK alone involved in metalworking to some extent, with 60% to 80% of these using emulsifiable fluids. If the smaller percentage is taken and it is assumed that 10% of these use formulations contain NPEs, then 3,000 facilities in the UK alone could be using these fluids. In terms of the types of facilities, these will mainly be engineering machine shops, component manufacturers, engineering plants at car manufacturers, metal fabricators, etc.

A similar number of facilities could be using NPEs in other EU countries, although there are likely to be fewer in most countries. For example, it is estimated that there are some 50,000 metalworking facilities in France and Germany; 30,000 in Italy; 15,000 in the Netherlands; and 8,000 in Belgium, with data unavailable for other countries.

Of additional relevance is the size of these companies, as this will impact on the nature of current activities and the effectiveness of any risk reduction measures. Data collected on the metalworking industry for a previous chemical risk reduction strategy indicates

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15 3,000t of concentrated fluids are used each year. 10% are assumed to contain APEs at an average concentration of 5%.

16 This assumes that all rolling fluids in the Netherlands contain APEs.

17 This equates to 60 out of 500 formulations.

18 This can be split into 11 tonnes of NP2, 3 tonnes of NP6 and 7 tonnes of N9.

19 65% of 21 tonnes equates to between 20% and 25% of the UK market.

that the profile in terms of company size is fairly consistent across the EU countries, as indicated by Table A1(d).

A1.10.4 Trends in Use

The three UK-based metalworking formulators providing data for the study have each made some form of commitment to reduce NPE usage:

- one has a commitment to phase out the use of NPEs, which is reasonably well advanced due to market pressures;

- another has reformulated products to eliminate the use of NPEs and has a general policy not to use NPEs in new products; and

- the other has a policy for no new uses for NPEs, for gradual replacement as products need reformulating where NPEs are currently being used; and for replacement of NPEs ahead of this deadline for products in sensitive markets.

This policy has been driven by growing environmental concerns and limitations in Scandinavian markets.

More generally, it is reported that the use of NPEs in Europe is being phased out (e.g. the German voluntary agreement discussed earlier), although NPEs are still used outside Europe. This is reflected in information from the Netherlands which indicates that there has been a move to phase out the use of APEs in cutting and drilling fluids, with all new products reported to be APE-free. The move away from APEs has been due to concerns over their ecotoxicity. Some companies have a commitment to minimise the use of potentially environmentally harmful substances while others seek to avoid products which require the use of risk and safety phrases R and S phrases) under the EC Directives on dangerous substances and preparations. In this regard, R and S phrases are reported to be required when products contain APEs above certain concentrations (Westra and Vollebregt, nd).

Table A1(d): Profile of Metalworking Companies by Size and Country			
Country	**Company Size as Percentage of Total Companies**		
	Small (< 50 employees)	**Medium (50-200 employees)**	**Large (>200 employees)**
Belgium	42	8	49
Denmark	32	18	50
France	41	9	50
Germany	25	25	50
Greece	44	8	48
Ireland	33	17	49
Italy	40	10	50
Luxembourg	39	11	50
Netherlands	36	16	49
Spain	36	14	50

A1.10.5 Issues in Replacement

It is reported that most acid and alkaline cleaners will be released to sewer following treatment. At a maximum, treatment takes the form of neutralisation and metal separation; NPEs will not necessarily be removed and thus will be probably be discharged to sewer. This appears to be the case in the Netherlands, where effluent is treated to remove solid waste and oils. Here, some NPEs will thus be discharged to water with the remainder treated as chemical waste (Westra and Vollebregt, nd).

In the UK, cleaners would normally be discharged with only pH adjustment to bring them within 'consent to discharge' limits. Only occasionally are oils recovered and burnt. It is reported that, generally, users will only be aware that a particular proprietary cleaning material contains alkaline salts, detergents, surfactants, etc. Even if NPEs are listed in a safety data sheet, it is doubtful that a user will be aware of its relevance to aquatic life and, further, be aware that any special measures need to be employed when disposing of spent material unless the data sheet specifically addresses this issue. In this regard, some 50% of metal finishing is by small (average 18 employees), sub-contract companies and many will not employ a person with a chemical background, instead relying on the recommendations of the suppliers.

With respect to disposal of emulsifiable metalworking fluids in the UK, there appears to be a range of practices:

- effluent is tankered and then disposed of to land;

- in-house treatment takes place prior to discharge to sewer, but, while the oil is removed from effluent, the NPEs probably remain; or

- removal is carried out by a waste disposal contractor and disposed of as special waste.

With respect to effluent treatment, this will depend on the size and sophistication of the operation (and local regulations).

The last type of practice parallels that in the Netherlands where it is reported that waste oils are treated as chemical waste. Conversely, "swarf is considered scrap metal and dumped on specific sites"(Westra and Vollebregt, nd).

NPEs are reported to be more cost-effective in supplementary emulsifiers for some applications and to provide lower foaming compared with the main alternative (alcohol ethoxylates) in equivalent concentrations.

While NPEs are cost-effective and have been widely used in the past, it is reported that they are not essential for many applications. NPEs can be removed either by reformulating fluids to avoid the need for supplementary emulsifiers or, where this is not possible, by replacing NPEs with other non-ionic surfactants.

In terms of performance and quality, one respondent envisaged no deterioration in the quality of the metal cutting fluid through the use of alcohol ethoxylates while two other respondents estimated that some limited loss in product quality would occur, impacting on the price of the product and its performance. These latter two respondents also indicated that they would require some two to five years to replace NPs in their products as opposed to the less than one year time frame quoted by the first respondent.

Costs of Substitution

The costs of using alternatives to NPEs relate mainly to the increased purchase cost of the substitute chemical, rather than to any changes in equipment, processing or waste disposal costs, although there are also obvious reformulation and re-registration costs to formulators of these fluids (with one respondent indicating these would be roughly 0.4 pence/litre). Another respondent envisaged increased purchase costs of 80% for a particular type of alcohol ethoxylate, stating that the increase in cost would be "small but significant". Increases in costs across a range of products is estimated at between 1 to 5 pence per litre of product, resulting in an increase in product cost of between 3 and 13% (with the latter relating to solvent degreasers).

Risk Reduction Issues

Formulators have indicated that there are a wide range of alcohol ethoxylates which could be used as substitutes to NPEs, with the choice varying according to the specific formula and/or application.

Risks associated with the use of alcohol ethoxylates as substitutes for NP/Es are discussed in Section 2.7. In general, alcohol ethoxylates are of lower toxicity though this may not always by the case in terms of a particular chemical (or mixture thereof) and specific toxic effects. Use of alcohol ethoxylates would be preferable to NP/Es provided that the choice of chemical is well researched in terms of its toxicity.

As metalworking fluids comprise 1-2% of the NP burden, eliminating this use would make a small but significant contribution to reducing environmental loads. Importantly, their substitution also appears to be feasible for most applications.

However, other risk reductions measures could be applied other than marketing and use restrictions. The trend in Europe is for metalworking fluids to be collected in central tanks and then taken by waste companies to be separated, recycled or incinerated, with this generally being the case for large and medium sized companies [over 50% of facilities in all of the EU countries referenced in Table A1(e)]. Smaller facilities in a number of the countries, however, may dispose of waste fluids to sewer or direct to the environment (although it is reported that in Spain and Italy all metalworking fluids disposal is undertaken by waste companies). This trend suggests that the use of limit values and EQSs could also be effective in minimising risks, although this would also require that limits were set on sewage treatment works. In some countries, this would lead to limits being placed on the nature and composition of effluents discharged to sewer (e.g. the UK), while in others it is likely that the utilities would absorb the costs.

A1.11 Pulp and Paper Industry

A1.11.1 Introduction

According to the risk assessment, 1000 tpa of NPEs are used in the pulp and paper (P&P) industry chemicals across the EU. The use of these chemicals can be split into two broad categories:

- processing aids: including products such as defoamers, which are used to facilitate the production process; and

- product enhancers: including products which improve the performance of the final product during use. For example, wet strength resins are added to kitchen towels so that they do not disintegrate during use, and starch is added to paper surfaces to improve paper strength and/or printing quality.

This section draws on the risk assessment and information gathered during consultation with two trade associations and eight companies, five of which provided data for the study.

A1.11.2 Summary of Uses

A recent industry survey of P&P industry products which contain NPEs resulted in the following list:

- felt conditioners/cleaners;
- defoamers (dripped into the wet end of paper manufacturing to reduce foaming);
- de-inking processes;
- wire cleaners;
- descalers;
- mould inhibitors;
- retention aids; and
- tissue softeners.

In addition to the above products, NPEs are also present in some cleaning products used by the P&P industry. For example, they are used in some formulations to clean the machines which print newspapers. The volume of NPEs used in cleaning products, however, is thought to be in addition to the 1000 tpa figure noted above, but accounted for in the I&I sector.

The risk assessment for NP/Es provides some more detailed information for two of the uses by the P&P industry and this is summarised below.

Defoaming Agents

NPEs are used as processing aids in defoamers in the wet end of paper manufacture, where they help ensure even dispersion of the defoaming agents. Taking board production, the level of use of defoaming agents is 0.03% (related to the amount of board produced). As NPEs are present in 1% of the defoaming agent, this correlates to 0.0003%, or 3g ethoxylate/tonne paper.

NPE is not retained on paper and thus the full amount used is released to process water. There is considerable recycling of this process water and consequently of NPEs (BRE, 1998).

Retention Aids

NPE is used in retention aids where it acts as a product enhancer to improve the performance of the final product during use. As indicated above, this includes wet strength resins which are added to kitchen towels to prevent disintegration during use, and the adding of starch to paper surfaces to improve paper strength and/or printing quality. In board production, retention aids are used at between 0.1 - 0.5% by weight of paper.

A1.11.3 Trends in Use

In the Netherlands, NPEs were used historically in the paper industry in de-inking processes, as defoaming agents and for the removal of resins. In 1995, APEs were reportedly only still used in defoaming agents with an estimated annual consumption of between 12 tonnes and 13 tonnes. At that time, there were claimed to be no technically equivalent substitutes for APEs.

As part of a German voluntary agreement (discussed in the section on metal processing), the industry was committed to phasing out the use of NP/Es in this sector by 1992. This indicates a realisation on the part of the industry that, for a number of sectors, substitutes are available or could feasibly be developed.

An EU organisation representing pulp and paper mills indicates that the industry is seeking in general to adopt a more robust strategy to reduce environmental concerns through the purchase of NP-free chemical formulations. Indeed, further consultation with individual companies suggests that the switch to NP-free formulations is being led largely by customer (i.e. the paper mills) pressure. The onus to minimise risk is being placed by the industry on their chemical suppliers.

A1.11.4 Issues in Replacing NPEs

Relative Performance and Time Required for Substitution

The evidence suggests that for most applications in the pulp and paper industry few problems with substitution are expected, with work on the development of substitutes progressing. However, consultees have indicated that there may be some difficulty with substitution in more technical applications such as the production of specialist impregnated and emulsion coated papers. It has not been possible within this study to confirm for certain whether this is likely to be the case and thus there may be the need for further investigation on this aspect.

Costs of Substitution

No details of the costs of adopting substitute chemicals (based on alcohol ethoxylates) have been made available for use in this study. Paper manufacturers have indicated that they would expect any increase in costs to be realised by the suppliers of raw materials (i.e. formulators), who would then pass them on to manufacturers.

Risk Reduction Issues

In the UK, there are around 100 paper mills with 56 of these discharging directly to rivers and estuaries in 1992 following some pretreatment. The quantity of effluent discharged daily is reported to vary considerably by mill, from, for example, 3,270 m^3 to 36,000 m^3 per day. With respect to emissions, while 85% of NPEs could be released to water during cleaning, this is likely to be too high a figure for applications such as defoaming.

Similarly, on-site treatment takes place at most Dutch paper mills, with producers removing solid waste for re-use on site, using an aerobic active sludge treatment process with the sludge usually being dumped or burnt. Those plants with no on-site treatment facilities discharge to external treatment plants.

Both of the categories of pulp production and paper and board production are covered by IPPC. IPPC applies to all pulp production (from timber and other fibrous materials), while it only applies to paper and board production facilities which have a capacity exceeding 20 tonnes per day. The use of this measure may therefore be effective in reducing the risks associated with use of NPEs in this sector (except for those smaller facilities not covered by the above capacity limit). Similarly, limit values and EQS could be applied at individual facilities and associated river stretches to provide for the effective reduction of NPEs in waste streams where it is causing environmental problems. Although treatment may capable of removing NPEs from effluent streams, it will result in an increase in NPEs in waste sludge. This raises the issue of the potential for on-going or increased risk to the terrestrial environment from sludge disposal.

It must be noted, however, that consultees in the pulp and paper sector have indicated they are moving away from the use of NPEs owing to their own desire to have more environmentally friendly products. They are, therefore, pressing their formulators to develop the necessary substitutes with the required performance levels. Cost increases would appear, therefore, not to be significant enough for them to attempt to address this issue through the addition of further treatment technology.

A1.12 Civil and Mechanical Engineering

A1.12.1 Introduction

The risk assessment indicates that around 93 tpa of NPEs are used in the civil and mechanical engineering sector, with this covering a range of uses as discussed below.

For the purposes of this study, further consultation was held with five trade associations and ten individual companies. Eleven of the organisations contacted provided data for the study.

A1.12.2 The Nature of Products and Their Use

NPEs are used in a number of different products, with those identified through the consultation exercise being as follows:

- non-destructive testing products;
- air-entrained concrete and cement admixtures;
- concrete modifiers, concrete mould release fluids and emulsion polymers in concrete;
- sand cleaning;
- possible use in plastic construction materials; and

- bitumen emulsions.

Non-Destructive Testing

NPEs are present in some non-destructive testing (NDT) chemicals used by the mechanical engineering industry to show up defects in manufactured components such as turbine blades, crankshafts and forgings.

Data has been provided by one company which uses 22 tpa of NPEs in the manufacture of 50,000 litres of NDT chemicals. These chemicals contain NPE's at various concentrations ranging from 5% to 50%. NPEs are used in two product types:

- magnetic crack detection: the part is magnetised and cracks are found using iron filings. NPEs are part of the carrier fluid for the iron filings; and
- dye penetration crack detection: this is the major use of NPEs with the dyes being oil-based materials containing fluorescence. Some are emulsified and are required to be water washable. A range of surfactants are used in washable products of which NPEs are one.

It is not known whether other producers of crack detection products use NPEs. In total, there are reported to be two or three large UK-based manufacturers of crack detection products and another three or four in mainland Europe. In addition, there are lots of smaller companies involved, both in the UK and the rest of the EU.

A major advantage of using NPEs is one of cost. They are generally 70% of the cost of alternative surfactants such as alcohol ethoxylates. Technically, there is no requirement in this sector to continue using NPEs. As a result, the one company identified as using NPEs is well along the path to replacing NPE's with readily available alternatives based on alcohol ethoxylates. To some extent, this has been driven by customer pressure with a large Scandinavian aircraft manufacturer asking for NPEs to be removed from its products. In general terms, it should be reasonably easy to formulate-out NPEs. With respect to timescales, however, some products are formulated for the US military and changes to formulations would require approval from them which takes six to nine months.

During use, NDT chemicals (by their very nature) are mixed with water and inevitably some NPE's end up in sewers. It is reported that most large end users of NDT chemicals have treatment plants to 'clean-up' the effluent before discharge, but whether this is an effective process for the removal of NPE's is not clear.

Concrete and Cement Admixtures

NPEs and NP ether sulphonates may be used in air-entraining concrete admixtures though the most common air-entrainers are reported to be salts of vinsol resin and alkyl benzene sulphonates.

Air-entraining admixtures are added to concrete to improve workablity and frost resistance and to reduce water use. This type of concrete is used by bodies such as the Highways Authorities which are concerned with the freeze-thaw cycles of road surfaces in the winter[20]. In ‘normal’ concrete, the moisture present in capillaries freezes causing high pressures which result in ‘ravelling’ in the surface of concrete. In air-entrained concrete, the capillary pressure is dissipated in the large bubbles which typify this product. This in turn gives a stronger concrete which is more resilient to freeze-thaw cycles.

There are reported to be around 100 companies formulating air-entraining admixtures used in concrete and mortar; however, 80% of the market is associated with just five of these. One of these major suppliers has indicated that NP-based products are no longer widely used in the concrete industry and no longer form the basis of any products. However, there are some specialist uses of NP (see section on other aspects of concrete production below).

Cement manufacturers may also use NPEs as there is a growing tendency for admixtures to be added at this stage rather than when concrete is produced[21]. One large cement manufacturer has indicated that none of its suppliers use NPEs or related compounds. In contrast, another cement manufacturer has indicated that some cements for air-entraining concrete do contain NPE. However, it is also reported that the NPE is added to the cement in a dry powdered form to prevent damage to the cement which is hydroscopic. On this basis it is argued that the use of NPE in cement formulation does not result in risks to the aquatic environment. Any risk from the use of NPE is reported to occur at the time when water is added to cement (i.e. in the production of concrete).

More generally, the UK concrete market can be divided as follows:

- 50% ready mix which is delivered to site in cement lorries;
- 20% or so of concrete products which are used to form lintels/slabs; and
- 20% or so of bagged cement.

It is reported that perhaps 20% of the ready mix market contains air-entrainers, most of which are added at the concrete production stage. NPEs are just one of many air-entraining chemicals on the market.

Other Aspects of Concrete Production

NPs are sometimes used at low levels as concrete modifiers and can confer some unique properties in certain specialist uses. One of the major admixture companies supplies two such products, but contends that it is unlikely that in-service use would result in exceedance of the PEC of 0.3 µg/l [see Table A1(e)].

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20 There are many such cycles in countries such as the UK which applies salt to roads in winter.

21 Cement, admixtures and other intermediates are combined to form concrete - each part of the chain (i.e. cement, admixtures and concrete) is wholly separate.

In addition, one of the key uses of NP-based emulsion polymers is reported to be in the production of concrete blocks, although no further details of this use became available during this study.

Table A1(e): Use of NP-based Concrete Modifiers

One NP-based concrete modifier containing 3% NP is typically used in concrete at a dose of 1% (maximum 2%) by cement weight. It is unlikely to be used in concrete with a cement content higher than 500 kg per cubic metre (kg/m^3) - typical cement content is 400 kg/m^3. On this basis, 1 m^3 of concrete will contain 10 litres of the modifier and 300g of the NP-based substance.

The concrete is used in water pipes with a typical thickness of 50 mm. Thus, 1 m^3 of concrete will have a surface area of 20 m^2, with each square metre containing 15 g of NP. If the concrete has a depth of 100 mm of water over it, the water will contain 150 µg/l of NP. However, this assumes that water remains static in the concrete for long enough for all the NP to diffuse out. Since even poor quality cement typically has a diffusion coefficient of better than 1×10^{-10} m^2 /second, it would take at least 20 years for all the NP to diffuse out from 50 mm concrete depth (i.e. 0.00075 g/year). This means that 100 mm depth of water would need to remain static for more than five months for 0.3 µg/l to be exceeded.

Research in the Netherlands has also indicated that APEs may be present in agents used to release concrete moulds on construction sites and brick production facilities. Around five to seven million litres of these fluids are used each year in the Netherlands with most being oil-based. The largest producer of these oil-based agents in the Netherlands[22] indicates that APEs are not used in these products. However, there is a trend away from the use of mineral- to vegetable oil-based products, some of which contain APEs[23]. APEs are present in other water-based products which are used only at brick production sites in the Netherlands. Annual usage of APEs is estimated to be 0.6 tonnes to 0.9 tonnes[24]. In 1995, efforts were being made to replace APEs, although there were some technical difficulties with the use of (fatty) alcohol ethoxylates. With respect to the fate of APEs, waste water is collected at brick production sites and released to sewer or surface water following the settling out of solid materials (Westra and Vollebregt, nd).

Consultation has identified one UK-based producer of concrete mould release fluids. The products are used, for example, to produce concrete facias for buildings. The company uses 0.1 tpa of NPEs in these products in the UK with total European usage of up to 0.5 tpa (including production in Germany, France, Belgium, Spain, Italy and Greece). The company has a policy to reformulate where possible using alternatives to NPE and does not use NPE in new products. The company estimates that it could replace NPEs within

[22] With a market share of 60% to 75%.

[23] Vegetable oils had only 1% of the market in 1995.

[24] One company produces 2 to 3 tpa of water-based releasing agents containing 6% APEs. This company has a market share of 20%.

about 12 months. The company produces a range of NPE-based products and has identified alcohol ethoxylates as the main alternative across the entire product range.

Sand Cleaning

It has been reported that NPEs may also be used for concentrating and cleaning sand. The aim of this cleaning process is to remove iron impurities from the sand so that it can be used in civil engineering applications. No further details on this use, however, have become available during this study.

Plastic Materials Used in Construction

The risk assessment assumes that NPE may be present in some plastic materials used in construction, particularly if they have been produced by an emulsion polymerisation route. Consultation indicates that PVC represents 60% of all plastic used in construction materials, with emulsion polymerisation being one of the four methods available for the production of PVC. With respect to NP, phenolic materials tend to be used as antioxidants (this is the case for TNPP - tri (4-nonylphenyl) phosphite), and would be used in construction materials to prevent weathering in the external environment.

In the risk assessment, releases from use of TNPP are thought to be negligible. Releases from the use of emulsion polymers are considered for the paint and the pulp and paper industries[25] but not for civil engineering. It has been assumed, therefore, that the risks associated with the use of these chemicals in plastic materials in the construction sector do not require reduction.

Bitumen Emulsions

Consultation with a manufacturer of bitumen emulsions has indicated that NPEs can be used as emulsifiers in these products. That said, the manufacturer does not add NPEs to its products, nor are they included in the proprietary emulsifiers purchased. No further data have been collated on this use.

A1.12.3 Trends in Use

As the above discussion highlights, across this sector, the trend has been one of moving away from the use of NPEs. Most consultees indicated that they had already moved to other products or were in the process of moving away from the use of NPEs, with the few exceptions noted above.

A1.12.4 Issues in Risk Reduction

It would appear that substitutes exist for most of the uses covered above, with these including a range of alternatives depending on the end application. For example:

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[25] While the section on the production of emulsion polymers indicates that this is the case, use of these products in pulp and paper appears not to be addressed.

- alcohol ethoxylates appear to be the key substitute chemicals for non-destructive testing applications, emulsifiers (with details of specific chemicals not provided), and concrete mould releases; while

- the substitutes identified for air-entraining admixtures are salts of vinsol resin and alkyl benzene sulfonates.

With regard to non-destructive testing applications, the main alternative for most applications would appear to be *Synperonic 13/9* (see also Annex 5 on Institutional and Industrial Cleaners). Review of data from the safety data sheet indicates that this substitute:

- is believed to be substantially removed from water during biological sewage treatment;

- is biodegradable; and

- is less toxic to the aquatic environment than NP/Es.

The only data made available during this study concerning the costs of adoption of substitutes is quoted above for non-destructive testing. In this case, the consultee also indicated that the substitute would provide a comparable level of performance and would not have a detrimental impact on the end product.

For many of the uses within this sector, it has become clear from our discussion that use of NPEs should result in minimal environmental risks, with the greatest risks associated with use as part of non-destructive testing and potentially at facilities involved in concrete mixing (although the addition of NPEs in powder form should minimise any risks). This suggests that the benefits of placing marketing and use restrictions on this sector may not outweigh the costs to industry of identifying and developing new substitutes. Instead, it may be more appropriate to ensure that any NPEs reaching the aquatic environment from the above uses remain at levels below the PNEC threshold. This should also apply to NPEs which are deposited on the terrestrial environment, primarily through application of sewage sludge, and which thus pose direct risks to this compartment and to the food chain (secondary poisoning).

A1.13 Electrical Engineering Industry

A1.13.1 Introduction

It is estimated that over 90 tpa of NP/Es were used in the electrical engineering industry in 1994. The main uses of NPE are as:

- acid baths used in the production of circuitry;
- acid cleaners used prior to electroplating;
- electroplating solutions;

- crack detection products;
- fluxes; and
- waterwashes and other cleaning products.

No data on the tonnages used for each of these purposes is available, although 22 tpa is estimated as being used in crack detection across all uses (see also civil and mechanical engineering). It should be noted that of the above uses, those related to the cleaning of electronic components are assumed to be covered under industrial and institutional (I&I) cleaning products within the risk assessment.

In gathering data on this area of use, consultation was undertaken with two trade associations and 17 companies, 12 of which provided data for this study.

A1.13.2 The Nature of Products and Their Use

Printed Circuit Board Industry

Consultation has identified four uses of NPEs in the manufacture and cleaning of printed circuit boards (PCBs). PCBs are the foundation for virtually all electronics in the world (USEPA, 1995)[26]. They provide the physical structure for mounting and holding electronic components as well as the electrical interconnections between them. A PCB consists of a non-conducting base (typically fibre glass or epoxy resin) onto which a conductive pattern or circuitry is formed. Copper is the most widely used conductor. Circuitry is formed using a photo-mask and an acid bath; the copper protected by the mask remains while the remainder of the copper is eaten away. The copper of the PCB is then coated with other metals, most often gold, although nickel and tin are also used.

Consultation has indicated that there are six or seven large PCB manufacturers in the UK and around 50 smaller ones. There may be around 10 times as many companies in the EU as a whole (i.e. 60 large PCB manufacturers and around 500 smaller ones). In this regard:

- Germany has a bigger industry than that of the UK;
- France's industry is smaller than the UK's but about the same size as that of Italy;
- the size of the industry in the Benelux countries is smaller still; and
- data is unavailable on the size of the industry in the other EU countries.

Electronic components are mounted onto PCBs by assemblers[27] using solder. Fluxes are used to remove unwanted solder as well as grease and copper oxides. Older type fluxes are acidic in nature and, if left on PCBs, would cause degradation. Thus, acidic fluxes are removed via solvent or water washing. While solvents were used predominantly in

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[26] Information on PCB manufacture is based heavily on USEPA, 1995, supplemented with data from the consultation exercise.

[27] Most PCB assemblers and PCB manufacturers are separate businesses.

the past, the move has been towards water-soluble washes. Some of the newer fluxes are non-acidic; therefore, washing is not required.

Etching of Circuit Boards

It is reported that NPEs are used in chemical baths as part of the etching of PCBs (Contensio, 1998); however, no further information has been identified concerning such use.

Acid Cleaners Prior to Electroplating

Acid cleaners are one of two types of chemical cleaners used in metal processing. Such products have very limited use with one of the main applications being in the production of PCBs. The cleaners are used here to activate copper prior to plating with other metals such as gold. The choice of surfactant is critical as it is important that none are left behind on the surface after water rinsing. Concentrations of NPEs in these baths are reported to be in the range 5% to 10%.

Electroplating Solutions

Consultation with a manufacturer of electroplating solutions has indicated that NPEs are used mainly in additives to the electroplating solutions used to produce PCBs. NPE is also used on one or two electronic components. In electroplating solutions, NPE is used as a grain refiner to achieve a smooth deposit which meets the electronics requirements for the board. In this regard, a PCB is a series of tracks which needs to be finished to make it solderable and conductive. The grain refiner achieves the necessary solderability and conductivity (i.e. it is used to achieve the necessary metallurgical properties from the plated metal).

With respect to levels of use, the consultee has indicated that NPEs are contained in around 20 of their 100 products. Volumes of NPEs used by the company are small, i.e. less than 10 tpa. With respect to the rest of the industry, it has been suggested that most suppliers of 'selected' electroplating solutions (taken to mean those for PCBs) use NPEs.

Use of NPE in Crack Detection

NPEs are also present in some non-destructive testing (NDT) chemicals used by some of the electronics industry to show up defects in PCBs. One UK-based company has been identified which uses 22 tpa of NPEs in NDT chemicals. The percentage of this usage associated with the electronics industry is not known, although these chemicals are most commonly used in the mechanical engineering industry to show up defects in manufactured components such as turbine blades, crankshafts and forgings. Further details of this application are, therefore, given in the section on civil and mechanical engineering.

Use of NPEs in Fluxes

One major producer of fluxes has indicated that some of their older fluxes do contain NP-derivatives. Data also indicates that NPEs are in at least one of the hand soldering fluxes produced by a German company.

Use of NPEs in Water Washes

More generally, consultation has indicated NPEs may be used in the cleaning of electronic components and specifically PCBs. If so, NPEs would be used as surfactants in water-washes which have been developed as one of the replacements for the solvent-based (e.g. CFC-based) cleaning systems phased out as a result of the Montreal Protocol.

From the information provided, it appears that water is used to remove traces of acid cleaners prior to electroplating. In addition, cleaning takes place after PCBs are assembled, with the aim of removing the flux generated by flow soldering. Surfactants are particularly important for the washing of components with high packing densities (e.g. a wristwatch radio). Such components have to be surface-mounted on PCBs with no leads, and in all available mounting systems the space between the component and the board is so small that surfactants are necessary to enable the water wash to penetrate the gap.

One supplier of water washes for electronic circuits has been identified. The company does not itself use NPEs, but has trialed one imported product which did contain 7% to 10% NPE. Based on its knowledge of the market, the company estimates that there may be 20 UK customers using water washes which contain NPEs for PCBs.

Consultation with those marketing NPEs suggests that special grades are likely to be required for the cleaning of PCBs. Cleaning products used by the electronics industry are required to have less than ten parts per million (ppm) of certain metal ions. The catalysts used in the production of general NPEs leave sodium or potassium ions at levels of around 200 ppm to 400 ppm. Thus, general NPEs would not meet these requirements.

Other Cleaning Products

Two further companies have been identified which produce cleaning products containing NPEs for use on electrical components or by those producing electrical goods:

- one company produces 15 NPE-containing products which are used in the cleaning of electrical components, but not in the manufacture of these components. In most cases, the products are solvent-based but contain up to 5% NPEs which are used for their detergent properties. It is reported that, as solvents, these products should be disposed of via special waste so that entry to water systems is avoided; and

- one other company has amongst its clients ten companies which produce electrical components. However, the cleaning products supplied are for uses other than the cleaning of electrical components. For example, one company producing lighting equipment uses cleaners on the outer casings of lights prior to painting. Another company uses cleaners on computer casings prior to assembly.

Given the nature of these products, they are more appropriately considered under 'I&I cleaning products'.

A1.13.3 Issues in Risk Reduction

Relative Performance and Time Required for Substitution

With regard to the use of NPEs in electroplating solutions, there are reported to be alternatives to NPEs, although withdrawal of NPEs from the market would cause problems in the short to medium term. Although other basic surfactants are available, there are no immediate alternatives for NPEs. For example, one company has tested a number of alternatives but has not yet found an adequate substitute surfactant. This is because the NPEs also confer other required qualities such as ductility (the degree to which things can bend without breaking) and solderability. It is estimated that it will take a couple of years to find replacements.

A ban on the manufacture of products containing NPEs would cause problems for the company as it has products designed for the US market. NPEs are not such an issue there and US-based customers may be unwilling to accept reformulated products.

In other cases, such as in crack detection, the alternatives are based on the use of alcohol ethoxylates, with these being readily available for use either at present or within a couple of years (e.g. 1 to 2). Responses to the consultation exercise indicate that these substitutes provide a comparable level of performance, although they are more costly.

In contrast, the potential implications of banning the use of NPEs used in the cleaning of electronic components and specifically PCBs may be significant. If, as suggested above, NPEs are used as surfactants in water-washes, they will essentially be acting themselves as substitutes for the types of solvent-based (e.g. CFC-based) cleaning systems which have had to be phased out as a result of the Montreal Protocol. Care must be taken, therefore, to ensure that the adoption of risk reduction measures affecting this type of use would not, therefore, lead to other environmental risks.

Costs of Substitution

The data available on the costs of moving to alternatives for the various uses in this sector are limited. The data provided by CESIO/CEFIC for the costs of moving to substitutes provides no information specific to this sector.

Data provided by one of the consultees concerning four different crack detection chemicals indicated the following (with these data also relating to civil and mechanical engineering):

- NPEs account for between 10% and 50% of the 'per unit' production costs, depending on the end-product itself, with these costs ranging from £0.99 to £2.82 per unit;

- a change to alcohol ethoxylates would increase 'per unit' costs of the end products by between 3 and 8% across the range of products; and

- one-off costs of roughly £0.48 per unit would be incurred from the need to modify storage facilities as the alternatives require a heated store, with this then resulting in on-going heating costs of an additional £0.05 to 'per unit' production costs.

Risk Reduction Considerations

The main environmental concern with regard to the use of NP/Es by this sector is the potential for effluent containing NPEs to be discharged to the aquatic environment or to be contained within sewage sludge and then spread onto land (resulting in risks to the terrestrial environment and subsequent risk of secondary poisoning). Consultation has indicated the following:

- a trade association representing the electronics industry has indicated that effluent from PCB manufacturing is unlikely to be put to sewer untreated; the effluent from such facilities is reported to contain many toxic chemicals which companies recycle and treat prior to disposal;

- with respect to NPE-containing solutions used in acid baths, these are renewed about every two weeks owing to microbial contamination, resulting in intermittent discharges (Contensio, 1998);

- for acid cleaners used prior to electroplating, eventually all cleaners (and thus NPEs) will be discharged to an effluent plant and then to sewer; and

- with respect to fluxes, it is reported that very little waste arises from fluxes for hand soldering and it is unlikely that there will be any direct contact with the water environment. In the case of flow soldering, water soluble fluxes require rinsing (washing off) before moving on. It is at this stage that the flux has the potential to enter the environment.

The implications of the above are that the setting of limit values or environmental quality standards (EQS) could be used to minimise risks from these sources, as an alternative to marketing and use (M&U) restrictions. This is particularly important given the difficulty of finding substitutes for some uses within this sector within the short to medium term.

IPPC may provide an alternative to the use of limits or EQSs. However, IPPC covers installations involved in surface treatment of metals using electrolytic processes where the volume of treatment vats exceeds 30 m^3. Discussions have indicated that this does not cover a large proportion of facilities of concern because many electrical engineering companies are small operations. As a result, IPPC could not be relied upon to provide effective risk reduction as it would not cover a large segment of the sector.

A1.14 Mineral Oil and Fuel Industry

A1.14.1 Introduction

Estimated use of NP/Es for 1994 in the mineral oil and fuels industry was 93 tpa, with this being spread over the following applications:

- production of detergents for use in lubricants;
- demulsifiers in fuels and lubricants; and
- specialist emulsifiers in diesel fuels.

No details were available on the quantity used in each of these applications.

A1.14.2 The Nature of Products and Their Use

Production of Detergents

Additives in lubricants comprise around 10% of the fluid (though some figures place this as high as 27.5% for passenger car motor fuels and 34.3% for heavy duty diesel fuels). Of these additives, less than 1% is comprised of NP-based substances. There is some debate as to whether NP/Es are used as detergents themselves or in the production of detergents. They are certainly used for the latter, e.g. in production of sulphonate and phenate detergents. This is likely to be the largest use of NPEs in this sector although issues with commercial confidentiality exist such that the extent of use of AP/Es in general is unknown, as is the proportion of this which is attributed to NP/Es.

It has been stated that use in this sector applies particularly to military use in gearboxes detergents can reduce the formation of aggregates of metal fragments.

Demulsifiers

Demulsifiers are employed when blending fuels and make up part of the additives packages which are usually obtained through independent suppliers. Of the small proportion of fuels made up of additives (0.05 - 0.5%), less than 1% is NP-based, or NP itself.

Specialist Emulsifiers in Diesel Fuels

Use in this sub-category is expected to be relatively low. Emulsification of the fuel provides an improvement in the combustibility of these fuels.

A1.14.3 Issues in Risk Reduction

On sites that manufacture fuel and lubricant additives using NPs (such as sulphonates), waste is usually treated on site by one of two means:

- by incineration; or
- in independent waste water treatment plants using separation of oils from aqueous fluid and biological treatment.

Losses to the environment during use are assumed to be small as fuel oils are burnt, resulting in low NP/E input to the environment. Lubricants on the other had are either burnt or disposed of in special collection facilities. Although some does pass onto road surfaces, this input is expected to be low since the NP component is so small.

The risk assessment indicates this use contributes significantly less than 1% to total continental NP burden (0.008%). Given this low level of risk, care must be taken to ensure that significant costs are not placed on this industry sector. For this reason, it is suggested that a limit value/EQS approach is applied, which would ensure that discharges from any manufacturing site do not exceed the PNEC level.

A1.15 Photographic Industry

A1.15.1 Summary of Use

For the purposes of this study, one trade association and four companies were consulted, with responses provided by three of these organisations. These consultees have indicated that NPEs are used by some companies within the photographic industry as wetting agents in the manufacture of photographic film and some photochemicals. In the manufacture of film, an extremely high grade surfactant is required to ensure an even coating of the light-sensitive particles across the film substrate. Although their use is important in this sectors, the total quantities used are fairly small, with the risk assessment estimating that the photographic industry accounts for less than one percent of total NPE usage (with the contribution to the continental burden of NP also less than one percent).

Where NPEs are used in photographic chemicals, they are primarily within commercial products designed for use in the ‘amateur’ field, which includes both home hobbyists who develop film themselves and photo developers and finishers who develop pictures for amateur photographers. Generally, these products contain less than 3% NPE, but in at least one commercial product the concentration is as high as 5%. These products are sold as concentrates and the user prepares the formula by adding water.

A1.15.2 Trends in Use

Discussions with the consultees who use NPEs in the manufacture of photographic film and chemicals indicate that efforts are being made to replace NPEs, but that the degree of technical accuracy required is very great, and few suitable substitutes have been identified thus far. It is expected that a full substitution across all products could take upwards of seven to ten years.

A1.15.3 Issues in Risk Reduction

As the Table 6.2 indicates, a 70% reduction in the background regional concentration of NP/E will result in acceptable levels of risk from smaller facilities in this sectors. For larger facilities, regulations in a number of EU countries require that commercial photo developers do not discharge their waste effluents to sewer. The largest users of photo-chemicals will, therefore, pre-treat their wastes and then discharge to sewer or dispose of wastes through a licensed contractor, while small and medium sized users will generally have their wastes taken off-site and disposed of by a licensed contractor. However, small amounts resulting from 'carryover' of solution to wash tanks may get discharged directly to sewer. Products used by home hobbyists are also likely to be discharged directly to sewer.

The above discussion suggests that marketing and use restrictions could result in disproportionately high costs for the resulting environmental benefits , and it appears that IPPC is not applicable to the photographic industry. Some reduction in the risks associated with discharges from large scale facilities could be achieved through the introduction of tighter treatment requirements prior to discharge to sewer or direct to the environment. This should reduce local concentrations of NPE to levels below the PNEC at those sites where current concentrations are resulting in risks to the aquatic environment. In addition, as small users will also effectively be discharging to sewer, the application of limit values and EQS at sewage treatment plants should ensure that the PNEC for the aquatic environment is not exceeded.

A1.16 Other Uses (Cosmetics, Personal Hygiene & Beauty-Care Products)

A1.16.1 The Nature of Products

NPEs are used in a range of cosmetics and beauty-care products including mascaras, eye shadows, shampoos, conditioners, shower gels, shaving foams, skin toners, face masks and tissue fresheners. For example, in 1996 it was reported[28] that 10% of Danish shampoos contained APEs. In addition, NPES are used in personal hygiene products such as hand cleaners and soaps and detergents used predominantly in the workplace.

[28] Dioxins and Oestrogen mimics in Toiletry Products, ENDS 257, June 1996.

A1.16.2 Trends in Usage

There has been a move away from the use of APEs by a number of manufacturers and retailers. For example, in April 1997 it was reported that Colgate Palmolive and Proctor & Gamble had removed APEs from all or part of their personal care ranges[29]. Specifically, Colgate Palmolive indicated that none of its personal care products sold in the UK contain APEs, while for Proctor & Gamble, APEs had been removed from the Pantene and Vidal Sassoon products manufactured in the UK and Denmark. In addition, Boots and Sainsbury were in the process of reformulating products and Boots had set up a working party looking at APEs in own-brand products.

At the European level, in 1995, the European Cosmetic, Toiletry and Perfumery Association (COLIPA) provided its member associations and companies with information on the issues associated with APEs and advised them to "consider the possible adverse publicity surrounding APEs, during their reviews of formulations"[30]. As a result, it is reported that the large volume uses of NPEs as surfactants and emulsifiers by the cosmetic industry have been rapidly replaced with alternative products.

At the national level, a survey of members of a trade association in this sector indicated that respondents had in place plans to replace the vast majority, if not all, NPEs in their products either "as soon as possible" or "by the year 2000". Furthermore, it is understood that reductions of over 90% have been achieved by some companies already. Thus, it appears that only a minority of cosmetics currently contain NPEs, typically at concentrations of the order of 0.2% up to a maximum of about 2% or 3% in a minority of products. Two companies have provided data on their remaining uses of NPEs in cosmetics and beauty-care products and these are summarised in Table A1(f).

A1.16.3 Issues in Risk Reduction

Relative Performance, Costs and Time Required for Substitution

As for other sectors, the best alternatives to NPEs appear to be alcohol ethoxylates. A producer of skin cleansers and other personal hygiene products has indicated that, depending on the type and volume of alcohol ethoxylate purchased, these can be between 40% and 100% more expensive than NPEs. In addition, they are not direct substitutes for NPEs in all formulations. In some cases, one NPE needs to be replaced with two or more alcohol ethoxylates. Hence, there are logistical issues in terms of tankage, paperwork and metering, etc.

However, these cost estimates are high when compared to figures given by another consultee who indicated that the increased costs associated with substitutes to NPEs in skin toners, mascaras and shower/bath and hair care products would be low, at less than

[29] ENDS 267, *Firms begin APE Phase-out*, April 1997.
[30] COLIPA Recommendation No. 2 on Alkylphenol Ethoxylates.

Table A1(f): Data on NPE Usage by Two Cosmetics and Beauty-Care Companies

In 1994, Company A had less than ten cosmetic and beauty care products on sale in Europe which contain direct additions of APEs. Since then, most of these applications have either been superseded or de-listed (i.e. discontinued) and the company has used a maximum of 5 tpa of NPEs. Two NPE-containing products remain representing a few hundred kg/annum of NPEs. However, it was envisaged that APEs would be replaced in these applications by the middle of 1998. In addition to direct additions of APEs, some of Company A's products may also contain very low level indirect additions of APEs via perfumes from suppliers. Such uses have essentially been eliminated via a prohibition of indirect uses in new perfumes and reformulation of existing perfumes.

Company B uses NPEs in the production of skin toners, shampoos, conditioners, shower gels, mascaras and perm neutralisers at concentrations between 0.002% and 1.2%. None of the products use NPEs as raw materials but use a raw material which itself contains NPEs. Total use of NPEs in 1997 was 1 tonne compared with 1.7 tonnes in 1994, demonstrating a policy to phase out NPEs. Since 1994, NPEs have been replaced in face masks and tissue fresheners. In the next few months, use of NPEs in skin toners will cease reducing total NPE usage to under 0.2 tpa.

Another company which uses 1.4 tpa of NPEs in skin cleansers has tried unsuccessfully to replace these chemicals in some formulations. The problem is that the main alternatives – again alcohol ethoxylates – are irritants (this is not the case for NPEs). Although this may not be a problem for some sectors (e.g. metalworking fluids which are already irritant), there are health and safety implications with the introduction of an irritant into personal hygiene products. The key products which are affected in this regard are waterless hand cleaners. One of these, for example, is used in mines and is designed to be very gentle to allow prolonged skin exposure.

However, another consultee has indicated that they have already found substitutes for skin toners.

With respect to the cosmetics industry, it is reported that NPEs are effective surfactants, emulsifiers and solubilisers at low concentrations, making them cost-effective in a variety of applications. When NPEs are used as such, replacement with an alternative surfactants is achieved with no more than normal product development problems. However, NPEs have also been popular as constituents of proprietary mixtures. For these materials, it has been suggested that it is necessary either to reproduce the benefits of the mixture using alternative materials or to persuade the supplier to reformulate the mixture. Where the mixture contains a material with unique, possibly patented, properties, only the second option is available.

It has also been reported that there are technical difficulties in replacing NPEs in some very specific formulations. Examples of these are where NPE functions as a solubilising agent in some hair products and decorative cosmetics at low levels. For these products replacement ingredients have not yet been identified.

Risk Reduction Measures

In identifying appropriate risk reduction measures, it must first be remembered that the risks associated with these products arise primarily from their end-use. In other words, they arise mostly from use by consumers as opposed to from the disposal of effluent from production or processing. The options available for reducing environmental risks are therefore limited to either marketing and use restrictions or voluntary agreements. Marketing and use restrictions would provide greater assurance that the risks would be reduced and this is important given the large number of individual companies and products of concern.

The next question concerns whether or not the benefits of adopting marketing and use restrictions would outweigh the costs to this sector. The general trend within this sector is one of voluntary movement away from the use of NPEs, with some consultees indicating that they had already replaced all NPEs as part of their wish to have environmentally friendly products, and others indicating that replacement could take a maximum of 2 to 5 years for some of the more difficult products (e.g. the bath/shower and hair care products). These findings, together with the indication that the NPE based additives account for a low percentage of end product costs (i.e. less than 5%) and that the alternatives should, in general, not be of significantly higher cost than the NPE based additives, suggests that the costs to industry would not be out of proportion to the significant level of risk reduction provided by marketing and use restrictions.

With respect to the safety of replacements, one company has pointed out that all individual ingredients employed in cosmetic products are systematically assessed for human safety as mandated by the 6th amendment (93/35/EEC) of the Cosmetics Directive (76/768/EEC). Similarly, formulations are also considered for environmental safety by the company. Any alternatives to NPEs would also have to be assessed as part of this process in the same way as for NPEs and any other ingredients. This suggests that the adoption of any restrictions should recognise that there will be a time lag resulting from the above procedures between identifying a substitute and its being marketable.

A1.16.4 Spermicides

One NPE (specifically nonoxynol-9 (NO9)) is used in some spermicidal creams and lubricants[31]. For the former, these are used at rate of around 30mg per condom (Westra and Vollebregt, nd).

Information on use has been provided by two manufacturers of condoms. In the last financial year, one company sold 3.5 million individual condoms, each containing approximately 22.75 mg of N09. The total quantity used was almost 0.08 tonnes. The company and its suppliers understand that there is currently no viable alternative to NO9 for this type of application. At this point in time, the result would be the removal of the spermicidal formulas which contain the NPEs from all products. As this would make the product unviable, the manufacturers would seek a derogation.

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[31] Dioxins and Oestrogen Mimics in Toiletry Products, ENDS 257, June 1996.

A1.17 Other Uses (Public Domain)

A1.17.1 Summary of Use

Products considered under this category include non-agricultural pesticides, vehicle and office cleaning products, correction fluids, inks and other office products. However, no data were available regarding quantities of these products in use.

A1.17.2 Issues in Risk Reduction

As no data were available on quantities in use for this sector, the risk assessment considered a 'worst case scenario' to assess the potential associated risks. Due to the lack of information on the risks, costs and benefits associated with the use of NPEs in products such as those listed above, it is difficult to propose M&U restrictions.

A1.18 Other Uses (Unknown Sources)

Some 12,600 tpa of NPE usage is not attributed to any particular industry sector within the risk assessment. For the purposes of the Assessment, this quantity is assumed to be split equally amongst the uses identified in the preceding sections in direct proportion to their current level of use.

The consultation undertaken as part of this study has identified one company which uses NPE in froth flotation processes for coal concentration, with 11 tpa used in this application. With respect to releases to the environment, as the main component of this product is diesel, the waste product is burnt rather than being released to sewer, resulting in minimal release into water. Foam floatation could replace this process, eliminating consumption of NPEs, although this is likely to be more costly.

ANNEX 2:

LIST OF CONSULTEES

List of Consultees

AGFA
AISE
Akcros Chemicals
Akzo Nobel Woodcare
Allied Colloids
Ambersil Ltd
Amity UK Ltd
Applied Chemicals Ltd
Approved Product Treatments
Arrow Chemicals Ltd
Atotech UK Ltd
Auxiliary Chemical Technologies Ltd
Boots Ltd
Brent Europe Ltd
British Association for Chemical Specialities
British Coatings Federation
British Leather Confederation
British Lubricants Federation
British Petroleum
British Plastics Federation
British Surface Treatment and Suppliers Association
CAMLAB Ltd
Castrol UK Ltd
Celestica Ltd
Cement Admixtures Association
Chemoxy International Plc
CIRIA
CK Chemicals Ltd
Clariant
Colas Ltd
COLIPA
CONDEA
Confederation of British Wool Textiles Ltd
Confederation of National Associations of Tanners and Dressers of the European Community
Cosmetic Toiletry and Perfumery Association Ltd (UK)
Croftshaw Solvents Ltd
DEB Ltd
Diversey Lever Ltd
Drinking Water Inspectorate
Electrolube
Ellis and Everard
Environment Agency
European Coatings Federation
European Commission
European Phenolic Resins Association

European Polymer Dispersion and Latex Association
European Vinyl Chloride Manufacturers Association
Exxon Chemicals Ltd
Federation of the Electronics Industry
FOSROC International Ltd
Four Ashes
Fry Technology UK
Fuchs Lubricants UK
Fuji-Hunt and Fuji
H Marcel Guest Ltd
Henkel Ltd
Houghton Vaughan
HSE Engineering NIG
HSE Paper & Printing NIG
HSE Plastics NIG
ICI Autocolor
ICI Paints
ICI Surfactants
Institute of Metal Finishing
International Wool Secretariat/ENCO
Jotun
Kalon Decorative Products
Kodak
Lea Ronal (UK) Plc
Litton Precision Products International
Magnaflux
National Chemicals Inspectorate
National Physical Laboratory
OSPARCOM
Paint Research Association
Paper Chemicals Association
Paper Federation of Great Britain
Photographic Waste Management Association
Pira International
Polartech Ltd
Printed Circuit Interconnection Federation
Proctor & Gamble
Quarry Products Association
RIVM Netherlands
Rohm and Haas France
Rugby Cement
Samuel Banner & Co Ltd
Soap and Detergent Industry Association
Scott and Bader Ltd
S'hertogenbosch
Solar Petroleum Ltd
Surface Engineering Association
Tergo-Data

Total Bitumen Products
Union Carbide (Europe)
Vinamul Ltd
William Canning Ltd
Yule Catto Consumer Chemicals

ANNEX 3:

NONYLPHENOLS, OCTYLPHENOLS AND THEIR ETHOXYLATES: ESTIMATE OF APPROXIMATE COSTS TO EU INDUSTRY (£ STERLING EQUIVALENT TO TABLE 5.1)

Table A3.1: Nonylphenols, Octylphenols and their Ethoxylates: Estimate of Approximate Costs to EU Industry (£1999*)

Uses	Estimated Consumption (1995) (kt)	Estimated Number of Formulations	Reformulation Cost per Formulation (£ 000s)	Cost of Substitution (£ million)		Total Cost to Industry (£ mill)
				Costlier Substitute**	Reformulation & Commercialisation	
NP/OP Chemical intermediate for resins & additives (excl. ethoxylates)	39	2,000	46	72	93	165
NPE/OPE Industrial Detergents	28	10,000	9	13	93	106
Emulsion Polymerisation	12	2,000	186	6	371	377
Textile & Leather Processing	18	2,000	23	8	46	55
Agrochemicals	6	1,000	139	3	139	142
Other Uses	16	10,000	23	7	232	239
Total		**27,000**	**NA**	**109**	**974**	**1,084**

* Converted from 1995 ECUs
** Assumed at £1.85/kg for NP/OP and £0.45/kg for NPE/OPE

Data in the table above provide the estimated costs to the EU industry for the use of alternatives to NP/Es and OP/Es. The data above are the British Sterling (£) equivalents of the Euro (€) data presented in Table 5.1.