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Working Party on Pollution Prevention and Control

ENVIRONMENTAL REQUIREMENTS FOR INDUSTRIAL PERMITTING

CASE STUDY ON THE PULP AND PAPER SECTOR

PART ONE

This document is the final report of the case study on the Pulp and Paper sector which is part of the publication within the project on Environmental Requirements for Industrial Permitting. The report comes in two parts: Part one [ENV/EPOC/PPC(99)8/FINAL/PART1] is the synthesis of the sectoral case study and Part two [ENV/EPOC/PPC(99)8/FINAL/PART2] contains the country profiles.

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FOREWORD

Permitting systems for industry are an integral part of environmental regulations in OECD countries. By requiring facilities to operate in an environmentally sound manner, permits help prevent environmental pollution and ensure that facility operators or enterprises adopt and pay for their own pollution control measures. However, there still remain many opportunities to improve permitting systems so that they can contribute more effectively to longer-term objectives such as sustainable development and resource conservation.

In late 1993, the OECD Environment Directorate launched a Project on Environmental Requirements for Industrial Permitting. The project involved three distinct phases: (i) a survey of permitting legislation, regulations and practices in OECD countries; (ii) the preparation of case studies of four industrial sectors (pulp and paper, metal finishing, oil refining, and iron and steel); and (iii) an international workshop on environmental permitting of industrial facilities which was held in May 1996. The main objectives of the project were:

- to increase international understanding of how different countries' environmental requirements for industrial point sources were established and applied;

- to examine the combined use of best available technology (BAT) requirements and environmental quality objectives (EQO) in setting permit conditions for industrial sources; and

- to develop policy recommendations for integrated and preventive approaches in environmental permitting, including increased use of cleaner technologies.

The project publications come in three volumes covering each of these phases. Volume 1 contains the policy study of the entire project. Volume 2 contains the proceedings of the international workshop and the summaries of the sectoral case studies, while Volume 3 presents the results of the survey on regulatory approaches. Two of the sectoral case studies, i.e. those in the pulp and paper, iron and steel sectors include detailed country profiles, and therefore are published as separate OECD documents.

This report on the pulp and paper sector provides an analysis of permitting approaches in Austria, Belgium (Wallonia), Canada, Finland, Germany, New Zealand, Norway, Sweden, Switzerland, and the United States. It comes in two parts: in Part One, the implications of the countries' policies to set environmental requirements for this sector are examined. The influence of permit conditions on the technological development and environmental performance of the facilities is analysed, and the specific action of industry is reviewed. The regulatory profiles of the participating countries have also been compiled and are included as Part Two. The report was revised and approved by OECD's Pollution Prevention and Control Group.

This report is published on the responsibility of the Secretary-General of the OECD.

ACKNOWLEDGEMENTS

The OECD would like to acknowledge the important assistance and support provided by government officials and experts from OECD Member countries during the preparation of this report on the pulp and paper sector. The project was also supervised by the "BAT-EQO" Advisory Panel, which included Delegates to the Pollution Prevention and Control Group from the following participating countries: Karel de Brabander and Bruno de Kerckhove (Belgium), James Riordan (Canada), Antero Honkasalo (Finland), Horst Mierheim (Germany), Robert Droop and Jan Suurland (Netherlands), David Mottershead (United Kingdom), Rick Picardi (United States), and Leopoldo Rubinacci (European Commission). In addition, national experts from the following countries were involved in this case study on the Pulp and Paper sector: Susanne Chian and Andreas Tschulik (Federal Ministry for the Environment, Austria); Bruno De Kerckhove (Ministère de la Région, Wallone, Belgium); Ian Mackenzie, Elaine Wasylenchuk and Larry Begoray [Alberta Environmental Protection], Harry Vogt and Alistair Stewart [British Columbia Ministry of Environment, Lands and Parks], and Ed Turner and Helle Tosine [Ontario Ministry of Environment and Energy], (Canada); Emelie Enckell (Finnish Environmental Protection Agency, Finland), Michael Suhr, (Federal Environmental Agency, Germany); Ray Salter [New Zealand Ministry of the Environment] and Paul Dell [Environment Bay of Plenty], (New Zealand); Anne Marie Mo Ravik (State Pollution Control Authority of the Ministry of the Environment, Norway); Staffan Lagergren (Swedish Environmental Protection Agency, Sweden); H. Leuenberger (Carbotech AG, Switzerland); and Rick Picardi, Danford Bodein, and Donald Anderson (Environmental Protection Agency, the United States).

Valuable input was also obtained from experts participating in the OECD Workshop on Environmental Requirements for Industrial Permitting held in Paris in May 1996. The amount of information gathering, fact checking and updating necessary to produce the survey and analysis of permitting approaches for these countries was substantial, and a great number of specialists in Member country administrations and industry organisations were instrumental in helping ensure that this was done in a thorough and accurate manner. Financial support for the project was provided by the governments of Austria, the Netherlands, Switzerland which is greatly acknowledged.

Environment Canada was responsible for organising this case study on the pulp and paper sector. It was carried out by the National Office of Pollution Prevention under the auspices of OECD's Pollution, Prevention and Control Group. The report was written by David Halliburton, assisted by Linda Maddison and David Simpson of Environment Canada, using information from this study and other material as referenced. The final draft has been reviewed by country experts involved in the case study, and OECD's Pollution Prevention and Control Group.

The final report was reviewed by Peter Wiederkehr of the Pollution Prevention and Control Division of the Environment Directorate. Input, assistance and advice by colleagues in the Environment Directorate, in particular Alain Rajotte and Laurent Renevier, are also acknowledged. Special thanks to Jane Kynaston and Freda O'Rourke who formatted, edited and compiled this voluminous publication into its final form.

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GLOSSARY

AOX	absorbable organic halides
BAT	best available technology/techniques
BACT	best available control technology
BEP	best environmental practice
BLOX	black liquor oxidation
BREF	BAT reference document
BATNEEC	best available technology not entailing excessive costs
BCT	best conventional pollutant control technology (US)
BDT	best demonstrated technology
BOD	biological oxygen demand to breakdown organic matter in water
BOD_5	biological oxygen demand over five days.
BOD_7	biochemical oxygen demand over 7 days
BPEO	best practical environmental option
BPO	best practicable option
BPJ	best professional judgement
CAA	Clean Air Act (US)
CEPA	Canadian Environmental Protection Agency
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act (US)
CO	carbon monoxide
COD	chemical oxygen demand
CODcr	chemical oxygen demand using chromium for the test
CODmn	chemical oxygen demand using manganese for the test
CSI	common sense initiative (US)
CTMP	chemi-thermo mechanical pulp
CWA	Clean Water Act (US)
EIA	environmental impact assessment
ELV	emission limit value
EMAS	ecomanagement and audit scheme
EMS	environmental management systems
EPA	Environmental Protection Agency
EPR	extended producer/product responsibility
EQO	environmental quality objective
EQS	environmental quality standard
EU	European Union
EEC	European Economic Community, forerunner of EU
fugitive emissions	incidental escape of dust and particles during industrial operations
HAPs	hazardous air pollutants
HELCOM	Helsinki Commission on the Protection of the Baltic Sea
HMIP	Her Majesty's Inspectorate of Pollution (UK)
IJC	International Joint Commission on the Great Lakes
IPC	Integrated Pollution Control Act (UK)
IPPC	Integrated Pollution Prevention and Control (EU Directive)
ITEQ	International Toxicity Equivalent

LAAPC	Local Authority Air Pollution Control (UK)
LAER	lowest acceptable emission rate
LCA	life cycle assessment
LRTAP	Convention on Long-Range Transboundary Air Pollution of the UNECE
MACT	maximum achievable control technology (CAA, US)
NAAQS	national ambient air quality standard (CAA, US)
NCG	non-condensable gas management systems
NGO	non-governmental organisation
ndg	normal dry gas
NO_2	nitrogen dioxide
NOx	nitrogen oxides
NSPS	new source performance standards (CAA-US)
NTP	normal temperature and pressure
OSPARCOM	Oslo and Paris Commission for the Protection of the North Sea and the North East Atlantic Ocean
P_{tot}	total phosphorus
PAH	polycyclicaromatic hydrocarbons
PCBs	polychlorinated biphenyls
pH	total acidity
PM	particulate matter
PM_{10}	PM of less than 10 microns size
$PM_{2.5}$	PM of less than 2.5 micron size
PSD	Prevention of Significant Deterioration (CAA, US)
PPCG	Pollution Prevention and Control Group (OECD)
PRTR	pollutant release and transfer registers
PVC	polyvinyl chloride
RACT	Reasonably Available Control Technology (US)
RCRA	Resource Conservation and Recovery Act (US)
SIP	State Implementation Plan (US)
SMEs	small and medium-sized enterprises
SNV	Swedish Environmental Protection Agency
SO_2	sulphur dioxide
SS	suspended solids
SVP	single vessel process
TA Luft	Technical Instruction on Air Pollution Control (Germany)
TCDD	Tetrachlorodibenzo-p-dioxin (e.g. 2,3,7,8 TCDD)
TMP	thermo-mechanical pulp
TRI	toxic release inventory (US)
TRS	total reduced sulfur
TSP	total suspended particulate matter
TSS	total suspended solids
UN ECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
UNIDO	United Nations Industrial Development Organisation
USEPA	the United States Environmental Protection Agency
VLAREM I & II	Flemish Implementation Decree (I & II) on Environmental Protection (Belgium)
VA	voluntary agreement
VOCs	volatile organic compounds
WHO	World Health Organization

EXECUTIVE SUMMARY

This study reviews the permitting practices of ten countries in the issuance of environmental permits to bleached chemical pulp and paper mills. Bleached kraft mill permitting was studied in Belgium (Wallonia), Canada, Finland, New Zealand, Sweden, and the United States. Bleached sulphite mill permitting was studied in Austria, Germany, Norway and Switzerland.

The report analyses how the concepts of Best Available Control Technology (BAT), and Environmental Quality Objectives (EQO's) are used to set permit conditions. In addition, the report analyses the technological response of the mills, and the views of mills on the permitting processes used in their respective countries. The report analyses water, air and solid waste permitting, and cases where permits for all these media are integrated into a single permit.

The report was prepared on the basis of a questionnaire survey in which each country described the permitting process and how BAT and EQO were considered. Countries were also asked to provide samples of permits to illustrate the approach used.

The report reviews how each country addresses the permitting of water, air and solid waste emissions. The report shows that there are differences in the types of authorities that issue permits in countries. Some countries use government officials and others constituted bodies to issue permits.

Another significant difference among countries is in the degree of latitude allowed in individual decisions. Six of the countries in the study have passed national regulations that set ceilings on the maximum releases allowed in effluent permits. In other countries, permitting requirements are defined on a case-by-case basis by regulatory authorities which balance different factors when making decisions, although some may be considered more relevant than others. It appears that all the limits are based on technical considerations assessing what minimum values of discharges can be attained. Although the given definition for BAT varies among countries, all permitting authorities have indicated its prime influence as a concept in shaping the outcome of permit conditions. The environmental requirements of sites are also assessed. In many cases these form the ultimate basis of the stringency to control releases.

Type of organisation that issues permits

In the case of seven countries, permits are issued by officials of either the federal or state/provincial governments, who have the authority to perform such a function. In three countries, permit issuance is delegated to constituted bodies, created by the government. In Sweden, permits are issued by the National Licensing Board and in Finland, by the Regional Water Courts (for water) and Regional Environmental Centres (for air and solid wastes). In New Zealand, Regional Councils issue the permits.

The objective of permitting

The objective of permitting is to ensure that the type and amount of releases from the process do not impair the environment. Permitting is carried out in accordance with national and/or state legislation.

For effluent and air emission permitting, two aspects are important: first, the quantity of waste releases from the process should be limited through the use of both internal pollution prevention and end-of-pipe treatment. Secondly, the wastes gas and liquid streams from the process should be introduced into the environment so that pollutants are effectively dispersed and their concentrations in the receiving media are such that they do not impair human health and the environment.

The objective of permitting is to establish what permit conditions to apply in order to ensure the protection of the environment. This includes specification of release limits.

The use of Environmental Quality Objectives (EQO's)

Water Quality Objectives have been established by all ten countries in the study and Air Quality Objectives by nine countries, with the latter being under consideration in the remaining country. The EQO's are used to determine acceptable ambient levels of pollutants in the media, following dilution.

The establishment of permit limits entails a two stage process. Under this, the mass emission rates using a given mix of pollution prevention and end-of-pipe treatment techniques is first estimated. Then, the impact of these levels of pollution on the environment is estimated using appropriate environmental effects models. If the impact of the anticipated emissions using the given technology is determined to be too high, a more stringent technological requirement would be set. It is observed that a significant number of permits in this study have relatively stringent limits for the deposit of biochemical oxygen demand (BOD). These apply to permits for mills discharging to rivers with low water flows. Minimisation of BOD is carried out in order to maintain the levels of dissolved oxygen in the water.

The use of national or provincial pollution release standards

Standards are usually established on the basis of the minimum pollutant releases considered attainable through the use of pollution prevention techniques and end-of-pipe treatment. Standards are prescribed by considering what best available technologies (BAT) are capable of attaining, while economic and environmental factors are also considered.

For those countries with such regulations, the limits in these regulations are considered as the maximum releases allowed in permits. In cases of sensitive ecosystems, more stringent requirements may be imposed based on EQO considerations.

In the case of water pollution control, two of the four countries that do not use national emission standards, have established performance that they regard as BAT. They use these targets as starting points for consideration by the boards that establish the permit conditions.

Actions followed in countries where pollutant release standards have not been issued

In the case of countries where national standards have not been set, permit decisions are based on case-by-case considerations. This includes emission reductions attainable through the use of pollution prevention and end-of-pipe treatment, environmental quality and economic factors. Permit limits are developed considering the individual circumstances, rather than a simple translation from regulations. The authorities consider what minimum emissions or releases can be achieved by applying the best available technology relevant to the case.

It could be debated that this situation is more effective than using national sectoral standards as the basis for limits. However, it is noted that these emission standards are developed based on similar BAT considerations. Secondly, for those countries where national/state standards are used, the authorities apply stricter limits in permits, on the basis of EQO considerations of sensitive sites.

Balancing technological and EQO considerations

In establishing permit conditions, authorities balance both technological and EQO considerations. Economics associated with the options are also taken into account.

In the case of a site in a sensitive area, more stringent limits than those in the regulation are set. The determination of the level of stringency is done using EQO models. However, it is observed in this study, that sites with high dilution capacities are not allowed to install anything other than BAT technologies.

Flexibility in the choice of equipment

The permitting processes followed impose release conditions, including limits. These are developed on the basis of existing technology capable of meeting the limits. Mills are permitted to choose what equipment to install to meet the limits. Flexibility is granted enabling them to do this in the most cost effective manner. Specific technologies are not mandated.

In some cases, permit conditions include the installation of specified equipment. It is noted that this is attained through prior discussions between the permitter and permittee. The specification therefore reflects an agreement between the parties, and not the mandating of equipment.

Influence of the selection of control parameters

The selection of indicators determined by the legal limits, as well as the time period over which compliance is attained, and the legal enforcement framework, have a bearing on the technological response of the mill.

Of the major regulatory parameters normally used to control effluents:

- Biological oxygen demand (BOD) was used by eight out of ten countries in the permits reviewed; however one country does not include it in all its permits.
- Chemical oxygen demand (COD) was used directly in six out of ten countries and indirectly in a permit of a seventh county as a result of an international agreement.
- Total suspended solids (TSS) was used in permits in six of ten countries.
- Toxicity (Acute Lethality) was used in permits of five countries.

- Nutrients (nitrogen and phosphorous) were used in permits of five countries.
- Absorbable organic halides (AOX) criteria were used in all but one country either directly or indirectly.
- Dioxins and furans were used in two countries.

The selection of which parameters are included as controls has a major influence on the control technologies required. In cases where emphasis is placed on COD controls, a high degree of internal pollution prevention may be necessary. Processes such as oxygen delignification may be required, but the installation of secondary biological treatment may not be necessary. However, in cases where BOD control is emphasised, secondary treatment installation may be necessary to meet the limits.

Effluent control

Biological oxygen demand (BOD) and chemical oxygen demand (COD) are the primary parameters used to control the discharge of dissolved solids. BOD limits were used in all countries except Norway and Sweden. (In Sweden some permits now include BOD limits but these are being phased out). Similarly COD limits were used in all countries reviewed except Canada, New Zealand and the US.

The selection of either BOD or COD determines whether an in-plant or an external, biological treatment approach is taken. The study shows that secondary biological treatment is almost universal at kraft mills in all the countries studied except Sweden, where it was applied at over half of the mills. COD is Sweden's primary dissolved solids control parameter.

Secondary treatment was applied at all the sulphite mills reviewed.

Absorbable organic halides (AOX) limits were applied in most countries.

Notwithstanding the different permitting practices used in participating countries to control effluent discharges, the study showed convergence towards low release values for the principle parameters (e.g. BOD, COD and AOX) that affect the choice of control equipment.

Emission limit values in all countries have become more stringent as a result of concerns about environmental impacts of mill effluents and the availability of environmentally-sound technological innovations.

Mills having both good internal measures, as well as secondary treatment, are observed to have the lowest releases for BOD and COD. For AOX, some of the mills with secondary treatment are amongst those with the lowest releases, but secondary treatment is not a prerequisite for this.

It appears that many mills are well ahead of the permit or regulatory limits that are set. This inference is drawn from information on the range of discharges of the principle pollutants from the process, per tonne of production shown in Figures 1 to 3. Many mills have discharges that are low compared to the levels that are set in regulations or targets. However, information on permit limits were only supplied for a few mills in each country. Nevertheless few mills are expected to have low permit discharge limits. This suggests that other factors than permit limits are driving the pollution control programs at mills.

The role of two forces appears to be important. The first is public concern over the effects of certain constituents in the effluents. This has led to the development of various international treaties, e.g. the Oslo and Paris Commission (OSPARCOM), the Helsinki Commission (HELCOM), and the International Joint Commission (IJC) of the Great Lakes. The second force is the desire of some companies to produce products that are perceived in certain markets to be better. For example pulps made by elemental chlorine free, or totally chlorine free processes. These market trends may induce mills to install processes that go beyond their discharge permit limits.

The overall results suggest that technology-based approaches used in the permitting and regulatory systems, in the different countries, are working well to limit effluent discharges to acceptable levels. It is observed that the pulp and paper sector has demonstrated high levels of ingenuity over the past decade. This has lead amongst other items, to the development of innovative pollution prevention technologies aimed at the virtual elimination of persistent and bioaccumulative compounds, such as dioxins and furans. New technologies that are developed in one country are quickly transferred to "state-of-the-art" mills in other countries. A relatively homogenous set of pollution prevention and control practices appear to be emerging in all countries.

Air permitting

Air permits apply source-by-source limits to the different units in the mills. The principle components controlled are particulate matter and gaseous emissions. For the sulphite industry, the control of SO_2 is important, while for the kraft process industry total air emissions of reduced sulphur emissions are important.

The air permit limits appear to be developed on a case-by-case basis considering the age of the units giving rise to the emissions. The control strategy is based on the use of a mix of in-plant and external measures. Similar limit values are observed for the same major process units in each country.

Solid waste control

The report has been unable to delineate the principles of application of BAT and EQO to solid waste permitting, to the same degree, as that for water and air pollution control. Solid waste control is directed at the safe disposal of wastes through proper incineration, land filling and other means. Criteria are developed to support these. Effort is also taken to minimise the volumes of waste created in plant, pollution prevention measures.

Technological response by mills

The analysis of the technology responses by mills indicates that mills in different countries have implemented similar technological measures in response to the permits. With respect to bleaching, pollution prevention measures have been taken to reduce the quantities of chlorine gas used. In some cases it has been totally replaced by chlorine dioxide. In other cases, even chlorine dioxide has been eliminated, and no chlorine compounds are involved in the production of pulp. In this area, mills have gone far beyond the AOX levels set in their permits. These developments appear to be more market driven than environmental permit/regulation induced.

Great efforts are made to use pollution prevention approaches and technologies in chemical recovery; spent pulping liquors are sent to high efficiency recovery boilers, where they are burnt and wastes destroyed. Valuable chemicals and energy are recovered in the process. Effort is directed at maximising effluent recycling through water reduction and effluent reuse programs. Examples include the use of stripped condensates from the recovery circuits to replace fresh make up water. The use of water is also minimised wherever possible to reduce the size and cost of equipment, and to enhance the autogenous firing of the spent liquors in the recovery process. Many mills have modified their pulping processes to remove more of the lignin and reduce the amount that has to be removed in bleaching. This allows more of the effluent to be treated and destroyed in the recovery boiler circuit.

Representatives in some countries however, expressed concern that the stringency of requirements were not always balanced by the needs of the environment. In some cases, limits were prescribed when technology had not been recognised capable of operating at that level. Despite these facts the industry appears to have met these challenges.

Overall Conclusions

This study shows that basically two regulatory approaches are applied in the permitting of pulp and paper mills. There are systems in which the minimum limits set by authorities in permit decisions are based on national or state standards. These standards are established based on the maximum reductions achievable using BAT. The application of pollution prevention techniques and appropriate end-of-pipe controls is also considered. EQOs are applied in the second stage of this approach. Dispersion/dilution modelling is used to forecast the levels of pollutants in the environment when meeting the regulatory limits. In cases where the impacts exceed EQOs that have been established, stricter limits are imposed.

The second type of approach involves case-by-case permitting in which BAT and EQO factors relevant to each case are applied, without reference to national regulations. This approach establishes BAT based on the application of pollution prevention techniques and appropriate end-of-pipe controls as in the previous case.

Despite the differences in permitting approaches, the available information on effluent quality, from kraft mills in the five countries reviewed, show similarities with respect to BOD and AOX discharges. Information was not available on COD discharges beyond the Scandinavian countries to extend this statement. It appears that most mills have discharges lower than their permit and regulatory limits. Economic and market factors are believed to drive this. Overall, environmental improvement may become less permit driven.

1. INTRODUCTION

In September 1993, the Pollution Prevention and Control Group (PPCG) of the Organisation for Economic Co-operation and Development (OECD), initiated a study on policies and approaches in permitting. The study examined the use of Best Available Technology (BAT), and Environmental Quality Objectives and Standards (EQO and EQS), in the environmental regulation and permitting of industrial pollution sources. The first phase of the project surveyed general policies of member countries. The results of this work have been published in a Reference Guide on Environmental Requirements for Industrial Permitting (OECD, 1997).

The study provided general information on the use of BAT and EQOs in environmental permitting and regulation in OECD Member countries. However, specific BAT and EQO use and application to industrial sectors were not well defined. The PPCG therefore decided to conduct a series of case studies on different industry sectors to improve understanding and identify significant issues and approaches with a view to developing policy guidance. Four industry sectors, pulp and paper, iron and steel production, oil refining, and metal finishing, were selected for study. In total, 15 member countries and one observer country participated in the studies. However, not all of the countries participated in each study. This report presents an analysis of pulp and paper mill permitting practices. A companion OECD report describes the permitting practices applied to the iron and steel industry (OECD, 1997).

The case studies were designed to provide an in-depth understanding of how environmental permit requirements in each country were defined and the rationale for them. The study was conducted by means of a questionnaire and by reviewing sample permits provided by each country. A copy of the survey questionnaire is provided in Appendix 1. The questionnaire was sent to the officials responsible for the development of environmental permits and regulations. The study attempted to define the technological response of facilities to which the permits applied, and their views on the permitting process. These were determined from the industry response to part of the questionnaire.

The study was used to define the principles used in air pollution permitting, water pollution permitting and solid waste management. It is noted that results of the survey did not provide in-depth detail on solid waste management. The study therefore concentrates on air and water permitting, with a brief discussion of solid waste permitting in cases where information was provided.

The participants in the pulp and paper study were Austria, Belgium (Wallonia), Canada, Finland, Germany, New Zealand, Norway, Sweden, Switzerland and the United States of America. Separate reports are available describing the permitting and regulatory systems of each country, and the technological response of their industries to the specific permits that were issued. Readers are referred to these individual reports for details of permitting.

This case study report is based on information compiled in the individual country reports. In addition, the report incorporates information from other sources as referenced. It is noted that the pulp and paper study refers only to the permitting practices applied to bleached chemical pulp and paper mills. This segment of the industry was chosen because of all the processes applied, it represents the greatest potential for environmental disruption. Furthermore, it was necessary to compare the permitting practices applied in each country to the same industry sector.

The study is presented in eight sections:

- Section 1 provides an introduction to the project.
- Section 2 provides an overview of the pulp and paper industry in each country and the potential significance of environmental releases from the overall bleached chemical pulp sector.
- Section 3 provides an overview of the permitting and regulatory processes used in the countries, covering constitutional authorities, the type of permitting authority used; a description of the permit issuance process, including appeals; information required to obtain a permit; and discussions on the use of multi-media permitting, environmental assessment and permit duration.
- Section 4 provides an analysis of the types of policy documents applied in permitting including the use of pollutant release limit regulations (rules) and other policies relating to emissions; environmental quality objectives; and concepts of best available technology.
- Section 5 presents an analysis of trends in air, water, solid waste and noise permits including limits and monitoring requirements.
- Section 6 describes pulp mills' response to permits requiring cleaner technologies in industry. The mills' views on the permitting process are also summarised.
- Section 7 presents a discussion.
- Section 8 presents the report summary and conclusion.

2. OVERVIEW OF PULP AND PAPER PRODUCTION AND ITS ENVIRONMENTAL IMPACTS ADDRESSED BY LEGISLATION

Pulp and paper products play an important role in modern life, serving in varied uses such as written communication media, information and storage, wrapping and shipping materials, and personal hygiene products. Raw pulp fibres are also used to construct a variety of other materials, such as building boards.

Large quantities of pulp and paper are used world-wide. They are mostly derived from wood, but some are also based on other plant materials such as bagasse and straw. In 1994, according to statistics compiled by the Canadian Pulp and Paper Association, total world paper and paperboard manufacturing capacity was 294 million tonnes and the production output equalled 269 million tonnes (Canadian Pulp and Paper Association, 1996).

Recycling of used paper and paperboard products plays a significant role in the economics of the pulp and paper industry. The importance of recycling in different countries can be seen from the following table based on information compiled by the Finnish Forest Industries Association (Finnish Forest Industries Association, 1996). Recovery rates for paper and board vary from 30 to 68%. Recycling enables fibres derived from wood and other sources to be reused several times.

Table 1. **Paper and board recovery rate as estimated for 1994**

Country	Paper and board recovery rate (%)
Austria	68
Germany	56
Holland	55
Switzerland	54
Japan	52
Sweden	50
Finland	46
USA	40
Denmark	38
Spain	37
Portugal	36
France	36
Norway	36
Canada	35
United Kingdom	33
Greece	31
Italy	30
Belgium	30

The manufacture of pulp and paper products from virgin fibre sources involves the separation of individual fibres. This produces a material called pulp which is formed into products such as paper sheets, boxboard, fluff pulp products, etc. Pulping and forming operations are conducted in an aqueous medium. The forming operations take advantage of the attraction between the individual fibres when the water is removed, allowing sheets to be formed. Good fibre separation is required to achieve good surface properties for various uses.

Two main categories of pulping processes are used to separate fibres: (i) mechanical pulping which uses force to separate fibres in the wood, and (ii) chemical pulping which uses inorganic chemicals to dissolve the wood matrix (referred to as lignin). This releases the individual cellulose fibres.

Mechanical pulping is used to produce materials such as newsprint. The process recovers about 90-95% of the wood as pulp. However, the pulp contains a lot of lignin, which is subject to decomposition and brightness reversion, and is not suitable for many uses.

Two chemical pulping processes are dominant: kraft pulping and sulphite pulping. The sulphite process was applied commercially before the kraft process. It uses sulphur dioxide, dissolved in a basic solution of sodium, magnesium, ammonium, or calcium hydroxide, as the cooking medium. Cooking separates the fibres, which are then washed and bleached. Bleaching removes the residual lignin and provides the required optical and physical qualities for particular end-uses. The spent pulping liquors are treated to recover sulphur dioxide and the base chemical. Most mills that formerly used calcium-based processes have now converted to magnesium-based processes in order to recover all of the spent chemicals. It is noted that one calcium-based sulphite mill covered in this study achieves partial recovery of its sulphur dioxide pulping chemicals.

The kraft process uses a solution of sodium sulphide and sodium hydroxide to separate the fibres. Following pulping, the fibres are bleached and the spent solutions recovered in a recovery boiler, lime kiln and slaking operation. Bleaching is applied to remove residual lignin.

Bleached chemical pulping recovers about 45 % of the wood as pulp. The balance is lignin and other water soluble compounds which are contained in the effluent. Effluents emanating from the pulping process are treated internally to produce energy or externally to ensure that they are benign.

Table 2 presents information on the number of pulp and paper mills in each of the ten countries studied. It also reports the annual output of pulp and paper in each country. From the table it can be seen that some countries have much larger industries than others. In some countries there are a large number of kraft and sulphite mills, while in others there are very few. Some countries also have a large number of paper mills, e.g. Germany. These countries rely heavily on imported wood pulp to produce their paper products.

Table 2. **Overview of the pulp and paper industry in participating countries**

Country	Number of pulp and paper mills	Number of kraft mills	Number of sulphite mills	Total pulp and paper output (tonnes)	Year data apply to
Austria	29	3	4	3 600 000	—
Belgium	27	1	0	—	—
Canada	157	43	8	27 929 000	1995
Finland	43	16	0	20 900 000	1994
Germany	223	0	6	13 520 000	1993
New Zealand	8	2	0	1 650 000	—
Norway	24	2	3	2 570 000	—
Sweden	70	22	7	20 000 000	—
Switzerland	21	0	1	1 450 000	1994
United States	565	120	15	82 290 000	1989

3. OVERVIEW OF ENVIRONMENTAL PROTECTION FRAMEWORKS

This section presents an overview of how different countries have created organisations to issue permits and under what legislation it is done. It describes the authorities that issue the permits in each country, and the policies and rules their governments have put in place to guide the authorities. Information is provided on pollutant release limit standards and environmental quality objectives. Information is also presented on BAT and BAT use in each country.

A brief commentary is made on technology based limits and environmental quality based limits. When setting permit conditions, environmental authorities are concerned with ensuring that plant emissions to the receiving media (air, land and water), do not impair the quality of the media for use by others. The authorities have to balance the interests of all users of the environment when issuing permits. In a perfect world, it would be desirable to have zero-releases from industrial facilities. However, in reality the creation of wastes is inevitable in all manufacturing, as well as in all living organisms. The authorities are therefore concerned with ensuring that plants are controlled in such a way that their pollution does not adversely impact the quality of the environment and negatively affect the interests of others.

3.1 Legislative and administrative aspects of permitting

In implementing permit systems, many governments provide guidance to their permitting authority. National requirements are also influenced by international conventions, e.g. the agreements and targets set by the regional sea conventions for the North Sea and North Atlantic (OSPARCOM) and the Baltic Sea (HELCOM), as well as by the International Joint Commission for the Protection of the Great Lakes. This guidance may be given in the form of technology based limits which governments either mandate or believe an industry should attain. Mandating is done by regulations or rules that governments have issued. Governments also issue targets that should be attained or limits that should be taken into consideration by the permitting authority, when issuing permits. In a target based approach in which overall goals are set for an industry sector, there is more latitude for variation in individual specific cases. In a regulation based approach all mills of a certain type have to meet the same level of performance.

The second area of guidance comes from environmental quality standards that governments have issued. These are often referred to as environmental quality objectives (EQOs). These describe what the quality of the receiving media should be for certain uses. EQOs for receiving waters cover items such as the concentrations of different pollutants in water, the physical properties of the water with respect to colour, visibility and temperature, and very importantly for water, the concentrations of dissolved oxygen. Dissolved oxygen is important with respect to pulp and paper mill pollution because large quantities of organic material may reduce the water's dissolved oxygen content below suitable levels for sustaining the organisms present.

Particular attention is paid in pulp and paper industry permitting to ensure that the releases of biological oxygen demanding materials are below levels that will affect dissolved oxygen. Many countries have specified EQOs in order to guide permit decisions. These EQOs are often used to develop more stringent limits beyond those applied under a technology based approach.

This report shows that there are basically two types of organisations that are responsible for the administration of the permit systems in the different countries. These are (i) officials of federal or state governments who are delegated the power to administer and issue permits, or (ii) constituted bodies established by government. Administration by government officials is the dominant form of permit administration and is the system in place in seven of the ten countries. The exceptions are Sweden and Finland where constituted bodies appointed by the government issue permits, and New Zealand where Regional Councils issue permits. Generally it appears that national governments have delegated the power to issue permits to a state or lower levels while maintaining some level of control. In some countries the constitutions empower provinces/states to issue the permits. The following provides a brief overview of the permitting and administrative systems in each country:

Austria: In Austria the federal government is responsible for developing and executing legislation dealing with business, industry, forestry, and water rights. These laws are used for environmental purposes including permitting. The laws specify which permit authorities can issue and administer permits. Construction permits are issued by area managers and most other permits by County Administrative Authorities. Provincial governments assist the local officials in this task.

Belgium: Belgium consists of three regions: Flanders, Wallonia, and Brussels. Under the Belgian constitution, regions have the authority to address “territorial policy matters,” including those dealing with environmental control. Regions establish the framework and laws for environmental control. Permits are issued by the provincial governments who report to the regional governments. The regional governments handle appeals and environmental impact assessments.

Canada: In Canada, responsibility for the environment is shared among the federal and provincial governments. Both the federal and provincial governments are involved in regulating effluent discharges. Air pollution and solid waste control issues are primarily managed by provincial governments. The federal government controls effluent releases to water under the Fisheries Act and pollutants that have been declared toxic under the Canadian Environmental Protection Act (CEPA). For pulp and paper, federal regulations serve as a national baseline standard. Administrative arrangements have been made between the federal government and most of the provinces dealing with the implementation of the federal legislation. Provinces may enact more stringent requirements as necessary to suit local requirements.

Finland: In Finland, environmental control is effected under a number of pieces of domestic legislation and international agreements. The Ministry of the Environment co-ordinates and directs environmental protection, prepares legislation and regulations, and supervises administration by local authorities. Permits for the discharge and control of liquid effluents causing water pollution are issued by Water Courts. Permits for the control of air pollution and for solid waste management are issued by thirteen Regional Environmental Centres located throughout the country.

Germany: Effluent releases are controlled under the Federal Water Act, air emissions under the Federal Immission Control Act, and solid waste management under part of the Federal Immission Control Act and the Waste Avoidance and Waste Management Act. With respect to the Water Act, state governments (Länder) may add to the federal law. In each Länder a number of local authorities are set up on a regional basis to grant and administer permits. Various ordinances issued under the Acts define permit requirements.

New Zealand: In New Zealand, the Resource Management Act forms the main legislation under which natural resource management is effected. Regional Councils are responsible for management of natural resources, including discharges to air, land and water and for resource use. The central government is less active in the delivery of environmental controls. In cases where it is necessary, the central government is empowered to promulgate national environmental standards on issues of national importance. District councils are responsible for land use management and subdivision. Both the regional and the district councils are local authorities with their own responsibilities and linkages to the central government.

Norway: Permits to discharge pollutants to the air and water are issued by the Norwegian Pollution Control Authority (SFT). In some cases, local environmental authorities issue permits for solid waste disposal. Under the Pollution Control Act, the Norwegian Ministry of Environment is responsible for the development of regulations to control industrial pollution and guidelines related to environmental quality. It is also responsible for the administration of the SFT. No pulp and paper mill regulations have been developed. Permits are established on a case-by-case basis.

Sweden: Environmental requirements in Sweden are set forth in the Environmental Protection Act. The Swedish Environmental Protection Agency (NV) is the central authority responsible for environmental matters including advising the National Licensing Board for Environmental Protection on individual permit decisions. The National Licensing board is responsible for the development and issuance of permits to large facilities including pulp and paper mills. The Board is autonomous with members appointed by the government. Permit decisions are based on hearings at which the NV defines BAT for the application. The board considers many factors in making permit decisions including BAT. Small facilities are permitted by the regional authorities, namely the County Administrative Boards. The County Administrative Boards also supervise the permits of large plants such as pulp and paper mills.

Switzerland: Responsibility for environmental protection in Switzerland is shared between the federal and canton governments. The federal government makes laws and regulations dealing with the environment. The federal government has established laws dealing with water and air pollution, as well as environmental quality objectives related to levels of pollutants in air and water bodies. The canton governments are responsible for applying them at the local level, including plant permitting.

United States: In the United States, Congress is responsible for passing legislation to ensure that environmental quality is maintained. The three main pieces of environmental legislation are the Clean Water Act (CWA), the Clean Air Act (CAA) and the Resource Conservation Recovery Act (RCRA). The Environmental Protection Agency (EPA) is responsible for implementing statutes and developing substantive details and procedures to ensure that environmental goals are met.

Environmental control requirements for pulp and paper mills and other industries are implemented using a permit system as well as rule based requirements. In some states requirements are issued to facilities by EPA Regional Offices. However, in most states, the EPA has granted state governments the authority where their requirements meet those of the EPA. The EPA retains oversight powers and can act when state implementation plans (SIPs) do not meet EPA requirements. The EPA provides funding to implement state programs.

Tables 3 and 4 provide a summary of the water and air permitting practices in each country including the type of administrative authority and the nature of the decision making process. It is noted that these tables refer to technologies that include minimum performance values that are mandated. These are in the form of maximum allowable limits. Better performance, stricter standards are set in cases such as sensitive sites.

Table 3. **Summary of effluent permitting practices**

Country	Effluent regulations	Administrative authority	Decision-making process
Austria	Federal	County Authorities assisted by province	Regulations set technology-based maximum values, but stricter requirements may be set based on EQOs
Belgium	Federal	Provincial governments report to regional governments	Case-by-case
Canada	Federal and Provincial	Provincial / federal government*	Regulations set maximum values, but stricter requirements may be set based on EQOs
Finland	None, but overall industry discharge targets set	Water Courts	Case-by-case considering a combination of BAT and EQO
Germany	Federal	State government	Regulations set BAT-based maximum values but stricter requirements may be set based on EQOs
New Zealand	None	Regional Councils	EQO on case-by-case basis
Norway	None	National government	Case-by-case basis
Sweden	BAT objectives set by NV	National Licensing Board	Case-by-case basis
Switzerland	Federal	State government	Regulations set BAT-based maximum values but stricter requirements may be set based on EQOs
United-States	Federal	State government as delegated; otherwise EPA Regional Offices	Regulations set technology maximum values but stricter requirements may be set based on EQOs. EQO provides ultimate basis

* Administrative agreements have been concluded or are under development with the provinces to provide a single window for the delivery of federal requirements.

Table 4. **Summary of air permitting practices**

Country	Air emission regulations	Administrative authority	Decision-making process
Austria	Federal	County Authorities assisted by province	Regulations set maximum values but stricter requirements may be set based on EQOs
Belgium	None but European Community and OSPARCOM used as guide	Provincial Governments report to Regional Governments	Case-by-case
Canada	Provincial regulations or objectives	Provincial government	Stack limits and/or point of impingement
Finland	Council of State decisions guide limits	Regional Environmental Centres	Case-by-case considering BAT & AQO’s
Germany	Federal regulations	State government	Regulations set BAT-based maximum values but stricter requirements may be set based on EQOs
New Zealand	None, but there are guideline values	Regional Councils	Case-by-case
Norway	None	National Government	Case-by-case
Sweden	BAT objectives set by NV	National Licensing Board	Case-by-case
Switzerland	Federal	State government	Regulations set BAT-based maximum values but stricter requirements may be set based on EQOs
United-States	Federal	State Government as delegated otherwise EPA Regional Offices	New plants and modified plants have to meet BAT limits under Federal Rules. Existing plants that are not modified are subject to state requirements

3.2 Discussion of the permitting process

Most countries participating in the study indicated that permits were required for the discharge of pollutants to the various media. The following provides a brief overview of the permitting process; readers are referred to the individual country reports for more detailed information.

3.2.1 *Events triggering permitting*

Most countries indicated that the permitting process is normally triggered by new plant construction, plant expansion or process alteration, or where environmental quality requires it.

3.2.2 *Permit application procedure*

While there is some variation in the permitting processes in the participating countries, a typical sequence of events would be:

- The permittee submits an application.
- The application is evaluated and proposals for permit conditions are made by the permitting authority. Public hearings may be held on the process although this is not common to all countries.
- The documents are released to the public for review and comment.
- The permitting authority makes a decision regarding permit limits and other conditions.
- The permittee and others with an interest in the permit have a right to appeal.
- Amendments are made to the permit if appropriate.

3.2.3 *Information required in permits*

The information required by countries is similar and concerns material inputs, process information, emissions to air and/or water, pollution control plans, and studies to predict environmental effects. The following summarises the information required by each participating country.

Austria: Industrial plant permits under the Trade and Industry Act require applicants to provide a waste management concept. Under the Water Act, the applicant must provide authorities with all technical documents (products, capacities, raw and auxiliary materials, and plans), requested water use in qualitative and quantitative terms, as well as any additional information regarding emissions expected from the plant (by type and quantity) for evaluation. In the case of projects covered under the Environmental Impact Assessment Act, applicants must provide an environmental impact report that encompasses an evaluation of the anticipated impact on the environment.

Belgium: Incident studies concerning the project must be submitted. These studies describe the general project to which the application applies, the environmental conditions of the site, and the types of emissions, including air emissions, noise, effluent discharges, solid waste management, and transportation effects. Mitigative measures must also be described.

Canada: Required information varies depending on the permitting province. The following information is typically required: process equipment specifications; process emission data (quantities, composition, and physical characteristics); for permit renewal, statistics on performance during the previous approval period; process overview and equipment modification summaries; and material flow balances, including chemical usage.

Finland: Permit applications require descriptions of the manufacturing process, raw materials and chemicals used, and measures employed for controlling pollution, including equipment specifications; estimates of the quantities and characteristics of wastewater; a description of the receiving water; and a prediction of the possible impact of the proposed activity on the environment.

Norway: Permit applicants must complete a form and include information describing: the location and the nature of the plant; the number of employees; any change in activity; the process type used; production capacity; direct and indirect releases of effluents, including quantities, chemical analyses and toxicity tests results; details of pollution control measures; details of the receiving waters; atmospheric releases including quantities, analyses and description of abatement measures, stack heights and results of dispersion modelling; sources of noise, and results of measurements in the locality; neighbours' concerns and details of planned abatement measures; contingency plans to address abnormal releases to water and air; internal pollution prevention systems that will be applied; and means to measure various releases and draft monitoring programs for air and water.

Germany: *Air* - Applicants are required to measure the quality of the environment in the area in which they want to locate or operate. They have to model the pollution they will generate and consider it in the broader emission pattern.

Water - An application must be made to use the water source. It must be demonstrated that the effluent meets the minimum requirements for pulp and paper mills discharging into the aquatic environment from the Nineteenth General Administrative Regulation on Minimum Requirements for Waste Water.

New Zealand: Applications are lodged for the use of natural resources. The application is advertised in the local press and written notice is also usually given to affected parties. A sign may also be erected on the site of the operation indicating the proposed activity.

Sweden: In order to obtain permits, applicants must provide details regarding current and anticipated environmental releases from the process; the generation and disposal of waste and noise; possible future remedial measures and the cost of such measures; and an environmental impact assessment.

Switzerland: The application should provide detailed information on the process, the emission of pollutants from various sources, and plans to abate and control releases.

United States: The application must contain basic information on the facility and its operations, including pollution and pollution control measures. For effluent permits, information must be provided on BOD, COD, TSS, ammonia, pH, and summer and winter temperatures. Mills must also do a priority pollutant scan covering an extensive list of analyses. This includes radio nuclides, heavy metals, toxics, pesticides, and semi-volatiles. The permitting agency may also require additional information.

Fewer air permits were reviewed as part of this study than in the case of water permitting. The reason for the differences between the number of water permits obtained and the number of air permits obtained could be explained by the fact that water permitting currently used an overarching permit system (the NPDES). For air permitting, an overarching permitting system under Title V of the CAA is in the course of being implemented. This will combine all the air requirements in a single document. These requirements are covered by various instruments issued in response to different air rules and systems. These include requirements under State Implementation Plans (SIP), New Source Performance Standards (NSPS), and the permitting rules related to the Prevention of Significant Deterioration (PSD) and New Source Review (NSR) requirements. These are described in detail in the Country Profile of the United States. (The absence of a consolidated document makes assembly of this information difficult.)

3.2.4 Process followed to develop limits including negotiations and hearings

Pollution limits are set in all jurisdictions but to differing degrees. The most common outcome is to allow a phase-in period for existing plants to meet new emission limits and conditions. New plants have to meet new emission limits upon start-up.

The countries in this study fell into two groups: those having technology-based regulations in which maximum authorised releases of pollutants in the water and air waste streams were set as regulations or rules, and those without such regulations. In the case of the former, the limits in the regulations are the maximum allowable limits that may be set in permits. However, in the case of sensitive ecosystems, more stringent requirements may be established by the regulatory authorities. Effluent dilution and air dispersion models are often used and ambient levels are compared with EQO parameters. Permissible releases are then calculated based on acceptable ambient levels.

In the cases of countries where such regulations have not been set, permit limits are established on a case-by-case basis, taking into consideration BAT, EQOs, and other factors such as economics.

The negotiation process is similar when establishing regulations and objectives, and when setting individual permits conditions. Different forums are used to obtain public input into the permitting and regulatory processes. In some countries, the forums include public meetings and/or notices to solicit comments from all parties. In others, discussions only involve the proponent and the permitting authority. However in the latter case, input is sometimes sought from other stakeholders toward the end of the process. Readers are referred to the individual country profiles for details.

Appeals are common in the permitting process; one country indicated that appeals must take place during the establishment of regulations and objectives rather than during the development of permit limits. Consecutive appeals can generally be made to increasingly higher levels of authority within government.

3.2.5 Consideration of economic factors

Economic considerations are weighed when establishing technology based emission regulations and individual permit conditions. For example, assessments are made as to what costs are reasonable for the installation of pollution prevention control measures. Consideration is also given as to how proposed regulations compare to those of other countries, and how trade may be affected.

A major economic concern is the timing of compliance for existing mills. New mills have to meet the regulations upon start up but a phase in period is generally allowed for existing mills. Achieving compliance with newer, more stringent limits is generally more difficult for existing mills than for new mills. Existing mills may have to replace or modify their current equipment and require greater accommodation to meet the financial obligations any new rules may impose. Most permits take this into account through schedules for the installation of equipment and periodic reviews of the permits.

3.2.6 Use of multimedia permitting

In the countries involved in this study, permits ranged from single media permits to fully integrated, multi-media permits. Austria and Belgium issue single media permits. The USA practices separate permitting under three acts of Congress relating to air, water, and solid waste. In Canada, some provinces use a single approval to cover air, water and solid waste, while other provinces use single media permits. Integrated, multi-media permits are issued by Norway and Sweden for releases to air, water, land

and noise. Integrated permits are also used by Switzerland covering releases to air, water, and land. Finland, Germany and New Zealand indicated that they are moving towards a more integrated approach to pulp and paper mill permitting. The recently adopted EU Directive on Integrated Pollution Prevention and Control (IPPC) requires an integrated approach to controlling industrial facilities.

3.2.7 Environmental impact assessment

Nine of the ten participating countries indicated that Environmental Impact Assessments (EIAs), in some form, are included in the permitting process. The use of EIAs in the US was not defined in this study. Details concerning the scope and content of EIAs are provided in the individual country profiles.

3.2.8 Permit duration

The duration of permits varies considerably among the participating countries with some countries issuing permits for fixed periods and other countries issuing permits for indefinite periods of time. Permit duration also varies according to the type of permit (air emission, effluent discharge, or solid waste) and the facility or process (e.g. pulp mill, kraft recovery boiler, power boiler). Most countries indicated that regardless of the permit length, permit review is possible in the event of process change, deterioration in effluent quality, or changes in the environmental laws. Table 5 identifies permit duration in different countries.

Table 5. **Permit duration**

Country	Permit Duration
Austria	Permits granted under the Trade and Industry Act generally have no time limit. Permits granted under the Water Act are usually valid for a limited time. The limits are specified in the permitting decision, and as a rule, they are valid for 5 years.
Belgium	The duration of authorisations varies according to the facility to which the authorisations apply. For example, authorisations for pulp mills apply for a maximum of 30 years, effluent discharge authorisations are valid for 4 years, boiler authorisations are valid for the life of the boiler, and waste management facility authorisations are valid for 10 years.
Canada	The duration of permits varies from province to province. In Alberta, for example, approvals are renewable on a 10-year cycle. In British Columbia, permits have no time limit. In Ontario, approvals are also of indefinite duration (Ontario approvals apply only to the design and operation of process equipment).
Finland	Permits granted by the Water Court specify renewal periods varies from between 3 to 10 years. Permits for emissions to air and for waste management have so far been granted indefinitely until further notice.
Norway	Once granted, permits have an indefinite life, but may be withdrawn after 10 years.
Germany	The two water permits provided had a duration of 20 years. Details were not available on the duration of air permits.
New Zealand	Permits are issued for a fixed period, usually 5–10 years, although some recent land-based permits issued by regional councils have been issued for 20 years. Equipment and processes with low environmental impact, such as new power boilers, may receive permits with terms of 35 years (the maximum period possible); potentially more environmentally significant process operations, such as low odour kraft recovery boilers, would receive permits of shorter duration
Sweden	There is no process requiring that permits be reviewed; however, after 10 years the NV may ask that a permit be reviewed.
Switzerland	Permits are normally issued for an indefinite period of time.
United States	Permits are issued for set time periods. In the case of water discharge permits reviewed most were of five-years duration.

4. PERMIT REQUIREMENTS AND DECISIONS

4.1 Overview

Permit limits are established by the permitting authorities. The limits are set by considering what emission levels mills can attain through the use of appropriate pollution prevention techniques and end-of-pipe treatment. In some cases, regulations may set maximum emission levels. These limits are considered as minimum requirements that the permitting authority may set at sites. In some instances, more stringent requirements may be imposed because of environmental considerations. In some countries, sectoral emission regulations have not been set and permit decisions are based on technology assessments carried out on a case-by-case basis. Some plants which produce the same products may be granted more lenient levels based on their unique circumstances.

The environmental sensitivity of a site is incorporated into the permit limit decision by projecting how emissions may affect the quality of the receiving medium. Air dispersion and water mixing models may be used. Results are reflected in the quantities of pollutants that facilities are permitted to release. In some instances, decisions may be based solely on the needs of the receiving environment, with the maximum permissible limits established based on assimilative capacity. This is referred to as an EQO-based approach.

Pollution prevention is an approach by which the creation of pollution is avoided, or its extent minimised, through internal process control measures at the mill. This approach encompasses the use of cleaner technology. It includes the reformulation of products to substitute less toxic chemicals for toxic compounds and the redesign of processes to destroy toxics created or used in the process. The three environmental “Rs” of Reduction, Reuse and Recycle are also used to minimise the quantity of waste generated thereby reducing releases and the capital and operating costs of end-of-pipe treatment.

External end-of-pipe treatment processes are used to remove/reduce pollutants from waste streams. They involve chemical, biological, and physical treatment of the wastes to remove pollutants or to render them harmless to the environment. Treatment processes generally do not result in the recovery of valuable materials and the processes represent a net cost to the facility.

4.2 The use of technology based regulations and targets for waste water discharge control

4.2.1 Countries with regulations

Six countries covered in the study, Austria, Belgium, Canada (at the federal level and the provincial level in British Columbia, Ontario and Quebec), Germany, Switzerland, and the US have issued technology based regulations or rules for water permitting. These set the maximum values that the permitting authorities may allow in a mill permit (in some instances, where EQO considerations require, even more stringent limits are set). The content and context of the individual regulations are described in the individual country profiles. Annex 2 includes tables summarising the regulations in each of the countries, including the actual values of the discharge limits.

Most regulations make the use of proxy parameters to ensure that a satisfactory effluent quality is attained, rather than regulating individual substances. The following summarises the application of the proxy parameters used in regulations:

- Biological oxygen demand determined (BOD) on a 5-day basis was used in the regulations of all six countries (Austria, Belgium, Canada, Germany, Switzerland, and the US).

- Total suspended solids (TSS) limits were used in five countries, Germany's regulation did not include TSS.

- Chemical oxygen demand (COD) limits were also included in the regulations of three countries, Austria, Belgium and Germany.

- Total organic carbon limits were included in the Belgium regulation;

- Absorbable organic halide (AOX) limits were included in the regulations of Austria, Germany, and some individual Canadian provinces. The US EPA has set AOX limits in new effluent guidelines issued on April 15, 1998 for bleached chemical pulp mills. These were developed under their Cluster Rule process and some states include AOX in regulations and permits. These new rules have not yet been incorporated into current mill permits.

- Both tetrachlorinated dioxins and furans were regulated under the Canadian federal regulations, and in the regulations of some Canadian provinces. The US EPA is also developing regulations for tetrachlorinated dioxins under the Cluster Rule process (some US effluent permits include tetrachlorinated dioxin limits).

- Acute lethality requirements, at different dilution levels, and using different fish species, were included in regulations of three countries, Canada, Germany and Switzerland. In addition, several permits in the US included monitoring requirements for acute and/or chronic toxicity at various dilution levels using various species. Readers are referred to the individual country profiles for details of the test methods and how the results are applied.

- Permit limits were set in terms of mass per tonne of production in four of the countries, Austria, Canada, Germany, and the US. Limits in Belgium and Switzerland were set as concentrations in the effluent.

4.2.2 Guidance provided in countries without regulations

The other four countries in the study, Finland, New Zealand, Norway and Sweden, have not found it necessary to issue specific regulations with legally-binding standards. Permit decisions are reached based on case-by-case considerations without reference to regulations. However, the three Scandinavian countries, Finland, Norway and Sweden, have issued policy guidance documents or other means to direct individual permit decisions. These guidance documents are often influenced by the agreements under the regional sea conventions for the Nordic countries, i.e. OSPARCOM, HELCOM, or other international conventions on transboundary air pollution and the Nordic Council of Ministers. New Zealand bases its permit on the needs of the local receiving media, however, it also takes into account the regulations of other countries.

The major elements pertaining to effluent control in the policy guidance documents of Finland, Norway and Sweden are summarised below:

Finland: Finland develops permit requirements on a case-by-case basis. Finland uses the recommendations of a Nordic Working Group on the pulp and paper industry as guidance for BAT and as a starting point for considerations in permit decisions. In 1993, a working group of representatives from Denmark, Finland, Norway, and Sweden made recommendations on air emission and effluent discharges from different types of mills, covering new and existing mills. The targets were specified as annual averages that should not be exceeded. The performance targets for existing and new mills are shown in Tables 6 and 7. These direct effluent performance using COD and AOX limits.

Table 6. **Nordic Working Group statement of performance targets, kg/t (annual averages), for different pulping processes applicable to existing mills**

Mill type	AOX	COD_{cr}	Total P	Total N(1)	Sulphur(2)	NO_x(2)
Bleached kraft	0.4	30	0.04	0.2	1.0	1.5
Unbleached kraft	—	15	0.02	0.2	1.0	1.5
Bleached sulphite	0.3	70	0.08	0.6	1.5	2.0
CTMP(3)	—	30	0.02	0.2	—	—
Mechanical(4)	—	10	0.01	0.2	—	—
Recycle(5)	—	10	0.01	0.2	—	—

Table 7. **Nordic Working Group summary of performance targets, kg/t (annual averages), for various types of new mills**

Mill type	AOX	COD_{cr}	Total P	Total N(1)	Sulphur(2)	NO_x(2)
Bleached kraft	0.2	15	0.02	0.15	0.5	1.0
Unbleached kraft	—	8	0.01	0.15	0.5	1.0
Bleached sulphite	0.1	35	0.04	0.3	1.0	1.0
CTMP(3)	—	15	0.01	0.1	—	—
Mechanical(4)	—	5	0.005	0.1	—	—
Recycle(5)	—	5	0.005	0.1	—	—

1. Any nitrogen discharges associated with the use of complexing agents should be added to the figure for total nitrogen above.
2. Includes all sulphur and NOx gaseous emissions from the mill except from its auxiliary boilers.
3. Chemi-thermo-mechanical pulp.
4. Mechanical pulp mills are integrated mills that produce newsprint or magazine paper.
5. The figures cover units producing pulp. Additional allowances would be made for papermaking operations.

In addition to these specific regulations, Finland has set overall targets that different segments of their pulp and paper industry should attain by 1995. The following targets were set for different segments, all of which have been met:

- For the overall wood processing industry: BOD_7 - 160 t/d (1995)
Phosphorus - 1.5 t/d (1995)
- For the kraft pulp industry: AOX - 1.4 kg/ADt (1994)
COD_{cr} - 65 kg/ADt
Phosphorus - 60 g/ADt
- For the fibreboard industry: BOD_7 - 10 kg/ADt

Norway: For guidance in permit decisions, the Norwegian Pollution Control Authority (SFT) uses the content of international agreements as a basis for its permitting decisions. As an example of a decision that it used, the SFT quoted Decision 95/2 made by the Paris Commission. These are summarised in Tables 8 and 9.

The effluent limits cover COD and TSS; the air limits cover SO_2, and NO_x on a plant “bubble” basis.

Table 8. **OSPARCOM limit values for sulphite in the pulp and paper industry**

	Limit values, kg/tonne of air dry pulp	
	Existing Mills up to 31-12-99	**New Mills, or capacity increased by more than 50% after 31-12-96**
COD	80	35
TSS	8.0	4.5
SO_2	5.0	3.0
NO_x	2.5	1.5

Table 9. **OSPARCOM limit values for sulphate in the pulp and paper industry**

	Limit values, kg/tonne of air dry pulp			
	Existing Mills up to 31-12-99		**New Mills, or capacity increased by more than 50% after 31-12-96**	
	Bleached Pulp	**Unbleached Pulp**	**Bleached Pulp**	**Unbleached Pulp**
COD	50	20	30	10
TSS	8.0	8.0	4.0	4.0
SO_2	2.0	2.0	1.0	1.0
NO_x	2.0	2.0	1.5	1.5

Sweden: Similar to Finland, Sweden also requires BAT to be applied on a case-by-case basis. The Swedish Environmental Protection Agency (NV) has its own in-house experts who appear before the permitting authorities for each permit decision. The NV has developed guideline values for the key control parameters for different pulping processes. This is used as a starting point for the consideration of permit limits when the NV appears before the National Licensing Board.

Table 10 summarises the recommended limits for the different processes, per tonne of pulp produced.

Table 10. **BAT recommendations for waste water discharge control at different types of mills in Sweden** (Swedish Environmental Protection Agency, 1992)

	AOX (kg/t)	**COD_{cr} (kg/t)**	**P (g/t)**	**N (g/t)**
Kraft Pulp	0.1–0.2	10–15	10–20	100–200
Sulphite Pulp	0	20–50	10–20	100–500
CTMP(2)		10–15	5–20	100–200
TMP(3)		3–5	4–6	50–100

1. CTMP, chemi-thermo-mechanical pulp.
2. TMP, thermo-mechanical pulp.

Different sets of limits have been developed for the kraft, sulphite, chemi-thermo-mechanical, and thermo-mechanical pulp industry.

For kraft and sulphite industries, effluent limits have been developed for AOX, COD_{cr}, phosphorus and nitrogen. For the bleached sulphite industry, a zero-AOX value is recommended, as non chlorine based bleaching processes are widely used. For air, limits are recommended for total sulphur and nitrogen oxide emissions from all combustion units, excluding power boilers.

For the CTMP and TMP industries limits are made for COD_{cr}, phosphorus and nitrogen.

In addition to this, the Swedish government, in an environmental bill passed in 1992, stated that the pulp and paper industry should work to attain no noticeable effect due to its effluent releases by the end of the century. The bill requires the development of technologies to attain this goal, where attention should be paid to non-chlorinated chemicals as well as chlorinated ones.

4.3 The use of technology based regulations and targets for air emission control

Similar to the case of effluent control, most of the countries included in the study have developed regulations (rules), or guidance documents for air emission control. These are applied within the permitting process in a similar manner as for effluents.

Control of air pollution is often a more complex task than that of liquid effluents because wastewater source are easier to collect into common or separate streams, for either recirculation to the process or for treatment. This is more difficult for waste air streams, and the size and cost of air ducting and moving systems (fans) is far more expensive than for wastewater effluent streams. The number of air emission point sources at the mills is far greater than for wastewater effluents. Each major production unit, e.g. power boiler, recovery boiler, lime kiln, slaking tank, etc., is a discrete source and may be considered separately in the permits. With regard to most wastewaters, effluents from discrete units go to common treatment processes. Thus fewer effluent point sources need to be considered in water permitting.

The profiles on the individual countries describe the air regulation and guidance frameworks where regulations have not been developed. The following provides a brief overview of the approaches in each country.

Austria: The permits require the application of BAT for emission control. Relative to pulp and paper mills, emission limits apply to kraft recovery boilers covering dust, SO_2, NO_2, and H_2S. For sulphite mills, limits are set for dust, SO_2, and NO_2 emissions. These are described in the Swiss profile.

Air quality objectives contain ambient concentrations for SO_2, particulates, CO and NO_2.

Belgium (Wallonia): Details of the air emission permitting system applied were not defined in the study.

Canada: Air regulation and permitting is implemented at the provincial level. The approaches vary among provinces as described in the Canadian profile.

Alberta

In Alberta, air pollution control requirements are contained in common approvals covering all three media (air, land and water). End-of-stack limits contained in approvals are based on a combination of (i) ambient air quality criteria, (ii) consideration of BAT, and (iii) site specific criteria.

Alberta also considers what requirements other authorities such as the US EPA have set as limits for the different sources. Alberta's approvals list all sources of air emissions (stacks, vents, exhausts, etc.) and their associated air pollution control equipment. Limits are specified for major emission sources. Approvals also specify applicable monitoring (for both source and ambient) and corresponding reporting requirements. The mills must report all incidents of non compliance to the environment ministry.

British Columbia

Pulp and paper permits contain end-of-stack emissions limits, ground level ambient air limits, and stack and ambient monitoring requirements. Measures such as upgrading and construction requirements may be included. Permits list all sources of air emissions (stacks, vents exhaust, etc.) and their associated air pollution control equipment. The end-of-stack limits in permits are developed considering BAT, pollution control objectives (see Table 11), site considerations and rules implemented in other jurisdictions.

Table 11. **British Columbia pollution control objectives for the forestry industry**

Source	**Total reduced sulphur**		**Particulate matter**	
	Level A	**Level B**	**Level A**	**Level B**
Recovery boiler	6.5 ppm	26 ppm	5.5 g/mol	11.0 g/mol
Lime kiln	—	—	5.5 g/mol	11.0 g/mol
Smelt tank	—	—	0.2 kg/ADt	0.4 kg/ADt
Fugitive emissions*	0.225 kg/ADt	0.350 kg/ADt	—	—

* Includes emissions from the pulp digester system, evaporators, condensate stripping, brown stock washing, black liquor oxidation, smelt dissolving tank, lime kilns and total reduced sulphur gas incineration systems.

Level A limits apply to new and modernised facilities; level B limits apply to facilities existing in 1977, with the expectation that they would be upgraded to level A within a reasonable time frame.

Ontario

New and modified air emission sources have to receive an approval. These sources must meet the point of impingement (POI) standards according to results calculated using an appropriate air dispersion model. Table 12 summarises the POI limits for substances of concern from kraft mills.

Table 12. **Ontario regulated point of impingement limits (partial list)**

Contaminant	**Limit ($\mu g/m^3$)**	**Time-average basis (minutes)**
H_2S	30	30
NO_x	500	30
SO_x	830	30
Particulate matter	100	30
CO	6 000	30
Ozone	200	30
Cl_2	300	30
ClO_2	85	30

In addition, particulate limits of 90 mg/m^3 are set in guidelines for wood combustors less than 200 t/d, and 50 mg/m^3 for those less than 200 t/d . A Boilers Regulation limits the sulphur content of fossil fuels to 1 per cent.

Quebec

A Pulp and Paper Mills Regulation (Province of Quebec, 1992) sets limits for air, water and solid waste discharges from pulp and paper mills. The air requirements contained in the regulation are based on the end-of-stack concept and set emission limits for kraft and sulphite mills. Sources covered include the recovery boiler, lime kiln and smelt dissolving tank. NCGs limits are set for the digester system, evaporator system, brown stock washers system and the condensate stripper systems. Table 13 summarises the limits set for kraft mill sources.

Table 13. **Quebec kraft pulp and paper air emission limits for different sources**

Source	**Total reduced sulphur(1)**		**Particulate matter(2)**	
	Existing units	**New units**	**Existing units**	**New units**
Recovery boiler	20 ppm	5 ppm	200 mg/m^3	100 mg/m^3
Lime kiln	10 ppm	10 ppm	340 mg/m^3	150 mg/m^3
Smelt tank		16 g/t BLS(3)	165 g/t BLS	100 g/t BLS
Digester blow and relief system	10 ppm	10 ppm	-	-
Evaporators	10 ppm	10 ppm	-	-
Condensate stripper	10 ppm	10 ppm	-	-
Brown stock washers	10 ppm	10 ppm	-	-

1. Total reduced sulphur emissions limits expressed in ppm are calculated on a dry basis corrected at 8% O_2.
2. Particulate matter emissions limits expressed in mg/m^3 are calculated at 25 ^0C and 101.3 kPa on a dry basis corrected at 8% O_2.
3. BLS is black liquor solids.

In addition to the pulp and paper regulations, Quebec's Air Regulation also sets limits for Power Boilers and Wood Waste Boilers. These include limits for NO_x and particulate emission limits from units involved in energy production at pulp mills. These limits also apply to similar units at other types of operations. Table 14 summarises the NO_x limits that apply to different types of units. The limits are summarised below.

Table 14. **Quebec power boiler NO_x limits**

Source	**Size**	**NO_x[1]**
Natural Gas Boilers	<70 MW ≥70 MW	150 ppm 200 ppm
Oil Boilers	<70 MW ≥70 MW	325 ppm 250 ppm
Coal Boilers	<70 MW ≥70 MW	450 ppm 500 ppm

1. Flues gas volumes corrected to 3% O2 and dry basis.

Table 15 summarises the particulate matter limits that apply to boilers burning different types of fossil fuels. Table 16 summarises the limits for woodwaste fired boilers.

Table 15. **Quebec power boiler particulate limits**

Type	**Size (output capacity)**	**New installation**	**Existing installation**
Gas/oil	3-15 MW	60 mg/MJ	85 mg/MJ
Gas/oil	>15 MW	45 mg/MJ	60 mg/MJ
Coal	3-70 MW	60 mg/MJ	85 mg/MJ
Coal	>70 MW	45 mg/MJ	60 mg/MJ

Table 16. **Quebec woodwaste boiler particulate limits**

Size of unit	Existing unit	New unit	Proposed new limit[1]
< 3 MW	600 mg/m^3	600 mg/m^3	-
> 3 MW	450 mg/m^3	340 mg/m^3	-
3 - 10 MW	-	-	340 mg/m^3
> 10 MW	-	-	100 mg/m^3 for existing units 70 mg/m^3 for new units

1. Flues gas volumes corrected to 7% O2 and dry basis.

Finland: Permit requirements are established on a case-by-case basis considering BAT, environmental needs and economics. Finland refers to the 1993 recommendations of the Nordic Council of Ministers as a starting point to BAT. These recommend an overall release target from all units excluding auxiliary boilers of 1.0 kg/tonne for sulphur in all forms. An NO_x target of 1.5 kg/ADt was recommended. These are applied on a bubble concept to the whole complex.

Several Council of State decisions also regulate air emissions; the following are relevant to pulp and paper mill control:

- Guidelines to Restrict the Particulate Emissions of Power and Boiler Plants (157/1987);
- Sulphur Concentration in Light Fuel Oil and Diesel Oil (158/1987);
- Restricting Emissions of Sulphur Compounds from Kraft Pulp Mills (160/1987);
- Restricting Incineration of Waste Oil (447/1987); and
- Restricting Sulphur Dioxide Emissions from Power and Boiler Plants Fired with Heavy Fuel Oil (890/1987).

Because of concerns over the effects of acid rain, an annual sulphur deposition target of 0.3 g/m^2 has been set. New proposals have also been made regarding malodorous sulphur compounds and breathable particles.

Germany: Sulphite pulping is the major chemical pulping process used. Regulations have been passed for SO_2 and NO_x covering various types of boilers including sulphite recovery boilers. Tables 17 and 18 summarise the limits. These are considered as minimum values in permits with the actual limits set being based on environmental and other factors.

Table 17. **SO_2 emission standards for different types of boilers, Germany**

Unit	O_2 reference value %	New Facilities > 10 MW	New Facilities < 10 MW	Existing Facilities > 10 MW	Existing Facilities < 10 MW
Sulphite Recovery Boilers	6	0.85	1.7	0.85 (individual combustion installations)	1.7
Power Boilers					
Bark fired	11	1.0	2.0	1.0 (individual combustion installations)	2.0
Solid fuels (except lignite)	7	1.0	2.0	1.0 (individual combustion installations)	2.0
Lignite fired	7	1.0	1.0	1.0 (individual combustion installations)	1.0
Oil fired	3	0.85	1.7	0.85 (individual combustion installations)	1.7

Note: Standards of the TA-Luft and Resolution of the Ministers of Environmental Affairs of the Länder, 1991; in [g/m^3]; dry basis.

Table 18. **NO_x emission standards for different types of boilers, Germany**

	O_2 Reference value	New Facilities		Existing Facilities	
Unit	**(%)**	**> 20 MW**	**< 20 MW**	**> 20 MW**	**< 20 MW**
Sulphite recovery boilers to 300 MW	6	0.3 (target value)		0.45	
Power boilers					
Bark fired	11	0.5		0.5	
Coal fired					
• *Grate combustion installations*	7	0.4		0.5	
• *except individual combustion installation for hard coal*	7	0.4		0.5	
• *Pulverised coal combustion installations*	7	0.4	0.5	0.5	0.5
• *Stationary fluidised bed combustion installation*	7	0.3		0.5	
• *Circulation fluidised bed combustion installation*	7	0.3	0.5	0.5	0.5
Oil fired	3	0.3 (target value)		0.45	

Note: Standards of the TA-Luft and Resolution of the Ministers of Environmental Affairs of the Länder, 1991; in [g/m^3]; dry basis.

New Zealand: New Zealand has not developed any national pulp and paper air standards. A range of guidelines have been developed covering such matters as air quality. In developing permits, the Regional Councils consider the requirements of foreign standards, such as the US EPA.

Norway: The SFT considers recommendations of the Paris Commission as a starting point for permit consideration. The limit values for sulphite and sulphate mills are shown in the Tables 19 and 20.

Table 19. **Limit values for sulphite paper pulp industry, Norway**

	Limit values, kg/tonne of air dry pulp	
	Existing Mills, up to 31-12-99	**New Mills, or capacity increased by more than 50% after 31-12-96**
SO_2	5.0	3.0
NO_x	2.5	1.5

Table 20. **Limit values for sulphate paper pulp industry, Norway**

	Limit values, kg/tonne of air dry pulp			
	Existing Mills, within 31-12-99		**New Mills, or capacity increased by more than 50% after 31-12-96**	
	Bleached Pulp	**Unbleached Pulp**	**Bleached Pulp**	**Unbleached Pulp**
SO_2	2.0	2.0	1.0	1.0
NO_x	2.0	2.0	1.5	1.5

Sweden: Similar to Finland, air permit requirements are developed considering the application of BAT and other factors. The NV appears at permit hearings. The NV has developed recommendations for the total sulphur (in all forms) and NO_x, from the kraft and sulphite processes as a starting point for BAT for air. These are considered along with other factors. Table 21 summarises the recommendations. Limits are also set for power boilers as shown in Table 22.

Table 21. **BAT recommendations for air emission control at kraft and sulphite mills in Sweden** (Swedish Environmental Protection Agency, 1992)

	S(1) (kg/t)	NO_x (kg/t)
Kraft Pulp	**0.4–0.5**	**1–1.5**
Sulphite Pulp	**1–1.5**	**1–1.5**

1. Total gaseous sulphur emissions, except from auxiliary boilers. Includes sulphur in SO_2 and in reduced forms.

Table 22. **BAT values for NO_x emissions from auxiliary boilers**
(in mg/MJ, Swedish Environmental Protection Agency)

	Existing boilers	New boilers
Biofuel	70	30–50
Coal	70–100	30–50
Oil	80–100	30–50

Switzerland: Switzerland has some standards but details were not given.

United States: In the US, air pollution control of pulp and paper mills and other industries is implemented under permits and rules that have been issued by the Environmental Protection Agency (EPA).

Pursuant to Title I of the Clean Air Act, the EPA has established National Ambient Air Quality Standards (NAAQS). Ambient standards are established by the EPA for each pollutant contained in a list of pollutants which the EPA determines "may reasonably be anticipated to endanger" public health or welfare. NAAQS were initially established for sulphur dioxide (SO_2), particulate matter smaller than 10 microns in size (PM_{10}), carbon monoxide (CO), ozone (O_3), nitrogen oxides (NO_x), and lead (Pb). Standards were later added for particulate matter smaller than 2.5 microns. These criteria pollutants have been scientifically proven to have adverse effects on human health, the environment and property. The EPA defines maximum concentrations above which the criteria pollutants have damaging effects. These thresholds are called National Ambient Air Quality Standards (NAAQS).

The NAAQS are broken down into primary and secondary standards. Primary standards are limits set to protect public health, including the health of sensitive populations such as asthmatics, children and the elderly. Secondary standards are limits set to protect public welfare, including protection against reduced visibility, damage to animals, crops, vegetation and other property. Table 23 summarises the six criteria pollutants and their primary and secondary standards. The values for the primary and secondary standards are the same for all criteria pollutants except for carbon monoxide and sulphur dioxide.

These air quality objectives are applied in the permitting process. The type of procedure applied is dependent on the nature of the air quality, relative to the objectives in the area in which a plant is located. Existing mills not subject to expansion or modification are not covered by the federal rules. However, these mills may have been affected by the State Implementation Plans designed to meet the NAAQS.

Table 23. **EPA air quality objectives: primary and secondary standards**

Criteria Pollutant	Primary Standard	Secondary Standard
Carbon Monoxide (CO)		
8-hour Average	9 ppm (10 mg/m^3)	No Limit Set
1-hour Average	35 ppm (40 mg/m^3)	No Limit Set
Nitrogen Dioxide (NO_2)		
Annual Arithmetic Mean	0.053 ppm (100 μg/m^3)	0.053 ppm (100 μg/m^3)
Ozone (O_3)		
8-hour Average*	0.08 ppm	0.08 ppm
Lead (Pb)		
Quarterly Average	1.5 μg/m^3	1.5 μg/m^3
Particulate Matter (PM) <10μm		
Annual Arithmetic Mean	50 μg/m^3	50 μg/m^3
24-hour Average	150 μg/m^3	150 μg/m^3
Particulate Matter (PM) <2.5 μm		
Annual Arithmetic Mean*	15 μg/m^3	15 μg/m^3
24-hour Average*	65 μg/m^3	65 μg/m^3
Sulphur Dioxide (SO_2)		
Annual Arithmetic Mean	0.03 ppm (80 μg/m^3)	No Limit Set
24-hour Average	0.14 ppm (365 μg/m^3)	No Limit Set
3-hour Average	No Limit	0.50 ppm (1300 μg/m^3)

* New standards set on June 25, 1997.

In 1978, New Source Performance Standards (NSPS) were passed under the under the Clean Air Act. These established emission limits for specified new production units. These were defined as units built after September 24, 1976. Specific to the industry, limits were set for the following production units:

- **Recovery Furnaces:** Opacity, particulate matter (PM), and total reduced sulphur (TRS);
- **Smelt Dissolvers:** PM and TRS;
- **Lime Kiln/Calciner:** PM and TRS;
- **Digesters and Evaporators:** TRS;
- **Non-condensible gas systems:** TRS;
- **Wood Fired Boilers:** NO_x, Opacity, and PM:
- **Oil Fired Power Boiler:** NO_x, Opacity, PM and sulphur dioxide (SO_2),
- **Natural gas Fired Boilers:** NO_x and opacity.

Existing mills in some states are covered by regulations passed as part of the State Implementation Plan to meet the national air quality objectives. Annex 2 of the US profile describes the regulatory limits of the EPA and various states. This covers limits for new and existing production units in kraft mills.

The limits in the federal NSPS were based on pollution control technology available to the sector at the time of promulgation (1978). They allowed the industry the flexibility to devise a cost-effective means of reducing emissions. Recent work conducted as part of the Cluster Rule development indicates that most sources (new and existing) meet limits set in the NSPS requirements. (EPA personal communications 1998).

As an example of limits, the following are given for recovery boilers under rules of different authorities. It is observed that the older units are granted higher limits.

Table 24. **Sample recovery boiler NSPS limits**

Federal NSPS	straight furnace cross furnace	5 ppmv @ 8 % O_2 (12 h) 8 ppmv @ 8 % O_2
Washington		5 ppmv @ 8 % O_2 ≤17.5 ppm for facilities built prior to 1970 with direct control evaporators @ 8 % O_2 (24 h)
Maine		5 ppmv for new units 20 ppmv for old units

In addition, permitting is carried out under EPA's Prevention of Significant Deterioration (PSD) Rules (see the US profile for a complete description). Under this, all new mills or expansions and modifications to existing mills that exceed the PSD emission rates for substances covered under the air quality objectives are subject to permitting. Each source then has to install best available control technology (BACT), as determined by what a similar source has done, unless it is demonstrated unfeasible. In this case, the next most effective option would be applied. A clearinghouse computer system coupled with communications between authorities in different parts of the US is used to enable this comparison. Under this approach, limits are ever decreasing as progressive BAT is applied.

Table 25 summarises the threshold increments for the relevant pollutants that trigger a PSD review. Projects where the incremental emissions stay under these values are not subject to PSD review.

Table 25. **PSD significant emission rates**

Emission	Significant Emission Rate (t/a)*
CO	100
NO_x	40
SO_2	40
TRS	10
TSP	25
PM_{10}	15
VOCs	40

* t: short tonne (2000 lb).

In regions of unsatisfactory air quality or non-attainment areas, as defined by reference to the NAAQS a more stringent policy is applied. This is referred to as New Source Review (NSR). Under this technology equivalent to the Lowest Achievable Emission Rate (LAER) has to be applied. The LAER refers to the emission rate that reflects the most stringent emission limitation contained in any State Implementation Plan (SIP), for a source category, or the most stringent emission limitation achieved by a source in that source category, whichever is more stringent. LAER does not take economic factors into account. In addition, new sources locating in non-attainment areas must purchase offsets from existing sources in the same area. The purpose of obtaining offsets is to counterbalance the emission increase from the new or modified source, so there is a net air quality benefit.

4.4 Environmental quality objectives

EQOs can be developed both for receiving waters (WQOs) and for the air media (AQOs). All countries, excluding New Zealand, have in place WQOs. New Zealand is developing WQOs at the level of its regional councils, under their regional plans.

The ultimate stringency of permits is frequently based on WQO considerations. WQOs are specified in various forms. In some cases (Canada and the USA) numerical values are specified for certain parameters and properties. In other cases, the water bodies are classed according to different quality classifications, typically from pristine to different degrees of disturbance based on various parameters. Due to the differences between approaches and an inability to succinctly summarise the various systems, readers are referred to the individual country profiles for details.

AQOs have been passed by nine of the ten countries and are now under development in the other country, New Zealand. Table 26 lists the different parameters established in the countries. The values are set as concentrations. Because of the variation in units and standard volume conditions, readers are referred to the country profiles for details.

Table 26. **Air quality objectives adopted by the participating countries**

Country	Established	Air Quality Objective Criteria
Austria	Federal	SO_2, dust, CO, and NO_2
Belgium	Federal	SO_2, dust, lead, NO_2, and ozone
Canada	Federal- Provincial objectives	SO_2, particulate, CO, NO_2, and ozone
Finland	National objectives	SO_2, particulate, CO, and NO_2
Norway	National objectives	SO_2, suspended particulate (under 10 microns), CO, fluoride, NO_2, and ozone
Germany	National objectives	SO_2, total suspended particulate, lead, CO, cadmium, chlorine, NO_2 and ozone
New Zealand	Under consideration	Under consideration
Sweden	National objectives	SO_2, ammonia, nitrogen oxides
Switzerland	Federal objectives	SO_2, total suspended particulate, lead, cadmium, dust fall per square meter, CO, NO_2 and ozone
United States	Federal	SO_2, particulate matter (less than 10μm and 2.5μm), lead, CO, NO_2, and ozone

4.5 Consideration given to best available technology

Best available technology (BAT) is a concept applied both in regulation development (where countries pass such regulations) and in case-by-case permitting. The process essentially consists of assessing the capability of available technologies to control pollutants of concern using engineering judgement, coupled with technical and economic analyses, to determine what is appropriate. BAT is normally developed through consultations between industry representatives and the regulatory authorities, with additional input from the public, environmental groups, and other stakeholders. BAT recommendations to guide permit decisions have been developed by various groups, e.g. the Nordic Council of Ministers and the Paris Commission.

A number of BAT approaches are used in the different countries, with the procedures of some countries being more formalised than others. The range of practices is illustrated by the following examples.

Austria: The term BAT is defined as the state-of-the-art based on scientific knowledge of advanced technological processes, facilities, and operational techniques, whose functionality has been tested and proven. In Austria, BAT is a dynamic concept that encompasses the present state of scientific advances and is oriented to international state-of-the-art technologies.

Belgium: Permit decisions are not based directly on the principle of BAT. Environmental control authorities and plant owners are aware of state-of-the-art production and pollution control technologies, which are considered indirectly in permit decisions. BAT concepts developed by the European Union are taken into account in Belgium; these concepts vary between those based purely on state-of-the-art and those which also consider economic aspects. In permitting, it is the results that are targeted, i.e., acceptable environmental quality.

Canada: The federal government has issued technology-based regulations, applicable to all pulp and paper mills, based on the use of technology equivalent to secondary treatment with sound water practices. These regulations specify limits for BOD, TSS, and acute lethality. The limits were developed based on engineering judgement and consideration of the performance attained by secondary treatment plants at existing mills. The regulatory limits are applicable to all mills including those currently in operation and those built in the future. The limits in these regulations are not strictly BAT-based as newer equipment and processes can achieve better performance. However, they represent an engineering judgement of what was reasonable for all mills to retrofit into their operation. Provincial regulators may also use BAT principles to set minimum industry standards for mills, where the provincial limits are more stringent than those established federally.

Finland: A BAT approach is used in individual permit decisions on a case-by-case basis. The assumed performance of technologies that are proposed by applicants are compared with those used in the best existing domestic or foreign plants. The application of BAT to each plant is considered as one factor in the decision-making process. Environmental quality and other factors, such as the amount of reconstruction required, including capacity changes, are also taken into account.

Germany: Conventional waters must be treated using best management practices prior to discharge. If the waters contain hazardous substances, state-of-the-art technology must be used to control releases. The technology is identified by reference to the performance of best available comparable procedures, facilities, or operating practices that have been demonstrated commercially.

New Zealand: Permit conditions are based on the needs of the receiving environment; hence, minimum standards based on a BAT approach are not mandated at each site. The rule of best practical option (BPO) can be included in a regional plan to prevent or minimise any actual or likely adverse effect on the environment from any discharge of a contaminant. Best practicable option is defined as follows:

> *A BPO in relation to a discharge of a contaminant or an emission of noise means the best method for preventing or minimising the adverse effects on the environment having regard among other things to:*

a) *the nature of the discharge or emission and the sensitivity of the receiving environment to adverse effects;*
b) *the financial implication, and the effects on the environment, of that option when compared with other options; and*
c) *the current state of technical knowledge and the likelihood that the option can be successfully applied.*

Application of BPO is usually carried out by a plant operator who must consider what options must be met, what standards are proposed, and the possibility that the standards cannot be achieved. For the pulp and paper industry, BPO would be used to determine whether a plant would be able to meet the required standards and to evaluate and assess the economic impact of implementing the necessary technology.

Norway: The understanding of BAT in Norway is very much in line with the description presented in the Paris Commission, where the term "Best Available Techniques" means the last stage of development of state-of-the-art processes, facilities or methods of operation, which indicate the practical suitability of a particular measure for limiting discharges, emissions and waste. It is important to note that Norway, as a part of the agreement of the European Economic Area, will implement European Community directives on Integrated Pollution Prevention and Control (IPPC), which include a definition of BAT.

Under current permitting practice, only emission limits are specified, leaving the enterprise free to choose which technology to meet the requirements. The permit limits are set based partly on consideration of the effectiveness and applicability of BAT.

Sweden: The principle of BAT is used as the starting point for setting allowable releases in case-by-case decisions. BAT is defined as the best technology used on a commercial scale at a similar plant, anywhere in the world. Experts from the Swedish Environmental Protection Agency provide advice to the Licensing Board on what constitutes BAT. In reaching permit decisions, the Licensing Board also considers the cost of installing the technologies and the effect on the environment. Consequently, some decisions may result in less stringent limits than those proposed by BAT.

Switzerland: Effluent discharge regulations were passed in 1972 based on a BAT approach. These include limits for BOD, TSS, and toxicity to fish. The regulatory limits are currently under review. The regulations are implemented at all sites; however, if further reductions are warranted at a site, assessments have to be made regarding the application of current BAT. This is defined as:

> *"If somewhere a plant or pilot plant already exists which reduces the emissions better than the standard technology, and if it is possible to monitor it, then the company has to prove whether or not they can make use of it. The economic situation has also to be taken into consideration. The authority then has the possibility of laying down new environmental standards according to the experience with this new technology."*

For new plants, environmental impact assessments have to be made and the plants have to prove that no cleaner technologies are available, other than those that will be applied.

United States: Different BAT type concepts have been applied under the requirements of the Clean Water Act (CWA) and the Clean Air Act (CAA) of the United States.

The CWA required EPA to develop national technology based standards for "existing" discharges by July 1, 1977, using what was defined as best practicable technology (BPT). This was defined as "the average of the best existing performance by well-operating plants within each category or sub-category." For sectors where it was determined that there was no well operating plants, technology could be transferred from other facilities.

BPT effluent limitations guidelines apply to discharges of conventional pollutants from existing sources. BPT guidelines are based on the average of the best existing performance by plants in a category or subcategory. In establishing BPT, the EPA considers the cost of achieving effluent reductions in relation to the effluent reduction benefits, the age of equipment and facilities, the processes employed, process changes required, engineering aspects of the control technologies, non-water quality environmental impacts (including energy requirements), and other factors as the EPA Administrator deems appropriate. CWA 304(b)(1)(B). Where existing performance is uniformly inadequate, BPT may be transferred from a different subcategory or category.

Relative to the pulp and paper industry, BCT limits and New Source Performance Standards (NSPS) were promulgated in 1974 and 1977. In developing these guidelines the EPA broke the industry into 31 process categories. Statistical analyses were made for each sector based on the performance of mills with secondary treatment. From these analyses, limits were developed for BOD and TSS releases in terms of pounds (0.4536 kg) per ton of product. (In the new cluster rule process that is underway the industry has been grouped into 12 process categories.). The BCT limits, which are the same as the BPT limits, were based on "the average of the best existing performance by well-operating plants within each category or sub-category.

The Act also required the development of a second set of standards by 1 July, 1983, based on the use of best available technology economically achievable (BAT), by the sectors. BAT was defined as the "very best control and treatment measures that have been or are capable of being achieved." The EPA interpreted "practicable" to mean justifiable in terms of total cost of industry-wide application of technology, compared with the benefits derived from effluent reduction. Section 301(b)(1) of the Act allowed in-plant measures to be considered when assessing the term "practicable." The definition of BAT allowed both end-of-pipe and in-plant measures to be considered.

In general, BAT effluent guidelines represent the best existing economically achievable performance of plants in the industrial category or subcategory. The CWA establishes BAT as a principal means of controlling the direct discharge of toxic and non-conventional pollutants to waters of the United States. The factors considered in assessing BAT include to age of equipment and facilities involved, the process employed, potential process changes, and non-water quality environmental impacts, including energy requirements. The Agency retains considerable discretion in assigning the weight to be accorded these factors. As with BPT, where existing performance is uniformly inadequate, BAT may be transferred from a different subcategory or category. BAT may be based upon process changes or internal controls, even when these technologies are not common industry practice.

EPA has also developed pre-treatment standards applicable to indirect discharges to publicly owned treatment works (POTWs). These apply to pollutants that can pass through, interfere with, or upset the operation or sludge disposal options of POTWs. These standards are based on technologies analogous to BAT.

Compared to water pollution control, air pollution control is exercised more by rules than by permits. BAT type concepts are applied, but depending on the rules, may have different content. (The new Title V permits which are under development will consolidate the outcome of all these rule decisions in a single document.)

Two programs play an important role in the maintenance of air quality. These are the Prevention of Significant Deterioration (PSD) rules and New Source Review (NSR) rules. The former applies to air quality attainment areas and the latter to non-attainment areas.

For projects covered by the PSD rules, the project must apply *best available control technology (BACT).* This is defined as a limit based on the maximum degree of emission reduction, considering energy, environmental and economic impacts, achievable through application of production processes and available methods, systems and techniques. BACT is applied on a case-by-case basis to individual processes and follows a top-down hierarchy. In this, options are ranked and the top ranked project is applied, unless it is shown infeasible. Limits are set on the basis of the most stringent result achieved from a similar project for the source and pollutant in question.

For projects in non-attainment areas, *New Source Review* (NSR) is followed. A criteria known as *Lowest Achievable Emission Rate* (LAER) applies. This is a rate of emission that reflects (i) the most stringent emission limitation in the implementation plan of any state, for such a source, unless the owner demonstrates that this is not feasible; or (ii) the most stringent emissions limitation achieved in practice, whichever is more stringent.

Another important type of control technology is Reasonably Available Control Technology (RACT). RACT is control technology that is reasonably available, and both technologically and economically feasible. This is usually applied to existing sources in non-attainment areas. RACT is generally less stringent than new source performance standards.

It is noted that the EPA's air and water programs use the concept of BAT differently. The background document prepared by EPA for each rule should be consulted to obtain precise information.

4.6 Solid waste permitting

Management of solid wastes produced by the industry is an important issue and is addressed in permits. Fewer criteria are issued to guide decisions than for effluent and air pollution control. Regulatory authorities include requirements for mills to minimise the quantities of wastes, and to dispose of them in a safe manner. Requirements include proper design and siting of facilities; measures to handle water run-off, and, in cases where incineration is used, proper design and operation of furnaces and boilers to minimise emissions. Criteria are also set where composting and land spreading are used. It is noted that few details were obtained on solid waste permitting in this study.

5. TRENDS IN PERMIT LIMITS

As a complement to the study of the permitting approaches, the study also investigated the content of permits by reviewing permits issued in the different countries. The questionnaire asked the countries to submit sample permits and to describe the circumstances applying to each permit. The permits were reviewed to determine the parameters controlled, monitoring requirements and, where possible, the limits in terms of allowable releases per unit of production.

Prior to describing the results of the analysis, it is noted that there were differences in the types of permits that were supplied. In some cases, countries supplied more than one permit covering a range of circumstances. Typical circumstances covered in the permits provided included:

(i) recently issued permits to new mills with state-of-the-art technology;
(ii) recently issued permits to existing mills with older equipment; and
(iii) permits for existing mills that were in the process of being revised.

In some cases, countries did not provide sample permits but instead provided details of what was covered in their permits. The following narrative describes the observations.

5.1 History of effluent control

Concentrated efforts to address pulp and paper mill effluents in North America and Scandinavia were initiated in the 1960's as a result of concerns about the quality of the receiving waters. The discharges of effluents at the time were high. For example in 1955, according to historic values included in a 1987 report on water pollution problems in Finland and Sweden (Committee for the Gulf of Bothia, 1987), discharges of BOD_7 from unbleached pulp production in Sweden amounted to 150 kg/ADt. Similarly the overall pulp and paper production in Finland in 1955 was reported to have resulted in BOD_7 discharges of about 150 kg/ADt. By 1970 the releases in both countries were of the order of 60 kg/ADt. Historic statistics reported by the Canadian Pulp and Paper Association of Canada, estimated BOD_5 discharges from total pulp production to have been 102 kg/ADt in 1959, and 58 kg/ADt in 1975.

The historic levels of BOD releases caused severe problems in many receiving waters with limited dilution capacities. This is illustrated by the following case, derived from a report prepared from the Ontario government (Bonsor, N., N. McCubbin and J.B. Sprague, (1988). This cites a 1952 study of the Spanish River in Ontario which involved a bleached kraft mill with a capacity of 200 tonnes per day, discharging 15 t/day of BOD_5 (corresponding to at least 75 kg BOD/tonne). The effluent caused the river's dissolved oxygen to be depressed to 4 mg/l. Progressive measures were taken to correct the situation including the addition of secondary treatment to the mill in the 1970's. The effectiveness of this was shown from a follow up study conducted in 1984-85. The second study showed that while pulp production had increased from 200 to 885 tonnes per day, the BOD discharges had been reduced to 2.2 t/day (2.5 kg/t pulp), and the minimum dissolved oxygen in the river was 7.8 mg/L. The dissolved oxygen levels were close to saturation and were considered satisfactory by the Ministry of the Environment.

In addition to oxygen depletion problems, the effluents at some sites also blanketed the bottoms of rivers, interfering with benthic organisms and causing anaerobic conditions. Toxic effects were also observed in fish populations.

Significant improvements in effluent quality have been attained over the past four decades by various means. A number of inefficient pulping plants based on sulphite pulping were closed down and replaced by other processes. As well, process changes have been made to limit emissions by implementing new processes within the mills themselves, and by adding external treatment. Thus while pulp and paper production rates have increased markedly, the per unit discharges of dissolved solids and suspended solids has decreased to a greater extent.

There have been some differences in control emphasis within the major kraft producing countries reviewed in the study, Canada, Finland, Sweden and the US. In Canada, Finland, and the US, major attention has been paid to BOD control. While efforts have also been directed at applying internal measures to reduce the gross pollution, close attention has been paid to BOD control and the use of secondary biological treatment. In Sweden, especially since the mid-seventies, attention was focused on the characteristics of pulp and paper effluents with respect to biodegradability, bioconcentration factors and toxic effects, covering wide spread areas, rather than in the local environment. Attention has been primarily directed to chlorinated organic compounds, as well as parameters represented by COD. As a consequence of this approach, effort has been concentrated on internal measures at a mill.

In the US, in the 1970's, the EPA passed BOD and TSS guidelines for different types of mills. These were incorporated as limits in mill permits. The limits were based on the median performance achieved by specific categories of mills having secondary treatment. Stricter limits were set where necessary based on water quality considerations. Thus, secondary treatment has been in place at US mills for over 20 years.

On 14 November 1997, the EPA Administrator signed final rules for bleached papergrade kraft and soda (BPK) and papergrade sulphite sectors (PGS), covering both water and air pollution requirements. These rules have been developed jointly under the "Cluster Rule" process. The rules were published in the Federal Register on April 15, 1998 at pp. 18504 - 18751. The rules will then be implemented through the various permit and rule systems used for water and air requirements. Annex 1 in the US profile describes the Cluster Rules. These new guidelines and rules will reshape the existing instrument used to control releases to air and water in the US.

In addition to this portion of the rules, the EPA also issued for comment in November 1997 proposed rules dealing with measures it proposes to introduce to control particulate matter (PM), particulate hazardous air pollutants (PMHAP) and total gaseous organic (TGO) hazardous air pollutants from chemical pulping combustion sources.

EPA also proposed certain certification in lieu of minimum monitoring requirements, submission of plans for mills choosing to enrol in the Voluntary Advanced Technology Incentives Program, and notice of data gathering on Totally Chlorine-Free (TCF) technology for future consideration as a basis for further revising New Source Performance Standards (NSPS) promulgated with these rules.

In Canada, in 1971, pulp and paper mill effluent regulations were passed controlling BOD, TSS and acute lethality under the Fisheries Act. The kraft mill BOD limits were based on the use of in-plant measures to control effluents. The regulations led to an overall improvement in the quality of the effluents but were limited in that they were only legally binding on new mills and served as non-enforceable guidelines for the existing mills (pre 1971). The regulations were later amended in 1992 as part of an overall package which also addressed dioxins and furans. Co-incidental with this, in 1992 several Canadian provinces passed limit regulations.

In Finland, effluent control has been based on the use of external as well as internal treatment. Finland found it necessary to move quickly on BOD control because of concerns about oxygen depletion in many of the slow flowing rivers on which most of the mills are located. The authorities found that while internal measures could reduce BOD discharges, their pace of development was slow relative to the time scale in which they wanted the reductions attained. Therefore, they recommended that external treatment be applied when appearing before the Water Courts. Aerated stabilisation basins were initially constructed, however, many of these have been replaced by activated sludge systems. As well, measures have been taken to address nutrients as the waters are also subject to nutrient enrichment problems.

The Swedish industry has concentrated on the use of in-plant measures to limit dissolved solids losses. The COD parameter has been applied to address these. In Sweden most of the mills are situated on marine environments with waters that are not subject to oxygen depletion. Concern has been expressed about persistent pollutants and these have been addressed through the COD, AOX and formerly the TOCl parameters. Secondary treatment has been installed to meet local needs where necessary. At present, eight of the 15 bleached kraft mills have secondary treatment, with a ninth mill having it under construction.

5.2 Water pollution permitting

Of the ten countries in the study, seven provided actual copies of permits and three details of what were in the permits. The number of permits provided by individual countries varied from one to up to eight. The actual number of permits submitted and their content are described in the individual country profiles.

The permits were analysed to determine the parameters controlled, the monitoring requirements and control limits. The type and quantitative values of the limits have a major influence on pollution prevention and control equipment a mill must install. In this study it is noted that the analysis that could be performed was limited due to factors such as: the absence of data on production rates to be able to normalise allowable discharges to a mass-per-tonne basis; the use of different analytical techniques for parameters; and differences in the measurement periods over which compliance is determined. In some cases limits were set for 24-hour periods, in other cases they were based on long term averages.

5.2.1 Parameters controlled in permits

Table 27 provides a summary of the use of commonly applied control parameters in the different countries.

Table 27. **Control parameters used in permits in different countries**

COUNTRY	BOD	COD	TSS	AOX	D&F	Toxicity	N	P	pH	Temp	Flow	Colour
Austria	✓	✓	✓	✓	—	✓	—	—	✓	✓	✓	—
Belgium	✓	✓	✓	—	—	—	—	—	—	✓	✓	✓
Canada		—	✓	isp	✓	✓	isp	isp	isp	isp	isp	isp
Finland		✓	—[1]	✓	—	—	—	✓	—	—	—	—
Norway	—	✓	✓	✓	—	—	✓	✓	—	—	—	—
Germany	✓	✓	✓	✓	—	✓	✓	✓	—	—	—	—
New Zealand	✓	—	✓	—	—	—[3]	—	—	✓	✓	—	—[3]
Sweden	—[4]	✓	✓	✓	—	—	✓	✓	—	—	—	—
Switzerland	✓	idl	✓	idl	—	✓	—	—	✓	—	—	—
United States	✓	….5	✓	iss	iss	iss	—	—	✓	iss	iss	iss
Total using Parameter	…8	…7	…8	…7	…2	…5	…4	…5	…5	…5	…4	…3

Note:

✓ Limits are included in permits.

— Limits are not set in permits.

1. The contribution of COD from suspended solids is considered in the COD homogeneous test. Mills must therefore consider solid losses when meeting the COD limit.
2. AOX is included as limits for mills using chlorine or chlorine dioxide bleaching, but not in the case of the total chlorine free mill reviewed.
3. In the future consents in New Zealand are likely to include limits for colour and toxicity.
4. Some permits now contain BOD_7 limits but future permits for these mills will apply only COD.
5. EPA has reserved its promulgation of COD limits until a later announcement.

isp Limits set in some provincial permits.

idl Indirectly limited under Rhine River Agreement; iss limits included in some permits issued by the states or Environmental Protection Agency.

iss Limits set in some state permits; the new Cluster Rules of the EPA will address dioxin discharges and AOX.

The following observations are made:

- The major control parameters are in the form of “proxy parameters”. Proxy parameters are parameters that represent a range of substances in pulp and paper mill effluents. These are measured by specific analytical techniques developed by recognised authorities. The proxy parameters commonly applied are BOD, COD, AOX and TSS.
- BOD, as measured over five or seven days, was the most frequently used parameter. It was used in permits of eight of the ten countries.
- Of the eight countries using BOD, seven measure the BOD_5 parameter the remaining country, Finland uses BOD_7. An ninth country, Sweden, requires mills to monitor their BOD_7 releases. However, COD rather than BOD is Sweden’s primary control standard. According to Simons (Simons Consulting Group, 1994), BOD_7 limits that are currently included in Swedish permits will be phased out, as the permits are renewed.
- Since the BOD_7 test is conducted over a longer period than BOD_5, the amount of oxygen consumed by the micro-organisms is greater. Simons quote a ratio of BOD_7 to BOD_5 of 1.3. This conversion factor has been used in this report to convert BOD_7 values to BOD_5, to enable inter-country comparisons to be made.

- Some permits in three countries [Canada (Alberta), New Zealand, and USA] included minimum limits for the concentration of dissolved oxygen that must be in the effluents, prior to discharge to ensure protection of the receiving waters.
- Chemical oxygen demand (COD) was used in permits from seven countries.
- EPA has reserved its promulgation of COD limits until a later announcement.
- Five countries used both BOD and COD limits in the permits. These are Austria, Belgium, Finland, Germany and Switzerland. Three other countries, Canada, New Zealand and the USA use only BOD_5 limits. Norway and Sweden use only COD limits.
- TSS discharges were limited in eight of the ten countries. A number of different tests are applied using filters with different pore sizes. These vary from 0.45 µ to 70 µ, thus results are not directly comparable in many cases.
- Finland and Sweden do not include TSS limits in recently issued permits. Finland noted that the COD test measures the COD from suspended particulate. Mills must therefore consider solids losses when designing measures to meet COD limits. The same is true for Sweden.
- AOX was used in some or all permits of eight countries at either the federal, provincial or state level. This is used to represent the amount of chlorine that is organically bound in organic compounds in the effluents. The exceptions were Belgium and New Zealand.
- 2,3,7,8-tetrachlorinated dibenzo-para-dioxin (2,3,7,8-TCDD) and 2,3,7,8-tetrachlorinated dibenzofuran (2,3,7,8-TCDF) limits were applied in Canada and in some state permits in the US.
- In a few instances, tests measuring the biological response (toxicity) of a sample of fish to the effluent were used. Acute lethality was used as a control parameter in permits in Austria, Canada, Germany and Switzerland. Acute lethality tests were also used as a monitoring requirements in some permits in the US.
- Different toxicity test protocols are used in different countries. Differences include fish species, the use of different effluent concentrations (some countries using 100% effluents and others a blend of effluent and river waters), and different percentage survival criteria to pass the test.
- Five countries set limits for total phosphorus and four for nitrogen. Both of these are nutrients that can stimulate undesirable levels of micro-organisms in receiving waters. In some cases, the requirements served as discharge limits, whereas in others the mills only had an obligation to measure and report the results.
- Physical parameters such as pH, temperature and colour were controlled in many cases. In five countries, limits were applied to pH and temperature. Colour was also controlled in three countries but not in all of the permits.
- Pentachlorophenol and trichlorophenol discharge limits were set by three countries, Belgium, New Zealand and the US. It is noted that the need to control these originates in from the use of certain slimicide formulations that contain them. Exemptions to the provision are provided in one country when slimicides are certified to be free of the substances.
- Heavy metal limits were included in some permits in the US. The US permits only included limits when calculations of the concentrations in the receiving water, following dilution of the effluent, approached a certain percentage of the level permitted in water quality objectives.

- Chlorate releases from chlorine dioxide generation were controlled in some Swedish permits. This was done to prevent chlorates killing important brown algae present in the brackish sea water.
- Chloroform was addressed in a few of the permits from two countries, Belgium and the US, and in Ontario's effluent regulations in Canada.

5.2.2 Form of limits

The discharge limits is most countries were mainly in the form of allowable mass discharges per unit of time (normally kilograms per day). This was calculated based on an assumed production rate, multiplied by an allowance per tonne of production. In many cases information was not available to establish what the mass per unit of production allowance was. In two cases, Belgium and Switzerland, the limits were in terms of concentrations. This observation applies to the proxy parameters of BOD, COD and TSS.

It is noted that where toxicity tests are used, the limits are in effect concentration limits. The concentrations of the toxicants in the effluents have to be below levels that will cause an acutely lethal effect as defined by the test.

5.2.3 Effluent monitoring requirements

Self-monitoring by mills, with results being reported to environmental agencies, was a common feature of permits. Effluent samples are normally collected on a daily basis using automated samplers, operating on a flow-proportional or time-interval basis. The composite samples are analysed for various constituents according to schedules developed with the agencies. The frequency varies from substance to substance with the following being typical:

TSS	Daily
BOD	Several times per week to daily
COD	Several times per week to daily
AOX	Once per week to daily
Nutrients (N and P)	Several times per week to monthly
Dioxins and furans	Less frequently, usually monthly or annually
Toxicity	Monthly, typically on grab samples or on daily composites

Analyses of the composite samples are conducted according to recognised test protocols issued by various state, national, or international bodies. In some countries, self-monitoring is augmented by inspections and sampling by regulatory authorities.

The permits normally include an obligation to report the results on a regular basis, such as monthly, quarterly, or annually. In addition to reporting regular results, several countries require mills to notify authorities immediately of any exceeding of limits and to take actions to address any excesses.

5.2.4 Other water permit conditions

Other requirements frequently specified in the permits reviewed were the development of emergency plans to manage and handle spills, and monitoring and reporting requirements related to controlled substances. Approximately half of the permits reviewed included requirements for the treatment plants and related facilities to the properly maintained.

Some permits included requirements to conduct investigations related to the development of cleaner technologies, the results of which are considered in future permit decisions. Mills in some countries are required to conduct studies on the ecosystem and on groundwater. In some countries, investigations had to be conducted into the reduction of total phosphorous and total nitrogen releases.

5.2.5 Trends in permit limits

A mill's technological response to permit conditions is determined by the parameters for which compliance limits are set, as well as the time period over which compliance is determined and the enforcement policy of the government. The lower the discharge limit per unit of production (say in terms of kg per tonne of finished product), then the more stringent are the technological requirements. This becomes more accentuated for shorter compliance periods because the results of "off-periods" cannot be averaged out by "good periods". This is important in mills where many sources, such as spills, leaks etc. contribute to the total effluent.

In order to evaluate the variation of control limits between the countries, attempts were made to convert the discharge limits for the most important pollutants controlled in permits, to a mass per tonne basis. For several countries, it was difficult to do this as the permits only gave details of the mass discharge rate allowed. Information often was not available on the daily or annual production rates of finished product. In some cases, countries provided estimates of the production rates allowing calculations to be made.

Results of the questionnaire survey indicated information gaps for some of the countries. In order to provide further information on kraft mills permitting, the author has referred to a 1994 Benchmarking Report on Kraft Mills prepared by Simons Consulting Group for Industry Canada and Forestry Canada (Simons Consulting Group, 1994). This included analysis of a number of permits in Canada, Finland, Sweden, the United States and several other countries. This report provides estimates of the limits for the major pollutants in terms of kg/tonne of finished product. In order to estimate these permit limits, Simons made use of information on the mass discharge rates allowed in the permits. They then prepared estimates of the daily production rate or annual production rates from their in-house knowledge. It is noted that when Simons did this work, they found it impossible to normalise the limits for many of the pulp mills into kg/ADt of bleached pulp. This was due to the integrated nature of operations at many mills. In this analysis we have selected only those mills that Simons was able to normalise the data.

With respect to technological requirements to meet permit conditions, the following parameters are considered important:

i) BOD and COD. Authorities use these as a measure of the total organic load of an effluent, these consider the dissolved and as well as the suspended solids in the effluent. In order to comply with the limits, mills have to ensure that their effluents do not include materials that will exceed the oxygen demands indicated by the tests. The mills achieve compliance by internal and/or external treatment to remove the dissolved solids.

ii) AOX: This parameter measures the amount of chlorine that is bound in organic material discharged in the effluent. The ability of mills to use especially chlorine gas and also chlorine dioxide diminishes as the allowable AOX decreases. Options include: increasing lignin removal in pulping, displacing chlorine with chlorine dioxide, and using non chlorine based bleaching agents e.g. oxygen, hydrogen, peroxide. In addition, some of the chlorinated organics that are measured in the AOX test are removed by secondary treatment. Thus effectively operated biological treatment provide a useful additional control approach.

iii) TSS: This parameter is of lesser importance in influencing the selection of the process technology used. The value of the limit and the size of the filter pore used in the test influences the degree of solids settling required. There is a large variation in filter sizes used in tests in permits in different countries, and in some cases within countries. Filter sizes can vary from 0.45 µ to 70 µ. Caution is advised when comparing limits.

iv) Nutrients: In cases where nutrient enrichment in waters is a concern, nutrient limits are set. The nutrient limits can affect the type of secondary treatment plant selected; the ability to use nutrient additives to make up for nitrogen and phosphorous imbalances for optimum BOD removal; and the need to apply tertiary treatment measures to remove excess nutrients.

The variation in the limit values for these key parameters, among the permits were reviewed. Separate tables were prepared for bleached kraft mills and bleached sulphite mills. The results for the different parameters are reviewed as follows.

5.2.5.1 BOD_5 limits for kraft mills

Table 28 summarises the range of BOD_5 limits in kg/ADt of production in kraft mill permits included in the study and also as derived by Simons (Simons Consulting Group, 1994). From this it is seen that three countries, Canada, New Zealand and the United States apply short term compliance periods over one-day. Monthly limits are also applied in Canada, Finland and the US. Long term average compliance periods are used in Belgium (Wallonia), Finland and Sweden. This period varies from 3-months to one year.

The daily limits fall into the range of 2.7-12.5 kg BOD_5/ADt. The lower value represents the case of a Canadian mill whose permit was based on water quality considerations. It is noted that there are other cases of mills in the US where similar low levels of releases apply.

Table 28. **Range of BOD_5 limits (kg/t) applied in permits of different countries over different compliance periods for bleached kraft mills**

Country	BOD_5 kg/ADt			Comments
	Daily Limit	Monthly Limit	Long Term Limit (Period)	
Belgium	—	—	2.1 (period not known)	See Belgium profile
Canada	2.7 - 12.5	1.35 - 7.5	—	See Canadian profile
Finland	—	1.5-2.9	2.9-4.8 (3-month avg.)	From Simons*
New Zealand	3.1	—	—	See New Zealand profile
Sweden[2]	—	—	9.3-12.6 (annual avg.)	From Simons*
USA	4.0-10.0	2.0-6.1	—	From Simons*

Note:

1. All the permits specify BOD releases in terms of mass per day allowable. The permits do not use kg/t. These have been calculated for this report. This table has converted BOD_7 to BOD_5 by using the 1.3 factor.
2. Simons (*Simons Consulting Group, 1994) reported that of the 15 bleached kraft mills in Sweden, only five of the mills have BOD_7 limits in their permits. Simons reported that Sweden was moving away from BOD_7 limits. COD would be used to address this issue. Simons reported that in 1994, eight of the 15 kraft mills had biological treatment in the form of aerated basins.

5.2.5.2 BOD_5 limits for sulphite mills

Table 29 review the BOD_5 limits for bleached sulphite mills covered in the study. From this it is noted that with the exception of Switzerland which has a daily limit of 6.6 kg/ADt, compliance is affected by means of long-term averages. In Austria, although the mill permit limits were not provided, a national regulation imposes a limit of 3 kg/ADt. In Germany, the two sulphite mill permits had limits of 1 and 4.2 kg/ADt. In Norway, a BOD_5 limit was not set for the sulphite mill control was implemented by means of a COD limit.

All the four sulphite mills reviewed in this study included secondary biological treatment.

Table 29. **Range of BOD_5 limits (kg/t) applied in permits of different countries over different compliance periods for bleached sulphite mills**

Country	BOD_5 kg/ADt			Comments
	Daily Limit	Monthly Limit	Long Term Limit (Period)	
Austria[(1)]	na	na	na	See Austrian profile
Germany	-	-	1-4.2 (period uncertain)	See German profile
Norway	-	-	-	BOD not applied
Switzerland	6.6	-	-	See Swiss profile

1. Information was not provided on the sulphite mills permit limits, however, a national regulation sets a limit of 3 kg/ADt.

5.2.5.3 COD limits in kraft mill permits

Table 30 shows that COD was used as limits for kraft mills in Belgium, Finland and Sweden, but not in Canada or the US. With respect to the limits, according to Simons, monthly limits of between 30-65 kg/ADt applied for Finnish mills, and between 37-87 kg/ADt for Swedish mills.

Table 30. **Range of COD limits (kg/t) applied in permits of different countries over different compliance periods for kraft mill permits**

Country	COD kg/ADt			Comments
	Daily Limit	Monthly Limit	Long Term Limit (Period)	
Belgium	-	-	30.7	See Belgium (Wallonia) profile
Canada	-	-	-	mills in Alberta have to monitor COD releases
Finland	-	30-56	42-81 (3-month)	Simons*
New Zealand	-	-	-	COD not applied
Sweden	-	37-87	49-67	Simons*
USA	-	-	-	COD not applied

* Simons Consulting Group, 1994.

5.2.5.4 COD limits for sulphite mills

Table 31 summarises the COD limits applicable to sulphite mills. This shows that the long term average limits were used in all the four countries. For the three countries where permits were provided, were seen to be in a range of 25-70 kg COD/ADt in the four countries. In the case of Austria, information was not provided on the sulphite mills permit limits, however, a national regulation sets a limit of 40 kg/ADt. In addition, the Norwegian mill had to meet a 30 kg/ADt monthly limit.

Table 31. **Range of COD limits (kg/t) applied in permits of different countries over different compliance periods for sulphite mill permits**

Country	COD kg/ADt			Comments
	Daily Limit	Monthly Limit	Long Term Limit (Period)	
Austria	na	na	40	See Austrian profile
	-	-	45-60	See German profile
Norway	-	30	25 (half year)	See Norwegian profile
Switzerland	-	-	70	See Swiss profile

5.2.5.5 AOX control limits for kraft mills

Table 32 summarises bleached kraft mill AOX limits in kg/ADt according to the different sources. The following points are noted:

- Daily limits of between 0.8 - 3.0 kg/ADt are applied in permits issued by Canadian provinces.
- Monthly limits are used in Canada, Finland and some US states and fall into a range of between 0.5-1.9 kg AOX/ADt.
- Sweden applies long term AOX limits of between 0.3-1.3 kg AOX/ADt. In addition, TOC1 limits of between 0.7 - 1.5 kg/ADt are used in older permits. An AOX/TOCl ratio of 1.3 is often applied (Bonsor, N., N. McCubbin and J.B. Sprague, 1988). This means that the older Swedish permits are equivalent to 0.9 - 2.0 kg/ADt AOX.

Table 32. **Summary of AOX limits (kg/t) applied in permits of different countries over different compliance periods for bleached kraft mills**

Country	AOX kg/ADt			Comments
	Daily Limit	Monthly Limit	Long Term Avg. (Period)	
Belgium	-	—	—	AOX not applied
Canada	0.8-3.0	0.5-1.5	—	See Canadian profile
Finland	-	1.1-1.8	1.1-2.3	Simons*
New Zealand	-	-	—	AOX not applied
Sweden(1)	- -	- -	0.3-1.3 (as AOX) 0.7-1.5 (as TOCl)	Simons*
USA	-	1.6-1.9(2)	1.3-1.5(2)	Simons*

1. Sweden uses total organic chlorine (TOCl) limits in older permits of 12 mills. More recently, AOX limits have been set in permits for another three mills. Limits are set as an annual average. The range of TOC1 limits expressed as AOX is approximately 0.9 - 2.0 kg/ADt based on a 1.3 times conversion factor.
2. For mills in Washington state, according to Simons (*Simons Consulting Group, 1994).

5.2.5.6 AOX limits for sulphite mills

Table 33 summarises AOX limits for the sulphite mills in the four countries. It is noted that one of the German mills uses a total chlorine free (TCF) process and has a very low AOX limit (0.1 kg/ADt). The Norwegian sulphite mill studied also has a TCF process and no AOX limit is set. The Swiss mill has a limit of less than 1.0 kg/ADt, but the time period over which this was determined was not specified.

Table 33. **Summary of AOX limits (kg/t) applied in permits of different countries over different compliance periods for bleached sulphite mills**

Country	AOX kg/ADt			Comments
	Daily Limit	Monthly Limit	Long Term Limit (Period)	
Austria	-	-	na[1]	See Austrian profile
Germany	<0.1[2]	-	-	See German profile
Norway	-	-	-[3]	See Norwegian profile
Switzerland	-	-	<1kg/t (period not known)[4]	See Swiss profile

Note:
1. Permit limit was not available. A national regulation sets 0.5 kg/t as a limit for bleached sulphite mills.
2. Mills use non-chlorine based bleaching.
3. Norway supplied a permit for a sulphite mill using a non-chlorine based process. No AOX limit was set; other mills using chlorine have AOX limits.
4. Mill has to meet this limit under a conference for the protection of the Rhine.

5.2.5.7 Total suspended solids limits included in both kraft and sulphite mill permits

Table 34 summarises the permit limits for TSS expressed in kg/ADt as derived from various sources. It is noted that a wide range of filter pore sizes is used in tests. The pore sizes used are indicated in footnotes to the table, where the values are known. These ranged from 0.45 to 70 μ. Caution has to be taken when doing any comparisons in this table.

It is noted that Finland has dropped the use of TSS in recent permits. Solids are addressed through the COD_{cr} limits. Germany does not include TSS limits in their permits.

Primary treatment will remove most of the solids prior to secondary treatment. The use of secondary treatment results in the creation of very fine suspended solids as the result of the biological decomposition of dissolved material. It is mainly these suspended solids that are measured in the suspended solids tests. Due to the fine floccular nature of these solids, the filter pore size used is critical. Coarse filters allow the flocs to simply pass through. When operating treatment plants proper settling has to be applied to remove biosolids.

Table 34. **Total suspended solids limits (kg/t) applied in permits of different countries over different compliance periods for mills**

Country	TSS Limit kg/ADt			Comments
	Daily Limit	Monthly Limit	Long Term Limits (Period)	
Austria	-	-	5[1]	See Austria profile
Belgium	-	-	8.2 (period not known)	See Belgium (Wallonia) profile
Canada	5.4-18.75	2.7-11.25	-	See Canadian profile[2]
Finland	-	-	5.1-8.2 (3-month)	Simons[3]
Germany	-	-	-	TSS not included
New Zealand	4.3	6.2	-	See New Zealand profile
Norway	-	8.75	7.5	See Norwegian profile
Sweden	-	1.0-3.8	0.5-4.8	Simons[4]
Switzerland	-	-	8.8	See Swiss profile
USA	3.7-26.1	2.0-14.2	-	Simons[5]

Note:
1. Value in Austrian regulation for sulphite mill.
2. Test uses a 0.45 μ filter pore size.
3. Simons (Simons Consulting Group, 1994) notes that Finland is moving away from TSS limits. The COD_{cr} limit considers COD derived from TSS and newer permits use this to address ant TSS concerns.
4. Some mills do tests using either a 10 μ or a 70 μ filter pore size.
5. Test uses a 0.45 μ filter pore size.

5.2.5.8 Nutrient limits in mill permits

In instances where there are problems with nutrient enrichment in the receiving waters, the authorities have included measures either limiting releases of nutrients, or requiring them to be monitored. The following summarises references to nutrients (total nitrogen and phosphorus), in the country profiles.

Belgium (Wallonia): Limits are included in the kraft mill permit for total phosphorus and nitrogen/ammonia. Details were not given.

Canada: The Ontario regulations applicable to all Ontario pulp and paper mills specify a total phosphorous limit of 280 g/ADt as a daily maximum, and a monthly average of 170 g/ADt. Alberta requires all of its mills to monitor both nitrogen and phosphorus. British Columbia includes limits of 5 mg/l for total nitrogen and 2 mg/l for total phosphorus for one mill. Some other mills are required to monitor the substances.

Finland: The Finnish profile notes that there is an overall target of 60 g/ADt for the kraft sector. The Water Court decisions also develop nutrient limits where required. The final draft on the Workshop on Environmental Permitting of Industrial Facilities - Approaches and Instruments, 1997 (OECD, 1997), refers to nutrient controls applied to a large Finnish mill on a small river. The mills permit has a limit of 10 g/ADt for total phosphorus and a COD_{cr} limit of 5 kg/ADt.

Germany: Concentration limits of 10 mg/l for total inorganic nitrogen and 2 mg/l phosphorus were set for one of the sulphite mills for which permits were supplied. This was on a moderately polluted river. The permit review for the other mill has not been finalised.

Norway: The sulphite mill permit that was reviewed required total nitrogen and phosphorus discharges be monitored. **Sweden:** Details were provided on nutrient requirements that could be expected in parts of a multi-media permit for an integrated bleached kraft pulp and paper mill. These included limits for total phosphorus but not total nitrogen**.**

United States: According to information in the US profile, limits for nitrogen and phosphorus discharges are developed where required. In other cases some mills are required to monitor and report the result.

5.2.5.9 Toxicity requirements in mill permits

Toxicity in the form of acute lethality is used in the following countries as described:

Canada: The discharge of any acutely lethal effluent is prohibited under both federal and provincial requirements. Non acute-lethality is determined using a Reference Method (Environment Canada, 1990). The test is conducted on rainbow trout which are kept in 100 % effluent. 50 % of the fish must survive over a four-day period to pass the test. In Alberta, more than 50 % of the fish must survive.

Germany: An acute lethality test is applied. For effluents predominantly from bleaching, goldfish must be able to survive when kept in a mix of 50 % effluent and 50 % river water, over a four-day period.

Switzerland: Test fish have to be able to survive in effluent diluted by no more than a factor of five (one part effluent to five parts water). Details on the test species, test duration and survival criteria were not given.

United States: Some National Pollution Discharge Elimination System (NPDES) permits in the USA incorporate a variety of acute and chronic tests on various fish species. These are carried out for monitoring rather than enforcement purposes.

5.2.6 A review of current effluent quality

While the questionnaire survey did not solicit information on the effluent qualities from all mills in each country, information on this was available for kraft mill discharges in five of the countries as part of a separate paper presented at a conference in New Zealand (Halliburton, D., 1997).

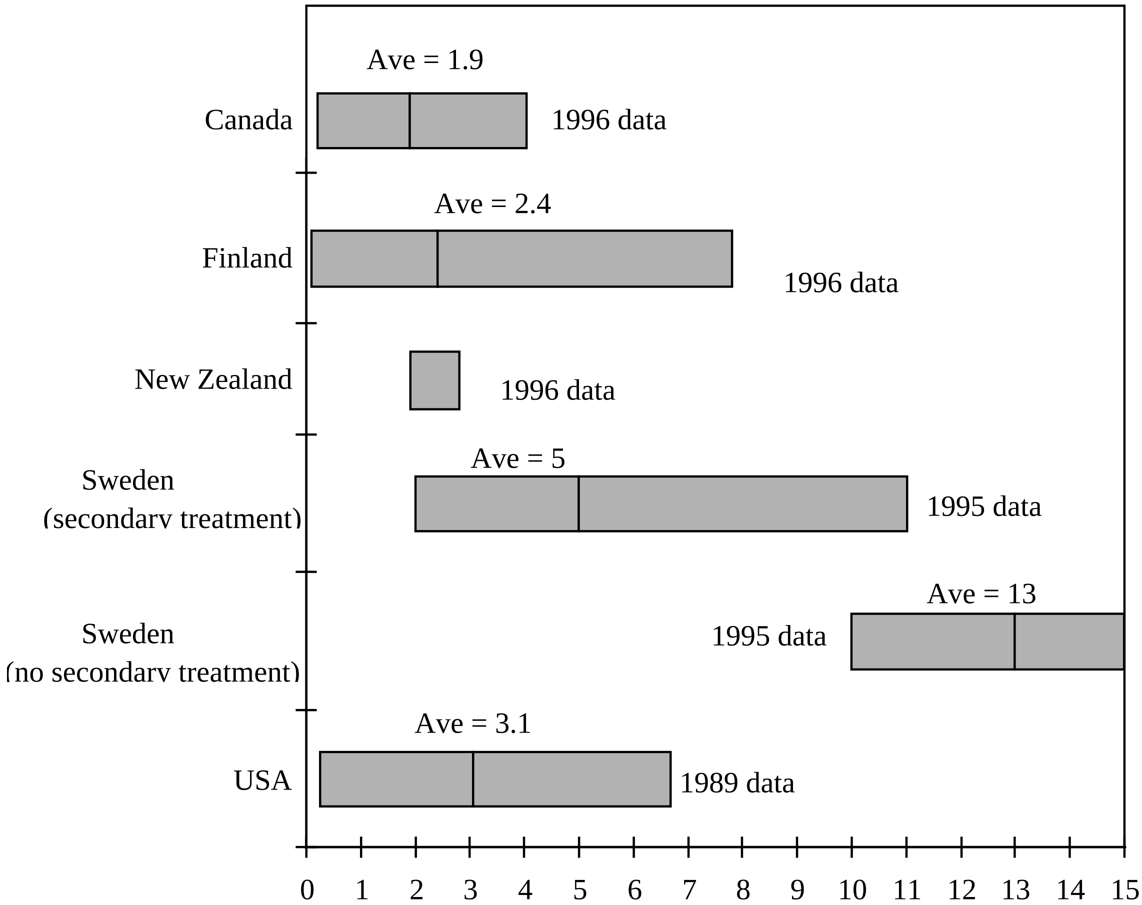
The following sections provide estimates of the qualities of the effluents from bleached kraft pulp mills in Canada, Finland, New Zealand, Sweden and the United States using the most recent information available for the referenced study. It is noted that the data related to 1995 or 1996 discharges for all countries except the US for which only 1989 data was available on a production normalised basis. The US data covered only about one third of the total kraft mills.

5.2.6.1 Analysis of BOD_5 Releases

BOD discharges in the different countries are compared in Figure 1. The following points are noted:

1. All the BOD results are normalised to BOD_5 values. In Finland and Sweden, BOD is measured using a 7-day rather than the 5-day test used elsewhere. The BOD_7 results have been converted to BOD_5, by dividing be a 1.3 factor (Simons Ltd, 1995).
2. The discharges are lower for mills that incorporate secondary biological treatment. Secondary biological treatment use is virtually 100% in all countries except Sweden. In Sweden 8 bleached kraft mills currently have secondary treatment and 7 do not. The BOD values illustrate the differences.
3. It is noted that all Canadian bleached kraft mills except one include secondary treatment. The BOD discharges from this mill, are outside the range shown, and have been excluded from the analysis. In the US all but two kraft mills have secondary treatment. The data shown only reflects the performance of about a third of the kraft mills. This is the best production normalised data that could be obtained.
4. For mills with secondary treatment, the average values of the BOD_5 ranged from 1.9 to 3.9 kg/t. These averages are significantly below the values set in the baseline rules of Canada and the US.
5. Several mills in the countries attained significantly lower discharges than those set in regulations. Mill discharges of below 2 kg/t were apparent in Canada, Finland and the US. In a few of these cases, the mill permits have low BOD limits but these are the exception.
6. There appears to be a convergence in the BOD loadings between the countries. This is especially true for mills that include secondary treatment. Mills without secondary treatment, are approaching the performance of the mills that include secondary treatment but are outside their band. Their performance was still beyond the range required in the Canadian and US technology based rules.

Figure 1. **BOD discharges from bleached kraft mills in various countries**

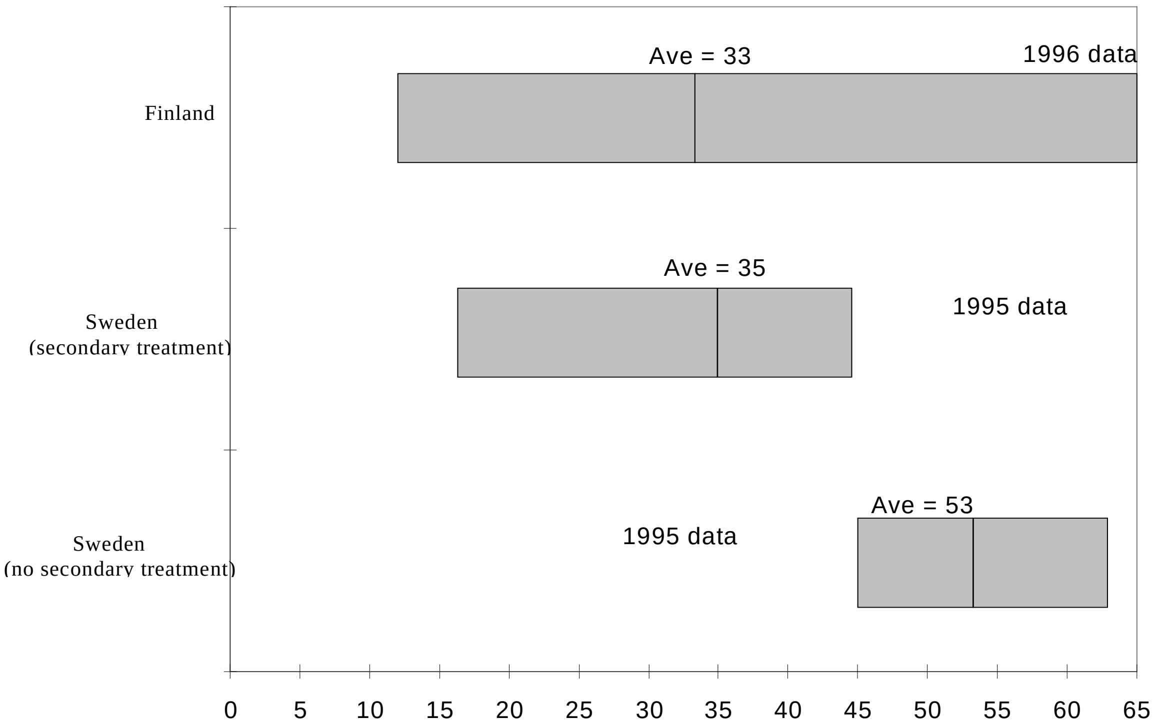


5.2.6.2 Analysis of COD Releases

Figure 2 compares the COD releases in the countries where it is used as a control parameter, Sweden and Finland. The following points are noted:

1. The average values of the discharges were similar in both countries.
2. Mills that included secondary treatment as well as internal measures, attained lower values.
3. Exemplary mills characterized by values below 25 kg/t, were present in both countries.
4. The range of discharges was narrower for mills in Sweden than that for Finland.

Figure 2. **COD discharges from bleached kraft mills in various countries**

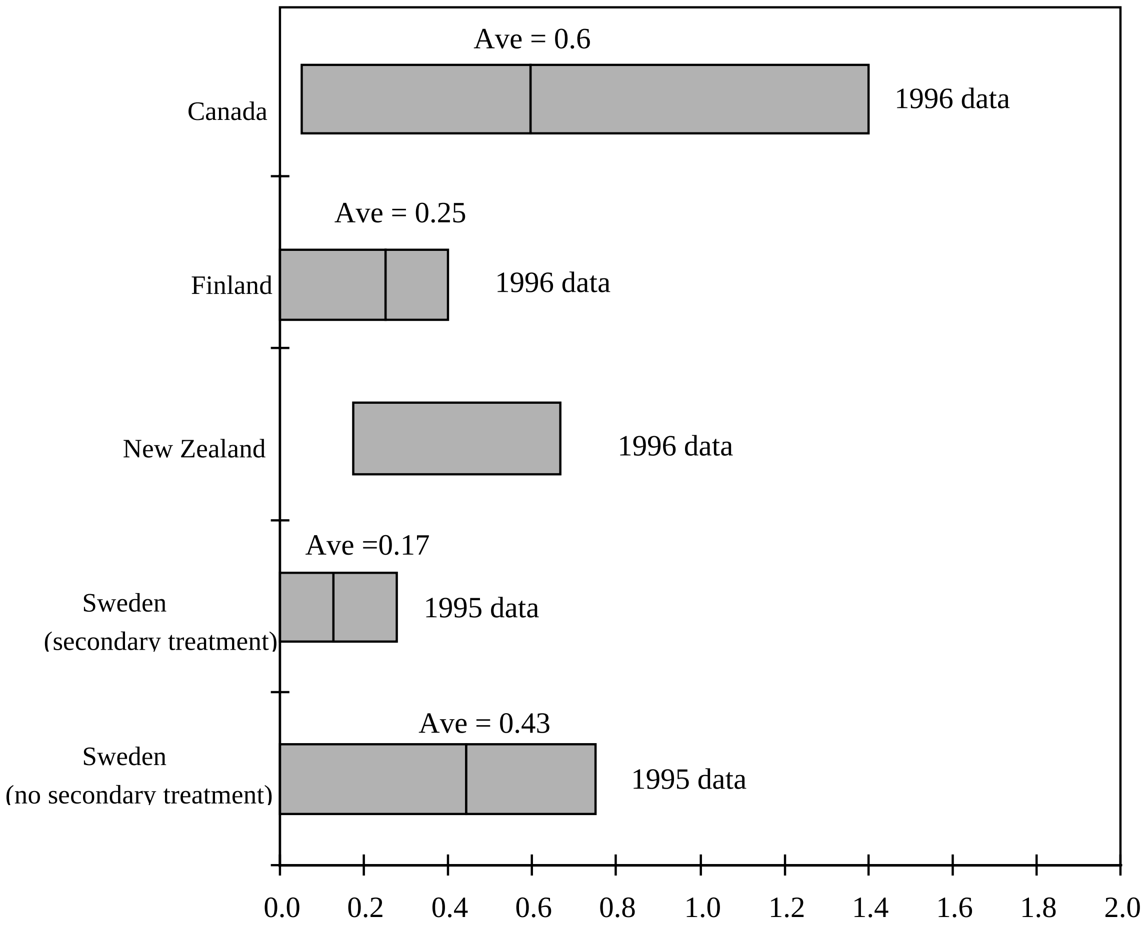


5.2.6.3 Analysis of AOX Releases

Figure 3 compares the AOX discharges. The following points are noted:

1. All of the discharges were low with no mill reporting results greater than 1.5 kg/t. Information was not available for US mills.
2. Canadian mills showed a wider range of values than mills in the other 3 countries. This is due to the less widespread adoption of oxygen pre-bleaching. All of the bleached kraft mills in Sweden, Finland and New Zealand apply it.
3. Some mills in Canada, Finland, and Sweden showed extremely low AOX releases, below 0.1 kg/t. This reflects the bleaching technologies applied.
4. It is noted that the discharge limits in most of the permits and regulations are of the order of 1-2 kg/t. The above performance is believed to be due to companies adopting technologies for economic and market reasons. This technology goes beyond the requirements needed to meet their permit conditions.
5. The Swedish results indicate that secondary treatment is beneficial in further reducing AOX.

Figure 3. **AOX discharges from bleached kraft mills in various countries**



5.2.6.4 Observation on the impact of different practices on effluent qualities

While there are significant differences in the permitting practices applied in the five countries reviewed, the effluent qualities in the countries appear to be similar. The discharges appear to be converging over time for BOD and AOX. However information is not available on COD discharges, beyond the Scandinavian countries to confirm this statement.

The selection of either BOD or COD as the principle control parameter to address dissolved solids has an influence on the technology chosen by a mill. (It is also noted that COD addresses the suspended solids to a large degree). The use of BOD promotes external secondary treatment. The use of COD promotes internal treatment using processes such as oxygen pre-bleaching. Both approaches seem to be applied in an increasingly complementary manner in the five countries covered.

It appears that most mills have discharges much lower than the permit and regulatory limits that are apparent from the OECD study. Economic and market factors are believed to account for this. Environmental improvement appear to be becoming less permit driven.

5.3 Air pollution permitting

Air permits are issued to mills authorising the emission of gas streams subject to various conditions. The permits usually include specifications relating to the concentrations of specific gases (e.g. H_2S, TRS, SO_2, NO_x, Cl_2) and particulates, in a volume of gas, corrected to specific pressure and temperature conditions. Emissions from combustion units, such as recovery boilers and lime kilns, are also normalised to a reference oxygen content.

In the US, air pollution from existing sources is controlled under requirements in the State Implementation Plans and for new sources under the rules issued by the EPA. The US air pollution control system is complex. Readers are referred to the US country profile for a description of the approach.

The process of developing air permits is generally more complicated than that of wastewater permits. This arises partly from the design of the plants, as well as from the fact that the measurement of air emissions is inherently more complicated than that of water sampling. In regards to plant design, it is a relatively easy task to move effluents round a mill whereas the movement of gases requires large flues and fans. Hence, air emission sources tend to be addressed on an individual basis, or through combination of gases from a couple of sources, e.g. the non-condensable-gases and a power boiler, or a lime kiln. In these cases the combination is made to use one unit to treat the gases from another source.

Air permits address the emissions on a point-by-point basis. In the case of kraft mills these include the recovery boilers, power boilers, lime kilns, smelt dissolving tanks, pulp washing area, evaporator and condenser systems, bleached chemical preparation area and bleach plant operations and miscellaneous vent associated with the process. For the kraft industry the collection of gases from some of the extraneous sources is important due to the presence of odorous reduced sulphur compounds such as hydrogen sulphide, methylmercaptans and methyl sulphides. These gases are formed as a result of reactions between the wood and the kraft cooking chemicals. In the absence of proper measures, complaints may arise from the local community.

The measures taken to mitigate releases consist of means to minimise the formation and transport of the pollutants in the gas streams (i.e. in-plant measures), as well as the use of external gas treatment processes. These consist of cyclones, electrostatic precipitators and scrubbers as well as chemical scrubbing to recover SO_2 the sulphite process.

The in-plant measures that are taken are based largely on the design of the operating units. For the kraft industry, one of the major components that can give rise to emissions is the recovery boiler. Newer mills, and old mills that have had major expansions or renovations, have newer low-odour boilers. These are larger and higher units than their predecessors, with differences in the design of the air firing ports. The boilers operate at higher solids contents and without the use of direct contact evaporators. This boiler design results in lower amounts of the odorous gases concerned. In contrast, many older boilers evaporate water from the boiler feeding directly into their exhaust gases. This leads to further formation of odorous sulphur compounds.

Burner design is also an important in-plant measure that is taken to alleviate NO_x problems. This is applied in various units such as the recovery boilers and lime kilns.

Air pollution control strategies are based on the use of external processes such as mechanical dust collectors, electrostatic precipitators, scrubbers, dedicated incinerators and regenerative thermal oxidation units. For the sulphite industry, the SO_2 scrubbers are an important element of the process and can be regarded as an in-plant device.

5.3.1 Approach and parameters covered

In all of the countries separate permits are developed for each source. This specifies the emission rates allowed in the form of concentrations under specified gas conditions (standard temperature, pressure and oxygen content).

In the case of Sweden and Finland, some permits also use a bubble concept, which sets maximum emission rates for sulphur in all forms, and nitrogen oxides (NO_x), from the mill operations excluding the auxiliary boilers.

For sulphite mills, limits are set for sulphur dioxide and particulate emissions from the recovery processes in permits supplied by Austria, Germany, Norway, and Switzerland. NO_x limits were also given in permits supplied by Austria and Germany.

Guidance is provided to the permitting authorities as in the case of water permitting. Most of the countries have in place air quality objectives to set acceptable levels of major pollutants in the ambient air Additionally, most of the countries have policy documents defining technology based limits for various pieces of equipment. These policies consist of regulations, guideline (rules in the US), objectives, etc. There is a wide variation in the systems between each country and readers are referred to the individual country profiles for details.

5.3.2 Trends in permit limits

In order to delineate trends in permit limits, reference was made to a report compiled by H. A. Simons Ltd. of Vancouver BC and its associate AF-IPK in Sweden and Norelco Dames and Moore, Vancouver (Simons Ltd., 1995). This reviewed air emission control technologies, regulations and analysed selected permits for new and modernised pulp and paper mills in the US (Federal and 8 states) , Canada (federal and provincial) and Europe (Sweden, Finland, Austria, France, and Germany) .

The report for Environment Canada and the Ministry of Lands, Parks and Environment of British Columbia involved reviewing permits for 22 recent, new and extensively modernised mills, comprising 20 kraft recovery furnaces, 14 smelt dissolving tanks, 16 lime kilns, 2 mechanical pulp mills, 2 sulphite mills, 17 wood and fossil fuel fired power boilers and 4 gas only fired boilers. A synopsis of the information on bleached kraft mills in Canada, Finland, Sweden and the USA is contained in Tables 35 through 12 covering the recovery boilers, lime kilns, non-condensable gas system and incinerators, smelt dissolving tanks, wood waste/fossil fuelled power boilers, bleach plants and mill wide limits applied in Finland and Sweden.

The following points are noted with respect to the control parameters in the permits applied to the major units in modern bleached kraft mills:

- **Chemical recovery boilers**: This is one of the major sources for air emissions in kraft mills. The analysis shows that sulphide emissions in the form of either TRS or H_2S is a major control parameter along with particulate matter. In addition, many permits had limits placed on SO_2 and NO_x emissions. Carbon monoxide, volatile organic carbon, sulphuric acid and beryllium limits were also included in some US permits as a consequence of the Prevention of Significant Deterioration Rules of the US Clean Air Act.

- Sulphide emissions limits contained in the permits in the four countries are grouped in a narrow range of 3-15 parts per million. This is indicative of low emissions achievable through well operated low odour recovery boilers.

- For particulate matter, limits were grouped in a range of 60- 346 mg/dry cubic meter. In the US limits were also included for particulate matter less than 10 microns.

- **Lime kilns**: Similar permitting practices and parameter limits apply to lime kilns as to recovery boilers with a range of limits set.

- **Non-condensable gas management systems**. NCG management is an important area for mills as the uncontrolled escape and venting of gases from various sources in a mill will give rise to serious odour problems and complaints from the community. It can also be an occupational health concern. Collection since the 1970's has included digester relief, evaporator and stripper concentrated sources. More recently, dilute sources from chip bins, washers and tank vents have been collected. Incineration is carried out in either power boilers or lime kilns, with dedicated incinerators being used in some cases. A variety of permit requirements are used relating to venting time and mill upset excursions and it is difficult to generalise. In some cases concentration limits are placed on emission sources.

- **Smelt dissolving tanks**: In all four countries limits were placed on either TRS or H_2S, and particulate. Control is normally affected using scrubbers. In Canada and the US some permits included SO_2 limits, and in the US, opacity limits.

- **Wood waste/fossil fuelled power boilers:** Power boilers play an important part in the mill. The boilers rely heavily on the use of wood waste as a fuel and provide an effective means of disposing of wood and effluent treatment sludge wastes from pulp and paper and allied saw milling operations. The boiler emissions are controlled by means of particulate emissions. In some cases limits are placed on sulphur and nitrogen oxides emissions as well.

- **Bleach plants and bleach preparation areas:** For the bleach plant and bleach chemical preparation areas, permit limits were set for chlorine and/or chlorine dioxide.

Table 35. **Range of permit limits for recovery boilers permits**

Country	**Canada**		**Finland**		**Sweden**		**US**	
No. of permits	**4**		**3**		**3**		**4**	
Limits	**No.***	**Range**	**No.***	**Range**	**No.***	**Range**	**No.***	**Range**
TRS	2	6.1 (24h) - 6.5 (4h) ppm_{dv}	0	-	0	-	1	3 ppm_{dv} (12h)
H_2S	2	5 - 15 ppm_{dv} (1h)	3	5 - 6 ppm_{dv}	3	5 - 7 ppm_{dv}	3	5 ppm_{dv} (12h)
PM	4	60 - 199 mg/SDm^3	3	67 - 346 mg/SDm^3	3	113 - 233 mg/SDm^3	2	57.2 - 68.7 mg/Dm^3
PM_{10}	0	-	0	-	0	-	2	45.8 - 61.8 mg/Dm^3
SO_2	3	150 (1h) - 600 (4h) ppm_{dv}	3	700 - 855 t/a	3	Covered by mill wide limits [1]	4	75 - 200 ppmdv
NO_x as NO_2	2	125 ppm_{dv}	3	132 ppm_{dv}	3	monitor	4	75 - 150 ppm_{dv}
Opacity	2	20%	0	-	0	-	4	<20 - <35%**
CO	0	-	2	monitor	2	monitor	4	200 - 1000 ppm_{dv}
VOC	0	-	0	-	0	-	3	0.048 - 0.07 lb/Mbtu
H_2SO_4	0	-	0	-	0	-	1	15.7 lb/hr
Be	0	-	0	-	0	-	1	0.006 lb/h.

These limits are at 8% O_2, unless otherwise noted.

* The figures in these columns show the number of permits that were examined in this study that included limits for that parameter. For example, of the 4 Canadian permits reviewed, 2 had TRS limits.

** Of the 4 permits that were reviewed, the opacities fell within the range of less than 20% to less than 35%.

1. Limits are placed on total sulphur emissions, SO_2 and TRS. For example one mill has a limit of 1.3 kg/t.

Table 36. **Range of permit limits for lime kilns permits**

Country	**Canada**		**Finland**		**Sweden**		**US**	
No. of permits	**4**		**3**		**3**		**2**	
Limits	**No.**	**Range**	**No.**	**Range**	**No.**	**Range**	**No.**	**Range**
TRS	1	10 ppm_{dv}	0	-	0	-	0	-
H_2S	2	10 - 12 ppm_{dv}	3	8 - 26 ppm_{dv}	3	23 - 56 ppm_{dv}	2	8 ppm_{dv}
PM	4	59-230 mg/SDm^3	3	73 - 183 ppm_{dv}	3	79 - 183 ppm_{dv}	1	228.9 mg/Dm^3
PM_{10}	0	-	0	-	0	-	1	80.1 mg/Dm^3
SO_2	2	100 (8% O_2) - 350 ppm_{dv}	2	43 ppm_{dv}	1	monitor	2	44 ppm_{dv}, 40 T/y
NO_x as NO_2	2	monitor	2	93 ppm_{dv}	1	monitor	2	100 ppm_{dv} and 241 T/y
Opacity	1	20%	0	-	0	-	2	<20%
CO	0	-	1	monitor	1	monitor	2	52 ppm_{dv}, 20 T/y
VOC	0	-	0	-	0	-	2	78 ppm_{dv}, 78 T/y
H_2SO_4	0	-	0	-	0	-	1	0.9 lb/h

Limits are at 10% O_2, unless otherwise noted.

Table 37. **Range of permit limits for NCG systems and incinerators permits**

Country	Canada		Finland		Sweden		US	
No. of permits	2		3		2		2	
Limits	No.	Range	No.	Range	No.	Range	No.	Range
TRS	0		1	incineration >97% of operating time			0	-
H_2S	1	0.2 kg/ADUt	2	36 ppm_{dv}	1	incineration >99% of operating time	2	5 ppm_{dv}
SO_2	1	200 ppm_{dv}	2	385 ppm_{dv}	2	monitor	1	300 ppm_{dv}
NO_x as NO_2			2	107 ppm_{dv}	1	monitor		

Table 38. **Range of permit limits for smelt dissolving tanks permits**

Country	Canada		Finland		Sweden		US	
No. of permits	4		2		2		4	
Limits	No.	Range	No.	Range	No.	Range	No.	Range
TRS	1	16.8 g/t BLS[(1)]	1	10 ppm_{dv}			0	-
H_2S	3	20 ppm_{dv}	1	7 ppm_{dv}	1	monitor	4	0.0168 - 0.033 lb/T BLS
PM	4	180-230 mg/SDm^3	2	100-260 mg/NDm^3	2	250 mg/NDm^3	2	0.12 - 0.2 lb/T BLS
PM_{10}	0	-					2	0.12 lb/T BLS
SO_2	2	40 ppm_{dv}					3	12 - 24 ppm_{dv}
Opacity							3	<20%

1. BLS - Black liquor solids.

Table 39. **Range of permit limits for power boilers permits**

Country	Canada		Finland		Sweden		US	
No. of permits	7*		3		2		3	
Limits	No.	Range	No.	Range	No.	Range	No.	Range
PM	5	45 - 460 mg/SDm^3	3	51 - 66 mg/SDm^3	2	93 - 545 mg/SDm^3	2	68 - 113 mg/SDm^3
PM_{10}	0	-	0	-	0	-	1	8.0 T/y
SO_2	3	80 - 1700 mg/SDm^3	3	300 - 600 t/a	0	-	3	1.0 - 788 T/y
NO_x as NO_2	3	131 - 540 ppm_{dv}	3	206 ppm_{dv}	2	monitor	3	51 - 953 T/y
Opacity	6	20 - 40%	0	-	1	monitor	3	<10 - <20%
CO	0	-	1	monitor	1	monitor	3	4 - 30 lb/hr
VOC	0	-	0	-	0	-	3	2.0 - 438 T/y
H_2SO_4	0	-	0	-	0	-	1	4 lb/h

* Four separate mills with a total of seven permits.

Table 40. **Range of permit limits for bleach plants and bleach preparation plants permits**

Country	Canada		Finland		Sweden		US	
No. of permits	4		3		2		2	
Limits	No.	Range	No.	Range	No.	Range	No.	Range
Cl_2	0	-	3	9 ppm_{dv}	2	0.5 kg/ADt	2	0.55 - 3.4 lb/hr
ClO_2	0	-	0	-	0	-	1	1.72 lb/hr
Cl_2+ClO_2	4	39-40 ppm_{dv}	0	-	0	-	0	-
Chloroform	0	-	0	-	0	-	1	25.0 lb/hr
Opacity	0	-	0	-	0	-	1	<20%

Table 41. **Examples of mill wide limits applied for some air permits in Finland and Sweden**

Country	Finland		Sweden	
No. of permits	3		0	
Limits	No.	Range	No.	Range
Cl_2			1	0.2 kg/ADt
Odour	2	Odorous gases from the process to be collected and incinerated, no noticeable odour by the year 2000	3	Odorous gases from the process to be collected and incinerated
S	0	-	3	1.2 - 1.5 kg/ADt
SO_2	3	3 - 4 kg/ADt	0	-

5.3.3 Permits for older mills

Permits for older mills are somewhat different recognising the age and constraints of the process technology. The limits set are higher than those for newer units in most cases. Time constraints and data availability have limited the discussion of this. Readers are referred to information in the separate country profiles for details. Examples that are available include state air regulation details in an annex to the US profile and information on provincial air pollution control programs in the Canadian profile. In addition, the New Zealand and US profiles give details of permits applied to old units at mills. Annex 3 summarises part of this information.

5.3.4 Air emission monitoring requirements

In a similar manner to wastewater effluent monitoring, self-monitoring of air emissions is used. Stack sampling is conducted using either continuous samplers or by manual stack sampling, following recognised stack sampling techniques. The approach used varies according to the parameter and the significance of the source. Emissions of total reduced sulphur and sulphur dioxide from major sources are usually determined using continuous analysers.

Measurement and control of *total reduced sulphur (TRS)* or *hydrogen sulphide (H_2S)* from the recovery boiler stack are important and continuous analysers are often used. Limits are often placed over short duration, such as 1 hour, 4 hours, or 24 hours. In some instances, limits may be such that emissions should not exceed specified values for more than a certain percentage of the time. TRS and H_2S are usually measured by manual stack sampling from sources such as lime kilns and smelt dissolving tanks.

Particulates are usually measured using grab samples; however, some permits require continuous samplers on the major sources. *Chlorine and chlorine compounds* are measured by manual stack sampling.

Some authorities require the monitoring of parameters that are not included in permits in order to determine the need for their control. Results of self-monitoring have to be reported to the authority in a similar manner as for wastewater effluents. Inspections are conducted on a similar basis.

5.3.5 Other air permit conditions

Often requirements related to plant operations are set in permits. These cover items such as (i) equipment maintenance; (ii) the minimisation of by-passes of control equipment, especially as it relates to the venting of non-condensable gases from various parts of the kraft process when the assigned combustion units are down; (iii) emergency planning, and (iv) ambient air monitoring. Investigations often have to be conducted to support the development of better control measures.

Some permits set caps on the time limits for the which venting may be done. Details on this were not available in all the permits. There is a trade off in allowing venting and avoiding the need for mill start ups because the emission of gases are greatest on plant start up when the different operating units are not quite in balance. There is a benefit in avoiding a plant start up, depending on the time over which venting occurs.

5.4 Solid waste permitting

Five countries provided permits or details regarding how solid wastes from pulp and paper operations are managed. In preparing this review, no underlying trends were apparent; however, the following general observations were drawn.

Solid wastes are generated from various stages of the process. Major sources are bark (this is also an energy resource) from logs used in making pulp or related saw milling operations, chemical residues from the chemical recovery process, boiler ash, primary and secondary treatment plant sludges, and de-inking plant sludges. With respect to secondary treatment sludge, it is noted that activated sludge treatment plants produce a steady quantity of sludge whereas aerated lagoons produce lower amounts with well designed and operated plants avoiding any sludge production.

The principal means of solid waste disposal are combustion and landfilling. Increasing use is being made of land applications and composting as a means of soil conditioning, however, this was not covered in any of the permits reviewed.

Conditions are specified on the composition of wastes that can be disposed through landfilling. Leaching tests are often used as the basis for classification. Wastes indicating high dissolution rates have to go to special disposal sites. Little, if any, pulp and paper mill wastes falls into this category. Conditions are often specified on the need for prior dewatering of wastes, the location and provision of security for sites, the height above ground level that the site may reach, dyking and berm requirements, and the collection and treatment of seepage and run off.

Restrictions in Europe are sometimes placed on the amount of organic carbon permitted in wastes for landfilling. In Germany, wastes with amounts greater than 5 per cent carbon on a dry basis have to be incinerated. This is usually done in bark/oil-fired power boilers. These units are covered by air pollution control permits.

An important aspect of solid waste control is the implementation of in-plant measures, to minimise solid waste formation. Some permits require mills to undertake studies to assess these aspects. However, regardless of whether this is specified in a permit, it is an important consideration for all mills.

5.5 Noise permitting

Details of noise control requirements were provided in the submissions from Norway and Sweden. Controls are exercised in many other countries through various municipal ordinances and other regulations. This study does not provide a comprehensive assessment of noise control.

In Norway, for mill noise control four reference points were set in the vicinity of a mill. As of 1 July 1995, noise levels cannot exceed 48 dB(A) at one point and 45 dB(A) at the other three. The company is also required to assess the cost of achieving 45 dB(A) at the point currently limited to 48 dB(A). Further orders may be considered once results of the studies are available.

In Sweden, noise is addressed in permits issued by the National Licensing Board. The limits are applicable at the nearest dwelling to the plant. The Swedish Environmental Protection Agency has issued the following guidelines, which are applicable to all types of industries. For pulp and paper mills, the noise limits are normally 5 dB(A) higher.

Table 42. **Noise guidelines, Sweden**

Period	New operations	Existing operations
Daytime (07.00–18.00)	50 dB(A)	55 dB(A)
Evening (18.00–22.00)	45 dB(A)	50 dB(A)
Sundays and public holidays	45 dB(A)	50 dB(A)
Night-time (22.00–07.00)[(2)]	40 dB(A)	45 dB(A)

1. The guidelines apply to all types of industries and are based on the location of the closest dwellings to the plants. With respect to permits for pulp and paper facilities, the noise limits are normally 5 dB(A) higher.
2. Night-time values must not momentarily exceed 60 dB(A).

6. TECHNOLOGY RESPONSE

6.1 Background

The questionnaire asked individual mills to describe:

(a) their technological response to permit requirements;

(b) the degree to which internal versus external treatment was used to meet the requirements;

(c) whether permits provide flexibility with respect to processes that can be applied to meet the requirements; and

(d) how they felt BAT and EQO considerations are reflected and balanced in permits.

Replies were received from ten kraft mills and four sulphite mills in total. Of the kraft mills, four were located in western Canada, three in the US and one each in Finland, New Zealand, and Sweden. Of the four sulphite mills, one each was located in Austria, Germany, Norway, and Switzerland. It should be noted that the mill responses may not be representative of the actions of all mills in these countries.

6.2 Technological response

6.2.1 Kraft mills

Most of the comments from kraft mills applied to existing mills that were undertaking major expansions or newly constructed mills. Two of the cases involved mills adapting to new permit conditions, without capacity increases. In cases where mills are being newly built, or are undergoing expansions, they have more flexibility than existing mills that are not undergoing capacity increases, as the capital costs can be spread over the incremental production capacity.

Frequent reference was made to the use of a proactive approach to determine, where possible, the best technology in use to meet the mill's current and future needs.

It appears that all mills have implemented internal measures to minimise the effluent load through the adoption of dry debarking, improved instrumentation to control cooking and bleaching operations, improved pulp washing, and, in most cases, the total elimination of chlorine gas in bleaching. Chlorine dioxide is used in place of chlorine gas to bleach the pulp. This approach eliminates dioxin and furan formation and reduces AOX discharges.

In one instance, a mill indicated that its plant would be designed to produce only total chlorine-free (TCF) pulp, without the use of any chlorine dioxide. Some mills are now able to do this, but also include chlorine dioxide production to allow them to produce elemental chlorine-free (ECF) pulp as well, which allows them to serve different pulp markets.

The use of extended cooking and oxygen delignification was almost universal in new mills, and was frequently used in many of the expanded mills. These processes permit more lignin to be removed before bleaching. The effluents from these processes are treated in the recovery boilers generating energy. The amount of effluent from the bleaching circuits requiring treatment is thus reduced.

Good spill control plays a central role in successful mill operations. Process instrumentation is installed to provide immediate detection of any spills and to permit spill prevention measures to be taken. Spills are diverted to holding tanks and either recovered in the evaporator-recovery boiler train or processed through the effluent treatment plant at controlled rates to avoid shock loading. Training courses are provided to plant personnel to effectively manage such events and protect the environment.

Measures are also taken to reduce water use in the process. These include recycling process liquors and the use of condensates from the evaporators in place of fresh water. The condensates have to be stripped to remove dissolved odorous gases prior to use to prevent odorous releases.

The use of primary and secondary effluent treatment plants was universal in the mills for which permit details were provided. The size and cost of the treatment plants were reduced through the in-plant pollution prevention measures described previously. In one instance, a mill has installed a dissolved air clarifier to remove colour. The mill noted that oxygen delignification has reduced the cost of operating this system.

With regard to air pollution control, releases of total reduced sulphur gases, which have a low odour threshold, are a major issue for the industry. In the absence of proper control measures, public complaints arise. Most of the mills under discussion use low-odour recovery boilers. Some other mills used direct-contact black-liquor oxidation. One of the mills had a chloride scrubber to control releases from the recovery boiler. The recovery boilers were generally equipped with high-efficiency electrostatic precipitators for particulate control. The boilers are operated in a manner that minimises TRS and particulate generation.

One mill indicated that the boiler would be fitted with a scrubber. The importance of collecting strong and weak non-condensable gases from various sources in the kraft mill was stressed. These gases were incinerated in various units in the mills, such as power boilers, lime kilns, and, in some instances, dedicated incinerators.

6.2.2 Sulphite mills

The sulphite mills in this study have installed measures to reduce water flows and recover chemicals from spent pulping liquors. These mills have been in operation for a long time, in some cases before the start of this century, and pollution control measures have evolved over time. Internal measures coupled with external treatment, form an integral part of the control approach.

All four mills made use of evaporators to concentrate spent pulping liquors, which are then burned in recovery boilers. The sulphur dioxide emitted is recovered in scrubbers and the base-metal oxides in electrostatic precipitators. One mill also produces ethanol and yeast from part of its spent sulphite-liquor stream; this unit has operated since 1914, with various expansions over time. This calcium-based sulphite mill only partially recovers sulphur from the spent sulphite cooking liquor with part lost as calcium sulphate in the boiler ash. The ash from the boiler, which also burns wood, is used to neutralise the bleach plant effluent prior to secondary treatment.

Mills in all four countries have implemented programs to reduce the use of chlorine and chlorine dioxide in bleaching. In the permits of mills from two countries, the use of chlorine bleaching compounds has been eliminated. Two of the four mills, produce total chlorine-free pulp using oxygen and hydrogen peroxide only. A third mill operates a similar oxygen-hydrogen peroxide bleaching line, as well as a line using a mix of chlorine gas and chlorine dioxide.

All of the sulphite mills studied used biological treatment.

6.3 Internal versus external controls

Generally, all mills commented that the use of internal treatment processes has been maximised. Only when releases could not be addressed internally was external treatment used. Maximisation of internal treatment is an implicit part of process optimisation. It is noted that significant developments are under way in the development of alternative bleaching processes to those using chlorine based chemicals as well as closed cycle, effluent-free operations.

6.4 Industry views on flexibility

Responding mills generally indicated that permitting processes were quite flexible because the permits set the releases limits but allowed the mills to choose what technology to install to meet them. In some instances, mills indicated that permits prescribed specific technology, however, this is based on prior negotiations, in which technical requirements are addressed ahead of implementation. One US mill commented that Prevention of Significant Deterioration Rules for new plant permitting gives limited flexibility as it is based on recently demonstrated BAT.

6.5 Industry views on the balancing of BAT and EQO

With respect to balancing BAT and EQO in permits, the responses of most mills suggested that although reasonably balanced, permit limits were based more on what BAT could attain, than on what the environment required. One mill stated that its permit limits were more stringent than what the local EQO required, another mill suggested the need for cost-benefit analysis to assist in permit decisions. In the case of one US air permit, the mill felt its permit focused more on BAT rather than EQO.

One mill noted that its AOX regulations were based on an EQO. When the regulations were set, the mill was uncertain that technology could provide effluent of the required quality. The mill subsequently developed technology to eliminate the use of chlorine in bleaching; the mills performance has surpassed that required by the standard.

7. DISCUSSION

This study was designed so as to answer a number of questions in order to obtain information on the environmental permitting practices. The questions were posted in the preamble to the questionnaire sent to the participating countries (Annex 1). The overview questions were:

I. *How are EQOs affecting permit requirements; what is the sensitivity of permit requirements to EQOs?*

II. *How is BAT applied in setting permit requirements?*

III. *How do the respective requirements derived from EQOs and BAT interact, and how are they applied in establishing permit requirements? Are they sequential or do they conflict?*

IV. *How are economic considerations dealt with in the regulations setting and permitting processes (particularly in view of policy issues that have arisen, such as whether BAT requirements could be relaxed in "clean" areas; and how to address BAT implementation in "areas of poor environmental quality," where BAT implementation is insufficient; and the relationship between requirements for point and non-point sources of the same pollutants)?*

V. *How do permit requirements influence:*

- *A.* *The type of pollution abatement and control technology employed? What is the rationale?*
- *B.* *The measures used to prevent the creation of pollutants, such as cleaner technology?*
- *C.* *Technological innovation?*

VI. *Do permit requirements and approaches differ for new facilities and/or major expansions as opposed to existing industries?*

VII. *How is integrated media permitting implemented relative to single medium permitting; and what are the advantages and disadvantages?*

VIII. *Which elements of the permitting systems are common to several countries, and what trends are developing related to industry's technological response to permits?*

7.1 Findings

1. How are EQOs affecting permit requirements; what is the sensitivity of permit requirements to EQOs?

All of the reporting countries indicated that, in the final analysis, permit requirements were established to ensure that the quantitative and qualitative environmental criteria necessary to protect health, property, and locally established uses of the environment are met. Such uses include fish habitat, recreation, potable and industrial water supplies, and air quality. In many cases, national regional, and waterbody environmental quality objectives have been established to direct permit decisions.

The EQOs are established by scientific investigations in each country with significant input from the international knowledge base, including the environmental objectives of other countries and organisations, such as the World Health Organization and the Commission of the European Union.

In cases where no national or regional EQOs have been developed, consideration is often given to criteria of other authorities and bodies as a guide to decision-making. Effluent and stack dispersion models are often used to determine concentrations of pollutants at various points in the receiving media. Permit conditions are established by considering EQOs.

It appears that in some countries, EQOs were the ultimate determinant of the severity of controls. This was particularly apparent for the case of water permits in the USA as well as for permits in Alberta and some in British Columbia. In these instances, the permitting authorities have quantitative values for the maintenance of the property of the receiving water. The situation of dissolved oxygen contents was stressed. Very stringent requirements were developed to limit BOD releases to avoid oxygen depletion.

The same practices were followed in New Zealand where the maintenance of water quality objectives was paramount. The mill limits for BOD were stricter than those considered as BAT for this reason. Details of the factors that had gone into permit decisions were not available for the other countries to draw similar conclusions.

Similarly air quality maintenance requirements serve to require stricter limits than BAT. It is noted that the PSD Rules of the US force BAT to be applied, regardless of local air quality conditions.

2. How is BAT applied in setting permit requirements?

Best available technologies is a concept applied in most countries to set regulations and permit requirements. Basically, two types of permitting systems are operated by the countries in this study. The first consists of countries in which emission regulations have been passed regarding maximum permissible releases to air and water. These regulations are frequently referred to as technology-based regulations, developed using concepts such as BAT. The regulations serve as the minimum requirements, or maximum release limits, allowed in permits. However, because of the limited assimilative capacity at a site, more stringent ambient-based requirements may be set.

The second type of permitting system consists of countries that do not have technology based emission regulations and set permit limits based on case-by-case considerations. These considerations include assessments of the minimum emissions that can be achieved by best available technology at the plant. These apply a similar evaluation process to that used to establish emission regulations, but this is conducted at the level of the individual plant rather than of the industry sector.

It is noted that each country has its own definition of BAT. In some of the countries the definitions change according to the media to which they apply and the vintage of the plant (new versus existing). Each definition has to be read separately.

It appears that BAT is established by determining what technologies are available world-wide for application to a particular situation. This includes consideration of other factors such as economics. In many instances BAT is developed by consultations between industry representatives and the regulatory authorities, with additional input from the public, environmental groups, and other stakeholders. Some countries and international agreements have defined it by reference to emission limits that mills can attain. These are used by authorities in negotiations to reach permit decisions.

It should be noted that BAT is applied under a number of environmental programs in the US. New facilities must meet the New Source Performance Standards, and if the plant is in a non attainment area, it is also subject to New Source Review regulations. BAT is applied to existing mills under the Prevention of Significant Deterioration rules, which affect expansion and modification of existing sources. In all cases, BAT is determined by the best performance of similar facilities in the US, taking environmental, economic, and energy requirements into consideration.

The types of technology that plants must install are dictated by the performance levels set in permits. Mills are left the choice of what equipment to install to meet the specified limits, and can select different technologies. In some countries, the permits specify the technology that should be employed; however, this is based on prior negotiations, in which technical requirements are addressed ahead of implementation.

3. How do the respective requirements derived from EQOs and BAT interact, and how are they applied in establishing permit requirements? Are they sequential or do they conflict?

The purpose of permits is to protect the environment. Protection is established by the relationship between the levels of pollutants in the given medium, following dilution/dispersion, and the EQO. EQOs are the concentrations of pollutants in air and water that are set to ensure that the media will not be impaired.

Different considerations influence the permit limits that are set. In some cases, use is made of BAT assessments carried out on a case-by-case basis for individual plants. In other cases, permit limits are imposed on the basis of national BAT-based emission regulations. The BAT limits established under such regulations form the maximum permissible (baseline) limits that may be set. In the case of sensitive ecosystems, more stringent requirements are imposed based on the maintenance of EQOs.

In cases where permits are established based on case-by case consideration, the EQOs are one element of the consideration. In some cases they may be the deciding factor, in others they are not. The use of one factor does not override the other; e.g., in cases where the quality of the receiving media is such that excess dilution is available to provide adequate EQO. This does not exempt the mill from having to implement a BAT requirement.

4. How are economic considerations factored into regulations and permits?

Economic considerations are weighed when establishing technology emission regulations and individual permit conditions. For example, assessments are made as to what the costs and consequences are when adopting specific technologies. Consideration is also given to how the proposed regulations compare with those of competitor countries, and how this may affect trade.

One of the major influences of economics appears to be the timing for implementation of new requirements for existing mills. New mills have to meet the requirements upon start-up, but a phase-in period is allowed for existing mills.

Achieving compliance with new rules is generally more difficult for existing mills than for new mills. Existing mills may have engineering factors such as space limitations for the installation of certain equipment. Additionally, the mills have to replace or modify their current equipment and require greater accommodation to meet the financial obligations any new rules impose. Most permits take this into account through time schedules for the installation of equipment and periodic reviews of the permits.

5. How do permitting requirements influence:

a) The type of pollution abatement and control technology employed?

As noted, mills are left the choice of what equipment and processes to apply. Different combinations of in-plant and external treatment can be used. This is the prerogative of the facility.

b) The measures used to prevent the generation of pollutants, such as cleaner technology?

Pollution prevention plays a major role in the abatement strategies that have been adopted. Permit limits are set considering what pollution prevention and end-of-pipe treatment technologies can achieve. The selection of technology is left to the mill. As end-of-pipe, external treatment equipment generally involves capital and operating expenses, without significant, if any product outputs and offsetting revenues, mills strive to maximise the use of pollution prevention, to optimise economic efficiency. Such approaches can involve re-design of processes and products, and the recycling and reuse of wastes. As a result, more environmentally friendly technologies have been developed and improved environmental protection has been encouraged.

The principles of reducing, reusing, and recycling waste, raw materials, and energy are used in the development of in-plant measures to meet the permit limits. The volumes of wastes requiring treatment are thus minimised, and the cost, and load on the environment reduced. In all of the chemical pulp and paper mills reviewed in this study, waste liquor incineration is used to recover chemicals and energy from the spent pulping solutions. The success of these processes is based on water minimisation and liquor concentration to permit autogenous firing.

Concern over the depletion of the dissolved oxygen content of the receiving water, which is vital to the life of fish, has lead to widespread adoption of biological treatment of wastewaters, although this is not universal at all mills in some of the countries. The prior use of in-plant measures minimises the size and capital and operating costs of these facilities. Some mills are beginning to approach the levels of BOD releases attained by biological treatment plants by the use of in-plant measures including extensive oxygen delignification and peroxide and ozone bleaching processes. These are coupled with the use of excellent spill control in pulping and low washer losses.

For the kraft sulphate processes, in addition to the economic advantages associated with recovering chemicals and energy, concerns over the release of odorous sulphur-containing gases have led to the development of high-efficiency chemical recovery techniques. The spent process chemicals from pulping are concentrated, allowing them to be burned in a boiler, recovered, and reused. Heat is also generated and recovered as steam, hot water and electrical power in many cases.

Permits for the kraft process commonly include conditions relating to the stripping of condensates from the chemical recovery process to remove dissolved sulphur-containing gases and the collection of off-gases from various sources in the process. These gases are burned in units such as lime kilns, power boilers, or dedicated incinerators, thereby avoiding the serious odour problems that can occur when such gases escape from sources within the plants.

Particulate emission limits have led to the installation of high-efficiency electrostatic precipitators, or scrubbers, to control airborne particulate releases. Emissions of chlorine and chlorine-containing bleaching agents are controlled using high-efficiency wet scrubbers that are installed to handle waste gases from the bleach-chemical preparation plant and the bleaching plant.

In addition to setting limits, some permits include requirements for mills to conduct investigations to develop new, cleaner, pollution-prevention manufacturing technologies. The results of these studies are used during the permitting process by regulatory authorities. Examples include studies on the control of nutrient releases from biological treatment plants, minimisation of sludge generation, combustion of sludges, and reduction in the use of energy and materials.

c) Technological innovation

A high degree of technological innovation has been demonstrated within the industry. Technologies that are developed successfully in one country are quickly adopted in others. Thus the leading edge technologies in use in mills in all countries are essentially becoming similar.

6. Do permit requirements and approaches differ for new facilities and/or major expansions versus those for existing mills?

It is difficult to give a categorical answer to this question as the case of all mills, in all the countries, have not been studied. From information assembled for the report it appears that existing mills that are not undergoing expansion when the permits are reviewed, receive more lenient consideration. In cases where air regulations have been issued, older processes such as direct contact evaporation based recovery boilers are given higher permissible TRS releases than newer low odour boilers. With respect to effluent control in the US, the NSPS limits for new mills are more rigorous than the BCT limits for existing mills. The circumstances that apply to case-by-case permit decisions is not that clear. However, in such decisions BAT application is one factor that is considered. Economics also plays a role. This can be expected to be more favourable to existing versus new mills.

7. Integrated Media Permitting

About one third of the countries reporting currently have integrated media permitting; another third is in the process of moving towards integration. In these cases, full integration is expected to take some time because of the different time frames for existing air, water, and waste permits. The other third have separate permitting systems for the different environmental media. Various means of co-ordination, at the regulatory official level, are used to address the intermedia transfer of pollution in the case of single media permitting.

The principal advantages of integrated permitting are the ability to control better the intermedia transfer of pollutants, smaller economic impacts, and improved efficiency in environmental protection and inspection procedures.

8. Which elements of the permitting systems are common to several countries, and what trends are developing related to industry's technological response to permits?

It appears that the use of an application for a permit, that documents the major elements of the process and their impact on the environment is common. There is also a high level of knowledge exchange among regulatory authorities and mill staff. Similar, pulp and paper buyers throughout the world want to acquire "environmentally friendly" type products, at the right price. These factors are leading all mills to move to a more modern, environmentally friendly type processes, as described previously.

8. SUMMARY AND CONCLUSIONS

This report describes the way in which environmental control permits for pulp and paper mills are developed in the participating countries. It is noted that in each country, the permitting authority establishes its requirements based on consideration of the technical means to reduce pollutants, as well as consideration of the environmental effects of the releases.

A notable difference between some countries is in the types of organisation that issue the permits. In the case of seven of the countries, permits are issued by officials of either the national or state/provincial governments. This applies to permits in Austria, Belgium (Wallonia), Canada, Germany, Norway, Switzerland and the United States. In the case of the other three countries, Finland, Sweden and New Zealand, permits are issued by constituted bodies established by the government. In the case of Finland, water permits are issued by the Water Courts, and air and solid waste permits by Regional Environmental Centres. In Sweden, a National Franchise Board issues permits covering all the three media, water, air and solid waste. In New Zealand, Regional Councils issue and manage permits.

As well as the differences in the type of permitting authority, another important distinction is in the type of permitting model applied. The results of the study show that basically two types of models are applied.

The first model consists of one in which governments have passed technology based regulations or guidelines. These specify the maximum quantities of pollutants that permits authorise mills to release. These are normally specified in terms of kg/tonne of product, although in some cases, concentration limits are set. The permitting authorities are also given discretion to impose stricter limits where required by the nature of the receiving media on an EQO basis. Results of this study show that this frequently occurs.

This second model, is one in which more latitude is given to the permitting authority in setting permit conditions. No minimum technology based limits have to be applied. Although in some cases, governments may have set targets for the overall industry sector to attain. The permitting authority decides the permit limits by considering and balancing several factors. Important factors that enter into this are: best available technology; the circumstances of the mill; the nature and state of the receiving media; and economics. Relative to assessing the needs of the receiving media, and protection of sensitive systems, environmental quality objectives have been developed.

8.1 Water Permitting

Water permits authorise the discharge of effluents subject to various conditions. Limits are typically set in terms of allowable mass quantities of pollutants, although Belgium expresses its limits as concentrations of pollutants in the effluents. Water permits also contain limits for parameters such as pH and temperature and include monitoring conditions. In some cases, permits establish requirements for the maintenance and operation of the treatment facility.

In developing permits, the authorities are concerned with balancing the interests of the various parties. This involves those of the mill owners at one extreme, and users of the water resource affected by a mill's discharges, at the other extreme. In addition, others with a less direct interest are involved including employees, suppliers, community residents, taxpayers, and environmental interest groups . The authorities thus have to consider the views of many parties when making a decision.

In order to provide a basis for the authorities to develop permits, the government makes use of a variety of tools including :

- Regulations establishing minimum acceptable levels of pollutant discharges (ceilings). Regulations are used in Austria, Belgium, Canada (federal and provincial), Germany, Switzerland and the United States. The permitting body is given the power to impose stricter limits based on EQO consideration at the individual sites.
- In cases where regulations have not been developed, decisions on permits often have as a starting point quantitative expressions of technical limits the governments consider reasonable. These are based on BAT concepts.
  - In the case of Finland, the environmental ministry considers limits given in the conclusions of a Nordic Working Group on pulp mills as a basis for its presentations at Water Court hearings to decide permit conditions.
  - In Norway, reference was made to the conclusion of a similar group under OSPARCOM;
  - In Sweden the Ministry of Environment noted that they have developed their own guidelines, which form their starting point for its presentations at National Franchise Board hearings.
  - In the case of New Zealand, the District Councils that are responsible for permitting base their decision on the EQO needs but also refer to the standards set by other authorities such as the US EPA.
- In 1987, Finland established 1995 discharge targets for their overall industry covering BOD_7, COD_{cr}, AOX and nutrients that should be met. These targets were to be taken into account by the National when setting individual permit limits but did not bind the individual permit outcomes. All of these targets have been attained.
- Different variants of BAT policies and definitions are in use in participating countries. These are used to define reasonably attainable pollution levels from various types of mills, considering technical and economic factors. Most definitions of BAT include an element of economic attainability, which leads to substantial differences between definitions of what is "best" in different jurisdictions. BAT definitions are also used when establishing regulatory and rule limits.
- A wide range of qualifications are applied to the word "best". Each definition is unique to the individual country. Caution should therefore be exercised when applying the terminology among countries.

- In permit decisions BAT considerations appear to be one element in the decision. It can also be said that "best is not always best", as several permits demonstrate that better performance was required at sites based on water quality objective consideration.
- Environmental quality objectives are developed to establish what level of pollutants or conditions in a water bodies are reasonable. The values are used to gauge whether the pollutant load imposed by a mill is reasonable. Dilution and environmental effects models are applied and results compared to water quality objectives.
- There is a wide range in the types of water quality objective systems applied. Some systems set quantitative limits for individual pollutants, at concentrations or physical properties sufficient to protect certain uses. Other systems classify the waters into different water quality grades based on a range of parameters. A range of systems are applied with objectives being developed on a national, regional or an individual waterbody basis. The wide divergence in the water quality objectives development practices and system specifications has limited the analysis of water quality objectives that could be done in this study.

All of the bleached chemical pulp mills in this study, whether they are kraft or sulphite, appear to pay attention to applying in-plant measures to remove pollutants prior to external treatment. The extent of in-plant controls varies in the kraft industry, particularly in countries with many mills of differing ages. This is especially true in North America where the industry wide incorporation of processes such as oxygen pre-bleaching, extended cooking and peroxide bleaching, are less than in Scandinavia.

The selection of either BOD or COD as the principle control parameter to address dissolved solids has an influence on the technology chosen by a mill. The use of BOD promotes external secondary treatment. The use of COD promotes internal treatment using processes such as oxygen pre-bleaching. Both approaches seem to be applied in an increasingly complementary manner in the five countries covered. However it is noted that processes such as oxygen pre-bleaching are less prevalent in North America.

Information in the report shows that the kraft mills in all six countries studied, with the exception of some mills in Sweden, applied secondary biological treatment. Secondary biological treatment was also applied at all the bleached sulphite mills reviewed. Primary clarification for suspended solids removal is used at all mills (kraft and sulphite).

In this study data on the effluent qualities from all the bleached kraft mills in five countries was reviewed. This showed that while there were significant differences in the permitting practices applied in the five countries, the effluent qualities in the countries appear to be similar. The discharges appear to be converging over time for BOD and AOX. However information was not available on COD discharges, beyond the two Scandinavian countries.

It appears that most mills have discharges much lower than the permit and regulatory limits that are apparent from this OECD study. Economic and market forces are believed to account for this. Environmental improvements appear to become less permit driven.

8.2 Air pollution permitting

Air permits are issued to mills authorising the emission of gas subject to various conditions. The permits usually include specifications relating to the concentrations of specific gases (e.g. H_2S, TRS, SO_2, NO_x, Cl_2) and particulates, in a volume of gas, normalised to specific pressure and temperature conditions.

Emissions from combustion units, such as recovery boilers and lime kilns, are also normalised to a reference oxygen content.

The air permit development processes are generally more complicated than that for wastewater permits. This arises partly from the design of the plants, as well as from the fact that air emission sampling is inherently more complicated than water sampling. Regarding plant design, it is a relatively easy task to move effluents round a mill whereas the movement of gases requires large flues and fans. Hence, air emission sources tend to be addressed on an individual basis, or through combination of gases from a few sources, e.g. the non-condensable gases and a power boiler, or a lime kiln. In these cases the combination is made to use one unit to treat the gases from another source.

Air permits tend to address the emissions on a point-by-point basis. In the case of kraft mills these include the recovery boilers, power boilers, lime kilns, smelt dissolving tanks, pulp washing area, evaporator and condenser systems, bleached chemical preparation area and bleach plant operations, and miscellaneous vent associated with the process. For the kraft industry the collection of gases from some of the extraneous sources is important due to the presence of odorous sulphur compounds such as hydrogen sulphide, methylmercaptans and methyl sulphides. These gases are formed as a result of reactions between the wood and the kraft cooking chemicals. In the absence of proper measures, complaints may arise from the local community.

The measures taken to mitigate releases consist of means to minimise the formation and transport of the pollutants in the gas streams (i.e. in-plant measures), as well as the use of external gas treatment processes. These consist of cyclones, electrostatic precipitators and scrubbers as well as chemical scrubbing to recover SO_2 from the sulphite process.

The in-plant measures taken are based largely on the proper design of the operating units to minimise the formation of odorous gases and pollutants. For the kraft industry, one of the major components that can give rise to emissions is the recovery boiler. Many new mills and older mills that have undergone major expansions or renovations, have chosen to install new low-odour boilers. These tend to be larger and taller units than their predecessors, with differences in the design of the air firing ports. The boilers operate at higher solids contents and without the use of direct contact evaporators. This boiler design leads to the formation of lower amounts of the gases concerned. In contrast, many older boilers evaporate water from the boiler feeding directly into their exhaust gases. This leads to more formation of odorous sulphur compounds.

Burner design is also an important element of in-plant design that is taken to alleviate NO_x formation. This is applied in units such as the recovery boilers, fossil fuel power boilers and lime kilns.

Air pollution control strategies are based on the use of external processes such as mechanical dust collectors, electrostatic precipitators, scrubbers, dedicated incinerators and in some cases regenerative thermal oxidation units. For the sulphite industry, the SO_2 scrubbers are an important element of the process and can be regarded as an in-plant device.

In all of the countries separate permits/rules are developed for each source. These tend to specify the permissible emission rates in the form of concentrations under set gas conditions (standard temperature, pressure and oxygen content).

In the case of Sweden and Finland, some permits also use a bubble concept, which sets maximum emission rates for sulphur in all forms, and nitrogen oxides (NO_x), from the mill operations excluding the auxiliary boilers.

For sulphite mills, limits were set for sulphur dioxide and particulate emissions from the recovery processes in permits provided by Austria, Germany, Norway, and Switzerland. NO_x limits were also given in permits supplied by Austria and Germany.

Guidance is provided to permitting authorities as in the case of water permitting. Most of the countries have in place air quality objectives and standards to set acceptable levels of major pollutants in the ambient air Additionally, most of the countries have policy documents defining technology based limits for various pieces of equipment. These policies consist of regulations, guideline (rules in the US), objectives, etc. There is a wide variation in the systems between each country and readers are referred to the individual country profiles for details.

The following points are noted with respect to the control parameters in the permits applied to the major units in modern bleached kraft mills:

- *Chemical recovery boilers*: This is one of the major sources for air emissions in kraft mills. The analysis shows that sulphide emissions in the form of either TRS or H_2S is a major control parameter along with particulate matter. In addition, many permits had limits placed on SO_2 and NO_x emissions. Carbon monoxide, volatile organic carbon, sulphuric acid and beryllium limits were also included in some US permits as a consequence of the Prevention of Significant Deterioration Rules of the US Clean Air Act.

- Sulphide emissions limits contained in the permits in the four countries fell in a narrow range of 3-15 parts per million. This is indicative of low emissions achievable through well operated low odour recovery boilers.

- For particulate matter, limits fell in a range of 60- 346 mg/dry cubic meter. In the US limits were also included for particulate matter of less than 10 microns.

- Lime kilns: Similar permitting practices and parameter limits apply to lime kilns as to recovery boilers with a range of limits set.

- *Non-condensable gas (NGS) management systems*. NCG management is an important area for mills as the uncontrolled escape and venting of gases from various sources in a mill will give rise to serious odour problems and complaints from the community. It can also be an occupational health concern. Collection practices since the 1970's have generally included digester relief, evaporator and strippers which are sources with high NCG concentrations . More recently, dilute sources from chip bins, washers and tank vents are also being collected. Incineration of the collected gases is carried out in either power boilers or lime kilns, with dedicated incinerators being used in some cases.

- *Smelt dissolving tanks*: In all six countries limits were placed on either TRS or H_2S, and particulate. Control is normally affected using scrubbers. In Canada and the US some permits included SO_2 limits, and in the US, opacity limits.

- *Wood waste/fossil fuelled power boilers***:** Power boilers play an important part in the mill. The boilers rely heavily on the use of wood waste as a fuel and provide an effective means of disposing of wood and effluent treatment sludge wastes from pulp and paper and allied saw milling operations. The boiler emissions are controlled by means of particulate emissions. In some cases limits are placed on sulphur and nitrogen oxides emissions as well.

- *Bleach plants and bleach preparation areas***:** For the bleach plant and bleach chemical preparation areas, permit limits were set for chlorine and/or chlorine dioxide.

8.3 Solid waste permitting

Five countries provided permits or details regarding how solid wastes from pulp and paper operations are managed. In preparing this review, no underlying trends were apparent. However, the following general observations were drawn.

Solid wastes are generated from various stages of the process. Major sources are bark (this is also an energy resource) from logs used in making pulp or related saw milling operations, chemical residues from the chemical recovery process, boiler ash, primary and secondary treatment plant sludges, and de-inking plant sludges. With respect to secondary treatment sludge, it is noted that activated sludge treatment plants produce a steady quantity of sludge whereas aerated lagoons produce lower amounts with well designed and operated plants avoiding any sludge production.

The principal means of solid waste disposal are combustion and landfilling. Increasing use is being made of land applications and composting as a means of soil conditioning, however, this was not covered in any of the permits reviewed.

Conditions are specified on the composition of wastes that can be disposed through landfilling. Leaching tests are often used as the basis for classification. Wastes indicating high dissolution rates have to go to special disposal sites. Little, if any, pulp and paper mill wastes falls into this category. Conditions are often specified on the need for prior dewatering of wastes, the location and provision of security for sites, the height above ground level that the site may reach, dyking and berm requirements, and the collection and treatment of seepage and run off.

Restrictions in Europe are sometimes placed on the amount of organic carbon permitted in wastes for landfilling. In Germany, wastes with amounts greater than 5 per cent carbon on a dry basis have to be incinerated. This is usually done in bark/oil-fired power boilers. These units are covered by air pollution control permits.

An important aspect of solid waste control is the implementation of in-plant measures to minimise solid waste formation. Some permits require mills to undertake studies to assess these aspects. However, regardless of whether this is specified in a permit, it is an important consideration for all mills.

9. REFERENCES

Bonsor, N., N. McCubbin and J.B. Sprague (1988). Kraft Mill Effluents in Ontario. Report Prepared for the Technical Advisory Committee, Pulp and Paper Sector of MISA, Ontario Ministry of the Environment, Toronto, Ontario, March 28.

Canadian Pulp and Paper Association (1996). Reference Tables, Canadian Pulp and Paper Association.

Committee for the Gulf of Bothia (1987). Water Pollution Problems of Pollution Problems of Pulp and Paper Industries in Finland and Sweden. Report of the Special Working Group. Naturvardverket Rapport 3348. May.

Environment Canada (1990). Biological Test Method: Acute Lethality Test Using Rainbow Trout. Report EPS 1/RM/9. July.

Finnish Forest Industries Association (1994), Finnish Forest Industries.

Halliburton, D. (1997). Environment Canada. A review of permitting practices for bleached kraft mills in Scandinavia, New Zealand and North America and their influence on effluent quality. Third International Conference on the Fate and Effects of Pulp Mill effluents, Rotorua, New Zealand. Proceedings in press**.**

OECD (1997). Environmental Permitting of Industrial Facilities - Approaches and Instruments, final draft. OECD Pollution Control and Prevention Group.

OECD (1997). Environmental Requirements for Industrial Permitting: Case Study on the Iron and Steel Industry. OECD Pollution Control and Prevention Group. May.

OECD (1997). Reference Guide on Environmental Requirements for Industrial Permitting.

Province of Quebec (1992). Pulp and Paper Mills Regulation. O.C. 1353-92 (as am. by O.C. 1529-93).

Simons Ltd. Consulting Engineers, in association with Norecol, Dames and Moore, Inc. and ÅF-IPK (Sweden) (1995). A Technical Background Information Document on Pulp and Paper Mill Air Emissions. P.5517A. The Ministry of Environment, Lands and Parks of British Columbia and Environment Canada. April.

Simons Consulting Group (1994). Forestry Sector Benchmarking Initiative: A Case Study in Environmental Regulations. Prepared for Industry Canada and Forestry Canada.

United States Environmental Protection Agency (1993). Development Document for Proposed effluent Limitations, Guidelines and Standards for the Pulp, Paper and Paperboard Point Source Category. EPA-821-R-93-019. Washington, DC.

ANNEX 1

OECD QUESTIONNAIRE FOR THE SURVEY OF THE USE OF BEST AVAILABLE TECHNIQUES/TECHNOLOGY (BAT) AND ENVIRONMENTAL QUALITY STANDARDS/OBJECTIVES (EQO) IN ENVIRONMENTAL PERMITTING OF INDUSTRIAL SECTORS

ISSUE

This document contains a questionnaire and background information on a study that is being conducted by the OECD, to determine how factors related to Best Available Techniques/Technologies (BAT) and Receiving Media Environmental Quality Standards/Objectives (EQO) are considered when environmental permits are issued for different industry sectors.

INTRODUCTION

In September 1993 the Pollution Prevention and Control Group (PPCG) of the Organisation for Economic Co-operation and Development (OECD) initiated a study of the policies for applying Best Available Techniques/Technologies (BAT) and Receiving Media Environmental Quality Standards/Objectives (EQO), in environmental regulation of pollution sources. This first phase of the project surveyed general policies of member countries, and results of this work have been summarised in an OLIS document ENV/EPOC/PPC(94)17.

This work provided general information on the use of BAT/EQO within the permitting and regulation systems of Member countries; however, application of policies on a case-by-case basis was not clearly defined. The PPCG therefore decided to conduct a series of individual case studies, to define the application of BAT/EQO within various industry sectors, as a way of improving understanding among Member countries and identifying significant issues and approaches for possible development of international guidance.

The case studies are being conducted by volunteer countries with a designated lead country for each of the four selected industrial sectors (pulp and paper, metal finishing, oil refining and iron and steel). A questionnaire approach will be used in conjunction with a review of sample permits. For the purpose of the studies a permit has been defined as an authorisation or license, including authorisations contained in regulations or legislation, to operate an industrial facility, in which there are conditions and requirements related to protecting the quality of the environment, or to the prevention or control of releases of polluting substances.

A copy of the questionnaire is attached. Your response along with the sample permits will be requested for the case studies in which you are participating.

The intent of these studies is to provide an understanding of how the requirements contained in the permits of participating countries are developed and the rationale for the permit conditions. It is not to compare emission limits. Analyses will be made by lead countries of the information provided to review the approaches being used to address releases to all media, water, air and solid waste. The use of multi-media permitting by different authorities will also be examined, especially to determine its implications for the nature of the requirements and its effects, if any, on encouraging pollution prevention.

Besides addressing the permitting approaches used by the authorities, the studies will assess the response by the regulated industries to the permit limits set. They will address their rationale for the choice of technologies, in particular, considerations related to the selection of pollution prevention versus end-of-pipe treatment to meet the requirements will be identified. Knowledgeable non-government organisations may also be contacted.

The lead countries will wish to send participating countries/provinces/states their analyses in order to engage them fully in the process. The overview questions, for which the study is seeking answers, are listed below. Participating authorities are encouraged to consider these questions in completing the questionnaire, they are also asked to provide answers to the questions wherever possible, from their knowledge of the permitting process in their own authority.

The overview questions are:

(i) How are EQO's affecting permit requirements; what is the sensitivity of permit requirements to EQO's?

(ii) How is BAT applied in setting permit requirements?

(iii) How do the respective requirements derived from EQO's and BAT interact, and how are they applied in establishing permit requirements? Are they sequential or do they conflict?

(iv) How are economic considerations dealt with in the standards setting and permitting processes (particularly in view of policy issues which have arisen, such as whether BAT requirements could be relaxed in "clean" areas; and how to address BAT implementation in "areas of poor environmental quality", where BAT implementation is insufficient; and the relationship between requirements for point and non-point sources of the same pollutants?)

(v) How do permit requirements influence:

 (a) the type of pollution abatement and control technology employed? What is the rationale?
 (b) the measures used to prevent the creation of pollutants such as cleaner technology?
 (c) technological innovation?

(vi) Do permit requirements and approaches differ for new facilities versus major expansions as opposed to existing industries?

(vii) How is integrated media permitting implemented relative to single medium permitting; and what are the advantages and disadvantages?

(viii) Which elements of the permitting systems are common to several countries, and what trends are developing related to industry's technological response to permits?

The following questionnaire has been prepared in order to generate information to prepare the studies.

(i) Part A: Background Information.

(ii) Part B: Information from permitting authorities on the sample permits. This information will assist the lead countries in interpreting the permits and BAT/EQO relationships. Separate questionnaires should be completed for each permit supplied.

(iii) Part C: Information from the regulated industrial plants on what has been their technological response to the permit limits set. These questionnaires should be sent by the participating authorities to the permittees and/or trade associations they select.

Note: When answering the questionnaire, you may wish to follow the suggested format, and/or provide the requested information with relevant literature and references.

Part A: BACKGROUND INFORMATION

The objective of this section is to ascertain the influence of ecological, economic, political and administrative decision making considerations on environmental permitting rules and procedures for the industrial sector under investigation. The questions are intended to generate background information, and to focus on details of the standard setting and permitting procedures. Your responses to the sections on BAT and EQO should include separate sections, as appropriate, describing how they are applied in water, air and solid waste pollution control/prevention.

[NOTE: Where countries have already provided answers to some or all of the following questions in response to the October 1993 Phase 1 BAT/EQO Questionnaire, they may so indicate.]

Industry Sector Details

A.1.1. Please describe the main characteristics of the industry sector:
-name of sector;
-total number of facilities;
-main environmental features (such as releases to various media);
-main industrial processes which are the focus of regulations.

A.1.2. What is the name(s) of the body(ies), or the title(s) of the official(s) who issue the permits or regulations?

A.1.3. Application?
- What triggers the process? (For example, new plant construction, plant expansion, or periodic reviews, etc.)
- What type of information must the applicant provide?
- What is the duration of the permit and it's renewal process?

A.1.4. Is there a process by which decisions of the permitting authority can be appealed, and to what extent can conditions based on BAT and/or EQO considerations be changed? Please discuss as appropriate.

A.1.5 What environmental standards are applicable to this industry sector?

Are these requirements derived from technology based standards, ambient quality based standards or on any other basis?

Please briefly describe the standard setting process, or provide background material describing it.

Are the standards subject to any negotiation in the permitting process?

A.1.6. Are separate permits granted for discharge/emission to different media (air, water, land) or do you use integrated i.e. multi media permitting systems?

A.1.7. Please provide information on the receiving environments into which releases from the process are emitted/discharged; and on the environmental impact of those releases, in so far as they are taken into account in the permitting decision?

A.1.8 How are the potential releases to different media, and possible options for their pollution prevention/abatement, dealt with in the permit?

If tightening down of one emission would result in increased emissions to another media, does it influence requirements in the permit? (For example is consideration given to achieving the least possible impact on the environment as a whole?)

A.1.9. Who conducts monitoring?

What methodologies and criteria are established to control the quality of monitoring results?

Is any monitoring carried out by the permitting authorities?

Are monitoring results available to the public?

Do the monitoring results influence the establishment of standards and the negotiation of permits?

Please adapt and explain the above in order to describe your approach.

Best Available Technique/Technology

The concept of Best Available Technique/Technology (BAT) is widely used by authorities when setting limits; however it's definition varies from country to country and sometimes organisation to organisation. Could you provide an understanding of what is meant by BAT, or similar concepts, within your authority in the issuance of permits, by answering the following questions.

A.2.1. Do you use a concept such as BAT, and if so could you provide a written definition of the terminology.

A.2.2. If applicable, what does your legislation/policies state to be the purpose of using BAT?

A.2.3. Do you apply a concept such as BAT when issuing permits, and if so could you describe how it is used in the development of permits?

A.2.4 Is BAT prescribed in a form such as pollution prevention and/or treatment technologies that must be used; operating practices that must be employed, or in terms of performance standards such as concentrations or mass emissions per unit of production?

A.2.5. Do you apply BAT concepts uniformly across this sector, or does BAT vary from plant to plant, depending on the circumstances and condition of the individual plants, for example, factors such as plant size, age, cost of production?

A.2.6. Are financial factors (e.g. the operator's ability to finance works) considered in determining what BAT is for a particular facility when setting limits?

A.2.7 How is the status of technology considered when setting permit requirements?

Do the permitting authorities obtain independent expert advice on pollution prevention and end-of-pipe treatments that could be applied, when setting permit requirements?

A.2.8 In cases where biological control systems performance may be affected by ambient temperatures and/or seasonal variation, do your standards include any accommodation? Please describe as relevant to your case.

A.2.9 In cases where a facility is operating in a sensitive ecosystem, do you require more stringent performance than in the case of sectoral BAT? How is this more stringent performance level determined?

A.2.10. Are there any government programs to aid the introduction of newer, cleaner technologies?

Environmental Quality Standards/Objectives (EQO)

The concept of Environmental Quality Standards/Objectives (EQO) is used by governments to establish environmental goals and targets (e.g. levels in various receiving media and pollutant reduction targets), and to determine if the receiving media i.e. air, water and soil, are of sufficient quality for specified needs, accepting environmental loads. Could you provide information of the methods by which ambient environmental quality standards/objectives are established, as well as how they are translated into regulatory requirements for the various sources?

A.3.1 Which emissions from the selected facilities are covered by an EQO? Do EQO's apply uniformly throughout your territory?

A.3.2. How were the EQO's developed? Are EQO's developed differently for sensitive ecosystems?

A.3.3 How do requirements derived from EQO's and BAT, if applicable, relate, and how are they applied in developing permit requirements? (Are they sequential or do they conflict with one overriding the other?)

Part B: QUESTIONNAIRE DESCRIBING SAMPLE PERMITS

Could you please complete this form for each sample permit/regulation supplied to illustrate the circumstances of the facility when the permits/regulation were issued, in order to assist the lead country in its analysis of the issuance process. Permits should be provided for water, air and solid waste control if possible. In cases where control is by means of regulations, only details of the regulation should be provided.

NAME OF PERMITTEE: …………………………………………………………………………
MEDIA TO WHICH APPLIED (Air, water or land/solid) …………………………………………….
DATE OF ISSUANCE: …………………………………………………………………………
DURATION OF PERMIT …………………………………………………………………………

B.1. What is the rationale for the selection of this permit, for example :

(a) are the contents of the permit innovative and illustrative of recent permitting trends?

(b) is the selected facility representative for the industrial (sub)sector?

(c) is it a state-of-the-art facility or a facility located on a sensitive ecosystem?

(d) is the permit representative for comparable facilities in the industrial (sub)sector?

Please describe using the above as a guide and adapt as necessary.

B.2. What were the circumstances of the plant to which this permit applies, for example:

(a) was this a new facility that was being built?

(b) was it an existing plant that was being modernised or expanded?

(c) was it an existing facility that was undergoing no changes?

(d) had there been any changes in government policies prior to permitting of this plant, that affect the contents of the permit issued?

B.3. Permits normally contain legal limits for the release of prescribed substances and properties, such as pH and temperature, so as to ensure that plants are operated in a manner that the environment is adequately protected. For this permit what substances/properties are controlled and what is the rationale for selecting them?

SUBSTANCE/PROPERTY	RATIONALE FOR SELECTION	MEASUREMENT PERIOD

(PRESENTATION IN THIS FORMAT WILL ASSIST THE LEAD COUNTRIES TO SUMMARISE THE INFORMATION)

B.4 Please indicate whether there are any technical/scientific guidance values. limits that form non-binding guidance values.

B.5 Please indicate whether there are other legal requirements, in addition to limit values, for example maintenance of plant equipment and spill emergency response plans?

B.6. For the limit values in the permit, over what measurement period do the apply?

- For example are limits based on grab samples, daily averages, 30-day averages of daily samples, or averages over longer periods? Please specify.

(You may have answered this in the table above)

B.7. With respect to limits in the permit, are the limits on releases of substances based on allowable discharges per unit of production, times a production rate, considering what the sectoral BAT can achieve, or have the limits been set considering the situation of the plant, with the limits then being based on the professional judgement of the permitting authority?

B.8. Does the permit specifically prescribe certain technologies? If so, what technology is selected for the facility? Is this representative for the sector?

B.9. If both EQO and BAT standards exist for the sector, which was given priority in setting the permit limit values and why? Does meeting BAT in this case also comply with EQO and vice versa?

B.10. Does this permit represent a case of a sensitive ecosystems, where more stringent limits have been prescribed than would be the general case?

B.11. Were economic factors considered in the issuance of this permit, and what methodologies were used for this?

B.12. Does the permit include a graduated schedule for compliance with the limits and what is done to ensure that plants meet the limits? Was economic feasibility an issue in establishing the timetable for final compliance with the limit values? Please explain

B.13. What is the time period for application of the permit/regulation? Is there a process for reviewing/amending the permit/regulation?

Part C: TECHNOLOGICAL RESPONSE

In order to solicit the industry's views on the effects of the permit requirements this questionnaire should be sent by the individual permitting authorities to industry representatives represented by individual permittees and/or trade associations.

C.1. What was the technological response of your facility to the permit requirements that were set?

C.2. To what extent were internal pollution prevention processes versus external treatment measures installed to meet the requirements?

C.3. Do the permit requirements provide flexibility with respect to processes that can be applied to meet the permit requirements?

C.4. How do you feel that BAT and EQO considerations have been reflected and balanced within the permit issued?

ANNEX 2

SUMMARY OF EFFLUENT REGULATION LIMITS IN DIFFERENT COUNTRIES

Austria

Annex Table 1. **Discharge limits for bleached pulp production (in cumulative wastewater)**

Parameter	Sulphate process	Sulphite process	Magnefite process
Temperature (°C)	30	30	30
BOD (kg/t)	3	3	3
TOC (kg/t)	13	15	18
COD (kg/t)	30	40	50
AOX (kg/t)	1.5	0.5	0.75
TSS (kg/t)	5	5	5

These limits are included in the Ordinance on the Limitation of Waste Water Discharge from the Production of Bleached Pulp (Federal Law Sheet 1991/181) (the discharge values are expressed in kg per tonne of air-dried pulp produced).

Belgium (Wallonia)

Annex Table 2. **Effluent discharge limits for Belgian pulp and paper mills**

Parameter	Discharge limits to watercourse	
	Pulp Mills	Kraft paper mills
General Requirements	—	—
Pathogens	Disinfection if necessary	—
pH	6.5–9	6.5–9
BOD_5 (mg/L)	45	75
Temperature (°C)	30	30
2 h settled solids (mg/L)	N/A	N/A
Total suspended solids (TSS) (mg/L)	120	75
CCl_4 hydrocarbon extractables (mg/L)	5	5
Detergents (mg/L)	3	3
Other conditions		
Colour (465 nm) (mg/L Pt/Co)	825	—
Total Phosphorus (mg/L)	2	2
Azote-ammonia (mg/L	2	2
COD (mg/L)	525	300
Sulphur and mercaptans (mg/L)	1	—
Total mercury (mg/L)	0	—

Limits are included in federal regulations passed in 1986.

Canada

Annex Table 3. **Regulation limits (kg/ADt) for kraft mills in Canada**

Parameter	Federal	British Columbia	Ontario	Quebec built prior to Oct 22, 92	Quebec built after Oct 22, 92
BOD Daily Monthly	 12.5 7.5	 7.5 7.5	 10.0 5.0	 8.0 5.0	 4.0 2.5
TSS Daily Monthly	 18.75 11.25	 18.75 11.25	 13.4 7.8	 16.0 8.0	 6.0 3.0
Toxicity Rainbow Trout *Daphnia magna*	 LC 50 ≥100%[1] Monitor	 LC 50 ≥100% —	 LC 50 ≥100% LC 50 ≥100%	 LC 50 ≥100% —	 LC 50 ≥100% —
Dioxin	Non-measurable	—	Non-measurable	-	-
Furan	Non-measurable	—	Non-measurable	-	-
2,3,7,8 TCDD TEQ			60 ppq	≤15 pg/l	≤15 pg/l
AOX Daily Monthly	 — — —	 — 1.5[2] —	 3.22, 1.93, 1.03[3] 2.5, 1.5, 0.8[3] —	 1.5 (hw), 2.5 (sw) 1.0 (hw), 2.0(sw) 0.8 by yr. 2000	 0.3 0.25
PCB's				3µg/l	3µg/l
Hydrocarbons				2 mg/l	2 mg/l
P-Total Daily	—	—	0.28 kg/t	—	—
P-Total Monthly			0.17 kg/t		
Chloroform Daily	—	—	3.72 g/t	—	—
Chloroform Monthly			1.88 g/t		
Phenol (Daily/Monthly)	—	—	0.413 g/t	—	—
Toluene (Daily/Monthly)	—	—	0.215 g/t	—	—
pH	—	—	—	6-9.5	6-9.5
Temperature	—	—	—	<65 ^{0}C	<65 ^{0}C

1. In the federal LC 50 test, a sample of the organisms is tested in 100 per cent effluent for a 4-day period. To pass the test, at least half of the sample organisms must survive.
2. In British Columbia, all mills have to meet a limit of 1.5 kg/t by 31 December 1995. Under a regulation, mills must eliminate bleach plant AOX releases by 2002.
3. The three values shown for Ontario must be met by 23 February 1994, 31 December 1995, and 31 December 1999 respectively.

Germany

Annex Table 4. **Effluent discharge limits for effluents predominantly from pulping**

Parameter	Sample Type	Limit
COD	Daily Composite	70 kg/t
BOD_5	Daily Composite	5 kg/t
AOX	Grab Sample	1 kg/t
Toxicity to fish, by dilution factor	Daily Composite	G_F =2

With respect to toxicity parameter G_F, a toxic effect has to be absent for effluents when diluted by the value indicated. For example, in the case of bleaching effluents, fish have to survive in a solution containing 50 per cent effluent (G_F = 2).

Annex Table 5. **Effluent discharge limits for manufacturing coated and wood-free papers**

Parameter	Sample Type	Limit
COD	2 h composite*	2 kg/t
BOD_5	2 h composite	25 mg/L
Nitrogen (inorganic, total)	2 h composite	10 mg/L
Phosphorus (total)	2 h composite	2 mg/L
AOX	Grab Sample	0.02 kg/t

* The COD test is conducted on either a 2 hour composite sample, or on qualified random samples (five random samples taken not more than 2 minutes apart and mixed afterwards).

Switzerland

In 1972, regulations were passed applying to pulp mill operations, these included limits for suspended solids, biological oxygen-demanding material, toxicity, temperature, pH, nutrients, metals, colour, taste, odours, dissolved material, etc. The following limits apply to parameters conventionally regulated for pulp mills:

- Toxicity: test fish have to be able to survive when the effluent is diluted by no more than a factor of 5.
- BOD_5: concentrations have to be less than 20 mg/L, measured as oxygen demand.
- Suspended solids have to be below 20 mg/L.

United States of America

Relative to the pulp and paper industry, in the 1970s and 1980s, the federal government passed guidelines (rules) that set maximum values for BOD and TSS, per tonne of finished production that may be allowed in mill permits. Relative to existing mills, BCT (best conventional control technology) limits apply. For new mills, more stringent new source performance standards (NSPS) limits apply. For the purposes of applying the guidelines, the EPA divided the US industry into 31 process categories. The table below summarises the limits applicable to the Market Bleached Kraft, Integrated Fine Paper based on Bleached Kraft, and Non-integrated Tissue paper sectors (United States Environmental Protection Agency, 1993).

Annex Table 6. **Summary of BCT and NSPS values in the EPA's effluent guidelines**

SUBCATEGORY	Maximum in Any One Day kg/t				Maximum – 30 Day Average kg/t			
	BOD_5		TSS		BOD_5		TSS	
	BCT	NSPS	BCT	NSPS	BCT	NSPS	BCT	NSPS
Market Bleached Kraft	15.45	10.3	30.4	18.2	8.05	5.5	16.4	9.5
Integrated Fine Paper based on Bleached Kraft	10.6	5.7	22.15	9.1	5.5	3.1	11.9	4.8
Non-integrated Tissue Paper	11.4	7.0	10.85	6.0	6.85	3.4	5.0	2.6

It is noted that the EPA is currently finalising guidelines to address dioxin and other toxic releases from the pulp and paper sector. This is being done under a program referred to as the "Cluster Rules." Readers are referred to the EPA's Internet site at http://www.epa.gov/for an update.

ANNEX 3

PERMITS APPLIED TO EXISTING MILLS

Permits applied to existing mills

Relative to the permit applied to existing older mills this information is presented as extracted from the country profiles.

United States: integrated kraft mill

The history and emission limits for the major operations are:

1. **Power Boilers**: Five power boilers are operated, the first a coal-oil fired unit built in 1986, the second, third and fourth coal fired units built in 1928, 1929 and 1946, and the fifth a wood waste fired unit built in 1952.

   As a result of the 1986 boiler project, the mill was given an annual sulphur dioxide emission limit of 8238 short tons per year from the oil-coal boiler and the three coal fired boilers. In addition, separate SO_2 limits were given to the units on the basis of so many pounds (0.4536 kg) of SO_2, per million BTU. For the 1986 coal-oil unit, limits of 1.2 pounds (0.5 kg) per million BTU apply for coal firing, and 0.8 pounds (0.4 kg) for oil firing; for the coal fired units, limits of 2.3 pounds (1 kg) of SO_2 per million BTU apply. These limits are met by purchasing fuels of sufficiently low sulphur content, coupled by testing using ASTM protocols.

   Under the PSD rules, a NO_x limit of 0.7 pounds (0.32 kg) per million BTU applies to the 1986 boiler. This is met by using tangentially fired burners with cold over-fired air to ensure low NO_x formation.

   A particulate limit of 0.08 pounds (0.04 kg) per million BTU applies to the 1986 coal-oil fired unit under the NSPS. This unit is equipped with an electrostatic precipitator with a 99.73 per cent design efficiency. The three coal fired units have particulate limits of 0.15 pounds (0.07 kg) per million BTU, imposed under the state implementation plans. These were issued in the 1970's, under the State Implementation Plan. The limits were met by the installation of electrostatic precipitators to the units. Similarly, a particulate matter permit limit of 0.21 pounds (0.95 kg) per million BTU was set for the combination coal-wood fired boiler. This is met through the use of a primary dust collector, an induced draft fan, and a venturi scrubber with a sump tank and two cyclone fly ash collectors after the venturi scrubber.

2. **Recovery boilers:** Two recovery boilers are operated. Each of these has particulate matter limits of 3.0 pounds (1.4 kg) per equivalent air dry ton of pulp produced on the line, and total reduced sulphur limits of 5 part per million, determined over 12-hours. The limits were set under the State Implementation Plan. Electrostatic precipitators are used to meet the particulate matter limit. Black liquor oxidation is used to ensure that the TRS limit is met. A three stage process is used in

which air is blown through the black liquor ahead of combustion. This process oxidises any sodium sulphide to sodium thio sulphate, thereby minimising TRS formation in the boiler. Direct control evaporator are operated on each boiler. As noted the boilers have TRS limits of 5 ppm as set under guidelines issued as part of the state implementation plan. In addition, the permit limits the amount of solids that may be fired in the boiler to avoid the occurrence of overloaded conditions.

3. **Dissolving tanks:** The tanks on both lines have permits under the SIP. These set particulate matter emission limits of 0.6 pounds per equivalent dry short ton (0.3 kg per tonne) of pulp for each line. Vertical flow, chevron type mist eliminators are used to comply with these limits.

4. The two **lime kilns** have particulate matter and TRS limits under the SIP. This is 20 ppm TRS. The particulate matter limits are 0.5 pounds (0.2 kg) per equivalent air dry ton of pulp for the line, measured in the kiln exhaust gas. These are met through the use of wet scrubbers. Control of the TRS is ensured by rinsing the lime mud prior to it being dried in the kiln as well as by optimising the feed air to the kiln.

5. **Lime handling system:** Both units have particulate matter limits. These are met through the use of cartridge filters, with Goretex cartridges with an area of 1152 square feet (107.02 m^2).

6. **Slakers:** Particulate matter limits are set on the slaker stacks under the SIP. These are met through the use of freshwater spray nozzles on the stack for particulate control.

7. In order to reduce the potential for white liquor to react with the pulp in oxygen delignification, the liquor is bubbled with air. A particulate limit is set on the exhaust under the SIP. This is met through the use of a chevron type, mist eliminator.

8. **Non-condensable gas systems:** Under the SIP, the digesters and the evaporators became subject to TRS control. TRS limits of 5 parts per million are applied for these sources. Non-condensable gases are collected from a number of sources including the pulp blow systems, the turpentine systems, the evaporator hotwells, and the foul condensate stripper feed tanks. The system is designed to keep the concentration of the NCG below the lower concentration explosion level. The collected gases are transported to one of the lime kilns for incineration. The other kiln acts as the backup point. Both kilns can be used jointly as required. Vents are located at various points in the system (21 vents in total). These are equipped with monitors to record the occurrence (frequency, time and duration) of events.

New Zealand

The air permit for the Tasman Pulp and Paper Company's mill (a new permit under the Resource Management Act) imposes limits on various operations as summarised in the following tables. In addition, it requires the mill to undertake various studies on the impact of emissions on the local environment and means to abate them. This was discussed earlier in Section 3.1.

The total amount of geothermal steam that may be used by the plant is 400 tonnes per hour and the maximum kraft pulp production allowed under this permit is 350 000 air dried tonnes per year.

In order to ameliorate potential odour problems, the permit requires the mill to have a treatment system to treat the foul condensate from the black liquor evaporators and turpentine system, and sufficient aeration capacity in effluent treatment ponds to minimise the production and release of odorous contaminants.

Annex Table 7. **Permit limits for recovery boilers 1 and 2, black liquor oxidation (BLOX) and tall oil plants, Tasman Pulp and Paper Company, New Zealand**

Source/Parameter	Limits	Averaging Periods
Recovery boiler: total reduced sulphur (TRS)	Continuous: 40 mg/m^3 Continuous: 20 mg/m^3 Manual: 30 mg/m^3	1 h 24 h 1 h (8–12 h testing)
BLOX plant: TRS	500 g/h (manual)	1 h
Tall oil plant, TRS	100 g/h (manual)	When fan operates
Recovery boilers: particulate matter	250 mg/m^3 (manual)	—
BLOX plant: chlorine gas (Cl_2)	10 mg/m^3 (manual)	—

1. Manual testing is required in the event of a breakdown or downtime of the continuous analyser of over 48 hours.
2. Limit did not apply until 1 January 1994.

Annex Table 8. **Permit limits for smelt dissolving tanks 1 and 2, Tasman Pulp and Paper Company, New Zealand**

Parameter	Mass (manual)	Averaging period
Total reduced sulphur	500 g/h	1 h
Particulate matter	6 kg/h	B

Annex Table 9. **Permit limits for lime kilns 1 and 2, Tasman Pulp and Paper Company, New Zealan**d

Parameter	Concentration	Averaging Period
Total Reduced Sulphur	Continuous: 35 mg/m^3 Continuous: 20 mg/m^3 Manual 35 mg/m^3	1 h 24 h 1 h (8–12 h testing)
Particulate matter (manual)	400 mg/m^3 (kiln #1) 250 mg/m^3 (kiln #2)	— —

Annex Table 10. **Permit limits for power boilers 1 and 2 (woodwaste burning), Tasman Pulp and Paper Company, New Zealand**

Parameter	Concentration (manual)
Particulate matter	250 mg/m^3

Annex Table 11. **Permit limits for bleach plants 1 and 2, Tasman Pulp and Paper Company, New Zealand**

Parameter	Limit (manual)
Chlorine gas (Cl_2)	10 mg/m^3 (bleach plants 1 and 2)
Chlorine dioxide gas (ClO_2)	5 mg/m^3 (bleach plant 2)

Annex Table 12. **Permit limits for chlorine dioxide chemical preparation plants, Tasman Pulp and Paper Company, New Zealand (acid sewer, hypochlorite tower, single vessel process (SVP), and HCl furnace vent)**

Parameter	Limit (Manual)
Chlorine Gas (Cl_2)	10 mg/m^3 (acid sewer, hypochlorite tower and SVP)
Chlorine Dioxide Gas (ClO_2)	5mg/m^3 (acid sewer, hypochlorite tower and SVP)
Hydrochloric Acid Vapour (HCl)	45g/m^3 (HCl furnace vent)

Annex Table 13. **Minimum stack heights for kraft mill units, Tasman Pulp and Paper Company, New Zealand**

Stack	***Height (meters from ground level)***
No. 1 recovery boiler	*57.9*
No. 2 recovery boiler	*57.9*
No. 1 recovery boiler smelt dissolving tank stack	*35.8*
No. 2 recovery boiler smelt dissolving tank stack	*56.0*
No. 2 and 3 power boilers	*58.5*
No. 1 and 2 lime kilns	*55.6*
Tall oil plant	*15.0*
Strong black liquor oxidation plant (BLOX)	*52.5*
No. 1 bleach plant	*32.9*
No. 2 bleach plant	*75.5*
Acid sewer vent	*28.0*
Single vessel process (SVP) CLO_2 *generator vent*	*26.0*
Geothermal stack	*57.9*
No. 2 chip bin	*38.3*
No. 3 chip bin	*36.1*
Fibreline	*32.0*
No. 4 power boiler	*54.8*