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Case Study on the Use of Best Available Technology (BAT) and Environmental Quality Objectives (EQOs) in the Environmental Permitting of Bleached Chemical Pulp and Paper Mills

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FOREWORD

In 1995 the Pollution Prevention and Control Group of the Organisation for Economic Co-operation and Development (OECD), commissioned a series of case studies on environmental permitting in different industry sectors. Separate case studies were made of the permitting practices used by countries when issuing permits to pulp and paper mills, iron and steel mills, oil refineries and metal finishing plants. Each study was lead by a different organisation, with the OECD Secretariat providing overall co-ordination of the various studies, a common reporting structure and information exchange. The pulp and paper study was conducted by Environment Canada's National Office of Pollution Prevention. This report was written by David Halliburton of Environment Canada.

This study is based on a series of Country Profiles which describe the permitting procedures of the ten individual countries in the Pulp and Paper Case Study. The countries examined are Austria, Belgium (Wallonia), Canada, Finland, the Federal Republic of Germany, New Zealand, Norway, Sweden, Switzerland, and the United States of America.

The studies were conducted by means of a questionnaire survey (Annex 1) sent to each of the participating countries. The questionnaire solicited information on the country's permitting practices. Countries were also asked to provide sample permits along with explanations of how various factors were taken into account in permit decisions. This information was augmented by information from various sources as referenced in the reports.

This report provides an analysis of the environmental permitting of bleached chemical pulp and paper mills in the ten countries studied. The report describes the regulatory responsibility and procedures applied in permitting; the use of emission standards and limit values; the consideration given to best available technology (BAT) and environmental quality objectives (EQOs) when setting permit conditions; the technological response of mills to the permit conditions; and the views of the mills on the permitting process applied in their country.

Readers are also referred to a 'Reference Guide on Environmental Requirements for Industrial Permitting' prepared by the OECD. A Workshop on Industrial Permitting was held in May 1996, where the main results from the different case studies were presented. Proceedings of the Workshop, presenting major findings and conclusions from the project, are available.

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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. Most countries have passed national regulations that set ceilings on the maximum releases allowed in effluent permits. In other countries, authorities 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. 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 cases of seven of the countries studied permits are issued by officials of either the federal or state/provincial governments, who have the authority to perform such a function. In the case of three countries this 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. For effluent and air emission permitting, two aspects are important: first, waste releases from the process are limited through the use of both internal pollution prevention and end of pipe treatment. Secondly, the wastes from the process are dispersed into the environment, and their concentrations diluted so that they do not cause harm to air and water.

The objective of permitting is to establish what permit conditions to apply so as to protect the environment. This includes specification of release limits.

The use of Environmental Quality Objectives (EQO's)

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

The use of national (provincial) pollution release standards

The standards are 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 on the basis of considering what best available technologies (BAT) are capable of attaining, as well as by consideration of economic and environmental factors.

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 five countries that do not use national emission standards, have issued effluent discharges targets. These state what levels of discharge from the overall pulp and paper sector should be achieved in the future. These are used to guide the direction of individual permit decisions. They serve as "vision targets". Examples include statements that the overall industry should attain certain BOD, COD or AOX targets by set dates.

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 considers 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 circumstances of the cases, rather than transferred from the regulations. The authorities consider what minimum emission 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 these emission standards are developed based on similar BAT

considerations. Secondly it is recognised that at some sites stricter control is required and the limits in the standards are overridden.

Balancing technological and EQO considerations

In establishing permit conditions it appears that authorities balance technological and EQO considerations. Technology considerations involve both pollution prevention and end of pipe treatment, to arrive at what constitutes reasonable, legal release levels for enforcement purposes.

It appears that consideration is given to what release levels are attainable from plants with "state of the art control", in both the country and abroad. This involves expert judgement, conducted by the authority, and in some cases, with support from engineering consultants.

Flexibility in the choice of equipment

The permitting processes followed impose release conditions, including limits. These are developed on the basis of technology that exists capable of meeting the limits. Mills are permitted to choose what equipment to install to meet the limits. Flexibility is thus granted enabling them to do it 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 arrived at through prior discussions between the permitter and permittee. The specification therefore reflects an agreement between the parties, and not mandating of equipment.

Influence of the selection of control parameters

The selection of indicators for which 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 four countries.
- Nutrients (Nitrogen and Phosphorous) were used in all or some permits of four countries.
- Adsorbable Organic Halides (AOX) was 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, high degrees of internal pollution prevention may be necessary. Processes such as oxygen delignification may be required and the

installation of secondary biological treatment may not be necessary. 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 mill 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 the mills. COD is Sweden's primary dissolved solids control parameter.

Secondary treatment was applied at all the sulphite mills reviewed.

Adsorbable 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 is apparent that most mills are well ahead of the permit or regulatory limits that are set. It is noted 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 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 regarded in the marketplace to be more environmentally benign. This leads mills to install processes that go beyond their discharge permit limits.

The overall results suggest that technology-based approaches used in existing permitting and regulatory systems, in the different countries, are working well to limit effluent at acceptable levels.

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 through in plant measures

Technological response by mills

The analysis of the technology responses mills indicates that mills in different countries have implemented similar technological measures in response to the permit limits set. 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 and 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 case's limits were prescribed when technology had not been demonstrated capable of operating at that level. Despite these facts the industry appears to have met these challenges.

Overall conclusion

Despite the different permitting and regulatory procedures used, it appears that the technological responses of mills in different countries are similar, as well the effluent qualities are converging. Effluent and air pollution controls are based on the use of pollution prevention techniques as

well as external treatment equipment. Technological innovations that occur in the field of pollution prevention and external treatment in one country, appear to be quickly transferred to other countries. The trend in air and water discharges internationally is a downward one. The amount of releases per tonne of production are falling.

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. [1]

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. [2]

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 THE PULP AND PAPER INDUSTRY AND ITS REGULATORY ENVIRONMENTAL IMPACTS

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[3].

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[4]. 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 Canadà, 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 local administrative boards. The County Administrative Board 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.

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 minimum 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 minimum 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 minimum 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	None, but overall target set	National Licensing Board	Case-by-case basis
Switzerland	Federal	State Government	Regulations set BAT-based minimum values but stricter requirements may be set based on EQOs
United-States	Federal	State Government as delegated; otherwise EPA Regional Offices	Regulations set technology minimum 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 minimum 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 minimum 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 minimum 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;

- Adsorbable 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. Paris Commission limit values for sulphite 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. Paris Commission limit values for sulphate 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 Water Court.

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, 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) Total gaseous sulphur emissions, except from auxiliary boilers. Includes sulphur in SO_2 and in reduced forms.
(2) CTMP, chemi-thermo-mechanical pulp.
(3) 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 recommendations 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. The table below 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 [5] 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 °C 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

Tables 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 respirable 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

* according to TA-Luft and Resolution of the Ministers of Environmental Affairs of the Länder, 1991; in [g/m³]; dry basis

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

Unit	O_2 Reference value (%)	New Facilities > 20 MW	New Facilities < 20 MW	Existing Facilities > 20 MW	Existing Facilities < 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	

* according to TA-Luft and Resolution of the Ministers of Environmental Affairs of the Länder, 1991; in [g/m³]; 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 below.

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, Swedish Environmental Protection, 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 (mg/MJ), Swedish Environmental Protection

	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 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 nonattainment 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 [6] 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 [3], 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. [7] 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 enroll 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.

5.1.1 Implications of the use of BOD and COD as a control parameter

- BOD and COD are both surrogate parameters that are used to represent the load of dissolved solids in the effluents. The authorities set the permit limits for these at levels sufficiently low to protect the receiving waters. The mills implement pollution prevention and control measures to mitigate their releases.

Both tests evaluate the effluent load in terms of a quantity of oxygen taken up during the test. In the case of BOD, the test measures the amount of dissolved oxygen consumed by micro-organisms when they feed on the effluent over a five or a seven day period. The test is intended to represent the effect of the effluent, in depleting oxygen in the receiving water, when the effluents are broken down in nature.

The COD test differs by measuring the amount of oxygen that is supplied from a strong oxidising agent, e.g. potassium dichromate, when the effluent components are chemically digested. The measurements from the BOD test only represent those substances which micro-organisms can consume.

On the other hand, the COD test measures the BOD components as well as the refractory components which the micro-organisms cannot consume.

Secondary treatment can attain high levels of BOD removal efficiency of more than 95%. In-plant measures could not attain such BOD removal efficiencies, baring the installation of all current state of the art production technologies and the possible development of some new technologies. Not all plants would have the financial capacity to retrofit these.

For COD control, secondary treatment is only effective in removing the non-refractory (i.e. the BOD) components. Thus, if high COD removal rates are required, and much of the COD is accounted for by refractory components, then in-plant control measures are favoured.

With respect to the cost of effluent control, internal treatment measures provide the opportunity of reducing the quantity of effluent generated and also allowing revenues to be gained in the value of the chemical and fuel components derived from the wastes. The payback from these processes may not however defray their cost in all cases. This especially relates to existing mills where there is incremental product output. External treatment on the other hand, is generally represented by an initial capital cost and on-going costs for labour, energy and materials. It is noted that a cash flow analysis based on the specific case would have to be made to determine which option is best. The analysis, however, ignores many other factors such as the value derived from having low effluent releases which may offer value in product marketing, public image, etc.

The structure and the design of the environmental permitting and regulatory systems has a major influence on the control strategy that mills will adopt. This is especially true for BOD and COD as illustrated by the following hypothetical case. The case applies to a bleached kraft mill representative of the pre-1970's, where most of today's permitting programs had their genesis.

The hypothetical mill has a COD discharge equivalent to 150 kg/ADt, and a BOD discharge of 50 kg/ADt. The mill is considering three possible options. (It is noted that the 50 kg/ADt BOD value is somewhat high and the mill would likely apply measures such as better pulp washing to remedy it to around 25 kg/ADt prior to considering secondary treatment.) The mills options are:

1. applying internal processes to capture and recycle more of the effluents, thereby reducing both COD and BOD;
2. applying secondary treatment. This will remove most of the BOD and part of the COD; and
3. implementing both the above options jointly.

It is assumed that the internal measures will reduce the COD and BOD both by a third. Secondary treatment will reduce 90 % of the BOD components and part of the COD. The same effectiveness are assumed for the hybrid option.

The following table represents the situation before and after implementation of the three options.

Table 27. Hypothetical case considering the impact of establishing control on either BOD or COD or both before and after

Effluent Situation	Internal measures[1] (kg/ADt)	Secondary option treatment (kg/ADt)	Combined[3] (kg/ADt)
COD (before)	150	150	150
BOD (before)	50	50	50
COD (after)	100	105	70
BOD (after)	33	5	3

Notes

1. Internal measures remove one third of the BOD and COD. The COD falls to 100 in the effluent to secondary. Of this BOD accounts for 33 kg/ADt.
2. The secondary treatment removes 90 % of 50 kg/ADt of BOD, the BOD falls by 45 to 5 kg/ADt. The COD falls by an equivalent amount to 105 kg/ADt.
3. Similar percentage removal rates are assumed for the combined option: internal measures followed by the secondary treatment. From internal measures, the COD falls to 100 kg/ADt and the BOD falls to 33 kg/ADt (as per note 1). Following internal measures, secondary treatment removes a further 90 % of 33 kg/ADt of BOD, the BOD falls by 30 to 3 kg/ADt. The COD falls by an equivalent amount to 70 kg/ADt.

The regulatory authorities have to be aware of what they want to achieve when they design their control frameworks. If they want to solve an oxygen depletion problem in the receiving water, they may find this best done by having mills install secondary treatment as this will attain high BOD reductions as shown in option 2 of the hypothetical case. If authorities do not want to prescribe the approach to be follow i.e. to add secondary treatment, but instead signal it through a discharge limit, then in this case they could set a BOD limit of 5 kg/ADt. The mill would then see it is best to follow option 2 rather than option 1.

If the permitting authority still wanted to focus on a dissolved oxygen problem, but to relate it to the COD control parameter rather than the BOD, they could set a COD limit of 100 kg/ADt. (The use of COD is often favoured over that BOD as the test results are obtained sooner). However the use of secondary treatment may have to be mandated in such a case to avoid the use of a pure internal strategy that may not be sufficiently effective for BOD.

If the authorities are concerned with persistent compounds that are better represented by COD, then internal treatment would be more effective. While the results in the table show that the in-plant and the secondary treatment options attain essentially the same COD values, the potential of secondary treatment to reduce the COD further is much less. Attention would therefore be directed to implement controls that can attain lower COD values.

The above example should not be interpreted as saying that external treatment is ineffective for COD control. It may be found that after many internal steps have been taken to remove COD, the costs and the difficulties involved in taking further internal steps, are greater than that of applying external treatment. External costs may include such as new processes affecting product quality and plant operations.

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

Table 28. Use of various parameters in different countries

COUNTRY	BOD	COD	TSS	AOX	D&F	Toxicity	N	P	pH	Temp	Flow	Colour
Austria	✓	✓	✓	✓	—	✓	—	—	✓	✓	✓	—
Belgium	✓	✓	✓	—	—	—	—	—	—	✓	✓	✓
Canada		—	✓	isp	✓	✓	isp	is p	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

Notes:

✓ 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[8], 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 exceedences of limits and to take actions to address exceedences.

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 exacting 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[8]. 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 dissolved and, to a lesser degree, 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 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 29 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 [8]. 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 29. 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[8]
New Zealand	3.1	——	——	See New Zealand profile
Sweden[2]	——	——	9.3-12.6 (annual avg.)	From Simons[8]
USA	4.0-10.0	2.0-6.1	——	From Simons[8]

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[8] 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 30 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 30. 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 31 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 31. 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[8]
New Zealand	——	——	——	COD not applied
Sweden	——	37-87	49-67	Simons[8]
USA	——	——	——	COD not applied

5.2.5.4 COD limits for sulphite mills

Table 32 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 32. 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 33 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[7]. This means that the older Swedish permits are equivalent to 0.9 - 2.0 kg/ADt AOX.

Table 33. 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[8]
New Zealand	——	——	——	AOX not applied
Sweden[(1)]	—— ——	—— ——	0.3-1.3 (as AOX) 0.7-1.5 (as TOCl)	Simons[8]
USA	——	1.6-1.9[(2)]	1.3-1.5[(2)]	Simons[8]

Notes:

(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[8].

5.2.5.6 AOX limits for sulphite mills

Table 34 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 34. 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

Notes:
(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 35 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 35. 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]

Notes:
(1) Value in Austrian regulation for sulphite mill
(2) Test uses a 0.45 μ filter pore size.
(3) Simons[8] 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 [9], 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: The mill for which an expected water permit was provided required that total nitrogen and phosphorus discharges be monitored.

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[10]. 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.[13]

The following sections provide estimates of the qualities of the effluents fron 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[12].
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 2 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 normalized 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.

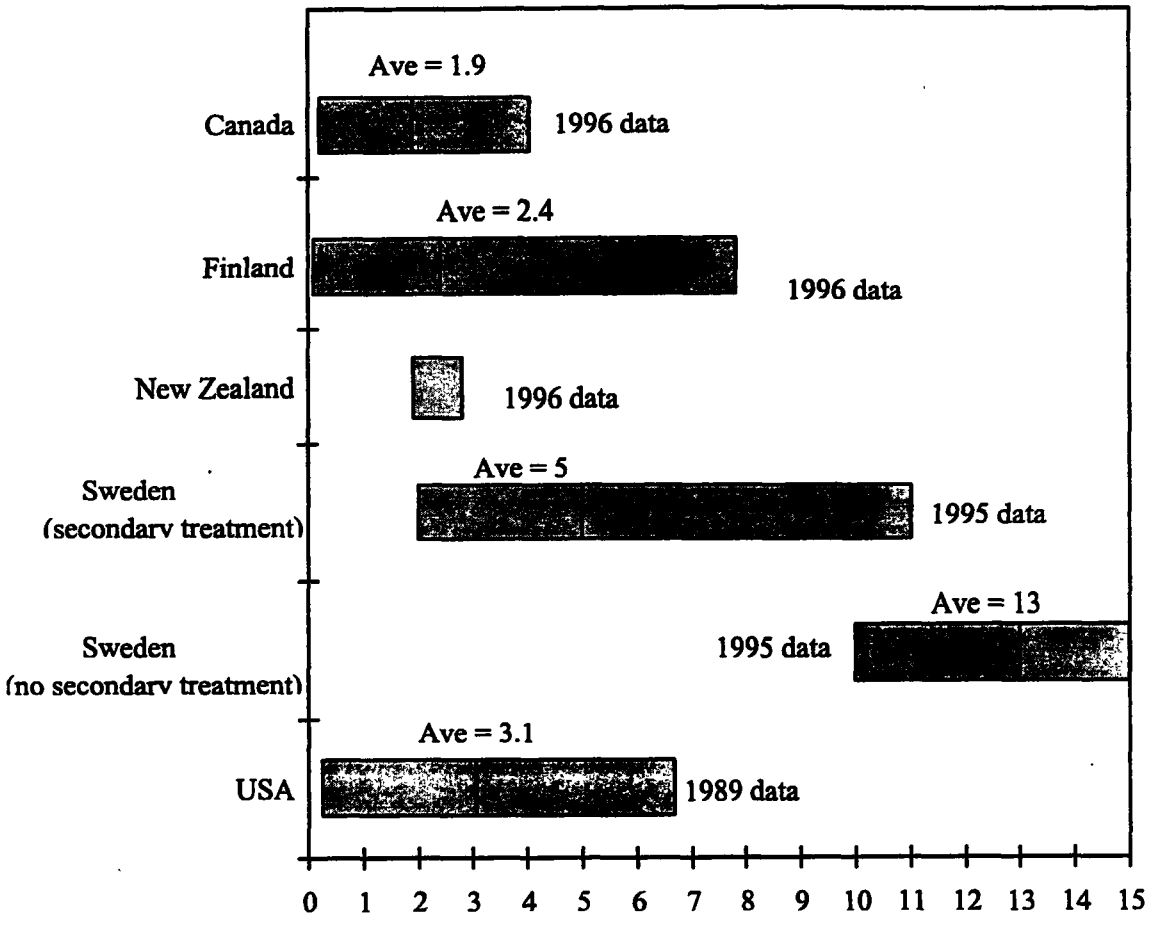


Figure 1: BOD discharges from bleached kraft mills in various countries

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 and,
4. The range of discharges was narrower for mills in Sweden than that for Finland.

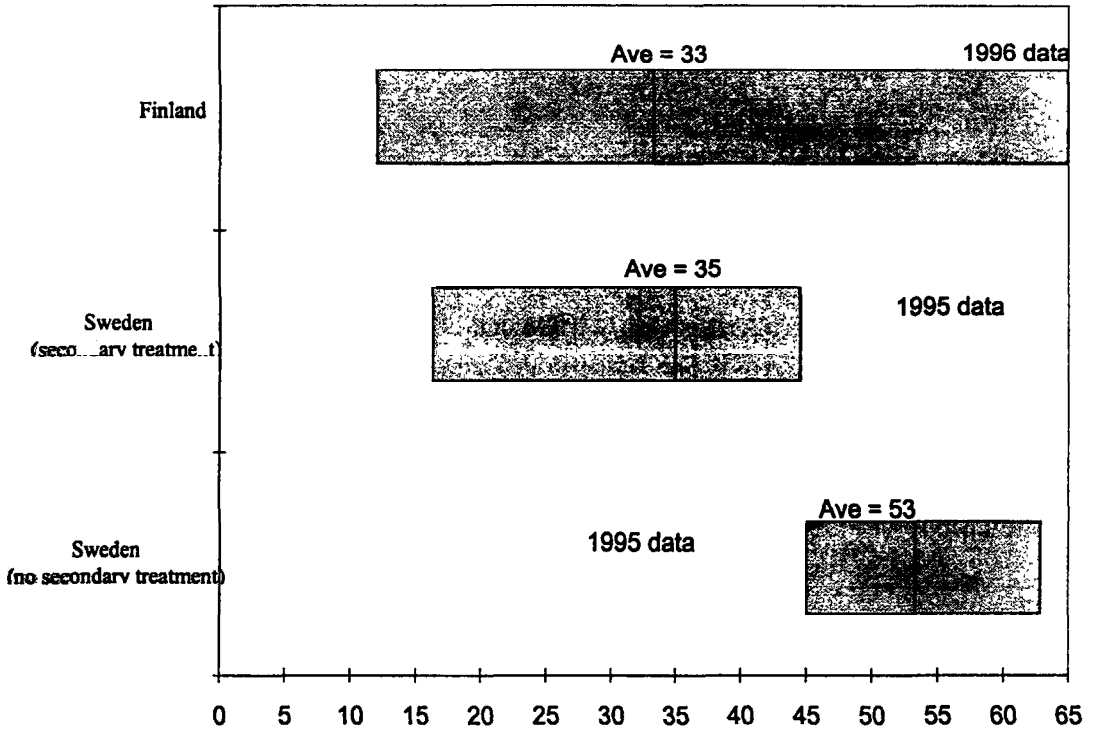


Figure 2: COD discharges from bleached kraft mills in various countries.

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 prebleaching. 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.

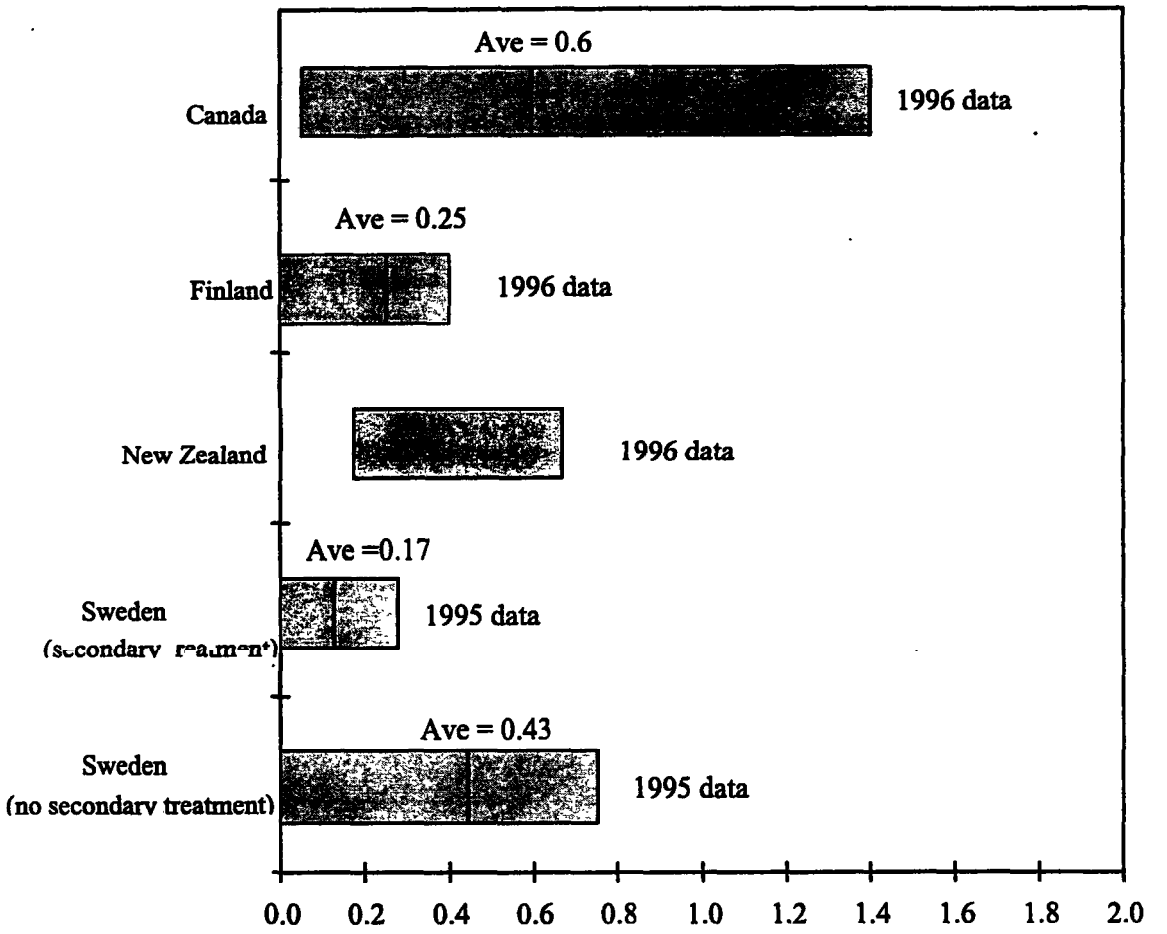


Figure 3: AOX discharges from bleached kraft mills in various countries.

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 prebleaching. 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 entrainment of the pollutants in the gas streams (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. The net effect of this boiler design is the entrainment of lower amounts of the problem gases. In contrast, many older boilers evaporate water from the boiler feed directly using their exhaust gases. This leads to more entrainment of odorous reduced 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 [12]. 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 36 through 42 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 36. 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	1.3 kg S/ADt	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 there 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%.

Table 37 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 38. 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 39. 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 40. 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 41. 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 42. 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 43. 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) Nighttime 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 exacting 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 brought to bear in setting 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 brought to bear in setting 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 Organisation 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 exacting 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 that 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 meetings have defined it by reference to emission limits 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 decisions they may be the deciding factor, in others they are not. The use of one factor does not override the other. For example, in cases where the quality of the receiving media is such that excess dilution is available to provide adequate EQO; this does not excuse 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 influence of economics appears to be on 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 mill.

b) The measures used to prevent the creation 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 support 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 iteratively by the permitting 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 pulp and paper mill environmental control permits 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 term 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 the Paris Commission;
  - In Sweden the environmental ministry 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 Water Courts 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 prebleaching, 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 prebleaching. 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 prebleaching 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 improvement appears to be becoming less permit driven.

8.2 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.

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. 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 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 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 entrainment of the pollutants in the gas streams (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 formation. 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. The net effect of this boiler design is the entrainment of lower amounts of the problem smelly gases. In contrast, many older boilers evaporate water from the boiler feed directly using their exhaust gases. This leads to more entrainment of odorous reduced 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 supplied 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 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 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 since the 1970's has 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 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.

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.

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ANNEX 1 QUESTIONNAIRE USED FOR CASE STUDIES ON USE OF BAT AND EQOS IN ENVIRONMENTAL PERMITTING OF DIFFERENT INDUSTRY SECTORS

OECD/PPCG

March 1, 1995

OECD QUESTIONNAIRE 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 brought to bear in setting 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

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)

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 Settlable 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

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	12.5	7.5	10.0	8.0	4.0
Monthly	7.5	7.5	5.0	5.0	2.5
TSS					
Daily	18.75	18.75	13.4	16.0	6.0
Monthly	11.25	11.25	7.8	8.0	3.0
Toxicity					
Rainbow Trout	LC 50 ≥100%[1]	LC 50 ≥100%	LC 50 ≥100%	LC 50 ≥100%	LC 50 ≥100%
Daphnia magna	Monitor	—	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	—	—	3.22, 1.93, 1.03[3]	1.5 (hw), 2.5 (sw)	0.3
Monthly	—	1.5[2]	2.5, 1.5, 0.8[3]	1.0 (hw), 2.0(sw)	0.25
	—	—	—	0.8 by yr. 2000	
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 °C	<65 °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

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 ($G_F = 2$).

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; and
- 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

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.

US 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 of SO_2, per million BTU. For the 1986 coal-oil unit, limits of 1.2 pounds per million BTU apply for coal firing, and 0.8 pounds for oil firing; for the coal fired units, limits of 2.3 pounds 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 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 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 % design efficiency. The three coal fired units have particulate limits of 0.15 pounds 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 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 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 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 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.

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 sparged 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.

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/m³ Continuous: 20 mg/m³ Manual: 30 mg/m³[1]	1 h 24 h 1 h (8–12 h testing)
BLOX plant: TRS	500 g/h[2] (manual)	1 h
Tall oil plant, TRS	100 g/h (manual)	When fan operates
Recovery boilers: particulate matter	250 mg/m³ (manual)	—
BLOX plant: chlorine gas (Cl_2)	10 mg/m³ (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.

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

Permit limits for lime kilns 1 and 2, Tasman Pulp and Paper Company, New Zealand

Parameter	Concentration	Averaging Period
Total Reduced Sulphur	Continuous: 35 mg/m³ Continuous: 20 mg/m³ Manual 35 mg/m³	1 h 24 h 1 h (8–12 h testing)
Particulate matter (manual)	400 mg/m³ (kiln #1) 250 mg/m³ (kiln #2)	— —

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

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)

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)

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*

Case Study on the Use of Best Available Technology (BAT) and Environmental Quality Objectives (EQOs) in the Environmental Permitting of Bleached Chemical Pulp and Paper Mills in Austria

Pre-publication version prepared by
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FOREWORD

This report reviews how the concepts of best available technology (BAT) and environmental quality objectives (EQOs) are taken into consideration in the environmental permitting of pulp and paper facilities in Austria. It was prepared by Environment Canada's National Office of Pollution Prevention based on responses to a questionnaire survey. The content of the questionnaire was developed by the Organisation for Economic Co-operation and Development's (OECD's) Pollution Prevention and Control Group.

This report is one of a series of reports prepared to provide background information on the procedures followed in the environmental permitting of pulp and paper mills in a number of OECD Member Countries. Information was gathered using a questionnaire designed to see how best available technology and environmental quality objectives were considered. The countries in the study were Austria, Belgium (Wallonia), Canada, Finland, the Federal Republic of Germany, New Zealand, Norway, Sweden, Switzerland, and the United States of America. Separate reports are available describing the permitting procedures of each country. This report is one of ten reports (Country Profiles) which describe the approach to environmental control of pulp and paper mills in each country. In addition, an overview case study report has been prepared describing the general permitting practices in the set of countries. These reports have been prepared by Environment Canada for the Pollution Prevention and Control Group (PPCG) of the Organisation for Economic Co-operation and Development (OECD).

This particular report provides details of the permitting approach in Austria, describing the legislative basis for permitting, the organisations that issue permits, and the use that is made of regulations, environmental quality objectives, best available technology, and economics. It also describes the technological response of mills to the permit conditions that have been set and the opinions of mills with respect to the permitting process.

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1. THE PERMITTING PROCESS

1.1 Constitutional responsibilities for environmental protection

The Republic of Austria is a federal state with a federal government and nine independent provinces. Under its constitution, the federal government is responsible for developing and executing legislation dealing with business, industry, forestry, and water rights. The provinces are responsible for environmental protection and construction matters.

The Constitutional Law on Extensive Environmental Protection (BVGuU), dated 27 November 1984, contains the framework for environmental protection within the Republic of Austria. Under this law, "extensive environmental protection" means preserving the natural environment as a foundation of life for humans against damaging effects. In particular, "extensive environmental protection" encompasses measures for keeping air, water, and soil clean, as well as for avoiding disturbances caused by noise.

The Austrian legal system does not encompass a uniform environmental law. Hence, regulations affecting the environment are passed under various laws (acts) at both the federal and provincial levels. Regulations are developed by the responsible minister, usually in consensus with other ministers, and regulate specific matters, for example, emission limits and principles for the construction and operation of plants. Regulations are amended, as required, to take into account new technical developments. Table 1 lists the federal acts under which regulations pertaining to the environment are passed and the ministry responsible for the relevant regulations.

Table 1. Acts under which federal environmental regulations are passed and the ministry responsible for the regulations.

Federal act	Ministry responsible*
Trade and Industry Act (GewO)	BMfwA
Steam Boiler Emission Act (LRGfK)	BMfwA
Forestry Act (FG)	BMfLA
Water Act (WRG)	BMfLU
Waste Management Act (AWG)	BMfU
Environmental Impact Assessment Act (UVPG)	BMfU
Environmental Control Act (UKG)	BMfU
Federal Clean-up Act (Altlastensanierungsgesetz)	BMfU
Ozone Act (OG)	BMfU
Smog Alarm Act (SAG)	BMfU

* Abbreviations:
BMfwA, Federal Ministry for Economic Affairs;
BMfLA, Federal Ministry for Agriculture and Forestry; and
BMfU, Federal Ministry for the Environment.

The Trade and Industry Act is the primary act under which industrial plants are permitted. Permits are issued in order to protect neighbouring residents and the environment in general.

The Steam Boiler Emission Act addresses the construction of, release of emissions from, and monitoring of power boiler facilities. An ordinance under the Act prescribes binding emission limits for major air pollutants resulting from the combustion of different fuels. The ordinance sets binding limits for sulphur dioxide (SO_2), nitrogen oxides (NO_x), dust, and total reduced sulphides (TRS). This applies to black liquor recovery boilers at chemical pulp mills.

The Forestry Act prescribes air quality standards for pollutants emitted from operations in forested areas that may damage trees. Emissions from pulp and paper production are also covered under this Act.

The Waste Management Act provides a framework for proper waste management at plants.

The Water Act regulates all aspects related to water use. A number of ordinances have been passed under this Act, covering plant operations, effluent discharge limits, and monitoring requirements. These ordinances are prescribed on a foundation of best available technology (BAT) and apply to a multitude of plant types, including pulp and paper mills. The following ordinances apply to the pulp and paper industry:

- Ordinance on the Limitation of Waste Water Discharge from the Production of Bleached Pulp.
- Ordinance on the Restriction of Waste Water Discharge from the Production of Paper and Boards.
- Relevant to the Danube and Mur rivers, and their tributaries, special ordinances control the water quality level that must be maintained (Class II according to a saprobic system). A number of pulp and paper mills discharge into these waters. Mill discharges must not cause receiving waters to degrade below prescribed water quality levels.

In 1993, an Environmental Information Act came into effect giving every person, without needing to prove a legal right, free access to environmental data on file with the authorities. In this context, it is noted that there is an increased awareness of environmental issues among the population. As a consequence of this Act, reports on air quality are published daily.

1.2 Permits

Austrian permitting decisions principally consider the environment affected by a plant's emissions. The construction, modification, and operation of industrial plants in Austria require permits under various laws. These permits are issued by different authorities. Integrated permitting is not practised. Instead, separate permits are issued. Examples of permits and permitting follow:

- construction permit;
- permitting under the Trade and Industry Act;
- permitting under the Water Act;
- permitting under the Steam Boiler Emission Act;
- permitting under the Forestry Act; and
- permitting under the Environmental Impact Assessment Act.

The Trade and Industry Act and the Water Act are the acts that control the permitting of industrial plants.

Permits under the Trade and Industry Act cover permission for the construction or modification of industrial plants. If permitting is carried out under the Trade and Industry Act, separate permitting is not required under the Steam Boiler Emission Act, the Forestry Act, or the Waste Management Act. In these cases, single permits are issued.

A separate permit is required under the Forestry Act if emissions from an industrial plant endanger a protected forest or a forest for protection against avalanches.

Permits are required under the Water Act whenever public waters are used. In practice, water-use permits grant permission to draw water and to discharge wastewater in defined quantities and at specified quality levels. Normally, an application for a water-use permit is submitted to the authorities simultaneously with an application for a permit under the Trade and Industry Act.

Since the Environmental Impact Assessment Act (EIAA) came into force on 1 July 1994, plants expecting to have a significant impact on the environment must assess these impacts beforehand. The types of plants covered are specified in the Act, and include the pulp and paper industry.

The EIAA provides for concentrated and co-ordinated permitting by all responsible authorities and allows effective permit conditions in order to avoid or mitigate environmental impacts. It covers permitting of new plants and permits for significant modifications with respect to the capacity of existing plants.

All permits applied for, such as permits under the Trade and Industry Act and water-use permits, are handled jointly in the EIA process resulting in a single permit being issued.

For all types of plants covered by the EIAA, public participation in the permitting process is obligatory. Everybody has the opportunity to express his opinion during the permitting process. Neighbours who can possibly be affected by the environmental effects of the project and , under certain conditions, citizens' initiatives can take a position as parties in the process.

The respective provincial government is responsible for carrying out the EIAA process, the duration of which must not exceed 18 months.

1.2.1 *Responsibility for permit administration*

The laws under which permits are developed specify the officials responsible for permit administration. In the case of construction permits, the mayors of the areas in which the plants are located are responsible in the first instance. During the construction permitting process, the proposed project is examined from the viewpoint of construction ordinances and zoning requirements (fire protection, distance of structures from neighbours, etc.).

The granting of a construction permit does not guarantee that a project will also receive an operating permit for an industrial plant.

County administrative authorities are generally responsible for all other permits. In practice, authorities are assisted by provincial authority experts. Each province maintains a staff of official experts whom the authorities (commercial authorities and water authorities) can employ as consultants during the permitting process.

1.2.2 *Prerequisites of permitting*

Permitting under the Trade and Industry Act

In permitting under the Trade and Industry Act, protection of neighbours and general environmental protection takes priority. The process includes the following:

An industrial plant permit may only be issued if the combination of BAT and findings from state-of-the-art medical and other applicable sciences:

- precludes the endangerment of human life and health;
- precludes the annoyance of neighbours by restricting odour, noise, dust, smoke, and vibration levels to acceptable levels;
- restricts detrimental effects on waters to acceptable levels;
- limits emissions of air pollutants in accordance with BAT; and
- avoids, recycles, or otherwise results in the disposal of waste in accordance with BAT.

Waste management must be implemented so that:

- damaging or detrimental effects, or consequences that otherwise may negatively impact the well-being of humans, animals, and plants, and their living space and natural environment, are kept to an absolute minimum;
- raw materials and energy reserves are conserved;
- the consumption of landfill volume is minimised as much as possible;
- residual wastes include only those materials whose deposition at landfill sites poses no potential danger to future generations (prevention principle); and
- operators submit a waste management concept to authorities.

Industrial plants with a particular danger potential:

- require state-of-the-art safety measures to protect humans, the environment, and the rights of others from the effects of breakdowns and
- must prepare a safety analysis and schedule of safety measures.

Permitting under the Water Act

Everyone is allowed to use public waters within limits prescribed by law. However, users must fulfill general caretaking duties to keep the water clean and to conserve it. When permitting water use, protecting the public interest and the rights of others takes priority. Public interests are enumerated in the law and an industrial plant can only be permitted if:

- water quality will not be adversely affected;
- there is no anticipation of significant impairment of the ecological functionality (self-cleansing capability) of the waterway; and
- conservative water use will be practised in the public interest.

Principles applied in wastewater discharge permitting include the following:

- A permit may only be issued if the public interest and the rights of others are not violated and the water use meets BAT requirements. Permitting the discharge of wastewaters into flowing waterways and public sewage systems requires consideration of state-of-the-art wastewater treatment technology and the possibility of reducing the volume of wastewater discharged.
- Additionally, hazardous contaminants in wastewater necessitate consideration of the possibility of avoiding the discharge of such contaminants through the use of BAT. (For pulp and paper mills, the highly polluted wastewaters from bleaching units must be utilised thermally.)
- Wastewater contaminants and waste energy (heated water) may only be discharged to the extent that is absolutely necessary.
- Reduction, avoidance, and recycling of wastewater contaminants and waste energy take priority in wastewater treatment.
- Protective measures for one body of flowing water must not divert pollution to other waterways to an unjustifiable extent.
- Quantities of wastewater discharged into flowing waterways must be kept as low as possible through the use of water-conservation technologies and methods.
- Wastewater pollutants should be retained at their place of origin or use (treatment of substreams) whenever possible.
- Dilution of wastewater is forbidden.

Permitting under the Environmental Impact Assessment Act

In an environmental impact report, a company must present and evaluate the effects of a planned facility on the environment. The scope of the report also encompasses measures to prevent or reduce any environmental impact, and the advantages and drawbacks of alternatives to a planned project and of the proposed industrial plant site.

Some of the principles of permitting under the Environmental Impact Assessment Act include the following:

- permitting prerequisites of other administrative regulations, such as the Trade and Industry Act and Water Act, must always be fulfilled;
- emission of pollutants must be restricted in accordance with BAT;
- the ambient quality that affects the objects to be protected (people, animals, soil, and plants) must be optimised;
- permitting must consider the results of the environmental impact report, including the position statements of affected parties;
- suitable requirements, conditions, time limits, project modifications, etc. shall be prescribed in the permitting decision; and
- the operation of a plant must not cause serious environmental pollution as a result of cyclical effects, accumulation, or diversion.

1.2.3 *Permitting procedures*

Trade and Industry Act

The Trade and Industry Act requires that a permit be obtained for the construction, modification, and operation of an industrial plant if the endangerment of humans and annoyance of neighbours cannot be precluded. This almost always applies to all facilities in the pulp and paper industry.

As the permitting process generally involves significant effort, the Trade and Industry Act provides a simplified procedure for what are termed "bagatelle facilities" (e.g., mechanical workshops). The installation of standardised machines and facility components in industrial plants does not require permitting, but does require reporting. Numerous standards exist for such machines and facility components.

Water Act

The Water Act specifies numerous permitting duties, including the following:

- any use of water that exceeds common domestic use requires permitting;
- industrial plants require permitting if there is any expectation of a detrimental impact on water quality; and
- the construction or modification of facilities for the use of water requires permitting.

Under the Water Act, the permitting procedure consists of four phases. The procedure is regulated by law.

i. Application to the authorities

The permitting procedure is normally initiated when a company submits an application to construct or modify a plant. In developing plans, it is noted that it makes sense to involve appropriate authorities early on in the planning process to obtain information about prerequisites regarding obtaining a permit.

The applicant must provide authorities with all technical documents (products, capacities, raw and auxiliary materials, and plans), as well as any additional information, regarding emissions expected from the plant (by type and quantity) as might be required for their evaluation. If ordinances exist for the planned type of facility, the applicant must determine whether the application meets these.

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. For projects covered under other acts, applicants need not provide an assessment of the effect on the environment nor an evaluation of the anticipated ambient quality situation.

Additionally, industrial plant permits under the Trade and Industry Act require applicants to provide a waste management concept. For dangerous facilities, a safety analysis and a schedule of safety measures, in the event of a breakdown, must be provided.

The water use permitting procedure also requires an applicant to describe requested water use in qualitative and quantitative terms.

Authorities leave the choice of the most appropriate technology to meet permit requirements to the applicant.

ii. Preliminary examination by authorities

During this stage of the permitting procedure authorities evaluate whether permit prerequisites have been fulfilled using BAT as the standard. Protection of neighbours and the environment must be assured.

iii. On-site hearing

Authorities must announce an on-site hearing. Owners of the industrial property and bordering properties must be summoned to the hearing personally. The hearing must be announced to neighbours by means of posting notices.

At the on-site hearing, neighbours can raise objections, which gives neighbours a position as a party in the procedure. They can also exercise their right of appeal against the issued requirements or against the permit in the next instance, which can lead to significant delays in the realisation of a project.

As a rule, one or more experts (from the fields of medicine, process engineering, safety engineering, hydrobiology, construction, biology, etc.) take part in the hearing and submit their evaluation of the project.

If the issuance of permit conditions (e.g., emission limits, production limits, preparations for emergencies, maximum pollutant discharge, safety measures in case of failure, etc.) qualifies the plant for permitting, no further on-site hearing is necessary. As a general principle, permit conditions must not change the character of the project.

The following example illustrates typical conditions set for a black liquor incineration furnace in a sulphite pulp mill:

- restriction of annual SO_2 emissions;
- emission limits for SO_2, NO_x, and dust (based on the results of a trial run);
- emission limits in the permitting decision that are lower than the legally binding limits set out in the Steam Boiler Emission Act; and
- if increased SO_2 emissions affect ambient quality in the area influenced by the plant, SO_2 discharges must be reduced by means of suitable in-house measures.

In this case the plant is situated at the edge of a city. The factory's exhaust gases impact on a forest that provides protection against avalanches.

iv. Permitting decision

On the basis of the situation described at the on-site hearing, authorities make a decision to deny or grant (possibly with attached conditions) a permit to the industrial plant.

The applicant has a right to the permit for the plant in as much as the permit prerequisites are fulfilled.

As a rule, after start-up of a plant, the facility is inspected to ensure adherence to prescribed regulations.

In accordance with the Steam Boiler Emission Act, authorities can temporarily permit a trial run if, after completion of the permitting process, uncertainty remains about the impact of the plant. Neighbours cannot appeal against temporary permitting of such trial operations.

1.3 Permit renewal process

Permits granted under the Trade and Industry Act generally have no time limit. Permits granted under the Water Act, however, are usually valid for a limited time. The limits are specified in the permitting decision, as a rule, are for 5 years. To extend a water-use permit, it must be continually applied for following the permitting process described above. If the application is submitted on time, the applicant has a legal right to extension of the permit in as much as the permit prerequisites are fulfilled.

Once a permitting decision goes into force, in principle it can no longer be modified, with the exception of the two situations described below.

1.3.1 *Later conditions imposed and renovation measures*

Under the Trade and Industry Act, if an existing plant is found to unreasonably annoy neighbours or pollute the environment despite adherence to permit conditions, authorities must, on their own initiative or on petition to the Ministry for the Environment (in response to complaints from neighbours or measurement results), impose additional conditions or require the plant operator to submit a renovation plan to the authorities for the permit. Permit decisions will contain reasonable time limits for carrying out necessary renovations.

In this context, it is noted that the Federal Environmental Agency has installed a nation-wide network for measuring ambient air quality and thus can identify polluters (see Section 3.2).

Additional conditions or renovation measures can only be prescribed if the cost (in terms of investment and operation) of fulfilling the conditions is not out of proportion with their intended effect (e.g., reducing the annoyance of neighbours as a result of excessive emissions).

Under the Water Act, authorities can modify a water-use permit after it has been issued and attach new conditions, prescribe adaptive goals, or temporarily prohibit the use of water when required to protect the public interest and the rights of others.

In carrying out adaptive measures prescribed in the permit, authorities must allow appropriate time limits and apply the principle that the cost of fulfilling the measures is not out of proportion with the intended result.

1.3.2 *Adaptation of ordinances*

Under the Trade and Industry Act a number of corresponding ordinances for certain process steps or branches came into force in the last years. These ordinances require adaptation of existing plants to the discharge limits of the ordinance. The transitional period for such adaptation of permitting plants is regulated in the ordinance (in general five years.)

Under the Water Act, the time limit for adapting existing plants to meet new binding emission limits must not exceed 10 years.

These regulations are especially relevant to existing pulp mills as the corresponding ordinances specify general principles concerning the technology to be used and the operation of the plant, as well as emission limits (Steam Boiler Emission Act, Ordinance on the Limitation of Waste Water Discharge from the Production of Bleached Pulp).

1.4 Multi-media permits

In general, Austria does not apply an integrated permitting process for plants (e.g., commercial permitting and water-use permit in one permit) because environmental ordinances are set out in various laws, and responsibility for enforcing these laws falls on different ministries, whereas responsibility for permitting falls on various authorities. Exceptions can be found in certain older permits for the indirect discharge of wastewater as they do not need a separate water-use permit.

One approach to an integrated assessment of the environmental impact is contained in the Environmental Impact Assessment Act. In this approach, a permit is granted for the overall project and authorities assess the effects of the project on the environment, including mutual effects.

1.5 Environmental assessment

Authorities assess the environmental impact of a plant on the basis of corresponding laws and ordinances. The use of different laws with differing permitting processes results in variation of the integrative assessment of environmental impacts under the different laws.

In accordance with the Trade and Industry Act, authorities must restrict emissions of air pollutants to at least what is achievable using BAT; protection of the air quality of a neighbourhood may require more stringent restrictions. In line with BAT, wastes must be avoided or recycled. If this is not economically justifiable, they must be properly disposed of.

The Water Act requires that wastewater discharge into waterways or into a sewage system should occur only to the extent that is absolutely necessary. Reduction, avoidance, and recycling of wastewater pollutants and waste energy take precedence over wastewater treatment measures. The discharge of hazardous pollutants in wastewater can only be permitted if state-of-the-art technologies offer no alternative. Additionally, the water management situation, especially existing usage and the current pollution situation, must allow for the additional discharge. Protective measures for one flowing body of water must not lead to unreasonable displacement of pollution to other waterways.

Likewise, the Water Act gives environmental quality standards priority over emission limits as prescribed by BAT, which means that more stringent emission limits can be imposed to protect waters or to maintain the self-cleaning capability of waters.

For projects that require permitting under the EIAA, the applicant must describe the effects of the project on the environment, including the interaction of effects. The EIAA requires at least the same quality standards as the separate media-specific laws i.e. limit the emissions of pollutants through the use of BAT; minimise emissions to the environment; reduce, avoid and recycle waste and dispose of wastes properly. The final decision in the EIA process is based on an integrated expertise, case by case, taking into account all relevant environmental effects.

In all three cited laws, the situation is based on restricting emissions of individual pollutants in line with BAT. In the permitting process, authorities make their decision based on the assessments of experts. Principally, the avoidance of emissions (clean technology) is preferred over pollutant reduction through end-of-pipe treatment processes.

2. BAT, EQOs, AND ECONOMICS

2.1 Standards setting

With respect to Austria's use of the term environmental standards, it is necessary to distinguish between plant-specific standards and environmental quality standards. The two are strictly separated in the Austrian legal system and fall under the competencies of different ministries.

As standards are not directly legally binding (although they are considered in the assessment of BAT), they are implemented in the form of ordinances to respective laws. These ordinances, among other items, include emission limits for various pollutants.

Environmental quality standards generally reflect EQOs. These standards include the:

- Environmental Quality Standards Agreements;
- The Second Ordinance Against Forest-damaging Air Pollution (ZVgfL);
- The Ground Water Threshold Ordinance;
- The Ordinance for the Improvement of Water Quality in the Danube River and its Tributaries (Danube River Ordinance); and
- The Ordinance for the Improvement of Water Quality in the Mur River and its Tributaries (Mur River Ordinance).

These ordinances are based on corresponding laws, which empower the competent minister to issue an ordinance and which also specify other ministries that need to be involved to attain a consensus. In practice, this involves all affected parties, including the ministries enumerated in the law as well as representatives from science, industry, and the Social Partners.

Ordinances not only impose binding emission limits, but also usually establish general principles for plant design and regulations for measuring emissions.

Environmental quality standards are prescribed on the basis of scientific studies to reasonably preclude any risk of damage to the object being protected (air, soil, and water).

The Austrian Academy of Sciences has established non-binding environmental quality standards under the concept of "dose effect" for many air pollutants. Authorities employ these standards in the assessment of ambient pollution during the permitting process.

At present, there are no binding environmental quality standards for water pollutants, but the federal Ministry for Agriculture and Forestry has established non-binding standards for numerous pollutants. In addition, the Ground Water Threshold Ordinance provides thresholds for pollutant concentrations in groundwater that trigger measures for decontamination in affected areas.

An environmental quality standards act for air and an environmental quality standards ordinance for flowing waters have been prepared by the respective ministries and are currently under discussion.

2.2 Cleaner technologies

The Austrian permitting system essentially allows the permit applicant to choose the most appropriate manufacturing technology to meet permit requirements.

The law requires the use of cleaner technologies by means of principles and regulations that are applied in the plant permitting process.

The following are some principles that the authorities apply strictly:

- Wastewater discharge into waterways or into an approved sewage system is permitted only to the extent that is absolutely necessary. Reduction, avoidance, and recycling of wastewater pollutants and waste energy take priority over wastewater treatment measures (e.g., collection of at least 98 per cent of used cooking acid, use of extended cooking, and chlorine-free bleaching).
- Quantities of wastewater discharged into flowing waters must be kept to a minimum through the use of water-conservation technologies and methods (e.g., efficient pulp washing, recovery of at least 98 per cent of used cooking acid, and use of extended cooking).
- Waste must be avoided, recycled, or otherwise disposed of in accordance with BAT (e.g., bark combustion in power boilers).
- Waste management must be directed at conserving raw materials and energy reserves.
- Emissions of air pollutants must be restricted in line with BAT.

2.3 Environmental quality objectives

In Austria, environmental quality objectives have been passed for air and water. These are considered in the development of permit requirements.

2.3.1 Air quality objectives

The Agreement of Ambient Air Quality Standards between the federal government and the provinces sets binding ambient air quality standards for several pollutants, such as SO_2, dust, CO, and NO_2, as summarised in Table 2.

Table 2. Agreement of ambient air quality standards

Pollutant	Ambient concentration (mg/m^3 at 20°C and 1 013 mbar)	Time interval
SO_2	0.2	Mean over 0.5 hour
Particulate	0.2	Mean daily value
CO	10	Mean over 8 hours
	40	Mean over 1 hour
NO_2	0.2	Mean over 0.5 hour

In cases where emissions from an industrial plant directly affect a forest, stricter ambient air quality standards apply. These standards are specified in the Second Ordinance Against Forest-damaging Pollution. All pulp and paper mills are affected by these ambient air quality standards. For example, the following SO_2 deposition limits apply:

- SO_2 deposition limit for April to October – 0.07 mg/m^3 and
- SO_2 deposition limit for November to March – 0.05 mg/m^3.

2.3.2 Water quality objectives

Special ordinances have been developed for the Danube and Mur rivers and their tributaries prescribing binding water quality objectives. As all Austrian pulp and paper mills discharge their wastewater either directly or indirectly into one of these rivers, the goal is to maintain the water at a water quality level of at least Class II under the four-level water quality system that has been established.

In addition to these ordinances, the federal Ministry for Agriculture and Forestry has prepared non-binding quality standards for many water pollutants.

2.4 Best available technology (BAT)

In Austria, the permitting process generally uses BAT as the basis for decisions. BAT is defined in corresponding acts, such as the Trade and Industry Act and the Water Act, as follows:

> "BAT is the state of the art that is based on corresponding scientific knowledge of advanced technological processes, facilities, and operational techniques and whose functionality has been tested and proven."

BAT is a dynamic term. It encompasses the respective state of scientific advance and is oriented toward international state-of-the-art technologies. Defining BAT requires expert knowledge in the field. This can lead to differences of opinion among affected parties (authorities, neighbours, and applicant) and thus to delays in the permitting process.

For certain types of industrial plants, BAT is specified in dedicated ordinances. Such plant-specific ordinances contain more detailed guidelines concerning the construction and operation of equipment, and emission limits and the measurement of emissions. These ordinances can be amended to account for technological change.

The following ordinances and act relate to the Austrian paper industry:

- Ordinance on the Limitation of Waste Water Discharge from the Production of Bleached Pulp;
- Ordinance on the Limitation of Waste Water Discharge from the Production of Paper and Boards; and
- Steam Boiler Emission Act.

The Ordinance on the Limitation of Waste Water Discharge from the Production of Bleached Pulp requires the following:

- collection of used cooking acid (at least 98 per cent);
- use of extended cooking;
- chemi-physical or biological treatment of condensates that occur during evaporation;
- replacement of elemental chlorine (Cl_2) in pulp bleaching as much as possible;
- collection, evaporation, and thermal utilisation of highly concentrated wastewater from the bleaching unit;
- steam stripping of volatile pollutants;
- removal of organic pollutants through adsorption; and
- aerobic final purification of all wastewater.

BAT requirements for the pulp and paper industry (for air and water releases) are listed in Tables 3 and 4.

Table 3. Emission limits for black liquor incineration units for pulp production. Limits are included under the Steam Boiler Emission Act (Federal Law Sheet 1994/785)

	Sulphate Process	Acidic Magnesium Bisulphite Process	Magnefite Process
Dust (mg/m^3)	50	50	50
SO_2 (mg/m^3)	400	700	300
NO_2 (mg/m^3)	400	400	400
H_2S (mg/m^3)	20	—	—

Table 4. Discharge limits for bleached pulp production (in cumulative wastewater). Limits are included in Ordinance on the Limitation of Waste Water Discharge from the Production of Bleached Pulp (Federal Law Sheet 1991/181) (emission values per tonne of air-dried pulp)

	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

2.5 Negotiation of standards

As noted earlier, Austria uses a negotiation process involving various ministries and interest groups that have a legal interest in the development of ordinances. Once an ordinance has been issued, its content is not subject to further negotiations during the permitting process. (There are some exceptions, however, as discussed in Section 2.6). The only legal option is to file an appeal in the constitutional court to repeal the ordinance.

As most permitting of plants in Austria proceeds on a case-by-case basis, conducted by the authorities, negotiations can take place. Authorities base their decisions on an evaluation of emissions according to BAT.

Most large projects undergo a route of informal discussions with authorities in order to inform the authorities of the proponent's plans on the one hand and to hear the opinion of the authorities with respect to the plans on the other. This ensures greater security in planning.

Once a permit has been granted, all legitimate parties affected by the decision have a legal right of appeal. Appeals may be launched to change a permit (e.g., change permit conditions) or to effect the repeal of a permit that is not yet in force through a superior authority. The first level of authority in these cases generally involves county administrative authorities; the second level involves provincial governors. Under certain conditions, a third level of authority would involve the responsible federal minister. Appeals against decisions of federal ministers can be made to the Administrative Court in the final instance.

If the appealing party believes that constitutionally protected rights have been violated, for example, the application of an illegal ordinance, a breach of the principle of equality, or the right to non-infringement of property, an appeal can be made to the Constitutional Court.

The Administrative Court and the Constitutional Court can revoke permits that are already in force.

2.6 Economic considerations

Economic factors are considered in decisions made by the government, for example, when issuing decrees and ordinances. This requires balancing environmental goals as well as economic considerations and other interests.

In the context of industrial plant permitting, authorities are not allowed to consider economic arguments of a permit applicant. The laws provide exceptions in connection with the issuing of additional conditions that require renovation measures. The cost of fulfilling the conditions is weighed against their intended effect as discussed in Section 1.2.

The different laws allow consideration of economic interests under certain conditions, e.g., less stringent regulations and extension of renovation deadlines, as discussed below.

2.6.1 Water Act

Less stringent regulations

Under the Water Act, an authority can apply less stringent discharge limits for wastewater than those prescribed in an ordinance if:

- adhering to the discharge limits proves technically impossible with economically reasonable investment;
- the public interest in the activity requiring the discharge outweighs that of protecting water purity; and
- exceeding the discharge limits can be accepted temporarily with respect to the local water management situation.

An example of this situation involves a pulp mill (reflecting BAT) that applied to the authorities for a water-use permit for in-house measures to reduce pollutant discharges and for re-issue of its water-use permit. The

proposed in-house management measures were well advanced and promised a drastic reduction in discharges. During the course of the permitting process, the Ordinance on the Limitation of Waste Water Discharge from the Production of Bleached Pulp was amended, with emission limits becoming more stringent. Thus, the water-use permit had to be renewed.

An expert position statement demonstrated to the authorities that all three of the above prerequisites were fulfilled. The emission limits prescribed by the amended ordinance could be met by using total chlorine-free bleaching. At the time, pilot studies were being carried out in the plant, but the technological prerequisites for a large-scale facility were not yet fulfilled anywhere in the world.

The public interest was reflected in the continued existence of the plant for economic reasons (protection of some 400 jobs, along with a super regional impact in the event of the plant closing). Although the water quality prescribed in the Mur Ordinance could not be met completely with the proposed wastewater discharge, an acute threat to the self-cleaning capability of the tributary was not anticipated.

Extension of deadlines

For the renovation of old plants, the Water Act permits an extension of legally binding deadlines for adaptive measures if:

- the water-use permittee demonstrates that meeting the deadline is impossible through no fault of the applicant or
- significant steps toward adaptation have already been undertaken.

An example of this situation involved a pulp mill that utilised BAT, but without biological wastewater treatment. The mill applied for an extension of the deadline to construct the prescribed biological wastewater treatment facility.

Over the course of recent years, the plant had implemented significant renovation measures. Due to a price decline for bleached sulphite pulp and fine paper, however, the mill encountered financial difficulties through no fault of its own. Thus, the plant was not able to implement the biological wastewater treatment facility approved in an earlier permitting decision. The authorities extended the deadline for the renovation because the plant was able to demonstrate that the two prerequisites above were fulfilled.

2.6.2 Steam Boiler Emission Act

In a similar manner, the Steam Boiler Emission Act allows deadline extensions for renovation measures if necessary. In Austria, all old plants have already been renovated due to legal regulations.

2.7 Interaction of BAT and EQOs

In Austria, BAT and EQOs are two separate concepts: BAT describes the state of the art and EQOs reflect the environmental policy goals of the nation. In the permitting process, authorities first check whether EQOs can be achieved by prescribing BAT. If not, stricter conditions are set to meet the EQO requirements. One operation of this system is illustrated by the following example.

i. Permitting under the Trade and Industry Act

A pulp mill applied for a permit to construct and operate a new black liquor boiler. The plant site was at the edge of a city and near a protected forest.

Relevant to emissions, binding emission limits are specified in the Steam Boiler emission Act based on past BATs. Following startup of the unit, the permit authority evaluated emissions after a one year trial run. This determined a new BAT. As a result, permit emission limits could be presented at significantly lower levels.

The maximum pollutant discharge that could be allowed was determined by Experts (medical, forestry, etc.) based on ambient air quality measurements. When certain the standards in the region are exceeded, the plant must reduce its SO_2 emissions.

ii. Permitting under the Water Act

Relevant to waste water discharges, a mill producing caustic soda using mercury cell applied for a discharge permit. The General Waste Water Discharge Ordinance set a mercury discharge level of 0.01 mg/L of effluent.

However, on the basis of the amount of waste water generated in the process, an expert determined that discharges of this amount would lead to an unreasonable level of river pollution. As a result, the permit decision prescribed a significantly lower mercury concentration. The legal basis for this decision is that "more stringent emission limits than those in the ordinances (BAT) may be prescribed if this is required due to the pre-existing pollution of the waterway."

3. TRENDS IN PERMITTING

3.1 Cleaner technology

Permit decisions indirectly reflect the influence of clean technologies when setting emission limits that are oriented to BAT, and thus to low-emission, cleaner processes (see also Section 2.2). Consideration of cleaner technologies is also reflected in the general principles expressed in various laws, ordinances, and regulations developed to protect the environment and taken into account during the environmental permitting process.

In accordance with the State Aid on Environmental Measures Act, measures to protect the environment receive state funding. Such measures include development work concerning clean technologies. In the past, funds have been received for:

- a pilot plant for Total Chlorine Free (TCF) and elemental chlorine-free (ECF) bleaching;
- a project to reduce AOX discharges at a mill;
- the transition from heavy oil to natural gas;
- monosulphite decomposition in a sulphite plant in combination with the recovery of chemicals; and
- a project aiming for zero waste water from pulp bleaching.

3.2 Trends in limits

Since Austria joined the European Union on 1 January 1995, there have been several changes made to Austrian environmental law.

All European Union laws and guidelines apply in Austria, although Austria, in part, has already passed its own, more stringent laws. One example is Austria's Environmental Impact Assessment Act, which is the primary permitting instrument in the Austrian pulp and paper industry for new plants and major capacity expansion.

3.2.1 Air

A comparison of Austrian clean air laws with those of the European Union shows that Austria's existing emission limits are more stringent. Austria will maintain these more stringent limits in the future.

A federal law dealing with air quality objectives is in the evaluation stage.

3.2.2 Water

Under the Water Act, the federal Minister for Agriculture and Forestry sets water quality standards for surface water in an EQO ordinance. A draft EQO ordinance for flowing water is in the evaluation stage. The water authorities frequently employ current drafts as guidelines for EQOs.

3.2.3 *Waste*

A comparison of European Union and Austrian waste management systems reveals that the Austrian web of regulations is much denser and broader than that of the European Union.

As the European Union wants to establish regulations only in the realm of international waste management, specific actions for other matters, such as measures to reduce solid waste, and provide a collection point for problematic wastes, must be handled by member nations. In Austria, the Waste Management Act, which is already in force, provides a foundation for orderly waste management.

3.3 Monitoring

With respect to environmental monitoring standards, Austria has installed a comprehensive measurement network for air and water. Responsibility for measurement is shared between the federal and provincial governments according to their competencies. The Federal Environmental Agency and the Federal Institute for Water Quality play a major role in the collection of measured data. Measurement results are made available to the public.

On an operational level, distinction is made between in-house monitoring by the companies themselves and external monitoring by others. In-house monitoring is primarily employed to collect data on a few parameters over short intervals, preferably with automatic, simple measuring devices. For example, for wastewater discharges, self-monitoring could involve continuous recording of wastewater quantities, temperature, and pH values; for a steam furnace, it could involve continuous emission measurements for plants over a certain fuel thermal value as set out in the Steam Boiler Emission Act. The nature and scope of in-house monitoring is prescribed in the permit. Results are generally archived at the plant and made available to authorities upon request.

In-house monitoring is usually augmented by external monitoring, likewise prescribed in the permit, in which case the plant operator commissions the inspection of certain parameters to officially authorised offices or civil engineers. Such authorised offices guarantee the quality of the measurements. In addition, authorities can conduct their own inspections, as in the case of Water Act authorities. Accessible inspection sampling points can be prescribed for this purpose.

Another monitoring activity under the Trade and Industry Act involves "recurrent assessment," in which the plant operator must inspect the plant (or have it inspected) at regular intervals (generally 5 years) for compliance with commercial regulations and permit conditions. Shortcomings must be reported to the authorities.

Dangerous industrial plants (e.g., black liquor boilers) must be inspected by authorised persons at intervals of at most 3 years, as well as immediately after the occurrence of a failure.

Public access to emission data has thus far been on a voluntary basis. The Environmental Information Act (UIG) is expected to improve the situation by providing restricted public access to emission data.

4. TECHNOLOGICAL RESPONSE TO PERMIT REQUIREMENTS

4.1 Equipment installed and measures taken

Industry responds to stringent environmental requirements by using the best available technology. For economic feasibility, clean technologies are given preference over end-of-pipe solutions.

The introduction of environmental thinking is being spurred within the pulp and paper sector. Currently, the industry is working on introducing environmental management systems. Environmental handbooks already exist in several plants.

Research on environmentally friendly, clean technologies has been and continues to be carried out. The following are some examples:

- chlorine-free bleaching of pulp (already realised);
- an environmentally friendly process for the production of cellulose fibres (soon to be realised);
- the reduction of CO_2 emissions to reduce the greenhouse effect through clean combustion technology;
- reclamation of paint colours from wastewaters of paper machines;
- optimisation of water routing in paper mills, with the long-range goal of developing a nearly wastewater-free paper mill;
- studies on the possibility of wastewater-free pulp bleaching; and
- new enzymes for enzymatic bleaches.

In the pulp and paper industry, BAT has been realised, for the most part, and emissions are sometimes even less than legally prescribed through the use of BAT. For example, chlorine-free bleaching has been realised in all sulphite plants.

For an Austrian sulphate plant (softwood), BAT takes the following form (Schweitzer A., Austrian Paper Convention 1995):

- dry debarking (maximum 0.2 kg COD/t in the wastewater);
- isothermal cooking and oxygen bleaching, delignification to a maximum kappa number of 12. The Kappa number indicates the amount of bleaching required;
- closed cycle pulp washing with sorting, washer losses 6 kg COD/t;
- ECF/TCF bleaches, with 100 per cent ClO_2 substitution; oxygen enhanced peroxide stage extraction with a waste water discharge of a maximum 21 kg COD/t, this uses a high shear mixer;
- condensate utilisation with 90 per cent condensate recycling in the process; COD discharge from condensates are a maximum 2 kg/t;
- biological wastewater treatment;
- black liquor collection (treatment over 99 per cent), this uses collection tanks with adequate tank volumes, monitoring devices, emergency tanks and backup facilities;
- high black liquor solids firing (over 70 per cent solids), and scrubbing of bleach plant exhaust gases
- collection and incineration of strong and weak gases, and incineration.

4.2 Flexibility considerations

In the Austrian permitting system, the choice of the most appropriate technology to use is left to the plant operator.

4.3 Views of industry surveyed

The following position statement of the Austrian pulp and paper industry on the subject of environmental protection and laws is taken from the periodical Papier aus Austria, April 1994, p. 27:

Industry and environmental protection

- Austrian industry advocates preventative and applied environmental protection.
- Industry must actively participate in environmental discussions on proposed solutions and strategies. For example, with respect to problems associated with the greenhouse effect, industry should practise and implement additional feasible and practical increases in energy efficiency and CO_2 reduction.
- Austrian environmental law should orient itself toward northern, progressive European Union nations and their enforcement practices (e.g., Germany, Holland) and not lose itself in national solo ventures that lead to serious competitive disadvantages that globally achieve nothing for the environment.

Austrian environmental law must be technically feasible, economically bearable, and efficiently enforceable within the existing authority apparatus.

- The law must be embedded in long-range considerations and calculable planning of overall goals of environmental policy.
- Consistent enforcement of the regulations for all sectors (industry, agriculture, business, individual transportation, and communities) must be guaranteed.
- The permitting process must be carried out tightly and concentrated into the shortest possible time.

Conditions and regulations must treat individual companies equally. The practices of provincial authorities must be co-ordinated and tuned to one another. Within Austria, equal competitive chances must be given.

The Austrian pulp industry has released the following emission values (Tables 5 and 6) for the year 2000 and for after 2005.

Table 5. Proposed annual average emission limits (kilograms per tonne) for existing pulp mills as of 1 January 2000

Type of mill	AOX	COD	TSS	Total S	NO_x
Bleached kraft pulp	1	30	5	1	2.5
Unbleached kraft pulp	—	10	4	1	2.5
Bleached sulphite pulp	0.3	40	5	5	2.5
Magnefite	0.3	50	5	5	2.5
Dissolving pulp	0.3	10	1	5	3
Chemi-thermo-mechanical pulp	—	45	5	—	—
Mechanical pulp	—	20	5	—	—

Source: Association of the Austrian Paper Industry, Vienna, July 1995.

Table 6. Proposed annual average emission limits (kilograms per tonne) for existing pulp mills as of 1 January 2005 and for new pulp mills and existing pulp mills increasing their capacity by more than 50 per cent on or after 1 January 1997

Type of mill	AOX	COD	TSS	Total S	NO_x
Bleached kraft pulp	0.8	30	5	0.5	2
Unbleached kraft pulp	—	3	1	0.5	2
Bleached sulphite pulp	0.05	40	5	3	2
Magnefite	0.05	50	5	3	2
Dissolving pulp	0.05	10	1	3	2.5
Chemi-thermo-mechanical pulp	—	30	4	—	—
Mechanical pulp	—	20	5	—	—

Source: Association of the Austrian Paper Industry, Vienna, July 1995.

5. CONCLUSIONS

Environmental regulations that must be considered in permitting the operation of a plant are specified in various laws. The Austrian legal system does not contain a uniform environmental law. This leads to an unclear legal situation with complex questions of jurisdiction. More and more plants must be permitted under various laws. This can lead to large expenditures of time and money in dealings with authorities.

Since 1994, under the Environmental Impact Assessment Act, certain industrial plants that endanger the environment require permitting. The Act provides a concentrated permitting process and enables affected citizens to be heard and, under certain conditions, to take a position as an active party in the permitting process.

For the pulp and paper industry, the Act applies to new plants and expansions in production.

The two primary acts taken into consideration in the permitting of industrial plants are the Trade and Industry Act and the Water Act. The Trade and Industry Act deals with the protection of neighbours and environmental protection in general. The Water Act protects the public interest and the rights of others. Reasonable annoyance of neighbours and pollution of the environment are the thresholds that determine allowable emissions from an industrial plant.

To assure adequate protection of the environment and of neighbours, Austrian industrial plant law prescribes the application of BAT. BAT encompasses state-of-the-art technologies and is oriented toward the international state of development of technologies.

For a number of types of plants, ordinances define BAT (i.e., provide guidelines on plant construction, operation, and equipment, and the allowable scope of emissions and emission limits). If an ordinance does not meet the targeted level of protection, authorities must include conditions in the permit decision that go beyond the limits set out in the ordinance (beyond the limits prescribed by BAT).

In the permitting process, evaluating the protection of neighbours and the environment, as well as assessing BAT, is handled by experts. These expert assessments can rely on the results of similar facilities; however, there is no legal obligation to do so. Permitting is handled on a case-by-case basis.

In accordance with an agreement between the federal government and the provinces, binding nation-wide ambient quality standards are to be applied for SO_2, NO_x, CO, and dust. If emissions from an industrial plant affect a forest, different, more stringent EQOs apply.

Preservation of the self-cleaning capability of waterways is the primary guideline for protecting water from wastewater discharges. For the Mur and Danube rivers and their tributaries, the goal is to achieve a water quality level of at least Class II. Through public cleanup measures and state-subsidised environmental protection measures by companies, this goal could be fulfilled in future years.

An EQO act for air and an EQO ordinance for flowing waters have been prepared and are awaiting implementation.

The pulp and paper industry has modernised its plants to a large extent. Biological wastewater treatment facilities have been installed at almost all plants. TCF bleaching has been realised already in all sulphite plants and TCF/ECF bleaching in Austria's only bleached kraft (sulphate) pulp mill.

The installation of clean technologies in industrial plants is assured through stringent permit prerequisites and by state funding.

A number of changes will take place in the area of environmental protection and industrial plant law as a result of Austria joining the European Union. All laws and guidelines of the European Union will apply in Austria after a transition period. The sometimes more stringent Austrian environmental protection regulations will continue to be maintained in Austria.

In connection with the Council Directive concerning Integrated Pollution Prevention and Control (96/61/EC) of the European Union, various institutions in Austria are discussing a uniform, transparent law for industrial installations.

Case Study on the Use of Best Available Technology (BAT) and Environmental Quality Objectives (EQOs) in the Environmental Permitting of Bleached Chemical Pulp and Paper Mills in Belgium (Wallonia)

Pre-publication version prepared by
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FOREWORD

This report reviews how the concepts of best available technology (BAT) and environmental quality objectives (EQOs) are taken into consideration in the environmental permitting of pulp and paper facilities in Belgium (Wallonia). It was prepared by Environment Canada's National Office of Pollution Prevention based on responses to a questionnaire survey. The content of the questionnaire was developed by the Organisation for Economic Co-operation and Development's (OECD's) Pollution Prevention and Control Group.

This report is one of a series of reports prepared to provide background information on the procedures followed in the environmental permitting of pulp and paper mills in a number of OECD Member Countries. Information was gathered using a questionnaire designed to see how best available technology and environmental quality objectives were considered. The countries in the study were Austria, Belgium (Wallonia), Canada, Finland, the Federal Republic of Germany, New Zealand, Norway, Sweden, Switzerland, and the United States of America. Separate reports are available describing the permitting procedures of each country. This report is one of ten reports (Country Profiles) which describe the approach to environmental control of pulp and paper mills in each country. In addition, an overview case study report has been prepared describing the general permitting practices in the set of countries. These reports have been prepared by Environment Canada for the Pollution Prevention and Control Group (PPCG) of the Organisation for Economic Co-operation and Development (OECD).

This particular report provides details of the permitting approach in Belgium (Wallonia), describing the legislative basis for permitting, the organisations that issue permits, and the use that is made of regulations, environmental quality objectives, best available technology, and economics. It also describes the technological response of mills to the permit conditions that have been set and the opinion of a mill with respect to the permitting process.

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1. THE PERMITTING PROCESS

1.1 Constitutional responsibilities for environmental protection

Belgium is a federal country consisting of three regions: Flanders, Wallonia, and Brussels. This case study addresses environmental permitting of an integrated bleached kraft pulp and paper mill in the region of Wallonia.

Under the Belgian constitution, the regions have the authority to address "territorial policy matters," including those dealing with environmental control. The regions establish the framework and laws for environmental control. With respect to the administration of environmental matters in Wallonia, the Regional Ministry of the Environment is responsible for the issuance of consents relating to the operation of solid waste disposal sites and liquid effluent discharge permits. In addition, the Ministry handles appeals and is responsible for the approval of environmental impact assessment studies, which form a key part of all permit decisions. Wallonia provides advice to its provinces regarding permit decisions through technical experts in different divisions of its Directorate General for Natural Resources and the Environment (DGNRE). The regional government is also responsible for the monitoring and inspection procedures set out in permits.

The pulp and paper mill reviewed in this case study is situated in the Province of Luxembourg. The *Deputation permanent de la Province de Luxembourg* issued the mill's permit.

A description of the environmental control framework for Belgium can be found in the OECD BAT/EQO Reference Guide.[1]

1.2 Permits

A permitting system operated by the provinces, in conjunction with consents issued by the regional governments, is used to maintain acceptable environmental quality in Wallonia. The power to issue permits is derived from the General Regulation for the Protection of Workers (RGPT).

The permits are issued on a case-by-case basis taking into account regional and federal requirements and other considerations, including economics and technology. They specify emission limits and other operating conditions. These limits and conditions are arrived at through a series of negotiations conducted by the regional governments.

Incident studies (*études d'incdences*) play an important part in the decision-making process with respect to consents and permits. These studies are conducted by qualified consultants approved by the Regional Ministry of Environment. The terms of reference for the studies are approved by the Region's Minister of the Environment. The 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 wastes, and transport effects. Mitigative measures are also described. Reports emanating from these studies provide a basis for decisions pertaining to consents and permits.

With respect to integrated pulp and paper mills, individual permits are issued for various operations in a mill. For example, there are individual permits for the pulp mill, paper mill, effluent treatment plant, boilers, and waste management facility.

The permitting and authorisation processes are triggered by new plant construction and activities such as the installation of a boiler, a liquid effluent treatment system, or a solid waste disposal facility. The duration of authorisations varies according to the facility to which they 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. Mills must apply to the government for new permits.

The permitting authorities also have the power to initiate reviews at any time they feel a review is warranted. This may apply when new cost-effective treatment techniques are found or if the impacts of an operation are more severe than previously expected.

Appeals can be made by mill owner's or the public regarding the imposition of any conditions. Appeals can be made to more senior levels in provincial governments and eventually to the Regional Minister of the Environment. In the case of appeals, the conditions in question are suspended until the outcome is decided.

1.3 Multi-media permits

Belgium does not use an integrated or multi-media permitting system. Separate permits are issued for liquid effluent discharges, air emissions, and solid waste management.

1.4 Environmental assessment

An environmental impact assessment is conducted for all permits/consents. The Regional Minister of the Environment is responsible for the assessments. The Minister determines the terms of reference of the assessment, which include effluent quantity and quality measurements and environmental impact modeling studies. The assessments are carried out as part of the incident studies.

2. BAT, EQOs, AND ECONOMICS

2.1 Standards setting

With respect to effluent discharges from pulp mills, federal standards were passed in 1986 imposing effluent quality standards for releases to watercourses.[2] The regulations include general rules, with limits for the discharge of suspended solids, biochemical oxygen demand (BOD_5), hydrocarbons, oil, and detergents. With respect to BOD_5 and suspended solids, limits of 45 mg/L and 120 mg/L, respectively, were set. For effluent as a whole, the pH must be between 6.5 and 9, the temperature must not exceed 30°C, and oil and grease must be non-visible. Complementary conditions were also included in the regulation's pertaining to colour, total potassium, azote-ammonia, chemical oxygen demand, sulphur plus mercaptans, and mercury.

For discharges from paper mills, a similar set of federal limits have been promulgated. Various limits have been established for the production of different types of paper according to its pulp composition. These limits cover the same parameters as those described above for pulp mills, except colour limits are not included.

Table 1 summarises the limits set for mills producing kraft pulp and kraft paper products (including papers and tissues).

Table 1. 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 Settlable solids (mg/L)	N/A	N/A
Total suspended solids (TSS)	120	75
CCl_4 hydrocarbon extractables (mg/L)	5	5
Detergents (mg/L)	3	3
Other conditions		
Color (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	—

2.2 Environmental quality objectives (EQOs)

Air quality standards (objectives) for dust, sulphur dioxide, lead, nitrogen dioxide and ozone have been developed in Belgium in accordance with directives issued by the European Union (EU). This was achieved by transcribing the EU requirements into regional laws. The air quality objectives have been passed by the Région de Wallonne.

Receiving water quality objectives have also been developed at the regional level for general application to waters. These objectives consider the following:

- the average existing situation;
- the impact of recently implemented sectoral standards;
- minimum acceptable water quality requirements for fish life; and
- the concerns of neighboring countries regarding watercourses that cross international boundaries.

In addition, Belgium regulatory authorities may require stricter discharge standards than those incorporated in EQOs in specially protected zones defined by legislation.

2.3 Best available technology (BAT)

In Belgium, permit decisions are not based directly on the principle of BAT. However, environmental control authorities and plant owners are aware of state-of-the-art production and pollution control technologies and these are considered indirectly in permit decisions. In permitting, it is the results that are targeted, i.e., acceptable environmental quality.

BAT has not been defined in Belgium, although a decree in 1993 regarding binding authorizations for air pollution stated that *"...the regulatory authority imposes conditions on plant owners which are based on the best technology available, taking into account both technology and economy."* BAT concepts developed by the European Union are also taken into account in Belgium; these concepts vary between those based purely on state-of-the-art and those which also consider economic aspects.

Some assistance is provided to pulp and paper mills for the introduction of new, cleaner technology. This assistance may cover up to 20 per cent of the research costs associated with the development of the new technology.

2.4 Negotiation of standards

Permit limits are developed as a result of negotiations during the permitting process between plant management and technical staff of the administration. Public meetings may be held during the impact assessment process.

2.5 Economic considerations

The permitting process takes into consideration the economics associated with technology. Mills may be allowed higher discharge limits in situations where the cost of treatment facilities could prove to be an unacceptable economic burden.

2.6 Interaction of BAT and EQOs

Wallonia authorises permits for each mill on a case-by-case basis, taking into consideration technology, economics, and environmental requirements.

Mills may be allowed higher permitted discharge limits in situations where the receiving environment has a greater assimilative capacity or where the cost of treatment facilities could prove to be an economic burden. Similarly, more stringent discharge limits may be required where the environment is found to be inadequately protected by permitted discharges, especially in protected zones as defined by legislation.

3. TRENDS IN PERMITTING

3.1 Cleaner technology

Permits and consents issued in Wallonia recognize the role to be played by pollution prevention practices, as well as the need to use end-of-pipe control measures where in-plant measures cannot attain the required environmental quality. This applies to the control of releases to water and air and to solid waste management.

An important component of the consent and permit decision-making process is the development of incident studies. These studies include a thorough evaluation of the mill and its situation. In response to the needs of the environment, mills develop plans to improve environmental control. In the case of the bleached kraft mill under discussion in this study, the mill informed the government of its plan to switch from a bleaching process using chlorine gas to one based on chlorine dioxide. This approach was accepted by the authority when the permit was issued; however, use of the technology was not set as a mandatory condition.

With respect to environmental control at a bleached kraft mill, the mill's effluent permit includes limits for releases of BOD_5, chemical oxygen demand, suspended solids, and colour. These limits are met through combinations of in-plant measures and primary and secondary external treatment. Measures are also included for the avoidance of spills by means of an emergency response plan outlining the tankage required and practices to be followed to control effluent spills.

Regarding air emissions, odorous, non-condensable gases at the kraft mill are collected and incinerated in boilers equipped with sulphur dioxide scrubbers. Combustion conditions with respect to oxygen and carbon monoxide, in particular, are controlled to ensure that total reduced sulphur gas emissions are minimised.

3.2 Trends in limits

Numerical values of some of the effluent limits specified in a sample kraft mill permit are summarised in Table 2. The permit limits are those shown in the second column. For most parameters, limits are set as concentrations in the final effluent. The fourth column of the table reports what the various limits are equivalent to on a mass per tonne basis, assuming that the mill operates at a daily production rate of 685 air dry tonnes per day.

Table 2. Summary of permit conditions in a bleached kraft pulp and paper mill permit.

Parameter	Authorised levels	Maximum	Mass per tonne of pulp
Flow	<70 000 m^3/d	70 000 m^3/d	102 m^3
TSS	55–25 mg/L	5.6 t/d	8.2 kg
COD	300 mg/L	21 t/d	30.7 kg
BOD_5	1.44 t/d	1.44 t/d	2.1 kg
Colour	550 mg/l Pt	38.5 t/d	56.2 kg
Temperature	30–35°C	35°C	

Other parameters controlled under the permit are pathogens, pH, temperature, carbon tetrachloride extractables, petroleum-ether extractables, oil and grease, detergents, total phosphorus, nitrogen/ammonia, mercaptans, mercury, PAH's, total phosphorus, chloroform, pentachlorophenol, chlorophenols, and stilbene derivatives.

3.3 Monitoring

Mill monitoring programs are specified in permits when they are issued. Specifications cover the parameters to be measured, the measurement frequency, the analytical methods to be used, and actions to be taken in the event that limits are exceeded.

Mills conduct self-monitoring and periodically provide results to authorities by registered letter. Responsibility for monitoring lies with the Division of Environmental Police (DPE), which is part of the DGNRE but is separate from that section of the DGNRE involved in the preparation of permits. Results of monitoring programs are considered in the permitting process.

If standards are exceeded, the administration can insist that modelling studies be repeated to determine if the discharges will result in unacceptable degradation of the receiving environment, taking into account environmental quality objectives. The public is allowed access to some results upon request.

Water taxes are collected by officials of the Nature & Forests Division within the DGNRE and of the federal Ministry of Agriculture. They make reference to the monitoring results.

4. TECHNOLOGICAL RESPONSE TO PERMIT REQUIREMENTS

4.1 Equipment installed and measures taken

The following section describes the technological response of an integrated bleached kraft pulp and paper mill to permit conditions that have been set. As noted earlier, pollution control is based on the use of pollution prevention practices associated with the use of end-of-pipe treatment, where the former is unable to meet effluent or emission quality requirements. The use of pollution prevention techniques is maximised for economic reasons.

In the area of effluent control, internal measures adopted by the mill include improved pulp washing, collection and reuse of condensates from the recovery process, and replacement of chlorine gas with chlorine dioxide. These measures enable pollution prevention and, along with secondary treatment have allowed discharges of chloroform and absorbable organic halides to be maintained well below set limits. A new chlorine dioxide generator was installed to eliminate gaseous chlorine bleaching.

Internal measures have been taken to avoid the emission of malodorous gases. Both condensable and non-condensable gases are collected from the chemical recovery process. The condensates are used in the process, reducing the fresh water requirements. The non-condensable gases are collected and burned in an incinerator. Boiler combustion conditions are controlled to ensure minimal formation of sulphur dioxide and total reduced sulphur gases. With respect to external treatment measures, a scrubber is installed to control sulphur dioxide releases. Electrostatic precipitators are installed on both the recovery and power boilers.

Table 3 summarises the internal and external treatment measures taken to meet permit requirements.

Table 3. Internal and external treatment measures taken to meet permit requirements.

Internal	External
Collection of odorous gases and effective combustion control (O_2 and CO)	
Fuel less than 1 per cent sulphur	Electrofilters on recovery boilers and lime kilns
Improved washing and recirculation of $CaCO_3$	Activated sludge biotreatment
Chlorine dioxide substitution	Maximise collection and treatment of leachates

4.2 Flexibility considerations

The mill expressed need for and the importance of flexibility in arriving at technological solutions to meet discharge limits. This is important for economic and technical reasons.

4.3 Views of the industry surveyed

With respect to balancing BAT and EQO factors in permits, it was noted that BAT and EQOs are considered as guidelines and not as objectives. Technological solutions are negotiated between the industry and the authorities. It was also felt that the limits set were sometimes more severe than local conditions required.

5. CONCLUSIONS

Wallonia operates a permit system under which permits are issued to pulp and paper mills by its provincial governments. Wallonia provides advice to its provinces on permit contents through the DGNRE.

The content of the permits is developed through case-by-case consideration. Incident studies are developed and play an important part in permit decisions. The terms of reference of the studies are approved by the Regional Minister of the Environment. The studies are also conducted by qualified consultants approved by the Minister. The 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 wastes and transport effects. Mitigative measures are also described. The studies provide the basis for decisions on consents and permits.

Requirements are developed based on the needs of the site and consideration of the regulations in place. The permit limits are met through a combination of in-plant and external treatments.

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Case Study on the Use of Best Available Technology (BAT) and Environmental Quality Objectives (EQOs) in the Environmental Permitting of Bleached Chemical Pulp and Paper Mills in Canada

Pre-publication version prepared by
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FOREWORD

This report reviews how the concepts of best available technology (BAT) and environmental quality objectives (EQOs) are taken into consideration in the environmental permitting of pulp and paper facilities in Canada. It was prepared by Environment Canada's National Office of Pollution Prevention based on responses to a questionnaire survey. The content of the questionnaire was developed by the Organisation for Economic Co-operation and Development's (OECD's) Pollution Prevention and Control Group.

This report is one of a series of reports prepared to provide background information on the procedures followed in the environmental permitting of pulp and paper mills in a number of OECD Member Countries. Information was gathered using a questionnaire designed to see how best available technology and environmental quality objectives were considered. The countries in the study were Austria, Belgium (Wallonia), Canada, Finland, the Federal Republic of Germany, New Zealand, Norway, Sweden, Switzerland, and the United States of America. Separate reports are available describing the permitting procedures of each country. This report is one of ten reports (Country Profiles) which describe the approach to environmental control of pulp and paper mills in each country. In addition, an overview case study report has been prepared describing the general permitting practices in the set of countries. These reports have been prepared by Environment Canada for the Pollution Prevention and Control Group (PPCG) of the Organisation for Economic Co-operation and Development (OECD).

This particular report provides details of the permitting approach in Canada, describing the legislative basis for permitting, the organisations that issue permits, and the use that is made of regulations, environmental quality objectives, best available technology, and economics. It also describes the technological response of mills to the permit conditions that have been set and the opinions of mills with respect to the permitting process.

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1. THE PERMITTING PROCESS

1.1 Constitutional responsibilities for environmental protection

In Canada, responsibility for the environment is shared among the federal and provincial governments. The division of powers outlined in the Constitution Act of 1867, under which the country was founded, makes no mention of the "environment." Consequently, jurisdiction is based on the allocation of powers in areas that lend themselves to environmental and resource management. As a result, each level of government has evolved jurisdictional powers over environmental matters.

The Constitution Act granted the federal government authority to regulate fisheries. It also empowered the federal government authority to regulate international and interprovincial matters. Under the federal Fisheries Act, the federal government has authority to control water pollution and maintain water quality.

The Constitution Act granted the provinces authority to control proprietary and civil rights within their respective province. This extended to controlling water pollution, air pollution, and solid waste management, as well as general matters such as approving industrial facilities that may have environmental impacts.

Both the federal and provincial governments are involved in regulating effluent discharges. With respect to air pollution and solid waste control, these issues are primarily managed by provincial governments.

Effective delivery of national environmental programs is ensured through the Canadian Council of Ministers of the Environment (CCME). Federal, provincial, and territorial ministers responsible for environmental matters are members of the Council. The CCME is the major intergovernmental forum for discussing and developing joint actions on environmental issues of national and international concern. Federal environmental programs that affect the role of the provinces in environmental management are co-ordinated through the CCME.

1.2 Federal environmental framework

With respect to pulp and paper mill environmental control, the federal government's role mainly encompasses the control of effluent releases to water under the Fisheries Act and pollutants that have been declared toxic under the Canadian Environmental Protection Act (CEPA).

In 1992, the federal government passed a National Pulp and Paper Regulatory Package for the Canadian pulp and paper industry. This included revised regulations under the Fisheries Act[1]; that imposed discharge limits for biochemical oxygen demand and total suspended solids, equivalent to levels achieved following the installation of well designed and operated, secondary biological treatment plants. In addition, the release of any effluents that were acutely lethal to fish was prohibited. The 1992 regulations updated earlier regulations issued under the Fisheries Act in 1971. The 1971 regulations only applied to mills built after 1971. The 1992 regulations apply to all mills.

The package also included two regulations under the Canadian Environmental Protection Act. One, the Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations,[2] requires mills to implement measures to prevent the formation of dioxins and furans. The other, the Pulp and Paper Mill Defoamer and Wood Chip Regulations,[3] imposes quality requirements for defoamers used in chlorine bleaching processes, and prohibits the manufacture of pulp from wood chips that have been treated with polychlorinated phenols. These were previously used as an antisapstain agent in the lumber industry. Dioxin formation occurred when wood chips

derived from trim-ends from such treated wood were used in the pulping process. Measures were therefore taken to prevent the use of such chips in pulping. These antisapstain agents have since been replaced by other chemicals.

Development of the federal regulations involved consultation with provincial environmental ministries in order to ensure that the regulations were compatible with provincial plans. A joint federal–provincial working group was established under the CCME to develop recommended control limits. These were then subject to broader public consultation, under federal regulatory development requirements, prior to promulgation in 1992. The federal regulations serve as a national baseline standard. Provinces may enact more stringent requirements as necessary to suit local requirements.

Table 1 summarises the effluent limits under federal regulations. The Fisheries Act regulations impose daily and monthly limits on releases of 5-day biochemical oxygen demand (BOD) and total suspended solids (TSS), and prohibit the discharge of any effluents that are acutely lethal to rainbow trout. The regulations require mills to routinely monitor their effluents according to specified test methods. Results have to be reported to the government on a monthly basis.

The CEPA Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations prohibit the discharge of chlorinated dioxins and furans in measurable concentrations as defined in Table 1.

Table 1: Effluent limits under the federal Fisheries Act and CEPA Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations.

Parameter	Limit
BOD (30-day average)	7.5 kg/ADt
BOD (daily)	12.5 kg/ADt
TSS (30-day average)	11.25 kg/ADt
TSS (daily)	18.25 kg/ADt
Acute Lethality	LC 50 ≥ 100%[1]
Dioxins (2, 3, 7, 8-TCDD)	Non-measurable[2]
Furans (2, 3, 7, 8-TCDF)	Non-measurable[2]

1. In the acute lethality test, ten rainbow trout are kept in a sample of 100 per cent effluent over a four day period. To pass the test, five or more fish have to survive the four-day period.
2. Non-measurable is defined as a concentration above the level of quantification (LOQ) of the test method. For dioxin (2,3,7,8-TCDD), a LOQ of 15 pg/L is applied; for furan (2, 3, 7, 8-TCDF), a LOQ of 50 pg/L is applied. (Section 2.3.1 provides an explanation of this).

In addition to effluent discharge monitoring under Fisheries Act regulations, mills are required to conduct environmental effects monitoring studies in their receiving waters on a 3-year cycle. These studies consist of a series of chemical, biological, and physical tests conducted on sediment, biota, and fish from the vicinity of each pulp and paper mill. The studies are required to determine the adequacy of protection at each site. Corrective measures will be developed at individual sites as needed. Implementation of possible remedial measures would include consideration of voluntary programs, and legislation at the provincial or federal levels etc. Under a Strategic Options Process involving consultation with all stakeholders, the federal government would implement the best option to meet the environmental needs. This option will be decided through analysis and consultation.

The Canadian Environmental Protection Act and the Fisheries Act allow the federal government to sign agreements with provinces and territories in order to administer the regulations under the act more efficiently and effectively. Two types of agreements are provided for under CEPA, namely Administrative Agreements and Equivalency Agreements. Administrative Agreements are joint work-sharing arrangements with provincial and territorial governments. These cover activities such as gathering information, reporting mill self-monitoring results, and inspecting plants. The objective of the arrangements is to create a single window for delivery of the regulations, to avoid federal and provincial overlap and eliminate duplication.

Equivalency Agreements (EAs), are arrangements between the federal government and individual provinces and territories. In the case of federal regulations under CEPA, the application of federal regulations may be terminated when a province or territory establishes equivalent measures under its own statutes and enforcement policies. Under Equivalency Agreements, the corresponding CEPA regulation no longer applies within that province or territory. Negotiation of EAs is allowed under CEPA Part II, which deals with toxic substances, and Part V, which deals with international air pollution. In order for the federal government to sign an EA with a province or territory, the provincial or territorial government must have established equivalent limits, and have included similar rights for individuals to compel investigations of suspected environmental offences, as those set out under CEPA. Provincial or territorial requirements may take the form of regulations, permits, or licenses.

EA negotiation is not provided for under the Fisheries Act; however, administrative agreements can be made.

1.3 Alberta framework

Alberta's pulp and paper mill environmental control framework is described in a paper by Nagendran et al.[4]

The Environmental Protection and Enhancement Act (EPEA) is the primary pollution control legislation in Alberta. In order to maintain environmental quality, the Activities Designation Regulation, under the Act, lists those activities that require approvals to operate. Pulp and paper mills are a designated activity hence, all pulp and paper mills require approvals. The approvals cover mill construction, operation and reclamation activities. The EPEA also requires all new mills with a capacity of more than 100 tonnes per day, to prepare an environmental impact assessment report as part of the approval process.

The approvals address air, water, and solid waste control requirements in a single document. The principles listed in Table 2 are applied during the approval development process.

Pollutant release limits, and other conditions, are established on a case-by-case basis. Discharge limits to air and water are determined based on the use of best available demonstrated technology (BADT) for new plants, and best practicable technology (BPT) for existing plants. These limits constitute minimum requirements that may be set in all cases. In the case of sensitive ecosystems, more stringent requirements are set based on environmental quality considerations.

Use of this approach is illustrated in the paper by Nagendran et al.,[4] which describes how the Alberta government approved effluent discharges from five mills located along the Athabasca River. A computer model was developed to predict the concentration of dissolved oxygen in the receiving waters, under winter ice conditions (the most sensitive period of the year), at various sites along the river. The model considered the input of BOD from the various mills, as well as sources of oxygenation, such as rapids. An algorithm was used to calculate the maximum BOD_5 loads that could be tolerated at each mill site, while maintaining a dissolved oxygen content of 5 mg/L (Alberta's water quality objective for the protection of fish). The model

resulted in the generation of EQO-based limits for all five mills. Monthly average BOD_5 approval limits were set at 3.0 kg/t for four mills and 1.5 kg/t for the fifth mill.

Table 2: Fundamental principles of Alberta's approval process for designating activities.

Principle	Comment
Pre-project environmental assessment	Certain sizes and types of proposed projects are subject to an environmental assessment process
Regulating activities through approvals	Legislation designates those activities that must obtain approvals
Single, multi-media approvals	Single approvals covering air and wastewater emissions; soil and groundwater contamination; land conservation and reclamation; hazardous waste generation and storage; pesticide use; potable water, etc. are issued for those activities requiring approval Waste minimisation and recycling is encouraged
Life cycle control	Approvals are needed for construction, operation, and reclamation activities
Emission standards and environmental quality objectives	Emission standards, based on best available demonstrated technology, and ambient environmental quality objectives, based on sustainability and reflecting public expectations, must be developed and used
Public involvement	The public has an opportunity to review and provide input into approvals and has the right to access approval-related information
Right of appeal	Legislation provides for a formal appeal mechanism and an Appeal Board for both approval holders and the directly affected public
Enforcement	Legislation sets out a wide range of administrative and judicial measures to ensure compliance with permit requirements

With respect to minimum performance levels, Alberta has not passed any effluent control standards of its own. However, the province requires best available control technology-type evaluations to be carried out. It also refers to regulatory limits that have been passed by other authorities, such as the federal government and the United States Environmental Protection Agency. The province has also passed ambient environmental quality objectives for air and water which are considered when setting individual permit requirements.

Alberta uses a multi-media based permitting system under which approvals are granted for plant construction, operation, and remediation. All requirements related to environmental matters are contained in a single document. Requirements under federal regulations are included in approvals as minimum requirements, with more stringent limits being set to meet local needs.

In order to avoid duplication of efforts at federal and provincial levels, the federal government and Alberta have entered into two formal agreements. Alberta meets the requirements of the CEPA Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations, and the Pulp and Paper Mill Defoamer and Wood Chips Regulations, under its own approvals; hence, under a CEPA Equivalency Agreement, the CEPA regulations do not apply. Under equivalent provincial legislation and requirements of an Administrative Agreement, Alberta takes the lead in administering the federal Fisheries Act regulations in the province. Information reporting, and monitoring and inspection activities are conducted by the province to comply with federal requirements.

1.4 British Columbia framework

The Waste Management Act (WMA) is the major piece of provincial legislation by which British Columbia controls environmental issues. The Act prohibits the discharge of any pollutant unless authorised by a waste discharge permit, approval order, or by a waste management plan approved by the Minister. Environmental control requirements are administered by the British Columbia Ministry of Environment, Lands and Parks.

Pulp and paper mills are required to obtain permits. In addition to obtaining permits, new mills and mills undergoing significant expansion are required to undergo an environmental assessment review process. Permits are issued by the ministry's regional managers based on a case-by-case consideration of technological, environmental, and economic factors.

British Columbia issues separate permits for water, air, and solid waste discharges. However, the permits are issued by the same regional manager, who takes into consideration the cross-media transfer of pollution due to environmental control.

In order to provide consistency in individual permit decisions, the Ministry has issued a number of regulations, objectives (guidelines), and policy documents. Limits set under regulations constitute the minimum performance values that must be met in addition to limits set in permits. More stringent requirements may be set based on the environmental sensitivity of the site. Regional managers have no authority to relax regulatory requirements. For items specified in objectives or other policy documents, less stringent requirements may be allowed where justified.

In 1990, British Columbia passed the Pulp Mill and Pulp and Paper Mill Liquid Effluent Control Regulation[5] under its Waste Management Act. The regulation required all mills to install secondary treatment plants by specified dates, and included discharge limits for the release of biochemical oxygen demand (BOD_5), total suspended solids and adsorbable organic halides (AOX). In addition, effluents had to be non-acutely lethal to rainbow trout. Table 3 summarises the regulatory limits.

Table 3: British Columbia effluent limits.

Parameter	Equivalent monthly limits (kg/ADt)	Equivalent daily limits (kg/ADt)
BOD_5	7.5	7.5
TSS	11.25	18.75
AOX by 31 December 1995	1.5	—
AOX by 2002	Eliminate AOX produced in the bleach plant	—
Acute Lethality		96-h LC 50 ≥ 100%

In 1995, British Columbia passed the Wood Residue Burner and Incinerator Regulations, requiring mills to phase out the use of beehive and silo burners by specified dates for each mill, (these dates extended up to 31 December 1998). The regulations also included particulate limits for wood residue burners, which do not incorporate heat recovery (Table 4). A Sulphur Content in Fuels Regulation also limits the sulphur content of fuels to 1.1 per cent.

Table 4: British Columbia emission limits for wood residue incinerators.

Parameter	Incinerator capacity (40 per cent moisture)	
Capacity	<50 t/h	≥50 t/h
Total particulate*	120 mg/m^3 (1 hour)	50 mg/m^3 (1 hour)
Opacity	15% (6 minutes)	15% (6 minutes)

* Reference conditions: 20°C, 101.325 kPa, and dry gas concentration corrected to 8 per cent flue gas oxygen by volume.

Further guidance is provided to regional managers in Pollution Control Objectives for the Forest Products Industry of British Columbia,[6] issued by the Ministry of Environment in 1977. These objectives contain guideline values with respect to emissions of particulate matter, total reduced sulphur (TRS), opacity, Ringelmann Number, and sulphur dioxide, for different types of operations in pulp and paper mills. Table 5 presents limits for TRS and particulate matter. The level A limits apply to new and modernised facilities, and 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.

Table 5: 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 mg/mol	11.0 mg/mol
Lime kiln	—	—	5.5 g/mol	11.0 g/mol
Smelt tank	—	—	0.2 kg/t	0.4 kg/t
Fugitive emissions*	0.225 kg/t	0.350 kg/t	—	—

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

The 1977 objectives also include ambient air quality objectives that are used to guide permit decisions (Table 6). Results from dispersion modelling are compared with these objectives. The 1977 objectives also include water quality objectives requiring that there be no more than a negligible change in the various parameters in the receiving water due to effluent discharge.

Table 6: British Columbia ambient air quality objectives.

Contaminant	Level A (μg /m^3)	Level B (μg /m^3)	Time-average basis
Total reduced sulphur (as H_2S)	7	28	1 hour
	3	6	24 hours
Sulphur dioxide	450	900	1 hour
	160	260	24 hours
	25	50	Annual
Total suspended particulate matter	150	200	24 hours
	60	70	Annual geometric mean

1.5 Ontario framework

The Environmental Protection Act is the main act for controlling environmental issues in Ontario. Various regulations are written under this Act.

The primary legislation for controlling water pollution from pulp and paper mills is the Clean Water Regulation for the Pulp and Paper Sector (Ontario Regulation 760/93),[7] which applies to all mills that discharge effluents directly into receiving water bodies. The regulations contain effluent limits and monitoring requirements for all direct discharge mills. Limits are included for 5-day biochemical oxygen demand, total suspended solids, total phosphorus, chloroform, phenol, toluene, adsorbable organic halide, 2,3,7,8-tetrachlorodibenzo-para-dioxin, 2,3,7,8-tetrachlorodibenzofuran, and total dioxins and furans, expressed on a toxic equivalent basis. The regulation also require that all effluents be non-acutely lethal to both rainbow trout and *daphnia magna*. Table 7 identifies equivalent effluent limits for kraft mills on a per unit of production basis.

Table 7: Unit of production loading limits for the sulphate (kraft) sector in Ontario Clean Water Regulations.

Parameter	Limit
BOD_5 (daily)	10.0 kg/ADt
BOD_5 (monthly)	5.0 kg/ADt
TSS (daily)	13.4 kg/ADt
TSS (monthly)	7.87 kg/ADt
Toxicity (rainbow trout)	LC 50 ≥ 100%
Toxicity (daphnia magna)	LC 50 ≥ 100%
Dioxin[1]	Non-measurable
Furan[2]	Non-measurable
AOX[3] (daily)	3.22, 1.93, 1.03
AOX[3] (monthly)	2.5, 1.5, 0.8
Total phosphorus (daily)	280 g/ADt
Total phosphorus (monthly)	170 g/ADt
Chloroform (daily)	3.72 g/ADt
Chloroform (monthly)	1.88 g/ADt
Phenol (daily)	0.41 g/ADt
Toluene(daily)	0.21 g/ADt

1. For 2,3,7,8-TCDD non-measurable is less than 15 pg/l
2. For 2,3,7,8-TCDF non-measurable is less than 50 pg/l. In addition, the discharge of all dioxins and furans expressed on a toxic equivalence basis under a specified protocol has to be less than 60 pg/l
3. The three AOX limits shown had to be met by 23 February 1994, 31 December 1995, and 31 December 1999 respectively.

1.5.1 Ontario approval system

A construction approval system is a key element of Ontario's environmental control system. Under this system, all equipment installed in industrial facilities that result in environmental releases must be approved

by the Ministry of the Environment and Energy (MOEE). Approvals are issued by staff of the Ministry's Approval Branch. In order to receive an approval, it has to be shown that the equipment used and processes applied will allow the mill to meet the requirements of environmental legislation pertaining to the plant. A brief description of Ontario's approval system is included in a report currently being prepared by Environment Canada.[8] The report also describes approaches to air permitting throughout Canada.

A new approval is required for each new piece of equipment, either for pollution control or for a process, that has associated emissions. If a mill requests a new approval, the MOEE may require the mill to control other sources of emissions before granting the approval.

A new or amended approval is also required for changes in production rates or modification of plant processes, or at the discretion of the Ministry. Approvals are usually valid until the equipment is modified.

With respect to the content of approvals relating to air emissions, facilities are required to meet point of impingement (POI) limits specified in regulations. Table 8 summarises the limits set for emissions of concern from kraft mills. POI limits for mills are calculated using a dispersion algorithm model approved by the Ministry. Equipment design and operation have to be such that the algorithm predicts that POI limits will be met. If this is not the case, the equipment design and operation must be modified in order to receive an approval.

As part of its development of general air standards, the Ontario government is reviewing the POI limits for various compounds. New proposed standards are expected to be released for public consultation shortly. The Ontario government, through a regulatory reform program is also investigating mechanisms to address local air issues on an airshed basis.

Table 8: 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

As part of the approval process, applications are advertised on a public registry for 30 days and the public is invited to comment. An approval decision is then made. Approvals can also be appealed by the plant and parties affected by the decision.

In addition to POI limits, Ontario also has an Ambient Air Quality Criteria Regulation that sets desirable air quality criteria for various contaminants. The criteria are summarised in Table 9.

Table 9: Ontario ambient air quality criteria.

Contaminant	Limit ($\mu g/m^3$)	Time-average basis
H_2S	30	1 hour
NO_x	400 200	1 hour Annual
SO_x	690 275 55	1 hour 24 hours Annual
Particulate matter	120 60	24 hours Annual
CO	36 200 15 700	1 hour 8 hours
Ozone	165	1 hour

The Ministry has also issued Interim Design and Review Guidelines for Wood-fired Combustors. The guidelines are based on an end-of-stack concept and prescribe end-of-stack limits for particulate emissions as shown in Table 10. The guidelines also specify minimum combustion temperatures and residence times for unit operations.

Table 10: Ontario guidelines for wood fired combustors.

Size of unit (tonnes per day)	Particulate Limit (mg/m^3)
<200	90
>200	50

A Boilers Regulation limits the sulphur content of fossil fuels to 1 per cent.

1.6 New Brunswick environmental control framework

The New Brunswick Government in 1983 passed regulations that include end-of-stack limits for air emissions from kraft and sulphite mills and hogfuel boilers. Specifically covered are recovery boilers, lime kilns, smelt dissolving tanks, digester and evaporator NCG's, as shown in Table 11. The Regulation provides the minimum limits that may be set in mill permits. More stringent requirements are set as necessary.

Table 11: NB regulated pulp and paper air pollutants.

Source	Maximum allowable emission of TRS[1]		Maximum allowable emission of PM	
	New Units	Existing Units	New Units	Existing Units
Recovery boiler	10 ppm_v	15 ppm_v	250 mg/m^3	375 mg/m^3
Lime kiln	20 ppm_v	20 ppm_v	0.5 kg/ADt	0.75 kg/ADt
Smelt tank			0.25 kg/ADt	0.50 kg/ADt
Wood waste boiler[2]			500 mg/m^3 and max of 60 kg/hour	
Digester relief system	Incineration or equivalent			
Digester blow system	Incineration or equivalent			
Evaporators	Incineration or equivalent			
Condensate strippers	Incineration or equivalent			

1 TRS concentration limits are at stack conditions and 4 hour average
2 Flues gas volumes corrected to 12% CO_2 and dry basis

1.7 Quebec environmental control framework

Since 1979, all pulp and paper mills in Quebec have been subject to regulation pertaining to releases to water, air, and soil. These regulations imposed effluent discharge limits for BOD and TSS, and contained requirements for the management (disposal, storage, and treatment) of solid wastes, and limits for air emissions from new kraft and sulphite mills.

In 1992 the Government of Quebec upgraded its 1979 regulations under its Environmental Quality Act. These upgrades included various requirements for different types of mills according pulp production. This section describes the requirements for kraft mills.

Effluent Discharge Limits

Table 12 summarises the effluent limits that were set for existing and new kraft mills under the 1992 regulations.

The regulations impose daily and monthly limits (as determined on a 30-day rolling average basis) for BOD and TSS. A non-acute lethality requirement is set using rainbow trout on an LC50 basis of 100% effluent.

Limits are also set for hydrocarbons, polychlorinated biphenols (PCB), AOX, and 2,3,7,8-TCCD and 2,3,7,8-TCDF. With respect to the latter, the toxic equivalence of the releases of the two congeners has to be less than 15 parts per quadrillion expressed on a toxic equivalence basis. The physical parameters of pH and temperatures have to be within prescribed limits.

With respect to AOX, differential limits are set according to time. Mills pulping hardwood were given stricter limits than those using softwood for an interim period. However, by 2000 all mills have to meet a AOX limit of 0.8 kg/t.

Table 12: Quebec effluent limits for existing and new kraft mills.

Parameter	Mills built prior to Oct 22/92	Mills built after Oct 22/92
BOD (kg/ADt)		
Daily	8.0	4.0
Monthly*	5.0	2.5
TSS (kg/ADt)		
Daily	16.0	6.0
Monthly*	8.0	3.0
Toxicity		
Rainbow Trout	LC 50 ≥100%	LC 50 ≥100%
Daphnia magna	—	—
Hydrocarbons	2 mg/l	2 mg/l
2,3,7,8 TCDD/F TEQ**	≤ 15 pg/l	≤ 15 pg/l
PCB's	3µg/l	3µg/l
AOX		
Daily	1.5 (hw), 2.5 (sw)	0.3
Monthly*	1.0 (hw), 2.0(sw) 0.8 by yr. 2000	0.25
pH	6-9.5	6-9.5
Temperature	<65 °C	<65 °C

*average for the last 30-day of production
**the sum of 2,3,7,8 TCDD + 0.1 2,3,7,8 TCDF shall be ≤ 15 ppq

Air Emissions

The 1992 regulations include air emission limits from sources involved in kraft and sulphite pulp production. The limits are based on the end-of-stack concept. Sources covered include the recovery boiler, lime kiln, smelt dissolving tank, and also the digester, evaporator, brown stock washers 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	TRS[1]		PM[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	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] Emissions limits expressed in ppm are calculated on a dry basis and for combustion sources, are corrected to 8% O_2
[2] Emissions limits expressed in mg/m^3 are calculated at normal conditions on a dry basis corrected to 8% O_2

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 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.

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: 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 15 summarises the particulate matter limits that apply to boilers burning different fossil fuels. Table 16 summarises the limits for woodwaste fried boilers.

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

Related to the operation of boilers that burn pulp and paper mill sludges, the 1992 regulations set a particulate emission rate of 180 mg/m^3. Quebec is in the process of introducing new regulatory limits. There will be a limit of 100 mg/m^3 for existing mills, subject to a performance test.

A regulation is also projected for new units covering NO_x. Under this regulation, a combustion device that has started operations or has been modified after the effective date of the Air Quality Regulation amendments, cannot have NO_x emissions above the limits shown in Table 17. A combustion device is considered modified when the burners have been replaced and the combustion chamber has been altered. The regulation would also apply to combustion devices using fossil fuels or used oil.

Table 17: Proposed NO_x limits for new units

Nominal Power (MW)	Type of Fuel	Emission Limits (g/GJ furnished by the fuel)
≥ 3 et ≤ 30	Gas	26
	Light oil	40
	Heavy oil (nitrogen content < 0.35%)	90
	Heavy oil (nitrogen content ≥ 0.35%)	110
> 30	Gas	40
	Light oil	50
	Heavy oil (nitrogen content < 0.35%)	90
	Heavy oil (nitrogen oil ≥ 0.35%)	125

Environmental Impact Assessments and Evaluations

Starting in January 1996, any newly constructed pulp and paper mill will be subject to an evaluation and environmental impact assessment. After the assessment is conducted, the Government of Québec may, by statutory order, impose more stringent requirements than those prescribed by the regulation, or any other conditions that may be required by the Minister.

1.8 Duration of regulations and permits

Federal and provincial regulations apply indefinitely until amended. The duration of permits varies from province to province. In Alberta, for example, approvals are renewable on a 10-year cycle; however, a review can be triggered by plant expansion. In British Columbia, permits have no time limit, but are reviewed when effluent quality or quantity change, and in cases of plant expansion, the adoption of new government policies, or where environmental quality requires it. In Ontario, installation or modification of equipment necessitates obtaining a new approval, which may trigger a review of the whole mill process. Once obtained, however, Ontario approvals are of indefinite duration.

1.9 Information required in permit applications

Permit applicants are required to provide documentation to support their application. The following types of information are 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.

Additionally, in most provinces new plants and major expansions trigger a comprehensive environmental assessment review process, which requires complete details on the plant and its receiving environment.

Public meetings are held to obtain input on individual permit decisions as well as to develop environmental policies.

1.10 Handling of appeals

In passing federal and provincial regulations and environmental quality objectives, public input is sought regarding the design of the proposed legislation. Stakeholders are provided an opportunity to comment on draft control instruments during their development. The comments are then taken into consideration by ministers. Once approved, there is no appeal of the legislation.

With respect to permitting decisions, information meetings are held in all provinces at which the public may make their concerns known. Decisions made by the responsible permitting officers can be appealed to the provincial ministry for resolution. Appeals can be made by the mills or other parties affected by the decision. Conditions in permits that are included under regulations cannot be appealed.

1.11 Permit renewal process

When renewing permits, information requirements and appeal procedures are similar to those pertaining to the initial permit application.

1.12 Multi-media permits

Alberta employs a multi-media-based permitting system under which a single approval covers all three media. Ontario and British Columbia use single-medium permit systems; however, the same staff process permits relating to releases to all three media. This allows consideration to be given to the transfer of pollution from one medium to another as a result of controls.

1.13 Environmental assessment (EA)

A new mill or an existing mill considering significant alteration would be subject to environmental assessment legislation, or its equivalent, in Canadian jurisdictions. Such legislation has broad application: first, because the usual definition of environment covers the natural, economic, and social environments; and second, because it can be applied to private sector activities and most activities that involve government legislation, funding, and property. The results of the EA may affect a mill's production process, size and effluent discharge requirements.

In Canada, the federal government, as well as most provinces, has environmental assessment legislation in place. Some provinces are currently developing such legislation.

The Canadian Environmental Assessment Act is the federal act covering environmental assessment. Under the Act, regulations require a detailed assessment or comprehensive study to be made for pulp and paper projects where any of the following conditions are met:

1. proposed construction, decommissioning, or abandonment of a pulp mill or pulp and paper mill;
2. proposed expansion of a pulp mill; or
3. changes to a pulp and paper mill that would result in an increase in its production capacity of more than 35 per cent, or more than 100 tonnes per day.

In order to avoid conducting two environmental assessments on the same project, the federal and most provincial environmental assessment acts allow the two levels of government to agree upon a joint review

process, thereby ensuring a more efficient and cost-effective project review. In most cases, assessments are carried out following provincial environmental assessment procedures.

An environmental assessment is required for new plants and expansion of existing plants to ensure that the projects are environmentally sound. The environmental assessment process considers the capability of control technologies, the environmental characteristics of the sites, and the cumulative environmental effects of the project in relation to other developments that are in place or will have an impact on the ecosystem.

2. BAT, EQOs, AND ECONOMICS

2.1 Regulatory and policy documents affecting permitting

Permit conditions in Canada are determined on a case-by-case basis at the provincial level. Provincial officials that issue permits are guided by policy documents that have been issued as well as regulations, guidelines, and objectives. These documents are guided by factors such as best available technology, environmental quality objectives, and economics. The following sections discuss the role of these factors at federal and provincial levels.

2.2 Environmental quality objectives (EQOs)

In Canada, Canadian Environmental Quality Guidelines (CEQGs) have been developed for air, water, sediment, biota tissue, and soil under Part 1, Section 8, of the Canadian Environmental Protection Act. The guidelines were developed by the federal government under the auspices of the Canadian Council of Ministers of the Environment and approved by the Council. They recommend concentrations or narrative statements for air, water, sediment, biota tissue, and soil. Values are set to protect, maintain, and enhance various resource uses as they relate to human health, recreation, aesthetics, aquatic and terrestrial biota, agriculture, and industry. Guidelines are developed using approved protocols to provide nationally consistent, science-based goals for environmental quality and protection.

National guidelines for water, soil, sediment, and biota tissue are developed on the premise that they must not be exceeded at any time in order to protect the uses to which they apply. Air quality objectives are not to be exceeded over specified time intervals.

CEQGs for water, are used to develop site-specific environmental quality objectives. These usually apply to specific geographic areas, such as a lake, a drainage basin, or the point where a river crosses a boundary. Development of EQOs typically involves provincial agencies, often working in conjunction with federal agencies and local agencies such as water basin planning boards, and interprovincial agencies, such as the Prairie Provinces Water Board. Development of EQOs for water, sediment, soil, and biota tissue takes into consideration national guidelines, designated resource uses at a site, local environmental conditions, and economic, social, and other environmental factors. Air quality objectives are national in scope.

The guidelines and objectives are used to assess the significance of the impacts of development proposals under the Canadian Environmental Assessment Act. The objectives are also considered when setting permit limits. Results from dispersion models are compared with the objectives to determine whether the limits established are adequate to protect a site.

With respect to water quality, guidelines have been passed pertaining to concentrations of organic, inorganic, radiological, physical, and microbiological parameters in water used for the following:

- drinking water;
- fresh water to support aquatic life;
- irrigation water;
- livestock water; and
- recreation.

Canadian water quality guidelines are summarised in a leaflet entitled Summary of Guidelines for Water Quality in Canada 1995, issued jointly by Health Canada and Environment Canada[9].

In addition, provincial governments have developed criteria for their own waters to guide decisions on permitting and licensing. In British Columbia and Alberta, this is done on a water body basis, taking into consideration the existing quality of the water and uses made of the water.

Water quality objectives are used to establish quantities of pollutants that may be released without impairing the water quality in relation to its intended uses. This approach employs hydrological models based on worst-case scenarios. An example of its use was described earlier in Section 1.3; Alberta applied a critical 5 ppm dissolved oxygen concentration criteria, to develop maximum permissible BOD_5 discharges from 5 mills along a river, under winter ice conditions.

The federal government through the CCME, has also established air quality objectives under the CEPA. The objectives specify desirable, acceptable, and tolerable concentrations for criteria pollutants in the ambient air. Concentrations are set for sulphur dioxide, particulate, carbon monoxide, nitrogen dioxide, and ozone. Federal air quality objectives are summarised in Table 17.

Table 18: Federal ambient air quality objectives ($\mu g/m^3$).(25^0C, 760 mm Hg).

	Desirable	Acceptable	Tolerable
H_2S			
1 hour	—	—	—
24 hours	—	—	—
NO_2			
1 hour	—	400	1 000
24 hours	—	200	300
Annual	60	100	—
SO_2			
1 hour	450	900	—
24 hours	150	300	800
Annual	30	60	—
Particulate Matter			
24 hours	—	120	400
Annual	60	70	—
CO			
1 hour	15 000	35 000	—
8 hours	6 000	15 000	20 000
24 hours	—	—	—
Ozone			
1 hour	100	160	300
24 hours	30	50	—
Annual	—	30	—

A number of provinces have also passed air quality objectives. Table 18 summarises the ambient air quality objectives of the different provinces, for those substances that may be emitted by kraft mills.[8]

Table 19: Provincial ambient air quality criteria (µg/m³).

Contaminant	Quebec	Ontario	British Columbia	Alberta	New Brunswick	Nova Scotia	Newfoundland	Saskatchewan
H_2S								
1 hour	14	30	7	14	15	42	30	15
24 hours	11	—	3	4	5	8	—	5
NO_x								
1 hour	414	400	—	400	400	400	400	400
24 hours	207	200	—	200	200	—	200	—
Annual	103	—	—	60	100	100	—	100
SO_2								
1 hour	1 310	690	450	450	900	900	900	450
24 hours	288	275	160	150	300	300	300	150
Annual	52	55	25	30	60	60	60	30
Particulate matter								
24 hours	150	120	150	100	120	120	120	120
Annual	70	60	60	60	70	70	70	70
CO								
1 hour	34 000	36 200	—	15 000	3 500	3 460	3 500	15 000
8 hours	15 000	15 700	—	6 000	1 500	1 270	1 500	6 000
24 hours	—	—	—	—	—	—	1 000	—
Ozone								
1 hour	157	165	—	160	—	160	160	160
24 hours	—	—	—	50	—	—	50	—
Annual	—	—	—	—	—	—	30	—

2.3 Best available technology (BAT)

2.3.1 Federal

A major involvement of the federal government with the pulp and paper industry in recent years has been the development of a federal regulatory framework to address effluent releases. This consists of regulations under the Canadian Environmental Protection Act, controlling the formation of chlorinated dioxins and furans; and under the Fisheries Act, controlling releases of conventional pollutants (BOD, TSS and acute lethality). These regulations were formulated in 1992, under a process co-ordinated through the Canadian Council of Ministers of the Environment. The control limits in these regulations were formulated by a federal-provincial advisory group composed of pulp and paper experts from both levels of government. The limits were formulated to be compatible with the permitting and regulatory plans of the provinces for their individual pulp and paper industries. The federal limits comprise a national baseline standard, with the understanding that provinces may enact more exacting requirements, where necessary to meet their own needs.

When formulating the CEPA Pulp and Paper Mill Effluent Chlorinated Dioxins and Furans Regulations, the federal government adopted a requirement that both 2,3,7,8-tetrachlorodibenzo-para-dioxin and 2,3,7,8-tetrachlorodibenzofuran be virtually eliminated . The need for these regulations was based on the conclusions of an Assessment Report conducted under CEPA[10]. This concluded that polychlorinated dibenzo-para-dioxins and dibenzofurans were "CEPA toxic," based on their properties of toxicity, persistence and bioaccumulation.

Regulations were developed based on a pollution prevention approach. These placed the onus on pulp and paper mills to demonstrate that 2,3,7,8-tetrachlorodibenzo-para-dioxin and 2,3,7,8-tetrachlorodibenzofuran were not released in measurable quantities in their effluents.

In order to apply the regulations a reference method for the measurement of dioxins and furans in pulp and paper mills effluents was developed[11]. This was based on state-of-the-art techniques using high-resolution gas chromatography/mass spectrometry. The regulations made it an offence for mills to discharge measurable concentrations of 2,3,7,8-tetrachlorodibenzo-para-dioxin and 2,3,7,8-tetrachlorodibenzofuran. Measurable concentrations were defined as concentrations that were above the levels of quantification in the Reference Method, for the two substances. An interlaboratory study on common test samples was used to determine the levels of quantification. For the purpose of applying the regulations, a limit of quantification of 15 picograms per litre (pg/l) is used for 2,3,7,8-TCDD, and 50 pg/l for 2,3,7,8-TCDF. The mills are required to implement measures to meet these requirements.

In the case of federal Fisheries Act regulations, the BOD_5 and TSS limits were based on a best practicable technology approach. The regulatory limits, in kilograms of BOD and TSS per tonne of finished product, were developed by reviewing the performance, attained over several years, by a group of mills whose effluent treatment processes included primary and secondary treatment. The analysis covered eight mills. Each mill's daily discharge information was reviewed to eliminate outlying, non-representative data-points. For example, days when the mill was shut down but the effluent treatment plant was still running The annual average and monthly average releases per tonne of finished product were then calculated for each mill.

Based on the separate mill data, the ratios of the maximum daily to annual average, and maximum monthly average to annual average releases, were calculated for the multi-year period for both BOD and TSS. For each mill, and for each year for which data was available, the maximum values of both the maximum daily to annual average, and the maximum monthly average to annual average ratios were recorded. The average values of these for all mills throughout the period were then calculated.

Results of the analysis are summarised below.

- Average mill BOD_5 releases for the 8 mills in 1985 = 4.9 kg/tonne
- Average mill BOD_5 releases for the 8 mills in 1987 = 5.0 kg/tonne

- Average mill TSS releases for the 8 mills in 1985 = 7.4 kg/tonne
- Average mill TSS releases for the 8 mills in 1987 = 6.7 kg/tonne

- Ratio of maximum daily to annual average BOD_5 releases for all 8 mills in the period = 2.45
- Ratio of maximum monthly to annual average BOD_5 releases for all 8 mills in the period = 1.55

- Ratio of maximum daily to annual average TSS releases for all 8 mills in the period = 2.48
- Ratio of maximum monthly to annual average BOD_5 releases for all 8 mills in the period = 1.42

Based on the above and rounding off the numbers the following limits were set in the regulations:

- BOD_5 Daily limit = 5.0 x 2.5 = 12.5 kg/tonne
- BOD_5 Monthly limit = 5.0 x 1.5 = 7.5 kg/tonne

- TSS Daily limit = 7.5 x 2.5 = 18.25 kg/tonne
- TSS Monthly limit = 7.5 x 1.5 = 11.25 kg/tonne

When federal effluent limits were formulated, the environmental needs of the receiving waters in general were considered. Limits were proposed as values that could be applied at most sites to ensure protection of the environment. In developing regulations, it was recognised that there could be instances where stricter limits might be required to protect sensitive ecosystems. This would be addressed through site-specific means by either the provinces or in separate federal regulations. Pursuant to this, in December 1992, the federal government passed the Port Alberni Pulp and paper Effluent Regulations[12] to protect an important salmon fishery on an estuary subject to periodic low water flow. The regulations included BOD_5 and TSS limits which were more stringent than those in the general Fisheries Act regulations.

Subsequent to passage of the federal pulp and paper effluent regulatory framework, , the federal government issued a Toxic Substances Management Policy[13] (TSMP) on 2 June 1995. This provides a science-based management framework and guidance to decision-makers in all federal departments for the management of different types of toxic substances. In December 1996, Environment Canada issued a draft implementation strategy for existing substances[14]. Interested readers are referred to the TSMP and a draft implementation policy for its application to existing substances.

2.3.2 Provincial

Provincial governments define concepts virtually identical to BAT.

Alberta

Alberta uses two levels of technology: best practicable technology (BPT), which is applied to existing mills, and best available demonstrated technology (BADT), which is applied to new facilities. More stringent requirements than these are imposed on plants located on sensitive receiving waters. BPT is similar to the level of treatment reflected by federal regulations, i.e., secondary treatment using aerated lagoons.

Although Alberta does not state the technology that forms the basis of kraft mill BADT, it is more rigorous than BPT and takes into consideration what in-plant pollution prevention measures can provide. For example, the recently constructed bleached kraft mills in the province have included the use of multi-stage digestion, oxygen delignification, high chlorine dioxide substitution, and collection and incineration of all non-condensable gases. Currently all but one mill in the province incorporate the use of oxygen delignification. This mill's new operating permit states that the mill should install oxygen delignification or its equivalent. The permits frequently specify elements of the wastewater treatment systems, such as basin liners, installation of spill reduction ponds, equalisation ponds, and treatment system retention time. Because most mills in Alberta are located in areas of sensitive ecosystems, most approval limits are based on environmental quality needs and are stricter than those prescribed by BADT.

Approvals also specify the pollution abatement equipment to be utilised on air emission sources, such as electrostatic precipitators, scrubber systems, and baghouses.

British Columbia

For existing plants, British Columbia applies standards equivalent to federal requirements. For new operations, a concept of best available control technology (BACT) is used. This is based on currently available, state-of-the-art control technology that has proven to be successful in reducing waste discharges and has been applied for at least 1 year in similar facilities in the province or other relevant jurisdictions. The

"control technology" may refer to the raw materials and fuels used, or the manufacturing technology and pollution control equipment applied, all of which influence the generation and discharge of wastes.

British Columbia is working to extend BACT requirements to all pulp and paper mills, not just new operations; however, no target date has been set. With respect to mills in areas of sensitive ecosystems, British Columbia requires performance levels better than those achievable using BACT. In one case, for instance, zero discharge of liquid effluents was specified for a mill located on a sensitive river.

Ontario

The concept of BAT was used to develop the effluent control limits in Ontario's effluent control regulations. BAT is defined as a combination of demonstrated treatment technologies and in-plant controls. Demonstrated technologies are those for which data are available that can be used to predict, with a reasonable degree of confidence, the reliability of technologies and the performance of technologies with respect to contaminant concentrations and effluent variability at any plant in the sector or subsector, given the expected variability among plants. Demonstrated technologies can be successfully retrofitted into existing facilities with a reasonable degree of confidence.

BAT options consider the following goals for an effluent:

- non-lethal to rainbow trout and *daphnia magna*;
- maximum use of reduction, re-use, and recycling, and smallest transfer to other media;
- maximum water conservation; and
- pollution prevention.

BAT is used only to set effluent limits; plants are not obliged to use a specific technology to meet the limits. Instead, they may choose the most appropriate types of technology to meet the BAT limits. For effluent, BAT limits are prescribed for different plant types: sulphate (kraft), sulphite-mechanical, corrugating, and deinking/board/fine papers/tissue. Separate BAT limits are prescribed for each of the four categories.

2.4 Negotiation of standards

Regarding regulations set out at both the federal and provincial levels, extensive public consultation sessions precede the establishment of any regulations. This enables stakeholders to have their views considered. Once regulations are passed, however, they are no longer subject to negotiation.

With respect to provincial permits, negotiations occur throughout the permit development process. The major influence of the negotiation process is on the time schedules established to meet case-specific limit requirements embodied under guidelines. In British Columbia, for example, negotiations can influence the time frame to meet requirements included under the 1977 Pollution Control Objectives, but not those embodied in the 1990 Waste Management Act Effluent Regulation. New mills in all jurisdictions are required to meet regulatory limits on start up.

2.5 Economic considerations

All regulations and permits take economic considerations into account. In the case of regulations, an economic analysis precedes the passing of the regulations. In the case of permits, economic factors influence compliance schedules for items covered under guidelines, where discretion is allowed.

2.6 Interaction of BAT and EQOs

Technology-based standards are applied as baseline control measures at all sites. More stringent requirements are implemented based on environmental quality factors to protect sensitive sites.

3. TRENDS IN PERMITTING

3.1 Cleaner technology

Standards and permits applied in Canada recognise the role to be played by pollution prevention practices as well as the need to use end-of-pipe control measures, where in-plant measures cannot attain the required environmental quality. This applies to controlling releases to water, air, and land media.

With respect to environmental control at kraft mills, federal effluent standards require mill effluents to be non-acutely lethal, to meet BOD_5 and suspended solids limits, and to have non-measurable dioxin and furan releases. In addition, the laws of several provinces set limits for AOX releases. In some provinces, the limits are becoming more stringent as time passes. In British Columbia, for example, regulations require mills to achieve zero AOX releases in effluents from bleach plants by 2002.

In Canada, effluent standards recognise the need to incorporate pollution prevention technology based on the use of "cleaner technologies and practices." For example, effective pulp washing using closed screens needs to be carried out, coupled with good spill control to prevent high chemical losses. Without this, an excessive load would be placed on the effluent treatment system.

The control of chlorinated substances including dioxins, furans, and organochlorines, is based on the use of cleaner technologies. This includes replacing, or totally eliminating, the elemental (gaseous) chlorine currently used in bleaching processes. Chlorine dioxide can be used in place of chlorine. In many cases, extended cooking and/or oxygen prebleaching are used ahead of pulp bleaching. This results in more lignin being removed before bleaching and reduces the demand for bleaching chemicals. It also leads to a reduction in organochlorine formation.

All Canadian kraft mills currently apply the equivalent of secondary biological treatment. Effluent treatment plants at Canadian mills are designed based on extensive use of in-plant pollution prevention methods ahead of treatment. This is done to minimise treatment plant size and associated costs. Mills incorporate measures such as recovering spent cooking liquors and minimising effluent volumes. Effluents are recycled to the process wherever possible.

With respect to air pollution control, effective design of combustion units is a key control element. The combustion units, including power boilers, recovery boilers, and lime kilns, are designed to provide effective combustion, thereby minimising the carry-over of partially combusted products and odorous materials. Recovery boilers at state-of-the-art mills are of a low odour design, with combustion conditions designed to minimise the formation of odorous total reduced sulphur compounds, SO_2, and nitrogen oxides. Similar considerations apply to lime kilns and power boilers. High-efficiency electrostatic precipitators, or in a few cases scrubbers, are used on these units to control particulate emissions.

Because of concerns over the release of non-condensable, odorous gases from spent pulping solutions (black liquor), off-gases from units where black liquor is processed are collected. The gases are directed to combustion units where they are incinerated and destroyed.

Pulp and paper manufacturing, and effluent treatment processes are operated to minimise the generation of solid wastes.

3.2 Trends in limits

3.2.1 Water pollution control requirements

Water pollution is controlled by both federal and provincial governments. Table 19 illustrates the ranges of limits applied under regulations of the federal government, British Columbia, Ontario and Quebec. Table 20 illustrates the ranges of limits applied in some permits of mills in British Columbia (BC) and Alberta. The limits have been normalised in terms of units of discharge per tonne of finished product produced, in order to compare the limits between jurisdictions.

Common requirements are that all effluents must be non-acutely lethal to rainbow trout. Limits for BOD_5 and TSS are somewhat case specific under provincial permits and are determined by applying technical and environmental quality considerations.

Because of concerns over the possible impact of releases of nutrients into certain water bodies, limits are placed on nitrogen and phosphorous releases in some permits. In other cases, mills have to monitor their concentrations and report them to provincial authorities on a regular basis. This allows the permitting authority to act as necessary.

Limits are also set for a number of trace compounds, as well as requirements to monitor and report levels of others.

Requirements are set regarding the temperature and pH of the effluent deposited, and in some cases colour. Colour limits may take the form of colour units in the effluents deposited or requirements that the colour of the receiving waters is not to increase beyond a certain value. This is done on a case-specific basis.

Table 20: 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	12.5	7.5	10.0	8.0	4.0
Monthly	7.5	7.5	5.0	5.0	2.5
TSS					
Daily	18.75	18.75	13.4	16.0	6.0
Monthly	11.25	11.25	7.8	8.0	3.0
Toxicity					
Rainbow Trout	LC 50 ≥100%[1]	LC 50 ≥100%	LC 50 ≥100%	LC 50 ≥100%	LC 50 ≥100%
Daphnia magna	Monitor	—	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	—	—	3.22, 1.93, 1.03[3]	1.5 (hw), 2.5 (sw)	0.3
Monthly	—	1.5[2]	2.5, 1.5, 0.8[3]	1.0 (hw), 2.0(sw)	0.25
	—	—	—	0.8 by yr. 2000	
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 °C	<65 °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.

Table 21 Permit/license limits (kg/ADt) for kraft mills in Canada.

Parameter	Celgar, B.C.	Crestbrook, B.C.	Howe Sound, B.C.	Weyerhaeuser, Alberta	Alpac, Alberta
BOD					
Daily	5.0	6.2	7.5	6.0	2.7
Monthly	—	—	4.5	3.0	1.35
TSS					
Daily	5.0	8.25	10.0	10.0	5.4
Monthly	—	—	7.0	5.0	2.7
Toxicity					
Rainbow Trout	LC 50 ≥100%	LC 50 ≥100%	LC 50 ≥100%	LC 50 ≥100%	LC 50 ≥100%
Daphnia magna	—	—	—	Monitor	Monitor
Dioxin	—	—	Non-measurable	Non-measurable	Non-measurable
Furan	—	—	Non-measurable	Non-measurable	Non-measurable
AOX					
Daily	2.3	2.3	2.3	3.0	0.8
Monthly	1.5	1.5	1.5	1.5	0.5
Annually	1.0	—	—	—	—
N-Total	5 mg/L	Monitor	Monitor	Monitor	Monitor
P-Total Daily	2 mg/L	Monitor	—	Monitor	Monitor
Chloroform	—	—	—	Monitor	Monitor
Phenol	—	—	—	Monitor	Monitor
Toluene	—	—	—	Monitor	Monitor
Dichlorophenol	—	—	—	—	Monitor
Resin and Fatty Acid	—	—	—	< 2 mg/L	< 2 mg/L
pH	6.5–8.5	6.5–8.5	6.0–8.5	6.0–9.5	6.0–9.5
Temperature	<40	—	<35	—	—
Colour	—	<15 unit inc.	—	Limit Set	Limit Set
Dissolved Oxygen	—	>2 mg/L	>2 mg/L	—	—

3.2.2 Air pollution control requirements

Air pollution control requirements are delivered by the provinces under permits and licenses. At kraft mills, several process operations give rise to emissions that may cause public health concerns as well as result in odour complaints. The main emission sources from kraft pulp mills are the power boilers, pulp digesters, and chemical recovery system, including the evaporators, condensers, recovery boiler, smelt dissolving tank, and lime kiln, as well as the bleaching circuit and the chlorine dioxide plants.

Air permit conditions are tailored according to the technical situation and environmental requirements of each plant. They authorise the release of waste gases from permitted stacks and vents, and include stack emission limits or point of impingement requirements. Tables 21 to 26 present examples of emission limits set for different operating units in sample mill permits in British Columbia and Alberta.

In Ontario, an approval system is used based on a point of impingement approach. Each piece of equipment giving rise to air emissions has to be approved under a Certificate of Approval. The equipment has to be designed so that point of impingement requirements are not exceeded.

Recovery boiler permit requirements include limits on releases of total reduced sulphur (TRS), particulates, and in some cases sulphur dioxide and opacity. Control is achieved through boiler design to ensure effective combustion of odorous, reduced sulphur compounds, while minimising SO_2 formation. Particulate emissions are controlled through the use of high-efficiency electrostatic precipitators.

The smelt produced in the recovery boiler is recovered in aqueous solution in smelt dissolving tanks. The waste gases from the tanks are treated in scrubbers. Smelt dissolving tank permits contain limits on TRS and particulate releases. The Celgar permit also contains limits for SO_2.

Lime kilns are used as part of the chemical recovery process. Emissions are controlled by controlling combustion conditions and through the use of electrostatic precipitators or wet scrubbers. Permits generally contain limits on the release of TRS, particulates, opacity, and SO_2.

An important issue in pulp mills is the potential release of odorous TRS gases from the process. These gases are formed when the sulphide chemicals used in the process react with wood and may be released from the processes to the environment. Proper measures have to be taken to collect all non-condensable gases and direct any contaminated streams to treatment facilities. Areas of the plants where these concerns arise include the pulp digester, liquor evaporation, chemical recovery, and pulp washing areas. Permits address these problems by requiring that gases from various operations be collected and transferred to units where they are incinerated to destroy the odorous TRS components. Combustion may be carried out in power boilers, lime kilns, or dedicated incinerators.

The release of chlorine and chlorine dioxide from its generation and use is addressed through permit limits and is based on the vented waste gases being scrubbed.

Wood waste power boilers play an important role in kraft mills. Emissions from the boilers are controlled through good furnace design and the use of high-efficiency electrostatic precipitators. Limits may be placed on particulates, SO_2, opacity, and NO_x.

Table 22: Example of limits in kraft mill recovery boiler permits.

Emission	Jurisdiction	Mill	Permit limits	Control technology
TRS ppm dry volume	British Columbia	Howe Sound	5 mg/m³ (24 hours) 10 mg/m³ (1 hour)	Design, process control and operation for good furnace mixing minimising formation of TRS
	British Columbia	Crestbrook	5 (24 hours) 15 (1 hr)	
	British Columbia	Celgar	5 (1 hour)	
	Alberta	Weyerhaeuser	6.5 (4 hours)	
	Alberta	Alpac	6.5 (4 hours)	
SO_2 ppm dry volume	British Columbia	Howe Sound	Not limited	Design, process control, and operation for good furnace mixing minimising formation of SO_2
	British Columbia	Crestbrook	150 (24 hour)	
	British Columbia	Celgar	150 (1 hour)	
	Alberta	Weyerhaeuser	150 (4 hours)	
	Alberta	Alpac	600 (4 hours)	
Particulate Matter mg/standard dry m^3	British Columbia	Howe Sound	150	Design, process control and operation for good furnace mixing and electrostatic precipitator
	British Columbia	Crestbrook	60	
	British Columbia	Celgar	60	
	Alberta	Weyerhaeuser	150 (1 hour)	
	Alberta	Alpac	100 (1 hour)	

Table 23: Example of limits in a sample of kraft mill smelt dissolving tank permits.

Emission	Jurisdiction	Mill	Permit limits	Control Technology
TRS ppm dry volume	British Columbia	Howe Sound	Global limit of 0.11 kg/ unbleached air dried tonne (adut) applied to the smelt tank, lime kiln, and power boiler.	Scrubber
	British Columbia	Crestbrook	≤20 in stack	Scrubber
	British Columbia	Celgar	≤20 in stack	Scrubber
	Alberta	Weyerhaeuser	<4.0 kg/h	Scrubber
	Alberta	Alpac	<1.75 kg/h	Scrubber
SO_2 ppm dry volume	British Columbia	Howe Sound	Not limited	Scrubber
	British Columbia	Crestbrook	≤40 in stack	Scrubber
	British Columbia	Celgar	≤40 in stack	Scrubber
	Alberta	Weyerhaeuser	Not limited	Scrubber
	Alberta	Alpac	Not limited	Scrubber
Particulate Matter in mg/m^3 standard conditions	British Columbia	Howe Sound	≤200	Scrubber
	British Columbia	Crestbrook	≤ 80	Scrubber
	British Columbia	Celgar	180	Scrubber
	Alberta	Weyerhaeuser	<15.0 kg/h	Scrubber
	Alberta	Alpac	<11.0 kg/h	Scrubber

Table 24: Example of limits in permits for kraft mill bleach plants and chemical preparation areas.

Emission	Jurisdiction	Mill	Permit limits	Control technology
Cl_2 and ClO_2 as Cl_2 in ppm	British Columbia	Howe Sound	150 µg/m³ at point of impingement	Scrubber
	British Columbia	Crestbrook	0.1 ppm at point of impingement and 39 ppm in stack.	Scrubber
	British Columbia	Celgar	40 ppm in stack	Scrubber
	Alberta	Weyerhaeuser	<5.7 kg/h from D stage , washer vents and ClO_2 scrubber	Scrubber
	Alberta	Alpac	<5.5 kg/h from D stage, washer vents and ClO_2 scrubber	Scrubber

Table 25: Limits set out for various emissions in a sample of kraft mill chlorine dioxide chemical preparation plant permits.

Emission	Jurisdiction	Mill	Permit limits	Control technology
Cl_2 and ClO_2	British Columbia	Howe Sound	150 µg/m³ at point of impingement	Scrubber
	British Columbia	Crestbrook	0.1 ppm at point of impingement and 39 ppm in stack.	Scrubber
	British Columbia	Celgar	≤9.2 kg/day	Scrubber
	Alberta	Weyerhaeuser	<2.4 kg/h	Scrubber
	Alberta	Alpac	<2.2 kg/h	Scrubber

Table 26: Limits for various emissions specified in a sample of kraft mill lime kiln permits.

Emission	Jurisdiction	Mill	Permits limit	Control Technology
TRS ppm dry weight	British Columbia	Howe Sound	Global limit of 0.11 kg/adut from the lime kiln, smelt dissolving tank, and power boiler.	All plants use good design, process control, and operation to ensure good kiln mixing and low emissions
	British Columbia	Crestbrook	12 (1-hour avg)	
	British Columbia	Celgar	12 (1-hour)	
	Alberta	Weyerhaeuser (the mill limit applies over a 4-hour period)	20 (prior to 1/12/97) 14 (prior to 1/12/98) 10 (after 1/12/98)	
	Alberta	Alpac	10 (4 hours)	
SO_2 ppm dry weight	British Columbia	Howe Sound	Not limited	Design, process control and operation for good kiln mixing and low emissions
	British Columbia	Crestbrook	100 (1 hour) 250 (1 hour) (when NCG is incinerated)	
	British Columbia	Celgar	350 (1 hour)	
	Alberta	Weyerhaeuser	Not limited	
	Alberta	Alpac	Not limited	
Particulate Matter mg/m^3 Standard Weight	British Columbia	Howe Sound	100 in stack	Design, process control, and operation for good kiln mixing and electrostatic precipitator
	British Columbia	Crestbrook	70 in stack	
	British Columbia	Celgar	80 in stack	
	Alberta	Weyerhaeuser (in stack 1 hour)	240 (prior to 1/12/97) 200 (prior to 1/12/98) 150 (for 1/12/98 on)	
	Alberta	Alpac	15 in stack (1 hour)	

Table 27: Limits set out for wood-fired power boilers.

Emission	Jurisdiction	Mill	Permit limits	Control technology
NO_x (mg/m^3)	British Columbia	Howe Sound	250 (daily average)	Design for staged air and operate for low excess air
Particulate Matter mg/m^3 standard weight	British Columbia	Celgar	45	Electrostatic precipitator
		Howe Sound	115 (annual) @12% CO_2	
	British Columbia	Weyerhaeuser	100 (1 hour)	
	Alberta	Alpac	100 (1 hour)	
	Alberta			
SO_2 (mg/m^3)	British Columbia	Celgar	235 (24-hours)[1] 1700 (24-hours)[2]	Design, process control, and operation for good furnace mixing
		Howe Sound	100 (24 hours) (daily average)	
	British Columbia			

1. When burning dilute non-condensable gases
2. When burning dilute and concentrated non-condensable gases

3.2.3 Solid waste control requirements

Control of solid waste is ensured through provincial permits that specify locations at mill sites where waste may be disposed, the types and quantities of waste that may be disposed, and the practices that must be employed to prevent run-off and ensure coverage of the waste. Effluents from the waste storage site have to be collected.

Combustion of wastewater treatment plant sludge is permitted. Such operations are subject to permit limits that apply to combustors. In some cases, mills apply wastewater treatment plant sludge to land as a soil conditioner. These practices are subject to provincial approval. This topic is not investigated in this report.

3.3 Monitoring

3.3.1 Effluents

In pulp and paper mills, effluents are combined where possible so as to minimise the number of separate discharge points. Effluents are discharged through outfalls designed to minimise the environmental impact of the discharge. Effluent flow rate, temperature, pH, and conductivity are generally monitored continuously. Automatic sampling equipment is installed on the effluent discharge pipes . Composite samples are usually collected on a volume integrated flow basis or at regular time intervals. Effluent samples are analysed for

various components at different frequencies; the following frequencies are typical: TSS daily; BOD three times per week; AOX daily; acute lethality monthly; and nutrients and other components, monthly.

Results are reported to the government on a monthly basis, including quality assurance and quality control results. Mills conduct their own sampling and analysis. Governments carry out auditing and collect verification samples to ensure accuracy.

3.3.2 Air emission monitoring

Air emissions from various sources are monitored under the terms of provincial permits and approvals. Monitoring frequencies vary according to the emission sources in the mills. Table 27 summarises monitoring requirements for various combustion-related sources in mills in Alberta and British Columbia.

Table 28: Monitoring requirements for different combustion sources.

Source	Mill	TRS	Particulate	SO_2	NO_x	Opacity
Recovery boiler	Celgar	Continuous	Quarterly	Continuous	Quarterly	Continuous
	Howe Sound	Continuous	Quarterly	Continuous	—	—
	Crestbrook	Continuous	Monthly	Continuous	Monthly	Continuous
	Weyerhaeuser	Continuous & Biannually	Biannually	Continuous &	Biannually	Continuous
	Alpac	Continuous & Biannually	Biannually	Biannually Continuous & Biannually	Biannually	Continuous
Lime Kiln	Celgar	Monthly	Monthly	Continuous	Monthly	—
	Howe Sound	Monthly	Quarterly	—	—	—
	Crestbrook	Continuous	Monthly	Continuous	Monthly	—
	Weyerhaeuser	Continuous & Biannually	Biannually	Biannually	Biannually	—
	Alpac	Continuous & Biannually	Biannually	Biannually	Biannually	—
Smelt Tank	Celgar	Monthly	Quarterly	Quarterly	—	—
	Howe Sound	Monthly	Quarterly	—	—	—
	Crestbrook	Monthly	Quarterly	Monthly	—	—
	Weyerhaeuser	Biannually	Biannually	—	—	—
	Alpac	Biannually	Biannually	Biannually	—	—
Power Boiler	Celgar	—	Bimonthly	Continuous	Continuous	Continuous
	Howe Sound	Monthly	Monthly	Continuous	Continuous	Continuous
	Weyerhaeuser	—	Biannually	Continuous	Biannually	Continuous
	Alpac	—	Biannually	Biannually	Biannually	Continuous

Recovery boilers are generally equipped with continuous monitors for volume, temperature, TRS, SO_2, and opacity. In some cases, power boilers have continuous monitors for SO_2, opacity, and nitrogen oxides. In addition to continuous monitoring, stack tests are conducted for particulates and NO_x.

Emissions from lime kilns and smelt dissolving tanks are monitored by manual stack sampling. Some lime kilns incorporate continuous monitors.

Monitoring of the stacks from the bleach plant and chlorine dioxide plant is usually carried out on a bi-weekly to bi-annual interval depending on permits requirements. Releases of chlorine compounds are measured.

In addition to measuring atmospheric releases, mills may be required to conduct ambient surveys under the terms of their permits. These consist of continuous measurements of TRS and related substances at

monitoring stations agreed to with provincial authorities. Sulphonation plates are often used at a network of sites to measure acid deposits. Monitoring stations are also equipped to measure wind speed and direction for use in atmospheric modelling.

In one case, a mill has noted that it must control its emissions in order to meet ambient TRS levels. Compliance with this ambient air control regime has required the mill to shut down periodically.

4. TECHNOLOGICAL RESPONSE TO PERMIT REQUIREMENTS

4.1 Equipment installed and measures taken

As noted earlier, pollution control is based on the use of pollution prevention practices in association with end-of-pipe treatment when the former is unable to provide the effluent or emission quality required. The use of pollution prevention techniques is maximised for economic reasons.

4.2 Flexibility considerations

Mills are given the flexibility to choose the most appropriate technology and effective equipment to install to meet the required limits. When developing responses to permit conditions, mills inform authorities of their plans. These plans are discussed during the permit issuance process and revisions are made where necessary.

4.3 Views of industry surveyed

A number of mills were surveyed to obtain their views on the permit conditions set. The following summarises the views of some kraft mills in Alberta, British Columbia, Ontario, Quebec, and New Brunswick that responded to the survey questionnaire. All of the mills were observed to have implemented similar measures in order to meet permit requirements. The use of pollution prevention practices was maximised.

With respect to the question of permits granting mills the flexibility to select the most appropriate technology to meet permit requirements, mills generally believe that permits do offer flexibility. However, one mill noted that British Columbia's policy requiring the use of best available control technology limited this flexibility, by making it difficult for mills to deviate from the technological norm during the permit review process. In some cases, mills believe that cost-benefit considerations should figure more prominently in the permit review process. Another mill commented that its permit stipulates the equipment to be used, and the mill could not deviate from this equipment without obtaining a revised permit.

Regarding balancing BAT and EQO considerations in the permits issued, it was generally believed that there was a reasonable balance. Owing to the high cost of technology, however, there was some feeling that money could be spent more effectively without jeopardising the environment and the public's health.

5. CONCLUSIONS

Canadian environmental control requirements are implemented through a mix of federal and provincial legislation. Federal government involvement is concerned largely with the control of liquid effluent releases. Provincial governments are concerned with effluent control, air emission control, and solid waste management. The development of federal environmental control legislation is co-ordinated with the provinces through the Canadian Council of Ministers of the Environment. In the three provinces studied, elements that are contained in federal effluent regulations, are included in complementary provincial regulations, or as for Alberta, in individual mill approvals.

Mills have to comply with the requirements of both regulations and permits. In two of the provinces Alberta and British Columbia, permits (known as approvals in Alberta), stipulate the conditions under which mills may deposit effluents including effluent limits. These are developed through a permit hearing process. Under the permits, mills must meet at least technology based regulations passed by the federal and provincial governments. Additionally, local site factors are taken into account and more stringent site specific requirements are developed where necessary. In Ontario, mills have to comply with the MISA Regulation for the pulp and paper sector. This regulation is a technology based limit that was passed in 1993. These were developed based on best available technology economically achievable, considering technology in use world wide. The effluent requirements throughout the country are relatively uniform with respect to the parameters covered and the limits set. The Ontario MISA Regulation is more stringent than the federal pulp and paper regulation.

Air permits are issued by the provincial governments. Permits are issued for individual mill processes that give rise to emissions. In British Columbia and Alberta, the limits are set as end-of stack concentrations. These are developed on a case by case basis, considering the mills permit application, technology available, site conditions and dispersion modelling, economics etc. In Ontario, mills must obtain approval for all equipment that is installed. The equipment has to be capable of meeting all the environmental standards that have been passed by the province. Relative to stack emissions, the concentration of pollutants at the point of impingement, must comply with the limits included in regulations passed by the province. Similar to the permit issuance process in other provinces, public notice and meetings are held concerning approval applications.

With respects to the integration of permitting, Alberta issues each mill a consolidated document, referred to as an approval. This covers all aspects relating to air, water and solid waste control and reclamation activities. In British Columbia separate permits are issued for air, water and solid waste control. These are, however, issued by the same officials in regional offices. The officials take into account cross media transfer of pollution when issuing the permits.

With respect to kraft mills, the regulation and permitting systems of the different authorities involved throughout the country, have lead to the use of similar practices throughout the sector. In the case of kraft mill effluent control, mills are operated so as to minimise the volumes of effluent produced. Effluents from the pulping circuits are recycled to chemical recovery where they are burned to recover spent pulping chemicals. The bleaching circuits have been modified reducing the need for elemental chlorine bleaching. Measures include chlorine dioxide substitution and oxygen bleaching.

The use of in-plant pollution prevention control technologies is complemented by external treatment to meet the required standards. In-plant measures reduce the size and cost of any necessary treatment plants.

With respect to air pollution control, pollution prevention based on effective combustion of waste gas streams is used, coupled with high efficiency gas cleaning for particulates. Control of sulphur dioxides and nitrogen oxides is exercised in permits in areas where acid rain is of a concern. These strategies are based on effective

combustion control using in-plant control measures. Particular attention is paid to control of total reduced sulphur gases to minimise odour complaints.

Permitting processes allow mills flexibility to choose the most appropriate technology to meet the requirements set.

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Case Study on the Use of Best Available Technology (BAT) and Environmental Quality Objectives (EQOs) in the Environmental Permitting of Bleached Chemical Pulp and Paper Mills in Finland

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FOREWORD

This report reviews how the concepts of best available technology (BAT) and environmental quality objectives (EQOs) are taken into consideration in the environmental permitting of pulp and paper facilities in Finland It was prepared by Environment Canada's National Office of Pollution Prevention based on responses to a questionnaire survey. The content of the questionnaire was developed by the Organisation for Economic Co-operation and Development's (OECD's) Pollution Prevention and Control Group.

This report is one of a series of reports prepared to provide background information on the procedures followed in the environmental permitting of pulp and paper mills in a number of OECD Member Countries. Information was gathered using a questionnaire designed to see how best available technology and environmental quality objectives were considered. The countries in the study were Austria, Belgium (Wallonia), Canada, Finland, the Federal Republic of Germany, New Zealand, Norway, Sweden, Switzerland, and the United States of America. Separate reports are available describing the permitting procedures of each country. This report is one of ten reports (Country Profiles) which describe the approach to environmental control of pulp and paper mills in each country. In addition, an overview case study report has been prepared describing the general permitting practices in the set of countries. These reports have been prepared by Environment Canada for the Pollution Prevention and Control Group (PPCG) of the Organisation for Economic Co-operation and Development (OECD).

This particular report provides details of the permitting approach in Finland, describing the legislative basis for permitting, the organisations that issue permits, and the use that is made of regulations, environmental quality objectives, best available technology, and economics. It also describes the technological response of mills to the permit conditions that have been set and the opinions of mills with respect to the permitting process.

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1. THE PERMITTING PROCESS

1.1 Constitutional responsibilities for environmental

In Finland, environmental control is effected under a number of pieces of legislation, including the following acts:

- Air Pollution Control Act;
- Chemical Act;
- Environmental Permit Procedure Act;
- Noise Abatement Act;
- Public Health Act;
- Public Water and Sewerage Systems Act;
- Waste Management Act ;and
- Water Act.

In addition to meeting requirements mandated under Finnish legislation, polluters also have to meet obligations imposed as a result of Finland's signature of international agreements. Agreements having a bearing on the domestic control of pollution include the:

- Accession to the Economic Communities;
- Convention on the Long Range Transport of Air Pollution;
- Convention on the Protection and Use of Transboundary Watercourses and International Lakes;
- Convention on the Protection of the Marine Environment of the Baltic Sea; and
- Convention on the Protection of the Marine Environment of the Northeast Atlantic.

Air, water, and solid waste control are implemented through a permit system operated by various bodies. The Ministry of the Environment co-ordinates and directs environmental protection, prepares legislation and regulations, and supervises administration by local authorities.

The national requirements are implemented through thirteen Regional Environmental Centres located throughout the country. These were established in March 1995 and amalgamated organizations that previously dealt with the separate environmental media. Previously, thirteen Water and Environment District Offices addressed regional water pollution control, and twelve provincial governments addressed regional air and solid waste management.

Legal ownership of surface waters resides with the adjacent landowners. The Government's status as an owner is similar to private landowners. The use of surface water is governed by general usage rights as well as the Water Act. In contrast, groundwater is commonly owned, although a landowner has a priority right for its use as a water supply. The polluting of groundwater is forbidden.

Permits for the discharge and control of liquid effluents causing water pollution are issued by Water Courts. There are three courts located throughout the country. These consist of a judge assisted by at least two specialists in engineering and environmental science. The Water Courts conduct public hearings and set permit conditions on a case-by-case basis.

Permits for the control of air pollution and for solid waste management are issued through the thirteen Regional Environmental Centres. A similar system of public hearings is conducted to establish permit conditions.

The Regional Environmental Centres are responsible for the supervision of permits issued to all but minor polluters. (The permitting and supervision of small enterprises that give rise to minor pollution are handled by Municipal Environmental Boards.) Pulp and paper mills do not fall into this category.

1.2 Permits

A permit system is used to meet environmental requirements. Requirements are established considering environmental, technical, and economic factors. Decisions are based on the principles that the fundamental target is to prohibit pollution; that the "polluter-pays" concept is applied; and that all polluters meet requirements set based on equal and impartial assessment of the environmental impacts and technical and economic possibilities.

Issuance of a permit involves the following steps:

- The permittee submits an application describing the activity, its effects on the environment, and proposed pollution control measures. For pulp and paper mills, the following is required: information on discharges by process units, a description of processes and recent control measures, and reviews on the fate and effects of chemicals used in the process, the efficiency of treatment plants, and results of risk assessments related to environmental releases.
- The application is evaluated and proposals for permit conditions are made by the independent authority's expertise (inquiry).
- The documents are released to the public and comments can be made on them.
- The permitting authority makes a decision regarding limits and other restrictions.
- The permittee and others with an interest in the permit have a right to appeal.
- Amendments are made to the permits as appropriate.

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. The authorities may request any additional information they consider appropriate. Applications for permits for a new activity are generally submitted at an early stage in the planning of the activity, since environmental considerations may affect the siting of the activity as well as technical and economic decisions. The public is notified of the application and may provide comments.

The Water Act prohibits the closing, diverting, and polluting of surface water unless a permit is granted by the Water Court. A prerequisite for granting a permit, as embodied in the Water Act, is that the adverse effects of pollution are considered minor compared with the benefits gained, and that the elimination of wastewater or substances polluting the water body is not possible by any other means at a reasonable cost.

In order to avoid overloading the Water Courts, the permitting procedure is supplemented by a notification process. Under this process, advance notification must be provided to Regional Environmental Centres of plans for wastewater discharges. The Centres assess the notification and determine whether the activity will cause water pollution. If the pollution is unavoidable, the polluter must apply for a permit. In the case of potentially large polluters, such as pulp and paper mills, applications are sent directly to the Water Court.

Installations covered by the Air Pollution Control Decree, Waste Management Decree, or Public Health Decree must submit permit applications to Regional Environmental Centres or, in specified minor cases, the local

Municipal Environmental Boards. Integrated permits covering waste management, air pollution control, and noise abatement are then issued. All permits are developed on a case-by-case basis.

1.3 Permit renewal process

Permits granted by the Water Court specify renewal periods varying between 3 and 10 years. Permits for emissions to air and for waste management have so far been granted until further notice. However, all permits have to be revised or re-issued whenever there are changes in production rates, processes, or the use of raw materials or chemicals that may affect environmental releases to any media. Additionally, they may be revised if the conditions assumed at the time of permit issuance are not realized in practice. The passage of new norms and standards may also necessitate revisions. In practice, changes at a plant that do not increase emissions or wastes, or their harmfulness, can take place without the need for re-application.

1.4 Multi-media permits

Multi-media control of pollutants from the pulp and paper industry has been identified as an urgent task by Finland. The wastewater permitting system is to be integrated with that for waste management, air pollution control, and noise abatement. Enabling legislation is currently being prepared.

1.5 Environmental assessment

The limit values set in permits consider both the environmental impact of emissions and the performance capability of available control technologies. Environmental impact assessment is an important part of the inquiry process used. Impact assessment is based on both the results of the ongoing monitoring programs conducted by the plants, as well as special investigations that plants may be required to conduct as part of the permitting process. The results of these investigations are considered when issuing future permits. Most of the programs are included in the permit conditions, financed by the polluters, and administrated by the authority.

The monitoring of the industrial effluents and the receiving water must be implemented according to a program approved by the Regional Environmental Centres (formerly Water and Environment District Offices). Monitoring programs are established for each plant according to guidelines issued by the Finnish Environment Agency (formerly the National Board of Waters and the Environment, recently the Finnish Environment Institute). Under these programs, the importance of biological test methods has increased. The most common methods used in biological investigations are those related to the sediments and bottom fauna, plankton, algae, and macrophytes. Toxicity, biodegradation, and bioaccumulation tests of effluents have only been used occasionally. Increased attention is paid to the utility of different nutrient sources, nutrient balance, and critical nutrient loads.

In the inquiry procedure, the water quality and biota of the watercourse are assessed and the current and potential uses of the water are investigated. Mathematical modelling may be used to ensure that the water quality does not deteriorate or preclude future needs.

Because of the sensitivity of the watercourses and their status as private property, a comprehensive compensation system is connected to permits for discharge of wastewaters. Thus, although best available technology (BAT) for that case is required, the polluter must pay significant compensation for the water pollution according to criteria affecting the value of the owner's shoreline, income from fishing, etc. In addition, the polluter might be

obliged to compensate by restocking the fish (implanting juveniles). Compensation does not affect requirements for pollution control measures.

The primary target for atmospheric emissions is to prevent pollution of the environment, i.e., to achieve environmental quality objectives (EQOs). In practice, the impacts of the emissions are evaluated during the application procedure using dispersion models and the permit conditions are set to prevent violation of air quality targets. Consequently, any violations of EQOs as a result of atmospheric emissions from point sources are expected to occur largely from process failures and breakdowns. However, the real air quality is methodologically difficult to supervise. As a rule, there are obligations to participate in area air quality monitoring programs, which are usually conducted by the municipality. The topic of acid precipitation is very important in Finland.

2. BAT, EQOs, AND ECONOMICS

2.1 Standards setting and targets

Although no wastewater discharge standards have been established, the government has developed internal guidelines to provide guidance to authorities for case-by-case decisions. Additionally, direction is provided from decisions of the Helsinki Commission and the work of the Nordic Council of Ministers of the Environment.

Council of State Decisions stipulate limit values for atmospheric emissions as well as target values from which the permit conditions may deviate only for special reasons. Noise is regulated by the Council of State Decisions on target values; this mainly affects physical planning and to some extent licensing of buildings. Guidelines for noise abatement are also issued by the National Board of Health to be applied in site licensing. For waste management, no binding numerical standards have been set. However, this is under rapid development.

In order to guide the authorities, several target programs have been developed by the Ministry of the Environment, some of which are confirmed by a Council of State Decision. These include emission targets. Programs setting targets up to 1995 partly addressed the wood processing industry:

- Water Protection Program to 1995 (1988);
- Decision taken on the Reduction of Discharges of Chlorinated Organic Compounds for the Pulp and Paper Industry (1989); and
- General Guidelines for Water Pollution Control Targets Up to 1995 in Industrial Sectors Other than the Pulp and Paper Industry (1992).

Relevant to water pollution control, the following targets were set. All of the targets have been reached:

- 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 - 65 kg/ADt
  Phosphorus - 60 g/ADt
- For the fibreboard industry: BOD_7 - 10 kg/ADt

Finland participates in the Nordic Council of Ministers of the Environment along with the governments of Denmark, Norway, and Sweden. Relevant to pulp and paper, in 1993, a Nordic Working Group on the Pulp and Paper Industry issued conclusions. These included performance targets that could be expected from various types of mills by the end of the century, covering existing and new mills. The targets were specified as annual averages that should not be exceeded. The values for existing and new mills are shown in Tables 1 and 2. However, the industry had some reservations and stressed the importance of EQOs and the need for environmental impact research. Although Finland has not incorporated these targets in Council of State Decisions, the performance levels are an important element when considering what constitutes best available technology relevant to individual permit decisions (see Section 2.2).

Table 1. Summary of performance targets, kg/t (annual averages), for various types of existing mills according to a Nordic Working Group

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 2. 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 NO_x 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.

Guidelines embodying standards and targets are prepared by the Ministry of the Environment, using their experts or advisory boards. Often expert working groups or committees are established which may include representatives from other authorities, universities and institutes, and from the private sector. The preparation generally includes large surveys of international standards and targets. In some cases, the preparation is based on Nordic co-operation. Final proposals are widely circulated for comment by authorities, institutions and associations in the private sector, and depending on the issue, by non-governmental environmental organisations. Proposals are generally publicised before the final decision. Final documents and proposals are public, while documents under preparation may not be public.

In 1994, the Ministry of Agriculture and Forestry, and the Ministry of the Environment, jointly adopted a Forestry Protection Program. It stresses the need to change the scope of forestry planning form production

volume planning, to multi-use planning that promotes biodiversity. A working-group established by the Ministry of the Environment to promote the implementation of the United Nations Convention on Biological Diversity also stressed in its report published in 1995 that "Forestry planning is seen as the most important means for promoting the conservation of biological diversity in economic forests".

A new water protection program to the year 2005 has been elaborated but not yet approved by the Ministry of the Environment. An application of Life Cycle Analyses for the wood processing industry was published in 1997. This addresses integrated pollution control covering the whole life cycle from forestry to waste management.

Regional water protection programs have been established for several regions since the early 1970s in order to guide water protection authorities in the licensing procedures and other measures. The regional water protection programs are not binding, but they give information on local targets, alternatives and their environmental, economic and social issues.

Several Council of State Decisions 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).

Strategies and proposals for further restricting emissions of nitrogen and sulphur compounds have been drawn up by two commissions:

- Report of the Nitrogen Oxides Commission (1990) and
- Report of the Sulphur Committee II (1993).

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 respirable particles. In addition, the Nordic proposals also include limits for emissions of sulphur in all forms, i.e., SO_2, and as reduced sulphides.

2.2 Environmental quality objectives (EQOs)

There are very few EQO standards prescribed in Finland. Ambient air quality objectives have been set covering sulphur dioxide, nitrogen dioxide, particulates, and carbon monoxide (Annex 1).

In the permitting process, the water quality and biota of the watercourse are assessed and the current and potential uses of the water are investigated. Mathematical modelling may be used to ensure that the water quality does not deteriorate or preclude future needs. Modelling is also used to determine the water area affected to determine the level of compensation due to water owners and fishermen.

Instead of EQOs as a normative system, a system of water quality classification has been developed and applied since the 1970s. It has served in the dissemination of public information, physical planning, the planning of

water protection targets, and licensing. The classification system takes different criteria into account depending on actual and potential uses of the watercourse. In principle, targets or EQOs for waters in Finland are equal to the original or natural background quality; this varies, for example, with the geology and morphology in different parts of the country.

There are several programs and decisions to be made for specially protected water, groundwater, swamps, nature conservation areas, and species. Their judicial status varies and they do not provide numerical EQOs. However, they all have some guiding effect on land use and location of activities.

2.3 Best available technology (BAT)

In Finland, environmental requirements are set on a case-by-case basis considering best available techniques as well as environmental and economic factors. A summary of the application of BAT in Finland and in other countries can be found in the *OECD Reference Guide* published in May 1996 for the Workshop on Environmental Requirements for Industrial Permitting.

The prerequisites for a permit as expressed in the Finnish environmental legislation correspond closely to the concept of BAT. BAT is used to set the level of emission limits. BAT evaluation takes place on a case-by-case basis during the licensing process. The technology proposed by the applicant is compared with the best existing plants in Finland, new foreign technology, and the results of applied research. The feasibility of replacing old technology and harmful chemicals is evaluated by the permit-granting authority. The levels of emissions and their impacts are estimated. The evaluation and licensing process includes negotiation with the applicant and requests for information on the applicability of alternative technologies, processes, raw materials, and chemicals. Energy, water, and raw material efficiency have not, as such, been included in the evaluation, although the issue is often touched upon as part of emission evaluation and requirements. The new Waste Management Act, however, introduces this efficiency criterion, stipulating that the enterprise shall save raw materials and use waste instead of raw materials.

Obligations to investigate and develop technology, processes, and the use of chemicals are often included in the permits. Since such investigations, including cost estimates, quickly become obsolete, they are, in some cases, linked to obligations to decrease the discharge during the current permit period. In some cases, they are timed to provide information for the next application. In order to improve the current situation during a permit period, the water authorities have also introduced plant-by-plant environmental risk analyses. This has not only improved risk management at the plant, but in some cases has resulted in the continuous emissions being decreased as well. The risk analyses also help to define BAT.

Permit conditions do not explicitly allow for breakdowns and upsets and they do not include specific reference to the effect of seasonal temperature variations on biological treatment. It is the task of the regulate to prevent occasional emissions.

Renewed permits have so far always been more stringent than the previous ones. For new and modernised production capacity, the permit conditions are more stringent and presume new, environmentally sound technology. An old plant's permit conditions depend partly on the extent to which production facilities are modernised. Modernisation may also be required by the authorities. Typically, the Finnish mills constantly undergo unit-by-unit reconstruction. The interpretation of BAT at old plants is a question of time schedule. Limit values are based both on environmental impact assessment and on evaluation of the technology available and improvements in its performance.

When BAT seems to achieve better results than required by the receiving water, the regulator may continue to demand implementation of BAT, referring to non-measurable long-term effects, the precautionary principle, and planning for emergencies. BAT is also required of all polluters in the same receiving area, although the share of a particular polluter's impact cannot be measured but can be assumed to be smaller than the impact of other larger sources. This is consistent with the principle of equal requirements within one branch and with the "polluter-pays" principle.

Elaboration of guidelines and reviews on BAT are often based on the work of consultants (funded and supervised by the authority), literature surveys, and research. The Finnish Environment Agency plays an important role in co-ordinating environmental research. In addition to the environmental, hydrological, and geotechnical research and monitoring vested in this institute, emphasis has been put *inter alia* on environmental research addressing the pulp and paper industry.

During 1990–1992, a comprehensive co-operative research program for the Finnish pulp and paper industry was carried out by the Finnish Environment Agency in conjunction with the Finnish Pulp and Paper Research Institute, universities, research institutes, companies, and others. During 1992–1993, a Nordic project also defined BAT for the late 1990s for the pulp and paper industry. The *Study on Nordic Pulp and Paper Industry and the Environment* was published by the Nordic Council of Ministers of the Environment in 1993. The limits recommended under this work are summarised in Section 2.1. In 1997 a report "The Finnish Background Report for the EC Documentation of Best Available Techniques for Pulp and Paper Industry" was published. A second report on classification of BAT will be forwarded to the EU during spring 1998.

2.4 Negotiation of standards

Resolution of environmental questions is typically reached in Finland through a process of negotiations. The content of laws under development, international recommendations, research programs, regional plans as well as monitoring programs are negotiated. The main purpose of the negotiations is to exchange information in order to base decisions on the best available knowledge.

In the case of permitting, discussions are often started early, covering the content of the application and necessary investigations. However, after discussions the enterprise prepares the application documents independently. The authority is not used as a consultant because it is not a specialist on the circumstances at the facility that affect costs and application. The authority can never take responsibility for a failure. As a rule, the enterprise is interested to know the authority's opinion on emission limits, but these are not negotiated to the stage of agreement. The competent body makes its decision on permit conditions independently.

Confidentiality is important in negotiations. Disclosure of so-called business secrets or other economic facts given in confidence to the authority is not allowed. Documents under preparation are confidential, but information such as application documents, permits, production figures, and the results of emission monitoring and impact assessments is made public.

2.5 Economic considerations

The permittee has to provide the authority with information on its costs for planned pollution control measures and alternative solutions. In principle, a cost estimate should also be made for pollution control measures needed to eliminate pollution. In practice, financial factors are included in the applicant's proposals. The permitting authority makes its decision based on the concept of reasonable costs, considering cost efficiency as well as

decreased emissions and environmental impact. In doing so, it obtains advice from the supervising authority and independent experts on these factors.

Finland provides some financial assistance for applied research, development, and investment in the field of energy saving and environmental protection. However, financial assistance is modest.

2.6 Interaction of BAT and EQOs

Limit values are based on an assessment of both BAT and environmental impacts. The Finnish surface watercourses and coastal waters are very shallow and sensitive to pollution. Because of the northern climate, the Finnish forests are equally sensitive. Thus the BAT requirements, though they satisfy international norms and criteria, are not often sufficient to prevent pollution, i.e., measurable adverse impacts on the recipient. As long as this is the case, the requirements are likely to become more stringent.

Exceptionally stringent performance may be required in specially protected areas. Mathematical modelling has been used in polluted areas both for inland waters and for coastal waters. In modelling, special attention has been paid to oxygen deficit in watercourses and prohibition of heavy eutrophication. Mathematical modelling is also used to forecast air quality and deposition.

3. TRENDS IN PERMITTING

3.1 Cleaner technologies as an integrated part of BAT

No performance standards or prescribed technologies have been specified as a basis for mandatory inclusion within Finnish environmental permits. Instead, emission limits are set based on the most stringent levels judged possible at the plant using some of the technical solutions available. The choice of equipment, resolution of problems, and any development work is left to the enterprise. Permit conditions are set taking into account technical, environmental, and economic factors. Integral to this process is consideration of what role cleaner pollution prevention technologies can play in abating emissions.

The control practices use a mix of both in-plant pollution prevention measures and external treatment. As shown in the studies that have to be performed in support of new permit applications, steps toward closure of the pulping circuits is a priority. Mills have to give consideration to the development of these techniques in their planning.

The Finnish permitting process recognises the role to be played by cleaner technologies (pollution prevention practices), as well as the need to use end-of-pipe control practices, where in-plant measures cannot meet environmental and health quality requirements. At Finnish mills that produce similar products, internal and external measures have developed in the same direction, although there is a variety of applications.

Technology development trends at kraft pulp mills include:

- reduction in the use of fresh water in processes, with intensified circulation of process water;
- separation of relatively clean cooling and sealing waters;
- dry barking at nearly all mills;
- reduction in the kappa number, with extended cooking and/or oxygen delignification before bleaching at all mills;
- effective washing before and after the oxygen delignification stage at all mills;
- bleaching without the use of elemental chlorine gas at all mills;
- bleaching with oxygen and/or peroxide at more than 80 per cent of mills;
- stripping and reuse of condensates at all mills;
- evaporation of the weak liquor to high dry solids content before the recovery boiler at nearly all mills (reduces SO_2);
- collection of concentrated malodorous gases (from digester, turpentine plant evaporators, tank ventilation systems, and condensate stripper columns) and burning in the lime kiln, or preferably in a separate incinerator, at all mills;
- collection of diluted malodorous gases (from chip bin, screening filter, pulp washing, smelt dissolver, tall oil plant, and tank ventilations) and burning in the recovery boiler, the bark boiler, or a separate incinerator at approximately 50 per cent of mills;
- avoidance of spillage with sufficient buffer volume integrated into spillage collection systems;
- good process control system and training of employees on how to operate the process to avoid spillage;
- risk management systems; and
- activated sludge treatment, which is used at all but three mills that have aerated ponds.

Development trends in technology at paper and board mills include:

- reduction in the use of fresh water in processes;
- separation of relatively clean cooling and sealing waters;
- precipitation of the mechanical pulp and dilution with circulation water before paper/board machine at a few mills;
- separate treatment of the wastewater from the coating kitchens at nearly all mills;
- good process control systems and training of employees on how to operate the process to avoid spillage;
- risk management systems;
- activated sludge treatment (mills producing mechanical pulp and wood-containing paper/board) and chemical precipitation (mills producing wood-free paper/board); and
- subject to research, pilot plant studies, and first applications is the use of flotation/filtration and membrane technology (with ultra- and nanofiltration and/or evaporation), to close process water circulation systems as far as possible.

Although the Finnish approach to environmental control has emphasised the use of in-plant control measures and cleaner technologies, in order to minimise costs, their development has been found to be too slow. The impacts in the receiving watercourses and the technical possibilities of external treatment have forced the industry to apply effective external wastewater treatment methods. The use of different types of external treatment plants in the industry is illustrated in Table 3. It is noted that the number of treatment plants exceeds the number of mill sites because there are two treatment plants at some sites. In one case, two mill sites have a common treatment plant.

Table 3. Wastewater treatment methods in use in Finland in 1995.

	AS	AL	AN+AL	C	M
Integrated mills (kraft pulp + paper/board and/or mechanical pulp)	4	1	1	—	1
Bleached kraft pulp	7	2	—	—	—
Semi-chemical pulp	2	—	1	—	—
Wood-containing paper/board + mechanical pulp	11	—	—	4	—
Wood-free paper/board	3	—	—	4	3

Abbreviations:
AS ..... activated sludge plant;
AL ..... aerated lagoon;
AN+AL.. anaerobic filtration and aerated lagoon;
C ..... chemical precipitation; and
M ..... mechanical sedimentation.

Effective design of combustion units is a major element of the air pollution control strategy. The combustion units, including the power boilers, recovery boilers, and lime kilns, are designed to provide effective combustion, minimising the carry over of partially combusted product and odours. Recovery boilers are of low odour design, with combustion conditions designed to minimise the formation of total reduced sulphur (TRS) compounds, SO_2,

and nitrogen oxides. Similar considerations apply to the lime kilns and power boilers. High-efficiency electrostatic precipitators are used on these units to control particulate emissions.

The pulp and paper making processes are operated to minimise the generation of solid wastes.

Finland requires mills to conduct investigations to evaluate means to reduce emissions in support of their permit applications. This is illustrated by the case of nine mills discharging into the Kymijoki River. The mills were required to conduct studies as part of their new permit applications, which were to be delivered before the end of 1995. This included studies in the following areas:

(i) To review the current situation of the mills by providing:

- an outline of discharges by process units, considering quantities, suspended solids, P, N, AOX, and other harmful components;
- a description of how these are affected by the processes and any recent innovations;
- an assessment of the effectiveness of treatment plants for removing these and their toxicity; and
- a description of the environmental management plans to address occasional and accidental spills, and to prevent process upsets (an updating of the environmental risk assessment plan).

(ii) To review the production capacity, considering descriptions of eventual production capacity and its timing.

(iii) To investigate means to decrease or eliminate water pollution, i.e.

a) Possibility to close the process water system:

- measures needed;
- costs;
- provisions for breakdowns and upsets;
- remaining total discharges; and
- effects of changes on air emissions, waste quality and quantity, and energy consumption.

b) If it is intended to close the process water system during the period of the permit, the following specifications are added:

- implementation schedule;
- discharges before closure;
- spill management plan; and
- sources of discharge, other than process waters, including quantities, options to reduce them, costs for reduction measures, and monitoring.

c) Other water pollution control measures; unless it is intended to close the process water system during the period of a permit, the applicant should conduct the following investigations:

- possibilities to reduce discharges by internal measures, e.g., by reducing water consumption (paper mills to 7 to 10 m^3/t and pulp mills to 20 to 25 m^3/t). This should include:
  - the necessary measures;
  - costs;
  - effects of discharges before wastewater treatment;

    - effects on the wastewater process;
    - effects on the pollution load to the receiving watercourse; and
    - a brief evaluation of effects on emissions to the air, waste quantity and quality, and energy consumption.
- possibilities to improve external wastewater treatment;
- possibilities to improve existing treatment plants, including effects and costs;
- possibilities to add tertiary treatment, including effects and costs; and

d) Based on the investigation mentioned, the following additional specifications should be provided:

- proposed measures and their time schedule;
- costs;
- wastewater discharges during the permit period;
- environmental management with regard to occasional and accidental discharges; and
- discharges other than those caused by process wastewater:
    - sources and quantities;
    - possibilities to reduce them;
    - costs of reduction measures; and
    - monitoring.

As the Integrated Pollution Prevention Control (IPPC) directive of the European Union will come into force in 1999, Finland is currently strengthening its integrated approach in its permitting and supervision procedures. The big challenges are how to take cross-media issues into account, how to weight the relative importance of environmental impacts from different releases, and consumption of resources.

3.2 Monitoring

Monitoring requirements are established by the local authorities who are responsible for permit administration. Quality assurance is a task of growing importance. Finland also considers international harmonisation, especially in the field of monitoring emissions to the air, a priority task.

Monitoring programs are negotiated (and revised) depending on the activity and options. Wastewater monitoring is well established in Finland and is regulated more closely than air emissions monitoring. All monitoring results are made available to the public. The reporting of breakdowns and process upsets is an important element of the monitoring program; these allow the authority to discuss the environmental management efficiency and to examine options to reduce discharge fluctuations. Monitoring results are important as they provide important information for the development of future permits and influence permit conditions.

3.2.1 Judicial background of self-control and reporting

Wastewaters

According to the Water Act, the permits granted for discharging industrial and municipal effluent have to include *inter alia* a condition for monitoring and reporting. In the permit condition, the plant is ordered to present a proposal on a monitoring program to the Regional Environmental Centre within a given time frame, usually from one to three months. The centre may require amendments before approving the monitoring program. The

programs can also be amended later without having to go through a new permit procedure. If the plant and the centre cannot agree on the program or amendments, the Water Court makes a final decision. The monitoring obligation includes:

(i) Internal plant operational information:

- the quantity and quality of wastewaters from different parts of the processes, and
- the treatment plant performance and efficiency.

(ii) External discharge information:

- the quantity and quality of wastewaters discharged, covering both process wastewater and other discharge sources, such as waters from storage yard areas, cooling waters, etc.

(iii) Monitoring of the effects on the recipient:

- effects on the water quality and
- effects on the biota.

The results of the monitoring must be reported to the supervising authorities (the Municipal Environmental Board and the Regional Environmental Centre). Violation of limit values must be reported immediately. Also, other exceptional incidents and discharges must be reported even if numerical limit values are not violated. Permits may contain other reporting requirements in addition to discharges, e.g., the use of chemicals or actions taken to prevent environmental accidents and exceptional loading. Individual permits also contain obligations to conduct studies or to develop plans for future pollution abatement programs. Results have to be sent to the authority and are considered in future permits.

The permits do not prescribe who should collect and analyse the samples. The choice is left to the permittee and they may conduct self-monitoring or hire a consultant. The in-plant operational monitoring is nearly always conducted by all plants regardless of size. In the case of external discharge monitoring, large and medium-sized plants usually conduct this themselves.

Emissions to air and solid wastes

As in wastewater permits, similar monitoring conditions are placed on the integrated permits that cover air and waste releases. The air emission monitoring components often include in-plant process and external emission monitoring. In addition, there is generally an obligation to participate in the air quality monitoring in the area, usually carried out by the municipality. With respect to solid waste, the mills have to document the types of wastes that are produced and how they are managed.

3.2.2 In-plant operation and external discharge control programs and reports

Wastewaters

The in-plant operation and external discharge control programs should be detailed to describe the following:

- sampling and flow measurement sites, methods, and equipment;

- maintenance and calibration of the sampling and flow measurement equipment;
- storage and pre-treatment of the samples;
- analytical methods and laboratories;
- data processing; and
- reporting.

In order to ensure accurate results, the Finnish Environment Agency issued both a general guideline covering monitoring programs and self-control systems, as well as specific guidelines on sampling practices and flow measurements. In practice, the comprehensiveness of the programs and monitoring systems varies from plant to plant. This depends on how old the programs are and on how active the supervising authority has been. For large and medium-sized polluters, continuous flow measurement and automatic composite samplers (preferably flow dependent) are required for external discharge monitoring throughout the country. Samples are typically taken over 24 hours, five to seven days a week. Analysis frequency depends on the size of the plant as well as on the quality variations of the effluent. In some cases, samples are frozen and combined to cover a longer period. The discharge monitoring may include 5 to 15 parameters, depending on the industry. In all cases, monitoring covers the types of parameters for which there are numerical limit values in the permit.

The reporting period for the monitoring results depends on the type and size of the plant, but it is usually once a month. The monthly production quantity is reported as well. For small polluters, the discharge limit values are given as 3 month averages and the reports are correspondingly submitted quarterly. In addition, an annual report using a uniform format must be submitted, covering the entire calendar year. Also, the plant reports annually internal and external investments in environmental protection and operating costs.

Exceptional events and discharges have to be reported immediately in a detailed format to the regional and municipal authorities. All monitoring data are made available to the public. The monitoring and cost data are compiled annually in a publication entitled *Industrial Water Statistics*.

The record-keeping obligations concerning, for example, information on process failures and running parameters of production processes are more comprehensive than the reporting obligations. The supervising authority has the right to check the diaries, to talk to the staff, etc.

Emissions into the air

Air emission monitoring programs should be similar in detail to the wastewater monitoring programs. Periodic measurements carried out by a consultant form an essential part of air emission monitoring, although the role and importance of continuous measurements have increased. The monitoring is complemented with material balance calculations. The monitoring results are reported annually. As well, the reports contain information on breakdowns of air pollution control facilities and other types of disturbances affecting emissions.

3.2.3 Supervision of self-monitoring

A working group under the Ministry of the Environment is preparing a proposal on the uniform quality assurance requirements of environmental laboratories.

Wastewaters

In Finland, the supervision policy of industry is partly based on self-monitoring. It is therefore important to ensure that the self-monitoring system is reliable. The penalty for falsifying monitoring results varies from a fine to up to 2 years imprisonment. During unannounced inspections, the authorities check different parts of the self-monitoring systems. In addition to inspections, regional authorities regularly take control samples, analyse them, and compare the results with the self-monitoring results. Every two or three years, the laboratory of the Finnish Environment Agency carries out an intercalibration of the analytical methods used by the plants applying self-monitoring. Only consultants under official supervision of the Finnish Environment Agency are permitted to carry out the self-monitoring, or part of it.

The frequency and comprehensiveness of inspections vary. Some districts have used only control samples to supervise the self-monitoring system. Though the supervision carried out by means of control samples has been rather effective, there is a clear need to intensify and widen inspections of the whole self-monitoring chain. As the continuous process wastewater discharges have been reduced, the importance of the other discharge sources and exceptional discharges has increased. Monitoring of these discharges is more difficult and requires from the plant an effective information system, clear instructions, flexibility, and a high state of readiness.

Emissions into the air

According to the Air Pollution Control Act, the supervising authority has inspection powers similar to those stipulated in the Water Act, e.g., to make inspections, take samples, check diaries, and so on. In practice, the Offices of Environmental Protection at the provincial government level have had less personnel to carry out inspections than the Water and Environment District Offices. Furthermore, the provincial governments have neither the equipment to take samples themselves nor the laboratories required to analyse the control samples. The new administration makes combined (multi-media) supervision possible.

3.2.4 Monitoring of the recipient waters

The legal authority to monitor the effects of the emissions on the recipient waters is based on the permits issued by the Water Court (statutory monitoring). In practice, monitoring is carried out by authorised environmental research laboratories (22 in total) according to the programs approved by the regional environmental authorities (Water and Environment District). The polluting plants are fully charged for the costs. The average cost for the recipient monitoring of a pulp and paper plant was approximately 25 000 USS per annum in 1991. Whenever possible, the recipient monitoring of a pulp and paper plant is integrated with the monitoring of other polluting plants and municipalities discharging into the same area. Typically, the statutory monitoring of a pulp and paper plant contains the following receiving water elements:

Water quality

- 15–40 stations, with at least one station in an unpolluted area;
- sampling 4–6 times per year at each station (end of winter stagnation, spring turnover, mid-summer, end of summer stratification, autumn turnover);
- sampling depths usually 1, 5, 10, 20, and 30 m, measured from the bottom; and
- common analyses include: temperature, Secchi depth, oxygen, turbidity, suspended solids, conductivity, pH, colour (mg/L Pt), COD (Mn), total P, PO_4-P, NO_3-N, NH_4-N, Na-lignosulhonate (or Na), and chlorophyll-a (0–2 m composite samples).

Biological monitoring

- usually every 3 years;
- phytoplankton primary production (in vitro), three sampling rounds a summer around 10 stations, 0–2 m composite samples;
- benthic animals, species, biomass, sampling in autumn around 10 sampling lines (e.g., 1 m, 5 m, hypolimnetic bottom); and
- general survey of littoral vegetation and sliming effects.

The statutory monitoring is often supplemented by sediment, ecotoxicological studies (e.g., distribution of chlorinated organic compounds, resin acids, fatty acids, sterols, triterpene alcohols, test fish liver glycogen, protein, UDP-GT and EROD activities) in connection with the renewal of the permit conditions (every 7–10 years.)

3.3 Trends in permits including limits

Finland submitted three permits to illustrate permitting practices. One set of permits is related to a modern kraft mill with an up-to-date water permit. The other two permits are related to mills applying for new permits and were provided to illustrate the types of studies that have to be made to support repermitting.

3.3.1 Case A

Mill A operates a large non-integrated (market) kraft pulp mill on a river with sufficient dilution capacity that it is not a sensitive ecosystem. The mill recently underwent a major expansion that increased its capacity by a factor of 3.5 times. In effect, the expansion meant that a new mill was constructed at the site. The mill is a state-of-the-art mill, and the permits are relatively new. The history of the various permits is summarised in Table 4.

Table 4. Permit history for case A

Permit	Date of issuance	Period of application	Period for review
Air	27 Sept. 1990	Until further notice	
Water	31 Mar. 1992 (appealed) 25 Nov. 1992 (valid)	Until further notice	New application to be made before 31 Mar. 2000
Waste	16 Dec. 92	Until further notice	Case under review based on an application

Water permit requirements

Pollution control limits

The permit issued by the Water Court contains limits for the release of BOD_7, COD_{Cr}, AOX, and phosphorus as shown in Table 5. The limits on BOD_7 and COD_{Cr} were chosen because of concerns over receiving water oxygen depletion by rapidly and slowly decomposing organic material respectively. The AOX limit was chosen to control organochlorine substances, many of which are toxic and bioaccumulative. Total phosphorous limits were set to address the release of nutrients that cause eutrophication in the receiving water. All of the above limits were set far below those of the Helcom Recommendation 11/14 of 1990.

The limits were set based on professional judgment, considering technological capabilities and environmental needs. The limits are expressed as maximum permissible quantities per day, established over a monthly period, except for AOX, where a 3-month running average is compiled. Besides these mass per day limits established over different time intervals, limits are also set as kilograms per tonne of production for COD_{Cr} and P-total. In addition, the permit sets an annual production capacity.

Compliance with the limits is ensured through a self-monitoring program. Samples are collected by time-activated, automatic samplers. Continuous on-line measurements are also made of flow, pH, and temperature. Measurements are also taken of suspended solids and conductivity three times a week based on daily composites. In addition, total nitrogen, sulphur, sodium, and chlorine are measured on monthly composites, similar to those for AOX and P-total. Dissolved nutrients are measured once every 2 weeks on daily composites.

Other requirements related to water pollution control

The permit requires the mill to investigate means to reduce the deposit of nutrients. Studies have to be conducted to develop techniques to reduce total phosphorous releases to levels between 30 and 40 g/t, as well as total nitrogen levels; however, no target goals are set for this. The results of these studies will be considered in the next permit review, scheduled for the year 2000. The mill is also required to conduct studies to assess the impact of effluents on the watercourse and the fishery and to restock fish to compensate for any effects.

Table 5. Summary of wastewater permit limits and testing requirements for case A.

Parameter	Limit kg/d	Limit as kg/t at capacity	Basis for compliance	Frequency of measurement
BOD_7	3 000		Monthly average	Once per week on 48-h composite
COD_{Cr}	50 000	30	Monthly average	Once per week on 48-h composite
AOX	1 700		3-month moving average	Once per month on a monthly composite
P-total	75	0.045	Monthly average	Once per week on 48-h composite

Air permit limits

The major process operations giving rise to air pollution at the plant are kraft pulp production involving the recovery boiler and the lime kiln and the bark fired power boiler. Air emission limits are set for these operations.

For kraft pulping, a total sulphur target emission limit, measured as SO_2, of 3 kg/t calculated over a year is set. The sulphur emissions are determined mainly as a result of measurements and are complemented by mass balance results. The plant is required to meet a reduced target value of 2 kg/t beginning in January 1998. The following emission limits also apply to different units in the plant:

Recovery Boiler Limits

Total reduced sulphur	10 mg of H_2S per normal cubic metre
Particulate	100 mg/nm^3

Lime Kiln Limits

Total reduced sulphur	20 mg of H_2S per normal cubic meter
Particulate	150 mg per nm^3

Power Boiler Limits

NO_x	150 mg of NO_2 per megajoule

Bleach Plant Limits

Cl (total)	30 mg of Cl_2 per normal cubic metre

Other requirements

The mill is required to conduct investigations on means to reduce NO_x to a level of 50 mg of NO_2 per megajoule from the lime kiln and the recovery boiler. Surveys have to be conducted on equipment breakdowns and upsets, and the composition of the fibre and wastewater sludges burned in the power boiler studied. The results will be considered in future permit reviews. Additional studies have to be conducted in association with the municipality on air quality in the area.

Solid waste permit requirements

The existing permit, which is now under review, requires that records be kept for all wastes, by lot number, regarding the quantities, quality, and deposition of the waste.

Waste oil can be burned in the furnaces, but the furnace temperature has to be maintained at a minimum of 800°C. Studies also have to be conducted on the effect of burning wastewater sludges, the solubility of waste ashes generated during combustion and disposed of at the site, and means to reduce the quantities of wastes from the operations.

3.3.2 Case B

Company B operates a sodium-alkali based, neutral semi-sulphite chemical (NSSC) based fluting mill. It is a mid-sized mill and its situation is typical of the licensing approach for that type of mill. The mill has operated since the 1960s and has undergone unit-by-unit reconstruction throughout its history. Wastewater volumes have

been reduced progressively over time. Currently, parts of the effluent from the evaporating stages and the power plant are discharged without treatment. This process is not regarded as up to date. Chemical recovery at the mill underwent modernization in 1994 and lowered total reduced sulphur emissions by about 75 per cent.

The mill is situated in an area with a relatively dense population and discharges to receiving water that is an important recreational resource. The mill accounts for a large proportion of the nutrient discharges to the system, and has reduced its discharges over time. This reduction has been reflected by improvements in the ecosystem, but there is a need for further improvements. Emissions to the air (TRS and SO_2) affect air quality in the city.

Individual air, water, and waste permits have been issued over time as summarised in Table 6.

Table 6. Permit history for case B.

Permit	Date of Issuance	Period of Application	Period for Review
Air	5 Jul. 1989	Until further notice	
Water	24 Oct. 1994 (appealed) Under review	Until further notice	New application to be made before 31Mar. 2003
Waste	20 Apr. 1993 14 May 1993 (extension of landfill)	Until further notice	Case under review based on an application

Water permit requirements

Pollution control limits

The permit issued by the Water Court includes limits for the release of BOD_7, COD_{Cr}, suspended solids, and total phosphorus. The limits on BOD and COD_{Cr} were set because of concern about receiving water oxygen deficiency. The COD_{Cr} limit also serves as a means of reducing some toxic substances. The limit on total phosphorus was set because of concerns over eutrophication due to the release of nutrients. The limits are set as permissible quantities per day, established over a monthly period. The requirements came into force 1 January, 1997.

The previous monitoring program was developed in 1986. In support of this, an intensive monitoring program was recently conducted over two months, in which daily measurements were made of COD, P and N and the toxicity of the effluents. These results were used to revise the sampling requirements. Samples are collected by time activated, automatic samplers. From 1 January, 1997 suspended solids and COD_{Cr} are measured daily, BOD once a week, and P-total and N-total, three every two weeks. In addition, continuous on-line measurements are made of flow.

The discharge limits are based on professional judgment, considering the technical possibilities and environmental needs, through court deliberations.

Other requirements related to water pollution control

The permit requires the mill to:

- properly maintain and operate the facilities to minimise releases;
- immediately inform authorities of accidental releases, take steps to minimise damages, and implement measures to prevent future occurrences;
- use chemicals that are as harmless as possible;
- conduct environmental risk analyses;
- investigate what emission reductions are feasible before the next application;
- reconsider the location of the discharge pipe to minimise impacts;
- conduct monitoring of the releases and study the impact of discharges on the receiving environment; and
- report releases in excess of the target values to the authorities.

Air pollution control

The air permit does not include air emission limits; however, it requires the mill to monitor its emissions subsequent to specified modifications. In addition, it has to conduct modelling of the hydrogen sulphide distribution and to participate in SO_2 model deposition studies.

Following the installation of new air pollution control equipment, releases of air pollutants are to be thoroughly assessed. Thereafter, emissions are to be measured every 3 years. These measurements cover SO_2, H_2S, and particulate from the soda recovery boiler; SO_2 from the digester; H_2S from the green liquor system; and particulate and NO_x from the power boiler. Emissions of SO_2 from the power boiler also have to be calculated from the sulphur contents of the fuels.

Solid waste management permit requirements

Practices are prescribed for solid waste management. These require that:

- all hazardous wastes be handled, stored, and recorded properly and be delivered only to licensed facilities;
- a plan for sludge treatment be developed;
- all wastes brought to the mill's disposal site be recorded; and
- leachate from the site be monitored, and the old landfill be covered and revegetated.

3.3.3 Case C

The case of Company C is provided to illustrate the type of studies required in support of a new water permit and the approach to multi-media permitting.

The mill is a medium-sized, integrated mill producing laminated and coated paper from unbleached kraft and mechanical pulp. In addition, a sawmill operates at the site. The permits cover releases from the whole operation. The plant is located in a heavily industrialised area of the Gulf of Finland. It is one of nine mills in the region, each of which can impact the local environment. Nutrients and toxic substances are a concern. The

mill has been in operation for over a century and has been renovated and enlarged several times. The technical solutions developed at the site are quite unique compared with other mills, and were developed to suit the mill's circumstances. The mill employs anaerobic treatment followed by aerobic treatment to process its wastewater. This differs from the activated sludge process that is commonly applied at other mills.

Table 7. Permit history for case C.

Permit	Date of issuance	Period of application	Period for review
Air	10 Aug. 1989	Until further notice	
Water	25 Jan. 1989 (appealed) 29 Nov. 1991 (valid)	Until further notice	New application to be made before end of 1995
Waste	27 May 1992	Until further notice	New application to be made before end of 1996

Water permit requirements

The current permit contains limits on the deposit of suspended solids and BOD_7, expressed in kilograms per day, as established over a monthly period. The BOD_7 limit was set to address oxygen depletion concerns. The suspended solid limit was set before the widespread adoption of activated sludge treatment processes by the Finnish industry. The use of suspended solid limits is regarded as obsolete as discharges tend to be high from activated sludge plants and tight limits impede the adoption of these more effective processes.

The BOD_7 and suspended solid limits are set on the basis of monthly averages of the samples that are collected. Suspended solids measurements are made daily, BOD_7 is measured once a week. In addition, the following monitoring is conducted:

- flow, pH, conductivity, and temperature by continuous on-line measurement;
- suspended solids, COD_{Cr}, and sodium daily; and
- phosphorus, nitrogen, and BOD_7 weekly.

The limits were based on professional judgments within Water Court deliberations. They reflected technical considerations and environmental needs. Pertinent to the case, the applications of the nine mills in the area were considered at the same time. The decision took into account the effects of the collective industry on the environment. As noted previously, this water permit is being reviewed along with the situation of other mills in the area. As a result of negotiations relating to repermitting, mills are required to conduct studies in support of their application. The content of these studies, relating to the Kymijovi River, is described beginning in Section 3.1.

Other requirements related to water pollution control

The permit includes a target value for the release of phosphorus. This limit was set as a target value as the environmental objective was to achieve a major reduction in BOD_7 discharges. It was feared that a binding total P limit could discourage the adoption of secondary treatment processes. This has not proved to be a concern.

Additionally, the mill is required to:

- minimise emissions through proper operation and maintenance;
- store and handle chemicals and sludges properly;
- immediately inform authorities of accidental releases, take steps to minimise damages, and implement measures to prevent future occurrences;
- perform monitoring;
- conduct studies on the impacts on receiving waters; and
- provide compensation for effects on resources.

Air pollution permit requirements

The permit contains limits for the release of SO_2 and total reduced sulphur (TRS), as determined on an annual basis. Particulate emission limits are also set. Particulates are measured using grab samples. TRS and particulate limits were set based on local health and community satisfaction (odour) concerns, SO_2 was limited because of acid rain.

The mill is required to make provisions for breakdowns and upsets. The mill is not allowed to exceed its TRS limits more than 10 per cent of the time.

The mill is required to conduct emission monitoring and to participate with the municipality in studies on the local air quality.

Solid waste permit requirements

The permit contains a restriction on the storage of waste liquid latex and pigments from the processes, with a dry content of less than 35 per cent at the landfill.

4. TECHNOLOGICAL RESPONSE TO PERMIT REQUIREMENTS

4.1 Equipment installed and measures taken

The three mills responding to the questionnaire provided details on how they had responded to the permit conditions that were set. All three mills said that they had applied in-plant pollution prevention practices to reduce the quantities of emissions, discharges, and wastes, followed by necessary external treatment. This was achieved by searching out best available technology within the industry and applying it. Examples included wastewater minimisation techniques, effluent recycling, extended cooking, efficient washing, use of recovered condensates, etc. The permits also required the mills to conduct investigations in support of new technology development. One mill observed that in-plant measures accounted for 50 per cent of its environmental expenditures.

All three mills in the study had implemented secondary biological treatment (anaerobic and/or activated sludge treatment) to meet water quality needs. This treatment was applied when the possibilities of further in-plant measures had been exhausted. One mill has achieved remarkable nutrient reduction.

4.2 Flexibility considerations

The permits specify the environmental requirements that are to be met. Mills are granted flexibility to choose the technology to meet these limits. Discussions between the mills and the authorities within the permitting process were noted to have been of assistance when developing abatement plans. All three mills had put significant efforts into Research and Development, aiming at plant-specific solutions, some of which may fall under the concept of BAT.

4.3 Views of industry surveyed

All three mills noted that the environmental requirements considered both BAT and EQOs. One mill (Case A) observed that its limits were mainly BAT based, with the exception of phosphorous limits, which were mainly EQO based. One mill noted that the state of the recipient and the objective for its development are established by the authorities with the help of independent experts.

5. CONCLUSIONS

Finland operates a case-by-case permitting system. This considers both the environmental needs and application of BAT to operations. BAT is evaluated by assessing practices used in mills worldwide. Technical and environmental research programs have aimed at solutions to the requirements set by authorities as well as by the markets. This has resulted in domestic technologies that fall well within the BAT concept. Special attention has been paid to environmental risk analyses and the development of self-monitoring.

The permits include emission limits as well as requirements to investigate internal and external pollution control methods to reduce releases. The permits also include requirements to monitor emissions and their impacts. Results of these programs are considered in future permit applications. All information is made available to the public.

No numerical standards have been developed to set minimum performance levels that have to be met by all mills, except for some regulations. These regulations cover sulphur dioxide emissions from coal-fired power boiler plants, sulphur concentrations in fuel, guidelines on air emission limit values and targets, and noise limits. However, various targets have been set relating to overall discharge targets that the industry should attain by set dates. Additionally, Finland has participated in a Nordic program to define limits that should be attained by pulp and paper mills by the end of the century. The permit granting authorities consider these when developing permit requirements.

Flexibility is granted to mills in the choice of technology to meet permit requirements. Priority has been placed on applying internal control measures. However, external controls are applied as necessary to ensure that environmental requirements are met.

Finland is moving toward issuance of multi-media permits. At present, effluent discharge permits are issued by one body and integrated air and waste permits by another.

Annex 1. COUNCIL OF STATE DECISIONS ON AIR QUALITY GUIDELINES

No. 537
Council of State Decisions on Air Quality Guidelines
28 June 1984

Section 1
Guidelines

With the aim of preventing air pollution, the guideline is that the maximum average sulphur dioxide, particulate, nitrogen dioxide, and carbon dioxide concentrations in outdoor air, with the exceptions referred to in paragraphs 2, 3, and 4, must be as follows:

Substance	Time	Maximum concentration (mg/m³)
Sulphur dioxide (SO_2)	Year	40
	24 h	200
	1 h	500
Particulates (total suspended particulates)	Year	60
	24 h	150
Nitrogen dioxide (NO_2)	24 h	150
	1 h	300
Carbon monoxide (CO)	8 h	10
	1 h	30

The average 24-hour sulphur dioxide concentration in the air may exceed the 24-hour average given in the table once over a period of 30 days, provided, however, that not more than 2 per cent of the average 24-hour values exceed the table value over a period of 1 year. One per cent of the hourly averages for the sulphur dioxide concentrations in the air may exceed the hourly average given in the table over a period of 30 days.

Three per cent of the average 24-hour particulate concentrations in the air may exceed the 24-hour average given in the table over a period of 60 days, provided, however, that not more than 2 per cent of the 24-hour averages exceed the table value over a period of 1 year.

The average 24-hour nitrogen dioxide concentration in the air may exceed the 24-hour average given in the table once over a period of 30 days, provided, however, that not more than 2 per cent of the 24-hour averages exceed the table value over a period of 1 year. One per cent of the hourly averages of the nitrogen dioxide concentrations in the air may exceed the hourly average given in the table over a period of 30 days.

Section 2
Regional guidelines

In preventing air pollution, the aim must be to ensure that the sulphur dioxide concentration in the air does not exceed an annual average of 25 mg/m^3 in large agricultural and forestry districts or regions important in terms of environmental conservation.

Section 3
Long-range goal

The long-range goal of air protection is to apply national and international measures to reduce the amount of sulphur compounds falling on the ground and on the waters from the air in such a way that the annual sulphur concentration (*sulphur deposition*) does not exceed 0.5 g/m^2 in the areas referred to in Section 2.

Section 4
Instructions for implementation

The Ministry of the Environment will issue more detailed instructions concerning air quality measurement, determination methods and their application, and other aspects of implementation of this Decision.

Section 5
Entry into force

The Decision comes into force on 1 September 1984.

Case Study on the Use of Best Available Technology (BAT) and Environmental Quality Objectives (EQOs) in the Environmental Permitting of Bleached Chemical Pulp and Paper Mills in the Federal Republic of Germany

Pre-publication version prepared by
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July 1998

FOREWORD

This report reviews how the concepts of best available technology (BAT) and environmental quality objectives (EQOs) are taken into consideration in the environmental permitting of pulp and paper facilities in the Federal Republic of Germany. It was prepared by Environment Canada's National Office of Pollution Prevention based on responses to a questionnaire survey. The content of the questionnaire was developed by the Organisation for Economic Co-operation and Development's (OECD's) Pollution Prevention and Control Group.

This report is one of a series of reports prepared to provide background information on the procedures followed in the environmental permitting of pulp and paper mills in a number of OECD Member Countries. Information was gathered using a questionnaire designed to see how best available technology and environmental quality objectives were considered. The countries in the study were Austria, Belgium (Wallonia), Canada, Finland, the Federal Republic of Germany, New Zealand, Norway, Sweden, Switzerland, and the United States of America. Separate reports are available describing the permitting procedures of each country. This report is one of ten reports (Country Profiles) which describe the approach to environmental control of pulp and paper mills in each country. In addition, an overview case study report has been prepared describing the general permitting practices in the set of countries. These reports have been prepared by Environment Canada for the Pollution Prevention and Control Group (PPCG) of the Organisation for Economic Co-operation and Development (OECD).

This particular report provides details of the permitting approach in the Federal Republic of Germany, describing the legislative basis for permitting, the organisations that issue permits, and the use that is made of regulations, environmental quality objectives, best available technology, and economics. It also describes the technological response of mills to the permit conditions that have been set and the opinion of mills with respect to the permitting process.

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1. THE PERMITTING PROCESS

1.1 Constitutional responsibilities for environmental protection

The Federal Republic of Germany is a federal state comprising 16 Länder (states). These Länder were given large powers under the Basic Law (the Constitution) established in 1949, but gradually the Bund (the Federation) acquired widespread powers. The Basic Law sets out the division of legislative competencies between the Bund and the Länder. However, in a large number of fields, the Bund and the Länder have joint legislative competence. The implementation of federal environmental protection laws is the responsibility of the Länder. Through the joint Bund Länder working committees and the Bundesrat, the Länder have a say in the development and adoption of federal standards.

The basic law for air pollution in Germany is the Federal Immission Control Act (*Bundes-Immissionsschutzgesetz*) of 1974, last amended in 1995. The concept of emission is defined to include air pollutants, noise, vibration, light, heat, radiation, and associated environmental factors affecting humans as well as animals, plants, or other things. The Constitution gives the Bund and the Länder competing legislative competence for emission control. This means that the Länder may only legislate on subjects in so far as the Bund has not or where the federal law provides legislation of the Länder.

The Federal Immission Control Act demands that industrial plants be constituted and operated in such a way that environmental impacts or other hazards are not caused. In particular, plant operators are obliged to employ "state-of-the-art" precautionary measures in order to prevent harmful environmental effects. Furthermore, Article 5 of the Federal Immission Control Act also lays down requirements concerning the avoidance and utilisation of residues generated in a plant.

The Federal Immission Control Act requires federal authorities to issue ordinances identifying the types of facilities that are subject to licensing, set licensing requirements for those facilities, and impose emission limit values and technical control requirements for all facilities, whether licensed or non-licensed. The Act itself sets only the statutory framework for environmental standards setting. The detailed and substantive legal requirements imposed on a plant and its operators and other relevant matters are defined in a number of decrees, split into legally binding ordinances (*Verordnungen*) and legally non-binding administrative regulations (*Verwaltungsvorschriften*). These administrative regulations are binding for the Länder authorities and thus act indirectly via the permit, like an ordinance, onto the operators.

Analogous to air pollution control, the legal instrument of water management is the Federal Water Act (*Wasserhaushaltsgesetz*) of 1976, last amended in 1996. The Act provides the main legal framework for the protection of surface water and groundwater. Each of the 16 Länder have their own laws, which repeat and add to the federal law. The competence for implementing the law lies with the Länder. Wastewater discharges are mainly dealt with in Article 7(a) of the Federal Water Act, which enables the passage of General Administrative Regulations concerning minimum requirements to be met by discharges everywhere in Germany, irrespective of the quality of the water into which the wastewater is discharged. Federal regulations have been passed covering 54 types of industrial operations, including pulp and paper as one sector. The Länder can strengthen the minimum requirements in permits if required by the quality of the recipient water body.

Requirements for solid waste management are included in both the Federal Immission Control Act, which lays down requirements concerning the avoidance and utilisation of residues generated in a plant, and the Waste Avoidance and Waste Management Act (*Abfallgesetz*) of 27 August 1986. The Waste Avoidance and Waste

Management Act is based on the principle that waste is to be avoided or recycled by implementing processes that generate less waste. Non-recyclable waste is to be disposed of in an environmentally friendly manner. It requires that waste must be disposed of in such a way that the public's welfare is not compromised. In the case of waste incineration, the Waste Incineration Installation Ordinance (*Bundes-Immissionsschutzverordnung*) prescribes emission limits.

On 7 October 1996, a new Act for Promoting Closed Substance Cycle Waste Management and Ensuring Environmentally Compatible Waste Disposal (*Kreislaufwirtschafts-und Abfallgesetz KrW-/Abf G*) came into force. The new Act augments the Waste Avoidance and Waste Management Act and sets higher requirements for waste management. The new Act, for example, introduces a hierarchy of avoidance, recovery, and disposal of waste. As a matter of priority, the generation of waste has to be avoided. Where avoidance is not possible, waste has to be recovered by material or energy recovery. Only in cases where this is not possible is waste disposal permitted.

1.2 Permits

Under the federal structure of Germany, implementation of environmental laws and decrees is the responsibility of the Länder. However, the implementation process differs somewhat among the Länder. In each Länder, a number of local authorities are set up on a regional basis and are responsible for granting authorisations within the region.

1.2.1 Air pollution control

Pulp and paper facilities are required to obtain approvals as they are included among those types of facilities that require approvals under the Federal Immission Control Act (a list of those types of facilities requiring approval is given in Section 6.1 of the Annex to the Fourth Ordinance of the Federal Immission Control Act.) The authorities (Länder) may grant approvals subject to the facilities fulfilling the obligations arising from the Act. The principal obligations are as follows:

- construction and operation of installations is prohibited without a license;
- installations must be constructed and operated in such a manner that environmental damage and other dangers (considerable disadvantages and substantial impairments) are prevented;
- all possible precautions must be taken against environmental damage, especially by limiting emissions in accordance with the use of state-of-the-art technologies; and
- residues must be avoided unless they can be used without causing damage to the environment; if they cannot be avoided or used, because of technical or economic reasons, they must be disposed of in a manner that causes the least possible harm.

In addition to these obligations, a number of ordinances and administrative regulations impose substantive details and legal requirements that affect plants and their operators. In the course of the licensing process, the competent authority, which is always a state authority, defines the requirements for emission control, particularly emission limits. Those emission values that are included in the TA Luft become legally binding emission limits when adopted in the license (permit) issued by the Länder.

With respect to air pollution control, the Technical Instructions on Air Quality Control (TA Luft), passed on 27 February 1986, are very important and provide guidance. These are referred to as the First General Administrative Regulation pertaining to the Federal Immission Control Act. Each facility subject to licensing has to comply with emission limit values (ELVs) for a large number of substances covered by the TA Luft. The ELVs do not depend on environmental quality standards and are applied uniformly throughout Germany, irrespective of local air quality. In addition to these ELVs, ambient air quality values (objectives) have been set for a number of substances under the TA Luft as outlined in Tables 1 and 2. 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. The results of this ambient air quality measurement and dispersion modelling are considered in the permit approval process. If an air quality value laid down in the TA Luft is breached, the facility must apply further control measures beyond those set out in the sector standards.

Table 1. Ambient air quality standards established for protection against health hazards.

Pollutant	IW 1 (long term)[1]	IW2 (short term)[2]	Units
Suspended Particles (without considering the components of the suspended particles)	0.15	0.30	mg/m^3
Lead and inorganic lead compounds as components of the suspended particles - indicated as Pb	2.0	—	$\mu g/m^3$
Cadmium and inorganic cadmium compounds as components of the suspended particles - indicated as Cd	0.04	—	$\mu g/m^3$
Chlorine	0.1	0.3	mg/m^3
Hydrochloric Acid - indicated as Cl	0.1	0.2	mg/m^3
Carbon Monoxide	10	30	mg/m^3
Sulphur Dioxide	0.14	0.4	mg/m^3
Nitrogen Dioxide	0.08	0.2	mg/m^3

* as long as hydrochloric acid cannot be measured clearly separated from chlorides, IW 2 shall be 0.30 mg/m^3

Table 2. Deposition standards established to protect against considerable disadvantages or substantial impairments.

Pollutant	IW 1 (long term)[1]	IW2 (short term)[2]	Units
Dust Deposition (non-hazardous dusts)	0.35	0.65	g/m^2d
Lead and inorganic lead compounds as components of the dust deposition- indicated as Pb	0.25	—	mg/m^2d
Cadmium and inorganic cadmium compounds as components of the dust deposition- indicated as Cd	5	—	$\mu g/m^2d$
Thallium and inorganic thallium compounds as components of the dust deposition- indicated as Tl	10	0.3	mg/m^2
Hydrofluoric Acid and inorganic gaseous fluorine compounds - indicated as F	1.0	3.0	$\mu g/m^3$

1. IW 1 is the annual arithmetic mean of all measurements.

2. IW 2 is the annual 98-percentile value of the cumulative frequency distribution of all measurements.

1.2.2 Water pollution control

The use of water requires the approval of the competent authority. This has to be denied if endangerment of the public health (e.g., the public water supply) is anticipated. Within defined water protection areas, certain activities may be partially or fully prohibited.

In the case of wastewater, each discharge, wherever it is located, has to comply with technology-based minimum requirements (best available techniques). Requirements are specified for 54 industrial sectors and municipal wastewaters in administrative regulations and will be incorporated into future administrative ordinances.

The Nineteenth General Administrative Regulation on Minimum Requirements for Waste Water includes minimum requirements for pulp and paper mills discharging into the aquatic environment. If these requirements are not met, approval for the discharge of wastewater is denied. Stricter requirements may be set by the Länder based on local water quality considerations.

The competent water authorities have far-reaching power. Applicants for wastewater authorisation have to meet various obligations, including the following:

- submission of an application to use the water source;
- co-operation with the supervisory authority;
- permission for authorities to have access to buildings and sites of operations;
- provision of information;
- making manpower, documents, and tools available; and
- making technical investigations and tests possible.

Applications for permits are assessed by the Water Management Agency of the concerned Länder in conjunction with local water authorities. A report is submitted to the region's administrative authority. This could be the Administrative District Office or a local municipality in cases where the municipalities are independent of the Länder. The Administrative District Office, or local municipality, develops draft permit requirements and submits these to the applicant for comment within a specific time frame. Comments by the applicants are then examined by the permitting authorities and a decision is rendered.

The responsible authority evaluates the present state and potential impact of planned activities on the environment. Following a comprehensive assessment of the impacts of wastewater discharges on the water body, the authority issues a permit. This includes at least the following:

- characterisation of all components (e.g., production capacity) that influence the amount and quality of discharge;
- limit values concerning the amount and quality (concentration and/or load) of direct and indirect discharges; and
- instructions concerning construction and safety; production processes and/or agents; operation and maintenance of treatment facilities; recovery of materials/substances and waste disposal; type and extent of control to be performed by the operator; measures to be taken in case of process failures and accidental spills; analytical methods to be used; schedules for modernisation, retrofitting,

investigations to be carried out by the operator; schedules for reports to be filed by the operator on monitoring/self-control, and investigation programs.

With respect to supervision, the responsible authority, or an independent institution authorised by the authority, is required to:

- inspect the amount and quality of discharges through sampling and analysis;
- control the attainment of permit requirements;
- arrange for monitoring of the impacts of wastewater discharges on the receiving environment; and
- review the permit when necessary.

Water protection officials have to be appointed by the mill if more than 750 cubic meters of wastewater per day is discharged.

1.2.3 Waste management

For the implementation of requirements concerning avoidance and utilisation of residues, a number of General Administrative Regulations/Master Regulations (*Musterverwaltungsvorschriften*) have been set by a Bund Länder Pollution Control Committee. These regulations may be used by the federal states in licensing and supervision procedures.

The treatment of waste must be conducted according to the provisions of the new Act for Promoting Closed Substance Cycle Waste Management and Ensuring Environmentally Compatible Waste Disposal. The Act introduces a hierarchy of approaches for plants to use to avoid the creation of waste. In cases where waste creation cannot be avoided, waste management requirements are set.

The following objectives are set concerning the management and supervision of waste:

- waste may only be transferred to operators of waste treatment plants if the plants are suited to handle the waste;
- a logbook must be kept on the type, quality, and treatment of waste;
- the competent authority must be notified of conditions requiring that a logbook be kept;
- the supervisory authority must be kept informed of the operations, systems, and facilities where waste treatment is carried out; and
- supervisory authority representatives must be allowed access to rooms or sites, and be allowed to inspect documents and to undertake technical tests.

Solid wastes may be treated, stored, or disposed of only at authorised plants or waste disposal facilities; the authorisation process takes into account environmental concerns. Waste management efforts strive to ensure that no livestock, birds, game, or fish are threatened; that no water bodies, soil, or crops are affected; and that no harmful environmental impacts are caused by air pollution or noise.

Facilities for waste disposal have to be authorised under the Waste Avoidance and Waste Management Act. Other waste treatment facilities, e.g., plants that treat waste thermally, sorting facilities, composting plants, and stationary waste storage facilities, have to be authorised under the Federal Immission Control Act or under building law. Additional requirements apply to hazardous waste disposal facilities. The Administrative District Office is the responsible permitting authority.

When licensing new stationary waste disposal facilities, Technical Instructions must be taken into account. When making major modifications to existing facilities, two Technical Instructions apply (these refer to hazardous waste and municipal waste). These instructions are legally binding on all licensing authorities, and must be implemented uniformly in the individual federal states. The instructions specify requirements for waste recycling, monitoring, and the use of best available technology, as covered in accompanying regulations. Departures from the regulations are allowed, in certain instances, if it can be shown that other appropriate technology will not pose a risk to the public.

Technical Instructions on Waste apply to:

- the development of waste management plans;
- licensing decisions on the establishment and operation of stationary waste treatment facilities;
- supervision of waste management and disposal; and
- licensing the collection, transportation, or delivery of waste.

1.2.4 Existing versus new facilities

In general, permit requirements for existing and new facilities are similar. For several facility types, however, the TA Luft distinguishes between new and existing facilities, concerning ELVs, based on technical considerations. There is also a difference in the periods over which existing facilities have to meet the emission limits required for new facilities. In western Germany, air emission requirements for existing facilities have been implemented since 1994. Special regulations apply to the eastern part of Germany for existing facilities. There, TA Luft requirements had to be implemented before 1996, or in special cases before 2000. For new plants, emission requirements have to be implemented immediately.

For solid waste facilities, the general principles in the Technical Instructions apply equally to both old and new facilities. The Technical Instructions apply immediately to new facilities, whereas transitional provisions, coupled with specific deadlines, apply to existing facilities.

1.2.5 Appeals

Decisions of the permitting authorities can be appealed by the permit applicant or by any persons who feel that their rights have been infringed upon (especially with respect to their health and property) as a result of a permit being granted. Permit applicants have no legal right guaranteeing that action will be taken with regard to their objections, except in the event that they may be injured, with respect to their health or property. Objections can be raised by stakeholders during the hearing stages of the permit issuance process, where technical and other requirements are presented. These objections have to be examined by the permitting authority. Permitting decisions are made following these hearings. The decisions of the permitting authority may be officially contested.

1.3 Multi-media permits

Permits for air, water, and solid waste are issued separately pursuant to media-specific legislative requirements, although there is a trend toward permits that incorporate all environmental media. Co-ordination of multi-media

protection is achieved in the permitting process through agreements between and declarations made by individual authorities. In a pulp and paper case study provided, declarations were made by the Water Management Agency (water), the State Environmental Protection Agency (waste, air, and noise), and bureaus of health.

It is a principle of all German environmental legislation that efforts must be made to prevent the release of environmental pollutants to other media. Releases to other media may be allowed only if the environmental pollutants are treated using the best available technology. Even then, a reduction in emissions to one environmental medium must not result in exceedences of emission standards for other media.

An example of multi-media consideration is reflected in the Waste Avoidance and Waste Management Act. This Act has several clauses that incorporate and consider water, air, and land aspects ensuring that authorisation under the Act will not have adverse effects on other media.

1.4 Environmental assessment

An environmental impact assessment (EIA) may be required, under provisions of the Environmental Impact Assessment Act, prior to issuing permits. In one of the case studies provided, an EIA was not carried out because it was assumed that it would not result in any significant improvement in the level of environmental protection.

In the future, wastewater treatment plants that have a daily BOD_5 load greater than 3 tonnes per day, or that discharge more than 1 500 m^3 of effluent every 2 hours, will have to undergo an EIA. This will follow an integrated or multi-media procedure.

2. BAT, EQOs, and ECONOMICS

2.1 Standards setting

Various standards have been developed for air and water media that are considered by the authorities when setting permit requirements. Several principles underlie the pollution control standards, including:

- The precautionary principle: minimisation of environmental risks should be achieved by continually updating emission standards in keeping with the state of the art and by ensuring that these emission standards are applied in each individual case.
- The polluter-pays principle: emission control measures must be borne by the party that causes the emission.
- The principle that pollution prevention (emission reduction) takes precedence over dispersion, for both air and water. Underlying this concept is the precautionary principle. In the case of water pollution control, wastewater pollutant loads must be kept as low as possible. This requires that relevant BAT-type standards be achieved by meeting indicated requirements using the best available techniques, as a minimum requirement. Consideration is not given to ambient water quality conditions. In a second step, water quality objectives for surface waters in particular must also be met (combined approach). Similar considerations apply to air pollution control.

2.1.1 Air emission standards

Air emission standards have been set to prevent tolerable pollutant levels in the ambient air from being exceeded by new or existing plants. These standards are developed on a sectoral basis and are contained as limit values in the TA Luft. The limits are based on state-of-the-art technical measures used for controlling emissions.

For pulp and paper mills, emission standards have been set governing releases of SO_2 and NO_x from existing and new process units. Tables 3 and 4 present standards that apply to various boilers.

Table 3. SO_2 emission standards for different types of boilers.
(according to TA-Luft and Resolution of the Ministers of Environmental Affairs of the Länder, 1991; in [g/m³]; dry basis)

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

Table 4. NO_x emission standards for different types of boilers
(according to TA-Luft and Resolution of the Ministers of Environmental Affaires of the Länder, 1991; in [g/m³]; dry basis)

Unit	O_2 Reference value (%)	New Facilities > 20 MW	New Facilities < 20 MW	Existing Facilities > 20 MW	Existing Facilities < 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	

Area-related provisions

To control air pollution on a regional basis, area-related provisions of the Federal Immission Control Act allow for the preparation of Clean Air Plans, designation of areas subject to investigation, and issuance of smog ordinances. Implementation of these provisions requires the preparation of emission inventories and impact assessments, as well as analyses of potential control measures and action plans. The first Clean Air Plans for the territory of the new federal states have been drawn up.

The TA Luft also specifies deposition standards for certain heavy metals. Although sulphur deposition standards for Germany do not yet exist, target loads for sulphur, based on calculations performed by the EKE Task Force on Integrated Assessment Modelling, have been made available.

2.1.2 Wastewater discharge standards

Water protection requirements in Germany are set out in the Federal Water Act. In general, water resources have to be managed in such a way as to prevent damage. The following passages from Article 7(a) of the Act illustrate the manner in which the pollution control requirements are developed:

- *permits for discharging wastewater shall only be granted if the load of noxious substances discharged is kept as low as is possible in compliance with the best available techniques;*
- *the federal government passed a Waste Water Ordinance on 21 March 1997, regulating four sections of dischargers, and further 50 sector-specific administrative regulations specifying minimum requirements to be met by dischargers, in keeping with best available techniques; and*
- *requirements can also be established for the very source of wastewater and for a locality before streams are mixed.*

The federal government has passed 54 sector-specific administrative regulations specifying minimum discharge requirements for wastewater releases to receiving environments. These regulations were published as appendixes to the General Framework Administrative Regulations Governing Minimum Requirements for Discharging Wastewater into a Body of Water on 8 September 1989. In individual permitting decisions, more stringent requirements may be set, where necessary, in order to preserve water quality.

Owing to the multitude of substances likely to be found in water, a sectoral approach, not a single substance approach, is taken. Requirements are set through the use of bulk parameters (BOD, COD, AOX), single parameters (e.g., heavy metals), and biological effects parameters (toxicity to fish, bacteria, and algae).

Table 5 presents standards that have been set relating to pulping and papermaking. With respect to toxicity, a toxic effect has to be absent for effluents diluted by the G_F factors shown. For example, in the case of primarily bleaching effluents, the tests have to be passed in a mix containing 50 per cent effluent ($G_F = 2$).

Table 5. 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

The standards shown in Table 6 have been passed with respect to effluents emanating from papermaking operations.

Table 6. 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

* 2 hour composite or qualified random sampling (five random samples taken not more than 2 minutes apart and mixed afterwards).

Standards are developed using expert committees of federal and state officials responsible for environmental control. Members are appointed by the Federal Ministry of the Environment in agreement with senior state officials responsible for water management and water legislation. Non-official representatives are appointed on the recommendation of relevant expert associations (industrial associations). Experts from outside government are often included in the advisory process concerning individual issues. Consideration is given to general (non-specific) legislative provisions, such as the concept of "best available techniques." Production-integrated pollution prevention measures are crucial, especially where best available techniques are concerned. Input is obtained from the federal states concerned with enforcing water legislation, suppliers of process and treatment technology, experts in relevant sciences, and others as appropriate.

Under the Federal Water Act, public and environmental groups are involved in the development of administrative regulations through prescribed hearings. If new aspects evolve after the working groups have wrapped up their deliberations, particularly in the course of the hearings, they are taken into consideration when the working groups prepare their draft documents. This method has proven to be effective.

Standards include accommodations for cases where biological control system performance may be affected by low ambient temperatures during winter. However, this has not been required for the pulp and paper industry as the temperature of wastewater remains relatively high throughout the year.

2.2 Environmental quality objectives (EQOs)

In the Federal Republic of Germany, environmental quality objectives have been issued defining acceptable levels of pollutants, in water and air receiving media, to ensure sustained use of these resources. Environmental protection is first ensured by applying best available technique (BAT) based point source emission standards. However, the application of BAT does not necessarily mean that all sites will be adequately protected, due to site-specific considerations. Thus, concentrations of dispersed pollutants are compared against EQO values and appropriate decisions are made. More stringent requirements are set, where necessary, to protect sensitive sites.

2.2.1 Air

General ambient air quality standards have been set for lead, total suspended particulates, SO_2, and NO_2 in air quality control directives of the European Union. Additionally, threshold values have been set for the ozone concentration necessary for the protection of human health and vegetation, as well as for issuing warnings to the public. These have been incorporated into Germany's national legislation.

The TA Luft included two types of standards. The first are health-related standards for pollutants, such as those for SO_2, total suspended particulates, NO_2, CO, lead, cadmium, and chlorine, which may be called real standards. These standards must not be exceeded. The second type of standards guard against considerable disadvantage and substantial impairment to the environment from, for example, dust deposition (non-hazardous dust); lead, cadmium, and thallium as components of deposited dust; and flour. These standards define guideline values and provide a means of comparing pollution impacts against other interests.

With respect to health-related standards, the TA Luft differentiates between long-term and short-term ambient air quality standards. A harmful environmental effect is assumed to have occurred if the pollutant concerned exceeds any of the ambient air quality standards. If this happens, a permit would be denied.

Table 7 summarises the TA Luft environmental quality standards for total suspended particulates, SO_2, and NO_2, which are the most significant air pollutants associated with the pulp and paper industry.

Table 7. Environmental quality standards

Pollutant	IW1 (long term)	IW2 (short term)
Total Suspended Particulate Solids (without consideration of components)	0.15 mg/m³	0.30 mg/m³
SO_2	0.14 mg/m³	0.40 mg/m³
NO_2	0.08 mg/m³	0.20 mg/m³

Notes:

1) IW1 is the annual arithmetic mean of all measurements.
2) IW2 is the annual 98th percentile value of the cumulative frequency distribution of all measurements.

With respect to air quality standards, it is noted that in September 1996 the European Union Council approved a new Framework Directive on the Evaluation and Monitoring of Air Quality. This Directive gives general direction to the work carried out on air quality in the European Union. Among other items, it is anticipated that

new air quality standards will be developed for particulates, SO_2, and NO_2 in the future. These will be included in a series of "daughter directives" issued by the European Union. Thus, it can be expected that, in the near future, Germany will revise its current air quality standards to reflect developments in the European Union.

2.2.2 Water

With respect to water quality objectives, it is noted that there are no legally binding aquatic environmental quality objectives, although non-binding targets have been developed for 28 organic pollutants, heavy metals and pesticides (Irmer, et al., 1995.) These targets are used to guide the permit decisions by the authorities. The proposed targets were developed separately to meet specific needs, such as protection of aquatic communities, drinking water supplies, and commercial and sport fishing. Compliance with these target values assumes that no threat would be posed to the objects or uses being protected. The target objectives are applied to the ambient aquatic environment throughout the Federal Republic of Germany. Only if problems arise with respect to individual substances are the sources investigated and preventive measures sought. Such measures might involve banning the substance concerned.

In addition, North Rhine-Westphalia is the only state that has developed general quality requirements for watercourses. The issuance of General Quality Requirements for Watercourses by the state Environment Ministry was designed to create a standardised basis for official enforcement. Owing to the peculiarities of each case, these requirements provide only decision-making assistance. They are not binding. These emission standards also refer to cases in which more stringent requirements are needed for wastewater discharges than those set out under best available techniques in the schedules of the Federal Framework Wastewater Administrative Regulations.

The Water Association of the Länder (LAWA) has recommended that Water Quality Class II criteria be met for all watercourses in the Federal Republic of Germany. This refers primarily to organic impurities and nutrients (referred to as a "saprobic index"). Although not legally binding, its adoption in some areas has led to increased development of biological sewage treatment plants as well as tertiary treatment. In 1995, 48% of the water courses (river length, 30.000 km determined) met the goal of Water Quality Class II.

2.3 Best available technology (BAT)

A concept of BAT is used to identify the minimum environmental requirements that should be applied to control air, water, and solid waste pollution within permit decisions. It is noted that BAT is defined in both air quality control and waste legislation. BAT is not explicitly defined, but is mentioned, in the Federal Water Act. The following discusses BAT's application to air, water, and waste pollution decisions.

2.3.1 Air

Under Section 5 of the Federal Immission Control Act, environmental risks are to be prevented by reducing emissions using state of technology in each case. In this context, state of technology ("Stand der Technik") means the state of development of advanced processes, facilities, or modes of operation deemed to indicate the practical suitability of particular techniques for restricting emission levels. When determining the state of the art, special consideration is given to comparable processes, facilities, and modes of operation that have been successfully proven in practical operation.

The Ordinance on Large Combustion Plants implements state of technology by stipulating specific emission control technologies and emission standards, as well as other construction and operational measures. It thus prescribes both scientific techniques and emission standards to be complied with.

2.3.2 Water

The Federal Water Act, the main legal framework for protecting surface water and groundwater, states that permission for discharging wastewater shall only be granted if the load of noxious substances of the wastewater is kept as low as possible by using the best available techniques. All releases of wastewater must be treated prior to their discharge according to minimum requirements.

The best available technique sets threshold values for concentrations and loads to be achieved in terms of wastewater constituents in reference to production capacity. Usually, it does not prescribe any specific prevention or treatment techniques.

2.3.3 Solid waste

The Technical Instructions on Waste (Hazardous Waste), the Technical Instructions on Municipal Waste, and other legislation define best available technology. With some minor wording differences, they state the following: best available techniques within the meaning of this Technical Instruction are the degree to which progressive procedures, installations, or operating practices have been developed, thereby ensuring the practical suitability of an environmentally friendly waste disposal technique. In determining the best available technology, comparable suitable procedures, installations, or operating practices that have been successfully tested in the field should especially be considered.

The Waste Avoidance and Waste Management Act of 1986 was thoroughly revamped in the early 1990s. On 27 September 1994, the Act for Promoting Closed Substance Cycle Waste Management and Ensuring Environmentally Compatible Waste Disposal was passed. It took effect in October 1996. By meshing the Federal Immission Control Act with this Act, best available technology requirements shall also apply, in the near future, to facilities that are to be approved under the Federal Immission Control Act.

In addition to the model administrative regulations for avoiding and recycling waste under the Federal Immission Control Act, which are designed to provide authorities with tangible directives for action, there are, with respect to hazardous waste production and specific waste, draft technology papers that describe best available technology for avoiding and recycling these wastes, e.g., lacquer sewage sludge, galvanic sewage sludge, waste acid, spent foundry sand, various oil-containing wastes, etc.

2.4 Negotiation of standards

Several regulations have been developed to control pollution releases from the pulp and paper industry. These regulations serve as minimum requirements in permits issued by the Länder; however, the authorities may impose stricter requirements if necessary. The only area subject to negotiation is the deadline for compliance on the part of existing plants.

2.5 Economic considerations

The financial capability of the permit applicant does have an effect on permit limit values.

General economic factors, however, have an indirect effect on pollution control. In order to pass BAT-type standards, it has to be demonstrated that they are economically justifiable and reasonable. Also, when permitting specific plants, time may be allowed for plants to come into compliance with the limits over a period of time if this is justified. Justification may be based on economic analyses.

Economic evaluations were carried out when the TA Luft was developed. During this phase, industry had an opportunity to bring forward arguments concerning economic aspects associated with the proposed measures. Where necessary, the proposed measures were modified in order to take into account these economic aspects. The advantage of this procedure is that economic aspects do not need to be reconsidered during each authorisation procedure.

2.6 Interaction of BAT and EQOs

In the permitting process, BAT requirements are regarded as minimum levels that may be set. However, the application of BAT does not mean that all sites will be adequately protected. Environmental quality objectives, ambient targets, and guidelines have been issued to show where stricter requirements may be needed to protect receiving environments. Some sites may be more sensitive due to factors such as population density, degree of industrialisation, size of rivers, morphological and atmospheric characteristics of the air shed, etc. In such cases, these more stringent requirements are based on EQO considerations.

Specifically, under EC Directive 91/271 EEC (Municipal Wastewater Directive), nearly all of the watercourses in Germany are considered to be sensitive areas. Consequently, stricter regulations are commonly enforced in these areas. There are no standardised procedures or uniform requirements for setting these stricter requirements. These decisions come under the jurisdiction of the permitting authorities.

3. TRENDS IN PERMITTING

3.1 Cleaner technology

The use of cleaner pollution prevention-based technologies plays a major role in permitting and is one part of the best available technology concept. In process design, recycling and recovery of the waste are used to minimise releases. Use is also made of external treatment processes, such as primary clarification and biological treatment, where necessary. Secondary treatment is common throughout the paper industry.

At the federal level, the Minister for the Environment, Nature Conservation and Nuclear Safety provides support for commercial-scale demonstration projects that will progressively evolve best available technologies. Results are incorporated within manufacturing processes and permits. Frequently, clean technologies are applied by the industry voluntarily, without being mandated by permit requirements.

3.2 Trends in limits

In order to illustrate how the permitting process is applied, the federal Environmental Agency provided details on considerations involved in permitting the operation of two integrated bleached sulphite paper mills. One case dealt with air, water, and solid waste management permitting and the other solely with water permitting.

3.2.1 Case study A

Mill A is an integrated pulp and paper mill with a capacity of 1 400 t of paper per day. The mill operates a bleached sulphite pulping line with a capacity of 278 t of pulp per day. The balance of pulp needed for paper production is purchased. The text that follows describes the approach taken to licensing when the mill installed a new chemical recovery plant, which incorporated waste liquor incineration and flue gas desulphurisation. General details are provided covering the mill's permits for air, water, and solid waste management, as well as monitoring requirements.

Air permitting

Air emissions from the plant are subject to emission standards laid down in the TA Luft. In issuing a license for the pulping operation, the regional administration office considered these values (emissions from papermaking operations are licensed by state Trade Inspection Offices). In this case, the legal values in the standards were set as the license limits, with the exception that a stricter limit was set for NO_x emissions. The stricter NO_x limit was set because the plant proposed a tighter limit in the submission it made in support of its permit application.

In general, installations subject to licensing must meet the BAT mass loading or concentration limits laid down in legislation in order to prevent harmful environmental impacts. For precautionary purposes, however, the licensing authority may require the operator to implement control measures beyond those prescribed by legislation. In this case, the operator could have been required to achieve technically feasible limits beyond those in the prescribed standards. This was not done, however, because it could result in an increase in the amount of excess acid discharged from the flue gas treatment chemical recovery plant, thereby increasing the

pollutant load in the wastewater stream. Permit requirements are met through boiler design, flue gas scrubbing, and the installation of a high-efficiency electrostatic precipitator.

Section 2.1.1 provides details of emission standards applicable under legislation for sulphur dioxide and nitrogen dioxide. Table 8 lists the substances for which limits are included in the permit and the monitoring requirements. Noise limits are also included in the license.

Table 8. Parameters monitored and monitoring frequency

Substance/ Property Monitored	Monitoring Requirement
Nitrogen Dioxide	Continuous
Sulphur Dioxide	Continuous
Dust	Continuous
Dust constituents covering: • arsenic • lead • cadmium • chromium • cobalt • nickel	Initial and Recurrent Measurements
Carbon Monoxide	Continuous
Halogenated Compounds	Initial and Recurrent Measurements

The initial and recurrent measurements required for various substances in dust and halogenated compounds have to be made no earlier than 3 months, and no later than 12 months, after commencement of operations. Thereafter, measurements have to be taken every 3 years. At least three individual measurements have to be taken with the plant operating at its thermal rating. An individual measurement may not last longer than half an hour. The result is expressed as a half-hourly value.

Concentrations and mass loading in waste gases are measured continuously. Operational parameters and data concerning the removal efficiency of the gas treatment plant are also recorded continuously. These measurements are used to establish whether or not the emission rates stipulated in the permit are being met. The percentage of oxygen in the waste gas is determined continuously. Emissions are calculated on the basis of half-hour and daily intervals, with the values converted to reference oxygen contents. Daily operating times are recorded as well. A remote reporting system is in place with the measured values passing directly to the Administrative District Office. The Administrative District Office is also able to interrogate the system to determine compliance.

Water permitting

A new water permit had to be issued because the wastewater treatment plant that handled the effluent from the two mills did not meet the wastewater regulation under the Federal Water Act. The new permit was issued on 25 June 1990, with a life of slightly more than 20 years, expiring on 31 December 2010. The permit was issued by the state regional administration following permit application and public hearings. Although the permit for air emissions was issued separately, the water permit hearing also reviewed the air permit application.

The receiving water for mill effluent is not a particularly sensitive water body; however, the state government was seeking to improve its general water quality to at least Water Quality Class II (moderately polluted). For this reason, somewhat more stringent requirements were set for some parameters than what are permitted under regulations. This was determined on the basis of justifiable effort and expenditure. Table 9 summarises the permit limits and levels permitted under the regulations.

Subsequent to permit issuance, limits were set for total inorganic nitrogen at 10 mg/L and total phosphorus at 2 mg/L in the combined effluent.

Table 9. Water permit and federal Water Act limits

Parameter	Pulp Mill		Paper Mill	
	Permit	Water Act	Permit	Water Act
COD (kg/t)	60	70	2	2
BOD (kg/t)	4.2	5	0.7	25 mg/L
AOX (kg/t)	0.032	1.0	0.006	0.02

The permit included accommodation for the mill to come into compliance subsequent to permit issuance in 1990. The wastewater treatment plant became operational in the summer of 1991 and has worked at capacity since the end of 1992. The compliance schedule was based on the time required to retrofit the treatment plant. The discharge permit does not prescribe technology, although it does provide a description of it.

Solid waste management permitting

The solid waste management permit for Mill A was not provided. It is noted that some aspects of solid waste control are covered under the wastewater permit, e.g., handling of wastewater treatment plant residuals.

The German federal Environmental Agency notes that the following factors from the Waste Avoidance and Waste Management Act would influence the solid waste management permit:

- The recycling/reuse of waste must take precedence over other forms of waste management where this is technically feasible, i.e., the additional costs incurred are not disproportionate with those of

other management processes, and a market exists for the resultant substances or energy, or one can be created, in particular through the involvement of third parties.
- In cases where it can be proven that waste cannot be recycled/reused, the waste shall be allocated to an installation for treatment or storage.

Wherever possible:

- A waste material shall be passed for chemical, physical, or biological treatment if it contains unacceptable quantities of environmentally harmful substances or compounds that can be separated, converted, or immobilised and thus rendered less harmful.
- A waste material shall be passed for incineration if it contains organic substances that can be destroyed by heat in accordance with state-of-the-art technology, or, alternatively, if it contains any other organic substances in quantities that are harmful to the environment.
- Waste may be allocated to ground-level dumping sites if the allocation parameters are met.
- Waste may be allocated to underground dumping sites if it contains no pathogens of communicable diseases.
- Single-substance dumping may be carried out above or below ground.

Relative to these requirements, the permit for Case Study A has a stipulation that wastewater treatment residuals have to be utilised or disposed of in an environmentally compatible manner. As it has not been possible to date, to utilise the secondary treatment sludge generated, e.g., in brick-making, the sludge has to be landfilled following sufficient dewatering.

With regard to monitoring, the Administrative District Office (the permitting authority) is responsible for monitoring waste management (transport, reclamation, and disposal).

Monitoring requirement

Water discharge compliance monitoring is controlled by the permitting authority, which conducts the monitoring. This varies from state to state. In Case Study A, wastewater monitoring is carried out on the company's behalf by two specialised authorities (NLO and StAWA). However, the permit-granting authority also conducts its own on-site monitoring several times a year. The company also conducts extensive self-monitoring and results are documented. Monitoring covers the parameters mentioned in the 19th General Administrative Regulation on Minimum Requirements for Waste Water, referred to in Table 9. In Bavaria, the location of Case Study B, there is a self-monitoring regulation, although the results do not have legal standing. Plants conduct self-monitoring as a means of ensuring proper functioning of the installations and that the limits of the parameters covered in the permit are observed. Compliance is determined by official inspection alone.

Analyses are mainly conducted according to DIN procedures. These are stipulated in the Framework Wastewater Administrative Regulations, under federal law, which are in turn subject to European Union information guidelines. Monitoring results are made available to the public.

Table 10. Water monitoring requirements for case study A

Parameter	Measurement Period
COD, concentration and load	24 h mixed sample, homogenised
AOX, concentration and load	24 h mixed sample, homogenised
Total Inorganic Nitrogen	24 h mixed sample, homogenised
Total Phosphorus	24 h mixed sample, homogenised
Toxicity to fish, dilution factor	24 h mixed sample, homogenised
pH	Random Sample
Temperature	Random Sample

The parameters listed in Table 10 are specified in administrative regulations covering monitoring. It is noted that administrative regulations require grab samples for AOX monitoring. However, in Case Study A, a 24-hour sample was used for AOX. This was allowed because the mill discharges AOX at levels substantially below what is allowed in its permit, releasing only 8 kg of AOX per day compared with the 278 kg of AOX per day permitted under the administrative regulations.

Whenever compliance monitoring results reveal that a plant has exceeded its threshold limits, the plant must implement corrective measures.

3.2.2 Case study B

The German Federal Environmental Agency also provided details of a draft permit that was to be issued to an integrated bleached sulphite pulp mill in late 1995 for two secondary biological treatment facilities. One system will handle the effluents predominantly from pulping and bleaching, and the other predominantly from papermaking. The following discussion centres on general details and trends in the decision-making process as the permit had not been issued at the time this study was conducted.

The mill under discussion commenced chemical pulping in 1898 and the manufacture of paper in 1963. Throughout its history, the mill has undergone progressive modernisation and expansion to meet market needs. This case study represents a situation in which a facility has adapted to changing environmental and market requirements rather than a situation involving a new state-of-the-art facility. The sewer system of the complete site has been renewed during the last 5 to 10 years, including strict separation of polluted and non-polluted wastewater streams, intensified reuse of water, and installation of water recycling and counter-current devices.

The mill discharges to a water body that is a sensitive ecosystem within the meaning of the EC Directive 91/271 EEC (Municipal Wastewater Directive). The receiving water body, the River Main, is Water Quality Class II, according to the German classification systems for surface waters. In Germany, the organic biodegradable pollutant load in flowing waters is classified according to seven quality classes. This evaluation of water quality is based on the assessment of certain characteristic organisms or combinations of organisms (saprobic index). Water Quality Class II, (moderate) refers to water sections with moderate pollution and good oxygen supply and a very large variety of species. The current water quality of the river receiving the pulp and paper effluents is Class II to III. To reach the Water Quality Class II target, the water authority decided that permit requirements had to be more stringent than the published federal minimum requirements for the industrial sector. The water permit will have a duration of 20 years and refers to the present production rate of 555 t of product per day.

Although not yet issued, the water permit would likely consist of two parts. It is noted that a draft permission is under discussion.

Part I: Effluents predominantly from the pulping process

Table 11 compares values in the draft permission with those in the 19th General Administrative Regulation on Minimum Requirements for Waste Water, Part A.

Table 11 Draft permission limits versus federal minimum requirements.

Parameter	Sample type	Minimum requirements	Draft permission
COD	Daily composite	70 kg/t	<45
BOD_5	Daily composite	5 kg/t	<1
AOX	Grab sample	1 kg/t	<0.1
Toxicity to fish, dilution factor (G_F)	Daily composite	2	2

The requirements for COD and BOD_5 are based on the levels of performance that generally acknowledged rules of technology (biological treatment) can achieve. The limits for absorbable organic halide (AOX) and toxicity are based on best available technology. With respect to AOX, it is noted that all German mills except one have developed chlorine-free technologies, leading to negligible AOX releases in comparison with those allowed under the 19th General Administrative Regulation on Minimum Requirements for Waste Water. The above-mentioned mill is now using a totally chlorine-free process voluntarily. This further reduces the annual wastewater charges the mill has to pay to the Länder under the wastewater discharge system.

With respect to dilution factor G_F, this is the minimum value at which all fish survive for more than 48 hours. The value is the volume ratio of an effluent to the mix of effluent and dilution (fresh) water required to sustain the fish. For example, if a sample of wastewater has to be diluted with three volumes of dilution water, for a total of four volumes, to show no acute toxicity, the dilution factor equals 4.

Part II: Effluents predominantly from the paper mill

Regulations were passed in 1992 under Annex 19 B of the General Administrative Framework Regulation covering releases from papermaking operations; seven different types of papermaking are covered, each with different limit values. The limits of these Minimum Requirements for coated and wood-free papers are shown in Table 5 for this mill more stringent values are being discussed, the scope of the operating license that will be issued has not yet been defined.

Local requirements

The mill discharges to a water body that is a sensitive ecosystem within the meaning of the EC Directive 91/271 EEC (Municipal Waste Water Directive.) The current quality of the river receiving the pulp and paper mill effluents is Class II to III according to the German classification system for surface water (Annex 1.) In Germany, the organic biodegradable pollutant load in flowing waters is classified according to seven quality classes. The evaluation of water quality is based on the assessment of certain characteristic organisms or combination of organisms (saprobic index.) Water Quality Class II, (moderate) refers to water sections with moderate pollution and good oxygen supply and a very large variety of species. To reach the Water Quality Class II target, the water authority decided that permit requirements had to be more stringent than the published federal minimum requirements for that industrial sector. It is not yet clear if the authorisation will apply to the effluent of both treatment plants separately, or to the combined discharge. The effluents of both parts of the pulp and paper mill are combined prior to the existing discharge monitoring point. Due to that fact, and to make monitoring easier, the permitted values are probably fixed at that point. Application of the mixing rule, taking into account the more stringent values (emission related) than the individual Minimum Requirements, is being discussed. The water permit will have a duration of 20 years and refers to a production rate of 555 t of pulp per day.

In addition to meeting the permit limits, in cases of pollutant spills into the River Main, the company must comply with the River Main Emergency Plan. The company is obliged to report immediately to the authority any malfunctions at the mill. In addition, whenever the quality of a receiving water body becomes critical, e.g., during summer if dissolved oxygen concentrations fall below a certain level, the competent authorities can order the company to decrease its production. This has been implemented by authorities in Germany in several instances.

In general, the permitting authority only prescribes concentration or loading limits; the companies decide the method and mode of operation that best ensures that the limits will be met. A precondition for a cost-effective final treatment is the realisation of a series of internal integrated wastewater measures, e.g., extended washing cycles, neutralisation of heavily polluted wastewaters prior to combustion and recovery of chemicals, anaerobic pretreatment of condensates from the pulping process, total chlorine-free bleaching, etc.

No special economic factors were taken into consideration when issuing this permit. The BAT concept already implies that the measures required are economically justifiable and reasonable. The competent authority can take into account the individual economic situations, for example, by setting a longer deadline to meet permit requirements.

The existing permit for the mill stipulated a deadline of 1 July 1994 for the start-up of the two biological wastewater treatment plants. Prior to this date, there was an adjustment period of about 3 years based on the time required for the delivery of materials and construction of the treatment plants, and not on the economic situation of the company.

If, during the life of the permit (20 years), the federal minimum requirements are changed in accordance with available technology, additional conditions may be imposed within reasonable periods of time. In addition, if it becomes necessary to impose new conditions to protect waters (due to unexpected damage, new insights, more stringent quality objectives, etc.), the permit may also be changed. Because the discharging of COD and AOX is taxable in accordance with the Wastewater Charges Act, it is in the company's interest to reduce the load of wastewater whenever new, more efficient technologies become available.

4. TECHNOLOGICAL RESPONSE TO PERMIT REQUIREMENTS

4.1 Equipment installed and measures taken

4.1.1 Case study A

With respect to Case Study A, the company developed a comprehensive wastewater treatment concept, in the 1960s, aimed at minimising pollution of the River Leine. This concept has been developed continually and gradually implemented in line with legal requirements. Measures taken to reduce pollutant loads in wastewater on the basis of generally acknowledged rules of technology were carried out in several stages.

Stage 1

- Conversion of pulping to extended cooking in 1974. This resulted in AOX discharges being reduced.
- Collection of spent cooking liquor and treatment in a thermal wastewater treatment plant, the evaporation plant, and the waste liquor incinerator were implemented in 1974/75.
- Chemical and mechanical treatment of the production effluents of the paper mill in an Infilco-Cyclator wastewater treatment began in 1974 (wastewater treatment plant no. 1).

Stage 2

- Waste liquor collection was increased to approximately 99 per cent through the installation of additional wash filters and closed-cycle screening of unbleached pulp in 1983.
- Over the period 1983 to 1985, an anaerobic biological treatment plant was constructed and came into operation. This handles highly polluted condensates from the evaporation plant and has a removal efficiency of approximately 75 per cent for COD and approximately 95 per cent for BOD_5.
- The pulp mills demand for fresh water was drastically reduced through recirculation and multiple use, including re-use of some of the effluent from the paper mill in the pulp mill; this was subsequently abandoned, however, for technical reasons.

Stage 3

- In 1985, construction and operation of an oxygen-peroxide prebleaching stage system commenced. This provided an environmentally compatible process that drastically reduced the use of chlorine in subsequent chlorine bleaching stages. It resulted in a reduction in the AOX load from about 4 kg AOX per tonne of pulp to less than 1.5 kg AOX per tonne of pulp.
- In 1985, construction and operation of a fluidised bed furnace commenced, with steam generation to burn bark, rejects, and wood residues. This reduced the amount of waste to be landfilled considerably.

Stage 4

- Conversion of the pulping process. In 1988, pulping in the pulp mill was converted from the conventional dolomite to magnesium bisulphite with chemical recovery. This allows the chemicals used in pulping to be kept in a virtually closed cycle with regeneration of magnesium oxide ash and recovery of SO_2 gas at the same time.
- Enlargement of the evaporation plant. In addition to cooking liquor, the more highly polluted effluents from the extended oxygen-peroxide prebleaching stage are now subjected to thermal treatment (evaporation and incineration).
- Construction of a new furnace (a new sodium-compatible design) allows the above-mentioned alkaline effluents to be incinerated together with the waste liquor.

Recent measures

- In 1991, the mill started up a new biological wastewater treatment plant and converted its bleach plant. This further reduced discharges of chlorinated and non-chlorinated substances.

4.1.2 Case study B

The mill in Case Study B has been in operation for more than 100 years. Throughout its history, the mill has responded to changes in the marketplace by modernising and expanding its plants. Environmental permits came into being in the 1970s and the plants operations have been affected by several permits.

The mill has responded to environmental requirements through the development of internal pollution prevention techniques to address pollution from its chemical-based pulp and paper manufacturing processes. It has also applied external treatment processes where necessary. Attention has been paid to reducing the effluent and gas volumes requiring treatment, as well as the volumes of waste sludges, in order to reduce the cost of external treatment. The following practices have been applied:

- increased collection of boiler waste liquor by introducing new washing systems and closed cycles;
- a change-over to a process that employs magnesium-based acid, allowing sulphur dioxide to be regenerated and avoiding a shift from water pollution to air pollution (SO_2);
- expansion of evaporation capacity;
- burning of thickened wastewater components with subsequent recovery of chemicals and heat;
- neutralisation of weak liquor (done for the first time in this manner);
- extended cooking to remove more lignin and reduce the amount of bleaching required; and
- use of total chlorine-free bleaching.

With the exception of the two biological treatment plants, all other measures can be regarded as techniques that are integrated into the production process. Relative to the overall reduction in pollution, these internal pollution prevention measures account for approximately 90 per cent COD and BOD removal and 100 per cent AOX elimination.

4.2 Flexibility considerations

4.2.1 Case study A

Company A used internal measures complemented with appropriate end-of-pipe treatment to meet environmental requirements. The mill has implemented controls in a progressive manner. The technology was developed in co-operation with equipment suppliers and supervisory authorities were kept informed and consulted.

During the licensing process, the way in which limit values were to be complied with was not an issue. A clear description of the process technology concerned had been given and this technology was also suited to ensuring compliance with the limit values set. The choice of technology was left to the mill.

4.2.2 Case study B (water permit)

Even though biological treatment of residual wastewater was required, there was flexibility in the methods used for the initial treatment as these methods were not prescribed. The same holds true for the reduction in the discharge of AOX. The minimum requirements stipulated one target only, without prescribing specific technologies to meet this target.

The company was not required to install specific technologies, nor to follow any prescribed methods in order to reach the other limit values set in the permit. As a rule, in the permit development and implementation process, measures proposed by the company were accepted. Occasionally, however, when implementing the detailed requirements of the permits set by some of the permitting authorities, the company realised that some detailed requirements had to be met, which the company did not always consider to be flexible.

4.3 Views of industry surveyed

Designed as a chemicals recovery plant, the flue gas desulphurisation plant in Case Study A is integrated in the pulp production process. As the waste liquor is utilised thermally, more energy is generated than is required for the pulp production process as a whole. As the flue gas treatment system is integrated in the overall process, no residuals arise and savings in digestion chemicals are achieved.

The air pollution control licensing and operation of the Case Study A facilities have brought about a re-definition of BAT with respect to the thermal utilisation of waste liquor from sulphite pulp manufacture. There is no conflict here between BAT and EQO.

In Case Study B, emphasis was placed on meeting targets concerning the quality of the surface water into which the company was discharging its wastewater, namely the River Main. Some of the measures required for this purpose involved technology that was not yet commercially available and had yet to be tried and tested. A number of the measures required have yet to be developed. This is especially true for the value prescribed for AOX under the minimum requirements of Section 7(a) of the Federal Water Act. This value was prescribed before any chemical pulp plant had even reached this limit value.

The item relating to "chlorine-free bleaching" in Case Study B shows that conservation measures do not necessarily have to be prescribed, but can be taken voluntarily by plant operators. The requirement of 1 kg of

AOX per tonne of pulp means that the bleaching process need not be totally chlorine-free; however, this plant exceeded the minimum requirements set out in the permit.

5. CONCLUSIONS

In the Federal Republic of Germany environmental control requirements for pulp and paper mills are set out in permits. The permits are issued by Administrative District Offices or local municipalities, and they fall under the authority of the Länder (states). Separate permits are issued for the control of air and water pollution and for solid waste management.

The Länder are granted authority for the content of the permits that are issued. However, the duty of permit issuance is delegated to the local government level by either the Administrative District Offices or local municipalities.

The federal government is involved in permitting through the preparation of federal regulations governing air and water pollution control and solid waste management. These requirements apply throughout the whole country and are incorporated into the permits that are issued. In addition to federal regulations, some Länder have implemented air and water regulations that are more exacting than the federal regulations.

The permits incorporate, as minimum requirements, performance standards for various compounds and groups of emissions as laid down in regulations under water and air pollution laws. These serve as minimum limits for releases to air and water.

In order to ensure adequate air quality, federal objectives have been developed for air contaminants in ambient air. These are referred to in permit decisions.

With respect to water quality, the Länder, through their Water Association, have recommended that a minimum target water quality, specified as Class II under the German Water Quality Classification System, should be attained in all waters. This quality system refers to a saprobic index. This is primarily based on organic levels of impurities and nutrients in waters. In addition, one Länder has developed objectives for some substances in receiving waters. No federal water quality objectives have been passed.

In the permits that are issued, requirements under federal and state government regulations are imposed as minimum values in all cases. These regulatory limits are based on a BAT approach. In the case of sensitive ecosystems, more stringent requirements are implemented on an environmental quality basis. This is determined using dispersion modelling and by reference to environmental quality criteria.

The pollution control philosophy is based on the use of both pollution prevention and end-of-pipe treatment. The use of pollution prevention is maximised to minimise the cost of control. External treatment is applied to the degree necessary to meet environmental requirements. Permits specify pollution limits, but mills select what technology to use to meet the limits. In the cases reviewed, the mills have adapted their production processes, developing new techniques to minimise pollution. The mills also utilise secondary treatment to meet the requirements. The inclusion of secondary treatment was taken as a given in the permit review process. The major challenge in meeting permit requirements has been with respect to parameters such as AOX. The levels in one permit, for instance, were beyond what was technically available at the time the permit was being developed. This required the mill to develop its own technology, which it did, surpassing the limits imposed in the permit.

REFERENCES

Irmer, U., Markard, Chr., Blondzik, K., Gottschalk, Chr., Kussatz, C., Rechenberg, B., and Schudoma, D. *Quality Targets for Concentrations of Hazardous Substances in Surface Waters in Germany.* Ecotoxicology and Environmental Safety 32, p. 233-243. 1995.

ANNEX 1

Legend to Water Quality Map

Quality Class I:
Unpolluted to very lightly polluted (oligosaprobe)

Stretches of water with clean, permanently near oxygen-saturated and low-in-nutrient water; low bacteria concentration; moderately densely colonised, primarily by algae, mosses, flatworms and insect larvae; where summer-cool, spawning water for salmonids.

Quality Class I-II
Lightly Polluted (oligosaprobe to betamesosaprobe)

Stretches of water with low inorganic nutrient input and organic pollution without significant oxygen consumption; densely colonised, and usually with a wide variety of species; summer-cool, salmonid waters.

Quality Class II
Moderately Polluted (betamesosaprobe)

Stretches of water with moderate pollution and good oxygen supply; very wide variety of species and high individual density of algae, snails, small crabs, insect larvae; water plant stocks may cover large areas; widely varied species of fish.

Quality Class II-III:
Critically Polluted (betamesosaprobe to alphamesosaprobe)

Stretches of water of which the pollution from organic, oxygen-consuming substances causes a critical condition; fish death possible due to lack of oxygen; reduction in the number of macroorganism species; certain species tend towards mass growth; conferva frequently from large bread-covering stocks.

Quality Class III:
Heavily contaminated (alphamesosaprobe)

Stretches of water with heavy organic, oxygen-consuming pollution, arid mostly low oxygen concentration: local sludge deposits; colonies of filiform sewage bacteria and adhering ciliophora exceed the occurrence of algae and higher-order plants; only few macroorganisms insensitive to lack off oxygen, such as leeches and water-hog louses, occur sporadically in masses; periodic fish death is to be expected.

Quality Class III-IV:
Very heavily contaminated (alphamesosaprobe to polysaprobe)

Stretches of water with for the most part restricted living conditions as a result of very heavy pollution from organic, oxygen-consuming substances, often exacerbated by toxic effects; at times total loss of oxygen; clouding caused by suspended matter in sewage; extensive sludge deposits, densely colonised by ciliophora, red blood-worms or mud-dwelling sabellariids; decrease in filiform sewage bacteria; fish only encountered in exceptional cases.

Quality Class IV:
Excessively Contaminated (polysaprobe)

Stretches of water with excessive contamination from organic, oxygen-consuming sewage; decay processes predominate; oxygen present at very low concentrations for long periods of time or completely absent; colonisation primarily by bacteria, flagellates and free-swimming ciliophora; no fish; with severe toxic pollution, biological desolation.

Case Study on the Use of Best Available Technology (BAT) and Environmental Quality Objectives (EQOs) in the Environmental Permitting of Bleached Chemical Pulp and Paper Mills in New Zealand

Pre-publication version prepared by
David Halliburton of Environment Canada for
Pollution Prevention Control Group of
Organisation for Economic Co-operation and Development
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FOREWORD

This report reviews how the concepts of best available technology (BAT) and environmental quality objectives (EQOs) are taken into consideration in the environmental permitting of pulp and paper facilities in New Zealand. It was prepared by Environment Canada's National Office of Pollution Prevention based on responses to a questionnaire survey. The content of the questionnaire was developed by the Organisation for Economic Co-operation and Development's (OECD), Pollution Prevention and Control Group.

This report is one of a series of reports prepared to provide background information on the procedures followed in the environmental permitting of pulp and paper mills in a number of OECD Member Countries. Information was gathered using a questionnaire designed to see how best available technology and environmental quality objectives were considered. The countries in the study were Austria, Belgium (Wallonia), Canada, Finland, the Federal Republic of Germany, New Zealand, Norway, Sweden, Switzerland, and the United States of America. Separate reports are available describing the permitting procedures of each country. This report is one of ten reports (Country Profiles) which describe the approach to environmental control of pulp and paper mills in each country. In addition, an overview case study report has been prepared describing the general permitting practices in the set of countries. These reports have been prepared by Environment Canada for the Pollution Prevention and Control Group (PPCG) of the Organisation for Economic Co-operation and Development (OECD).

This particular report provides details of the permitting approach in New Zealand, describing the legislative basis for permitting, the organisations that issue permits, and the use that is made of regulations, environmental quality objectives, best available technology and economics. It also describes the technological response of mills to the permit conditions that have been set and the opinions of mills with respect to the permitting process.

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1. THE PERMITTING PROCESS

1.1 Constitutional responsibilities for environmental protection

In New Zealand, the Resource Management Act (RMA), passed in 1991, forms the main legislation under which natural resource management is effected. Its purpose is to promote the sustainable management of natural resources and to avoid, remedy, or mitigate the adverse effects of development. Regional councils are responsible for managing the natural resources, including discharges to water, air, and land, and for their use. These councils are geographic in scope and consist of elected bodies assisted by officials. 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.

Included within the responsibility of the regional councils is the administration of permits (consents) to control the effects of various activities, including industrial, municipal, and other activities, that may affect the environment. These permits impose conditions on the effects resulting from plants. Regional councils can also develop land use plans indicating which land use matters the regional council wishes to control, separate from the district council.

Decisions on permits are based on consideration of the environmental effects of the operations, with limits and conditions being established based on the environmental bottom line that is necessary to protect the receiving media. Decisions are made on a case-by-case basis, unless policy has been developed and rules instituted under a regional plan.

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. In cases of operations that affect the coastal zone, the Department of Conservation, a central government body, is included in decision making.

1.2 Permits

Regional councils issue permits based on applications lodged for the use of natural resources. Where an activity is likely to have significant effects, notice is provided of applications and interested parties can lodge a submission. 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. Regional councils will hold hearings on applications that have a significant effect and hear submissions from various parties.

Notice is provided of the decisions made by the regional councils on permit applications. Any party that made a submission at the first hearing may appeal the decision to the Environment Court, an independent legal body established to hear appeals within New Zealand. The Environment Court has the authority to delete, change, or add any conditions, as deemed appropriate, with respect to the permit.

Regional councils may decline applications for permits and the Environment Court may decline applications for appeals.

A similar, but different, process is followed for the development of comprehensive plans for managing the environment over an entire district, region, or basin. A district must have a district plan (wider land use),

whereas regions can have a range of plans based on an area or activity. These plans can set environmental bottom lines or standards which are established by the regional councils. In some cases, these may consider the application of best practicable option (BPO), for that resource, particularly where it is not practicable to conduct an individual Assessment of Environmental Effects (AEE) (see Section 1.5) on many minor uses, e.g., septic tank discharges and dairy shed discharges. The concept of best practicable option is related to that of best available technology (BAT).

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); however, boilers at potentially more environmentally significant operations, such as low odour kraft recovery boilers, would receive permits of shorter duration. In a plan, an activity can be specified as permitted if a set of criteria are met. In such cases, a permit is not required. Permitted activities are restricted to those having a minor environmental effect.

1.3 Permit renewal process

Under the Resource Management Act, a permit is viewed as a contract between the regional council (representing the community) and plant owners. During the life of a permit, review of its conditions can be undertaken only if:

- There are clearly defined changes in the permit conditions and/or impact on the receiving environment. This would cover situations of plant expansion or modification, where these would result in increased water use or a change in effluent content, that would affect the receiving environment. Similarly, a new boiler may require that part of the permit to be amended. Generally, a permit would not require modification if the modified plant is able to operate within the conditions of the existing permit limits.
- Such a review is included in the conditions of the permit at the time of issue.
- The regional council implements a detailed management plan for the receiving environment, at which time conditions for all permits within the catchment can be reviewed within 6 months of the plan being finalised.

The term of a permit (e.g., 10 years) cannot be changed.

1.4 Multi-media permits

At present, New Zealand is moving toward multi-media permitting through the Resource Management Act, however existing permits (air, land, and water) cannot be changed, it will take time to achieve consolidated permits. It should also be noted that, generally, district council land use planning is in perpetuity. The intent of the new legislation is to ensure that all activities are integrated within a single process so that the relationship of air to land to water can be fully assessed. Implementation will take some time due to the different lengths of time existing permits have to run.

There is also a procedure for joint hearings between regional and district councils to ensure that all permit issues are considered at the same time.

Despite the lack of a formal multi-media permitting process, council staff who work on permits consider intermedia transfer effects of control. Concerns are thus addressed by this process.

1.5 Environmental assessment

An application for a permit must be accompanied by an Assessment of Environmental Effects. This includes all known or anticipated environmental effects, a statement of whether they are within acceptable standards/guidelines, and, for those cases where standards/guidelines are expected to be exceeded, an indication of how these can be avoided, remedied, or mitigated.

2. BAT, EQOs, AND ECONOMICS

2.1 Standards setting

In New Zealand, permit requirements are established based on the bottom line required to ensure protection of the environment. No national regulations have been passed establishing what the minimum levels of environmental performance should be. Instead, regional councils establish what the requirements should be based on consideration of the receiving media. This establishes what the limits should be to ensure the environmental quality required to maintain the use of the environment. This is based on detailed site evaluations, including the use of water and air modelling.

New Zealand has not developed any national pulp and paper standards even though its receiving waters are, for the most part, sensitive, being of relatively low flow and high environmental quality, which is of great value to the multitude of users of the resource. This situation, therefore, requires that proper safeguards be taken. In reviewing permits, the regional councils take into account the requirements of foreign standards such as the US Environmental Protection Agency. Although the central government has not developed set standards, a range of guidelines have been developed covering such matters as air quality and nuisance growths.

2.2 Cleaner technologies

In New Zealand, permitting authorities take into consideration the effects of the activity and the use of cleaner technology in reducing the pollutant load. This is highlighted in the more stringent requirements enforced on water effluents. However, economic factors are quite influential when permit authorities are assessing which permit limits are to be imposed. If it is apparent that using cleaner technology is not financially sustainable for a company, it is expected that some form of dispensation will be given, and a phase-out period would most likely be implemented. However, this would normally only apply to an existing industry. A greenfield development, on the other hand, would be required to meet the necessary environmental standards immediately.

2.3 Environmental quality objectives (EQOs)

Discharge permit limits are established on the basis of what is needed to ensure the sustainability of natural and physical resources. The requirements that are set vary depending on the condition of the receiving medium, the use of that medium (active recreation, water supply, etc.), and the sensitivity of that medium to the particular discharge. The Resource Management Act is effects based.

With respect to water systems, a number of regions have programs in place to develop water quality objectives for various water bodies/catchment areas. These objectives are being developed by regional councils through regional plans. The purpose of these plans is to provide guidance for all decisions that are taken regarding sustainable management of environmental resources, including decisions related to permits. The set water quantity/quality rules in the plans become statutory once the documents have gone through the necessary process, including appeals.

Regarding pulp and paper mill operations, a plan is close to completion for the Tarawera River Catchment. This basin includes the operation of a bleached kraft and newsprint mill and a tissue mill, which affect the water quality. Other activities also influence the water quality, including waste geothermal fluid. The Tarawera Plan is currently at a "proposed" (publicly notified) stage and has been developed through a 2 year consultative

process. It expands on an earlier plan developed in 1985. It is expected that the current plan will have gone through all of the statutory processes by 1998.

The Tarawera basin exhibits a wide range of water quality, varying from pristine in the upper basin to heavily polluted downstream of the town of Kawerau, where industrial operations, including pulp and paper and geothermal discharges, occur. The 1985 plan identified colour, dissolved oxygen, and toxicity as the main issues.

The new plan notes that colour and dissolved oxygen are the main issues, whereas concern over toxicity has been reduced. The discharge of sewage has also been highlighted as being culturally offensive by the Maori. The impact of the low dissolved oxygen on the river ecology is now better understood. As a result, the "proposed" plan includes specific policies that can be taken to remedy the situation in the lower river.

In developing the plan, the uses and values associated with water quality are assessed, water monitoring is described, and the influence of key parameters is described. These cover the influence of dissolved oxygen content, colour and clarity, temperature, pH, odour, suspended solids, nutrients, tainting, oil, grease and scum, and biological growth, and the effects of sewage discharges and dairy shed effluents. Based on this background, a series of water quality objectives is proposed for different water types.

Relative to the Lower Tarawera River location to which the pulp mills discharge, the following objectives are proposed:

- colour: no increase beyond five points on the Munsell hue scale and no visual clarity change of more than 20 per cent of the ambient black disc measurement relative to a reference point on the river;
- acute and chronic toxicity: no detectable increase between an effluent sample diluted at the specified mixing ratio for the mixing zone and river water from the reference point;
- temperature: no increase of more than 3°C and the maximum not to exceed 25°C; pH: in the range of 6.5–8.5;
- no production of conspicuous oils and grease films, scums or foams, or floatable or suspended materials;
- aquatic food resources shall not be rendered unsuitable for human consumption and the water for cattle watering;
- no increase in emissions of objectionable odours; and
- effective 1 July 2000, limits will be placed on filamentous growth on the river beds and on biomass in the water.

In addition, a schedule has been set for the dissolved oxygen content that should be maintained in the receiving waters. Table 1 summarises the dissolved oxygen content that should be maintained for different periods.

Table 1. Dissolved oxygen contents that should be maintained in the receiving waters

Period	Consecutive 30 day mean (g/m^3)	Consecutive 7 day mean (g/m^3)*	Absolute minimum (g/m^3)
Until 30 June 96	5.0	4.0	3.5
1 July 96 to 1 July 98	5.5	4.0	3.5
From 1 July 98	6.5	5.0	4.5

- The 7-day mean value is likely to be deleted.

The application of these new dissolved oxygen objectives is having a significant impact on the allowable BOD_5 discharges from the two pulp mills. Annex 1 compares the former BOD_5 loads allowable under the historic situation against the new regime. The allowable loads are calculated using a model that calculates the dissolved oxygen concentrations in the receiving waters under set conditions. The maximum tolerable BOD_5 loads are calculated for the river flow and temperature conditions. Annex 1 shows that the tolerable allowances have fallen significantly under the new model. For example, formerly at a river flow of 16 m^3 per second and a temperature of 16^0C, a total load of 7 t/d was allowed. Under the new model this value falls to 2.4 t/d. It is noted that the permissible discharges are a function of the river flow and water temperature.

All of the above classification standards are based on the effects of a permitted discharge, but exclude natural perturbations.

In addition, the plan includes a list of measures that pulp and paper mills could apply in order to meet these dissolved oxygen objectives in downstream waters. This is based on a report prepared by the mills. These options include adding oxygen to the river to compensate the effect of effluents.

Environmental quality objectives are under development for the ambient air and for land application of effluents. Reference is made to objectives of other countries to guide permit decisions.

In cases of more sensitive waters, more stringent objectives could be set, as is being done in the "proposed" Tarawera Plan.

2.4 Best available technology (BAT)

As noted earlier, permit conditions are established on the basis of the needs of the receiving environment; hence, minimum standards based on a BAT approach are not mandated at each site. Before a regional council includes in a regional plan a rule requiring the adoption of BPO (best practicable option) to prevent or minimise any actual or likely adverse effect on the environment of any discharge of a contaminant, the regional council shall be satisfied that having regard to:

- the nature of the discharge and the receiving environment; and

- other alternatives, including a rule requiring the observance of minimum standards of quality of the environment;

The inclusion of that rule in the plan is the most efficient and effective means of preventing or minimising those adverse effects on the environment.

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, proposed standards, 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 impact of the cost of implementing the necessary technology.

It is appropriate to note that the dissolved oxygen situation in the Tarawera River is a critical issue for mills that discharge into the river. The Tarawera Plan will limit mills to releasing 2 tonnes of BOD per day during critical periods (down from the historic total of 7 tonnes per day) based on the results of the dissolved oxygen model. These releases may be much lower than what might be permitted under a BPO model if the mills were discharging into the ocean or into a river with a much higher flow rate.

In evaluating permits, on occasions where detailed technical knowledge is required, regional councils seek expert advice regarding the capability and cost of pollution abatement technology. However, the staff perform the bulk of the assessments on the capability of the technology.

It is important to note that the type of technology used in plants is not prescribed by permit authorities. The only technology mentioned in permits is what the applicants plan to install. Reference is made to this technology to ensure that the monitoring requirements associated with that technology are clear as monitoring and maintenance procedures may have to be changed if the technology is changed.

In the case of environmental issues affecting health, best practicable options have to be installed if required to meet minimum standards.

With respect to the development of new technology, this is left to the prerogative of the industry as government funds are not committed to carry out such work.

2.5 Negotiation of standards

Negotiations may take place during the development of requirements in the permit-granting process and during the development of detailed plans for an entire catchment area (such as the Tarawera Plan). Negotiations are common in the permitting process, where pre-hearings may be held to allow contentious matters to be discussed and negotiated. This may result in one or more conditions being added to the permit that are acceptable to all parties, obviating the need for formal hearings or further consideration of the matter. Where health effects are concerned, requirements for effluent treatment are not negotiable.

2.6 Economic considerations

As part of the permit review process, New Zealand considers the financial impact of implementing effluent quality standards. Where compliance with standards is felt to be economically onerous, extended implementation schedules are granted or the imposition of requirements is delayed, for example, extended implementation schedules for colour removal (10 years) and the deferral of requirements for the installation of a low odour recovery boiler for a kraft mill.

2.7 Interaction of BAT and EQOs

New Zealand regulates its pulp and paper industry primarily using EQO-based requirements. It considers the best practicable options available to industry in order to meet these limits, taking into account technical, economic, and environmental factors. The BPOs serve as guidelines, with plant owners being free to select the most appropriate means to meet the requirements.

3. TRENDS IN PERMITTING

In order to illustrate the permitting practices in New Zealand, the New Zealand government provided examples of water, air, and solid waste control permits issued to two pulp and paper mills. These permits were issued by the regional government, which in these cases was the Bay of Plenty Regional Council (Environment BOP). The two pulp and paper mills were located in Kawerau. The two mills were the Tasman Pulp and Paper Company's integrated kraft and mechanical papermaking operations, and the Carter Holt Harvey Tissue operation.

With respect to the development of the water permits, the content of the permits was were influenced by the Tarawera River Catchment Plan. As both mills have an influence on the river water's dissolved oxygen content, the mills were allocated a shred BOD_5 deposition load.

Tasman Pulp and Paper operates two bleached kraft pulping lines and three newsprint machines at its site, these have a total capacity of 630 000 tonnes per year. Of this total, 280 000 t is bleached kraft, 225 000 t is stone groundwood (to be replaced by thermo-mechanical pulp in 1997), and 125 000 t is refiner mechanical pulp. Of the two bleached kraft pulping lines, one is a semi-bleached line with a capacity of 100 000 tonnes per year, that uses an HH sequence (two hypochlorite stages). This sequence was installed recently to replace an earlier CEH (chlorine, extraction, hypochlorite stages) sequence in order to reduce colour discharges. The second line which is larger, is a fully bleached line and has a capacity of 165 000 tonnes per year This uses an OD/CEoDND sequence. (In this, O represents oxygen prebleaching, D represents chlorine dioxide, C represents chlorine, Eo represents oxygen enhanced extraction and N represents a neutral wash.) The output from the mill is both paper and market pulp. The paper is comprised of newsprint and telephone directory paper, with an annual capacity of 400 000 tonnes. The market pulp capacity is 190 000 tonnes.

The Carter Holt Harvey Tissue mill uses bleached-sulphonated-chemical-thermo-mechanical pulping (BSCTMP). The mill has a rated capacity of 75 000 tonnes per year. The plant makes a variety of unbleached and peroxide-bleached pulps for different end uses. It operates three paper machines to manufacture tissues and light-weight and specialty-grade papers. Its total papermaking capacity is 55 000 tonnes per year.

With respect to permitting by the regional council, the control of water discharges has been a priority as the river is a valuable resource with a relatively low flow rate of 20 cubic metres per second. Measures have to be taken to ensure its protection.

3.1 Cleaner technology

Local environmental requirements necessary to ensure the sustainability of natural and physical resources determine the limits that are set. The industry is free to select what measures to install in order to meet these limits. Cleaner pollution prevention techniques have played a major role in pollution control.

In the case of effluent control, internal pollution prevention measures taken by the Tasman mill include a reduction in water use, a reduction in process fibre losses, the use of chemical and lime mud, the installation of oxygen delignification, the use of enzymes for pre-bleaching, improved operational control, upgrading training systems, and an increase in chlorine dioxide substitution. Secondary biological treatment is used in order to meet the tight BOD requirements necessary to protect the dissolved oxygen levels in the river. The cost of this treatment is minimised and its effectiveness enhanced as a result of pollution prevention techniques applied in the mill ahead of effluent treatment. The mill has estimated that internal pollution abatement expenditures have accounted for 70 per cent of its total pollution abatement expenditures, with the other 30 per cent going toward external treatment.

At the Carter Holt Harvey Tissue mill, internal effluent control measures are being undertaken in accordance with a planned strategy aimed at achieving zero discharge to the river by 1999. Key to this is a program to reduce water usage by about 9–10 per cent per year up to that time. Since 1984, water usage has been reduced by approximately 50 per cent and in 1995 was less than 8 000 cubic metres per day. This program involves increased water recycling and the improvement in its quality, and a reduction in the freshwater usage through by means of measures such as, better filtering, showering, fines removal and through the addition of variable speed, alternating current drives, and dynamic or mechanical seals, on pumps and agitators.

Air emissions are a concern for the Tasman mill, where kraft pulping and geothermal energy production are used. The Carter Holt Harvey Tissue mill causes minimal air pollution from the main processing plant, but has an occasional odour problem associated with its rapid infiltration basins, although this is currently being addressed by the installation of a biofilter.

The Tasman kraft pulping mill operates two recovery boilers installed in the 1950s and 1960s. These use a black liquor oxidation process rather than the more modern low-odour design. The current mill permit calls for the mill to provide a report by 31 January 1996 showing the results of air dispersion modelling, impact assessments, and odour control assessments. In the report, the mill is required to provide plans on how it intends to attain total reduced sulphur (TRS) discharge levels of 12 mg/m^3 (24 hour averages), from all major stationary discharge sources in the mill, regardless of the results of the dispersion models. The regional council is empowered to review the terms of the current air permit and impose appropriate conditions based on these results within 6 months of receiving the study. This approach allows the mill to consider what approaches to use (internal and external) in order to meet future requirements.

3.2 Trends in limits

3.2.1 Water pollution control requirements

At the time of this study, both mills had water permits that would expire in 1995. The content of these permits had been developed using a predictive dissolved oxygen content model. The permissible BOD_5 load was set based on the river flow and temperatures. The allowable BOD_5 loads for different river conditions, in these permits are shown in Appendix 1. These are listed under the column entitled Historic Limits. Under these current permits, 7.0 t/d of BOD_5, was set as the maximum allowable from both mills under critical river conditions. This load was shared between the two mills on the basis 79.3 per cent to Tasman and 20.7 per cent to Carter Holt Harvey. These limits applied to the critical summer temperature and flow conditions.

Environment Bay of Plenty is currently in the process of developing new water permits for both mills. The permits are being developed with the objective of maintaining the river's dissolved oxygen content at the values shown in table 1. A computer model has been developed which predicts the allowable BOD5 loads that could be tolerated for different river flows and temperatures, while maintaining the dissolved oxygen levels. The final column in Appendix 1 shows the BOD_5 limits proposed for different river conditions to maintain the dissolved oxygen levels.

These calculations indicate that under the low flow and high water temperature conditions experienced in the summer, the total allowable BOD_5 load for the two mills could be of the order of 2 tonnes per day. The allowable values are considerably less. In order to implement these new requirements, Environment Bay of Plenty has indicated that it plans to stage the introduction of the stricter limits for the two mills. It is also considering the

use of oxygen injection within the river as a means of allowing for higher BOD inputs to the river, recognising technology constraints re mill production processes.

The permits place limits on the daily and peak per second effluent flowrates, the effluent temperature, pH, total suspended solids, and the pentachlorophenol and trichlorophenol concentrations. Table 2 summarises the limits in the permits for the two mills. In addition, the BOD limits are set based on the river flow and temperature conditions shown in Appendix 1, subject to the conditions described above.

It is noted that under it permit that expired in 1995, the Tasman mill had a BOD allocation of 5.5 tonnes per day. Under its normal production rate, the mill would release an amount of BOD_5 corresponding to about 3.1 kg BOD per tonne of mill output.

In addition, prohibitions are placed on the discharges of floating solids and foams, oils and greases, and wastewaters that give rise to objectionable odour, and wastewater containing dyes that may affect the colour of the river.

The new permits will allow for the inclusion of limits on permissible colour increases to the river, outside of the effluent mixing zone, as a result of the Tasman Pulp and Paper Company Enabling Act (special government legislation) being repealed. Under the existing permits this special legislation excluded the Company from complying with the "no conspicuous change in colour requirement" of the river water classification. With the repeal of the legislation, however, this requirement cannot be immediately met so a transition period has been allowed.

With respect to monitoring, the mills are required under the existing permits to test and report monthly on their effluent releases. Testing for the different parameters is done at the frequencies shown in Table 2. A provision in the permits allows monitoring to be conducted on an annual basis for pentachlorophenol and trichlorophenol if the mills certify that compounds containing these pollutants are not used in the process.

Table 2. Water pollution control requirements.

Parameter	Tasman Pulp and Paper	Carter Holt Harvey Tissue
Wastewater flow		
Daily	260 000 m³/d	33 100 m³/d
Peak	3 200 L/s	1 419 L/s
BOD_5		
Daily	Refer to Annex 2	Refer to Annex 2
TSS		
Daily	20.0 t/d	9.5 t/d
Monthly average	14.0 t/d	5.0 t/d
Temperature	Not to exceed 35°C	Not to exceed 35°C
pH	6.0–9.0	5.0–9.0
Pentachlorophenol	1.87 kg/d	0.28 kg/d
Trichlorophenol	6.01 kg/d	0.25 kg/d

In addition, the permits incorporate additional monitoring requirements as described later. The permits also require the mills to have contingency plans in place outlining actions to be taken in the event of the spillage or discharge of wastewater in amounts that do not comply with the permits, or the spillage of a hazardous substance stored on-site.

The mills are also required to submit annual reports on the operation of their wastewater treatment plants, including details on all modifications to the equipment in the plant and its operating condition. Details on all in-mill modifications carried out or proposed that may affect the quality of wastewater discharges, particularly in relation to water use, colour, and toxicity, have to be included in the report.

With respect to external treatment, the Tasman mill has a clarifier, a screw press and four lagoons with a 5.5 day retention period. The Carter Holt Harvey Tissue mill has two wastewater streams. One stream consists mainly of suspended solids, which originate from the paper machines and the pulp mill's cleaning operations. The other stream is effluent with mainly dissolved solids which arises from the bleached-sulphonated-chemical-thermo-mechanical pulping process. The streams containing suspended solids are treated in a traditional gravity clarifier prior to discharge. The other stream, containing the BSCTMP wastewater, is treated along with the sewage from the town of Kawerau in a high-rate anaerobic process. The combined treated effluent is then discharged to rapid infiltration basins (RIBs) and/or the river.

Conditions for the operation of RIBs are established in a separate permit. This includes monitoring the volume discharged for treatment and groundwater monitoring of the water level, sodium content, and BOD_5 at a series of wells around the RIBs. Groundwater impact assessment reports, showing the impact on the surrounding groundwater and the Tarawera River, have been prepared by Carter Holt Harvey and submitted to the regional council.

The RIBs are expected to be replaced in the future by a spray irrigation system. A trial spray system is to be commissioned soon. The RIBs will remain, however, as a backup system.

3.2.2 Air pollution control requirements

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 Tables 3–9. 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.

Table 3. Permit limits for recovery boilers 1 and 2, black liquor oxidation (BLOX) and tall oil plants

Source/Parameter	Limits	Averaging Periods
Recovery boiler: total reduced sulphur (TRS)	Continuous: 40 mg/m³ Continuous: 20 mg/m³ Manual: 30 mg/m³[1]	1 h 24 h 1 h (8–12 h testing)
BLOX plant: TRS	500 g/h[2] (manual)	1 h
Tall oil plant, TRS	100 g/h (manual)	When fan operates
Recovery boilers: particulate matter	250 mg/m³ (manual)	—
BLOX plant: chlorine gas (Cl_2)	10 mg/m³ (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.

Table 4. Permit limits for smelt dissolving tanks 1 and 2

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

Table 5. Permit limits for lime kilns 1 and 2

Parameter	Concentration	Averaging Period
Total Reduced Sulphur	Continuous: 35 mg/m³ Continuous: 20 mg/m³ Manual 35 mg/m³	1 h 24 h 1 h (8–12 h testing)
Particulate matter (manual)	400 mg/m³ (kiln #1) 250 mg/m³ (kiln #2)	— —

Table 6. Permit limits for power boilers 1 and 2 (woodwaste burning)

Parameter	Concentration (manual)
Particulate matter	250 mg/m³

Table 7. Permit limits for bleach plants 1 and 2.

Parameter	Limit (manual)
Chlorine gas (Cl_2)	10 mg/m³ (bleach plants 1 and 2)
Chlorine dioxide gas (ClO_2)	5 mg/m³ (bleach plant 2)

Table 8. Permit limits for chlorine dioxide chemical preparation plants (acid sewer, hypochlorite tower, single vessel process (SVP), and HCl furnace vent)

Parameter	Limit (Manual)
Chlorine Gas (Cl_2)	10 mg/m³ (acid sewer, hypochlorite tower and SVP)
Chlorine Dioxide Gas (ClO_2)	5mg/m³ (acid sewer, hypochlorite tower and SVP)
Hydrochloric Acid Vapour (HCl)	45g/m³ (HCl furnace vent)

Table 9. Minimum stack heights for kraft mill units.

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

3.2.3. Solid waste pollution control requirements

A permit for the disposal of solid waste from a recycled fibre plant was issued to the Tasman Pulp and Paper Company in March 1995. The permit is valid for 20 years. (In New Zealand, permit duration depends on the type of activity, environmental effect, and sensitivity of the receiving disposal area.)

The Tasman permit applies to the disposal of waste material, such as fillers and inks, left over when fibres are recovered from recycled paper products. The waste sludge is applied to forest lands. Table 10 summarises the permit requirements.

Table 10. Solid waste permit limits for the Tasman Pulp and Paper Company

Parameter	Limit
Quantity	65 t/ha per day
Depth of spreading	Average: 50 mm Maximum: 500 mm
Maximum slope	15° from horizontal
Reapplication period	24 months
Distance from watercourse	30 m

Limits are placed on the amount, frequency at which material may be applied, slope, and buffer zone requirements in order to ensure sustained operations. The copper content of the waste, being the highest contaminant, determined the permissible application rate. The permit includes a requirement to operate test plots to determine the effects on vegetation growth and composition.

3.3 Monitoring

Industries are expected to implement day-to-day compliance monitoring according to requirements specified in the permits. These requirements cover:

- parameters to be measured;
- frequency of monitoring;
- type of samples and test protocols; and
- requirements for duplicate analyses at independent laboratories.

Environment BOP (Bay of Plenty Regional Council) operates continuous monitors for some parameters (river dissolved oxygen, temperature) and also conducts audit checks of effluent streams. Company monitoring results are made available to the public through the council in the form of monitoring reports, which are produced every month in the case of both air quality and liquid effluent discharges. Regional council monitoring results are made available to the public as soon as they are reported as the council is a public forum.

3.3.1 Water monitoring and investigation requirements

The two permits reviewed require each company to measure the regulated substances, summarise the results in a report, and submit the report to Environment BOP within 15 days of the end of each month. Table 11 summarises the measurement frequency of the regulated substances. In addition, annual reports describing the operations of the wastewater treatment plants must be submitted for each calendar year. In some instances, quarterly reports have been required.

Table 11. Measurement frequency of water permit monitoring requirements

Parameter	Tasman Pulp and Paper Company	Carter Holt Harvey Tissue
Flow volume	Daily (continuous)	Daily (continuous)
Peak flow rate	Daily (continuous)	Daily (continuous)
BOD_5	Daily (24 h composite)	Daily (24 h composite)
Total suspended solids	Daily (24 h composite)	Daily (24 h composite)
Dissolved oxygen	Daily (continuous)	Daily (spot check at 09.00)
Temperature	Daily (continuous)	Daily (continuous)
pH	Daily (continuous)	Daily (continuous)
Colour	Daily (24 h composite)	—
Pentachlorophenol	Annually (24 h composite)	—
Trichlorophenol	Annually (24 h composite)	—

3.3.2 Air monitoring and investigation requirements

Air emission requirements of the Tasman permit require the submission of monthly reports on emission monitoring results, air pollution control operations, and details of any failures, malfunctions, or changes in the operation of the plant. The reports are due on the 15th day of each month. The regional council then makes the results available to the public.

A comprehensive monitoring program is in place at the Tasman mill. Total reduced sulphur emissions from the two recovery boiler stacks, the two lime kiln stacks and the black liquor oxidation scrubber are measured on a continuous basis. In addition, continuous opacity monitors are in place on the two recovery boiler and two power boiler stacks. Ambient total reduced sulphur and particulate levels are also measured using two mobile monitors set up at various locations.

In addition to continuous monitoring, manual tests measure emissions of various compounds from the stacks as shown in Table 12.

Table 12. Manual monitoring requirements on various stacks (frequency per month)

Source	TRS (manual)	Particulate Matter (manual)	Cl_2 (manual)	ClO_2 (manual)	HCl (manual)	VOCs
Recovery Boilers	*	2	—	—	—	—
Smelt Dissolving Tanks	1	1	—	—	—	—
Lime Kilns	*	2	—	—	—	—
BLOX Plant	2	—	2	—	—	—
Tall Oil Plant	1	—	—	—	—	—
Power Boilers	—	1	—	—	—	—
HCl Furnace Vent	—	—	—	—	1	—
No. 1 Bleach Plant	—	—	1	—	—	—
No. 2 Bleach Plant	—	—	1	1	—	—
Single Vessel Process	—	—	1	1	—	—
Acid Sewer	—	—	1	1	—	—
Hypochlorite Tower	—	—	1	1	—	—
Fibreline and Chip Bins	Once every 3 months	—	—	—	—	Once every 3 months

* When the continuous monitors are non-operational for more than 48 hours, manual testing (16 samples every 8 hours) is required every second day.

In addition to conducting monitoring, the mill has to undertake studies on how to update its current air pollution controls to meet more stringent requirements, as discussed earlier. The plant currently uses a scrubbing process to remove odorous components from the exhaust of the black liquor oxidation plant. Three cross-flow scrubbers are employed that utilise hypochlorite to remove hydrogen sulphide, methyl mercaptan, dimethyl sulphide, and dimethyl disulphide. The conditions of the permit will be reviewed based on the results of the current scrubbing process.

Supplementary programs include:

- a program to determine the levels of chlorinated organic compounds, volatile organic compounds, and total reduced sulphur in the air;
- sampling and analysis of foam particulates from the effluent treatment ponds for acetic acids, chlorinated phenolic compounds, resin and fatty acids, extractable neutral compounds, and dioxins and furans, and an assessment of the risks imposed and effects of such compounds on the receiving environment (by 30 December 1994);
- an assessment of methanol discharges from the mill site and their environmental effects (by 31 December 1994);
- a program to collect meteorological data to better predict the behaviour of contaminants in the immediate and wider receiving environments of the mill (to commence by 30 September 1994);
- a program to assess the mill discharge odour threshold to determine the threshold of the combined mixture of reduced sulphur gases (to commence by 1 August 1995);
- a monitoring program and report to identify and recommend control measures for minor odour sources (by 31 July 1995);

- a monitoring program and report to determine the particle size distribution of particulate matter in discharges from the power boiler, recovery boiler, and lime kiln stacks (by 31 July 1995);
- testing and analysis of the emission of chlorine from the BLOX plant (three months from the date of commissioning the secondary scrubbing stage of the BLOX Plant Odour Reduction Project with chlorine water); and
- a survey of the trace element content of soils and vegetation in the surrounding environment (during 1996).

Investigation and reporting requirements required in this permit include:

- an investigation and report on options to meet standard continuous obscuration requirements in the power boiler stacks and recovery boiler stacks (submitted by 31 July 1995);
- an investigation and report on options for continuous chlorine monitoring of discharges from the BLOX plant (submitted by 31 January 1995);
- an operational plan to manage the geothermal steam field (submitted for approval by 31 December 1994);
- a report on the program to progressively reduce the production and use of ozone-depleting substances (submitted by 31 January each year);
- a report on options available to progressively reduce the production of greenhouse gases (submitted to regional council before 31 January 1995);
- a report on the implementation of options to reduce the production of greenhouse gases (submitted to regional council before 31 January each year);
- an investigation of the flow from the recovery boiler and lime kiln stacks and a report on options for suitable flow measurement methods from these stacks (by 31 January 1995);
- an assessment of radon 222 and its decay products in the geothermal stack discharge, and an assessment of the risks imposed by and effects of radon 222 and its decay products on the receiving environment (by 31 December 1994);
- an assessment of hazardous air pollutants in mill emissions and the risks imposed by and effects of such contaminants on the receiving environment (by 30 September 1995); and
- a report on dispersion modelling and impact assessments, and an evaluation of suitable odour control options for mill discharges (by 31 January 1996).

3.3.3 Land monitoring and investigation requirements

Permit requirements for the Tasman recycled fibre plant require that the location, area spread, and depth of application be recorded on a weekly basis and reported to the regional council annually.

The company is required to monitor the soil, vegetation, groundwater, and residual solids at three different sites within the area of land spreading, and to report on the results of this monitoring to the regional council every 3 years.

Under its permit, Tasman was required to establish a pilot program to help determine the environmental effects of land spreading of recycled fibre waste. This program includes the monitoring and analysis of 35 different substances in various soils, surface waters, and groundwater. The company is required to report to Environment BOP on the results of this pilot program every 3 months.

Within seven months of commencing operation of the recycled fibre mill, and every three years thereafter, the company is to supply Environment BOP with a report on the nature of the recycled fibre solids with respect to the 35 substances monitored in the pilot program. Tasman has not proceeded with the recycled fibre mill.

The Carter Holt Harvey Tissue mill is proposing to use its anaerobic treatment plant effluent in the near future as irrigation water in a forest. The forest soil consists of volcanic tephra that drains rapidly, is low in nutrients, and is subject to water shortages from time to time. This can result in stress to the trees. The use of wastewater containing treated sewage and BSCTMP wastewater seems an ideal mix to assist in overcoming this problem. Before applying the irrigation water as a full-scale operation, a trial utilising approximately 5 per cent of the full flow will be implemented. This will be run over a number of years and should enable the environmental effects to be ascertained.

4. TECHNOLOGICAL RESPONSE TO PERMIT REQUIREMENTS

4.1 Equipment installed and measures taken

The responses of the Tasman Pulp and Paper Company to permit requirements have been very pro-active. A number of the measures taken by the company are based on a knowledge of technological advances, likely future requirements, and incorporation of stand-alone or other upgrades. Other measures taken are based on practicality, economics, and availability of technology. The most recent plant installations to meet permit requirements have been mainly in the area of air emission improvement and monitoring.

Within the plant, a mix of internal and external measures have been taken. In terms of capital expenditures over the last 5 years, the percentage of internal to external expenditures is approximately 70 per cent internal and 30 per cent external.

Carter Holt Harvey Tissue has a policy of being an efficient user of resources and minimising waste from its operations. This is seen by the company as an environmentally responsible approach to its operations. Therefore, it has embarked on a program to improve efficiency in all aspects of its operation that is having a significant impact on its use of natural resources. This is considered to be key to minimising waste and relies on a constant capital expenditure commitment on improvements that keep pace with technology. Consequently, the company's greatest concentration is on process improvements rather than treatment systems. This is generally less costly, with the associated benefits regarding efficiency and waste minimisation in turn resulting in a reduced need for treatment processes. This approach results in lower capital and operating costs for treatment processes and makes it easier to utilise new technologies in the treatment area. The balance of expenditures over the last 5 years has been approximately 90 per cent internal and 10 per cent external.

Focusing on effects has resulted in the company investigating the right environment to discharge into as much as it has the treatment options available. As a result, the company will be able to achieve a better environmental effect than it would have achieved had it pursued BAT. Furthermore, the BAT option could not have been economically sustained by the company.

4.2 Flexibility considerations

Permits issued in New Zealand offer the flexibility to choose the most appropriate technology to achieve the identified sustainable environmental effects and/or permit requirements. This is in keeping with the requirements of the Resource Management Act, where the focus is on the effects of the activity rather than the activity itself.

4.3 Views of industry surveyed

It is generally thought that a balance of BAT and EQO considerations is reflected in the permits. However, there is some debate in New Zealand regarding the real issues surrounding the impacts of the pulp and paper industry and the influence that public interest groups exert on local politics and the resultant influence on the permitting process.

The New Zealand legislation is written in such a way that it is necessary to study carefully the definitions of sustainable management, natural and physical resources, contaminant, and environment in the Act in order to understand the full meaning and implications of the Act. This is often not the case with the general public or

environmentalists who tend to read it as they understand the normal or dictionary meanings of these terms. This results in misunderstandings, wasted time in responding to submissions, and additional time before consents are granted.

Although it is desirable to establish EQOs based on public perceptions, the issues involved are often highly technical and beyond the layman's understanding. This tends to lead to a precautionary approach to the issues rather than the real, technically determined effects on the environment. Public opinion, of course, greatly influences the political arm of the regional councils and technical staff, which can lead to decisions that are not entirely supportable technically.

Notwithstanding these comments, it is considered that an effects-based approach is more desirable than one based solely on the BAT approach, e.g., why limit pH in the discharge to BAT standards when the receiving water may naturally have a pH of 5 due to volcanic activity. To do so diverts funds and resources from areas where they may be better and more productively utilised. After all, it is managing the effects on society and the environment as a whole, to ensure that each may be sustained and available to future generations, that is the key issue. Achieving BAT in all instances may result in that not being the case, as the social and economic impacts on society may be significantly adversely affected to the extent that people lose jobs and families are disadvantaged for little or no ecological benefit.

5. CONCLUSIONS

New Zealand operates a decentralised permit system that establishes individual mill permit requirements. The system is operated by regional councils. Requirements for mills are set on the basis of what is needed to minimise effects on and ensure the sustained use of the environment. These requirements are based on consideration of the results of extensive monitoring and dispersion models.

The New Zealand approach is predominantly based on environmental quality objective criteria rather than requiring mills to meet a best available technology type standard. However, it should be noted that the receiving media tend to be sensitive and thus require rigid limits, characteristic of BAT-type approaches, to be applied. In some cases, particularly with regard to effluent controls, more stringent BAT-type limits are required due to water quality considerations in relatively small water bodies.

Mills use both pollution prevention and end-of-pipe treatment techniques to meet the limits. Permitting processes require mills to develop in-plant measures to meet expected goals. Results have to be provided to the regional councils and are considered in the development of subsequent permit requirements.

Guidance with respect to the establishment of permit requirements is provided by Regional Management Plans developed by the regional councils and some national guidelines. These consider the uses and environmental requirements necessary to meet various needs. The plans are based on extensive public input.

ANNEX 1-Proposed BOD_5 load limits: Tarawera Plan

Flow [a] m^3/s	Temperature [a] (°C)	Historic Limits	Proposed BOD Limits
16.00	12.00	8.90	4.38
18.00	12.00	10.60	4.96
20.00	12.00	12.30	5.54
22.00	12.00	14.00	6.12
24.00	12.00	15.50[b]	6.70
26.00	12.00	15.50[b]	7.29
28.00	12.00	15.50[b]	7.88
30.00	12.00	15.50[b]	8.47
16.00	14.00	7.40	3.50
18.00	14.00	8.80	3.96
20.00	14.00	10.30	4.42
22.00	14.00	11.80	4.88
24.00	14.00	13.30	5.35
26.00	14.00	14.80	5.82
28.00	14.00	15.50[b]	6.29
30.00	14.00	15.50[b]	6.75
14.00	16.00	7.00[b]	2.40
16.00	16.00	7.00[b]	2.76
18.00	16.00	7.30	3.13
20.00	16.00	8.60	3.49
22.00	16.00	9.80	3.86
24.00	16.00	11.10	4.23
26.00	16.00	12.40	4.60
28.00	16.00	13.80	4.96
30.00	16.00	15.10	5.34
16.00	18.00	7.00[b]	2.16
18.00	18.00	7.00[b]	2.44
20.00	18.00	7.00[b]	2.73
22.00	18.00	8.10	3.01
24.00	18.00	9.30	3.30
26.00	18.00	10.40	3.59
28.00	18.00	11.60	3.88
30.00	18.00	12.70	4.16
16.00	20.00	7.00[b]	1.66
18.00	20.00	7.00[b]	1.88
20.00	20.00	7.00[b]	2.10
22.00	20.00	7.00[b]	2.32
24.00	20.00	7.60	2.54
26.00	20.00	8.60	2.76
28.00	20.00	9.60	2.98
30.00	20.00	10.60	3.20
16.00	22.00	7.00[b]	1.26
18.00	22.00	7.00[b]	1.42
20.00	22.00	7.00[b]	1.59
22.00	22.00	7.00[b]	1.75
24.00	22.00	7.00[b]	1.92
26.00	22.00	7.10	2.09
28.00	22.00	7.90	2.25
30.00	22.00	8.80	2.42

a. at Awakaponga
b. arbitrary limits

Proposed Limits: The recalibrated GUM model was used to predict DO concentrations at Matata. This removes the need to specify the DO drop below Awakaponga. The BOD limits are calculated by requiring the daily minimum DO concentration at Matata to exceed 5.0 g/m^3 at all times given a diurnal DO range of 1.0 g/m^3 and using the upper 95% confidence limit on equation 11. The total BOD load was evenly distributed between Tasman and Caxton and the DO deficit caused by low DO concentrations in the Tasman effluent was assumed to be 0.5 g/m^3.

ANNEX 2

TABLE 1 (Provisional)
ALLOWABLE TOTAL DAILY BOD_5 (TONNES)

(To obtain the "Adjusted Allowable Total Daily BOD_5" subtract 0.3 tonnes from each value) [1]

River Flow	WATER TEMPERATURE (°C)										
m^3/s	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°
14	7.3	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
15	8.1	7.4	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
16	8.9	8.2	7.4	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
17	9.8	8.9	8.1	7.4	7.0	7.0	7.0	7.0	7.0	7.0	7.0
18	10.6	9.7	8.8	8.0	7.3	7.0	7.0	7.0	7.0	7.0	7.0
19	11.4	10.5	9.6	8.7	7.9	7.2	7.0	7.0	7.0	7.0	7.0
20	12.3	11.3	10.3	9.4	8.6	7.8	7.0	7.0	7.0	7.0	7.0
21	13.1	12.0	11.0	10.1	9.2	8.4	7.6	7.0	7.0	7.0	7.0
22	14.0	12.8	11.8	10.8	9.8	9.0	8.1	7.4	7.0	7.0	7.0
23	14.8	13.6	12.5	11.5	10.5	9.6	8.7	7.9	7.2	7.0	7.0
24	15.5	14.4	13.3	12.2	11.1	10.2	9.3	8.4	7.6	7.0	7.0
25	15.5	15.3	14.0	12.9	11.8	10.8	9.8	9.0	8.1	7.4	7.0
26	15.5	15.5	14.8	13.6	12.4	11.4	10.4	9.5	8.6	7.8	7.1
27	15.5	15.5	15.5	14.3	13.1	12.0	11.0	10.0	9.1	8.3	7.5
28	15.5	15.5	15.5	15.0	13.8	12.6	11.6	10.6	9.6	8.8	7.9
29	15.5	15.5	15.5	15.5	14.5	13.3	12.1	11.1	10.1	9.1	8.4
30	15.5	15.5	15.5	15.5	15.1	13.9	12.7	11.7	10.6	9.7	8.8
31	15.5	15.5	15.5	15.5	15.5	14.5	13.3	12.2	11.1	10.2	9.2
32	15.5	15.5	15.5	15.5	15.5	15.1	13.9	12.8	11.6	10.6	9.7
33	15.5	15.5	15.5	15.5	15.5	15.5	14.5	13.3	12.2	11.1	10.1
34	15.5	15.5	15.5	15.5	15.5	15.5	15.1	13.8	12.7	11.6	10.6
35	15.5	15.5	15.5	15.5	15.5	15.5	15.5	14.4	13.2	12.1	11.0
36	15.5	15.5	15.5	15.5	15.5	15.5	15.5	14.9	13.7	12.6	11.5
37	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	14.3	13.1	11.9
38	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	14.8	13.6	12.4
39	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.3	14.1	12.8
40	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	14.6	13.3

[1] ***The value of 0.3 tonnes is the BOD_5 allocated to the Kawerau Borough Council. This may be varied in future to take into account improved treatment and/or increased population growth.***

TABLE 1B

ALLOWABLE TOTAL DAILY BOD_5 (TONNES)

(To obtain the "Adjusted Allowable Total Daily BOD_5" subtract 0.3 tonnes from each value) [1]

River Flow	WATER TEMPERATURE (°C)										
m^3/s	12°	13°	14°	15°	16°	17°	18°	19°	20°	21°	22°
14	9.8	9.2	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
15	10.6	9.9	9.2	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
16	11.4	10.6	9.8	9.2	9.0	9.0	9.0	9.0	9.0	9.0	9.0
17	12.3	11.4	10.6	9.9	9.1	9.0	9.0	9.0	9.0	9.0	9.0
18	13.1	12.3	11.4	10.6	9.7	9.1	9.0	9.0	9.0	9.0	9.0
19	13.9	13.0	12.0	11.2	10.4	9.8	9.1	9.0	9.0	9.0	9.0
20	14.7	13.7	12.6	11.8	11.0	10.4	9.7	9.0	9.0	9.0	9.0
21	15.5	14.5	13.4	12.5	11.6	11.0	10.3	9.5	9.0	9.0	9.0
22	15.5	15.3	14.1	13.2	12.2	11.5	10.8	10.0	9.2	9.0	9.0
23	15.5	15.5	14.9	14.0	12.9	12.2	11.4	10.6	9.7	9.0	9.0
24	15.5	15.5	15.5	14.7	13.6	12.8	12.0	11.1	10.2	9.4	9.0
25	15.5	15.5	15.5	15.3	14.2	13.4	12.5	11.6	10.7	9.9	9.1
26	15.5	15.5	15.5	15.5	14.8	13.9	13.0	12.1	11.2	10.3	9.5
27	15.5	15.5	15.5	15.5	15.5	14.6	13.7	12.7	11.7	10.8	10.0
28	15.5	15.5	15.5	15.5	15.5	15.3	14.3	13.2	12.1	11.3	10.4
29	15.5	15.5	15.5	15.5	15.5	15.5	14.9	13.8	12.6	11.7	10.8
30	15.5	15.5	15.5	15.5	15.5	15.5	15.5	14.3	13.0	12.1	11.2
31	15.5	15.5	15.5	15.5	15.5	15.5	15.5	14.9	13.6	12.7	11.7
32	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	14.2	13.2	12.1
33	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	14.8	13.7	12.5
34	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.3	14.1	12.9
35	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	14.7	13.4
36	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.2	13.9
37	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	14.3
38	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	14.6
39	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.1
40	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5	15.5

(1) ***The value of 0.3 tonnes is the BOD_5 allocated to the Kawerau Borough Council. This may be varied in future to take into account improved treatment and/or increased population growth.***

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Case Study on the Use of Best Available Technology (BAT) and Environmental Quality Objectives (EQOs) in the Environmental Permitting of Bleached Chemical Pulp and Paper Mills In Norway

Pre-publication version prepared by
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Organisation for Economic Co-operation and Development
July 1998

FOREWORD

This report reviews how the concepts of best available technology (BAT) and environmental quality objectives (EQOs) are taken into consideration in the environmental permitting of pulp and paper facilities in Norway. It was prepared by Environment Canada's National Office of Pollution Prevention based on responses to a questionnaire survey. The content of the questionnaire was developed by the Organisation for Economic Co-operation and Development's (OECD), Pollution Prevention and Control Group.

This report is one of a series of reports prepared to provide background information on the procedures followed in the environmental permitting of pulp and paper mills in a number of OECD Member Countries. Information was gathered using a questionnaire designed to see how best available technology and environmental quality objectives were considered. The countries in the study were Austria, Belgium (Wallonia), Canada, Finland, the Federal Republic of Germany, New Zealand, Norway, Sweden, Switzerland, and the United States of America. Separate reports are available describing the permitting procedures of each country. This report is one of ten reports (Country Profiles) which describe the approach to environmental control of pulp and paper mills in each country. In addition, an overview case study report has been prepared describing the general permitting practices in the set of countries. These reports have been prepared by Environment Canada for the Pollution Prevention and Control Group (PPCG) of the Organisation for Economic Co-operation and Development (OECD).

This particular report provides details of the permitting approach in Norway, describing the legislative basis for permitting, the organisations that issue permits, and the use that is made of regulations, environmental quality objectives, best available technology and economics. It also describes the technological response of mills to the permit conditions that have been set and the opinions of mills with respect to the permitting process.

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1. THE PERMITTING PROCESS

1.1 Constitutional responsibilities for environmental protection

A total of eleven pulp and paper mills are in operation in Norway. These consist of two kraft mills, three sulphite mills (two of which use thermo-mechanical-pulping (TMP), three mechanical/TMP mills, two semi-chemical mills and one chemi-thermo-mechanical pulp mill. In addition there are several minor paper producers. Most of the mills are located in coastal areas, with discharges to sea water predominating. A few mills are located in towns that are heavily industrialised and air pollution is a major concern.

A fundamental principle of Norwegian pollution control policy is that any pollution is prohibited in the absence of a permit. The permits are designed to ensure that pollution is kept to a minimum. Permits to discharge pollutants to the air and water are issued by the Norwegian Pollution Control Authority (SFT). Permits for solid waste disposal are, in some cases, issued by local environmental authorities.

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.

1.2 Permits

Under Section 7 of the Pollution Control Act, all activities giving rise to pollution must be carried out under the terms of a permit. Without a permit the discharges are illegal. All industrial operations must have a permit to allow pollutants to be discharged. The construction of new plants or the expansion of existing facilities triggers a permit review.

Permit applicants must complete a form and include information describing:

- the location and the nature of the plant, the number of employees and any change in activity;
- the type of process used and the production capacity;
- both direct and indirect releases of effluents, from the process and solid waste disposal sites, including quantities, chemical analyses and toxicity tests results, and details of pollution control measures;
- details of the receiving waters;
- atmospheric releases including quantities, analyses and description of abatement measures, such as control equipment, stack heights and results of dispersion
- sources of noise, and results of measurements in the locality;
- neighbours' concerns and details of planned abatement measures;
- contingency plans to address any abnormal releases to water and air;
- internal pollution prevention systems that will be applied to control releases; and
- means to measure various releases and draft monitoring programs for air and water.

Applications for permits are made public and neighbours and other parties have an opportunity to provide comments and express concerns regarding the application. Similarly, authorities in surrounding counties and municipalities are contacted for their views and a copy of the application is sent to the municipal and county

authorities for public viewing. The applications are available to the public. A copy of the application is sent to the local authority in the municipality for public viewing. Announcements pertaining to the application of this are made in local newspapers.

A separate department within the SFT, the Department of Industry, is responsible for handling applications for discharge permits. This department is broken down into different units that handle applications from various types of industry. The department is also responsible for following up on permits by reviewing reports on internal control measures that have been installed, and participating in inspections and audits that are conducted by the SFT's Pollution Control Department. The Department of Industry administers monitoring programs in areas polluted by industry and offshore operations, and follows up on programs implemented to develop cleaner technologies. It also participates in International activities.

SFT's Pollution Control Department is responsible for ensuring compliance with the Pollution Control Act, the Product Control Act and any regulations pursuant to these acts, as well as any permits to individual enterprises. In addition, the Pollution Control Department identifies risk of accidental discharges and proposes relevant risk-reduction measures.

The permitting authority's decisions are based on case-by-case consideration of each application. In setting permit requirements, consideration is given to the nature of the discharges, the conditions of the receiving environments, the cost-effectiveness of available control options, and cost-benefit analysis of the pollution abatement measures that could be taken. The latter analyses weigh the benefits of reduced pollution against the cost of controls. Economic analyses, which consider the financial effects of control options on the enterprise, influence the compliance schedule but not the final value of the limits that are set.

Permit review and approval usually takes 9 to 12 months to complete. Once granted, permits have an indefinite life, but may be withdrawn after 10 years. Decisions of the county authorities can be appealed to the SFT, and decisions by the SFT can be appealed to the Ministry of Environment. Any interested parties may make an appeal, (plant owners, neighbours or environmental organisations).

Integrated permits are issued covering releases to water, air, solid waste disposal and noise abatement. Limits are set as maximum discharges to the various media. Permits for existing facilities often include stepwise reduction schedules, over a limited time, to meet the environmental requirements.

1.3 Permit renewal process

As mentioned above, once granted, permits have an indefinite life span and do not require renewal in the absence of a major change in the activities of the plant, unless it turns out that the damage caused by the pollution is different than first anticipated, or if new technology makes it possible to reduce the pollution to a significant degree, and this can be done with reasonable costs. In practice, changes in permits take place regularly due to changes in the above mentioned circumstances. In the case of major plant expansion or process changes, a new application is required. For minor changes, only those sections of the permit affected will require revision.

After 10 years, the SFT may withdraw or change the permit. This would only be done, however, after taking into consideration the advantages and disadvantages of such action with respect to the environment and the enterprise, and bearing in mind the cost involved. The "10-year rule" is seldom used for the purpose of withdrawing a permit, but it may be used to change/update permits based on new knowledge.

1.4 Multi-media permits

Norway uses an integrated permitting system, with a single permit covering discharges to all media, (air and water pollution, noise and waste disposal). In issuing permits, if the decrease of emissions to one media, will result in increases of releases to another, then consideration is given to setting requirements that lead to the least possible environmental impact overall.

1.5 Environmental assessment

Before a permit is issued, an evaluation of the receiving water and air is required , so that the effects of pollution can be assessed prior to setting the permit conditions. Normally there is also a requirement for an evaluation of the receiving environment after the required discharge levels have been achieved to determine whether further measures are needed.

For new activities that may cause pollution, there is a demand for an Environmental Impact Assessment (pursuant to the Building and Planning Act), prior to the permitting process.

2. BAT, EQO'S AND ECONOMICS

2.1 Standards setting

In issuing pulp and paper mill permits, Norway has found it unnecessary to prescribe maximum limits for pollutants that mills may release. Permits are issued on case-by-case consideration of each application, taking into account the condition of receiving environments and the abatement measures that are possible. In addition, BAT and the cost involved are considered. As a minimum requirement of all permits issued, international agreements that concern Norway must be fulfilled.

An example of international agreements are decisions made by the Paris Commission. Decision 95/2 covers discharge and emission limit values for integrated and non-integrated sulphite paper pulp industry and kraft pulp industry. The limit values applicable to the sulphite and kraft pulp and paper industries are summarised in the tables below.

Table 1. Limit values for sulphite paper pulp industry.

	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
COD	80	35
TSS	8.0	4.5
SO_2	5.0	3.0
NO_x	2.5	1.5

Table 2. Limit values for sulphate paper pulp industry.

	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
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

2.2 Cleaner technology

The use of Cleaner Technologies is an integral part of the permitting process which is managed by the SFT's Department of Industry. In their permit applications, enterprises have to provide details of internal pollution prevention techniques that will be applied. These are reviewed during the approval process. The department also administers a program to provide funds to assist in the development of cleaner technologies to meet priority needs.

The following examples illustrate how cleaner technologies have been applied in a pulp and paper mill permit.

The Cleaner Technology program is an important part of the environmental authorities contribution to environmental technology. In 1995, SFT provided approximately 20 million Norwegian Krones to subsidise demonstration projects in a number of branches in industry. Support for the various project depends on the fulfilment of certain criteria, of which the following are the most important:

- the project must help to solve high priority environmental problems in Norway;
- the enterprise ("the owner of the problem") must contribute financially; and
- the results of the program should be transferable to other enterprises.

In the pulp and paper industry, there have been several projects related to biological treatment systems that have been partially funded by the Cleaner Technology program. This also includes treatment and combustion of sludge. One mill received support to evaluate non-chlorine bleaching processes. The financial contribution from SFT has varied from 100 000 to 5 million Norwegian Krones. At present, the contribution cannot exceed 35 per cent of the total proposed cost.

2.3 Environmental quality objectives

Legally binding environmental quality standards, i.e. regulations pursuant to the Pollution Control Act, have not been established thus far, however, EQO-guidelines for water and air have been established. These are used as a supplement to the overall evaluation of the pollution situation in an area, and guide the decisions of the permitting authority. The damaging effects of the emissions must be weighed against the gain to society from the activity concerned. The environmental quality objectives are based on deliberations by expert groups.

With respect to receiving waters, systems of classifications have been established for both marine and fresh waters. Both types of waters are assessed according to their suitability for various uses based upon water quality and the degree of pollution associated with that water. The environmental quality will depend upon both natural conditions and anthropogenic impact (pollution). The degree of pollution represents the anthropogenic impact only.

The quality and degree of pollution of a given water body are classified into five different categories/degrees, whereas the assessment of water quality for various uses (suitability) is classified in four categories. Within each category there is a unique set of criteria for classifying the effects of nutrients, organic matters, micropollutants and, for freshwater, acidifying components and fecal bacteria.

In 1997, Norway set legally binding regulations, pursuant to the Pollution Control Act, on local air pollution and noise. The regulations address effects of air pollution on houses, kindergartens, schools, health service centres and so on, of pollution and noise from roads, railways, airports, industry and larger combustion plants.

The purpose of the regulation is to protect public health and welfare by setting maximum acceptable values for air quality contaminants and noise. The limits in these regulations have to be phased in according to the processes and by the time shown in the table below.

Table 3. Maximum acceptable values for air quality and noise.

		Limit Values µg/m³ and application		
	Average	*1	From 1997 *2	By 2005 *2
NO_2	hourly	200	400	300
SO_2	daily	150	400	200
Particulates (PM 10)	daily	90	350	300
Pb	daily	0.5	0.5	0.5
Noise (in house)	daily	35 dB (A)		42 dB (A)

1. Study on effects and possible control measure should be carried out when exceeding these limit values. The purpose of the study is to increase the knowledge of air pollution in an area and give background for planning measures to be taken.
2. Measures are to be taken to reach the given limit values.

2.4 Best available technology

Norway is a participant in the Paris Commission, which in 1994 agreed to a description of Best Available Technologies and Best Environmental Practice for the Kraft Pulp Industry and for the Sulphite Paper Pulp Industry. The most important measures mentioned in these descriptions are dry debarking, closed screening, reuse of most condensates in the process, extended delignification followed by oxygen delignification (kraft pulp), secondary treatment for waste water discharges, technology for the reduction of SO_2 and NO_x emissions, collection and incineration of odorous gases (kraft pulp) and the principle of substitution to a product that is less hazardous to man and the environment when possible. The description is considered as an element of the permitting process.

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. In determining whether a set of processes, facilities and methods of operation constitute the best available techniques, in general or individual cases, special consideration is given to:

- comparable processes, facilities or methods of operation that have been used successfully;
- technological advances and changes in scientific knowledge and understanding;
- the economic feasibility of such techniques;
- time limits for the installation of such techniques in both new and existing plants; and
- the nature and volume of the discharges and emissions concerned.

Techniques include both the technology used and the way in which the installation is designed, built, maintained, operated and dismantled.

It is important to note that Norway, as a part of the agreement of the European Economic Area, will implement European Community (EC) directives on Integrated Pollution Prevention and Control (IPPC), which include a definition of BAT.

According to Section 2 of the Pollution Control Act (§2), the Act shall be used to "*achieve satisfactory environmental quality on the basis of a total appraisal of health, welfare, the natural environment, costs related to control measures and economic considerations. The prevention and abatement of pollution and waste*

problems shall be based on the technology which, on the basis of a total appraisal of present and future use of the environment and of economic consideration, gives the best result." This means that BAT, defined strictly on a technological basis, is not used as an absolute requirement in the permitting process. When determining conditions in the individual permits, an overall evaluation must be conducted based on several aspects (condition of the recipient, main polluting problems, cost-effectiveness of measures, etc.). Nevertheless, BAT is an important aspect and is linked to environmental goals and considerations of cost-benefit and cost-effectiveness.

Previously, permits generally contained requirements concerning which technology should be used, along with corresponding emission limits. Under current practice, only emission limits are specified, leaving the enterprise free to choose which technology to meet the requirements. However, in the permit issuance process, permit limits are set based partly on consideration of the effectiveness and applicability of best available technology.

2.5 Negotiation of standards

Permit limits are determined on a case-by-case situation and involve consideration of the views of various parties, and hence involve some degree of negotiation. With respect to time frames for meeting limits, these are based on the economic feasibility of installing controls. The negotiations between plant owners and the SFT regarding time frames for implementation of the permitted standards take place during the application review process. SFT takes into account the views of all parties.

2.6 Economic considerations

In Norway, cost-benefit and cost-effectiveness assessments are included in the permit review process, these influence the emission limits set and the time-frames established for the implementation of controls. It is noted that economic feasibility influences the time frame for the installation of controls but not the absolute values of the limits.

The cost of pollution control technology and the environmental impact of the discharges are weighed against the installation costs of control measures to the plant.

2.7 Interaction of BAT and EQO's

Permit requirements are developed on a case-by-case basis. This involves consideration of both available technologies and environmental quality objectives.

3. TRENDS IN PERMITTING

3.1 Cleaner technology

The case-by-case permitting approach used in Norway considers the part to be played by cleaner, pollution prevention technologies and by end-of-pipe treatment. Pollution prevention techniques are applied to minimise the need for, and the costs of air, water and solid waste control systems.

In order to illustrate their recent permitting approach, Norway provided a permit that was recently issued to a mechanical-sulphite based pulp and paper mill. Effluents are required to meet limits for chemical oxygen demand (COD) and suspended solids. Internal controls are employed to reuse much of the white water originating from the paper making process. In addition, waste water from parts of the pulping operation is reused in the process. The mill has also modified its sulphite pulping to minimise the effluent volumes and the cost of effluent treatment.

With respect to chlorinated substances, including dioxins and furans, and absorbable organic halide, the mill has obviated the need for such controls by applying a hydrogen peroxide bleaching process to satisfy its need for bleached pulp. This avoids the use of chlorine and chlorine dioxide.

With regard to air pollution control, sulphur dioxide pulping operations are a concern. These emissions are controlled through the use of a magnesium oxide based pulping process that allows the spent sulphur dioxide to be recovered in an absorption scrubber and magnesium oxide in an electrostatic precipitator.

Gaseous emissions from the power boiler are controlled by cyclones and an electrostatic precipitator.

Secondary, biological treatment and internal control measures are used to meet the COD limits. The process results in the generation of waste sludges that are burned in the power boiler along with bark, thereby minimising the need for solid waste disposal.

An effort is being made to reduce the quantities of waste requiring disposal and to find alternative uses for it, e.g., for generating energy or soil conditioning. Under its permit, the company is to draw up a waste minimisation program which includes further plans for the utilisation of ash from the incineration of bark/sludge and possible utilisation of other waste currently sent to landfill sites.

3.2 Trends in limits

In order to illustrate recent permitting trends, the Norwegian Pollution Control Authority provided a recently amended permit issued in February 1995 for a mechanical-sulphite based paper mill. The permit covers all media (air, water, land and noise). It applies to a major modernisation in which thermo mechanical pulping capacity would be increased to 230 000t per year, allowing groundwood pulp production to be abandoned, when the thermo-mechanical pulp (TMP) plant was fully on-line. Of this capacity, 80 000t of the TMP would be bleached with hydrogen peroxide and used to make high grade paper products. About 240 000t of paper are expected to be produced per year. As a result of the TMP's better properties compared to groundwood, less sulphite pulp is required to make paper. Consequently, about 40 000 t of sulphite pulp will be available for sale, but it needs to be bleached and dried. A hydrogen peroxide bleaching process will be used to achieve this.

The mill is located in one of the most polluted air sheds in Norway. The environmental situation is further complicated because the mill is situated in the centre of a town. As a result, more stringent limits for SO_2 emissions and noise are required than for mills in other locations. In addition, there are greater concerns regarding particulates and odours emanating from the plant.

The permit applies to a plant that was undergoing process modification, a small expansion and the installation of a secondary treatment plant. The permit illustrates recent trends, such as substances controlled, the need for receiving environment studies and general conditions. The following describes general requirements related to water, air, noise and solid waste control.

The permit includes conditions related to the release of pollutants; in cases of non-compliance with any conditions, these must be documented. Failure to comply with emission limits is an offence under the Norwegian Penal Code.

In addition to meeting prescribed limits, the permit requires the company to have an emergency response plan to detect, prevent, and address any discharges exceeding the normal course of events, and to mitigate their impact if they do occur. Abnormal discharges must be reported to the authorities immediately.

As well as meeting the conditions of its permit, the company has a duty to employ instructions, controls and other measures to ensure that the operation of the plant proceeds in such a way as to limit harmful effects and nuisances as much as possible at all times. This includes a responsibility to avoid abnormal operating conditions that result in increased emissions, and to reduce or suspend operations under circumstances that would otherwise lead to emissions that would significantly exceed normal levels.

3.2.1 Water pollution control requirements

Effluent discharge limits are prescribed for COD and total suspended solids (TSS) based on the average results of measurements over monthly and half yearly periods. Graduated limits for suspended solids are applied as shown in Table 4. The graduated schedule was adopted in order to allow the mill time to optimise the performance of an effluent treatment system that was to start up in the first half of 1996.

Table 4 also shows the applicable limits in kilograms per tonne of final product, assuming that the mill produced an average of 800t of paper per day and bleached market sulphite pulp. These limits are determined by prorating the annual production of 230 000t of paper per year, and 40 000t of bleached market sulphite pulp, assuming 350 operating days in a year. (Calculated for the purpose of this OECD project)

Table 4. Water pollution control limits.

Pollutant	Limit t/day monthly av.	Limit t/day half yr. av.	Applies from	Limit as kg/t (month)	Limit as kg/t (half year)
COD	30	25	Current	37.5	31.3
TSS	7.0	6.0	Current	8.75	7.5
TSS	3.0	2.5	01/09/95	3.75	3.13
TSS	2.5	2.0	01/06/96	3.13	2.50

The plant has to implement internal measures to ensure effective effluent treatment plant operation. These measures consist of keeping sewage effluent separate from fibre containing process effluent, reducing freshwater usage wherever possible, having sufficient tank capacity to handle surges of fibre containing slurries and process effluents, keeping cooling water and other clean water separate from process effluents, and using screens to separate out fibres. The plant has also to discharge through designated outfalls to minimise the environmental impact, and to ensure that the outfalls do not freeze or move.

In addition to measuring COD and TSS, the mill has to monitor and report nitrogen and phosphate discharges.

The mill has to conduct wastewater characterisation and ecotoxicological studies, according to prescribed programs, when its effluent treatment plant is in operation.

One year after the commencement of operations, the mill has to report annually to the SFT on the operational reliability and effectiveness of the treatment plant. In case of unsatisfactory effects, the mill has to submit proposals for measures to improve performance. The first report on the effluent treatment system is due in July 1997.

The mill must also conduct a study on the Skienselva River, downstream of the mill once the treatment facility is running. The study has to cover an annual cycle and be co-ordinated with receiving environment studies conducted by the various levels of government in the area. A final report is to be submitted by the end of 1997, with plans submitted for comment well in advance.

3.2.2 Air pollution control requirements

The permit also states that if the SO_2 emissions or odours prove greater than anticipated, the SFT can ask the mill to reduce its sulphite pulp production on short notice.

Air pollution control equipment and stack heights for dispersion of waste gases from the sulphite plant and oil/bark incinerator are stipulated in the permit as well.

Up to 18 400t of fuel oil, with maximum 1.0 per cent sulphur may be consumed each year. The actual amount of oil consumed must be specified by the mill in their reports.

The permit requires a study report on the possible measures and the associated costs that could be taken to reduce the total emissions of SO_2 (including diffuse emissions) from the sulphite pulp plant. The study should cover possible emission levels of both 3 and 1.5 kg SO_2 per tonne of cellulose, corresponding to 14 and 7 kg/hour of SO_2 at a production rate of 40 000 tonnes per year. The study will be used by Norwegian Pollution Control Authority (SFT) in considering more stringent emission levels for SO_2.

3.2.3 Noise control

Theoretical noise levels are controlled at four reference points in the vicinity of the mill. Noise levels cannot exceed 52 dB(A) at one reference point and 50 dB(A) at the other three. As of July 1, 1995, the noise level limits will be decreased to 48 dB(A) at the first point and 45 dB(A) at the other three. The company is to assess the cost of further reduction to 45 dB(A) at the first reference point.

Once measures to reduce noise levels have been implemented, the company must take noise measurements to verify that the targets have been attained. Orders requiring further reports and measures may be considered once existing orders have been implemented.

3.2.4 Solid waste control

The company is permitted to burn bark along with sludge from its treatment plant in its oil/bark power boiler. In addition, the mill is allowed to incinerate up to 10 000 tonnes of oil waste per year, limited to 60 tonnes a day. The mill must comply with requirements laid down in a regulation on incineration of waste oil. The waste oil for incineration must be of certain quality as specified below:

- less than 50 mg PCB/PCT per kg waste oil
- less than 1000 mg organic halogens per kg oil
- lower heating value should be higher than 30 MJ per kg
- flash point should be higher than +55°C.

Table 5. Emission limit values for oil waste.

	Limit values Mg/Nm^3 Daily Average
Cd	0.5
Ni	1
Cr+Cu+V	1.5
Pb	5
Cl (as HCl)	100
F (as HF)	5
Particulates (dust)	50

Emission values should be monitored at least twice a year. The results should be reported to SFT once a year.

Solid wastes, including boiler ash, are disposed at municipal landfill sites. Special wastes are dealt with according to the Special Waste Regulation.

Sludges from the effluent treatment plant have to be stored in such a way that nuisances, such as odour and run-off, are avoided as much as possible. Any special wastes that are held for delivery/collection have to be stored in a secure system and in such a manner to prevent run-off into the soil, surface water or drainage systems, and to prevent evaporation to the atmosphere.

3.3 Monitoring

Limits for emissions to air and water and for noise have to be complied with during measurement periods specified in each discharge permit, unless more specific requirements are laid down in the meantime.

Case Study on the Use of Best Available Technology (BAT) and Environmental Quality Objectives (EQOs) in the Environmental Permitting of Bleached Chemical Pulp and Paper Mills In Norway

Pre-publication version prepared by
David Halliburton of Environment Canada for
Pollution Prevention Control Group of
Organisation for Economic Co-operation and Development
July 1998

FOREWORD

This report reviews how the concepts of best available technology (BAT) and environmental quality objectives (EQOs) are taken into consideration in the environmental permitting of pulp and paper facilities in Norway. It was prepared by Environment Canada's National Office of Pollution Prevention based on responses to a questionnaire survey. The content of the questionnaire was developed by the Organisation for Economic Co-operation and Development's (OECD), Pollution Prevention and Control Group.

This report is one of a series of reports prepared to provide background information on the procedures followed in the environmental permitting of pulp and paper mills in a number of OECD Member Countries. Information was gathered using a questionnaire designed to see how best available technology and environmental quality objectives were considered. The countries in the study were Austria, Belgium (Wallonia), Canada, Finland, the Federal Republic of Germany, New Zealand, Norway, Sweden, Switzerland, and the United States of America. Separate reports are available describing the permitting procedures of each country. This report is one of ten reports (Country Profiles) which describe the approach to environmental control of pulp and paper mills in each country. In addition, an overview case study report has been prepared describing the general permitting practices in the set of countries. These reports have been prepared by Environment Canada for the Pollution Prevention and Control Group (PPCG) of the Organisation for Economic Co-operation and Development (OECD).

This particular report provides details of the permitting approach in Norway, describing the legislative basis for permitting, the organisations that issue permits, and the use that is made of regulations, environmental quality objectives, best available technology and economics. It also describes the technological response of mills to the permit conditions that have been set and the opinions of mills with respect to the permitting process.

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1. THE PERMITTING PROCESS

1.1 Constitutional responsibilities for environmental protection

A total of eleven pulp and paper mills are in operation in Norway. These consist of two kraft mills, three sulphite mills (two of which use thermo-mechanical-pulping (TMP), three mechanical/TMP mills, two semi-chemical mills and one chemi-thermo-mechanical pulp mill. In addition there are several minor paper producers. Most of the mills are located in coastal areas, with discharges to sea water predominating. A few mills are located in towns that are heavily industrialised and air pollution is a major concern.

A fundamental principle of Norwegian pollution control policy is that any pollution is prohibited in the absence of a permit. The permits are designed to ensure that pollution is kept to a minimum. Permits to discharge pollutants to the air and water are issued by the Norwegian Pollution Control Authority (SFT). Permits for solid waste disposal are, in some cases, issued by local environmental authorities.

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.

1.2 Permits

Under Section 7 of the Pollution Control Act, all activities giving rise to pollution must be carried out under the terms of a permit. Without a permit the discharges are illegal. All industrial operations must have a permit to allow pollutants to be discharged. The construction of new plants or the expansion of existing facilities triggers a permit review.

Permit applicants must complete a form and include information describing:

- the location and the nature of the plant, the number of employees and any change in activity;
- the type of process used and the production capacity;
- both direct and indirect releases of effluents, from the process and solid waste disposal sites, including quantities, chemical analyses and toxicity tests results, and details of pollution control measures;
- details of the receiving waters;
- atmospheric releases including quantities, analyses and description of abatement measures, such as control equipment, stack heights and results of dispersion
- sources of noise, and results of measurements in the locality;
- neighbours' concerns and details of planned abatement measures;
- contingency plans to address any abnormal releases to water and air;
- internal pollution prevention systems that will be applied to control releases; and
- means to measure various releases and draft monitoring programs for air and water.

Applications for permits are made public and neighbours and other parties have an opportunity to provide comments and express concerns regarding the application. Similarly, authorities in surrounding counties and municipalities are contacted for their views and a copy of the application is sent to the municipal and county

authorities for public viewing. The applications are available to the public. A copy of the application is sent to the local authority in the municipality for public viewing. Announcements pertaining to the application of this are made in local newspapers.

A separate department within the SFT, the Department of Industry, is responsible for handling applications for discharge permits. This department is broken down into different units that handle applications from various types of industry. The department is also responsible for following up on permits by reviewing reports on internal control measures that have been installed, and participating in inspections and audits that are conducted by the SFT's Pollution Control Department. The Department of Industry administers monitoring programs in areas polluted by industry and offshore operations, and follows up on programs implemented to develop cleaner technologies. It also participates in International activities.

SFT's Pollution Control Department is responsible for ensuring compliance with the Pollution Control Act, the Product Control Act and any regulations pursuant to these acts, as well as any permits to individual enterprises. In addition, the Pollution Control Department identifies risk of accidental discharges and proposes relevant risk-reduction measures.

The permitting authority's decisions are based on case-by-case consideration of each application. In setting permit requirements, consideration is given to the nature of the discharges, the conditions of the receiving environments, the cost-effectiveness of available control options, and cost-benefit analysis of the pollution abatement measures that could be taken. The latter analyses weigh the benefits of reduced pollution against the cost of controls. Economic analyses, which consider the financial effects of control options on the enterprise, influence the compliance schedule but not the final value of the limits that are set.

Permit review and approval usually takes 9 to 12 months to complete. Once granted, permits have an indefinite life, but may be withdrawn after 10 years. Decisions of the county authorities can be appealed to the SFT, and decisions by the SFT can be appealed to the Ministry of Environment. Any interested parties may make an appeal, (plant owners, neighbours or environmental organisations).

Integrated permits are issued covering releases to water, air, solid waste disposal and noise abatement. Limits are set as maximum discharges to the various media. Permits for existing facilities often include stepwise reduction schedules, over a limited time, to meet the environmental requirements.

1.3 Permit renewal process

As mentioned above, once granted, permits have an indefinite life span and do not require renewal in the absence of a major change in the activities of the plant, unless it turns out that the damage caused by the pollution is different than first anticipated, or if new technology makes it possible to reduce the pollution to a significant degree, and this can be done with reasonable costs. In practice, changes in permits take place regularly due to changes in the above mentioned circumstances. In the case of major plant expansion or process changes, a new application is required. For minor changes, only those sections of the permit affected will require revision.

After 10 years, the SFT may withdraw or change the permit. This would only be done, however, after taking into consideration the advantages and disadvantages of such action with respect to the environment and the enterprise, and bearing in mind the cost involved. The "10-year rule" is seldom used for the purpose of withdrawing a permit, but it may be used to change/update permits based on new knowledge.

1.4 Multi-media permits

Norway uses an integrated permitting system, with a single permit covering discharges to all media, (air and water pollution, noise and waste disposal). In issuing permits, if the decrease of emissions to one media, will result in increases of releases to another, then consideration is given to setting requirements that lead to the least possible environmental impact overall.

1.5 Environmental assessment

Before a permit is issued, an evaluation of the receiving water and air is required , so that the effects of pollution can be assessed prior to setting the permit conditions. Normally there is also a requirement for an evaluation of the receiving environment after the required discharge levels have been achieved to determine whether further measures are needed.

For new activities that may cause pollution, there is a demand for an Environmental Impact Assessment (pursuant to the Building and Planning Act), prior to the permitting process.

2. BAT, EQO'S AND ECONOMICS

2.1 Standards setting

In issuing pulp and paper mill permits, Norway has found it unnecessary to prescribe maximum limits for pollutants that mills may release. Permits are issued on case-by-case consideration of each application, taking into account the condition of receiving environments and the abatement measures that are possible. In addition, BAT and the cost involved are considered. As a minimum requirement of all permits issued, international agreements that concern Norway must be fulfilled.

An example of international agreements are decisions made by the Paris Commission. Decision 95/2 covers discharge and emission limit values for integrated and non-integrated sulphite paper pulp industry and kraft pulp industry. The limit values applicable to the sulphite and kraft pulp and paper industries are summarised in the tables below.

Table 1. Limit values for sulphite paper pulp industry.

	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**
COD	80	35
TSS	8.0	4.5
SO_2	5.0	3.0
NO_x	2.5	1.5

Table 2. Limit values for sulphate paper pulp industry.

	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**
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

2.2 Cleaner technology

The use of Cleaner Technologies is an integral part of the permitting process which is managed by the SFT's Department of Industry. In their permit applications, enterprises have to provide details of internal pollution prevention techniques that will be applied. These are reviewed during the approval process. The department also administers a program to provide funds to assist in the development of cleaner technologies to meet priority needs.

The following examples illustrate how cleaner technologies have been applied in a pulp and paper mill permit.

The Cleaner Technology program is an important part of the environmental authorities contribution to environmental technology. In 1995, SFT provided approximately 20 million Norwegian Krones to subsidise demonstration projects in a number of branches in industry. Support for the various project depends on the fulfilment of certain criteria, of which the following are the most important:

- the project must help to solve high priority environmental problems in Norway;
- the enterprise ("the owner of the problem") must contribute financially; and
- the results of the program should be transferable to other enterprises.

In the pulp and paper industry, there have been several projects related to biological treatment systems that have been partially funded by the Cleaner Technology program. This also includes treatment and combustion of sludge. One mill received support to evaluate non-chlorine bleaching processes. The financial contribution from SFT has varied from 100 000 to 5 million Norwegian Krones. At present, the contribution cannot exceed 35 per cent of the total proposed cost.

2.3 Environmental quality objectives

Legally binding environmental quality standards, i.e. regulations pursuant to the Pollution Control Act, have not been established thus far, however, EQO-guidelines for water and air have been established. These are used as a supplement to the overall evaluation of the pollution situation in an area, and guide the decisions of the permitting authority. The damaging effects of the emissions must be weighed against the gain to society from the activity concerned. The environmental quality objectives are based on deliberations by expert groups.

With respect to receiving waters, systems of classifications have been established for both marine and fresh waters. Both types of waters are assessed according to their suitability for various uses based upon water quality and the degree of pollution associated with that water. The environmental quality will depend upon both natural conditions and anthropogenic impact (pollution). The degree of pollution represents the anthropogenic impact only.

The quality and degree of pollution of a given water body are classified into five different categories/degrees, whereas the assessment of water quality for various uses (suitability) is classified in four categories. Within each category there is a unique set of criteria for classifying the effects of nutrients, organic matters, micropollutants and, for freshwater, acidifying components and fecal bacteria.

In 1997, Norway set legally binding regulations, pursuant to the Pollution Control Act, on local air pollution and noise. The regulations address effects of air pollution on houses, kindergartens, schools, health service centres and so on, of pollution and noise from roads, railways, airports, industry and larger combustion plants.

The purpose of the regulation is to protect public health and welfare by setting maximum acceptable values for air quality contaminants and noise. The limits in these regulations have to be phased in according to the processes and by the time shown in the table below.

Table 3. Maximum acceptable values for air quality and noise.

		Limit Values µg/m³ and application		
	Average	*1	From 1997 *2	By 2005 *2
NO_2	hourly	200	400	300
SO_2	daily	150	400	200
Particulates (PM 10)	daily	90	350	300
Pb	daily	0.5	0.5	0.5
Noise (in house)	daily	35 dB (A)		42 dB (A)

1. Study on effects and possible control measure should be carried out when exceeding these limit values. The purpose of the study is to increase the knowledge of air pollution in an area and give background for planning measures to be taken.
2. Measures are to be taken to reach the given limit values.

2.4 Best available technology

Norway is a participant in the Paris Commission, which in 1994 agreed to a description of Best Available Technologies and Best Environmental Practice for the Kraft Pulp Industry and for the Sulphite Paper Pulp Industry. The most important measures mentioned in these descriptions are dry debarking, closed screening, reuse of most condensates in the process, extended delignification followed by oxygen delignification (kraft pulp), secondary treatment for waste water discharges, technology for the reduction of SO_2 and NO_x emissions, collection and incineration of odorous gases (kraft pulp) and the principle of substitution to a product that is less hazardous to man and the environment when possible. The description is considered as an element of the permitting process.

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. In determining whether a set of processes, facilities and methods of operation constitute the best available techniques, in general or individual cases, special consideration is given to:

- comparable processes, facilities or methods of operation that have been used successfully;
- technological advances and changes in scientific knowledge and understanding;
- the economic feasibility of such techniques;
- time limits for the installation of such techniques in both new and existing plants; and
- the nature and volume of the discharges and emissions concerned.

Techniques include both the technology used and the way in which the installation is designed, built, maintained, operated and dismantled.

It is important to note that Norway, as a part of the agreement of the European Economic Area, will implement European Community (EC) directives on Integrated Pollution Prevention and Control (IPPC), which include a definition of BAT.

According to Section 2 of the Pollution Control Act (§2), the Act shall be used to "*achieve satisfactory environmental quality on the basis of a total appraisal of health, welfare, the natural environment, costs related to control measures and economic considerations. The prevention and abatement of pollution and waste*

problems shall be based on the technology which, on the basis of a total appraisal of present and future use of the environment and of economic consideration, gives the best result." This means that BAT, defined strictly on a technological basis, is not used as an absolute requirement in the permitting process. When determining conditions in the individual permits, an overall evaluation must be conducted based on several aspects (condition of the recipient, main polluting problems, cost-effectiveness of measures, etc.). Nevertheless, BAT is an important aspect and is linked to environmental goals and considerations of cost-benefit and cost-effectiveness.

Previously, permits generally contained requirements concerning which technology should be used, along with corresponding emission limits. Under current practice, only emission limits are specified, leaving the enterprise free to choose which technology to meet the requirements. However, in the permit issuance process, permit limits are set based partly on consideration of the effectiveness and applicability of best available technology.

2.5 Negotiation of standards

Permit limits are determined on a case-by-case situation and involve consideration of the views of various parties, and hence involve some degree of negotiation. With respect to time frames for meeting limits, these are based on the economic feasibility of installing controls. The negotiations between plant owners and the SFT regarding time frames for implementation of the permitted standards take place during the application review process. SFT takes into account the views of all parties.

2.6 Economic considerations

In Norway, cost-benefit and cost-effectiveness assessments are included in the permit review process, these influence the emission limits set and the time-frames established for the implementation of controls. It is noted that economic feasibility influences the time frame for the installation of controls but not the absolute values of the limits.

The cost of pollution control technology and the environmental impact of the discharges are weighed against the installation costs of control measures to the plant.

2.7 Interaction of BAT and EQO's

Permit requirements are developed on a case-by-case basis. This involves consideration of both available technologies and environmental quality objectives.

3. TRENDS IN PERMITTING

3.1 Cleaner technology

The case-by-case permitting approach used in Norway considers the part to be played by cleaner, pollution prevention technologies and by end-of-pipe treatment. Pollution prevention techniques are applied to minimise the need for, and the costs of air, water and solid waste control systems.

In order to illustrate their recent permitting approach, Norway provided a permit that was recently issued to a mechanical-sulphite based pulp and paper mill. Effluents are required to meet limits for chemical oxygen demand (COD) and suspended solids. Internal controls are employed to reuse much of the white water originating from the paper making process. In addition, waste water from parts of the pulping operation is reused in the process. The mill has also modified its sulphite pulping to minimise the effluent volumes and the cost of effluent treatment.

With respect to chlorinated substances, including dioxins and furans, and absorbable organic halide, the mill has obviated the need for such controls by applying a hydrogen peroxide bleaching process to satisfy its need for bleached pulp. This avoids the use of chlorine and chlorine dioxide.

With regard to air pollution control, sulphur dioxide pulping operations are a concern. These emissions are controlled through the use of a magnesium oxide based pulping process that allows the spent sulphur dioxide to be recovered in an absorption scrubber and magnesium oxide in an electrostatic precipitator.

Gaseous emissions from the power boiler are controlled by cyclones and an electrostatic precipitator.

Secondary, biological treatment and internal control measures are used to meet the COD limits. The process results in the generation of waste sludges that are burned in the power boiler along with bark, thereby minimising the need for solid waste disposal.

An effort is being made to reduce the quantities of waste requiring disposal and to find alternative uses for it, e.g., for generating energy or soil conditioning. Under its permit, the company is to draw up a waste minimisation program which includes further plans for the utilisation of ash from the incineration of bark/sludge and possible utilisation of other waste currently sent to landfill sites.

3.2 Trends in limits

In order to illustrate recent permitting trends, the Norwegian Pollution Control Authority provided a recently amended permit issued in February 1995 for a mechanical-sulphite based paper mill. The permit covers all media (air, water, land and noise). It applies to a major modernisation in which thermo mechanical pulping capacity would be increased to 230 000t per year, allowing groundwood pulp production to be abandoned, when the thermo-mechanical pulp (TMP) plant was fully on-line. Of this capacity, 80 000t of the TMP would be bleached with hydrogen peroxide and used to make high grade paper products. About 240 000t of paper are expected to be produced per year. As a result of the TMP's better properties compared to groundwood, less sulphite pulp is required to make paper. Consequently, about 40 000 t of sulphite pulp will be available for sale, but it needs to be bleached and dried. A hydrogen peroxide bleaching process will be used to achieve this.

The mill is located in one of the most polluted air sheds in Norway. The environmental situation is further complicated because the mill is situated in the centre of a town. As a result, more stringent limits for SO_2 emissions and noise are required than for mills in other locations. In addition, there are greater concerns regarding particulates and odours emanating from the plant.

The permit applies to a plant that was undergoing process modification, a small expansion and the installation of a secondary treatment plant. The permit illustrates recent trends, such as substances controlled, the need for receiving environment studies and general conditions. The following describes general requirements related to water, air, noise and solid waste control.

The permit includes conditions related to the release of pollutants; in cases of non-compliance with any conditions, these must be documented. Failure to comply with emission limits is an offence under the Norwegian Penal Code.

In addition to meeting prescribed limits, the permit requires the company to have an emergency response plan to detect, prevent, and address any discharges exceeding the normal course of events, and to mitigate their impact if they do occur. Abnormal discharges must be reported to the authorities immediately.

As well as meeting the conditions of its permit, the company has a duty to employ instructions, controls and other measures to ensure that the operation of the plant proceeds in such a way as to limit harmful effects and nuisances as much as possible at all times. This includes a responsibility to avoid abnormal operating conditions that result in increased emissions, and to reduce or suspend operations under circumstances that would otherwise lead to emissions that would significantly exceed normal levels.

3.2.1 Water pollution control requirements

Effluent discharge limits are prescribed for COD and total suspended solids (TSS) based on the average results of measurements over monthly and half yearly periods. Graduated limits for suspended solids are applied as shown in Table 4. The graduated schedule was adopted in order to allow the mill time to optimise the performance of an effluent treatment system that was to start up in the first half of 1996.

Table 4 also shows the applicable limits in kilograms per tonne of final product, assuming that the mill produced an average of 800t of paper per day and bleached market sulphite pulp. These limits are determined by prorating the annual production of 230 000t of paper per year, and 40 000t of bleached market sulphite pulp, assuming 350 operating days in a year. (Calculated for the purpose of this OECD project)

Table 4. Water pollution control limits.

Pollutant	Limit t/day monthly av.	Limit t/day half yr. av.	Applies from	Limit as kg/t (month)	Limit as kg/t (half year)
COD	30	25	Current	37.5	31.3
TSS	7.0	6.0	Current	8.75	7.5
TSS	3.0	2.5	01/09/95	3.75	3.13
TSS	2.5	2.0	01/06/96	3.13	2.50

The plant has to implement internal measures to ensure effective effluent treatment plant operation. These measures consist of keeping sewage effluent separate from fibre containing process effluent, reducing freshwater usage wherever possible, having sufficient tank capacity to handle surges of fibre containing slurries and process effluents, keeping cooling water and other clean water separate from process effluents, and using screens to separate out fibres. The plant has also to discharge through designated outfalls to minimise the environmental impact, and to ensure that the outfalls do not freeze or move.

In addition to measuring COD and TSS, the mill has to monitor and report nitrogen and phosphate discharges.

The mill has to conduct wastewater characterisation and ecotoxicological studies, according to prescribed programs, when its effluent treatment plant is in operation.

One year after the commencement of operations, the mill has to report annually to the SFT on the operational reliability and effectiveness of the treatment plant. In case of unsatisfactory effects, the mill has to submit proposals for measures to improve performance. The first report on the effluent treatment system is due in July 1997.

The mill must also conduct a study on the Skienselva River, downstream of the mill once the treatment facility is running. The study has to cover an annual cycle and be co-ordinated with receiving environment studies conducted by the various levels of government in the area. A final report is to be submitted by the end of 1997, with plans submitted for comment well in advance.

3.2.2 Air pollution control requirements

The permit also states that if the SO_2 emissions or odours prove greater than anticipated, the SFT can ask the mill to reduce its sulphite pulp production on short notice.

Air pollution control equipment and stack heights for dispersion of waste gases from the sulphite plant and oil/bark incinerator are stipulated in the permit as well.

Up to 18 400t of fuel oil, with maximum 1.0 per cent sulphur may be consumed each year. The actual amount of oil consumed must be specified by the mill in their reports.

The permit requires a study report on the possible measures and the associated costs that could be taken to reduce the total emissions of SO_2 (including diffuse emissions) from the sulphite pulp plant. The study should cover possible emission levels of both 3 and 1.5 kg SO_2 per tonne of cellulose, corresponding to 14 and 7 kg/hour of SO_2 at a production rate of 40 000 tonnes per year. The study will be used by Norwegian Pollution Control Authority (SFT) in considering more stringent emission levels for SO_2.

3.2.3 Noise control

Theoretical noise levels are controlled at four reference points in the vicinity of the mill. Noise levels cannot exceed 52 dB(A) at one reference point and 50 dB(A) at the other three. As of July 1, 1995, the noise level limits will be decreased to 48 dB(A) at the first point and 45 dB(A) at the other three. The company is to assess the cost of further reduction to 45 dB(A) at the first reference point.

Once measures to reduce noise levels have been implemented, the company must take noise measurements to verify that the targets have been attained. Orders requiring further reports and measures may be considered once existing orders have been implemented.

3.2.4 Solid waste control

The company is permitted to burn bark along with sludge from its treatment plant in its oil/bark power boiler. In addition, the mill is allowed to incinerate up to 10 000 tonnes of oil waste per year, limited to 60 tonnes a day. The mill must comply with requirements laid down in a regulation on incineration of waste oil. The waste oil for incineration must be of certain quality as specified below:

- less than 50 mg PCB/PCT per kg waste oil
- less than 1000 mg organic halogens per kg oil
- lower heating value should be higher than 30 MJ per kg
- flash point should be higher than +55°C.

Table 5. Emission limit values for oil waste.

	Limit values Mg/Nm^3 Daily Average
Cd	0.5
Ni	1
Cr+Cu+V	1.5
Pb	5
Cl (as HCl)	100
F (as HF)	5
Particulates (dust)	50

Emission values should be monitored at least twice a year. The results should be reported to SFT once a year.

Solid wastes, including boiler ash, are disposed at municipal landfill sites. Special wastes are dealt with according to the Special Waste Regulation.

Sludges from the effluent treatment plant have to be stored in such a way that nuisances, such as odour and run-off, are avoided as much as possible. Any special wastes that are held for delivery/collection have to be stored in a secure system and in such a manner to prevent run-off into the soil, surface water or drainage systems, and to prevent evaporation to the atmosphere.

3.3 Monitoring

Limits for emissions to air and water and for noise have to be complied with during measurement periods specified in each discharge permit, unless more specific requirements are laid down in the meantime.

The mill's program for measuring and controlling emissions to air and water must be kept up-to-date with respect to the requirements laid out in the discharge permit. The company's own regulation of its discharges is to be quality controlled. Details on updated measurement/control programs must be submitted to the SFT for information purposes.

For effluents, suspended solids and COD measurements must be made using daily composite samples. In addition, nitrogen and total phosphorus analyses must be made using weekly composite samples. Analyses are carried out on unfiltered samples according to prescribed test methods. The results are reported to SFT in a yearly report.

For atmospheric emissions sulphur dioxide is measured continuously at the sulphite pulping exhaust stack. Particulate emissions from the oil/bark/sludge incinerator are measured continuously, but from the sulphite liquor magnesium oxide recovery system, particulate emissions are measured randomly (1-2 times a year). In addition, the company has to prepare a report documenting the atmospheric releases from the oil/bark/sludge power boiler, including the development of a representative sampling regime. This covers the development of techniques for the effective combustion of treatment plant sludges, from the new biological treatment plant.

The company has to file a report with the SFT, at least once a year, summarising its emissions to air and water, any deviations from applicable requirements and how such deviations have been remedied. These reports use standardised forms sent out by SFT. Results from the reports are available to the public on request.

All enterprises in Norway have to fulfil Internal Control Regulations (laid out by the Royal Decree of 22 March 1991). Internal Control Regulations contain provisions stipulating that the person responsible for an enterprise has the obligation to arrange for a systematic follow-up of current requirements, as laid out in the Working Environment Act, the Pollution Control Act, the Civil Defence Act and the act relating to Inspection of Electrical Installation and Electrical Equipment. The purpose of this follow-up is to promote health and a good working environment, protect the external environment and to improve safety.

The Internal Control System shall contain, among other components:

- Management's objectives for the environmental and safety activities of the enterprise.
- A description of how the enterprise is organised, including environmental and safety activities of the enterprise, and associated job descriptions.
- Written routines and procedures for ensuring that the enterprise complies with acts and regulations. This should include the names of personnel responsible for examinations and the implementation of measures, how these are performed, and details on follow-up activities.
- A description of how the Internal Control System is systematically and regularly updated and how employees and other affected parties are informed of the changes.

According to the acts mentioned above, supervisory authorities also supervise implementation of and compliance with these regulations.

The Pollution Control Department's monitoring of compliance will consist of either a 1 day inspection, or a 3-5 day audit focusing on the Internal Control System. In some cases, measurements of effluents are also used as a quality control check of the company's own monitoring.

4. TECHNOLOGICAL RESPONSE TO PERMIT REQUIREMENTS

4.1 Equipment installed and measures taken

A combination of pollution prevention techniques and external treatment has been applied to meet permit requirements. In-plant measures consist of reducing water use, recycling effluents from papermaking and pulping operations, improved screening methods to minimise fibre losses, and recovering spent sulphur dioxide and magnesium oxide from sulphite pulping. Problems associated with organic halide and dioxins and furans were avoided by the use of hydrogen peroxide bleaching.

As well as in plant measures, external treatment in the form of biological treatment plants and cyclones and electrostatic precipitators are used. In plant treatment is used before external treatment to minimise cost.

Noise control measures have been applied at the source at about 100 different points within the plant.

4.2 Flexibility considerations

Flexibility is allowed as a result of the permit specifying only the emission limits and leaving the mill to choose which technology to install to meet the limits.

4.3 Views of industry permittee

The company is of the opinion that flexibility is granted by being allowed to participate in the development of the permit conditions. It also believes that BAT and EQO considerations are balanced in a sensible manner in the permit review and issuance process. It believes that the Norwegian Pollution Control Authority has allowed the company to make suggestions on how environmental requirements can be met, and has taken these suggestions into reasonable consideration, while tending toward a BAT approach.

5. CONCLUSIONS

In Norway permits are issued on a case-by-case basis. Conditions and circumstances at the pulp and paper mill site determine the permit requirements. These are set based on appraisals of the present and future usage of the environment, taking into consideration the cost-effectiveness of available abatement options and cost-benefit analyses of these options. The cost of pollution is weighed against the value of the benefits derived from pollution reduction. Limits are set based on the best option. This means that BAT, strictly defined on a technological basis is not the primary determinant, but rather an important consideration. The environmental quality of the site determines the extent to which BAT is applied. These factors are balanced in the cost effectiveness and cost benefit analyses. As a minimum, international agreements should be fulfilled.

Case Study on the Use of Best Available Technology (BAT) and Environmental Quality Objectives (EQOs) in the Environmental Permitting of Pulp and Paper Mills in Sweden

Pre-publication version prepared by
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Pollution Prevention Control Group of
Organisation for Economic Co-operation and Development
July 1998

FOREWORD

This report reviews how the concepts of best available technology (BAT) and environmental quality objectives (EQOs) are taken into consideration in the environmental permitting of pulp and paper facilities in Sweden. It was prepared by Environment Canada's National Office of Pollution Prevention based on responses to a questionnaire survey. The content of the questionnaire was developed by the Organisation for Economic Co-operation and Development's (OECD's) Pollution Prevention and Control Group.

This report is one of a series of reports prepared to provide background information on the procedures followed in the environmental permitting of pulp and paper mills in a number of OECD Member Countries. Information was gathered using a questionnaire designed to see how best available technology and environmental quality objectives were considered. The countries in the study were Austria, Belgium (Wallonia), Canada, Finland, the Federal Republic of Germany, New Zealand, Norway, Sweden, Switzerland, and the United States of America. Separate reports are available describing the permitting procedures of each country. This report is one of ten reports (Country Profiles) which describe the approach to environmental control of pulp and paper mills in each country. In addition, an overview case study report has been prepared describing the general permitting practices in the set of countries. These reports have been prepared by Environment Canada for the Pollution Prevention and Control Group (PPCG) of the Organisation for Economic Co-operation and Development (OECD).

This particular report provides details of the permitting approach in Sweden, describing the legislative basis for permitting, the organisations that issue permits, and the use that is made of regulations, environmental quality objectives, best available technology, and economics. It also describes the technological response of mills to the permit conditions that have been set and the opinion of a mill with respect to the permitting process.

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1. THE PERMITTING PROCESS

1.1 Constitutional responsibilities for environmental protection

Environmental requirements in Sweden are delivered under the Environmental Protection Act. The Swedish Environmental Protection Agency (NV) is the central authority responsible for environmental matters. Its responsibilities include delivery of decisions made by Parliament (*Riksdag*) and implementation of government programs. These responsibilities include advising the National Licensing Board for Environmental Protection on individual permit decisions. This requires the NV to keep abreast of new process developments and environmental effects in order to provide sound advice to the Licensing Board.

The Environmental Protection Act controls environmentally hazardous operations. This covers operations on property and in permanent plants that may disturb the neighbourhood. Disturbances include releases to air and water that might result in pollution and noise. Activities causing disturbances require permission. In the case of operations that may have a large disruptive effect, such as pulp and paper mills, permission is granted by the Licensing Board. For activities which typically give rise to less disturbances, permissions are granted by one of the 24 County Administration Boards. If disturbances are of a minor nature, the local health and environmental boards are to be informed before the activity starts.

In addition to advising the Licensing Board on permit decisions, the NV is also the central environmental supervisory agency for the country. It supervises the activities of County and Local Administrative Boards, providing assistance as necessary. In Sweden, supervision of large plants, such as pulp and paper mills, is carried out by the County Boards. In the case of small facilities, supervision is carried out by the Local Boards.

1.2 Permits

In Sweden, environmental requirements for major polluters, such as pulp and paper mills, are established by the National Licensing Board for Environmental Protection on a case-by-case basis, through written applications, written statements by national, regional and local authorities, and neighbours and public hearings. The Licensing Board is a central autonomous authority with a status similar to that of a court. The government appoints the board members, the appointees are experts in the fields of industrial processes, environmental impacts, and legal matters. In the case of pollution from smaller facilities, permits are issued by the County Boards.

At hearings, the various parties with an interest in decisions related to the permit are heard. The national environmental interest is represented at the hearings by the Swedish Environmental Protection Agency and the regional interest by the County Boards. The agency has broad expertise in technical and economic aspects of environmental control and in environmental effects. The NV evaluates the control measures proposed by the plant, taking into consideration emissions, costs, and environmental effects. Based on this evaluation, it makes a recommendation to the Board on what it considers to be the best available technology (BAT) for the plant.

The permits issued by the Licensing Board consider the views of various stakeholders, including the NV County Board, industry, environmental groups, the local community, and the public. The Board considers and balances the views of all parties when rendering a decision. Permits granted to individual mills specify emission limits and sometimes other conditions, such as the installation of specific technologies.

In making its decisions, the Licensing Board may decide on limits that are less stringent than what can be regarded as BAT for the industrial sector in general, based on its assessment of the individual merits of the case. Factors such as the cost of installing the technology at the mill, the general economics of the mill, and the assimilative capacity of the receiving environment may override the need to apply what is regarded as BAT for the sector.

The permitting process is triggered by new plant construction, plant expansion, or alteration of the process, which may affect the environment. 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.

Permits by the Licensing Board can be appealed to the government whereas permits by the County Board can be appealed to the Licensing Board.

1.3 Permit renewal process

There is no process requiring that permits be reviewed; however, after 10 years the NV may ask that a permit be reviewed. The NV may also request a review prior to expiration of the 10-year period. Such a request may be made in cases where technical advances have been made that allow pollution to be further reduced, or where environmental needs justify a permit review. A similar process is followed for permit renewal or permit revision.

The government asked NV in 1991 to see to it that all pulp mills have modern and appropriate conditions within ten years.

1.4 Multi-media permits

Sweden uses a multi-media permitting system that considers releases to air, water, land, and noise. This aspect is discussed further in the sections dealing with best available technology and actual permit requirements.

2. BAT, EQOs, AND ECONOMICS

2.1 Standards Setting

Sweden has not found it necessary to issue regulations imposing minimum environmental performance limits that pulp and paper mills must attain. Instead, environmental requirements are set on a case-by-case basis in individual permit decisions.

In order to provide direction when setting permit conditions, the government has issued various policy documents. These are used to guide the work of the Licensing Board as well as developments throughout industry. Relative to the operation of bleached kraft pulp, in 1987 the NV issued an Action Plan for Marine Pollution.[1] This included discharge targets for organochlorine substances. Graduated targets were set whereby organochlorine discharges, measured as total organically bound chlorine (TOCl), were to be reduced to the order of 6 500 tonnes per year by 1992; 2 000 tonnes per year by 2005, and 500 tonnes per year by 2010. These targets compared with TOCl releases of the order of 10 000 tonnes per year in 1988. The plan was issued to stimulate the development of pollution prevention technologies and to promote their use within the permit issuance process. This program has been effective in stimulating new technologies.

In 1992, Parliament provided further direction in an Environmental Bill.[2] This directed that environmental control measures should be focussed on other substances in addition to adsorbable organic halides. It recommended that releases of specific chlorinated and non-chlorinated substances, nutrients, metals, and chemicals used in the manufacturing processes should also be considered. Importantly, a goal was set for pulp mills to achieve discharges that would result in no noticeable environmental effect in receiving waters by the end of the century. It directed that technologies should be developed to attain this goal. As well, environmental studies should be undertaken to document the attainment of no noticeable environmental effects at mill sites.

2.2 Environmental quality objectives (EQOs)

With respect to water quality, the NV has issued criteria for the classification of lakes and watercourses.[3] Criteria have been established for nutrients, dissolved oxygen concentration (including oxygen-consuming materials), acidity status, light conditions, and concentrations of metals in fresh water. For each of these aspects, waters are assigned to one of five "status classes" and one of four "degrees of anthropogenic perturbation".

The system was developed to support reporting and assessing water quality data for use by local government in environmental protection planning, local environmental monitoring, and official environmental statistics. It is designed to enable simple outline reporting in table or map form covering environmental conditions in lakes, rivers, and streams, as well as illustrating the degree to which these conditions have been disturbed by human activity. The system is not intended as a substitute for the use of the more sophisticated measurements and expertise needed to evaluate the effects of different types of human interference. Nor does it represent any position regarding what standards of water quality are desirable.

Water quality objectives are referred to in permitting decisions. If an objective is exceeded in the receiving water, more stringent limits would be imposed for the relevant pollutants.

With respect to air quality objectives, criteria have been set covering, for example, sulphur dioxide and nitrogen dioxide in urban areas. Attention is also focussed on achieving reductions in acidifying gases. The following reduction targets have been set for Sweden:

- emissions of sulphur dioxide are to be reduced by 80 per cent between 1980 and the year 2000;
- emissions of nitrogen oxides are to be reduced by 30 per cent between 1980 and 1998; and
- emissions of ammonia in southern Sweden should be reduced by 25 per cent by 1995 in comparison with 1993 levels.

2.3 Best available technology (BAT)

The NV considers the application of best available technology as the starting point for the technical recommendations it makes to the Licensing Board as part of the permit hearing process. The agency defines BAT as the *best technology used on a commercial scale at a similar plant anywhere in the world.* The NV bases its recommendations on emission limits, on the use of this technology taking into account the costs and the receiving environment. In reaching its permit decision, the Licensing Board also takes these factors into account. Consequently, some permit decisions may result in less stringent limits than what is proposed as BAT for the sector in general.

In setting permit limits, consideration is given to achieving the least possible environmental impact as a whole. Preference is given to the use of in-plant measures as opposed to end-of-pipe treatment. The use of in-plant measures is seen as a likely step toward the ultimate goal of closed-loop processes.

The NV has its own pulp and paper experts on staff who provide the Board opinions regarding release limits for permits. In order to guide this process, the NV developed BAT guidelines in 1992 for various parameters from different processes. The numerical values in these guidelines are summarised in the following tables.

Table 1. BAT recommendations for different types of mills, NV, 1992.

	AOX (kg/t)	COD_{Cr} (kg/t)	P (g/t)	N (g/t)	S[1] (kg/t)	No_x (kg/t)
Kraft Pulp	0.1–0.2	10–15	10–20	100–200	0.4–0.5	1–1.5
Sulphite Pulp	0	20–50	10–20	100–500	1–1.5	1–1.5
CTMP[2]		10–15	5–20	100–200		
TMP[3]		3–5	4–6	50–100		

(1) Total gaseous sulphur emissions, except from auxiliary boilers. Includes sulphur in SO_2 and in reduced forms.
(2) CTMP, chemi-thermo-mechanical pulp.
(3) TMP, thermo-mechanical pulp.

Table 2. BAT values for NO_x emissions from auxiliary boilers (mg/MJ).

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

Table 3. Noise guidelines.[1]

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)
Nighttime (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) Nighttime values must not momentarily exceed 60 dB(A).

The setting of final conditions in permits can be postponed to allow the mills to conduct investigations to develop cleaner technologies or more efficient end-of-pipe measures.

With respect to providing assistance for the introduction of new, cleaner technologies, the Swedish government has run a modest program for several years. However, this program ended in January 1995. The program provided total funding of SEK 25 000 000 (about USD 3.5 million) to all industries, of which the pulp and paper industry received a small share.

2.4 Negotiation of standards

Permit requirements are established on a case-by-case basis and involve a negotiation process that weighs all factors involved in the case.

2.5 Economic considerations

Financial aspects are taken into account when establishing permit conditions. In principle, consideration is given to the situation of the sector as a whole, based on the circumstances of representative mills, rather than the individual mills in question. Sometimes, longer times are allowed for the implementation of necessary measures at existing mills.

2.6 Interaction of BAT and EQOs

In Sweden, mill permits are developed on a case-by-case basis that takes into consideration a balance of technical, environmental, and economic factors. Permit decisions depend on the individual circumstances of a mill. Depending on environmental quality considerations, release limits may be more or less stringent than those regarded as BAT for the sector. Economic factors influence the schedule for the completion of capital investments.

3. TRENDS IN PERMITTING

3.1 Cleaner technology

Permit conditions are set taking into account technical, environmental, and economic factors. The use of cleaner pollution prevention processes is an integral part of these conditions. The mill develops its own abatement plan, which is subject to critical review at the permit hearing. The NV provides the Licensing Board with comments on the mill's proposals.

3.2 Trends in limits

3.2.1 General background

In order to illustrate the permitting process applied, the NV provided a sample permit that was issued on 2 June 1993 to Sodra Cell AB for their Monsteras Mill. This represents a permit for a modern bleached kraft pulp mill that was to undergo a major expansion. The expansion was to involve the construction of a new, large bleached kraft pulp line with a capacity of 450 000 tonnes per year, including all of the associated raw material handling and processing facilities. In addition, equipment changes were to be included for the existing bleached pulp line, as well as measures to integrate the new and existing lines. Once implemented, the combined mills would have the capability of producing 800 000 tonnes of fully bleached kraft pulp per year. It is noted that this expansion did not take place as a result of market conditions. However, the permit is considered illustrative of current permitting practices.

3.2.2 Water permit limits and other requirements

The permit specifies limits for the discharge of adsorbable organic halide (AOX), chlorate (ClO_3), total nitrogen, and phosphorus and for chemical oxygen demand (COD_{Cr}) as shown in Table 4. The permit specifies two types of limits:

- Limits that are not to be exceeded; these are based on annual averages of the releases calculated over a year. The mill must not exceed these values. If it does, enforcement action may be taken.
- Target values; these are computed over a shorter period, normally a month. If a mill exceeds these limits, it must institute corrective measures to remedy the situation. If it does not, enforcement action may be taken.

Table 4. Water permit limits.

Parameter	Maximum values (t/d) (annual average)	Target values (t/d) (monthly average)	Maximum values (kg/t) (annual average)	Target values (kg/t) (monthly average)
COD_{Cr}	20	24	(8.7)	(10.4)
AOX	—	—	0.10	0.12
ClO_3	0.2	0.24	(0.001)	(0.0012)
N	0.6	0.7	(0.262)	(0.306)
P	0.050	0.060	(22 g/t)	(26 g/t)

Notes:

(1) Maximum values are legal limits that must not be exceeded. Exceeding the values may result in enforcement action being taken.

(2) "Target values" are limits that, if exceeded, require the permit holder to take the necessary measures to ensure that they are not exceeded again. Failure to do so may result in legal action being taken.

(3) The values presented are the limits that appear in permits. The values in parentheses are what the releases would be per unit of production assuming that the mill operated at its maximum capacity of 800 000 tonnes per year. These values do not appear in the permit.

(4) In this study, the maximum daily capacity is assumed to be 2 286 tonnes per day based on 350 operating days per year.

In issuing the permit, the Licensing Board required the mill to implement the process operations described in its permit application. These consisted of:

- Dry debarking.
- For pulping, extended cooking coupled with the use of oxygen prebleaching, to a kappa number 12, along with washing, to provide a brownstock (the raw pulp fed to bleaching) COD_{Cr} of about 8 kg/t. In addition, most of the condensates from the recovery section had to be steam stripped to remove foul condensates. The resulting condensates had to be used in pulp washing.
- Bleaching was to be carried out without the use of any gaseous chlorine. Chlorine dioxide was the only permissible chlorine-containing bleaching agent allowed. In addition, the mill was required to investigate the use of ozone and peroxide as a bleaching agent, to further reduce COD_{Cr} and organochlorine releases. An integral part of the investigation was the evaluation of the recovery and incineration of waste bleaching liquors, to eliminate the release of pollutants, such as nutrients and spent chelation chemicals, from the process.
- Effluents were to be treated in an aerated lagoon, followed by a chemical precipitation process.
- Emergency response plans had to be developed describing proactive measures that would be taken to manage the chemicals used in the process and to prevent and address accidental releases.

3.2.3 Air pollution permit limits and other requirements

The permit specifies limits for the emission of total gaseous sulphur (oxides and sulphides), nitrogen oxides, particulates, odours, and chlorine and chlorine dioxide to the ambient air. These limits are summarised below.

- Annual maximum mean sulphur emissions from the plant: 0.6 kilograms per tonne of pulp.
- Annual maximum mean emissions of nitrogen oxides: 0.9 kilograms per tonne of pulp.
- As a target value, emissions of hydrogen sulphide from the new and existing recovery boilers should not exceed 10 mg/m^3 NTP (normal temperature and pressure) (dry) for more than 5 per cent of the operating time each month.
- As target values, emissions of hydrogen sulphide from the new and existing lime kilns should not exceed more than 50 mg/m^3 NTP (dry) for more than 5 and 10 per cent, respectively, of the operating time each month.
- As a target value, odorous gases should be destroyed in one of the lime kilns for a minimum of 95 per cent of the operating time each month. For the balance of the time, destruction is permitted in a stand-by flare.

Particulate limits were set for new and existing units as indicated in Table 5.

Table 5. Particulate Limits for New and Existing Equipment (mg/m^3 NTP at 13 per cent CO_2)

Source	New unit	Existing unit
Recovery boilers (annual average)	50	200
Lime kilns (monthly average)	100	250
Bark boilers (monthly average)	No new unit	50

Discharges of chlorine and chlorine dioxide were limited to 0.05 kg/t, expressed on an equivalent chlorine basis as a yearly average.

A noise limit of 45 dB(A) was set for nighttime and 55 dB(A) for daytime at a distance of 600 m from the industrial area.

As noted earlier, a requirement was set to strip foul condensates prior to their use to prevent odorous emissions. The stripped gases had to be incinerated.

Due to concerns over acid rain and the creation of eutrophication, requirements were set to install urea-based, non-catalytic reduction processes in both the new and existing recovery boilers to limit the release of nitrogen oxides.

3.2.4 Solid waste disposal requirements

The permit authorises solid waste to be disposed of at the mill's existing waste disposal site subject to the following conditions:

- waste must not rise higher than 20 m above natural ground level;
- only those wastes covered in the mill's application for a permit may be disposed of;
- all wastes must be dewatered before being disposed of as landfill and wastes from operations involving chemicals must be well washed before disposal;
- depressions must be filled with inert materials;
- the waste disposal site must be secured to prevent unauthorised disposal of waste;
- leachate must be collected (as is done at present) and directed to the existing compensation basin;
- normally, water levels in the compensation basin must be maintained below the water table within the landfill site; and
- collected leachates must be directed to the mill's wastewater treatment facility for treatment in the sedimentation basin, the aerated lagoon, and the chemical precipitation process.

In addition, the Licensing Board granted the regulatory authority powers, where necessary, to address:

- other means to ensure effective leachate collection;
- the design of the disposal facility, including protective dikes and ditches;
- a reduction in the quantity of wastes;
- land filling methods, including off-gas collection; and
- final restoration of the waste disposal site, including revegetating the site and other aesthetics.

3.3 Monitoring

Monitoring requirements for pulp and paper mills are specified in programs set by the County Administrative Boards. Mills conduct their own sampling and results are submitted monthly to the County Board. An independent consultant checks monitoring procedures, takes audit samples, and assesses compliance with permit requirements each year. Reports are sent to the County Administrative Board. Results are made available to the public. Table 6 summarises the parameters monitored, the monitoring frequency, and, where relevant, the periods over which the target and maximum values are applied.

Table 6. Monitoring practices.

Parameter	Monitoring frequency	Maximum value period	Target value period
COD_{Cr}	Four 24–hour composites per week, with one 3–day composite on the weekend	Year	Month
AOX	Weekly composite	Year	Month
Chlorate		Year	Month
Total P	Weekly composite	Year	Month
Total N	Weekly composite	Year	—
Total gaseous S	Rec. Boiler Continuous	Year	—
NO_x	Rec. Boiler Continuous	Year	—
Particulate		Month	—
H_2S		Month	—
Cl and ClO_2		Year	—
Noise		Each measurement	—

4. TECHNOLOGICAL RESPONSE TO PERMIT REQUIREMENTS

4.1 Equipment installed and measures taken

The company, in providing its response to the questionnaire, noted that they did not proceed with expansion of the mill due to poor market conditions. However, it was noted that a new project is now in the planning stage. This is based on the process technology described in Section 3.2. The only change in the proposal that will be submitted for the new plant is that chemical precipitation, following secondary biological treatment, will not be required. This is a consequence of the mill changing to total chlorine-free, bleached hardwood pulp production in December 1994. Chlorine and chlorine compounds are no longer used to produce bleached hardwood pulp. This would allow the bleach plant effluent to be recovered and incinerated. (Subsequent information from the NV, however, indicates that this does not occur.) The closure of the bleach plant and use of secondary biological treatment will probably enable the goal for COD_{Cr} (10 kg/t) to be met without requiring chemical precipitation. This approach is being considered in the new proposal the company has made for a 550 000 tonnes per year mill. A permit to produce 550 000 tonnes per year was received in 1995, and the mill is currently applying for a permit to produce 750 000 tonnes per year.

4.2 Flexibility considerations

The permit indirectly prescribes certain technologies based on the mill's application to the Licensing Board. The mill must adhere to this when constructing the plant. If major revisions are involved, the mill must apply to the Licensing Board for approval. If only minor changes are required, this can be handled by the County Administrative Board.

4.3 Views of industry surveyed

The mill was of the opinion that its permit requirements were based on considerations of BAT rather than what the environment required based on EQO factors.

5. CONCLUSIONS

In Sweden, permit requirements are determined on a case-by-case basis by the National Licensing Board for Environmental Protection. The use of best available technology is a key consideration in all decisions. The NV provides advice to the Board on each application from pulp mills. The permits issued generally include limits based on the use of BAT unless there are overriding factors considering aspects such as the cost of controls and the nature of the receiving environment. In such cases, these variations relate more to the eventual time by which mills must meet the BAT-based limits.

Sweden has not introduced any regulations specifying minimum performance limits for pulp and paper mills. However, general policies have been issued specifying goals that the industry should attain, namely effluent that would result in no noticeable environmental effect in receiving waters by the year 2000. In 1992 NV developed guidelines on what levels of performance could be attained through the use of BAT at different types of mills. The guidelines have been used in the process of reviewing conditions in pulp mill permits and to guide the individual permit decisions made by the Licensing Board.

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Case Study on the Use of Best Available Technology (BAT) and Environmental Quality Objectives (EQOs) in the Environmental Permitting of Bleached Chemical Pulp and Paper Mills in Switzerland

Pre-publication version prepared by
David Halliburton of Environment Canada for
Pollution Prevention Control Group of
Organisation for Economic Co-operation and Development
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FOREWORD

This report reviews how the concepts of best available technology (BAT) and environmental quality objectives (EQOs) are taken into consideration in the environmental permitting of pulp and paper facilities in Switzerland. It was prepared by Environment Canada's National Office of Pollution Prevention based on responses to a questionnaire survey. The content of the questionnaire was developed by the Organisation for Economic Co-operation and Development's (OECD's) Pollution Prevention and Control Group.

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This particular report provides details of the permitting approach in Switzerland, describing the legislative basis for permitting, the organisations that issue permits, and the use that is made of regulations, environmental quality objectives, best available technology, and economics. It also describes the technological response of mills to the permit conditions that have been set and the opinion of a mill with respect to the permitting process.

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1. THE PERMITTING PROCESS

1.1 Constitutional responsibilities for environmental protection

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 canton governments are responsible for applying them at the local level, this includes plant permitting. Transboundary issues, i.e., discharges into rivers, which cross borders, and emissions to air, which give rise to transboundary air pollution, are an important issue.

With respect to permits, water permits were formerly issued by the Cantonal Office for Water Protection and air permits by the Cantonal Office for Air Pollution. On 1 July 1995, however, these two offices combined to form the Cantonal Office for Environmental Protection, which now issues both water and air permits. Current and previous cantonal authorities operate under federal pollution control legislation.

1.2 Permits

The cantonal offices are responsible for the application of federal laws and ordinances. The federal government has established laws dealing with water and air pollution, as well as environmental quality objectives related to levels of pollutants in the air and in water bodies. In order to ensure that these environmental quality objectives are met, the release of pollutants from operations throughout the country is controlled through permits.

In order to obtain a permit, plants must file an application providing detailed information on the process, the emission of pollutants from various sources, and plans to abate and control releases. The information is kept confidential. The cantonal permitting authority may obtain advice from experts in the federal government or independent consultants to assist in their reviews. Decisions of the permitting authority are based on environmental standards that have been issued by the government, as described in Section 2.

Plants may appeal the decision of the permitting body to the administrative court if:

- the regulatory authority demands more restrictive environmental standards than permitted by law or
- abatement technology proposed by the plant is rejected by the regulatory authority.

1.3 Permit renewal process

Permits are normally issued for an indefinite period, although review is possible in the event of process changes, deterioration in effluent quality, or changes in environmental laws. In the case of the pulp and paper industry, ongoing discussions have occurred between the regulatory body and the industry as a result of concerns over water and air quality, the impact of international agreements, the availability of improved pollution prevention technology, and increased production rates, leading to greater pollution loadings. The industry is aware of the general world-wide concern and has moved to adopt pollution prevention technologies, such as reduced use of chlorine in bleaching and the use of other bleaching agents, without these having to be embodied in permit requirements.

1.4 Multi-media permits

The current policy in Switzerland is to issue a single permit covering air, water, and solid waste releases. However, the permits that were issued for the mill that is the subject of this case study were issued under the previous rules and consist of separate air and water permits.

An ordinance related to the treatment of solid wastes has been in effect since 1991. Previously, there was no need for a special permit, as long as the waste was treated according to the federal law. The amount of waste was not restricted.

1.5 Environmental assessment

Environmental assessment is applied to new industrial operations prior to start-up or as a result of a major change in the production process; this requirement is not extended to existing operations.

2. BAT, EQOs, AND ECONOMICS

2.1 Standards setting

In 1972, the Second Environmental Water Protection Law was passed. This included regulations prescribing permissible values for various parameters in wastewater streams. These are applicable to all industries. The limits in these regulations form the minimum requirements for the contents of the permits.

These limits were determined in 1972 in consultation with the industries, considering what performance levels could be attained by using then available technology. This followed a best available technology (BAT) approach. These limits are currently being reviewed.

Pertinent to pulp mill operations, the standards include limits on a wide range of substances covering suspended solids, 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; and
- suspended solids have to be below 20 mg/L.

Similar emission standards have been set covering the emission of pollutants to the air. These are considered when setting air permit requirements.

Additional direction is provided to the contents of the permits through decisions taken at international forums in which Switzerland participates. For example, decisions emanating from Parcom and the Conference for the Protection of the Rhine have set target values for effluent parameters: $BOD_5 < 5$ kg/t, COD < 70 kg/t, and AOX < 1 kg/t.

2.2 Cleaner technologies

The permitting approach considers the contributions that can be made through the use of cleaner technologies in reducing the pollution load. The role of such technologies has been very significant in the pulp and paper industry where waste values in effluent streams are reduced through fermentation processes, and waste is concentrated through evaporation, allowing the concentrated liquors to be burned to generate steam. The need and cost of external treatment processes are thereby minimised.

2.3 Environmental quality objectives (EQOs)

The federal government has passed objectives that determine acceptable qualities for water and air receiving media. These values are used in establishing permit requirements, and conditions in plant permits should be such that the objectives are not exceeded.

For water, the objectives relate to temperature, transparency, colour, smell, toxicity, salt content, suspended solids, pH, dissolved oxygen, surface density, and the content of various dissolved metals and organic and

inorganic compounds. Annex 1A provides a complete list of water objectives. The authority notes that the limits for heavy metals are under discussion.

With respect to air quality, ambient air quality objectives have been passed for sulphur dioxide, nitrogen dioxide, carbon monoxide, ozone, total suspended particulates, lead, cadmium, and dust fall per square metre. In the case of dust fall, limits also apply to the lead, cadmium, zinc, and thallium contents in the dust. Half-hourly, daily, and annual concentration limits apply for some of the parameters, at the receptor points, as shown in Annex 1B, which summarises the air quality objectives.

In cases where the objectives are exceeded, the authority has to look for the source of emissions and seek remedial actions. It is noted that not all objectives are attained in all areas in Switzerland.

2.4 Best available technology (BAT)

As noted, environmental quality standards passed under the federal law form the basis for release limits in permits. These standards form minimum requirements. If further reductions are required at a site, a BAT assessment concept is applied. 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."*

Cases where this approach is used are:

- the start-up of a new mill or plant;
- where it is necessary to meet existing EQO-based standards; and
- where the regulatory authority wishes to make existing legally binding EQO-based standards more stringent.

Implementation of new technology may be supported by the Swiss government through interest-free loans if this is determined to be appropriate.

2.5 Negotiation of standards

Negotiations are conducted between the permitting authority (the canton) and the mills when permit conditions are set. Negotiations are also held when general standards are developed. Industries may also be required to develop technologies to meet environmental needs. New plants are expected to meet BAT requirements immediately. For existing plants, BAT may be phased in over a period of time. These conditions are established through negotiation.

2.6 Economic considerations

Economic considerations play a part in the permitting and standards development process. Economics is a primary consideration in determining when certain technology will be installed at existing plants, and limits met. It is less of a consideration for new plants.

2.7 Interaction of BAT and EQOs

Switzerland regulates its pulp and paper industry using environmental performance standards. The permitting authority has the flexibility to tighten or relax the performance standards based on the assimilative capacity of the receiving media. However, the EQOs of the water and air media must be maintained in any relaxation of BAT. In permitting, BAT is only applied in the cases of the commencement of a new plant operation, or in areas where the receiving media conditions warrant.

It is noted that the existing environmental standards are more than a decade old and are under review. The existing standards do not necessarily reflect BAT.

3. TRENDS IN PERMITTING

3.1 Cleaner technology

Pollution control in Switzerland is based on the use of pollution prevention and necessary end-of-pipe pollution control measures. This is exemplified in the approach used for pollution control for the sample permit provided for the Cellulose Attisholz Ltd. mill at Luterbach. This is a non-integrated, bleached calcium sulphite-based pulp mill. The mill manufactures pulp for use in papermaking as well as a range of by-products from effluent wastes generated in the process.

Mill operations commenced in 1881, vastly predating the implementation of water permits in 1973 and air permits in 1984 and 1988. However, the mill has applied pollution prevention throughout its history. Their pollution control approach is described in Section 4.1.

In 1973 when the water pollution permit was issued, discussions between the mill and the permitting authority resulted in expansion of the existing fermentation plant, expansion of waste liquor evaporation, and construction of an additional recovery boiler to generate power and regenerate spent chemicals. The mill also installed primary and secondary biological treatment to handle other effluents, as well as an additional boiler to burn waste wood bark and process sludges.

The focus on the combustion of spent chemicals to reduce water pollution, starting in 1962, lead to an intermedia transfer of pollution problems to the air. The issue of SO_2 emissions became important. As a result, the mill, in consultation with the cantonal and federal authorities, began to look at measures to recover sulphur dioxide.

The application of off-the-shelf technologies proved unsuccessful and a pilot plant process was initiated to resolve the problem. As a result, a tailor-made, low temperature solution, SO_2 scrubbing process was successfully developed and implemented in 1985 under the terms of its air permit.

The permitting approach used is based on consideration of the mill's circumstances and the most effective means to implement controls, considering what pollution prevention and external treatment technologies can achieve. The cantonal and federal authorities require the mill to carry out studies to define this and consider the results in the permitting decision.

3.2 Trends in limits

3.2.1 General background

The Cellulose Attisholz mill is a 130 000 tonnes per year, bleached sulphite pulp mill that has been in operation for more than a hundred years. The mill has been expanded and modernised throughout its history. The water and air receiving environments are sensitive to emissions and permits have been issued to ensure their protection. The permit conditions are based on interactive negotiations between the mill and the cantonal permitting authority. The permit discharge limits are designed to ensure that environmental quality objectives are met. Reference is made in the permits to technologies that the regulatory authority and the mill agree will achieve the objectives.

Under the approach used, separate permits were issued for water and air pollution control. These permits are of an indefinite duration and are to be reviewed as required. The water permit was issued on 28 February 1973 and

the air permit on 9 July 1984, with the air permit being reissued on 29 February 1988. Under the new approach, a single permit would be issued for all media.

The water permit issued in 1973 followed promulgation of the Second Environmental Water Protection Law in 1972, and the air permit the Air Pollution Control Law of 1985. The Third Environmental Water Protection Law (1992) has resulted in further actions by the industry related to the reduction of the AOX and COD loads.

3.2.2 Water permit limits and other requirements

In 1973, daily permit limits were set considering the technology at the plant. The permit imposed both concentration and load-based limits for the release of biological oxygen demand and suspended solid materials. The limits are shown in the second and third columns of Table 1. The fourth column calculates what these limits are in terms of kilograms per tonne of pulp production, assuming that the mill operates at a rate of 130 000 tonnes per year for 350 operating days per year (372 tonnes per day). It is noted that the latter figure does not appear in the permit and has been calculated in order to provide an estimate of the production normalised limits, set in 1973.

Table 1. Water permit limits.

Parameter	Emission limits (mg/L)	Emission limits (kg/day)	Estimated emission limits (kg/t)
BOD_5	50	2 450	6.6
Suspended solids	62.5	3 300	8.8
pH	6.5–8.5	—	—

In addition to meeting permit limits, the mill has worked with the federal and cantonal offices of the environment to ensure that emerging environmental issues are addressed and that international requirements are met. Pertinent to effluent discharges, the Conference for the Protection of the Rhine has set limits for releases: BOD_5 < 5 kg/t, COD < 70 kg/t, and AOX < 1 kg/t. The mill has been able to meet these limits through the pollution prevention and external treatment measures that it has implemented since 1973.

The mill is required to maintain the wastewater treatment plant in excellent condition and to inform the environmental agency immediately of any problems.

Under the 1992 Third Environmental Water Protection Law, the mill is required to improve the efficiency of the biological treatment plant. This relates to the reduction of COD and suspended solids loads in the effluent.

3.2.3 Air pollution permit limits and other requirements

The air pollution permit passed in 1985 introduced the limits shown in Table 2. These were met through the use of particulate controls on the combustion and material handling units. The sulphur dioxide emissions are controlled through a company-developed scrubbing process. The recovered gas is reused in the pulping process. More than 95 per cent of the sulphur dioxide is recovered.

Table 2: Air permit levels

Parameter	Concentration/level
Dust	50 mg/Nm³
SO_2	90 kg/h
HCl	30 mg/Nm³

3.2.4 Solid waste disposal requirements

Solid wastes have to be managed according to an ordinance issued in 1991; however, no permit is required relating to the management of these wastes. The ordinance requires that wastes containing more than 5 per cent organic carbon on a dry basis have to be treated (incinerated) prior to disposal.

Waste disposal sites are allowed for the disposal of wastes that fall into the following three categories:

- inert materials;
- residues; or
- bioactive materials.

Classification of each material is defined according to the criteria presented in Annex 2.

3.3 Monitoring

The permit issued by the regulatory agency specifies the minimum acceptable program to be carried out by plant owners for monitoring effluent discharges. The mill must measure relevant parameters daily as indicated in Table 3. Results of the monitoring program must be provided to the regulatory agency and may be used to influence future measures and to tighten regulations and environmental quality standards. Results of the monitoring program are not normally published. If the public wishes to obtain monitoring results, however, companies will normally provide them upon request.

Table 3 summarises the monitoring frequency required for various parameters under the water and air permits respectively. In addition to the monitoring requirements stipulated in the permits, the mill has monitored the following effluent parameters over the periods and frequencies indicated: potassium permanganate (1960–93), 24 h average – DOC (since 1970), 24 h average – COD and AOX (since 1987), 24 h average – and mercury (1960–92), regular intervals.

Table 3. Monitoring frequency for various parameters

PARAMETER	MEASUREMENT PERIOD
Water	
BOD_5	24 h average
Suspended solids	24 h average
pH	On-line
Air	
Dust	On-line
SO_2	On-line
HCl	On-line

The Cantonal Office for Environmental Protection is obliged to verify at least four times per year whether companies comply with defined environmental quality standards (limits in the permits).

4. TECHNOLOGICAL RESPONSE TO PERMIT REQUIREMENTS

4.1 Equipment installed and measures taken

The Luterbach mill was established in the 1880s and its operation preceded permit requirements, which came into force in 1973. The need to reduce waste discharges from the process has been long recognised. In 1914, an alcohol fermentation process was installed to recover alcohol from waste wood sugars. In 1944, yeast production was initiated from the non-fermentable substances.

In 1952, the First Environmental Water Protection Law was passed. In 1958/62 waste liquor evaporation began with lignin derivatives being produced for use in dyes, pesticides, and foodstuffs. The balance of the liquor was incinerated for steam production. In 1962, the chemical evaporation plant was removing about 18 per cent of the total COD load. In 1972, the chemical evaporation and recovery plant was expanded to further remove COD and recover the chemical values associated with it. This measure further reduced COD by 65 per cent. Subsequent to this the mill underwent expansion, and because of the limited capacity of the chemical recovery plant, the overall COD recovery rate fell to 50 per cent.

This coincided with the initiation of the development of a water pollution control permit for the mill. In order to meet the requirements of the permitting authority, the mill developed plans to expand liquor evaporation and to build a second recovery boiler to generate steam and recover the spent chemicals. The capacity of the alcohol and yeast plants was also expanded, and a solid sedimentation and a two-stage biological treatment plant were installed. A boiler was also installed to burn waste bark and sludges from the process.

The mill uses a calcium-based sulphite pulping process. Traditionally such mills have been unable to recover the spent pulping chemicals from the solutions following pulping. However, the Cellulose Attisholz mill has developed its own innovative partial recovery process allowing it to retain the use of the calcium process. The mill first concentrates the spent calcium sulphite liquors and then burns it along with wood bark in a boiler. The boiler produces heat for use in the process. Part of the sulphur in the liquor forms sulphur dioxide and part is converted into calcium sulphate, which is not broken down in the boiler. Following particulate removal, the waste gases are scrubbed with calcium carbonate at low temperatures. The sulphur dioxide is absorbed, forming calcium bisulphite, which is reused in pulping. Approximately 98 per cent of the sulphur dioxide in the off-gases is recovered in the scrubber. Part of the sulphur in the spent pulping liquor is lost as (unrecoverable) gypsum. Fresh sulphur is burned to form sulphur dioxide to make up for this loss. The ash from the SO_2 recovery boiler contains calcium sulphate (24 per cent), calcium carbonate (12 per cent), and calcium oxide (46 per cent) and is basic. It is used to neutralise the acidic bleach plant. ahead of effluent treatment.

By 1980, as a result of the above measures, approximately 80 per cent of the COD load was being recovered. Further internal treatment measures taken have reduced the COD load to about 60 kg per tonne of pulp. Further in-plant measures are under study.

Related to effluent treatment, cleaner technologies have also been implemented in the bleaching process in order to meet concerns over chlorinated organic releases. This includes the addition of oxygen prebleaching systems in 1986, complementing the addition of peroxide bleaching in 1977. AOX releases of about 0.5 kg/t have been achieved.

Related to the production of chlorine, the company worked to improve the loss of mercury from its production cells, reducing losses from 60 g of mercury per tonne of chlorine in 1960 to 12 g/t in 1980. In 1991, it eliminated

the use of all mercury by switching to mercury-free membrane production cells. This was not an economically feasible process and was done for environmental protection and security reasons.

As noted previously, air pollution controls have been implemented through the use of scrubbing processes to recover SO_2 generated in the combustion process, and particulate control devices.

4.2 Flexibility considerations

Permits specify effluent and air emission qualities that have to be attained. Mills are granted the flexibility to choose how they will meet these standards.

4.3 Views of industry surveyed

The mill is of the opinion that the permitting authorities have always considered the special circumstances of the plant when setting limits. In order to develop effective environmental protection measures, the mill has been required to carry out intensive research and development investigations in its own research facilities. These investigations have included effluent treatment and flue gas desulphurisation. The mill has also voluntarily purchased and installed best available technology-type processes.

5. CONCLUSIONS

Pulp and paper mill pollution is controlled under an effluent permit system operated by the cantons. Separate permits are currently in place to control air and water pollution releases. These permits were issued prior to the establishment of the system to issue a single permit governing air, water, and waste management in a consolidated instrument.

The permits include, as minimum requirements, performance standards for various compounds and groups of emissions, as laid down in regulations under water and air pollution laws. These serve as minimum limits for releases to the air and water. These regulatory requirements are currently under review.

The permitting authorities may set more stringent requirements based on consideration of best available technology. This would be applied at large new plants. For existing plants that meet current standards, set down in law, the application of BAT, in co-operation with industry, is possible. This could occur during expansions, or renovations when a permit revision is required.

There is only one cellulose pulp mill in Switzerland. This mill uses both pollution prevention technologies and end-of-pipe treatment to meet permit requirements. The use of pollution prevention is maximised. The permitting program has required the mill to develop pollution prevention technologies. The mill has also applied pollution prevention technologies outside of permit requirements to reduce its effluent releases.

Permits set the control limits to be met. The choice of the technology used to meet these limits is left to the mill.

6. ANNEX 1A - Environmental Quality Objectives (EQO's) Water

Temperature	The normal water-temperature of a river or a lake shall be raised less then 3 °C by the discharge of waste water or cooling water. The maximum allowed temperature of the water in a river is 25 °C.
Transparency	No change for the worse.
Colour	No change of colour by the discharge of waste water
Smell	No change of smell by the discharge of waste water
Toxicity	No toxicity
Salt content	No effect allowed for natural waters
Suspended solids	There should be no sludge on the ground of a river because of the discharge of waste water.
pH-value	The natural pH-value should not be changed
Dissolved oxygen	The dissolved oxygen must be over, 6 mg 02A
Surface density	> 65 dyn/cm at 20 °C No effect allowed for natural waters

Quality Standards

Chemical	Quality Standard (mg/l)
Al	0.1 *
As	0.01 *
Bs	0.5 *
Pb	0.05 *
B	1.0 *
Cd	0.005*
Cr-III	0.05 *
Cr-VI	0.01 *
Fe	1.0 *
Co	0.05 *
Cu	0.01 *
Ni	0.05 *
Hg	0.001 *
SO_3	no toxicity *
Ag	0.01 *
Zn	0.2 *
Sn	0.5 *
Cl_2	no toxicity
Br_2	no toxicity
NH_3/NH_4^+	0.5
ClO_2	no toxicity
Cl^-	100
CN^-	0.01
F^-	1.0
NO_3^-	25.0
NO_2^-	no toxicity
P_{tot}	as low as possible
SO_4^{2-}	100-0
S^{2-}	no toxicity
DOC	2.0
TOC	no value
COD	no value
$KMnO_4$	no value
BOD_5	4
aromatic amine	0.005
fat and organic oils	no value
total hydrocarbons	0.05
chlorinated solvents	0.005
organic chlorine hydrocarbons	0.005
organochlorine pesticides	0.005
phenols	0.0005
non-volatile	0.005
volatile	0.005

* Soluble after filtration by a 0.45 µm membrane filter.

These are the limits for the different parameters in the water of a river. If the water quality of a river is worse as these limits above, the authority has to look for the source and has to reduce the emissions.

7. ANNEX 1B - Environmental Quality Objectives (EQO's) Air

For air the following emission limits are valid:

Pollutant	Impact Threshold	Statistical Importance
Sulphur dioxide (SO_2)	30 µg/m³ 100 µg/m³ 100 µg/m³	mean annual unit 95% of annual half-hourly mean units must lie below this figure 24- hour mean unit may be exceeded not more than once a year
Nitrogen dioxide (NO_2)	30 µg/m³ 100 µg/m³ 80 µg/m³	mean annual unit 95% of annual half-hourly mean units must lie below this figure 24- hour mean unit may be exceeded not more than once a year
Carbon monoxide (CO)	8 mg/m³	24- hour mean unit may be exceeded not more than once a year
Ozone (O_3)	100 µg/m³ 120 µg/m³	98% of annual half-hourly mean units must lie below this figure mean hourly unit may be exceeded not more than once a year
Total suspended particulates	70 µg/m³ 120 µg/m³	mean annual unit 95% of 24-hour mean units must lie below this figure
Lead (Pb) in suspended particulates	1 µg/m³	mean annual unit
Cadmium (Cd) in suspended particulates	10 ng/m³	mean annual unit
Total dust fall	200 mg/m²	mean annual unit
Lead (Pb) in dust fall	100 µg/m²	mean annual unit
Cadmium (Cd) in dust fall	2 µg/m²	mean annual unit
Zinc (Zn) in dust fall	400 µg/m²	mean annual unit
Thallium (Tl) in dust fall	2 µg/m²	mean annual unit per day

8. ANNEX 2 - Solid Waste Disposal Requirements

(The ordinance relating to the treatment of Waste is in force since 1. Feb. 1991)

1. Waste with more than 5 percent organic carbon, relative to the dry substance, has to be treated (Incineration) before it can be brought in a landfill.

2. The following three types of waste disposal sites are allowed:
   1) Inert material
   2) Residues
   3) Bioactive materials

Inert materials

Waste shall be deemed to be inert materials if chemical analysis proves that:

a) over 95 percent by weight of the waste, relative to the dry substance, consists of stone similar material such as silicates, carbonates or aluminates;

b) The limit values of heavy metals laid town in the table below shall not be exceeded;

Heavy Metal	Exceedence Amount (mg/kg dry waste)
Pb	500
Cd	10
Cu	500
Ni	500
Hg	2
Zn	1000

c) Two eluate tests shall be carried out:

- **Test 1** (Water continually saturated with carbon dioxide shall be used as eluate agent)
- **Test 2** (Distilled water shall be used)

The Federal Office will issue guidelines on the eluate test method.

For Test I the limit values are in Tab I

Aluminum	1.0 mg/l
Arsine	0.01 mg/l
Barium	0.5 mg/l
Lead	0.1 mg/l
Cadmium	0.01 mg/l
Chrome-III	0.05 mg/l
Chrome-VI	0.01 mg/l
Cobalt	0.05 mg/l
Copper	0.2 mg/l
Nickel	0.2 mg/l
Mercury	0.005 mg/l
Zinc	1.0 mg/l
Tin	0.2 mg/l

For Test 2 the limit values are in Tab. 2:

Ammonia/Ammonium	0.5 m- N/I
Cyanide	0.01 mg CN/I
Fluoride	1.0 mg/l
Nitrite	0.1 mg/l
Sulphite	0.1 mg-1/1
Sulphide	0.01 mg/l
Phosphate	1.0 mg P/I
dissolved organic carbon (DOC)	20.0 mg C/I
Hydrocarbons	0.5 mg/l
lipophile, non volatile, organic Chlorinated compounds	0.01 mg CI/I
chlorinated solvents	0.01 mg CI/I
pH-Value	6-12

Residues Materials

Disposal sites for residues shall only be used to deposit residues. Residues means waste which fulfils the requirements laid down in the next paragraphs.

a) The chemical composition of at least 95 percent by weight of the waste, relative to the dry, weight, shall be known, if necessary by means of chemical tests.

b) It shall be proved by means of chemical analysis that:

- The waste, relative to 1 kg dry substance, contains no more than 50 g organic carbon and 10 mg high- boiling, lipophile organic chlorine compounds; .

- When a pulverised sample of waste is extracted with ten times its weight of distilled water, no more than 50 g of waste per kg dry substance is dissolved;

- The waste has a neutralisation potential (alkalinity) of at least 1 Mol per kg dry substance, unless it is proven that it cannot react with any acids;

- On contact with other residues, water or air, the waste cannot form either gases or highly water-soluble substances.

c) Two eluate tests shall be carried out:

- **Test 1** (Water continually saturated with carbon dioxide shall be used as eluate agent)

- **Test 2** (distilled water shall be used)

The Federal Office will issue guidelines on the eluate test method.

For Test I the limit values are in Tab 3

Aluminum	10.0 mg/l
Arsine	0.1 mg/l
Barium	5.0 mg/l
Lead	1.0 mg/l
Cadmium	0.1 mg/l
Chrome-III	2.0 mg/l
Chrome-VI	0.1 mg/l
Cobalt	0.5 mg/l
Copper	0.5 mg/l
Nickel	2.0 mg/l
Mercury	0.01 mg/l
Zinc	10.0 mg/l
Tin	2.0 mg/l

For Test 2 the limit values are in Tab 4

Ammonia/Ammonium	5.0 mg N/I
Cyanide	0.1 mg CN/I
Fluoride	0.0 mg/l
Nitrite	1.0 mg/l
Sulphite	1.0 mg/l
Sulphide	0.1 mg/l
Phosphate	10.0 mg P/I
dissolved organic Carbon (DOC)	50.0 mg C/I
Biochemical Oxygen Demand (BOD_5)	10.0 Mg 01/1
Hydrocarbons	5,0 mg/l
lipophile, non volatile, organic	
Chlorinated compounds	0.05 mg C I /I
Chlorinated solvents	0.1 mg Cl/L
pH-Value	6-12

d) It, shall be proved:

- by means of a bacterial toxicity test, that the eluate has no toxic effect, or that the composition and origin of the waste precludes any toxic effect.

e) The authority may lower the limit values laid down in paragraphs for waste of the same type supplied by an owner if:

- The owner supplies more than 500 t of the same type of waste per year;
- The owner finds this technically and operationally feasible and economically viable.

Bioactive Materials

Subject to paragraphs 1 and 2, bioactive disposal sites shall only be used to deposit the following wastes:

a) waste admitted for deposition on disposal sites for inert materials

b) slag from incineration plants for municipal waste and other slag with similar properties

c) sewage sludge from public sewage treatment plants containing less than 65 percent water per weight, which cannot be reused or cannot be incinerated due to insufficient plant capacity

d) building waste which can not be deposited on disposal sites for inert materials, cannot be otherwise treated due to insufficient plant capacity and is not mixed with hazardous waste

e) municipal waste which cannot be incinerated due to insufficient plant capacity

f) waste which is comparable with the types of waste listed in letters a-e in terms of its composition, water solubility and behaviour and which is not hazardous waste

Case Study on the Use of Best Available Technology (BAT) and Environmental Quality Objectives (EQOs) in the Environmental Permitting of Bleached Chemical Pulp and Paper Mills in the United States of America

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FOREWORD

This report reviews how the concepts of best available technology (BAT) and environmental quality objectives (EQOs) are taken into consideration in the environmental permitting of pulp and paper facilities in the United States. The report was prepared by Environment Canada's National Office of Pollution Prevention based on written reports prepared by the Environmental Protection Agency (EPA) as well as information available on its internet sites. This information has also been augmented a background report on world air permitting and regulation prepared for Environment Canada and the British Columbia Ministry of Environment, Lands and Parks.[1] As well, some information was provided by the EPA under a questionnaire survey.

In developing this report, the author notes that the environmental legislation in the United States, and the regulations that are written under it, are very complex. A proper description of the field, as it addresses the pulp and paper industry, requires detailed discussion and the avoidance of generalisations. The resources that would be required to properly present this subject were beyond the scope of this study. Readers are cautioned that this study presents a brief synopsis in order to illustrate the general approach. Readers requiring detailed information are advised to refer directly to the Environmental Protection Agency's information sources. Internet sites to commence this search are provided in the report.

This report is one of a series of reports prepared to provide background information on the procedures followed in the environmental permitting of pulp and paper mills in a number of OECD Member Countries. Information was gathered using a questionnaire designed to see how best available technology and environmental quality objectives were considered. The countries in the study were Austria, Belgium (Wallonia), Canada, Finland, the Federal Republic of Germany, New Zealand, Norway, Sweden, Switzerland, and the United States of America. Separate reports are available describing the permitting procedures of each country. This report is one of ten reports (Country Profiles) which describe the approach to environmental control of pulp and paper mills in each country. In addition, an overview case study report has been prepared describing the general permitting practices in the set of countries. These reports have been prepared by Environment Canada for the Pollution Prevention and Control Group (PPCG) of the Organisation for Economic Co-operation and Development (OECD).

This particular report provides details of the permitting approach in the United States, describing rules, legislative basis for permitting, the organisations that issue permits, and the use that is made of regulations, environmental quality objectives, best available technology, and economics. It also describes the technological response of mills to the permit conditions that have been set and the opinions of mills with respect to the permitting process.

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1. THE PERMITTING PROCESS

1.1 Constitutional responsibilities for environmental protection

In the United States, Congress is responsible for passing legislation to ensure that environmental quality is maintained. The executive branch of government implements statutes, developing the substantive details and procedures relating to the statutes in the form of regulations (rules) to ensure that specified goals are met. In the case of environmental programs, the Environmental Protection Agency (EPA) is responsible for this and is headed by an Administrator. It is further divided into ten regions that are responsible for different parts of the country.

Different acts of Congress deal with different aspects of environmental control namely:

- the Clean Water Act (CWA);
- the Clean Air Act (CAA); and
- the Resource Conservation Recovery Act (RCRA).

A major means for the delivery of environmental control requirements for pulp and paper mills and other industries are permit systems. However, not all environmental requirements are implemented through permitting. For example under the CAA, New Source Performance Standards (NSPS) and National Emission Standards for Hazardous Air Pollutants (NESHAP) are administered by rules. With respect to permit administration, the EPA has delegated this to most of the state governments where state plans meet EPA requirements. In some states, however, permits are issued by the EPA regional office. The EPA retains oversight powers and can act when state requirements do not meet the EPA requirements. In some cases state governments have further delegated the administrative role to regional authorities.

The content of the permits is defined by technology limits and ambient quality requirements. These two items are contained in sets of guidelines and environmental quality objectives that have been passed by the EPA as empowered by Congress. In addition, many state governments have passed similar criteria. The content of permits is developed on a case-by-case basis considering these criteria.

The following narrative provides a summary of the major acts under which federal environmental requirements are developed. Further details on the standards (rules) and environmental quality objectives under the CWA and CAA are provided later in the text.

The Clean Water Act

The Clean Water Act is a 1977 amendment to the Federal Water Pollution Control Act of 1972, which sets the basic structure for regulating discharges of pollutants to waters of the United States. The primary objective of the Federal Water Pollution Control Act, commonly referred to as the CWA, is to restore and maintain the chemical, physical, and biological integrity of the nation's surface waters. Pollutants regulated under the CWA include "priority" pollutants, including various toxic pollutants; "conventional" pollutants, such as biochemical oxygen demand (BOD), total suspended solids (TSS), fecal coliform, oil and grease, and pH; and "non-conventional" pollutants, including any pollutant not identified as either conventional or priority. The CWA regulates both direct and indirect discharges.

The **National Pollutant Discharge Elimination System (NPDES)** program (CWA §402) controls direct discharges into navigable waters. Direct discharges or "point source" discharges are from sources such as pipes and sewers. NPDES permits are issued by either EPA or an authorised State. (EPA has presently authorised forty States to administer the NPDES program.) The permits contain industry-specific,

technology-based and/or water quality-based limits, and establish pollutant monitoring reporting requirements. A facility that intends to discharge into the nation's navigable waters must obtain a permit prior to initiating a discharge.

A permit applicant must provide quantitative analytical data identifying the types of pollutants present in the facility's effluent. The permit will then set forth the conditions and effluent limitations under which a facility may make a discharge. A NPDES permit may also include discharge limits based on Federal or State water quality criteria or standards, that were designed to protect designated uses of surface waters, such as supporting aquatic life or recreation. These standards, unlike the technological standards, generally do not take into account technological feasibility or costs.

Water quality criteria and standards vary from State to State, and site to site, depending on the use classification of the receiving body of water. Most States follow EPA guidelines which propose aquatic life and human health criteria for many of the 126 priority pollutants.

The law requires EPA to establish effluent guidelines and standards on an industry sector basis. These guidelines contain limitations and standards that are technology based; they are applied as baseline minima in permits. Facilities are free to use any technologies as long as the limitations and standards are met. In cases of sensitive ecosystems, as noted, more stringent limits are applied using EQO's. Section 2.1.1 describes the major water protection rules relative to pulp and paper that have been passed by the EPA.

The Clean Air Act

The Clean Air Act is the comprehensive federal law that regulates air emissions from area stationary and mobile sources. The law authorises the EPA to establish National Ambient Air Quality Standards (NAAQS) to protect public health and the environment.

The goal of the Act was to set and achieve the NAAQS in every state by 1975. The setting of air quality objectives or air standards was coupled with directing the states to develop State Implementation Plans for appropriate industrial sources in the state, in order to meet the NAAQS.

The Act was amended in 1977 primarily to set new goals (dates) for achieving attainment of NAAQS since many areas of the country had failed to meet the deadlines. The 1990 amendments to the Clean Air Act in large part were intended to meet unaddressed, or insufficiently addressed problems, such as acid rain, ground-level ozone, stratospheric ozone depletion, and air toxics. These amendments also established an overarching permit program under Title V, and the establishment of Best Available Control Technology (BACT) by industry segment similar to that of the CWA.

The CAA and its amendments, including the Clean Air Act Amendments (CAAA) of 1990, are designed to "protect and enhance the nation's air resources so as to promote the public health and welfare and the productive capacity of the population." The CAA consists of six sections, known as Titles, which direct EPA to establish national standards for ambient air quality, and for EPA and the States to implement, maintain, and enforce these standards through a variety of mechanisms. Under the CAAA, many facilities will be required to obtain permits for the first time. State and local governments oversee, manage, and enforce many of the requirements of the CAAA. CAA regulations appear at 40 CFR Parts 50-99. The following summarises the Titles of the Act.

Pursuant to Title I of the CAA, EPA has established national ambient air quality standards (NAAQSs) to limit levels of "criteria pollutants,"including carbon monoxide, lead, nitrogen dioxide, particulate matter, ozone,

and sulphur dioxide. Geographic areas that meet NAAQSs for a given pollutant are classified as attainment areas; those that do not meet NAAQSs are classified as non-attainment areas. Under §110 of the CAA, each State must develop a State Implementation Plan (SIP) to identify sources of air pollution and to determine what reductions are required to meet Federal air quality standards.

Title I also authorises EPA to establish New Source Performance Standards (NSPS). There are nationally uniform emission standards for new stationary sources falling within particular industrial categories. NSPS are based on the pollution control technology available to that category of industrial source but allow the affected industries the flexibility to devise a cost-effective means of reducing emissions.

Under Title I, EPA also establishes and enforces National Emission Standards for Hazardous Air Pollutants (NESHAPs); these are nationally uniform standards oriented towards controlling particular hazardous air pollutants (HAPs). Title III of the CAAA further directed EPA to develop a list of sources that emit any of 189 HAPs, and to develop regulations for these categories of sources. To date EPA has listed 174 categories and developed a schedule for the establishment of emission standards. The emission standards are being developed for both new and existing sources based on "maximum achievable control technology (MACT)." MACT is defined as the control technology achieving the maximum degree of reduction in the emission of the HAPs, taking into account cost and other factors. Relative to this study, it is noted that new rules were published in the Federal Register on April 15, 1998 for the bleached paper grade kraft and soda (BPK) and paper grade sulphite (PGS) sectors. A brief synopsis of these rules is presented in Annex 1. These rules have not yet been incorporated into permits. Hence they have not been considered in this study.

Title II of the CAA pertains to mobile sources, such as cars, trucks, buses, and planes. Reformulated gasoline, automobile pollution control devices, and vapour recovery nozzles on gas pumps are a few of the mechanisms EPA uses to regulate mobile air emission sources.

Title IV establishes a sulphur dioxide emissions program designed to reduce the formation of acid rain. Reduction of sulphur dioxide releases will be obtained by granting to certain sources limited emissions allowances, which beginning in 1995, will be set below previous levels of sulphur dioxide releases.

Title V of the CAAA of 1990 created an operating permit program for all "major sources" (and certain other sources) regulated under the CAA. One purpose of the operating permit is to include in a single document all air emissions requirements that apply to a given facility. States are developing their permit programs in accordance with guidance and regulations from EPA. Once a State program is approved by EPA, permits will be issued and monitored by that State. This program is in the process of being implemented.

Title VI is intended to protect stratospheric ozone by phasing out the manufacture of ozone-depleting chemicals and restricting their use and distribution. Production of Class I substances, including 15 kinds of chlorofluorocarbons (CFCs), will be phased out entirely by the year 2000, while certain hydrochloro-fluorocarbons (HCFCs) will be phased out by 2030.

The Resource Conservation and Recovery Act

The Resource Conservation and Recovery Act gives EPA the authority to control hazardous waste from "cradle-to-grave" and also includes a permit system. Coverage includes the generation, transportation, treatment, storage, and disposal of hazardous waste. RCRA also set forth a framework for the management of non-hazardous wastes. This study has not covered RCRA permitting.

1.2 Permits

A major element of EPA's approach for the protection of the environment is a permit system. Permits are used to control specified activities that give rise to pollution. Separate systems are applied to the three-media. Under the systems many activities that release pollutants to the air, land and water must obtain permits or obey rules. Permitting is carried out by either individual states or EPA regional offices. In most cases permit granting has been devolved to the states with EPA retaining oversight provisions.

The content of permits is developed on a case-by-case basis. Different systems are applied to air, water and solid waste permitting as noted previously.

In the case of water permitting, technology based emission guidelines or standards are applied as a minimum requirement. More stringent conditions are imposed based on environmental quality requirements, as needed. Minimum performance based emission guidelines and environmental quality objectives have been developed by the EPA and the states to direct permit decisions, (see later sections).

In the case of air permitting, a mix of instrument are applied as described in Section 2.1.2. Decisions are affected by air quality, best available technology type considerations, economics and other factors. The attainment of NAAQS is an overriding requirement.

Water permit issuance generally involves the following stages:

- a mill submits a permit application in accordance with applicable regulations. The permit must contain basic information on the facility and its operations, including pollution and pollution control measures. In the case of effluent permits, this covers information on biological oxygen demand (BOD), total suspended solids (TSS), ammonia, pH, and summer and winter temperatures. Mills must also perform a priority pollutant scan covering an extensive list of analytes. This includes radio nuclides, heavy metals, toxics, pesticides, and semi-volatiles. The permitting agency may also require additional information;
- the application is reviewed by the various government agencies involved at the state and federal levels. Discussions normally occur between the permittee and the authorities. A draft permit is then developed;
- a draft permit is issued for public information and input. Public hearings may be held to solicit comments;
- the permit is issued;
- permits may be appealed through administrative hearings; and
- decisions of administrative hearings may be appealed to the different courts. For permits issued by state governments, appeals are made to the state court. In the case of EPA issued permits, appeals are made to the federal court.

Section 2.1.2 describes some of the process steps that apply regarding administration of the federal air rules.

1.3 Permit renewal

NPDES permits are issued for set time periods. A similar process applies to permit renewal as for permit issuance. Table 1 summarises the dates of issue and expiry for the nine sample effluent permits reviewed in this study. Of the eight permits reviewed in this study for which dates were available, seven had a five year term and one was just slightly under five years.

Table 1. Dates for sample permits

Facility	Effective Date	Expiration Date	Issuing Body
Mill A	June 25, 1991	June 25, 1996	State of Washington
Mill B	October 1, 1994	June 30, 1998	State of Wisconsin
Mill C	NA	NA	State of Virginia
Mill D	January 8, 1991	January 7, 1996	State of Mississippi
Mill E	October 1, 1991	September 30, 1996	State of Alabama
Mill F	September 28, 1989	August 31, 1994	State of Wisconsin
Mill G	May 10, 1991	May 10, 1996	State of Washington
Mill H	April 7, 1992	April 7, 1997	EPA Region X
Mill I	October 25, 1989	October 24, 1994	EPA Region IV

1.4 Multi-media permitting

As noted, separate Acts of Congress are used to control pollution of different media. Each Act has its own permit or rule system. Multi-media permits are not used. However, relevant to the pulp and paper sector, it is noted that the EPA has followed a "Cluster Rule" process when developing its new effluent and air rules under the Clean Water Act and the Clean Air Act. Under this process, the new sectoral rules for water and air pollution control have been or are being developed and promulgated jointly. However, each rule is promulgated under its own enabling legislation. Their joint development allows better decision making by considering the cost impacts of both pieces of legislation in one go. It also considers the cross-media effects of abatement measures.

In April 1998, the EPA promulgated new air and water rules for the bleached papergrade kraft and soda (BPK) and the papergrade sulphite (PGS) sectors. The EPA is continuing the development of rules for the other sectors. Annex 1 provides a brief synopsis of the Cluster Rules applicable to the BPK and PGS industries.

2. BAT, EQO, AND ECONOMICS

2.1 Standards setting and policy development

EPA legislation uses a system of permits and rules to ensure that environmental quality is maintained. The permitting approach basically follows a BAT-EQO process.

In effluent permitting, permit writers develop permit limits first considering BAT limits that have been passed, and then local environmental quality conditions. In the case of plants discharging effluent to receiving waters with good mixing, the guideline's BAT limits are set. For plants with limited mixing, more stringent EQO based requirements are set.

The control of air pollution is somewhat different as a rule based approach, requiring the application of BACT is applied. This is done to ensure that the ambient air quality is maintained. Different rules are applied depending on the nature of the air quality. This is described in Section 2.1.2

2.1.1 Effluent control framework

Effluent control requirements are delivered under a permitting system referred to as the National Pollutant Discharge Elimination System (NPDES). This establishes permit requirements based on consideration of technology based standards and water quality objectives. WQOs ultimately determine the stringency of discharge limits with the technology based standards establishing a ceiling beyond which discharge may not go.

For sectors of the industry where EPA has not established any guidelines or standards, the permitting authority is required to establish performance using Best Professional Judgement (BPJ). As noted in the case of sensitive sites, more exacting limits are set in permits based on the local water quality objectives.

Review of current technology based standards

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.

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.

New source performance standards (NSPS) were also set and are based on the best available demonstrated technology. This can be derived for sectors based on the performance of the single best existing source.

The development of sectoral limits and standards considered the cost of control in relation to the benefits from effluent reduction, the age of the mills and equipment, the process used, the process changes required, engineering aspects, and other non-water quality factors (including energy), that the EPA Administrator deemed important. The Administrator also has the power to transfer technology from other categories where the performance of a particular category is inadequate.

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.

Amendments to the CWA in 1977 included provisions leading to a greater focus on toxic pollutants rather than conventional pollutants. "Conventional pollutants" had been established as biochemical oxygen demand (BOD), total suspended solids (TSS), fecal coliform bacteria, oils and grease, and pH. These may be removed by secondary treatment. Toxic pollutants, are pollutants that are specified pursuant to Section 307 of the CWA. The amendments also added a new "best conventional pollutant control technology (BCT)" definition, applicable to conventional pollutants. BCT limits, like the former BPT limits, were to be developed for all industry sectors, but were to apply only to conventional pollutants. In effect, the BCT limits for conventional pollutants have turned out to be the same as those for the BPT limits for the pulp and paper industry.

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 in terms of pounds per ton of product. (In the new Cluster Rule process, 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," at the time of development.

More stringent limits were set for the NSPS category, as new mills do not encounter retrofitting problems faced by existing mills. The EPA considers technical and economic factors in the development of NSPS but not to the same degree as for existing mills.

The guidelines also addressed toxic pollutants originating from the use of tri- and penta-chlorophenols, and zinc in the process. The chlorophenols originate from chlorophenolic-biocides used to prevent slime formation on the equipment. The zinc originates from zinc-hydrosulphite use in bleaching. The requirements are incorporated in the permits. However, if a mills certifies that such products are not used, the provisions are not applied. It is noted that the new Cluster Rules augment toxic controls. These requirements have only just been promulgated and are not yet included in any BPK and PGS mill permits.

Table 2 presents a summary of the 1977 limits for three of the 31 categories of mills covered in EPA 1997 pulp and paper guidelines. It is noted that the BOD and TSS guideline limits shown are used as multipliers by the permit writers. Permissible discharges are established by multiplying each of these by the annual average production rates. The values are summed across all the process categories in a mill, to give the mills' total allowable discharges. Depending on the vintage of the equipment BCT or NSPS factors are used.

Table 2. Summary of BCT and NSPS values in EPA's 1977 effluent guidelines.

SUBCATEGORY	Maximum in Any One Day kg/t				Maximum – 30 Day Average kg/t			
	BOD_5		TSS		BOD_5		TSS	
	BPT/ BCT	NSPS	BPT/ BCT	NSPS	BPT/ BCT	NSPS	BPT/ 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

The CWA requires the EPA guideline requirements to be implemented in permits by set dates. In the past this could be up to three years after promulgation. Various implementation time limits will apply to the new cluster rules as outlined in Annex 1.

2.1.2 Air emission control framework

Unlike the water pollution control framework where the NPDES system applies, there is currently no overarching permit system to address air pollution. Air pollution is controlled via a number of federal rules as well as State Implementation Plans. However, an overall air permitting system is in the course of being developed under the basis of Title V of the Clean Air Act. This will result in the issuance of an operating permit to facilities that contain all the air emission requirements in a single document. Discussions in 1998 with the EPA, indicate that some states have been delegated authority to issue Title V permits. In other states, delegation is under negotiation; and in other states it remains a federal authority. Discussions indicated that some delegated states had withheld the issuance of Title V permits to mills pending the announcement of the recent air portion of the Cluster Rules. Many states can now write the requirements, given the announcement. In this study no Title V permits were available for review. It is not known whether any Title V permits have yet been issued to mills.

Section 1.1 provides details of the relevant sections of the Clean Air Act that address air pollution control from a mill. As well as these federal requirement, some states have state regulations. The requirements that are imposed on the operations of a mill are a function of the age of the equipment, as well as the nature of the air quality in the region where the mill is located. The CAA has evolved over the years with various instruments being developed. Important elements are described below.

(a) National Ambient Air Quality Standards

Pursuant to Title I of the CAA, 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 3 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 3. 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 $\mu g/m^3$)	0.053 ppm (100 $\mu g/m^3$)
Ozone (O_3)		
8-hour Average*	0.08 ppm	0.08 ppm
Lead (Pb)		
Quarterly Average	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$
Particulate Matter (PM) <10μm		
Annual Arithmetic Mean	50 $\mu g/m^3$	50 $\mu g/m^3$
24-hour Average	150 $\mu g/m^3$	150 $\mu g/m^3$
Particulate Matter (PM) <2.5 μm		
Annual Arithmetic Mean*	15 $\mu g/m^3$	15 $\mu g/m^3$
24-hour Average*	65 $\mu g/m^3$	65 $\mu g/m^3$
Sulphur Dioxide (SO_2)		
Annual Arithmetic Mean	0.03 ppm (80 $\mu g/m^3$)	No Limit Set
24-hour Average	0.14 ppm (365 $\mu g/m^3$)	No Limit Set
3-hour Average	No Limit	0.50 ppm (1300 $\mu g/m^3$)

* New standards set on June 25, 1997.

(b) New Source Performance Standards (NSPS)

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.

The NSPS apply to new sources. In addition to these federal requirements, a number of states have also developed their own regulations for kraft mill production units as part of their State Implementation Plans designed to ensure the attainment of the air quality objectives. (When the NSPS were issued the EPA issued guidelines to be considered by the states when developing state control plans. This has addressed air pollution from many of the existing mills that were not affected by the NSPS.) Annex 2 provides numerical limits for the federal NSPS and regulations of some states. Information in this table is derived from a report prepared by Simons Consultants et al, for Environment Canada and the British Columbia Ministry of Lands and Parks.[1]

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)

It is noted that the NSPS do not address emissions of SO_2 and NO_x from the primary process units involved in kraft pulp production. However, SO_2 and NO_x NSPS emission limits exist coal, oil and natural gas fired industrial boilers as shown in Annex 2.

(c) Prevention of Significant Releases

Initially, the EPA established nationally applicable, technology based emission limitations for new or modified sources under its NSPS program. This instrument, however, was not able to ensure that areas already meeting the NAAQS would continue to do so. Consequently the EPA adopted a Prevention of Significant Deterioration (PSD) policy. This policy requires all new or modified sources, larger than certain thresholds, to use Best Available Control Technology (BACT). BACT is defined as the maximum degree of emission reduction that is determined to be achievable, on a case-by-case basis, taking into account energy, environmental and economic aspects and other costs. The PSD policy was passed under the Clean Air Act Amendments of 1977. No construction or major modification of a source is allowed in areas subject to Prevention of Significant Deterioration (PSD) requirements, unless the emission source uses best available control technology (BACT).

Table 4 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 4. 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)

Under the PSD rules, affected unit processes in a plant must install BACT. BACT is defined as the maximum degree of emission reduction that is achievable on a case-by-case basis, taking into account energy, environmental and economic impacts and other costs. BACT is established by listing all of the technologies that could be applied. A "top-down" emission control evaluation process is then followed. Under this, for a given source and contaminant that exceeds its emission increment specified above, all the available control technologies are ranked in descending order of control effectiveness. The most stringent, or "top" alternative is examined first. That alternative is established as BACT unless it is demonstrated that technical considerations, or energy, environmental, or economic impacts justify a conclusion that the most stringent technology is not "achievable". The technology options are reviewed in descending order of effectiveness, until a feasible option is found.

In essence BACT is determined for each emission source on a case-by-case basis by the permitting authority. There are five key steps in performing BACT analysis: (1) identification of all control technologies; (2) elimination of technically unfeasible options; (3) ranking of the remaining control technologies by control performance; (4) evaluation of the most cost effective controls and documentation of results; and (5) selection of BACT. The NSPS form a baseline for BACT. In no event can emissions of any pollutants be in excess of the emissions allowed by any applicable NSPS.

Estimates of control costs combine capital, financial and operating costs, averaged over a time period. However, there appears to be no universal definition amongst permitting authorities. Cost effectiveness of control is a key parameter for BACT determination. The cost effectiveness threshold is not defined by regulations and is discretionary and is independently determined by jurisdiction. In some jurisdictions, according to Simons et al[1], cost effectiveness is pollutant specific and in others it is the same for each pollutant. Further, there is wide variation in cost effectiveness thresholds among jurisdictions. For example, EPA has considered $10,000 per ton of pollutant removed reasonable under some circumstances, while the State of Washington considers $5,000 to $10,000 per ton of pollutant removed as cost effective. These criteria are not pollutant specific. In Oregon, the criteria is $3,000 to $10,000 per ton depending upon the type of pollutant. Simons found that in general, states were reluctant to define a specific cost effectiveness criteria and instead determined cost effectiveness at a facility, on a case-by-case basis. However, this is highly variable and should only be regarded as general information.

(d) New Source Review

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.

Administration of air permitting has been largely delegated to the states. This has occurred in instances where the EPA has approved a State Implementation Plan. This depends on the acceptability of the state implementation plan by EPA, similar to the area of water permitting previously described. In most instances, permitting is administered by the states under State Implementation Plans accepted by the EPA.

Guidance to authorities in permitting is provided through a BACT/LAER Information System (BLIS). This is an electronic database clearinghouse which contains information on Reasonable Achievable Control Technology (RACT), BACT, and LAER determinations, made by pollution control agencies within the United States. The clearinghouse function is to provide state and local agencies with current control technology determinations; to summarise recent determinations for sources of similar size and nature; to provide data on specific emission limits imposed on existing, new, or modified sources across the United States; and to allow posting of permit information by federal and state authorities. BLIS is also accessible to the public. Updating the information is the responsibility of designated users at each pollution control agency, therefore, the completeness and accuracy of the data will depend on the priority and resources allocated by each of the contributing agencies.

BLIS contains information on specific facilities including whether the facility is new or modified, process types, the basis for the limits (RACT, BACT, LAER, NSPS), operating parameters such as capacity, pollutant emission limits and control technology, permit dates, and agency contacts.

The report by Simons et al[1] provides examples of limits set for different mill sources as extracted from BLIS. Table 5 presents a summary of the ranges of limits applied to different sources as compiled in the report. These cover wood waste/hogged fuel and wood fired power boilers, recovery boilers and recovery furnaces. The basis for the determinations was almost exclusively BACT-PDS. Occasionally, however, a basis was not specified. None of the determinations were LAER based, because LAER is required only for new sources or modifications to existing sources in non-attainment areas. Due to the stringency of LAER and the requirement for offsets, the report noted that new pulp and paper mill sources are unlikely to locate, or existing sources are unlikely to undergo modification, in such non-attainment areas.

The summary table from the above report is reproduced in this section. It is noted that this table does not report the range of TRS limits that were set for different devices. However, information in the appendix of the report showed that of the cases reviewed, TRS limits were set for:

i) eight recovery boilers. Six of these set a value of 5 ppm at 8% O_2; one had a limit of 8 ppm at 8% O_2; and the other an 8lb/ton limit. Six of the decisions were based on BACT-PSD and two on NSPS;
ii) seven lime kilns which had TRS limits of 8 ppm at 10% O_2.
iii) six smelt dissolving tanks which had TRS limits ranging from 0.02 - 0.03 lb/T of block liquor solids.

Table 5. BACT/LAER clearinghouse emission limits - range of values for different types of units.

Units	CO		NO_x		PM			SO_2		VOC	
	lb/ MBtu	ppm_{dv}	lb/ MBtu	ppm_{dv}	lb/ MBtu	g/dscf	mg/ SDm^3	lb/ MBtu	ppm_{dv}	lb/ MBtu	ppm_{dv}
Oil Fired Boiler	0.12	[120]	0.1-0.3	[61-182]	0.03	—	[35]	0.51	[222]	—	—
Natural Gas Fired Boiler	0.02-0.12	[20-120]	0.3-0.5	[133-221]	0.01	—	[12]	—	—	0-0.01	[18]
Wood Waste/ Hogged Fuel Boiler	0.3-0.4	[292-389]	0.1-0.3	[59-177]	0.02-0.1	—	[23-113]	0.01-0.03	[4-13]	0.02-0.03	[34-51]
Wood Fired Boiler	0.29-0.4	[282-389]	0.15-0.3	[89-177]	0.01-0.1	—	[11-113]	0.1	[43]	0.04-0.08	[68-136]
Power Boiler	0.35-0.8	[340-778]	0.3-0.5	[354-590]	0.03-0.06	—	[34-68]	0.1-0.6	[43-225]	0.03-0.1	[51-170]
Recovery Boiler	—	200-879[a]	—	75-150[a]	—	0.03-0.04[a]	[69-92]	—	100-200[a]	0.03-0.05	2.8[a] [50-83]
Recovery Furnace	—	—	—	200[a]	—	0.04[a]	[92]	—	200[a]	—	—
Lime Kiln	-	52-200[b]	0.85	100-290[b] [455]	—	0.03-0.13[b]	[69-297]	—	44[b]-200[c]	—	31-185[b]
Smelt Dissolving Tank	—	—	—	—	—	—	—	—	12-100[d]	—	—

NOTES:

a. Values presented in square brackets are conversions to ppm_{dv} or mg/SDm^3 as appropriate, with Standard Conditions of 20 °C and 101.325 kPa.

b. At 10 percent O_2

c. At 3.6 percent O_2

d. Percent O_2 not specified in BLIS.

2.1.3 Process for the development of rules / policy

The development of sectoral emission guidelines follows a formally defined process:

- Advance Notice of a Proposed Rulemaking may be given. This is done through a notice in the Federal Register informing the public of the development of the rule and soliciting comments.
- EPA conducts a survey of the industry to develop data on which to base the draft rule and to determine the impact of pollutants on the environment. EPA also visits many mills, and samples selected mills to generate data on the performance of process and control technologies. In the case of the Cluster Rules, industry also voluntarily submitted a significant amount of information and data important to both the air and water rules.
- In the case of the new pulp and paper 'Cluster Rules', EPA also conducted an "open" process in which it sponsored a number of public meetings prior to and after proposal of the rules to share information and data as it was developed. EPA also met extensively with representatives of industry and environmental stakeholder groups through the entire process. Reports were also prepared assessing treatment options, emission limits attainable, costs and economic impacts considering various socio-economic factors.
- Proposed Rules are published in the Federal Register including information on where supporting documentation may be obtained and comments provided. A minimum comment period of 30-days is provided.
- Comments are considered and information is provided on how the comments have been taken into account by the EPA in the final rules.

These are published in the Federal Register. The rules are then incorporated into permit decisions. Time frames are specified by which this implementation has to occur.

2.2 Best available technology

The environmental control requirements developed and applied in the US consider best available technology type concepts. Each concept is unique to its field of application and is defined accordingly. The concepts applied to water pollution control are different than that for air pollution control.

Water Pollution Control

Best available technology concepts apply prominently in the definition of discharge limits for under the effluent guidelines. Different concepts are applied to different situations.

Best Practicable Control Technology Currently Available (BPT):

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.

Section 304(a)(4) designates the following as conventional pollutants: biochemical oxygen demanding pollutants (measured as BOD_5), total suspended solids (TSS), fecal coliform, pH, and any additional pollutants defined by the Administrator as conventional. The Administrator designated oil and grease as an additional conventional pollutant on July 30, 1979 (44 FR 44501).

The CWA amendments of 1977 added a definition of *"best conventional pollutant control technology"* (BCT) Conventional pollutants were identified as biochemical oxygen demand (BOD), total suspended solids, fecal coliform bacteria, oils and grease, and pH. These may be removed by secondary treatment. Toxic pollutants, are pollutants that are specified pursuant to Section 307 of the CWA. BCT limits, like the former BPT limits, were to be developed for all industry sectors, but were to apply only to conventional pollutants. In addition to other factors specified in section 304(b)(4)(B), the CWA requires that BCT limitations be established in light of a two part " cost-reasonableness" test. The EPA issued a methodology for the development of BCT limitations in July 1986 (51 FR 24974). In effect, the BCT limits for conventional pollutants have turned out to be the same as those for the BPT limits for the pulp and paper industry.

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.

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.

Section 301(b)(1) of the Act allowed in-plant measures to be considered when assessing the term "practicable." Similarly BAT allowed both end-of-pipe and in-plant measures to be considered. New source performance standards (NSPS) were also set and are based on the best available demonstrated technology. These may be derived for sectors based on the performance of the single best existing source. New plants have the opportunity to install the best and most efficient production processes and wastewater treatment technologies. As a result, NSPS should represent the most stringent controls attainable through the application of the best available control technology for all pollutants (i.e., conventional, non-conventional, and toxic pollutants). In establishing NSPS, the EPA is directed to take into consideration the cost of achieving the effluent reduction and any non-water quality environmental impacts and energy requirements.

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.

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 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."

More stringent limits were set for the NSPS category, as new mills do not encounter retrofitting problems faced by existing mills. The EPA considers technical and economic factors in the development of NSPS but not to the same degree as for existing mills.

The guidelines also addressed toxic pollutants originating from the use of tri- and penta-chlorophenols, and zinc in the process. The chlorophenols originate from chlorophenolic-biocides used to prevent slime formation on the equipment. The zinc originates from zinc-hydrosulphite use in bleaching. The requirements are incorporated in the permits. However, if a mills certifies that such products are not used, the provisions are not applied. It is noted that the new Cluster Rules augment toxic controls. These requirements have only just been promulgated and are not yet included in any BPK and PGS mill permits.

Table 2 presents a summary of the 1977 limits for three of the 31 categories of mills covered in EPA 1997 pulp and paper guidelines. It is noted that the BOD and TSS guideline limits shown are used as multipliers by the permit writers. Permissible discharges are established by multiplying each of these by the annual average production rates. The values are summed across all the process categories in a mill, to give the mills' total allowable discharges. Depending on the vintage of the equipment BCT or NSPS factors are used.

Air Pollution Control

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 documnet.)

With respect to the New Source performance Standards (NSPS) that were developed for the industry in 1978, these are based on the performance of pollution control technology available to the sector at the time. They allowed the industry to develop cost-effective means to reduce emissions. The standards only applied to new or expanded operations at mills. Thus retrofitting issues at existing mills adopting to new rules were not a factor in their development.

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.

A database is used by permitting authorities to record air control decisions in the US. This is referred to as the BACT-LAER Clearing House. Authorities refer to this and apply decisions itteratively in determinations. Projects are only excused from applying the most stringent controls based on overriding energy and economic factors.

In the case of mills in non-attainment areas, the "best' technology under the BAT/LAER system would have to be applied. In addition, offsets have to be made; for example paying to reduce emissions at someone else's plant.

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 nonattainment 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.

2.3 Environmental quality objectives

Air

Refer to NAAQS discussion on page 11.

Water

Similar to air quality objectives, numeric and narrative statements on water quality have been developed at the state and EPA level in order to protect the quality and use of receiving waters. These include quantitative limits to ensure the protection of aquatic life and human health, as well as limits to ensure the water is satisfactory for specific uses.

The EPA develops water quality objectives under the Clean Water Act (CWA). The goal of the CWA is "to achieve wherever attainable, the level of water quality necessary to support the protection and propagation of fish, shellfish, and wildlife, as well as recreation in and on the water" (referred to as the "fishable/swimmable" goals), as well as other uses". Individual states also develop their own objectives.

It is noted that the vast majority of WQOs are developed at the state level rather than by the EPA. It appears that most states are developing WQOs on a regional basis. These WQOs serve as the ultimate determinant of the stringency of any discharge limits. Values calculated from WQOs generally supersede what is authorised under the technology based rules.

Objectives are applied in the permitting process to define acceptable levels of discharges from plants. Calculations are made to determine release rates that will not lead to exceedences of the objectives in receiving waters. Discharge limits are then set on the basis of these calculations. This step is applied after first applying at least a technology based limit. All facilities have to meet at least a BAT limit, with sensitive ecosystems being protected by a WQO based limit.

2.4 The process of developing standards and emission limits

Extensive public consultation precedes the development of all rules such as guidelines policies and objectives. Once passed, these rules are implemented through permit requirements or other systems and there is no authority for them not to be applied. In addition, the legislation under which the rules are passed, require them to be implemented by set dates. In the case of the existing effluent guidelines, this could be up to three years after promulgation for individual mills. These "phase-in" periods allow the mills time to plan and retrofit equipment, and the permitting authorities to develop and issue permits. It is noted that the term 'rule' is frequently used in the US and is equivalent to the term regulation that is used elsewhere.

As noted, there is an ongoing dialogue between the permitting authority and the mill in the development of permits. The public is notified of permit details and can participate in public hearings and appeals.

The objective of permitting is to attain set environmental quality goals. The EPA and the states have issued objectives specifying these, as well as technology based standards. The enabling legislation calls for attainment by set dates. This reduces the scope for negotiations. In permitting decisions, attention is paid to the substantive details of meeting the legislation's goals.

2.5 Economic considerations

When developing effluent guideline limits different types of BAT criteria are applied. These take into account financial and economic factors in applying the technology. With respect to existing plants, the economics of applying the technology is given more accommodation than in the case of new plants. Similarly, when applying the PSD policy economic and other factors are considered.

2.6 Interaction of BAT and EQOs.

Permits are ultimately designed to protect the environment. 'BAT' limits as applied to effluent permits form the baseline minimum. Stricter EQO based requirements are applied where necessary. Water quality considerations at the individual site determine the ultimate stringency of limits.

With respect to air emission control, the air quality of the region in which an expanding or modifying mill is located influences permitting. In such cases, BACT as a minimum has to be installed, even if the objectives are attained. BACT for air permits is determined on a top-down approach. The best feasible option is applied.

For non attainment areas LAER has to be applied.

3. TRENDS IN PERMITTING

3.1 Cleaner technology

The US environmental control program goal is the attainment of good environmental quality in the receiving media. This is attained through permitting and rules systems to limit the release of pollutants. The attainment of these goals recognises the use of in-plant and end-of-pipe treatment measures. However, the choice of how it is achieved is left to the discharger.

The effluent guidelines on which the current water discharge permits are based were passed in 1974 and 1977. The limits were based on what end-of-pipe control (secondary biological treatment) could attain. As well they considered what the then available in-plant technology could attain. Several important in-plant technologies have evolved since that time.

It is noted that the technology selection is left to the mill. The permits set limits for the mills to meet. The guidelines under which the limits are developed, are based on the existence of technology capable of meeting them.

It is noted that the 1974 and 1977 guidelines do not address today's commonly defined toxic pollutants, e.g. dioxins and AOX. The EPA has recently promulgated limits for these and other specific organochlorines under the Cluster Rules. These new requirements are based largely on the use of cleaner technology. These new rules will reshape the existing water permits.

3.2 Trends in water permitting

In order to illustrate the permitting practices for bleached kraft pulp mills in the US, the EPA submitted details of the effluent permits applicable to nine bleached kraft pulp mills. These covered mills in different parts of the country representing the north-west, north-central and south west regions. Because of the number of mills in the US, the composition of this limited sample cannot be regarded as representative. Some apply to new mills and others to older mills. Results of this analysis does not represent how all mills are permitted. The work is presented in order to illustrate the approaches taken. In most cases, the mills were also involved in the manufacture of paper products from their kraft pulp production. The mills studied in this report were located in the states of Washington, Idaho, Wisconsin, North Carolina, Mississippi, Alabama, Virginia and Georgia. The permitting authorities were the state departments that are responsible for environmental matters, with the exception of one permit. In this case the EPA Regional Office issued the permit.

The permits were analysed by Environment Canada to define their basic philosophy and intent. This covered the parameters for which limits were set and monitoring requirements. It is noted that it is difficult to generalise on how these factors apply to a broad group of permits issued by different authorities within a large country. The following narrative describes this. Notes developed from the permit analysis are included in Annex 3.

(a) Philosophy behind the permits

The permits were developed with the intent of maintaining the integrity of the receiving waters. The pollutants released from the process and their impact on the receiving waters were projected. Control dealt with items such as:

- the effect of BOD discharges on dissolved oxygen levels. Permissible BOD discharges were often linked to receiving water flow rates, temperature or varied with the time of year, to ensure that dissolved oxygen levels were maintained.
- total suspended solid releases;
- the concentrations of dissolved metals in the receiving waters relative to water quality objectives. In many instances non-problem metals were screened out. In cases where metals could be a problem, limits were set;
- nutrients; and
- temperature elevation effects in the receiving water;

(b) Parameters controlled in the permits

BOD_5: The maintenance of dissolved oxygen levels in the receiving water was perhaps the most important water quality aspect of the permits developed. All permits included limits for maximum allowable BOD releases. These limits were as a maximum based on the EPA effluent limit guidelines for various process units, multiplied by the unit's production rate. Different process limits were applied to process units if the unit was an existing unit (BCT) or a new one (NSPS). The application of the guideline factors led to the specification of maximum daily and maximum monthly BOD allowances.

In many cases, predictive models of the potential effects of BOD_5 releases on dissolved oxygen levels lead to more restrictive BOD_5 requirements. In the case of the nine mills, five mills had to meet more restrictive limits than under the effluent guidelines. A number of approaches were applied:

- In the case of three mills, permissible BOD_5 releases were a function of river flow. Mill BOD_5 allowances decreased with decreasing river flow. In the case of two mills, the BOD_5 allowance was also related to river temperatures. Permissible releases decreased with increasing water temperature.
- One mill had BOD limits that varied with the time of year. One period covered November to April inclusive. The limit was based on EPA guidelines. A more stringent discharge limit applied from May to October based on the lower river flow and higher water temperature for the season.
- Discharges from the fifth mill, to a sensitive ecosystem, were restricted to the period from November to March. The mill was required to pond its effluents during the intervening period. For the period of allowable releases, effluent control limits applied, including BOD_5 limits.

Total Suspended Solids: Limits were established for TSS in a similar manner to BOD, based on EPA effluent guidelines. These limits applied throughout the year and did not vary with the season or river conditions for the permits reviewed.

Dissolved Metals: Of the seven mill permits with continuous effluent releases, 5 permits included limits on dissolved metals. Copper and lead were limited in 2 permits, and lead, nickel, aluminium, arsenic, mercury and cadmium in one. These metal largely originated from the chlorine dioxide generation process, and in the case of mercury, from a chlorine generator. The permit that included cadmium specified that it was for an

interim period and would not apply when the effluent diffuser had been relocated. Relocation of the diffuser would give improved dilution. Cadmium concentrations would be below its WQO.

pH: All the permits included pH limits with allowable ranges lying between 5 and 9. Some mills had narrower pH ranges from 5 to 8.5.

Temperature effects: Four of the permits included temperature restrictions and a fifth one required upstream and downstream temperatures to be periodically monitored. Two of the permits required that the receiving water temperature not increase by more than 0.3°C due to mill discharges. A third permit set 92°F for maximum effluent temperature, and placed a heat load on the thermal mass of the effluent. This varied with river temperature. The fourth permit required the river temperature to be maintained below a specified maximum.

Nutrients: Nutrient limits for phosphorous or total nitrogen applied to two mills. A third mill was required to monitor nutrients on a regular basis.

Acute Toxicity: Toxicity tests using various species were applied at five mills. Only one mill had a discharge limit requiring 80 % survival of salmonoid in 65 % effluent. The other four mills were required to monitor acute toxicity and report the results.

Chronic Toxicity: One permit included a chronic toxicity effluent discharge requirement and two others had monitoring requirements.

Chloroform: Concentrations were limited in one permit.

AOX: Three permits included monthly average limits for AOX. Two of the permits also included annual average limits. The limits in two of the permits were based on bleached pulp production rates. The monthly values were 1.5 and 1.6 kg/t; one of these mills had an annual limit of 1.3 kg/t. Note this subject is being addressed as part of the new Cluster Rules.

Dioxin: 2,3,7,8-tetra chloro dibenzoparadioxin limits were included in four of the eight mill permits reviewed. One mill had an effluent limit of 1.85 picograms per litre, another 0.1 picograms per litre, another a limit of 0.73 mg/d and another a limit of 0.00029 pounds per day.

(c) Effluent Monitoring

All permits include requirements for the monitoring of effluents for the measurement of parameters stipulated in the permit. Parameters are measured and analysed using approved protocols, developed by recognised bodies. The following frequencies apply to the different parameters:

- Effluent flowrates: permits require flowrates to be measured continuously;
- BOD_5: all of the permits, except one, required BOD_5 to be measured daily using 24-hour composite samples;
- TSS: similar monitoring requirements applied to TSS as for BOD;
- Temperature: generally permits required the temperature of the effluent discharges to be measured continuously. In addition, some permits required the temperature of the river to be measured on a daily basis;
- pH: monitored continuously.

With respect to specific parameters other than BOD and TSS, these had to be measured at less frequent intervals. The monitoring frequency for nutrients (ammonia and phosphorous) varied from weekly to monthly; dissolved metals semi-annually, and copper, which is only in one mill's permit, weekly.

Acute and chronic toxicity testing was less frequent ranging from annually to quarterly.

3.3 Trends in air permitting

Fewer air permits were reviewed as part of this study than in the case of water permitting. Details were obtained of what was in the permits of three mills. (See Section 4.) 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 in individual documents. These include requirements under State Implementation Plans, NSPS, PSD and NSR requirements.

Section 4 provides details of the air pollution requirements imposed on different process units for three mills under various instruments and policies. In addition, information has been assembled on limits applied to units under various EPA and state programs according to the report by Simons[1]. The latter covers information mainly on PSD requirements.

Details of air requirements are provided in:

- Annex 2: giving details of limits for different process units under federal NSPS and regulations of some states.
- Table 5: providing examples of limits for some units under PSD rules, and
- Section 4: giving examples of limits set for three mills.

3.4 Trends in solid waste permitting

This study was unable to define how solid wastes were managed. It is noted that this is addressed extensively in permits but the analysis was beyond the scope of this study.

4. TECHNOLOGICAL RESPONSE TO LIMITS: INDUSTRY'S VIEW

4.1 Equipment installed and measures taken

The EPA forwarded the questionnaire on mill technological response to permits to three bleached kraft mills, in different parts of the country. The following summarises the responses. It is noted that two mills commented on responses to both the air and water permits, and one to only the air permits.

a) Mill one's response to its effluent and air permits

This company operates two mills at a site in Alabama as part of a bleached, integrated kraft papermaking operation. One of the mills was built in 1978 and the other in 1991. The company provided details of how it had responded to a new effluent permit issued by the Alabama Department of Environmental Management. The response related to how the new effluent guidelines under the Cluster Rules were expected to be accommodated. These address dioxin, AOX and various organochlorine compunds.

Relative to its existing permit, before the emergence of the dioxin issue, the mill's permit addressed BOD_5, TSS, pH, and penta and trichlorophenols. The limits were based on the EPA's NSPS discharge factors, using the maximum values set. However for BOD_5, more stringent limits applied for the period May-October, when the river flow was lower. The mill incorporated secondary biological treatment and good internal control practices to meet these limits.

The new permit issued on October 1, 1991 included a daily discharge limit of 0.00029 pounds per day for dioxin (2,3,7,8-TCDD). The mill is required to monitor this in its effluent on a quarterly basis, using a 24-hour composite, and to report the dioxin concentration. In addition, the mill has to conduct annual collection and testing of fish tissue and lipid for 2,3,7,8-TCDD. The dioxin discharges were calculated based on a total daily maximum load and a waste load allocation to ensure compliance with a state water quality standard for 2,3,7,8-TCDD. It is understood that this limit can be reopened and reissued, depending on future actions by the state or EPA.

In its response, the mill noted that it had had to modify its production processes in anticipation of the Cluster Rules' dioxin and organochlorine requirements. The program to meet the new permit conditions necessitated the addition of internal process changes to the existing mill, as well as incorporation of these and other measures in the new mill built in 1991.

With respect to the 1978 mill, process modifications included the addition of:

- oxygen prebleaching (delignification);
- a newer, more efficient chlorine dioxide generator;
- high shear mixing of bleaching chemicals and pulp;
- the capability to use hydrogen peroxide in the extraction stage to adjust pulp brightness, and
- a switch to water based defoamers in place of oil based defoamers, eliminating dioxin and furan precursors.

For the new 1991 mill, state of the art measures were included in its design. This included the use of extended modified continuous cooking, a dual-stage oxygen prebleaching system, two stage pressure diffusion washing and a bleach plant capable of 100 % chlorine dioxide substitution. Water based defoamers were also used.

The internal measures were coupled with effective secondary treatment.

With respect to air permits, both the 1978 and 1991 mills were subject to federal New Source Performance Standards (NSPS), as well as the Best Available Control Technology requirements (BACT) under the Prevention of Significant Deterioration policy. These requirements were applied under the State Implementation Plan, when the permits were issued. The pollution control measures installed included electrostatic precipitators and/or wet scrubbers for particulate control, and collection and incineration of non condensable gases (NCG). A stand-by incinerator was installed for backup on low volume concentrated NCG sources. With respect to the natural gas fired boilers, steam injection and flue gas recirculation were installed to minimise nitrogen dioxide formation. Also, operational limits were set on the sulphur content of the fuel oil and in its consumption rates, so as to minimise sulphur dioxide generation.

The bleach plant and chlorine dioxide generator stacks were equipped with wet scrubbers to meet state air quality standards. As well, in anticipation of the future federal standards for hazardous air pollutants under the Cluster Rules, steam stripping of foul condensates was applied.

b) Mill two's response to its air permits

Mill 2 is an integrated, bleached kraft pulp and paper mill located in North Carolina. The mill was originally built in the 1908 and has undergone expansions and modifications with the addition of major pieces of new equipment. The following comments apply only to the air permit.

Because of the age of the various process units, only a coal-oil fired power boiler built in 1986 was subject to the EPA's New Source Performance Standards. This unit was subject to NSPS, as well as to the Prevention of Significant Deterioration rules for NO_x. The other process units were given permit limits under the State Implementation Plan passed in the 1970's. The following permit limits applied:

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 for the combined oil-coal boiler and three coal fired boilers. In addition, separate SO_2 limits were set for individual units on the basis of pounds of SO_2 per million BTU. For the 1986 coal-oil unit, limits of 1.2 pounds of SO_2 per million BTU apply for coal firing, and 0.8 pounds for oil firing. For the coal fired units, limits of 2.3 pounds of SO_2 per million BTU apply. These limits are met by purchasing low sulphur content fuels.

   Under the PSD rules, a NO_x limit of 0.7 pounds 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 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 % design efficiency. The three coal fired units have particulate limits of 0.15 pounds per million BTU, under the State Implementation Plans. The limits are met using electrostatic precipitators. Similarly, a particulate matter limit of 0.21 pounds 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 boiler has particulate matter limits of 3.0 pounds per equivalent air dry ton of pulp produced on the line, and total reduced sulphur limits of 5 parts 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 contact evaporators are used on each boiler. The boiler permits also limits the amount of solids that may be fired in the boiler to avoid overloading.

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

4. **Lime kilns:** The two lime kilns have particulate matter and TRS limits set under the SIP. The particulate matter limits are 0.5 pounds per equivalent air dry ton of pulp measured in the kiln exhaust gas. These are met through the use of wet scrubbers. The TRS limit is 20 ppm. Control of TRS is ensured by rinsing lime mud prior to drying in the kiln, as well as by optimising 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.

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. **White liquor:** In order to reduce the potential for sulphide in the white liquor to react with the pulp in oxygen delignification, the liquor is sparged 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 to 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 NCG below the lower explosion level concentration . The collected gases are transported to one of the lime kilns for incineration. The other kiln acts as the backup kiln. Both kilns can be used jointly as required. Vents are located at various points in the system (21 vents in total). These vents are equipped with monitors to record the occurrence (frequency, time and duration) of events.

c) Mill three's response to air and water permits

Mill three operates an integrated bleached kraft and thermo-mechanical pulp and paper mill in the state of Washington. The mill provided details of how it met the requirements of air and water permits.

The mill has secondary treatment to meet BOD and TSS limits. In the late 80's the dioxin and organochlorine issues emerged. Permit limits were set for these parameters by the state. The mill responded to the limits by implementing pollution prevention measures involving the addition of a new Kamyr MCC continuous digester, a new pulp screening and washing system, oxygen delignification and elemental chlorine free bleaching.

For air quality, the following pollution control technologies were installed: an improved noncondensible gas collection system, including collection of dilute, low concentration high volume sources; an additional precipitator chamber on the recovery boiler; modernising the two existing electrostatic precipitator chambers; and replacing the scrubber on the smelt dissolving tank with a venturi scrubber.

Air emissions were also reduced by changing the fuel in the power boiler to natural gas from higher sulphur content fuel oil.

4.2 The use of internal treatment versus external measures.

From the preceding examples it is seen that all mills met their permit limits through combinations of internal and external treatment measures. In the case of effluent treatment, it should be noted that all of the kraft mills were using secondary treatment before their most recent permits were issued. Secondary treatment has been in place at all kraft mills discharging to navigable waters in the USA as a result of the EPA's NPDES program of the 1970's and the 1980's. As the case of two mills noted, future effluent control issues involve addressing toxic pollutants that can pass through biological treatment plants. In such cases, effluent control basically requires pollution prevention approaches using internal measures.

With respect to air pollution control, it is noted that both external and internal measures are used to meet the requirements. All three mills noted a strong emphasis on the use of external measures. The external measures included the use of particulate collection devices and demisters, as well as collection and incineration of non-combustible gases. For air pollution control, internal measures are also important. These include the proper design of combustion units to minimise pollutant formation and particulate carry over. As well, practices are used such as purchasing of low sulphur fuels, proper furnace design and fuel firing conditions, and the oxidation of chemicals such as sodium sulphide that may give rise to TRS formation in the boilers.

4.3 Flexibility considerations.

Two mills commented that flexibility was given in the choice of equipment. The permit imposed limits, but the mills were free to select what technology to use, provided they met the limits. The third mill felt that its water permit provided more flexibility than its air permit.

4.4 Views of permitees on balancing of BAT and EQO.

With respect to the balancing of BAT and EQO's, two mills noted that the permit conditions that were set reflected BAT and EQO considerations at the time of issuance. One mill noted that its air permit focused more on BAT. It felt its water permit reflected a better balancing of BAT and EQO.

5. CONCLUSIONS

In the US Congress is responsible for the statutory authorities for environmental management. These address water, air and solid waste management under separate acts. The acts are: the Clean Water Act, the Clean Air Act and the Resource Conservation Recovery Act.

A government agency, the Environmental Protection Agency (EPA) is responsible for the development of programs and their substantive details to meet the aims and goals of the Congressional Acts. The EPA is subject to congressional scrutiny and third party law suits if these aims and goals are not attained.

The approaches to air and water control are different but make use of technological considerations and environmental quality objectives. Their application varies for the two media.

With respect to the discharge of wastewater pollutants to navigable waters, all facilities are required to obtain a permit under the National Pollutant Discharge Elimination System (NPDES) of the Clean Water Act. Permits are issued by either the state government or the EPA. Permit conditions are based on effluent guideline rules issued by the EPA and water quality conditions. With respect to the stringency of controls, no permit may be issued allowing discharges greater than the values permitted in the EPA's Effluent Guidelines. Relative to this, the EPA issued guidelines in the 1974 and 1977 addressing the discharge of BOD_5 and total suspended solids (TSS) as well as pH, fecal coliform bacteria, oil and grease, PCP, TCP and zinc.

The guidelines specify BOD and TSS limits per unit of production for the different types of processes that were in operation in the US industry, when they were developed. More stringent limits are set for new operations. Permit writers set allowable discharges for each mill based on the production of different types of product in the mill and corresponding discharge allowances under EPA guidelines. Water quality considerations are then applied.

Relative to water quality, a series of quantitative water quality objectives have been developed covering the water bodies in the US. Most of these have been developed at the state government level, on an individual waterbody basis. The objectives cover a wide array of parameters including suspended solids, dissolved oxygen, dissolved metals, and nutrients, etc.

In permit applications, mills are required to provide extensive information on the flow and composition of their effluents. The relative value of the different pollutants in the receiving waters following dilution are compared to those of the water quality objectives for the waterbody. Action is then taken on those parameters that are of concern.

Relative to the results of this study, it is noted that consideration of the effects of BOD releases on dissolved oxygen content was of major importance. It was observed that in the case of the nine permits studied, six mills had more restrictive limits for BOD than allowed under the technology based guidelines. The permits illustrated the use of a number of approaches to address such situations. In some cases permissible BOD_5 releases were a function of the river water's dissolved oxygen flux (linked to flow and temperature). In other cases, the permissible releases varied with the time of the year. In one case, a mill had to store its effluent during the warmer part of the year and discharge only during the cooler months.

Several permits specified acute and chronic toxicity fish testing for monitoring purposes. This appears to have been done to assess the need for further action. One mill had a toxicity discharge limit.

The BOD and TSS limits set in the EPA's guidelines were based on a statistical analysis of the performance achieved by the best performing mills in a subcategory at the time of guideline development. Separate limits

were developed for each process category based on group performance. Existing mill limits are based on Best Conventional Control Technology. The limits also took into account economic and other factors considered appropriate by the EPA. With respect to new mills, the limits considered the use of in-plant measures as well as secondary treatment.

Current EPA guidelines also address the release of tri and penta-chlorophenols, and zinc. These arise from the use of certain biocides in the process and zinc in bleaching. With respect to toxic pollutants it is noted that the EPA has just finalised the Cluster Rules for the bleached paper grade kraft and soda, and paper grade sulphite sectors. Annex 1 provides an overview of these rules. These rules will have a major impact on future US water and air permits. This report has not discussed the potential impact of the new rules.

Relative to the new Cluster Rules, the use of best available (in-plant) process change technology was an important factor in their development. An important component of the proposed technology based, BAT limits is the requirement for all mills to use best management practices (BMPs). This covers pulping liquor leak and spill prevention control.

In order to remove biases and ambiguity, the EPA places reliance on the performance achieved by representative groups of plants with appropriate technology and practices, in setting limits. Factors such as economics are considered.

With respect to air pollution control, the Clean Air Act calls for the attainment of air quality objectives throughout the country. Air Quality Objectives have been issued setting acceptable ambient air concentrations for criteria pollutants covering carbon monoxide, sulphur dioxide, ozone, lead, nitrogen dioxide and particulate matter (less than 10 microns and 2.5 microns).

Specific to pulp and paper mill air emission control, the EPA passed New Source Performance Standards in 1978. These contain Best Available Technology based limits reflecting state-of-the art technology performance at the time of development. Limits were set for particulate matter, total reduced sulphur and plume opacity. The NSPS limits do not apply to existing sources i.e. production operations at mills that were in existence prior to NSPS promulgation in 1978, unless these units are expanded or modified. Whilst in effect such units were grand-fathered into compliance with the federal NSPS, many states required the older units to meet air pollution limits under their State Implementation Plans.

In addition to these technology based rules, all new mills, and mills undergoing expansions are covered by the Prevention of Significant Deterioration policy (PSD) or the New Source Review policy. The applicability of the rules depends on the air quality in their region. These rules impose additional considerations in permitting so as to promote the maintenance and enhancement of air quality. These rules apply to the criteria pollutants carbon monoxide, NO_x, SO_2, TRS, TSP, PM_{10} and VOCs. New mill construction and expansion is subject to the rules for each criteria pollutant if the incremental emission of that pollutant exceeds specified values. The severity of the permitting approach depends on the nature of the air quality in the area where a plant is located, relative to the air quality objective for each substance.

Under the PSD policy, in areas where the national ambient air quality standards are met, new, modified or expanded parts of an operation are required to meet *best available control technology* (BACT) at the time of the project. Permit writers determine this by reviewing a mill's proposal and comparing this against current BACT. The authorities throughout the US maintain a computer based clearing-house system to enable this. The system maintains information on all permit decisions, including technology and permit limits set for all air pollution sources e.g. recovery boilers, lime kilns, etc. throughout the country. The permit writers select the most stringent requirements and impose them unless they can be demonstrated to be technically or economically unfeasible. Under this approach BACT tends to become increasingly more stringent as newer processes are developed. The rule is not relaxed in areas where air quality objectives are attained

In the case of new and expanding plants in non-attainment areas, more exacting requirements are set. This is covered by the New Source Review policy. The policy requires proponents to apply the Lowest Achievable Emission Rate (LAER) technology. LAER 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. As well facilities have to purchase offsets from other polluters in the region to compensate for incremental air pollution.

With respect to the technology required to meet the limits, mills can select what technology to use.

6. REFERENCES

1. A. Simons Ltd., AF-IPK, and Norecol, Dames & Moore Inc. 1994. A Technical Background Information Document on Pulp and Paper Mill Air Emissions. The Ministry of Environment, Lands and Parks of British Columbia and Environment Canada. P.5517A.

7. ANNEX 1: SUMMARY OF THE APRIL 15, 1998 CLUSTER RULES

Summary of recent bleached papergrade kraft and soda (BPK) and papergrade sulphite (PGS) sector Cluster Rules as published in the Federal Register of April 15, 1998

7.1 Introduction

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 as described in the earlier sections of this report. The time lines for implementation, considering various incentive programs, are described in this text. It is noted that the provisions of the rules may be challenged by any party (as of this date environmental groups have served notice of their intention to litigate the water rules).

This following review provides a brief synopsis of the water and air rules as they relate to these two sectors. It is noted that the rules are very complex with each rule comprising of several hundred pages, plus several thousand pages of supporting documents. For readers who must fully understand the implications of the rules, these can be accessed on the Internet at either of the following sites:

http://www.epa.gov/OST/pulppaper/
http://www.epa.gov/ttn/oarpg/t3pfpr.html

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 enroll 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.

7.2 Effluent guidelines

To date, EPA has promulgated rules that will apply to the bleached papergrade kraft and soda (BPK) and papergrade sulphite (PGS) subcategories under its effluent guidelines of the Clean Water Act and Tier III MACT rules of the Clean Air Act. It is currently finalising the effluent rules that will apply to other subcategories of the pulp and paper industry. Relative to this it has grouped the remaining mills into 10 other subcategories. Rules for these sectors will follow. As well the EPA will announce its intentions on outstanding items for this sector, for example its position on the use of chemical oxygen demand as a regulatory parameter.

Significant aspects of the new effluent guidelines are:

- the guidelines will be implemented through the National Pollution Discharge Elimination System (NPDES) permits, by the states or EPA regions, with appropriate compliance

periods determined on a case-by-case basis and built into permits after Federal Register publication;

- the guidelines contain baseline limits as well as more stringent tiered limits as part of a Voluntary Advanced Technology Incentives Program. Mills electing to adopt more stringent tiers will be granted longer times to come into compliance, (see incentive program discussion);
- the limits for biochemical oxygen demand (BOD_5) and total suspended solids (TSS) have been left unchanged from the previous guidelines;
- EPA has reserved its promulgation of COD limits until a later announcement;
- the rules contain various bleach plant limits for specific organochlorine compounds, including TCDD and TCDF, along with end of pipe limits for adsorbable organic halide (AOX); The BOD and TSS limits are unchanged from the previous guidelines (1977).
- New sources receive stricter limits. New direct discharging sources are defined as those starting construction 60-days after publication. For indirect dischargers, these are defined as those where construction began after 17 December 1993.

7.2.1 Bleached papergrade kraft effluent rules

Table 6 summarises the effluent discharge limits for existing sources in the bleached papergrade kraft and soda subcategory. Most of the limits cover discharges of specific chlorinated organic compounds created in the bleaching process. These are set on an in-plant basis, at the bleach plant discharge points. In addition, end-of -pipe limits are set for biochemical oxygen demand (BOD), total suspended solid (TSS) and Adsorbable organic halide (AOX). For BOD and TSS, separate limits apply to the various sub-sectors of the kraft industry, hence the table reports these as a range. The limits for BOD and TSS were set in earlier guidelines.

With respect to the limit values for the specific organochlorine substances, some parameters have a numerical limit, whereas others have to be non-detectable, at specified detection levels, using prescribed analytical methods.

In addition, the guidelines also require the pH of the discharged effluents to be in a range of 5-9. This applies to all sectors of the industry

Table 6 Effluent discharge guidelines for existing mills.

Parameter	Units	Max day	Max. Month	Measured at
TCDD	pg/L	ML at 10	----------	Bleach plant
TCDF	pg/L	31.9	----------	Bleach plant
Chloroform	g/t	6.92	4.14	Bleach plant
Trichlorosyringol	ug/L	ML at 2.5	----------	Bleach plant
3,4,5 & 6 Trichlorocatechols	ug/L	ML at 5.0	----------	Bleach plant
3,4,5 & 6 Trichloroguaiacols	ug/L	ML at 2.5	----------	Bleach plant
2,4,5 & 6 Trichlorophenols	ug/L	ML at 2.5	----------	Bleach plant
Tetrachlorocatechol	ug/L	ML at 5.0	----------	Bleach plant
Tetrachloroguaiacol	ug/L	ML at 5.0	----------	Bleach plant
2,3,4,6-tetrachlorophenol	ug/L	ML at 2.5	----------	Bleach plant
Pentachlorophenol	ug/L	ML at 5.0	----------	Bleach plant
AOX (mandatory)	kg/t	0.951	0.623	Outfall
AOX (Tier 1 voluntary)	kg/t	0.58	0.26 (ann avg)	Outfall
AOX (Tier 2 voluntary)	kg/t	0.23	0.10 (ann avg)	Outfall
AOX (Tier 3 voluntary)	kg/t	0.11	0.05 (ann avg)	Outfall
Effluent flow (Tier 2 voluntary) *	m^3/t	10 (annual avg.)		
Effluent flow (Tier 3 voluntary) *	m^3/t	5 (annual avg.)		
COD	-----	future	future	----------
BOD**	kg/ t	10.6 - 15.45	5.5 - 8.05	Outfall
TSS**	kg/ t	22.15 - 30.4	11.9 - 16.4	Outfall

Notes:
ML = Less than the analytical Minimum Level at the concentration stated
"t" refers to tonne product off machine for paper on air dry basis (10% moisture), except for the chloroform and AOX provisions where it is for unbleached kraft pulp on air dry basis.
BOD and TSS limits depend on final product. Highest are for market kraft, lowest for integrated fine paper mills
* Effluent flow limits apply to the total pulping and bleaching areas, including condensates. They apply only to the Voluntary Incentives Program, and are not mandatory for any mill
** Previously promulgated limitations

The limits have been established based on the assessment of Best Available Technology economically achievable. Relative to existing kraft and soda mills, BAT is defined on the basis of 100% chlorine dioxide (ClO_2) substitution, without the use of extended delignification or oxygen prebleaching

In the case of new operations, that are governed by New Source Performance Standards, (NSPS), BAT is based on the use of 100% ClO_2 along with extended delignification, or oxygen prebleaching. Different options apply depending on what bleaching technology a plant chooses to employ:

- *Totally Chlorine Free (TCF) mills*

  - For new plants electing to use TCF processes, these are not subject to the in-plant organochlorine limits. Instead, they must attain the Minimum Level limit (ML) for AOX at the end-of-pipe. The ML is defined as the level at which the analytical system gives recognizable signals and an adequate calibration point. For AOX a ML of 20 micrograms per litre has been set.

- Under the above scenario, if a mill used an effluent volume of 100 cubic metres per tonne, then an AOX value greater than the Minimum Level (ML) would apply.
- In addition BOD and TSS limits apply; in the case of new bleached papergrade kraft and soda mills, new effluent limitations apply

- *For new non-TCF mills*

  - New non-TCF mills must meet the same in-plant, bleach plant limits for organochlorine compounds as the existing mills. In addition, they have to meet stricter end-of-pipe AOX limits, of 0.476 kg/tonne, daily; and 0.272 kg/tonne, monthly average. In the case of plants built after promulgation of the rules, the BOD and TSS limits are slightly stricter.

As noted previously, a Voluntary Advanced Technology Incentive Program has been introduced. This provides longer compliance periods to promote mills to adopt more environmentally benign processes. The content of this program is described later.

7.2.2 Papergrade sulphite category

This sector is divided into 3 segments based on the pulping chemicals used and the products produced:

- calcium, magnesium, and sodium based mills
- ammonia based mills and
- specialty grade mills producing pulps containing a high proportion of alpha cellulose and a high brightness

For BOD and TSS, the limits are the same as in the previous guidelines. However additional limits have been set for organic compounds based on EPA's assessment of available technologies. Different technologies have been set as the basis of BAT for the three sub-categories:

- For the calcium, magnesium and sodium based mills, TCF-bleaching has been established as BAT. No in-plant organochlorine limits have been set. However, for AOX the mills have to meet the same Minimum Level limit at the end of pipe, as that described for the kraft and soda, TCF-mills.
- For the ammonia and specialty grade mills, Elemental Chlorine Free-bleaching (ECF) has been established as BAT. The mills have to meet the same in-plant, organochlorine limits as the sulphate and soda papergrade sector, except that limitations for chloroform have been reserved. As well, the mills will be subject to AOX and COD limitations at a later date.
- The ammonia and specialty grade mills are also granted the option of selecting to use a TCF process. The same conditions would then apply to them i.e. no in-plant limits but an end-of-pipe AOX ML requirement, as well as BOD and TSS limits.

7.2.3 Best Management Practices (BMPs)

Because of concerns over the environmental effects of leaks and spills of spent pulping liquors, the EPA has introduced a set of Best Management Practices (BMPs) applicable to chemical pulping mills. The plans are designed to avoid, contain and recover, planned and non-planned diversions of liquor. The plans are required to contain ten common elements, including the following examples:

- installation of devices and means to detect, contain and recover spills of spent pulping liquor, turpentine and soaps; these include the use of secondary containment systems, similar to those used for fuel oils;
- the plans must place priority on returning spills to the process, or at least when liquor is sent to treatment, not affecting the biological treatment plant operations;
- inspection/repair and maintenance programs are employed to control events;
- initial and on-going operator training programs have to be used;
- monitoring programs to determine the effectiveness of BMPs in detecting and controlling leaks and spills
- action levels that trigger corrective responses and/or investigations of the reasons for leaks and spills
- the rules require mills to develop BMP plans within certain dates set out in the Federal Register publication. The plans and control criteria are approved by mill management, and not by the regulatory agency. Detailed record keeping is required and must be available to the regulator for inspection.

7.3 Air Rules

The 1990 Clean Air Act Amendments established EPA's authority to set National Emission Standards for Hazardous Air Pollutants (NESHAPs). This was aimed at protecting the nation's air resources. The NESHAPs are industry specific with the parameters and the limits set on the basis of an industry's pollution characteristics. The rules have to be developed from the Maximum Achievable Control Technology (MACT) limits attainable. These are known as MACT standards.

For the pulp and paper industry, the EPA is developing standards under three different MACT groupings, referred to as MACT I, MACT II and MACT III. These apply to different segments and parts of the industry. The MACT I and MACT III rues have been decided. The MACT II rules are at the comment stage.

7.3.1 MACT I

The MACT I standards apply to non-combustion sources at kraft, soda, sulphite and semi-chemical pulp and paper mills. The rules establish limits for hazardous air pollutant emissions from pulping, bleaching, wastewater and condensate emission sources at new and existing mills. The rule was signed along with the effluent rules on 14 November and published in the Federal Register on April 15, 1998 at pp. 18504 - 18751.

The rule is aimed at addressing hazardous air pollutants that are emitted from chemical pulping, bleaching processes, and wastewater sources. Of the HAPs methanol is the major constituent. Chlorine and its compounds are also involved from bleaching. The control technology on which the limits are based is proper hooding and ventilation, followed by incineration, or scrubbing for the bleach plant sources. The rules establish limits and conditions applying to different process units in the mills.

It is noted that the methanol control measures that are set, will also capture total reduced sulphur constituents from the same sources. This will indirectly address the major concern associated with mills, namely odour. The net impact on the emissions of other pollutant is illustrated in the benefits section at the end of the summary.

The MACT standards are based on a review of the performance attained by mills using the technologies underlying the MACT standards. For existing sources, the MACT standards are set based on the average performance attained by the top 12% of the plants. For new operations, the NSPS limits are based on the best performing plant.

The rules differentiate between sources according to their volume flowrates and the concentrations of the HAP constituents. Two categories are defined i.e. those of a Low Volume and High Concentration (LVHC) nature, and those of a High Volume and Low Concentration (HVLC) nature. Offgases from LVHC sources are easier to control than those from HVLC sources. The rules grant longer compliance periods under the permits for the HVLC sources, 8-years compared to 3-years.

7.3.1.1 Pulping system requirements for kraft, semi-chemical and soda operations

The rule classifies sources according to their HAP concentrations. The LVHC sources include the vents from the digesters, turpentine recovery, evaporators, steam strippers, and deckers using process water other than fresh water and paper making system waters, or process waters with a low HAP content and any other equipment providing these functions.

The HVLC sources include brownstock pulp washers and oxygen delignification systems.

All of the above processes (LVHC and HVLC sources) have to be enclosed and vented to a gas collection system. Criteria are set for the systems covering maintenance of a set negative pressure, visual inspection and repair programs.

The collected gases have to be directed to destruction units. Two options are granted both of which must destroy 98% of the HAPs by weight, measured as total HAP or methanol. The options are:

(a) the use of a Thermal Oxidizer, operating at 1600 °F for a 0.75 second retention time, or
(b) the introduction of the vented gases along with the primary fuel, or addition of the gas into the flame zone of a boiler, lime kiln or recovery furnace.

The rules require that the on-line time of the systems be maintained. For the LVHC systems, a 1% downtime is allowed, excluding start-up, shutdown and malfunction periods. For the HVLC system a 4% down time is permitted.

The rules also include a **"clean condensate option"**. Under this option a mill may choose to attain an equal or greater HAP reduction by hard-piping methanol-containing condensates to biological treatment system and achieving minimum removals across treatment as measured by certain monitoring requirements. This is described later.

7.3.1.2 Sulphite pulping requirements

For existing sulphite mills, the digesters, evaporators and pulp washing systems have to be enclosed and vented according to the same requirements as in *1.3.1.1.* The vented gases then have to be treated so as to meet prescribed HAP removal performance.

For calcium and sodium based pulping, gas treatment has to attain either

- 92% HAP removal, as total HAP or methanol, or
- an outlet HAP concentration equal to or less than 0.44 kg/tonne of oven dried pulp.

For ammonia and magnesium based mills, gas treatment has to attain either

- 87% HAP removal, as total HAP or methanol, or
- an outlet HAP concentration equal to or less than 1.1 kg/tonne of oven dried pulp.

For new sulphite mills, the above sources, as well as the weak black liquor storage, strong liquor storage and acid condensate storage tanks and vents have to be controlled to the same standards.

7.3.1.3 Kraft condensate treatment requirements

These apply to condensates from new and existing sources, covering (a) the digester systems; (b) the turpentine recovery systems; (c) each weak liquor stage in the evaporator system; (d) the LVHC collection system, and (e) the HVLC system. These require the condensates to be conveyed in a closed collection system, designed according to criteria described previously, until the condensates reach one of the treatment options specified (rule based on stream stripping).

Mills have the option to (a) treat all of the condensates, or (b) a fraction of the concentrates provided that this fraction contains greater than a certain percentage, or amount of the total HAPs. Under the latter option the mill has to either treat 65% or more of the total mass of HAPs in concentrated segregated wastewater streams, or more than a specified quantity of HAP set on a kg/tonne of product basis.

In the above cases, with respect to condensate treatment, mills are given three choices:

1. to recycle all of the treated concentrates to controlled process units in the mill, that meet the pulp venting criteria. This in effect avoids their release to the ambient air, or
2. to treat the condensate biologically, to attain a 92 % removal of or greater HAPs, or
3. to stream strip it to attain a similar 92 % removal.

7.3.1.4 Bleaching system requirements

These standards apply to operations at kraft, sulphite and semi-chemical mills that use chlorine or chlorine containing compounds in bleaching. Mills using TCF operations are excluded from having to comply with this rule.

The standards require all bleaching operations in which chlorine and chlorine containing compounds are used to be enclosed. Offgases have to be collected and vented according to the criteria described earlier. The gases have to be scrubbed to achieve either a 99 % HAP removal, or an outlet concentration of less than 10 ppmv, or HAP emissions of less than 0.001 kg/tonne of oven dry pulp.

In addition, a chloroform option requires the mills to either meet the relevant revised BAT effluent limitations for the sectors, or to not use any gaseous chlorine or hypochlorite in their bleaching processes. The substitution of these chemicals excuses the facility from the rule. Under this, mills using 100 % ClO_2 and no hypochlorite are excused from the provisions.

7.3.1.5 The Clean Condensate Option

Kraft mills are granted the option to reduce the concentrations of HAPs in their process waters and instead to forgo, or partially forgo the requirements applying to their pulping system vents. It has to be demonstrated by calculations, that the mills plans will attain a greater HAP reduction than under the basic rules.

Mills may take into account reductions achieved in the pulping, bleaching, causticizing and papermaking operations. They may not use emissions achieved from the black liquor, recovery furnace or tall oil systems. The mill condensate requirements still apply.

7.3.2 MACT III Rules

The MACT III rules relate to paper machines, mechanical pulping, secondary fibres and non-wood pulp mills. These were proposed on 8 March 1996 and are expected to be included in the Federal Register with the November package when it is published.

The rules apply to sources that use chlorine or chlorine dioxide for bleaching. The mills must collect the offgases for such units and treat them to the same level as for kraft bleaching. Hypochlorite bleaching is not covered.

7.4 Voluntary Advanced Technology Incentives Program

The "cluster rules" contain a voluntary incentives component designed to encourage interested mills to incorporate further environmental improvements before making investment decisions. The program encourages mills to commit to advanced levels of environmental performance in exchange for extended compliance times and a reduced regulatory burden.

The effluent component of the program is designed to encourage mills to install advanced pollution prevention technologies or process changes that further pollution prevention of toxic pollutants, beyond the limits set in the rules. It is aimed at seeing broader use of extended delignification and TCF processes, as well as the reduction of bleach plant effluent flows as an important step towards closed loop process operations.

Participation in the program is voluntary. Mills have one year to commit to the program and submit a plan for complying with the limitations. The program includes three levels, or "tiers" of performance. The limits are based on assumed ranges of technologies. Once enrolled mills will be assigned to a particular tier and appropriate milestones developed by the responsible permitting agency, for enforcement purposes.

If mills participate in the program, they will get 6 years instead of 3 years to comply with the air program. The air standards also provide up to 8 years to comply with the HVLC component. The air component is included in the Voluntary Program to promote the installation of pollution prevention measures to reduce toxic air emissions from the pulping processes, as well as air and water pollutant discharges from the bleaching operations.

Table 7 summarises the compliance deadlines set for the different tiers under the incentive program

Table 7 Compliance schedules for the tiers.

	Years after promulgation
Base effluent guidelines	3
If committing to attaining Tier I performance	6
If committing to attaining Tier II performance	11
If committing to attaining Tier III performance	16
Atmospheric emission guidelines (except HVLC systems)	3
Atmospheric emission guidelines (HVLC systems)	8

Base date for effluent discharge compliance is publication in the Federal Register
Base date for atmospheric emissions is 14 November 1997
HVLC = High volume low concentration (pulp washers etc.)

7.5 MACT II Rule issued for comment

Proposed rules were announced and issued for comment on 14 November 1997. These cover particulate matter (PM), particulate hazardous air pollutants (PMHAP) and total gaseous organic (TGO) hazardous air pollutants from chemical pulping combustion sources, namely the kraft and soda recovery boilers, the smelt dissolving tanks, the lime kilns, sulphite recovery boilers and semi-chemical combustion units.

Table 8 summarises the proposal as it applies to the various combustion sources in kraft mills, covering existing and new sources. It is noted that these are proposals and are subject to change based on comments.

Table 8. MACT II proposal for kraft mill combustion sources.

Source	Particulate matter HAP	Total gaseous HAP
Recovery Furnace		
Existing	0.10 g/dscm @ 8% O_2	no standard
New	0.034 g/dscm @ 8% O_2	0.012 kg/tonne BLS as methanol
Smelt Tank		
Existing	0.10 kg/tonne BLS	no standard [a]
New	0.06 kg/tonne BLS	no standard [a]
Lime Kiln/r Calciner		
Existing	0.15 g/dscm @ 10% O_2	no standard [a]
New	0.023 g/dscm @ 10% O_2	no standard [a]

7.6 Estimate of emission reductions attainable from the new rules

An associated document summarises the benefits of the new rules in terms of actual pollutants emitted after the MACT controls versus those before. Table 9 below summarises the results for the major air pollutants.

Table 9 Summary of total mill emissions before and after MACT I and III implementation

Pollutant	Emissions before MACT I and III	Emissions after MACT I and III	% reduction from action
Total HAPs	198,000	69,700	65
Methanol	135,000	42,500	69
VOC	814,000	417,000	49
Particulate	(9)	83	(800)
TRS	142,000	66,500	53

The table shows that the total HAP emissions from the MACT I and III sources covered by the two rules are estimated to be reduced by 65 %. Methanol decreases by 62 % and TRS by 54 %. It is noted that particulate emissions are estimated to rise by 83 tonnes. The bracketed data for particulates indicate an increase.

The reports also show that SO2, NOx and CO emissions will also increase as result of the MACT I implementation. The increases are below:

- SO2 emissions 94,500 tonnes per annum
- CO emissions 8,660 tonnes per annum
- NOx emissions 5,230 tonnes per annum

8. ANNEX 2: AIR REQUIREMENT TABLES

Simons Report Tables

Table C-2: Kraft Pulp Mill Regulations for Recovery Furnace

Pollutant	REGULATORY AUTHORITY								
	Federal NSPS	**Alabama**	**Florida**	**Georgia**	**Louisiana**	**Maine**	**New Hampshire**	**Oregon**	**Washington**
Opacity[a]	35% (6-min). Continuous monitoring is required.	20% (6-min) and up to 40% (6-min in any 1-h period)	45% (6-min) and up to 60% (6-min in any 1-h period)	40% (6-min).	40% (6-min); allowance of higher opacity (6-min in any 1-h period).	30% (5-min in any 3-h period, existing); 20% (5-min in any 3-h period, new).	20% (facilities constructed after 1970); 40% (older facilities) (1-min).	35% (30-min out of 180 min or for 60-min in any 24-h period). Continuous monitoring is required.	35% (6-min).
PM	0.044 gr/dscf @ 8% O_2.	1.11-4 lb/T of unbleached air-dried pulp; applies to furnaces constructed before 1972 or '73 in specific counties; e.g., existing facilities).	3 lb/3000 lb of black liquor solids.	55 po.11-40 lb/h, where p - process rate in T/h for P>30 T/h. 4.1 po.67 lb/h, where p = process rate in T/h for P≥30 T/h.	4.0 lb/T unbleached air-dried pulp.	4 lb/T of pulp.	4 lb/T of pulp.	4 lb/T and 0.13 gr/dscf; 2 lb/T and 0.044 gr/dscf (PM control equipment modified after 7/88).	0.10 gr/dscf @ 8% O_2 in 3 1-h tests.
SO_2		1.8-4.0 lb/MBtu heat input for fuel burning equipment.			2000 ppmv (3-h) (applies to general process equipment).			300 ppmv (3-h) (except for fuel oil)	500 ppmv @ 8% O_2 (1-h).
TRS	5 ppmv (straight furnace); 25 ppmv (cross furnace). Limits are @ 8% O_2 (12-h). Continuous monitoring is required.	Sum of TRS emission from furnaces, kilns, digesters, and evaporators must be less than 1.2 lb H_2S/T of pulp. 20 ppmv (old furnace); 5 ppmv (new furnace). Limits are @ 8% O_2 (12-h). Continuous TRS monitoring required.	Cross recovery furnaces are required to meet straight recovery furnace TRS emission limits when green liquor sulfidity exceeds 28% and black liquor being burned contains an average of more than 7% solids (12-h). 17.5 ppmv (old straight furnace, new straight furnace not direct-fired, and new direct-fired suspension-burning furnace); 5 ppmv (new direct-fired furnaces that are not direct-fired suspension-burning furnace); 25 ppmv (cross furnace). -burning furnace);	Sum of TRS emissions from existing furnaces, kilns, digesters, and evaporators must be less than RB + LK + 0.065 lb/T of pulp. 20 ppmv (old straight furnace); 5 ppmv (new straight furnace); 25 ppmv (cross furnace). Limits are @ 8% O_2 (24-h) Continuous TRS monitoring required.	20 ppmv (old straight furnace); 5 ppmv (new straight furnace); 25 ppmv (cross furnace). Limits are @ 8% O_2 (12-h).	5 ppmv (new straight furnace equipped with dry-bottom or wet-bottom ESP employing water); 15 ppmv (new straight furnace equipped with wet-bottom ESP employing black liquor); 20 ppmv (old straight kraft recovery furnace). Limits are @ 8% O_2 (12-h). Continuous monitoring is required.	300 ppmv, 150 ppmv, and 20 ppmv by 1/92, 1/94, and 1/96, respectively (old furnace); 200 ppmv, 120 ppmv, 20 ppmv by 1/92, 1/94, and 1/96, respectively, and also must meet 20 ppmv limit prior to 1/96 if any furnace achieves 20 ppmv limit for 60 consecutive 12-h shifts (new furnace). Limits are @ 8% O_2 (12-h) Continuous monitoring is required.	5 ppmv and 0.15 lb S/T of pulp (new facilities); 10 ppmv and 0.30 lb S/T of pulp (existing facilities) (24-h). Continuous monitoring is required.	5 ppmv; ≤ 17.5 ppmv (facilities constructed prior to 1970 with a contact evaporator). Limits are @ 8% O_2 (24-h our).
			Limits are @ 8% O_2 (12-h). Continuous TRS monitoring required.						

a. Where applicable, the averaging period is specified for the emission limit. For example, a 3-h emission limit of 95 ppmdv means that the average arithmetic mean of the measured emission over a 3-h period must not exceed 95 ppmdv.

Table C-3: Kraft Pulp Mill Regulations for Smelt Dissolver

Pollutant	REGULATORY AUTHORITY								
	Federal NSPS	Alabama	Florida	Georgia	Louisiana	Maine	New Hampshire	Oregon	Washington
Opacity[a]		20% (6-min) and up to 40% (6-min in any 1-h period).	10% (1-min) or compliance with PM standard.	40% (6-min)	20% (6-min); allowance of higher opacity (6-min in any 1-h period).	20% (5-min in any 1-h).	20% (1-min).	20% (3-min in any 1-h period).	35% (6-min).
PMPM	0.2 lb/T black liquor solids	0.3-0.5 lb/T of pulp.	3.59P0.62 lb/h where P is the process weight in T/h.		0.5 lb/T unbleached air- dried pulp.	0.5 lb/T of pulp (2-h).	0.5 lb/T of pulp.	0.5 lb/T; 0.3 lb/T (PM control equipment modified after 7/88).	0.3 lb/T of solids fired at recovery furnace.
SO_2					2000 ppmv (3-h) (applies to general process equipment).				1000 ppmv @ 7% O_2 (1-h).
TRS	0.033 lb/T of black liquor solids (12-h).	0.033 lb/T of black liquor solids in recovery furnace (12-h).	0.0480 lb/3000 lb of black liquor solids as H_2S (12-h). CEM for TRS required.	0.0168 lb/T of black liquor solids fired in recovery furnace (24-h).	0.016 g/kg black liquor solids fired in recovery furnace (12-h).	0.033 lb/T black liquor solids as H_2S (12-h).	0.033 lb/T black liquor solids as H_2S (12-h).	0.033 lb/T black liquor solids; 0.066 lb/T (if explosion hazard) (24-h). (Quarterly TRS monitoring required)	

a. Where applicable, the averaging period is specified for the emission limit. For example, a 3-h emission limit of 95 ppmdv means that the average arithmetic mean of the measured emission over a 3-h period must not exceed 95 ppmdv.

Table C-4: Kraft Pulp Mill Regulations for Lime Kiln/Calciner

Pollutant	REGULATORY AUTHORITY								
	Federal NSPS	Alabama	Florida	Georgia	Louisiana	Maine	New Hampshire	Oregon	Washington
Opacity[a]		20% (6-min) and up to 40% (6-min in any 1-h period).	10% (1-min) or compliance with PM standard. 20% (2-min) and up to 40% (2-min in any 1-h period) if <30 MBtu/h; 30% and up to 40% (2-min in any 1-h) if >30 MBtu/h.	40% (6-min).	20% (6-min); allowance of higher opacity (4-min in any 1-h period).	80% (combined process Limit is for any 1 h period (10-min). 30% (fuel burning equipment <250 MBtu/h); 40% (fuel burning equipment >250 MBtu/h). Limits are for 15-min in any 3-h period. 40% (solid waste and combined fuel burning equipment). Limit is for 20-min any 2-h period.	20% (facilities constructed after 1970); 40% (older facilities) (1-min).	20% (3-min in any 1-h period).	35% (6-min).
PM	0.067 gr/dscf @ 10% O2 (gaseous fuel); 0.13 gr/dscf (liquid fossil fuel).	1 lb/T of pulp	3.59 $P^{0.62}$ lb/h where P is the process weight in T/h.	55 $P^{0.11}$-40 lb/hr where p = process rate in T/h for { >30 T/h; 4.1 $P^{0.67}$ lb/h when P≤30 T/h	1.0 lb/T unbleached air-dried pulp.	1 lb/T of pulp.	1 lb/T of pulp.	1 lb/T and 0.2 gr/dscf; 0.5 lb/T and 0.067 gr/dscf (gaseous fuel, PM control equipment modified after 7/88); 1 lb/T and 0.13 gr/dscf (liquid fuel, PM control equipment modified after 7/88) @ 10% O_2.	0.13 gr/dscf @ 10% O_2.
SO_2		1.8-4.0 lb/MBtu heat input for fuel burning equipment.			2000 ppmv (3-h).		0.4% sulfur content (fuel oil #2); 1% sulfur content (fuel oil #4); 2% sulfur content (fuel oil #5 & #6); 5 gr/100 ft^3 (gaseous fuel).	1.4 lb/MBtu (liquid fuel, 150-250 MBtu/h); 0.8 lb/MBtu (liquid fuel, >250 MBtu/h); 1.75% sulfur content (residual oil); 0.3% sulfur content (distillate oil #1 & #2).	500 ppmv @ 10% O_2 (1-h).
TRS	8 ppmv @ 10% O_2; Continuous monitoring is required.	Sum of TRS emission from furnaces, kilns, digesters, and evaporators must be less than 1.2 lb H_2S/T of pulp. 20 ppmv. Limit is @ 10% O_2 (12-h). Continuous TRS monitoring required.	20 ppmv Limit is @ 10% O_2 (12-h). Continuous TRS monitoring required.	Sum of TRS emission from existing furnaces, kilns, digesters, and evaporators must be less than RB + LK + 0.065 lb/T of pulp. 40 ppmv. Limit is @ 10% O_2 (24-h).	20 ppmv Limit is @ 10% O_2 (12-h).	20 ppmv Limit is @ 10% O_2 (12-h). Continuous monitoring is required.	20 ppmv Limit is @ 10% O_2 (12-h). Continuous monitoring is required.	20 ppmv and 0.1 lb/T of pulp (24-h). Continuous monitoring is required.	80 ppmv as H_2S in any one day. Limit is @ 10% O_2 (2-h). 50 ppmv; ≤ 20 ppmv (facilities built after 1985). Limits are @ 10% O_2 (24-h).

a. Where applicable, the averaging period is specified for the emission limit. For example, a 3-h emission limit of 95 ppmdv means that the average arithmetic mean of the measured emission over a 3-h period must not exceed 95 ppmdv.

Table C-5: Kraft Pulp Mill Regulations for Digester/Evaporator

Pollutant	REGULATORY AUTHORITY								
	Federal NSPS	**Alabama**	**Florida**	**Georgia**	**Louisiana**	**Maine**	**New Hampshire**	**Oregon**	**Washington**
Opacity[a]		20% (6-min) and up to 40% (6-min in any 1-h period).	20% (1-min).	40% (6-min).	20% (6-min); allowance of higher opacity (6-min in any 1-h period).	20% (5-min in any 1-h period.	20% (1-min).	20% (3-min in any 1-h period).	20% (6-min).
SO_2					2000 ppmv (3-h) (applies to general process equipment).				1000 ppmv @ 7% O2 (1-h).
TRS	Must comply with the 12-h TRS limit unless gases are incinerated in a lime kiln, recovery furnace, or similar at >1200 °F for at least 0.5 sec. 0.005 g/kg ADP (0.01 lb/T ADP) 5 ppmv. Limit is @ 10% O2 (12-h). Continuous Monitoring is required.	Sum of TRS emission from furnaces, kilns, digesters, and evaporators must be less than 1.2 lb H2S/T of pulp; must comply with the 12-h TRS limit unless gases are incinerated in a lime kiln, recovery furnace, or similar at >1200 °F for at least 0.5 sec. 5 ppmv. Limit is @ 10% O2 (12-h).	5 ppm (12-h) if controls other than incineration are used. Limit is at actual O_2 content of untreated flue gas. Continuous TRS monitoring is required.	Sum of TRS emission from existing furnaces, kilns, digesters, and evaporators must be less than RB + LK + 0.065 lb/T of pulp; must comply with the 5 ppmv (12-h) TRS limit unless gases are incinerated in a lime kiln, recovery furnace, or similar at >1200 °F for at least 0.5 sec. 5 ppmv. Limit is @ 10% O_2 (24-h).	5 ppmv (12-h).	TRS emissions from digesters, brown stock washers, evaporators, and condensate strippers must comply with 5 ppmv (12-h) TRS limit or gases must be incinerated at 1200 °F for 0.5 sec; backup system to operate within 40 minutes after primary control system failure. 5 ppmv. Limit is @ 10% O_2 (12-h). Continuous TRS monitoring required. Limit	Must comply with the 5 ppmv (12-h) TRS limit unless gases are incinerated in a lime kiln, recovery furnace, or similar at >1200 °F for at least 0.5 sec. 5 ppmv. Limit is @ 10% O_2 (12-h).	Non-condensibles from digesters, evaporators, and condensate strippers shall be incinerated in a lime kiln or similar at 1200 °F for at least 0.3 sec; venting during changeover shall not exceed 1 h.	Non-condensibles from digesters, evaporators, and condensate strippers shall be treated at all times equal to incineration in a lime kiln; a backup control system must be installed to assure continual treatment if primary control system breaks down.

a. Where applicable, the averaging period is specified for the emission limit. For example, a 3-h emission limit of 95 ppmdv means that the average arithmetic mean of the measured emission over a 3-h period must not exceed 95 ppmdv.

Table C-6: Kraft Pulp Mill Regulations for Other sources including knotter, brown stock washer, black liquor oxidation vents, and condensate stripper.

Pollutant	REGULATORY AUTHORITY								
	Federal NSPS	Alabama	Florida	Georgia	Louisiana	Maine	New Hampshire	Oregon	Washington
Opacity[b]		20% (6-min) and up to 40% (6-min in any 1-h period).	20% (1-min).	40% (6-min).	20% (6-min); allowance of higher opacity (6-min in any 1-h period).	20% (5-min in any 1-h).	20% (1-min).	20% (3-min in any 1-h period).	20% (6-min).
SO2					2000 ppmv (3-h) (applies to general process equipment).				1000 ppmv @ 7% O2 (1-h).
TRS	Continuous monitoring from brown stock washer and condensate stripper is required.				5 ppmv (condensate stripper) (12-h).	TRS emissions from digesters, brown stock washers, evaporators, and condensate strippers must be < 5 ppmv @ 10% O2 or gases must be incinerated at 1200 °F for 0.5 sec; backup system to operate within 40 minutes after primary control system failure. Continuous monitoring from condensate stripper is required.		Non-condensibles from digesters, evaporators, and condensate strippers shall be incinerated in a lime kiln or similar at 1200 °F for at least 0.3 sec; venting during changeover shall not exceed 1 h. Sum of TRS emissions from other sources including knotters, brown stock washer, and black liquor oxidation vents must be less than 0.156 lb/T (24-h).	Non-condensibles from digesters, evaporators, and condensate strippers shall be treated at all times equal to incineration in a lime kiln; a backup control system must be installed to assure continual treatment if primary control system breaks down.

a. Where applicable, the averaging period is specified for the emission limit. For example, a 3-h emission limit of 95 ppmdv means that the average arithmetic mean of the measured emission over a 3-h period must not exceed 95 ppmdv.

Table C-7: Kraft Pulp Mill Regulations for Tall Oil Plant

Pollutant	REGULATORY AUTHORITY								
	Federal NSPS	**Alabama**	**Florida**	**Georgia**	**Louisiana**	**Maine**	**New Hampshire**	**Oregon**	**Washington**
Opacity[a]		20% (6-min) and up to 40% (6-min in any 1-h period).	20% (1-min).	40% (6-min).	20% (6-min); allowance of higher opacity (6-min in any 1-h period).	20% (5-min in any 1-h period).	20% (1-min).	20% (3-min in any 1-h period).	20% (6-min).
SO_2					2000 ppmv (1-h) (applies to general process equipment).				1000 ppmv @ 7% O2 (1-h).
TRS			Must comply with 5 ppmv (12-h) TRS limit unless incinerate gases in a lime kiln or similar. 0.05 lb/T of crude oil produced (12-h). Continuous TRS monitoring required.						

a. Where applicable, the averaging period is specified for the emission limit. For example, a 3-h emission limit of 95 ppmdv means that the average arithmetic mean of the measured emission over a 3-h period must not exceed 95 ppmdv.

Table C-8: Kraft Pulp Mill Regulations for NCG Systems[a]

Pollutant	REGULATORY AUTHORITY								
	Federal NSPS	Alabama	Florida	Georgia	Louisiana	Maine	New Hampshire	Oregon	Washington
Opacity[a]		20% (6-min) and up to 40% (6-min in any 1-h period).	5% (1-min) and up to 20% (3-min in 1-h) (incinerator <50 T/day charge); 20% (incinerator > 50 T/day charge).	20% (6-min) and up to 27% 6-min in any 1-h)	20% (6-min); allowance of higher opacity (6-min in any 1-h period).	80% (combined process equipment). Limit is for any 10-min in any 1-h period. 30% (fuel burning equipment <250 MBtu/h); 40% (fuel burning equipment >250 MBtu/h). Limits are for 6-min in any 3-h period. 40% (solid waste and combined fuel-burning equipment). Limit is for 20-min in any 2-h period.	20% (3-min in any 1-h period).	20% (3-min in any 1-h period).	20% (6-min).
PM		0.12-0.8 lb/MBtu heat input (depending on the size of the fuel burning equipment and the county where the equipment is located).	0.08 gr/dscf (new); 0.10 gr/dscf (existing). Limits are at 50% excess air and for incinerators > 50 T/day charge.	1 lb/h (charge rate of 500 lb/h or less); 0.2 lb/100 lb of charge (charge rate greater than 500 lb/h).	0.6 lb/MBtu (fuel burning equipment).	0.2 gr/dscf (chrage rate ≤50 T/d. Limits are at 12% CO_2 (2-h).	0.3 gr/dscf (<200 lb incinerator built before 1974); 0.2 gr/dscf (>200 lb incinerator built before 1974); 0.08 gr/dscf (>4000 lb/h incinerator built after 1974). Limits are at 12% CO_2 (2-h).	0.10 gr/dscf (new source); 0.20 gr/dscf (existing source). Limits are @ 50% excess air and a standard temperature of 60 °F.	0.1 gr/dscf. Limit is @ 7% O2.
SO2		1.8-4.0 lb/MBtu heat input for fuel burning equipment (depending on the county).			2000 ppmv (3-h) (applies to general process equipment).		0.4% sulfur content (fuel oil #2); 1% sulfur content (fuel oil #4); 2% sulfur content (fuel oil #5 & #6); 5 gr/100 ft3 (gaseous fuel).		1000 ppmv @ 7% O_2 (1-h).
TRS	Non-condensible gases must be incinerated in a lime kiln, recovery furnace, or similar at >1200 °F for at least 0.5 sec. Monitoring of combustion temperature is required.	Non-condensible gases must be incinerated at >1200 °F for at least 0.5 sec. 20 ppmv Limit is @ 10% O_2 (12-h).	5 ppmv Limit is at 10% O_2 (12-h). Continuous TRS monitoring required.	Non-condensible gases must be incinerated in a lime kiln or similar at >1200 °F for at least 0.5 sec.		Non-condensible gases must be incinerated at 1200 °F for 0.5 sec; backup system to operate within 40 minutes after primary control system failure.	Non-condensible gases must be incinerated in a lime kiln or similar at 1200 °F for at least 0.5 sec.	Non-condensibles from digesters, evaporators, and condensate strippers must be incinerated in a lime kiln or similar at 1200 °F for at least 0.3 sec.	Non-condensibles from digesters, evaporators, and condensate strippers must be treated at all times equal to incineration in a lime kiln; a backup control system must be installed to assure continual treatment if primary control system breaks down.

a. Non-condensible gases (NCG) from several sources such as digesters, evaporators, condensate strippers, etc. must be incinerated in a lime kiln, recovery furnaces, or similar incineration units at > 1200 °F for at least 0.3-0.5 second, depending on the regulatory agency. Regulations for lime kilns and recovery furnaces are presented elsewhere. The regulations included in this table applies to the use of other similar incineration units.

b. Where applicable, the averaging period is specified for the emission limit. For example, a 3-h emission limit of 95 ppmdv means that the average arithmetic mean of the measured emission over a 3-h period must not exceed 95 ppmdv.

Table C-9: Kraft Pulp Mill Regulations for Chemical Preparation Plant/Bleach Plant									
Pollutant	**REGULATORY AUTHORITY**								
	Federal NSPS	**Alabama**	**Florida**	**Georgia**	**Louisiana**	**Maine**	**New Hampshire**	**Oregon**	**Washington**
Cl_2						<3.0 lb/h. Continuous monitoring of total chlorine is required.			
ClO_2						<3.0 lb/h			
Opacity[a]		20% (6-min) and up to 40% (6-min in any 1-h period).	20% (1-min) or compliance with PM standard.	40% (6-min).	20% (6-min); allowance of higher opacity (6-min in any 1-h period).	20% (5-min in any one h).	20% (1-min).	20% (3-min in any 1-h period).	20% (6-min).

a. Where applicable, the averaging period is specified for the emission limit. For example, a 3-h emission limit of 95 ppmdv means that the average arithmetic mean of the measured emission over a 3-h period must not exceed 95 ppmdv.

Table C-10: Kraft Pulp Mill Regulations for Paper Machines/Pulp Machines

Pollutant	REGULATORY AUTHORITY								
	Federal NSPS	Alabama	Florida	Georgia	Louisiana	Maine	New Hampshire	Oregon	Washington
Opacity[a]		20% (6-min) and up to 40% (6 min in any 1-h period).	20% (1-min).	40% (6-min).	20% (6-min); allowance of higher opacity (6-min in any 1-h period).	20% (5-min in any one h).	20% (1-min).	20% (3-min in any 1-h period)).	20% (6-min).
PM		0.55-68.96 lb/h (depending on the process weight rate and county).	3.59 $P^{0.62}$ lb/h (for process rate P ≤ 30 T/h); 17.3$P^{0.16}$ lb/h (for process rate P > 30 T/h).	4.1$P^{0.67}$ lb/h where P is process rate in T/h and P≤30 T/h.	Less stringent of the following limits where P is process rate in T/h: 4.10$P^{0.67}$ lb/h (P≤60,000 lb/h); {55.0$P^{0.11}$ - 40} lb/h (P>60,000 lb/h); 3.59$P^{0.62}$ lb/h (P≤60,000 lb/h); 17.31$P^{0.16}$ lb/h (P>60,000 lb/h).	3.59$P^{0.62}$ lb/h (P≤60,000 lb/h); 17.31$P^{0.16}$ lb/h (P>60,000 lb/h). P is process rate in T/h.	4.10$P^{0.67}$ lb/h (new, P≤60,000 lb/h); 5.05$P^{0.67}$ lb/h (existing, P≤60,000 lb/h); 55.0$P^{0.11}$ - 40 lb/h (new, P>60,000 lb/h); 66.0$P^{0.11}$ - 46 lb/h (existing, P>60,000 lb/h). P is process rate in T/h.	4.10$P^{0.67}$ lb/h (P≤60,000 lb/h); {55.0$P^{0.11}$ - 40} lb/h (P>60,000 lb/h). P is process rate in T/h.	0.10 gr/dscf.

a. Where applicable, the averaging period is specified for the emission limit. For example, a 3-h emission limit of 95 ppmdv means that the average arithmetic mean of the measured emission over a 3-h period must not exceed 95 ppmdv.

Table C-11: Regulations for Wood-Fired Power Boilers

Pollutant	REGULATORY AUTHORITY								
	Federal NSPS	Alabama	Florida	Georgia	Louisiana	Maine	New Hampshire	Oregon	Washington
NO_x	0.30 lb/MBtu (new boiler >100 MBtu/h using wood and >10% natural gas) (30-day). Continuous monitoring is required.								
Opacity[a]	20% (6-min) and up to 27% (one 6-min period per h) (new boiler >30 MBtu/h). Continuous monitoring is required.	20% (6-min) and up to 40% (6-min in any 1-h period); 76% (existing boiler >300 MBtu/h in Talladga county); 40% (boiler built before 1972 in Autauga county). Continuous monitoring is required.	30% (1-min) except up to 40% (2-min) (carbona-ceous fuel burning equipment >30 MBtu/h); 20% and up to 40% (2-min) (carbona-ceous fuel burning equipment <30 MBtu/h).	20% (6-min) except up to 27% (6-min in any 1-h period). Continuous opacity monitoring is required for wood waste fired boiler >100 MBtu/h.	20% (6-min); allowance of higher opacity (6-min in any 1-h period).	30% (fuel burning equipment <250 MBtu/h); 40% (fuel burning equipment >250 MBtu/h). Limits are for 15-min any 3-h period.	40% (1-min) except up to 60% (6-min in any 1-h period) (boiler built before 1970); 20% (1-min) except up to 60% (6-min in any 1-h period) (boiler built after 1970).	10% (1-min) except up to 20% (3-min per h).	20% (6-min) with allowance for higher opacity (15-min in an 8-h period).
PM	0.10 lb/MBtu (new boiler >30 MBtu/h heat input).	0.3 gr/dscf (existing boiler); 0.2 gr/dscf (modified boiler burning wood only or wood/oil); 0.17 gr/dscf (modified boiler burning wood/gas); 0.60 gr/dscf and ≤347 lb/h (existing boiler >300 MBtu/h in Talladga county); 2.43 lb/MBtu and 589 lb/h (boiler built before 1972 in Autauga county). Limits are at 50% excess air. 1972	0.3 lb/MBtu (carbona-ceous fuel burning equipment built before 1974); 0.2 lb/MBtu (new carbona-ceous fuel burning equipment).	0.7 lb/MBtu (<10 MBtu/h before 1972); $0.7(10/R)$0.202 lb/MBtu ($10<R\leq2000$ MBtu/h before 1972); 0.24 lb/MBtu (>2000 MBtu/h before 1972); 0.5 lb/MBtu (<10 MBtu/h after 1972); $0.5(10/R)^{0.5}$ lb/MBtu ($10<R\leq2000$ MBtu/h after 1972); 0.10 lb/MBtu (>2000 MBtu/h after 1972). 1972).	0.6 lb/MBtu.	log y = 0.034 - 0.256logx where y is lb/MBtu and x is MBtu/h heat input (wood burning equipment <150 MBtu/h); 0.30 lb/MBtu (wood burning equipment >150 MBtu/h)	0.60 lb/MBtu (<10 MBtu/h before 1985); $0.880I^{-0.166}$ lb/MBtu ($10<I<10{,}000$ MBtu/h before 1970); 0.19 lb/MBtu (>10,000 MBtu/h before 1970); $1.028I^{-0.234}$ lb/MBtu ($100<I<250$ MBtu/h 1970-1985); 0.10 lb/MBtu (>250 MBtu/h after 1970); 0.30 lb/MBtu (<100 MBtu/h after 1985); 0.15 lb/MBtu (100-250 MBtu/h after 1985).	0.05 gr/dscf @ 12% CO_2 (wood waste boiler); 0.2 gr/dscf (existing fuel burning equipment); 0.1 gr/dscf (new fuel burning equipment). If the salt in the wood is the cause of emissions in excess of the 0.1-0.2 gr/dscf limits, then the resulting salt portion of the emissions will be exempt; however, the emissions should not exceed 0.6 gr/dscf.s	0.2 gr/dscf (wood boiler built before 1983); 0.1 gr/dscf (wood boiler built after 1983). Limits are @ 7% O_2.
SO_2		1.8-4.0 lb/MBtu heat input for fuel burning equipment (depending on the county).		1.2 lb/MBtu (boiler >250 MBtu/h modified or built after 1972); 0.8 lb/MBtu (boiler >250 MBtu/h modified or built after 1972 and use fuel derived from wood residue); 2.5% S by weight (boiler <100 MBtu/h); 3% S by weight (boiler ≥100 MBtu/h).	2000 ppmv (3-h) (applies to general process equipment).				1000 ppmv @ 7% O_2 (1-h).

a. Where applicable, the averaging period is specified for the emission limit. For example, a 3-h emission limit of 95 ppmdv means that the average arithmetic mean of the measured emission over a 3-h period must not exceed 95 ppmdv.

Table C-12: Regulations for Oil-Fired Power Boilers

Pollutant	REGULATORY AUTHORITY								
	Federal NSPS	Alabama	Florida	Georgia	Louisiana	Maine	New Hampshire	Oregon	Washington
NO_x	0.10-0.20 lb/MBtu (new boiler >100 MBtu/h burning natural gas and distillate oil); 0.30-0.40 lb/MBtu (new boiler >100 MBtu/h burning residual oil) (30-day). Continuous monitoring is required.		0.3 lb/MBtu (existing >250 MBtu/h) (30-day).	0.3 lb/MBtu (oil-fired equipment ≥250 MBtu/h and built after 1972).					
Opacity[a]	20% (6-min) and up to 27% (one 6-min period per h) (new boiler >30 MBtu/h). Continuous monitoring is required.	20% (6-min) and up to 40% (6-min in any 1-h period)).	20% (1-min) except up to 27% (6- min per h) (existing fossil fuel steam generator).	20% (6-min) except up to 27% (6-min in any 1-h period). Continuous monitoring is required for fuel burning equipment >250 MBtu/h.	20% (6-min); allowance of higher opacity (6-min in any 1-h period).	30% (fuel burning equipment <250 MBtu/h); 40% (fuel burning equipment >250 MBtu/h). Limits are for any 3-h period.	40% (1-min) except up to 60% (6-min in any 1-h period) (boiler built before 1970); 20% (1-min) except up to 60% (6-min in any 1-h period) (boiler built after 1970).	40% (1-min) with allowance of higher opacity (3-min per h) (existing); 20% (1-min) with allowance of higher opacity (3-min per h) (new).	20% (6-min).
PM	0.10 lb/MBtu (new boiler >30 MBtu/h heat input).	0.12-0.8 lb/MBtu heat input (depending on the size of the fuel burning equipment and the county where the equipment is located).	0.1 lb/MBtu (existing fossil fuel steam generator >250 MBtu/h); BACT (existing fossil fuel steam generator <250 MBtu/h).	0.7 lb/MBtu (<10 MBtu/h before 1972); 0.7(10/R)0.202 lb/MBtu (10<R≤2000 MBtu/h before 1972); 0.24 lb/MBtu (>2000 MBtu/h before 1972); 0.5 lb/MBtu (<10 MBtu/h after 1972); $0.5(10/R)^{0.5}$ lb/MBtu (10<R≤2000 MBtu/h after 1972); 0.10 lb/MBtu (>2000 MBtu/h after 1972). 1972).	0.6 lb/MBtu.	0.12 lb/MBtu (fossil fuel burning equipment <50 MBtu/h); 0.08 lb/MBtu (fossil fuel burning equipment 50-250 MBtu/h); 0.06 lb/MBtu (fossil fuel burning equipment >50 MBtu/h).	0.60 lb/MBtu (<10 MBtu/h before 1985); $0.880I^{-0.166}$ lb/MBtu (10<I<10,000 MBtu/h before 1970); 0.19 lb/MBtu (>10,000 MBtu/h before 1970); $1.028I^{-0.234}$ lb/MBtu (100<I<250 MBtu/h 1970-1985); 0.10 lb/MBtu (>250 MBtu/h after 1970); 0.30 lb/MBtu (<100 MBtu/h after 1985); 0.15 lb/MBtu (100-250 MBtu/h after 1985).	0.2 gr/dscf (existing fuel burning equipment); 0.1 gr/dscf (new fuel burning equipment).	0.05 gr/dscf (boiler built after 1983); 0.1 gr/dscf (oil burning equipment built before 1983). Limits are @ 7% O_2.
SO_2	90% emission reduction or 0.08 lb/MBtu (new boiler >100 MBtu/h); 0.5% S by weight or 0.5 lb/MBtu (new boiler 10-100 MBtu/h). Continuous monitoring is required except for boiler <30 MBtu/h burning distillate oil.	1.8-4.0 lb/MBtu heat input for fuel burning equipment (depending on the county).	1.10-2.75 lb/MBtu (existing >250 MBtu/h); BACT (existing <250 MBtu/h).	0.8 lb/MBtu (boiler >250 MBtu/h modified or built after 1972); 2.5% S by weight (boiler <100 MBtu/h); 3% S by weight (boiler ≥100 MBtu/h).	2000 ppmv (3-h) (applies to general process equipment).		0.4% S (fuel oil #2); 1% S (fuel oil #4); 2% S (fuel oil #5&6);	1.4 lb/MBtu (oil burning equipment 150-250 MBtu/h); 1.75% S by weight (residual oil); 0.3% S by weight (distillate oil #1&2).	1000 ppmv @ 7% O_2 (1-h).

a. Where applicable, the averaging period is specified for the emission limit. For example, a 3-h emission limit of 95 ppmdv means that the average arithmetic mean of the measured emission over a 3-h period must not exceed 95 ppmdv.

Table C-13: Regulations for Natural Gas-Fired Power Boilers

Pollutant	REGULATORY AUTHORITY								
	Federal NSPS	**Alabama**	**Florida**	**Georgia**	**Louisiana**	**Maine**	**New Hampshire**	**Oregon**	**Washington**
NO_x	0.10-0.20 lb/MBtu (new boiler >100 MBtu/h burning natural gas and distillate oil); 0.30 lb/MBtu (new boiler >100 MBtu/h burning natural gas and wood) (30-day). Continuous monitoring is required.		0.3 lb/MBtu (existing >250 MBtu/h) (30-day).	0.2 lb/MBtu (gas-fired equipment ≥250 MBtu/h and built after 1972).					
Opacity[a]	20% (6-min) and up to 27% (one 6-min period per h) (new boiler >30 MBtu/h). Continuous monitoring is required.	20% (6-min) and up to 40% (6-min in any 1-h period).	20% (1-min) except up to 27% (6-min per h) (existing fossil fuel steam generator).	20% (6-min) except up to 27% (6-min in any 1-h period). Continuous monitoring is required for fuel burning equipment >250 MBtu/h.	20% (6-min); allowance of higher opacity (6-min in any 1-h period).	30% fuel burning equipment <250 MBtu/h); 40% (fuel burning equipment >250 MBtu/h). Limits are for 15-min in any 3-h period.	40% (1-min) except up to 60% (6-min in any 1-h period) (boiler built before 1970); 20% (1-min) except up to 60% (6-min in any 1-h period) (boiler built after 1970).	40% (1-min) with allowance of higher opacity (3-min per h) (existing); 20% (1-min) with allowance of higher opacity (3-min per h) (new).	20% (6-min).
PM		0.12-0.8 lb/MBtu heat input (depending on the size of the fuel burning equipment and the county where the equipment is located).	0.1 lb/MBtu (existing fossil fuel steam generator >250 MBtu/h); BACT (existing fossil fuel steam generator <250 MBtu/h).	0.7 lb/MBtu (<10 MBtu/h before 1972); 0.7(10/R)0.202 lb/MBtu (10≤R≤2000 MBtu/h before 1972); 0.24 lb/MBtu (>2000 MBtu/h before 1972); 0.5 lb/MBtu (<10 MBtu/h after 1972); $0.5(10/R)^{0.5}$ lb/MBtu (10≤R≤2000 MBtu/h after 1972); 0.10 lb/MBtu (>2000 MBtu/h after 1972).	0.6 lb/MBtu.	0.12 lb/MBtu (fossil fuel burning equipment <50 MBtu/h); 0.08 lb/MBtu (fossil fuel burning equipment 50-250 MBtu/h); 0.06 lb/MBtu (fossil fuel burning equipment >50 MBtu/h).	0.60 lb/MBtu (<10 MBtu/h before 1985); $0.880I^{-0.166}$ lb/MBtu (10<I<10,000 MBtu/h before 1970); 0.19 lb/MBtu (>10,000 MBtu/h before 1970); $1.028I^{-0.234}$ lb/MBtu (100<I<250 MBtu/h 1970-1985); 0.10 lb/MBtu (>250 MBtu/h after 1970); 0.30 lb/MBtu (<100 MBtu/h after 1985); 0.15 lb/MBtu (100-250 MBtu/h after 1985). MBtu/h	0.2 gr/dscf (existing fuel burning equipment); 0.1 gr/dscf (new fuel burning equipment).	0.05 gr/dscf (boiler built after 1983); 0.1 gr/dscf (fuel burning equipment built before 1983). Limits are @ 7% O_2.
SO_2		1.8-4.0 lb/MBtu heat input for fuel burning equipment (depending on the county).	1.10-2.75 lb/MBtu (existing >250 MBtu/h); BACT (existing <250 MBtu/h).	2.5% S by weight (boiler <100 MBtu/h); 3% S by weight (boiler ≥100 MBtu/h).	2000 ppmv (3-h) (applies to general process equipment).		5 grains H_2S per 100 scf.		1000 ppmv @ 7% O_2 (1-h).

a. Where applicable, the averaging period is specified for the emission limit. For example, a 3-h emission limit of 95 ppmdv means that the average arithmetic mean of the measured emission over a 3-h period must not exceed 95 ppmdv.

9. ANNEX 3: MILL PERMIT SUMMARIES

Mill A

1. Mill discharges to a marine environment. The mill's new permit applied to a new diffuser located in deep water, rather than the previous shallow diffuser.
2. In developing the permit conditions, the permit writers set out to ensure that critical water quality standards would not be exceeded. Pertinent to the application it was deemed that:
    - a dissolved oxygen content of 5 mg/l be maintained in the receiving water
    - no measurable temperature increase (0.3°C) be permitted in the receiving water if the temperature will exceed 19°C .
    - That toxic material concentrations shall be below those that affect water uses, cause chronic or sub acute effects, or affect public health.
    - that aesthetic values be maintained.
3. The permit writers screened the permit application. With respect to pollutants that may affect human health, no compounds were present in amounts that could cause human health water quality criteria to be exceeded.
4. With respect to compounds causing acute water quality effects, the authorities reviewed all the water quality monitoring data submitted. They deemed that compounds that were present at concentrations of half the federal acute water quality parameters were a concern. Soluble copper fell into this category. Hence a soluble copper discharge limit is included. The review also noted that a number of compounds were present in the effluent that may be of concern. These consisted of chlorinated organics (AOX), chloroform, phenol, methylphenols, chlorophenols, resin acids and polyclinic aromatic hydrocarbons (PAHs). The permit therefore include clauses requiring these compounds to be analysed in the influent, effluent, sediment and particulate.
5. The permit set effluent discharge limits for:
    - BOD_5 and TSS (daily maximum and monthly average) on the basis of given production rates in permit applications and the values for the applicable process categories in the EPA Guidelines. Relevant to the incremental production NSPS limits were applied versus BCT limits for the rest of the mill.;
    - Soluble copper limits of 48 mg/l monthly average, and 59 mg/l daily maximum to ensure that the water quality criteria is not exceeded outside a given dilution zone, and accounting for background copper levels.
    - pH values of between 5.4-9.0
    - An Interim Control Program was set for dioxin and AOX based on changes the mill was implementing. This had to be complied with by 8 March 1994. Relevant to this control limits were set of:
    - 1.85 ppq for 2,3,7,8-TCDD;
    - 1.5 kg /t for AOX as a monthly average based on brown stock fed to the bleach plant; and kg/t for AOX on a daily maximum.
6. With respect to monitoring the following requirements were set:
    - BOD and TSS daily;
    - Soluble copper weekly; and
    - pH, flow and temperature continuous.
7. The mill was instructed to fund and participate in a program to develop chronic tests for marine species. In the interim for the completion of these studies, the mill was instructed to conduct chronic tests on two freshwater marine species and oyster larvae.
8. In addition the mill has to conduct tests on
    - particulates in the effluent;
    - sediment constituents;
    - acute toxicity on three species once per year;

- chronic toxicity, as noted previously; tests at the edge of the mixing zone to confirm the dilution ratios; and studies of the influent and effluent compositions to document the fate of pollutants.

Mill B

1. Applies to an integrated bleached kraft pulp and paper mill with stone ground wood, thermo-mechanical pulp and coating operations.
2. Permit was of a shorter duration than normal. The period was shortened so all permits on a river basin expired at the same time.
3. Discharges effluent to a river with a 7-day Q_{10} and a mean annual flow of 1 230 and 4 948 cubic feet per second. Treated effluent is discharged at an average rate of 27. 9 million gallons per day. This is equivalent to 41.4 cubic feet per second
4. The permit sets limits for:
    - BOD and TSS on a daily maximum and a monthly average basis. These are calculated on the basis of the different categories of pulp and paper produced, times the unit allowances for those categories in the EPA Guidelines. This uses the BCT or the NSPS values based on the vintage of the process operations.
    - With respect to permissible BOD releases for the periods May to October, lower limits may apply depending on the flow of the river and its temperature in the previous day. Tables of temperature and river flows are developed to calculate the permissible BOD releases. These are based on maintaining the dissolved oxygen contents.
    - Phosphorous in terms of mg/l on a monthly average basis, and an annual mass discharge rate. These limits were developed to implement the states antidegredation policy.
    - a cadmium discharge limit of 0.46 lb. per day. This was estimated based on the concentrations following dilution at the site of the present outfall. The effluent was to be moved to another discharge point by a set date. Following this action better dilution will be afforded and this water quality based limit will no longer apply.
    - the pH has to be between 5.0-9.0.
5. Monitoring consists of :
    - Effluent flow, pH and temperature, continuous;
    - BOD and TSS, daily;
    - phosphorous, monthly; Cadmium monthly until the clause expires; 5.0 and 9.0;
    - A 2,3,7,8-TCDD limit of 0.73 mg/d is applied
    - Temperature limits of 120°F and 95°F are placed on pump water and cooling water streams respectively.
    - nitrogen. Ammonia and nitrite plus nitrate nitrogen, continuous during the summer low flow period;
    - 2,3,7,8-TCDD and 2,3,7,8-TCDF monthly for a 24 month period and every 6-months thereafter.
6. In addition a number of acute toxicity and chronic toxicity tests have to be performed on the whole effluent between specified period in the life of the permit. This is done to provide data on which to establish the effect of discharges on the receiving water.
7. The permit also includes conditions under which the mill may landspread its effluent treatment plant sludges on land. Limitations are applied with respect to the application rate in wet tons per acre, the nitrogen , chloride, dioxin , cadmium and specified metal contents. Samples have to be taken of the sludge applied and the soil to which it is applied.
8. Prohibitions are placed on applying sludge to livestock grazing lands, land where certain wild life species exist and within 1200 feet of a public water supply.
9. Approval is given to spread at designated sites with the mill being allowed to make applications for additional sites.

Mill C

1. The permit applies to an integrated bleached kraft fine paper mill with tall oil, turpentine, lumber and particle board by-products operations. This permit has no expiration date. Compliance date - 04/02/94.
2. The receiving water is the Blackwater River, a small river flowing into the Chowan and Dismal swamps and Chowan River. The waters in this river are classified as Section 1, Class II.
3. The mean flow, as reported in permit VA 0004162, is 103 MGD and the 7 day Q_{10} is 1.36 MGM.
4. The discharge from the outfall 001 is limited in the following manner:
    - discharge schedule was adjusted to minimise the effect on receiving stream;
    - discharge schedule was regulated so that the dissolved oxygen (DO) standards in both the states of Virginia and North Carolina are maintained at all times. A monthly report of instream DO levels must be submitted during release months to ensure that North Carolina and Virginia guidelines are met;
    - discharge period was limited to the months of November, December, January, February and March;
    - waste flows from the plant site are collected and discharged through a primary clarifier or aerated stabilisation basin.
5. There are limits set for the following:
    - Flow (daily)
    - BOD_5 (daily) - 30 mg/L average, 57 mg/L maximum
    - BOD_5 average - 25485 lb/day, maximum - 49075 lb/day
    - TSS (daily) - 59 mg/L average, 110 mg/L maximum
    - TSS average - 50614 lb/day, maximum - 94190 lb/day
    - Colour (PCU) (weekly)
    - Total Nitrogen (weekly) NL average and maximum
    - Total Phosphorus (weekly) - 2.0 mg/L average, 0.27×10^6 lb/season
    - The pH of the discharge should lie between 6.0–9.0. (daily)
    - There should be no discharge of floating solids or visible foam in other than in trace amounts.
6. Biological and Chemical Testing:
    - Annual Acute Toxicity Testing using Ceriodaphnia dubia (annually)
    - Two sets of chronic tests using C. dubia and Pimephales promelas (annually)
    - Pesticides and PCBs using EPA method 608
    - A minimum detection limit (MDL) of priority and non-priority extractable pollutants and volatile organics.
7. Dioxin Monitoring Program
    - Implementation of an effluent monitoring program to determine dioxin and furan concentrations in the wastewater discharged from the aerated stabilisation basin year round and outfall 001 during the discharge season.
    - 24 hour composite samples collected monthly and analysed for 2,3,7,8-TCDD and 2,3,7,8-TCDF using a method equivalent to EPA method 1613.
    - Target analytical detection limit is 10 ppq.
    - The limitations for dioxins is 0.056 ppq (4.9×10^{-6} kg/day) based on a monthly grab sample.
    - The limitations for furans is no limit (NL) maximum.(reporting is required).

Mill D

1. Permit for a manufacturer of bleached market pulp with a production capacity of 1626 tons per day. The $7Q_{10}$ flow is 440 cfs. The receiving water is the Leaf River.
2. Currently the mill has screening, primary, and secondary clarification and extended aeration practices in place to reduce pollution. The discharge is classified as 001 process wastewater.
3. All test samples should be taken at the nearest accessible point after final treatment but prior to mixing with the receiving water. The following parameters are limited and monitored.

Parameter	Daily Average	Daily Maximum	Measuring Frequency	Sample Type
Flow	—	—	Continuously	Recorder
TSS	14013 kg/day 30894 lbs/day	26846 kg/day 59186 lbs/day	3 days per week	24-hour Composite
BOD_5	8113 kg/day 17886 lbs/day	—[1]	3 days per week	24-hour Composite
Colour	50 C.U.	65 C.U.	twice per week	
Dioxin	40 ppq [2]	76 ppq [2]	quarterly	72-hour Composite

1. This value is dependent on the flow and the temperature of the water. For example, a flow of 500 cfs and a temperature greater than 28°C, the daily maximum allowable BOD_5 is 3300 lbs/day whereas a flow of 1250 cfs and a temperature less than 16°C, the daily maximum allowable BOD_5 is 33496 lbs/day. The daily BOD_5 value cannot exceed 33496 lbs per day or the value contained within Table #1 in permit #MS0031704, whichever is less.
2. This value represents the quarterly average and maximum.

4. The pH must not be less than 5 and must not exceed 8.5. The total time during which pH values are outside of the specified pH range shall not exceed 7 hours and 26 minutes during any one calendar month. No individual deviation from the average range must not exceed 60 minutes.
5. There must not be any discharge of floating solids or visible foam, nor should there be any occurrence of visible sheen on the surface of receiving waters.
6. Dissolved oxygen, pH, temperature, and colour of Leaf River must be monitored both upstream and downstream from the discharge point at a frequency of twice per week.
7. Dioxins and furans must be monitored once per quarter with 72 hour composite sample at the following points using EPA method 8290:
    - influent to wastewater treatment facility
    - sludge
    - landfill leachate
    - final effluent
8. The chloro-benzo dioxin and furan levels in ambient fish tissues downstream of the discharge must be sampled and tested annually.
9. WQS in Mississippi require that all waters be free from substances in concentrations which are harmful to humans, animals, or aquatic life. The following parameters were tested prior to the permit and all were found to pass all requirements:
    - Chromium (Cr) - 0.267 mg/L average, 0.69 mg/L maximum
    - Cadmium (Cd) - 0.011 mg/L average, 0.09 mg/L maximum
    - Zinc (Zn) - 0.06 mg/L maximum
    - Phenol - 0.09 mg/L maximum

Mill E

1. The discharge from this mill is classified as 001 - treated process, sanitary and storm waters from process areas.
2. All samples are collected at the nearest accessible location just prior to discharge and after final treatment.
3. The following parameters are tested:

The following table shows the limitations during the period from November 1st to April 30th.

Parameter	Units	Daily Minimum	Daily Maximum	Monthly Average	Measurement Frequency	Sample Type
Flow	NGD	—	Monitor	Monitor	daily	Totalised
pH	s.u.	6.0	8.5	—	daily	Grab
BOD_5	lbs/day	—	33651	18266	daily	24-h Composite
TSS	lbs/day	—	52715	27897	daily	24-h Composite
PCP[1]	lbs/day	—	5.9	5.9	daily	24-h Composite
TCP[1]	lbs/day	—	37	37	daily	24-h Composite
Dioxin	lbs/day	—	0.00029	—	quarterly	24-h Composite
Dioxin	ppq	—	Monitor	—	quarterly	24-h Composite

1. These values are based on initial permit requirements. Initially, the company is required to monitor it.

The following table shows the limitations during the period from May 1st to October 31st.

Parameter	Units	Daily Minimum	Daily Maximum	Monthly Average	Measurement Frequency	Sample Type
Flow	NGD	—	Monitor	Monitor	daily	Totalised
pH	s.u.	6.0	8.5	—	daily	Grab
BOD_5	lbs/day	—	22389	12442	daily	24-h Composite
TSS	lbs/day	—	52715	27897	daily	24-h Composite
PCP[1]	lbs/day	—	5.9	5.9	daily	24-h Composite
TCP[1]	lbs/day	—	37	37	daily	24-h Composite
Dioxin	lbs/day	—	0.00029	—	quarterly	24-h Composite

The quantity of discharge used to calculate the mass discharged shall be the average of all daily process wastewater discharges occurring in the past 12 months of mill operation. Zero process discharges are not included in calculation of average daily flow.

4. There must be annual collection and testing of fish tissue for dioxin and lipid content. One six fish composite sample of each a predator and an omnivore or bottom feed at the following locations must be taken:
    - 3-5 miles from the discharge site
    - 9-12 miles from the discharge site
    - as close to a dam as possible (if a dam is located less than 9 miles from the discharge site

    All fish samples must be collected between September and November.

5. Dioxin levels are tested using EPA method 1613. If dioxin is not detected, it should be reported as being less than detectable. This should be written as, i.e. <10, where 10 is the detection limit. All non-detections are considered to be zero.

Mill F

1. Permit for a manufacturer of paper products such as toilet tissue, napkins, non-woven and paper fibres and paper towels which are made by deinking waste papers. Auxiliary facilities that also exist are diaphragm-cell chlor-alkali plant, towel dispenser machine shop, and a 70 MW coal fired co-generation power plant.
2. The permit became effective on September 28, 1989 and expired in August 31, 1994.
3. The output of this plant is as follows:
    - 992.8 tons per day (TPD) sanitary paper from deinked pulp
    - 4.4 TPD of sanitary paper products from purchased pulp
    - 24.6 TPD caustic soda
    - 23.2 TPD (as Cl_2) of Calcium Hypochlorite
4. Existing decontamination equipment:
    - Primary clarification - 27 MG clarifier
    - 5 Concrete lined aeration basins
    - Secondary clarifier

Effluent Characteristic	Daily Effluent Limitations					Monitoring Requirements	
	Quantity kg/day (lbs/day)		Other Limitations (Specify units)				
	Average	Maximum	Minimum	Average	Maximum	Sample Frequency	Sample Type
Flow (MGD)	—	—	—	—	—	Daily	Continuous
BOD_5	7046 (15539)	13539 (29854)	—	—	—	Daily	24-h comp
TSS	9547 (21051)	17772 (39189)	—	—	—	Daily	24-h comp
pH (s.u.)	—	—	5.0	—	9.0	Daily	Continuous
Temperature (°F)	—	—	—	—	—	Daily	Grab
PCB	(0.019)	—	—	0.17 µg/L	—	2x-Weekly	24-h comp
Ammonia (mg/L as N)	—	—	—	—	—	Monthly	24-h comp
Kjeldahl Nitrogen (mg/L as N)	—	—	—	—	—	Monthly	24-h comp
Nitrite Nitrogen (mg/L as N)	—	—	—	—	—	Monthly	24-h comp
Phosphorus, Total (mg/L as P)	—	—	—	—	—	Weekly	24-h comp
Whole Effluent Toxicity	—	—	—	—	—	3x -Yearly	Bioassay
Aluminum, total recoverable	—	—	—	—	—	Monthly	24-h comp
2,3,7,8-TCDD	—	—	—	—	—	Quarterly	24-h comp
2,3,7,8-TCDF	—	—	—	—	—	Quarterly	24-h comp

The daily quantity of BOD_5 is further limited during the months of May through October inclusive annually. The value of the limit can be determined from tables contained within the permit. These tables outline limit values that are dependent on the temperature of the previous day and the flow rate of the

previous 4 days average. A low temperature and high flow has the highest BOD_5 limit whereas a day with a high temperature and low flow has the lowest BOD_5 limit.

For example, in the month of June, on a day with a temperature of 86°F and a flow of 750 cfs, the maximum allowable daily BOD_5 is 16681 lb/day. On a June day with a temperature of 41.0°F, and a flow of 8001 cfs, the maximum allowable daily BOD_5 is 42756 lb/day. The chart value depends on the month of the year, temperature and the flow.

The sum of the actual daily discharges of BOD_5 for any 7 consecutive day period may not exceed the sum of the daily point source values from the tables for those same 7 days. For any one day period, the actual discharge of BOD_5 may not exceed 134% of the value obtained from the table for similar conditions.

5. There shall be no discharge of floating solids or visible foam in other than trace amounts.
6. TCDD and TCDF monitoring is done using EPA 440/1-88-025, March 1988, with a detection limit of 10 pg/L or less.
7. Chronic Toxicity test must be done once every 4 months for the fist two years of the permit and annually for the remainder of the permit. Each set of chronic toxicity tests shall be performed on at least two freshwater test species, including one vertebrate and one invertebrate. Fathead minnows (Pimephales promelas) and Ceriodaphnia dubia are used as the test species. The procedure to be used is outlined in EPA/600/4-85/014. Toxicity is indicated if less than 80% of the test organisms survive.
8. Acute Toxicity tests must be performed annually for the term of the permit. Each set of acute toxicity tests shall be performed on at least one freshwater test species as outlined in EPA/600/4-85/013. Ceriodaphnia dubia is the test species used. Toxicity is indicated by less than a 90% survival rate of the control.
9. The testing for PCBs is performed so that the company may develop of study plan to reduce PCBs with the ultimate goal of achieving zero detection.

Mill G

1. Facilities include:
   - Kraft and Thermo-mechanical Pulp and Paperboard Mill
   - Chlor-Alkali Plant
   - Wood Products
   - Newsprint Deinking
   - Inorganic Chemical
2. Discharge into Columbia River.
3. Permit effective date - 05/10/91
   Permit expiration date - 05/10/96
   Permit compliance date - 03/08/94
4. There is a TSS allowance of 400 lbs/day (monthly average) and 800 lbs/day (daily maximum) for the mill's 001/002 outfall. This is based on the best engineering judgement determination of the Best Conventional Technology.
5. Limitations from the discharge in outfall 001/002 following modernisation of the mill.

PARAMETER	EFFLUENT LIMITATIONS		MONITORING REQUIREMENTS	
	Monthly Average	Daily Maximum	Frequency	Sample Type
Dioxin (2,3,7,8-TCDD) and AOX	<10 ppq, 1.6 Kg/t	—	—	—
BOD_5 (lbs/day)	31417	58760	Daily	24-h Comp.
TSS (lbs/day)	51806	98789	Daily	24-h Comp.
pH	5.0 – 9.0	5.0 – 9.0	Continuous	Recording
Flow, MGD	—	—	Continuous	Recording
Temperature, °F	—	—	Continuous	Recording
Fecal Coliform	—	—	Annual	Grab

6. The chlorine plant discharges to the pulp mill outfall (001/002) at a junction just prior to the outfall entering the Columbia River. The effluent limitations must be met prior to this junction and are based on Best Available Technology (BAT) as promulgated June 29, 1982 by the EPA, and Best Conventional Technology (BCT).
7. pH values between 4.0 and 10.0 are not considered violations provided no single excursion exceeds 60 minutes in length and the total excursions do not exceed 7 hours and 26 minutes per month. Any excursion below 4.0 or above 10.0 is a violation.
8. There shall be no discharge of visible foam or floating solids in other than trace amounts.
9. Chlorine plant discharge (prior to junction with pulp mill discharge):

Parameter	Effluent Limitations		Monitoring Requirements	
	Monthly Average	Daily Maximum	Frequency	Sample Type
Total Chlorine Residual (lbs/day)	6.7	11.0	Continuous	Recording
Copper (lbs/day)	4.1	10.2	Semi-annually	Composite
Lead (lbs/day)	2.0	5.0	Semi-annually	Composite
Nickel (lbs/day)	3.1	8.2	Semi-annually	Composite
TSS (lbs/day)	189	503	Quarterly	Composite
Flow, MGD	—	—	Continuous	Recording

- If the instantaneous total chlorine residual exceeds 5.0 mg/L, a written report of the incident must be submitted to Ecology.

10. During the term of the permit the mill is allowed to discharge filter backwash and sediments from the existing raw water treatment system to the Columbia River. The basis for this is the unique suspended solids loadings in the intake of water caused by the eruption of Mt. Saint Helens. This will be reviewed in 1996.
11. Acute Salmonid Bioassay - the discharge after secondary treatment should allow at least 80 percent survival of salmonid test fishes in a minimum of 65 percent concentration of treated effluent for a 96 hour period. These should be collected quarterly. If the test fails, the bioassays are then conducted monthly for three consecutive month. All three of theses tests must be passed before returning to quarterly testing.
12. No measurable temperature increase of (0.3 °C) in the receiving water is permitted.
13. Dioxin and Chlorinated Organics:
    - TCDD and TCDF 24-h composite tests on effluent will be done quarterly
    - AOX 24-h composite test on effluent will be done weekly
    - TCDD and TCDF grab tests on sludge will be done quarterly
    - TCDD and TCDF are analysed using EPA Method 1613
    - SCAN-W 9:89 protocol analytical method is used to analyse AOX
    - TCDD daily maximum - 0.56 mg/day* (4.2 ppq daily max, 2.55 year average).

*This value is derived based on the statistical method presented in the EPA Technical Support

Document for Water Quality-based Toxics Control. The basis of the derivations are:

- a log-normal distribution for TCDD effluent data
- a coefficient of variation of 0.6
- effluent occurrence probability of 0.05 (the 95th percentile)
- detection limit for TCDD 10 ppq or less
- AOX annual average(average of the monthly maximum values for 12 calendar months) - 1.3 kg/ADMT of bleached pulp
- AOX monthly maximum (Average of the weekly values for the month)- 1.6 kg/ADMT of bleached pulp
- bioaccumulation monitoring - done in year 4 of the permit to determine if there is any bioaccumulation of dioxin and furan.

Mill H

1. Permit effective date - April 7, 1992, expiration date - April 7, 1997
2. The receiving waters of this mill are the Snake and Clearwater Rivers.
3. Limited and monitored discharges are outlined in the table below:

Parameter	Discharge Limitations		Monitoring Requirements		
	Monthly Average	Daily Maximum	Frequency	Sample Type	Sampling Point
BOD_5 (River flow ≥22000 cfs) lb/day	22800	43800	Daily	24h Composite	Final Effluent
BOD_5 (River flow <22000,≥20000 cfs) lb/day	18900	36300	Daily	24h Composite	Final Effluent
BOD_5 (River flow <20000≥18000 cfs) lb/day	15100	29000	Daily	24h Composite	Final Effluent
BOD_5 (River flow<18000 ≥16000 cfs) lb/day	12800	24600	Daily	24h Composite	Final Effluent
BOD_5 (River flow <16000≥14000 cfs) lb/day	10600	20400	Daily	24h Composite	Final Effluent
BOD_5 (River flow <14000 cfs) lb/day	9800	18800	Daily	24h Composite	Final Effluent
TSS lb/day	43400	80700	Daily	24h Composite	Final Effluent
Temperature (°F)	—	92	Continuous	N/A	Final Effluent
Total Phosphorus (mg/L)	—	—	Monthly	24h Composite	Final Effluent
Total Ammonia (mg/L as N)	3.0	5.4	Weekly*	24h Composite	Final Effluent

*Sampling frequency of ammonia should be daily when ammonia is added to the treatment system. At other times, sampling for ammonia should be weekly.

4. The heat discharge rate cannot exceed the Snake River flow at diffuser in cfs multiplied by 593000 BTU/cfs day.
5. The following compounds are monitored quarterly (24-h composite samples). If after one year, all compounds in any one groups listed below are non-detect, monitoring for that group may be discontinued:
    - Resin Acids
    - Fatty Acids
    - Chlorophenols
    - Guaiacols
    - Catechols
    - Miscellaneous Organics
6. Toxicity testing using Ceriodaphnia dubia (water flea) and Pimephales promelas (fathead minnow). It should include a series of 6 test solutions, and shall determine the NOEC (no observable effect concentration) of the effluent control water. The NOEC is the concentration of effluent for which there is not statistically significant difference in response (at the 95% confidence level) between the test and control organisms. Quality assurance in accordance with EPA/600/4-85-013, EPA/600/4-89/001 and EPA/600/4-78-043.
7. TCDD and TCDF must be monitored and a plan devised to reduce the emissions. The objectives of the plan are to reduce, to the maximum extent practical, formation of TCDD, TCDF and AOX in pulping and bleaching operations through process changes and process modifications and to reduce the discharge of

TCDD, TCDF and AOX through changes in wastewater treatment system operations. A 24-h composite sample must be taken quarterly and the following locations:

- Each Bleach Line
  - fully bleached pulp (grab samples every 8 hours)
  - combined bleach plant wastewater prior to mixing with other process wastewater and non-contact cooling waters in the mix basin
- Wastewater Treatment Sludge
  - secondary sludge (when removed from the wastewater treatment system)
  - primary sludge
- Final Effluent
  - final treated process wastewater effluent prior to discharge and prior to mixing with non-contact cooling waters

8. The above samples are analysed for TCDD and TCDF using EPA method 1613, for AOX using EPA method 1650, SCAN-W 9:89 or ISO/DIS 9562. A value of non-detect is computed as one-half of the detection value.
9. Best Management Practice (BMP) plans should be developed to prevent, or minimise release of pollutants.
10. A plan must be made by the mill within 60 days of the effective date. This plan should include:
    - monthly monitoring of metals and quarterly monitoring of turbidity in both Clearwater and Snake Rivers.
    - weekly monitoring of dissolved oxygen, travel time/velocity, temperature, pH, and nutrients at 5 specified locations (4 in Snake River and 1 in Clearwater River) during the time between July 15 to October 15.
    - BOD_5 samples shall also be collected weekly at one location in each Snake River and Clearwater River during the time between July 15 and Oct 15.
    - The above samples should be analysed for total recoverable and dissolved metals and acid soluble selenium.

Mill I

1. Effective date of the permit is 25 October 1989. The expiration date is 24 October 1994 and the compliance date is 04 June 1992.
2. Receiving water - Pigeon River. Outfall 001 - treated process wastewater
3. Type of facility: Integrated bleached kraft pulp and paper manufacturing facility producing food board and fine paper.
4. The first table outlines some effluent limitations and monitoring requirements in the permit analysed. Note subsequent to the analysis a new permit was issued. The second table summarises the new effluent limits:

Parameter	Discharge Limitations				Monitoring Requirements	
	kg/day (lbs/day)		Other Limits		Measurement Frequency	Sample Type
	Monthly Avg	Daily Max	Daily Avg	Daily Max		
Flow	—	—	29.0 MGD	—	Continuous	Recorder
BOD_5	2942 (6472)	5663 (12458)	—	—	Daily	Composite
TSS	19096 (42012)	35538 (78184)	—	—	Daily	Composite
TCDD	—	—	0.1 pg/L	—	Quarterly	Composite

Parameter	Discharge Limitations			
	kg/day (lbs/day)		Other Limits	
	Monthly Avg	Daily Max	Daily Avg	Daily Max
Flow	—	—	29.9 MGD	—
BOD_5	2942 (3598)	5663 (12458)	—	—
TSS	5704 (12549)	10240 (49560)	—	—
TCDD	—	—	0.1 pg/L	—

5. All effluent samples should be taken at the nearest accessible point after final treatment but prior to actual discharge or mixing with the receiving waters.
6. There shall be no discharge of floating solids or visible foam in other than trace amounts.
7. The monthly in-stream temperature (measured at a point 0.4 miles downstream) should not exceed 32°C during the months of July, August and September and shall not exceed 29°C during the months October through to June.
8. The concentration of dissolved oxygen should not be less than 6.0 mg/L.
9. The pH of the effluent should be between 6.0 and 9.0.
10. Chronic no observable effect level (NOEL) of the discharge should be less than 85%. (based on 7Q10 flow value of 52.7 cfs)
11. The average daily dissolved oxygen concentration shall not be less than 5.0 mg/L and the instantaneous minimum dissolved oxygen concentration shall not be less than 4.0 mg/L.

12. A limitation for chloroform was incorporated to protect human health. Using the mean annual flow of the Pigeon River at the point of discharge, the effluent limit of 3.3 mg/L was set as the daily average chloroform concentration.

It is noted that this mills permit has changed since this report was written. Under temperature, a maximum change of 13.9 ^{0}C was set for the river water. BOD fell to 3598 lb/day on a monthly average. This was driven by water quality standards. The dissolved oxygen content of the effluent has to be greater than 6.0 mg/l.