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Environmental considerations related to building a new Eucalyptus marked pulp mill in Uruguay

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PFI – REPORT

Paper and Fibre Research Institute

Title

Environmental considerations related to building a new Eucalyptus marked pulp mill in Uruguay

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Summary

Metso-Botnia is planning to build a mill for producing bleached eucalyptus pulp in Uruguay. In this respect, the Uruguay government wanted a third opinion on the consequences of running the operation in the country. PFI was going to deliver a brief report including the following topics 1) Characteristics and environmental profile of Metsä Botnia 2) Characteristics and environmental profile of a similar Eucalyptus marked pulp mill and 3) emission levels of modern kraft mills.

Environmental profile of Botnia
Marked pulp producers in Scandinavia have been leading the development of a new environmental technology in the pulp and paper industry due to strict national/regional regulations and marked demands. Hence, Scandinavian mills have strong focus on environmental profile and their emission levels. On average, emission levels from mills in Scandinavia are lower than in other parts of the world. With respect to emission levels, Botnia pulp mills perform well compared to other Scandinavian pulp mills. Hence, Botnia pulp mills are modern and have a strong focus on emission levels. Today, Botnia do not produce marked pulp from Eucalyptus wood.

Characteristics and environmental profile of a Eucalyptus marked pulp mill
Aracruz Celulose in Brazil is the world's leading producer of marked pulp from Eucalyptus. With two mills only, the Company is responsible for 28% of the global supply of the product. Aracruz mills are modern and have modern emission levels. However as the Aracruz mills are so huge (overall production about 2.400,000 million tons pulp a year) that the mills should have the best environmental technology available to minimize the emission levels.

Recommendations related to permitting building of a large Eucalyptus pulp mill in Uruguay

- Botnias application for permission to discharge effluents to receiving waters in Uruguay should contain the same main points which are included in such applications in Finland. The main points which should be included in the application are:
  1) Technical information on the process (process description, estimated effluent loadings, measures for reducing the loading)
  2) Description of the receiving water (water state and expected changes in it, the suitability of the water for various uses and how this will be affected, cost of reducing discharges, names water owners, ways known to the applicant of completely preventing the expected adverse effects).
- The mill should be built with the Best available techniques (BAT) for kraft pulp process as described in he final draft of Best Environmental Practice (BREF) in the European Council IPPC[1] Directive (96/61/EC) for the Pulp and paper Industry.
- Emission levels should not exceed the emission levels set in the IPPC Directive or the emission levels of similar Eucaluptus pulp mills as Aracruz Celulose. In this case emission levels are particular importance since:
  1) The receiving waters is a river and the recipient point is located quite far from the ocean
  2) The mill planned is large (i.e higher total effluent load)
  3) The recipient river, Uruguay River, is the natural borderline between Uruguay and Argentina.

Fagområde	**Søkeord**
Pulp, Paper	Emissions, legislation, Eucalyptus pulp, marked pulp, COD, AOX, BAT, BREF,

[1] Integrated Pollution Prevention and Control

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BACKGROUND

Scope of this report

Metsä-Botnia is planning to build a mill for producing bleached eucalyptus pulp in Uruguay. In this respect, the Uruguay government is interested in a third opinion about the consequences of running the operation in the country.

PFI was contacted by Miriam Ferraz from the Fermar Associates in Oslo, Noway, and it was agreed that PFI was going to deliver a brief report including the following topics:

- Characteristics of Oy Metsä Botnia pulp mills and their environmental profile
- Characteristics of a similar Eucalyptus marked pulp mill (Aracruz in Brazil)
- Emission levels of modern kraft mills

Botnia pulp mill project in Uruguay

Botnia has started to assess prospects for starting a mill for production of 1.000,000 million tons bleached eucalyptus pulp per year in Uruguay, and has set up a company called Botnia S.A. for this purpose. Fray Bentos in Western Uruguay, a town with 20.000 inhabitant, has been chosen as the site of the planned pulp mill. As the map in Figure 1 shows, Fray Bentos is located by Uruguay River which is the natural borderline between Argentina and Uruguay.

A decision on whether to go ahead with the construction of the mill will be possible at the end of 2004 when all the necessary studies have been completed and the relevant permits granted. The schedule depends also on the general economic situation. Investment costs are estimated to 1,000 millions USD.

Figure 1: Map of Uruguay

Together with UPM, Botnia owns a company called FOSA in Uruguay, specialized in eucalyptus cultivation. FOSA owns ca. 100.000 hectares of land, of which 60.000 is good-quality eucalyptus forest that has been planted on grassland. FOSA is one of the three big forest owners in Uruguay and its plantations are situated near our intended pulp mill site at Fray Bentos. At present, the plantations produce over one million cubic metres of wood. The aim is that one half of the planned pulp mill's wood requirement comes from FOSA and the rest from private forest owners. The mill's wood consumption is approx. 3,5 millions of m^3.

EFFLUENT LOADINGS AND STATUS FOR THE ENVIRONMENTAL TECHNOLOGY FOR THE PULP AND PAPER INDUSTRY

Effluent loadings from the forest industry

In terms of their chemical composition, effluents are still not completely understood, particularly those arising from chemical pulp production. In the case of bleaching effluents, for example, only 10-30% of the compounds present have so far been identified. This naturally causes difficulty in making a proper assessment of the effects of such effluents and to choose the most appropriate methods of treatment. Attempts to characterize effluents have normally involved methods of measurement developed to serve the needs of effluent treatment technology. While this practice is basically sound, it has obvious shortcomings. Whatever method of measurement is used, mention should be made of the analytical method (standard) concerned. Despite progress in standardization, comparisons between one country and another are still difficult.

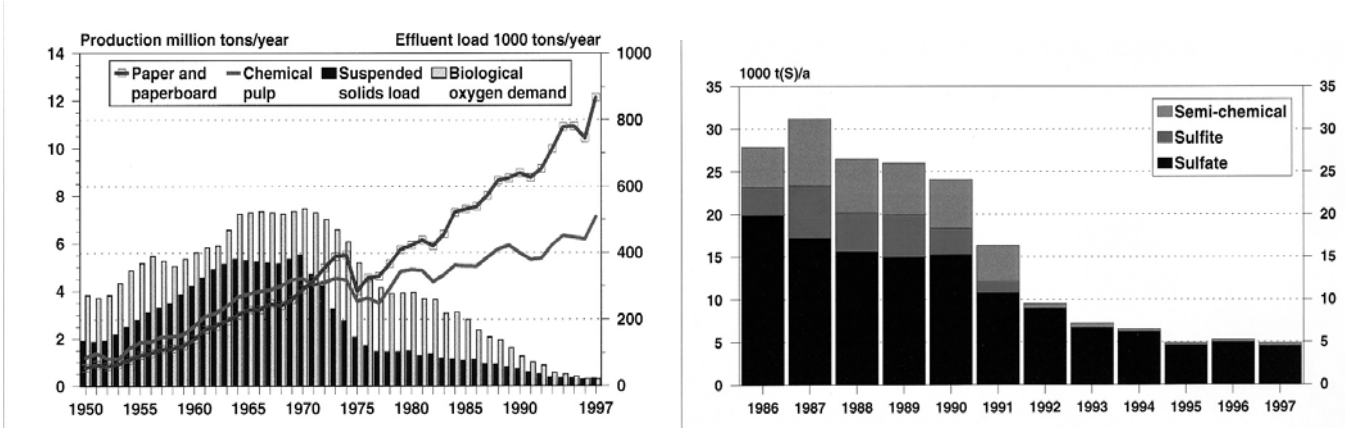
The most common measurements used for characterizing effluents are BOD, CODCr, Suspended solids, AOX, Chloro-organic compounds, Nitrogen, Toxicity, Color and phosphorus, see explanations below. These effluent parameters are known to correlate with the impact on the receiving water.

BOD:	Biological oxygen demand. In Finland BOD is measured and quoted as BOD7 which means the amount of oxygen required by microbes to break down wastes over a period of seven days.
COD_{Cr}	Chemical oxygen demand (CODCr) is a measure of the amount of oxygen consumed in the chemical decomposition of waste. CODCr reflects more than just the amount of organic matter present and should not be used as the sole measure of "organic" matter content as often seems to be the case.
Suspended solids	suspended solids content of effluent is frequently determined using a GF/A filter with a nominal pore size of 1.6 mm
AOX	AOX is a measure of the halogens present in organic matter; in the case of forest industry effluents, the halogen is almost entirely chlorine.

Developments in environmental technology the last decade

Remarkable developments in reducing emissions to air, water and solid waste have been demonstrated by the pulp and paper industry in the 1990's. The work has largely concentrated on pollution prevention through low effluent process technologies as well as efficient effluent treatment. Tight control of water use and water recycling requires special systems and methods for metal management, chloride control, balancing of chemicals, solid waste handling, etc.

Effluent loadings and sulfur emissions from the Finnish forest industry for in the period 1950 to 2000 is shown in Fgure 2.

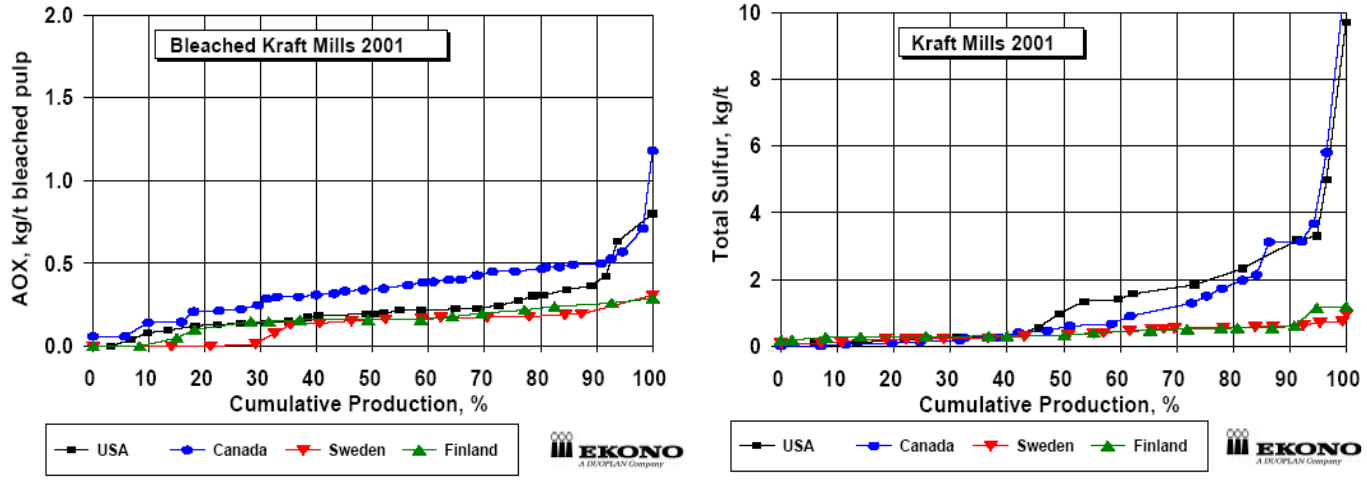


a) b)

Figure 2 a) Effluent loadings (BOD, suspended solids) and production from the Finnish forest industry in the period 1950-2000 b) Sulphur emissions from Finnish pulp mills the last 10 years (Hynninen 1998)

The Scandinavian situation

Due to strict national or regional regulations as well as marked demands, marked pulp producers in Scandinavia has been leading the development of a new environmental technology in the pulp and paper industry. Hence, Scandinavian mills have strong focus on environmental profile and their emission levels. On average, emission levels from mills in Scandinavia are lower than in other parts of the world, see Figure 3.



a) b)

Figure 3 a) AOX Discharges from Bleached Kraft Pulp Mills in 2001 b) Total Sulfur Air Emissions from Bleached Kraft Pulp Mills in 2001.

Source: EKONO Inc "Environmental Performance, Regulations and Technologies in the Pulp and Paper Industry (2003). Th EKONO 2003 issue includes an assessment of the BAT applied in the mechanical pulp and paper industry and describes the “Best Performing Mills”, selected from EKONO’s database, including selected Swedish, Finnish, Canadian and US mills. The documentation includes a description of the mills and the measures taken to become one of the best performers. Both older mills and newer mills are reviewed.

Botnia pulp mills - Characteristics and environmental status

Oy Metsä-Botnia Ab - Characteristics

Oy Metsä-Botnia Ab is Europe's second largest pulp producer. Botnia's softwood, birch and aspen pulps are ideally suited for the production of high-quality printing and writing papers, packaging boards and tissue. Today, Botnia do not produce marked pulp from Eucalyptus wood.

Botnia's five mills are located in different parts of Finland, at Joutseno, Kaskinen, Kemi, Rauma and Äänekoski. It total the mills have a total combined production capacity of 2.7 million tonnes a year of ECF and TCF bleached pulp. About eighty per cent of production is sold to the paper mills of Botnia's owners, while the other 20 per cent is sold on the market, mainly in Europe. Botnia's wood raw material is procured by Metsäliitto Cooperative. When operating at full capacity, Botnia uses over 13 million cubic metres of wood a year. In 2003, 87.5 per cent of this was domestic wood. Botnia owns around 40,000 hectares of forest in Finland. Botnia is owned by M-real Corporation (47%), UPM-Kymmene Corporation (47%) and Metsäliitto Cooperative (6%).

Botnia mills:

- Joutseno mill produces 600 000 tonnes of ECF bleached softwood pulp for wood-containing printing papers (SC and LWC), as well as high-quality coated printing and special papers (wood consumption 3.5 million m³/a).
- Kaskinen mill produces 425 000 tonnes of ECF and TCF bleached hardwood pulp for fine paper and folding box boards.
- Kemi mill produces 560 000 tonnes of unbleached and ECF bleached softwood and hardwood pulp for tissue paper and specialty paper.
- The Rauma mill produces 560 000 t/a of TCF bleached softwood pulp for magazine paper manufacture and bleached tissue paper pulp.
- The Äänekoski mill produces 485 000 tonnes of ECF bleached softwood and hardwood pulp for fine paper and folding boxboard.

Oy Metsä-Botnia Ab –Environmetnal status

In Figure 4, emissions from Botnia mills in 2003 are compared with effluents from other mills in Sweden and Finland. The Figure 4 reveals that Botnia pulp mills perform well compared to other Scandinavian pulp mills.

Figure 4 Specific emissions from Botnia pulp mills compared to other pulp mills in Finland and Sweden. The emissions for 2002 from Finnish mills are published by the Finnish Forest Industries Federation and those for the Swedish mills by Naturvårdsverket. a) Chemical oxygen demand (COD_{Cr}) kg/tonne of pulp, b) AOX (Chlorine and other halogens bound to organic material in effluent) kg/tonne of pulp, c) Phosphorus (P) g/tonne of pulp.
Source: Botnia annual report 2003 – Environmental sheet

Aracruz Celulose - Characteristics and environmental status

Aracruz Celulose - Characteristics

Aracruz Celulose in Brazil is the world's leading producer of marked pulp from Eucalyptus. With two mills only, the Company is responsible for 28% of the global supply of the product. Aracruz mills are modern and have rather low emission levels. However since the mills are so huge (overall production about 2.400,000 million tons pulp a year) the mills should have the most environmental technology available to minimize the emission levels.

Aracruz Celulose is the world's leading producer of bleached eucalyptus pulp. The Company is responsible for 28% of the global supply of the product, used to manufacture printing and writing, tissue, and high value added specialty papers.

Aracruz's forestry operations involve some 252,000 hectares of eucalyptus plantations situated in the states of Espírito Santo, Bahia, Minas Gerais and Rio Grande do Sul. Aracruz's nominal pulp production capacity, totaling 2.4 million tons a year, is distributed between two pulp making units: Barra do Riacho in Espírito Santo, and Guaíba in Rio Grande do Sul, see map in Figure 5.

Aracruz mills:

- Barra do Riacho mill produces in total 2.000,000 million tons a year of pulp based on three production units. Environmental control is ensured through modern systems that treat all emissions, effluents and solid wastes.
- Guaíba mill produces about 400,000 tons of market pulp and 40,000 tons of printing and writing paper.
- A third manufacturing facility, Veracel Celulose, is being built in the municipality of Eunápolis, in the south of Bahia, in partnership with Stora Enso (both partners owning a 50% stake). With startup of operations scheduled for 2005, Veracel will have a nominal capacity of 900,000 tons a year of bleached eucalyptus pulp.

Figure 5 Locations (approximate) of Aracruz' Eucalyptus marked pulp mills in Brazil

Aracruz pulp mills - Environmental status

Emission levels from Aracruz mills in 2003 are shown in Figure 6. Aracruz mills are modern and have modern emission levels. However, since the Aracruz mills are so huge (overall production about 2.400,000 million tons pulp a year) the mills should have the best environmental technology available to minimize the emission levels.

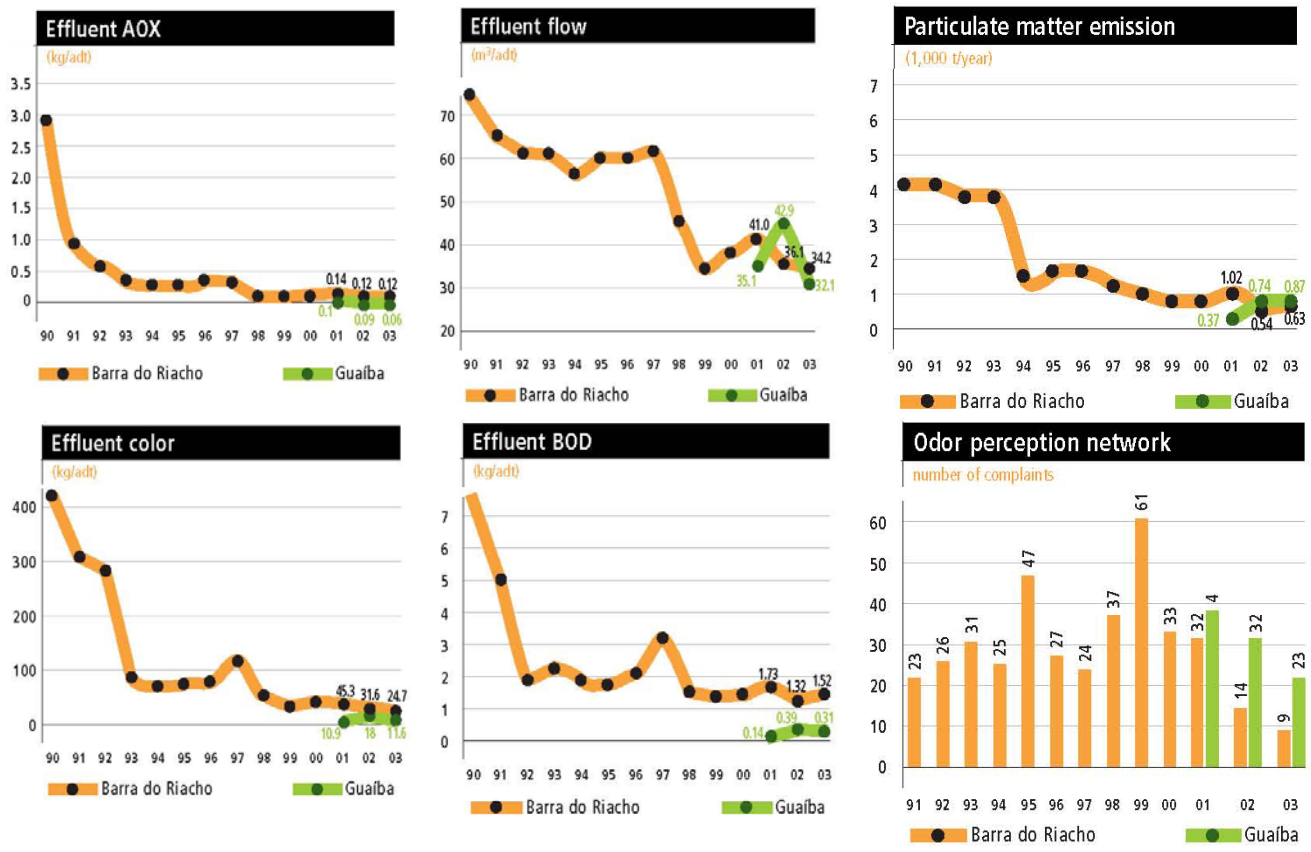


Figure 6 Emissions from Aracruz mills (Aracruz annual report 2003)

ENVIRONMENTAL PERMITS FOR THE INDUSTRY

The practice with regard to permits depends on national or local environmental acts and decrees. Decisions are made as a result of court proceedings or they may take the form of rulings by the relevant authorities. Appeals against such rulings usually lead to court hearings.

Discharge of effluents to receiving waters – Practice in Finland

Hynninen (1998) described the current practice in Finland. Unlike in other countries, most waters in Finland and Sweden are privately owned. The main points which should be included in an application for permission to discharge effluent are:

❋ Technical information on the process	- Description of process used for product manufacture - Estimated effluent loading - An account of measures for reducing the loading
❋ Description of the receiving water	- State of the water and expected changes in it - The suitability of the water for various uses and how this will be affected - Cost of reducing discharges - Names of those who own the water (as far as applicant is aware) - Ways known to the applicant of completely preventing the expected adverse effects

Applications are submitted to the water rights court in whose area the water in question is located. In dealing with an application, the water rights court may adopt the procedure of giving public notice of the application, usually in cases where loadings have been reduced. The application is publicly announced and the court bases any further action on complaints or other feedback. While the discharge permit may be granted, measures relating to the payment of compensation are not dealt with in the same way. What usually happens is that the water rights court appoints a suitably qualified engineer to carry out the necessary further investigations. The parties involved (applicant, water owners, and the National Board of Waters and the Environment representing the public interest) normally voice their concerns as part of this procedure.

Based on the information it has received, the water rights court issues the technical conditions under which the permit is to be granted and determines compensation to be paid for any damage caused to the environment. In most cases, the technical conditions require a plan for a treatment plant to be submitted to the relevant authorities, discharge limits in kg/d, expressed in terms of the usual effluent parameters (suspended solids, BOD, COD, AOX, and nutrients), and a plan, to be approved by the relevant authority, for monitoring the receiving water. The relevant authority in most cases is the district organization of the National Board of Waters and the Environment. If the parties concerned are not satisfied with the decision, they normally have the right to appeal to Water Rights Appeal Court.

Despite recent improvements, the processing of applications still takes a considerable length of time, especially in regard to investigating and deciding compensation for damage. Today, decisions are reached fairly quickly, taking between six months and two years. This is thanks to changes in the nature of the application. Discharges are diminishing and less time is spent dealing with compensation-related matters. Permits granted by a water rights court are

normally valid indefinitely. However, there is usually a clause stating the date by which an application should be made to renew the permit.

Location-related environmental permits

Finland has a broad body of legislation concerning the use and protection of the environment, much of it found in different laws passed at different times. The building or expansion of an industrial plant has always required a large number of permits or approval from the authorities. The following have always been subject either to permits or to legislation in general:

- Choice of construction site and the size and type of building
- Emissions to the air
- Waste management
- Noise abatement
- Public health and safety at work
- Storage and transport of toxic or otherwise dangerous and inflammable substances
- Transport of dangerous substances
- Construction and use of pressure vessels
- Electricity supplies.

Many of the above are also significant for environmental protection. Most of the present regulations relating to air pollution control and waste management for existing plants are based on notifications regarding air pollution control and waste management submitted by the plants to the environmental protection departments of provincial governments, and on the resulting rulings.

An air pollution control notification is a document detailing the quantities of emissions and their sources, and what measures are to be taken regarding the emissions. An application must also include an estimate of the cost of lowering emissions. A waste management notification must contain an account of the quantities of waste and explain how the waste can be rendered harmless.

The provincial government has made rulings either approving or amending the proposed measures. The environmental protection departments of provincial governments have now been merged into the regional environment agencies.

With the exception of the discharge of effluents to receiving waters, the system of controls today is based almost entirely on stipulations issued in response to air pollution control and waste management notifications and on the statutory monitoring requirements for environmental protection and environmental impacts set out in siting permits. The environmental permits mentioned earlier are now being introduced as the basis for controls.

ENVIRONMENTAL LEGISLATION AND REGULATIONS

Even today, environmental legislation still differs considerably from one country to another. Marked variation also occurs in other administrative practices applied in major pulp and paper-producing countries, on the part of norms and regulations, permit procedures, and implementation authorities. The reasons for this are the historical, economic, and social differences between the countries as well as their varied level of industrialization.

The European Union recently made efforts to harmonize environmental legislation with the issue of council directive 96/61/EC concerning Integrated Pollution Prevention Control (IPPC) in September 1996, later revised in 2001. After a transition period, the implementation of this directive will be gradual in the member countries.

Other examples of voluntary harmonization and development in environmental protection are the international ISO 14000 series standards and the respective European Union council regulation (EEC 1836/93) on Eco-Management and Audit Scheme (EMAS).

Integrated Pollution Prevention and Control (IPPC) Directive (96/61/EC)
In 1996, the Council adopted the IPPC directive. This directive is of great importance in harmonizing environmental legislation within the European Union. The purpose of the directive is to achieve a high level of protection of the environment by laying down measures designed to prevent or, where that is not practicable, to reduce emissions in air, in water, and on land from specified activities, including measures concerning waste. The IPPC directive will be applied without prejudice to EIA directive 85/337/EEC.

The final draft on ***Best Environ-mental Practice (BREF)*** on Pulp and paper Industry has been available since December 2001, see http://www.epa.ie/Licensing/IPPCLicensing/BREFDocuments/. The member states shall adopt the laws, regulations, and administrative provisions necessary to comply with the IPPC directive no later than three years after its entry into force.

The most important principles and obligations included in the directive are:

- Permits for new and existing installations
- Requirements of applications for permits
- Decisions and conditions of permits
- *Best available techniques (BAT)*, environmental quality standards and developments in BAT
- Exchange of information
- Community emission limit values

Best available techniques (BAT) for kraft pulp process according to the final draft BREF on Pulp and paper Industry
Manufacturing of pulp and paper is not a single process but a series of unit processes, often linked and interdependent. Consequently, several BATs for different mill classes are necessary to address all products and processes involved in the European pulp and paper industry. For describing **best available techniques** for this sector the following aspects should be kept in mind:

- There is no single reference of best available techniques in pulp and paper industry. The list of best available techniques consists of many process integrated and some external measures for prevention and control of pollution that constitute the overall BAT for pulp

and paper mills. These components may be combined in different ways. BAT is therefore always a suitable combination of techniques.

- The BAT-concept includes a process-related element because the environmental impact may vary when processes with different pollution potential are applied.
- The best available techniques cannot be defined solely by describing unit processes. Instead, the whole installations must be examined and dealt with as entities.
- Instead of single distinctive values the environmental performance of paper mills is expressed as a range of values reflecting that the manufacturing of different paper grades requires different quantities and qualities of raw materials (e.g. softwood/hardwood, different qualities of waste paper, mixture of furnishes etc.), with the consequence that emissions per end product may vary within a certain range.

Best available techniques for kraft pulp mills are according to BREF (2001) considered to be:

- Dry debarking of wood - Increased delignification before the bleach plant by extended or modified cooking and additional oxygen stages - Highly efficient brown stock washing and closed cycle brown stock screening - Elemental chlorine free (ECF) bleaching with low AOX or Totally chlorine free (TCF) bleaching - Recycling of some, mainly alkaline process water from the bleach plant - Effective spill monitoring, containment and recovery system	- Stripping and reuse of the condensates from the evaporation plant - Sufficient capacity of the black liquor evaporation plant and the recovery boiler to cope with the additional liquor and dry solids load - Collection and reuse of clean cooling waters - Provision of sufficiently large buffer tanks for storage of spilled cooking and recovery liquors and dirty condensates to prevent sudden peaks of loading and occasional upsets in the external effluent treatment plant

In addition to process-integrated measures, primary treatment and biological treatment is considered BAT for kraft pulp mills.

Best available techniques for reducing emissions to air are

- Collection and incineration of concentrated malodorous gases and control the resulting SO_2 emissions. The strong gases can be burnt in the recovery boiler, in the lime kiln or a separate, low NO_x furnace. The flue gases of the latter have a high concentration of SO_2 that is recovered in a scrubber. - Diluted malodorous gases from various sources are also collected and incinerated and the resulting SO_2 controlled. - TRS emissions of the recovery boiler are mitigated by efficient combustion control and CO measurement - TRS emissions of the lime kiln are mitigated by controlling the excess oxygen, by using low-S fuel, and by controlling the residual soluble sodium in the lime mud fed.	- The SO_2 emissions from the recovery boilers are controlled by firing high dry solids concentration black liquor in the recovery boiler and/or by using a flue gas scrubber - BAT is further the control of NOx emissions from the recovery boiler (i.e. ensuring proper mixing and division of air in the boiler), lime kiln and from auxiliary boilers by controlling the firing conditions, and for new or altered installations also by appropriate design - SO_2 emissions from auxiliary boilers are reduced by using bark, gas, low sulphur oil and coal or controlling S emissions with a scrubber. - Flue gases from recovery boilers, auxiliary boilers (in which other biofuels and/or fossil fuels are incinerated) and lime kiln are cleaned with efficient electrostatic precipitators to mitigate dust emissions.

For bleached and unbleached kraft pulp mills the BAT emission levels to water and air are specified see Table 1 a) and b). The emission levels refer to yearly averages and standard conditions.

Table 1 a) Yearly average values for emission levels to water which is considered to be BAT for bleached and unbleached kraft pulp b) Yearly average values for emission levels to air which is considered to be BAT for bleached and unbleached kraft pulp

a)

	Flow m^3/Adt	COD kg/Adt	BOD kg/Adt	TSS kg/Adt	AOX kg/Adt	Total N kg/Adt	Total P kg/Adt
Bleached pulp	30 - 50	8-23	0.3-1.5	0.6-1.5	< 0.25	0.1-0.25	0.01-0.03
Unbleached pulp	15 - 25	5-10	0.2-0.7	0.3-1.0	-	0.1-0.2	0.01-0.02

b)

	Dust kg/Adt	SO_2 (as S) kg/Adt	NOx ($NO+NO_2$ as NO_2) in kg/Adt	TRS (as S) kg/Adt
Bleached and unbleached kraft pulp	0.2-0.5	0.2-0.4	1.0-1.5	0.1-0.2

Determination of BAT concerning emissions to water - An example

Suhr (2000) briefly highlights some characteristics of the Pulp and paper Industry and explains how the document presents best available techniques (BAT) for this complex industry with different raw materials and a wide variety of products. Suhr (2000) exemplified how BAT is addressed in the Best Environmental Practice (BREF) wth regard to water discharges for the pulp and paper industry. For simplicity, Suhr (2000) the description focuses on emissions to water and within this subject on the sum of discharged organic substances usually measured as chemical oxygen demand (COD).

Kraft pulp mills are characterised by the fact that they have concentrated their environmental efforts on process-integrated measures. This trend is reflected in the BREF. BAT for bleached kraft pulp production is in the first place a combination of 11 internal measures shown in the two boxes below:

- Dry debarking of wood
- Modified cooking
- Closed cycle brown stock screening
- Highly efficient brown stock washing
- ECF or TCF final bleaching
- Some, mainly alkaline, process water recycling from the bleach plant
- Purification and re-use of the condensates

- Effective spill monitoring, containment, and recovery system
- Sufficient black liquor evaporation plant and recovery boiler to cope with the additional liquor and dry solids loads due to collection of spills, bleach plant effluents etc.
- Collection and re-use of clean cooling water
- Primary treatment of waste water

Figure 7 BAT for bleached kraft pulp production is in the first place a combination of 11 internal measures shown in the two boxes below (Suhr 2000).

The efficiency of each of these measures varies considerably with the design and operation practices at different mills. To be regarded as BAT, a measure must also be well designed and

operated. Depending on the type of pulp wood used, the specific process-integrated measures implemented and the technical characteristics of the mill, specific emission levels to water are associated with the use of a combination of BAT. In order to ensure transparency, the BREF gives BAT ranges before and after biological treatment. In doing so, the reader is in a position to easier follow how the BAT conclusions flow from the selected techniques and the assumptions made. The BREF therefore presents both the environmental performance of process integrated measures only, as well as the combination with external treatment.

In our example of bleached kraft pulp mills, the BAT range before biological treatment is:

30 - 45 kg COD per tonne of pulp produced

Biological waste water treatment is further regarded as BAT. A reduction efficiency of biological treatment of > 55 % for COD is considered BAT. In well designed and controlled low loaded activated sludge plants with long retention times up to 65-75% are achieved. That gives a calculated BAT range after biological treatment of:

13.5 - 21 kg COD per tonne of pulp, or 8 - 12 kg COD per tonne of pulp with best achievements.

The BREF finally gives a BAT range of 8 - 23 kg COD per tonne of pulp. This emission level is achieved when a combination of together 12 measures is applied.

The BAT emission ranges in the BREF are always based on a number of real world examples that have achieved this level. In our example, there are 3 bleached kraft pulp mills that achieve around 8 kg COD per tonne of pulp (Canada, Finland, Sweden). These mills are the very best performers and confirm the lower end of the range.

Normally, for recently build mills or for those mills, which have increased substantially their production capacity it is somewhat easier to perform at the lower end of the BAT range presented in the BREF. On the other hand, the ranges are set wide enough to be applicable to most existing mills. This is confirmed by a larger number of other real world examples that fall within the whole BAT range. The upper end of the range considers also different starting points of mills and includes a balancing of cross media effects and cost aspects on a sector level. Those mills not achieving within the range associated with this general BAT could normally improve their performance towards the range. Under a European perspective - and also compared to the competitors in North America and Asia - the whole BAT emission range for kraft pulp mills stands for well performing mills. The very best performers could be expected to lie within the better part of the range whereas other mills achieving within the range may have implemented a set of BAT measures but not necessarily all and not necessarily to their full extent. The influence of different raw materials (softwood/ hardwood) and different product qualities (market pulp, pulp for integrated paper production) is also taken into account when proposing these ranges.

For some users of the BREF the range of emissions associated with BAT might seem to be quite wide. This is reflecting that for technical and economic reasons the majority of the TWG did not support more narrow ranges, which are closer to the very best achievements. The given BAT emission ranges are a result of balancing all the different views and technical and economic arguments exchanged in the TWG.

They are not representing the best of the best. Nevertheless, they are reflecting a high level of protection of the environment as a whole.

International Conventions

International conventions have been signed to protect extensive water areas and the atmosphere beyond national boundaries and to achieve a homogenous goal in the level of environmental protection between all parties. Still, it must be emphasized that in most cases, the agreements include only recommendations for decreasing or limiting pollution and thus the responsibility to implement the proposed measures lies with each individual party.

The PARCOM Convention

The purpose of PARCOM is to protect marine pollution from land-based sources. The parties are obliged to undertake the following pollution control measures:

- Eliminate, when necessary by stages, the release of specified substances (e.g., organohalogen compounds, Hg and its compounds, Cd and its compounds)
- Strictly limit the release of substances, such as organic compounds of P, Si and Sn, and elemental P, As, Cr, Co, Pb, Ni, Zn.

The Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR)

OSPAR is intended to replace the PARCOM Convention after its ratification among the signatories. The OSPAR Convention emphasizes especially the precautionary and the polluter pays principles of Community environmental policy. OSPAR includes the concepts of Best Available Techniques (BAT) and Best Environmental Practice (BEP):

The Helsinki Convention (HELCOM)

The Convention on the protection of the marine environment of the Baltic Sea area was established in 1974 and revised in 1992. The parties agree to promote the use of BAT and BEP. BAT is to be used for point sources of pollution and BEP for all sources of pollution.

HELCOM 1992 also includes regulations on issuing permits for industrial plants. The appropriate national authority shall issue the permit after comprehensive assessment with special consideration of the above mentioned principles. Minimum requirements for each permit are stated as follows:

- Limit values for amount and quality (load and/or concentration) of direct and indirect discharges and emissions
- Type and extent of control to be performed by the operator (self control) and analytical methods to be used.
- The appropriate national authority or an independent authorized institution shall inspect the amount and quality of discharges and/or emissions by sampling and analyzing.
- With regard to the pulp and paper industry, the following HELCOM recommendations are adopted as revised in March 1996:
- HELCOM recommendation 17/8 (reduction of discharges from the kraft pulp industry)
- HELCOM recommendation 17/9 (reduction of discharges from the sulfite pulp industry.

In addition, HELCOM 17/8 also recommends that:

- Molecular chlorine not be used in the bleaching of kraft pulp after Jan. 1, 1997 (2000 for countries in transition)
- Limit values for nitrogen should apply to kraft pulp mills located on the coast
- The signatories should report every three years starting in 2000
- With the development of BAT, especially with the change of chelating agents to biodegradable compounds, the recommendation must be reconsidered in 1998.

BAT for the kraft pulp industry per 1995 is determined as follows:

- Dry debarking with minor wastewater discharges - Closed screening - Stripping of most concentrated condensates and reuse of most condensates in the process - Systems which enable the recovery of almost all spillages - Extended delignification in the digester followed by oxygen delignification	- Efficient washing before the pulp leaves the closed part of the process - At least secondary treatment for wastewater discharges - Partial closure of bleach plants. The main part of the discharge from bleach plants is to be piped to the recovery system. - Use of environmentally sound chemicals in the process, for example, use of biodegradable chelating agents wherever possible.

Table 1 shows discharge limits according to HELCOM 17/8.

Table 2 Annual average discharge limit values for the kraft pulp industry according to HELCOM recommendation 17/8 (Hynninen 1998)

The following annual average discharge limit values in kg per metric ton of Air Dry Pulp (kg/t ADP) produced are not exceeded from Jan. 1, 2000, for any mill which has started to operate before Jan. 1, 1997:

Pulping process	CODCr	AOX	Tot-P	Tot-N
Bleached pulp	30	0.4	0.04	0.4
Unbleached pulp	15	–	0.02	0.3

In countries in transition, the following annual average discharge limit values (kg/t ADP) produced are not exceeded from Jan. 1, 2005, for any mill which has started to operate before Jan. 1, 1997:

Pulping process	CODCr	AOX	Tot-P	Tot-N
Bleached pulp	35	0.4	0.04	0.4
Unbleached pulp	20	–	0.02	0.3

For any mill, starting to operate or considerably increasing its capacity (by more than 50%) after Jan. 1, 1997, the following annual discharge limit values (kg/t ADP) exist:

Pulping process	CODCr	AOX	Tot-P	Tot-N
Bleached pulp	15	0.2	0.02	0.35
Unbleached pulp	8	–	0.01	0.25

Proposals of the Nordic Council of Ministers

The Nordic Council of Ministers established a working group comprising experts from Sweden, Finland, Norway, and Denmark to evaluate the impact of the pulp and paper industry on the environment and to compile a report on it by 1993. The Nordic Council of Ministers (Study on Nordic Pulp and Paper Industry and the Environment) issued the report on Nov. 7, 1993. This report presented the following proposals related to environmental protection and pollution control:

- The Nordic Pulp and Paper Industry should strive toward the use of cleaner production technology.
- Molecular chlorine should not be used when bleaching chemical pulp
- Pollution loads, as shown in Table 2a, expressed as annual averages, should not be exceeded for any mill by the end of this century.

- In the case of any new or considerably enlarged (on the order of 30%) mill, the following levels, as shown in Table 2b, should not be exceeded as annual averages.

Table 3. Annual average limit values of pollution loads (kg/a.d. metric ton) according to a proposal by the Nordic Council of Ministers 1993 (Hynninen 1998)
a) Limit values to be reached by the end of this century. b) New and enlarged mills

a)

Type of mill	AOX	CODCr	Tot-P	Tot-Na	Sulfurb	NO_xc
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 sulfite	0.3	70	0.08	0.6	1.5	2.0
CTMP		–	30	0.02	0.2	–
Mechanicald	–	10	0.01	0.2	–	–
Recycled fiber	–	10	0.01	0.2	–	–

[a] *Any nitrogen discharge associated with the use of complexing agents should be added to the figure for tot-N given above*
[b] *Gaseous sulphur emissions, as S, except from auxiliary boilers*
[c] *Gaseous nitrogen oxide emissions, as NO_x, except from auxiliary boilers*
[d] *"Mechanical" means integrated mills producing newsprint or magazine paper*

b)

Type of mill	AOX	CODCr	Tot-P	Tot-Na	Sulfurb	NO_xc
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 sulfite	0.1	35	0.04	0.3	1.0	1.0
CTMP	–	15	0.01	0.1	–	–
Mechanicald	–	5	0.005	0.1	–	–
Recycled fiber	–	5	0.005	0.1	–	–

[a] *Any nitrogen discharge associated with the use of complexing agents should be added to the figure for tot-N given above*
[b] *Gaseous sulphur emissions, as S, except from auxiliary boilers*
[c] *Gaseous nitrogen oxide emissions, as NO_x, except from auxiliary boilers*
[d] *"Mechanical" means integrated mills producing newsprint or magazine paper*

International Conventions for air Pollution Control

The 1979 Geneva Convention (Convention on Long-range Transboundary Air Pollution)
The Geneva Convention is the cornerstone of international sulfur and nitrogen emission policy. The following protocols have been promulgated on the basis of the Geneva Convention:

- The Geneva Protocol 1984 (monitoring and evaluation)
- The Helsinki Protocol 1985 (sulfur compounds)
- The Sofia Protocol 1988 (nitrogen oxides).

The Protocols include goals for future air emissions and claim to use BAT to achieve these targets. Development and harmonization of the monitoring and analysing procedures between the contracting parties is also required.

The 1992 Framework Convention on Climate Change

The Framework Convention by the United Nations has been ratified in some 160 UN member states. All EU member countries have ratified the Convention. The purpose of the 1992 Rio Convention is to stabilize the content of greenhouse gases in the atmosphere at a level where no harmful or dangerous changes can occur. No numerical target concentrations, however, are given.

Legislation in Finland

The EU directive on Integrated Pollution Prevention and Control (IPPC directive) was incorporated into Finnish legislation in 2000. The directive requires that the conditions set in environmental permits, e.g. for pulp mills, should be based on use of the ***best technology available*** in the European Union.

The Finnish Government made a decision in October 1988 on a basic program for water pollution control up to 1995 including some restrictions for the pulp and paper industry (COD_{Cr}, AOX, phosphorus). A continuation of this program up to 2005 is under way. For the pulp and paper industry in Finland, the recommendations of the Helsinki Commission (HELCOM) and the Nordic Council of Ministers must also be followed, see the section International Conventions.

The Finnish Government issued two decrees on ambient air quality recommendations and restrictions in June 1996 as follows: 1) Decree No. 480 on recommendations on ambient air quality and target levels of sulfur precipitation, see Table X a) 2) Decree No. 481 on ambient air limit values to prevent health damage, see Table X b).

Table 4 a) Ambient air quality recommendations in Finland b) Ambient air limit values to prevent health damages in Finland (Hynninen 1998)

Compound	Limit value	Statistical definition (20 °C, 1 atm)
Nitrogen dioxide (NO_2)	200 µg/m³	One year's hourly values 98. percentile
Sulfur dioxide (SO_2)	80 µg/m³	Average of one year's daily values
	250 µg/m³	One year's daily values 98. percentile
Particulates, total suspended particulate (TSP)	300 µg/m³	One year's daily values 95. percentile
	150 µg/m³	Annual average
Lead (Pb)	0.5 µg/m³	Annual average

a)

Compound	Value (20 °C, 1 atm)	Statistical definition
Carbon monoxide (CO)	20 mg/m³	Hourly value
	8 mg/m³	Moving average of 8 hourly values
Nitrogen dioxide (NO_2)	150 µg/m³	One month's hourly values 99. percentile
	70 µg/m³	The second highest daily value of one month
Sulfur dioxide (SO_2)	250 µg/m³	One month's hourly values 99. percentile
	80 µg/m³	The second highest daily value of one month
Particulates, total suspended particulate (TSP)	120 µg/m³	One year's daily values 98. percentile
	50 µg/m³	Annual average
Respiratory particulates (PM_{10})	70 µg/m³	The second highest daily value of one month
Total amount of odorous sulfur compounds (TRS)	10 µg/m³	The second highest daily value of one month (TRS expressed as sulfur)

b)

CONCLUSIONS / RECOMMENDATIONS

Metso-Botnia is planning to build a mill for producing bleached eucalyptus pulp in Uruguay. In this respect, the Uruguay government wanted a third opinion on the consequences of running the operation in the country. PFI was going to deliver a brief report including the following topics 1) characteristics and environmental profile of Metsä Botnia 2) characteristics and environmental profile of a similar Eucalyptus marked pulp mill and 3) emission levels of modern kraft mills.

Environmental profile of Botnia
Marked pulp producers in Scandinavia have been leading the development of a new environmental technology in the pulp and paper industry due to strict national/regional regulations and marked demands. Hence, Scandinavian mills have strong focus on environmental profile and emission levels. On average, emission levels from mills in Scandinavia are lower than in other parts of the world. With respect to emission levels, Botnia pulp mills perform well compared to other Scandinavian pulp mills. Hence, Botnia pulp mills are modern and have a strong focus on emission levels. Today, Botnia do not produce marked pulp from Eucalyptus wood.

Characteristics and environmental profile of an Eucalyptus marked pulp mill
Aracruz Celulose in Brazil is the world's leading producer of marked pulp from Eucalyptus. With two mills only, the Company is responsible for 28% of the global supply of the product. Aracruz mills are modern and have rather low emission levels. However as the Aracruz mills are so huge (overall production about 2.400,000 million tons pulp a year) the mills should have the best environmental technology available to minimize the emission levels.

Recommendations related to permitting building of a large Eucalyptus pulp mill in Uruguay

- Botnias application for permission to discharge effluents to receiving waters in Uruguay should contain the same main points which are included in such applications in Finland. The main points which should be included in the application are:
  3) Technical information on the process (process description, estimated effluent loadings, measures for reducing the loading)
  4) Description of the receiving water (Water state and expected changes in it, the suitability of the water for various uses and how this will be affected, cost of reducing discharges, names water owners, ways known to the applicant of completely preventing the expected adverse effects).
- The mill should be built with the Best available techniques (BAT) for kraft pulp process as described in he final draft of Best Environmental Practice (BREF) in the European Council IPPC[2] Directive (96/61/EC) for the Pulp and paper Industry.
- Emission levels should not exceed the emission levels set in the IPPC Directive or the emission levels of similar Eucaluptus pulp mills as Aracruz Celulose. In this case emission levels are particular importance since:
  1) The receiving waters is a river and the recipient point is located quite far from the ocean
  2) The mill planned is large (i.e higher total effluent load)

[2] Integrated Pollution Prevention and Control

3) The recipient river, Uruguay River, is the natural borderline between Uruguay and Argentina.

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