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ENVIRONMENTAL REQUIREMENTS FOR INDUSTRIAL PERMITTING

CASE STUDY ON THE IRON AND STEEL SECTOR

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FOREWORD

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

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

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

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

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

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

This report on the iron and steel sector provides an analysis of permitting approaches in Finland, Germany, Japan, Korea, Sweden, the United Kingdom and the United States. It examines the implication of the countries' policies to set environmental requirements for this sector. The influence of permit conditions on the technological development and environmental performance of the facilities is analysed, and the specific action of industry is reviewed. The regulatory profiles of the participating countries have also been compiled and are included in the Annex of the report.

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

ACKNOWLEDGEMENTS

The OECD would like to acknowledge the important assistance and support provided by government officials and experts from OECD Member countries during the preparation of this report on the iron and steel sector. The project was also supervised by the “BAT-EQO” Advisory Panel, which included Delegates to the Pollution Prevention and Control Group from the following participating countries: Karel de Brabander and Bruno de Kerckhove (Belgium), James Riordan (Canada), Antero Honkasalo (Finland), Horst Mierheim (Germany), Robert Droop and Jan Suurland (Netherlands), David Mottershead (United Kingdom), Rick Picardi (United States), and Leopoldo Rubinacci (European Commission). Valuable input was also obtained from experts participating in the OECD Workshop on Environmental Requirements for Industrial Permitting held in Paris in May 1996. The amount of information gathering, fact checking and updating necessary to produce the survey and analysis of permitting approaches for these countries was substantial, and a great number of specialists in Member country administrations and industry organisations were instrumental in helping ensure that this was done in a thorough and accurate manner. Financial support for the project was provided by the governments of Austria, the Netherlands, Switzerland which is greatly acknowledged.

The project publications were compiled and written in the Pollution Prevention and Control Division of the Environment Directorate. The main responsibility for this work rested with Alain Rajotte and Laurent Renevier under the direction and editorial oversight of Ms. Rebecca Hanmer, former Head of Division, and Peter Wiederkehr. Environment Canada, the Dutch Ministry of Environment, and the UK Department of the Environment, respectively, were responsible for carrying out the other case studies on the pulp and paper, metal finishing, and oil refining sectors. Input, assistance and advice by past and present colleagues in the Environment Directorate are also acknowledged. Emily Neighbour, Freda O’Rourke and Lyndia Levasseur ably provided editing and logistical assistance.

The report was revised and approved by OECD’s Pollution Prevention and Control Group.

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GLOSSARY

AOD	argon-oxygen decarburisation vessel
AOX	adsorbable organic halogens
BAT	best available technology/techniques
BACT	best available control technology
BEP	best environmental practice
BREF	BAT reference document
BATNEEC	best available techniques not entailing excessive costs
BDT	best demonstrated technology
BOD_7	biochemical oxygen demand over 7 days
BOF	basic oxygen furnace
BPEO	best practical environmental option
BPO	best practicable option
BPJ	best professional judgement
CAA	Clean Air Act (US)
CEPA	Canadian Environmental Protection Agency
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act (US)
COD	chemical oxygen demand
CSI	common sense initiative (US)
CWA	Clean Water Act (US)
EAF	electric arc furnace
EIA	environmental impact assessment
ELV	emission limit value
EMAS	ecomanagement and audit scheme
EMS	environmental management systems
EPA	Environmental Protection Agency
EPR	extended producer/product responsibility
EQO	environmental quality objective
EQS	environmental quality standard
EU	European Union
EEC	European Economic Community, forerunner of EU
fugitive emissions:	incidental escape of dust and particles during industrial operations
HAPs	hazardous air pollutants
HELCOM	Helsinki Commission on the Protection of the Baltic Sea
HMIP	Her Majesty's Inspectorate of Pollution (UK)
IISI	International Iron and Steel Institute
IJC	International Joint Commission on the Great Lakes
IPC	Integrated Pollution Control Act (UK)
IPPC	Integrated Pollution Prevention and Control (EU Directive)
ITEQ	International Toxicity Equivalent
LAAPC	Local Authority Air Pollution Control (UK)
LAER	lowest acceptable emission rate
LCA	life cycle assessment
LRTAP	Convention on the Long-Range Transboundary Air Pollution of the UNECE
MACT	maximum achievable control technology (CAA-US)
NAAQS	national ambient air quality standard (CAA-US)
NGO	non-governmental organisation
ndg	normal dry gas

NSPS	new source performance standards (CAA-US)
NTP	normal temperature and pressure
OH	open hearth furnace
OSPARCOM	Oslo and Paris Commission for the Protection of the North Sea and the North East Atlantic
PAH	polycyclicaromatic hydrocarbons
PCBs	polychlorinated biphenyls
PM_{10}	particulate matter of 10 micron size
PPCG	Pollution Prevention and Control Group (OECD)
PRTR	pollutant release and transfer registers
P_{tot}	total phosphorus
PVC	poly vinyl chloride
RCRA	Resource Conservation and Recovery Act (US)
SMEs	small and medium-sized enterprises
SNV	Swedish Environmental Protection Agency
SS	suspended solids
TA Luft	Technical Instruction on Air Pollution Control in Germany
TRI	toxic release inventory (US)
TSP	total suspended particles/particulates
UN ECE	United Nations Economic Commission for Europe
UNEP	United Nations Environmental Programme
UNIDO	United Nations Industrial Development Organisation
USEPA	the United States Environmental Protection Agency
VLAREM I & II	Flemish Implementation Decree (I & II) on Environmental Protection
VA	voluntary agreement
VOCs	volatile organic compounds
WHO	World Health Organization

EXECUTIVE SUMMARY

This case study on the iron and steel sector is part of a broader OECD project on environmental requirements for industrial facilities that examined the role and effectiveness of environmental permitting systems in industry. The provision of permits to industrial facilities is an integral and most significant component of the regulatory process for controlling sources of pollution. There are typically two different approaches for setting requirements in permits: (a) the technology-based approach under which emission limit values (ELVs) and related conditions are derived from an assessment of the performance of a range of technological options; and (b) the environment-oriented approach under which pollution limits are based on an appraisal of the conditions of the local environment into which releases occur and must comply with environmental quality standards (EQSs).

OECD countries make frequent use of both “best available technology and techniques” (BAT) and environmental quality objectives (EQO) and standards (EQS) in setting environmental requirements for industrial point sources. However, actual practices may vary significantly among countries.

The iron and steel industry has environmental relevance for several reasons: its high energy intensity with special requirements for fuels and technologies; it is important in terms of releases and changing impacts to the various environmental media, and also its global role and significance regarding CO_2 emissions. This study reviews seven countries’ approaches to issuing environmental permits in the iron and steel sector. It used permit samples and information provided by Finland, Germany, Japan, Korea, Sweden, the United Kingdom (UK) and the United States (US) to examine how the concepts of best available technology/techniques (BAT) and environmental quality objectives and standards (EQOs/EQSs) are used to set environmental requirements for industrial point sources. The influence of other determinants, e.g. economic considerations and international obligations, is also considered, as are the implications of integrated permitting.

This survey was prepared on the basis of a questionnaire in which each country described their permitting process and in particular how BAT and EQO were considered in setting permit requirements. Another questionnaire was given to those facilities that provided their view on the permitting process and its influence on the type of technological response, e.g. preventative versus end-of-pipe approaches. Permit samples include different types of facilities, i.e. integrated and non-integrated steel plants, and iron foundries. In a few cases, respondents provided only the rationale for the standards without providing detailed information on the latter. Numerical values of the standards, when provided have been included in the analysis. Country-specific information has been included in separate country profiles.

Additional sources of information included statements by representatives of public authorities, international commissions and trade associations, as well as published literature on the iron and steel industry.

Regulatory and permitting approaches and instruments

Typically, legislation provides the framework for controlling the environmental impacts of the iron and steel sector. Environmental regulations affect the industry through all stages of the manufacturing and production processes. These regulations address the generation, disposal, export, import and transit of waste and toxic waste materials, air and water pollution, noise, the risk of major accidents and environmental impact statements. Regulations set standards for air, land and water quality through a permitting system that sets timetables for compliance. Different permitting approaches are used to implement and/or tailor these regulations at industrial point sources:

– Germany, Japan, Korea and the US use a media-specific permitting approach, i.e. separate permits are issued for releases to the air, water and waste;

– Finland uses a semi-integrated system where integrated permits are issued for air, waste and noise, while water permits are issued separately; and

– Sweden and UK use an integrated system where total emissions/discharges are considered when defining emission limit values (EVLs) and other permit conditions.

Environmental permits are issued by either federal or provincial/state authorities (e.g. in Germany, Japan, Korea, and US), by other government (e.g. in Finland and Sweden), or the responsibility is split between national and local authorities, like in the UK. Two of the four European Union (EU) Member states (Finland and Germany) are in a transitional phase in which they must implement an integrated approach in accordance with European Commission Directive on integrated pollution prevention and control (IPPC).

The key role and influence of international and regional institutions and fora[1] must also be underlined. For instance, the Oslo and Paris Commission for the Protection of the North Sea (OSPARCOM) and the Helsinki Commission for the Protection of the Baltic Sea (HELCOM) have been the chief political body for the landmark agreement leading to the adoption of the precautionary principle for the protection of marine environments. Discussions at the IJC have played an important role in introducing stringent environmental quality goals (e.g. the virtual elimination of persistent toxic compounds) in the different state and provincial jurisdictions of the North American Great Lakes. Although non-binding, these guidelines are generally integrated in the regulatory framework of the contracting parties.

The use of EQOs and BAT

There are typically two different approaches for setting pollution limits and permit conditions that affect industrial activities, including those of the iron and steel sector:

– Emission limit values (ELVs) that must be met within a given time frame. These limits are based on an appraisal of the best available technology/techniques for reducing discharges and emissions, taking into account the economic feasibility of those means. Although the

1. Such as the Oslo and Paris Commission for the Protection of the North Sea (OSPARCOM), the Helsinki Commission for the Protection of the Baltic Sea (HELCOM), the International Joint Commission for the Great Lakes (IJC) or the UN/ECE Convention on Long-Range Transboundary Air Pollution (LRTAP).

permit samples show that all countries have used BAT to set permitting conditions, the concept is only made explicit in the legislation of Finland, Germany, Sweden, UK, and US;

– Environmental quality standards (EQSs) and objectives (EQOs). EQSs define the concentration limits not to be exceeded at particular locations and the EQOs provide long-term policy guidelines or targets. Permitting systems in Japan and Korea, for instance, are based on the use of EQSs when determining ELVs for industrial point sources.

The stringency of BAT-based emission limits usually depends on the size of the plant, type and amount of releases, and the nature of the receiving environmental media. The European Union Member states adopted a similar definition for BAT where performance-based limits are set on the basis of the upper 15 per cent of the best environmentally and commercially-established technologies. In the wake of the IPPC Directive of the EC, there is also a likely trend toward harmonisation of integrated BAT-based limits in the EU. Approaches to applying BAT differ among countries: e.g., regulatory frameworks in Germany and the US are more rigid and are more rigidly interpreted preventing any relaxation of BAT-based limits. In Finland, Sweden, and UK, definitions are more general, and there is generally room for discretion on the part of the authorities who may relax BAT-based limits if the quality of the local environment allows it. This, however, is the exception confirming the rule. In addition, Germany, the UK and the US have also established national emission standards which serve as minimum binding requirements when determining pollution limits in permits.

Although BAT-based limits appear to be a common driver for setting permit requirements, they are themselves influenced by the need to preserve a certain level of environmental quality. Each country has reported that EQSs and EQOs are defined according to a different type of environment, e.g. sensitive ecosystems, urban areas, etc. The carrying capacity of the environment is usually determined by taking into account different factors such as the protection of public health, the protection of ecosystems, the avoidance of transboundary pollution, water uses, and cost/benefit trade-offs of the activities under review. In some cases, EQSs and/or EQOs may lead to more stringent requirements than BAT, as reflected in one case provided by Finland. In countries such as Japan and Korea, national EQSs are negotiated at the national level and cannot be relaxed in any circumstances when defining permit conditions.

Differences in regulatory approaches aside, the permit samples and information provided show that BAT and EQSs/EQOs complement each other in setting optimal and tailored permitting requirements. For example, all countries use EQSs as an overriding regulatory principle which is often accompanied by some form of technological assessment when assessing optimal and cost-effective pollution limits. This complementarity is increasingly acknowledged, even in countries like Japan and Korea whose permitting approaches are legally based on the translation of EQSs into pollution limits for industrial point sources.

Overview of permit samples and related procedures

All countries have provided permits for air while six out of seven included permits for water (either as media-specific or integrated permits). Finland, Sweden and UK provided permits covering land and waste issues. This report focuses on water and air pollution, and discusses integrated approaches where country information is available.

The results and conclusions of this study only serve to illustrate general trends and findings, since they are based on a limited number of permits which are not easily comparable. However, while participating countries represent only a small fraction of the global iron and steel industry, the conditions and ELVs contained in the permit samples do reflect current trends for the sector. Thus, there are similarities in the type of environmental controls and requirements set by the different countries. Pollution prevention and control of emissions and discharges of heavy metals (e.g. mercury, cadmium) and persistent organic compounds (e.g. dioxins), the handling and treatment of waste, as well as related monitoring programmes are all covered in the permits. The following sections further highlights some similarities as well as differences in permitting approaches and conditions as found in the permit samples for air and water.

Air permits:

- Control parameters and requirements vary between countries. Differences may be explained by the types of industrial processes under review, as well as related to the complexity and costs associated with different means of control parameters and monitoring programs;

- All countries use sum parameters (e.g. dust, opacity) although some countries have targeted specific substances (e.g. dioxin and mercury) as a means of increasing pollution prevention and control;

- There is a trend towards using specific ELVs-based limits per unit of production to prevent dilution as a means of meeting compliance while concentration-based limits are still used (e.g. in the Korean permit); and

- Schedules for compliance are extensively used in permit samples to provide flexibility to the operator. Operators can also ensure compliance monitoring conditions by either lowering production volumes (e.g. in the US) or by reducing environmental impacts permit of production performance beyond permit conditions (e.g. in Finland).

Water permits:

- There are countries where discharge limits are more stringent than those adopted in international agreements; e.g. the pollution limits set in the Finnish permit and notification procedure are reported as more stringent than in the HELCOM decision 11-5;

- In both Japanese permits, BAT has been used as a driver for complying with EQSs because of the inadequacy of the latter to set appropriate discharge levels for multiple point sources in a single sector; and

- ELVs in the Swedish permit indicate that BAT-based limits override EQOs and economic considerations to comply with reduction targets regarding depositions of acidifying compounds and persistent toxic compounds.

Conclusions

Despite differences in national policies, the permit samples show that both technology-based and environmental quality-based approaches have been used for setting permitting requirements by all countries reviewed. There is a convergence in approaches with EQSs representing minimum standards not to be exceeded in any circumstances, while BAT is the first criteria for decisions, even in countries like Japan and Korea who do not legally stipulate its use. Permitting decisions may relax BAT-based limits if allowed by local conditions, but this represents the exception rather than the rule.

Differences between countries which stipulate BAT as a key regulatory factor lie in the relative discretion of authority for setting pollution limits. While Germany and US have binding rules governing the setting of BAT-based limits, other countries have more discretionary power taking other considerations into account. However, such procedures and approaches are rather exceptional.

An important difference is that some countries, e.g. Germany, the UK and the US have established national limits, while Finland and Sweden defined BAT on a case by case basis. It is beyond this study to identify any assessment of the relative advantages between case-by-case and top-down permitting. However, some permit samples indicated that local considerations might increase the stringency of permit conditions beyond BAT-based levels.

There are a number of differences in ELVs and permit conditions among the samples. This may be related to differences in means to implement permit conditions (e.g. specific substance versus sum parameter, concentration-based or production-based limits leading to different end results) or national preferences regarding risk assessment (e.g. BAT-based limits actually ban sintering operations in Sweden, while the process is allowed under UK's BATNEEC note). The flexibility allowed by the type of permitting system also influence the stringency of permit conditions at the margin (e.g. monitoring and/or control parameters requirements have implications on the stringency of similar levels of ELVs).

According to the permit samples, the combined use of BAT and EQO appears to be a prerequisite for setting the most appropriate permitting requirements, taking into account local conditions.

There is however a gap between current practices, e.g. BAT versus EQO, and current legislation and rules that only partially stipulate the practice. For instance, Japan and Korea do not reference the concept of BAT in their legislation, while other countries have overly rigid provisions for BAT. Again, it is beyond the scope of this study to assess the relative impact of current approaches on the capacity of the sector to spur the best environmental performance, but several questions still remain regarding case-by-case treatment versus top-down approaches, and how to integrate local considerations.

The information provided by countries indicate that environmental management systems and life-cycle approaches are increasingly used to set the most appropriate permitting requirements. This highlights the importance of the competence and professional judgement of permitting authorities in dealing with point sources, and keeping abreast of scientific, technical and economic developments at the local, national and international level.

There is a convergence in country's approaches whereas control parameters, measurement periods and timetable for compliance vary in accordance with the nature and circumstances of the environmental impacts, as well as the age, size and status of the facilities under review.

Permitting outcome on the technological response

The technological response to the permit requirements shows that industry is capable of adapting to stringent requirements, and that pollution prevention is increasingly taking the fore of environmental strategies. It also illustrates that countries are moving from control and mitigation approaches towards pollution prevention by focusing on resource productivity or eco-efficiency strategies in order to meet both environmental and economic objectives. A hierarchy of actions from this case study seemed to emerge:

- Pollution prevention and reduction at source (e.g. for dioxins and heavy metals), by better management of input materials and fuels, and rationalisation of processes (e.g. continuous casting);

- Increased recycling of wastes and by-products to be used as input materials, in order to increase resource productivity;

- Development of closed-loop systems, e.g. closing of water circuits; and

- The use of end-of-pipe techniques to control and reduce remaining emissions.

In their replies, the most operators agreed that the permitting system ensures an appropriate balance between BAT and EQO considerations. However, some operators, i.e. in Sweden and the US, have criticised the conditions under which the permit conditions were adopted. In the Swedish permit, the operator argued that ELVs were based only on BAT considerations and not on a balance of EQO and economic considerations. In the US, the operator judged that some permitting conditions were unnecessary and generating costs. In general, the operators felt that performance-based limits were appropriate as they provide enough flexibility to comply with permit conditions, and thus faster innovation.

1. INTRODUCTION

In September 1993, the Pollution Prevention and Control Group (PPCG) of OECD's Environment Policy Committee initiated a study on the use of Best Available Technology and Techniques (BAT) and Environmental Quality Objectives (EQO) and Standards (EQS) in environmental regulations of industrial pollution sources. The first phase of the project surveyed general policies in Member countries. The results of this work have been published in the Reference Guide on Environmental Requirements for Industrial Permitting (OECD, 1997).

This survey provided general information on the use of BAT and EQO within the permitting and regulation systems of Member countries. However, the specific use and application of policies for individual industrial sectors was not analysed. The PPCG, therefore, decided to conduct a series of case studies to define the application of BAT and EQOs within some sectors of industry, in order to improve understanding among Member countries and identify key issues and approaches for policy development. Pulp and paper, metal finishing, oil refining, and iron and steel were the four sectors of industry selected for carrying out case studies in which 16 Member countries participated.

The purpose of these case studies was to provide more in-depth understanding of how the requirements contained in environmental permits were developed. Through the analysis of actual permit requirements assigned to specific facilities, the case studies were designed to shed light on the relationship between all the determinants of permitting decisions and the environmental and technological performance of permitted facilities.

This report on the iron and steel sector is an analysis of the information and the permits which have been provided by participating countries. Seven OECD Member states (Finland, Germany, Japan, Korea,[2] Sweden, the United Kingdom, and the United States) and one Observer country participated in the iron and steel case study. The relatively small number of permit samples provided for this case study and the fact that they did not cover all media in each country has made it difficult to carry out a detailed comparative assessment of the integrated approaches and media-specific permitting systems. Some of the information gaps have been filled by literature surveys on environmental issues in the iron and steel industry, contacts with regulatory agencies, international organisations and the private sector. The principal questions and issues examined throughout the project included:

i) How are EQOs brought to bear in setting permit requirements: what is the sensitivity of permit requirements to EQOs?

ii) How is BAT being applied in setting permit requirements? How are BAT-based requirements being strengthened in "areas of poor environmental quality", where basic control technology requirements are insufficient; and what is the relationship between requirements for point sources and non-point sources of the same pollutants?

2. At the time of the project, Korea was an Observer country. It became an OECD Member country in 1996.

iii) How do EQO and/or BAT-based requirements interact, and how are they defined in establishing permit requirements? Are they combined or are they set independently from each other?

iv) How are economic considerations being dealt with in the standard setting and permitting process, particularly in view of policy issues related to the possible relaxation of BAT-based requirements in "clean" areas?

v) How do permit requirements influence:

a) the type of pollution abatement and control technology used?
b) the measures and management techniques used, such as cleaner production processes, to prevent the generation of pollutants?
c) technological innovation?

vi) Do permit requirements and approaches differ for new facilities and existing industries that undergo major expansions or modifications?

vii) How is integrated media permitting being implemented compared to single medium permitting? What are the advantages and disadvantages?

viii) Which are the common elements of the permitting systems of different countries, and what are the trends in industry's technological response to permits?

In spite of the limits of this policy analysis, the case studies have produced valuable information on permitting approaches in participating countries which may be of interest to public authorities, associations of industry and the general public in the different countries. In addition, the report provides sector-specific information for the various studies that have been published in the course of this project on Environmental Requirements for Industrial Permitting (i.e. the project report and the Reference Guide on Environmental Requirements for Industrial Permitting).

Structure of the Report

Chapter 2 provides an overview of some key economic, environmental and regulatory perspectives for the iron and steel industry. Chapter 3 compares the regulatory framework and policies in participating countries, in particular the relationship between regulatory concepts in use and permitting trends. Chapter 4 examines the information provided in permit samples so as to illustrate various permitting strategies. The technological responses of the facilities to permit conditions are also provided. Chapter 5 focuses on the overview questions of the project, namely how BAT and EQO approaches are being used in setting pollution limits and permit conditions as well as their influence on the type of technological response induced. Finally, in Chapter 6, the report draws conclusions on the key issues that have been identified in the permit samples and permitting information provided by participating countries.

Country profiles are provided as separate annexes to the main report. Each country profile includes a summary of the national regulatory framework, its implication for the permitting procedure as well as a detailed presentation of the permit samples that were provided and the related technological responses of the selected facilities.

2. GENERAL OVERVIEW OF THE IRON & STEEL INDUSTRY

2.1 Economic and Technological Perspectives

The iron and steel industry is by far the largest and most important metallurgical industry in the world.[3] World crude steel production grew steadily from 1960 to 1975 with annual average growth rate of 4.2 per cent. During this period, OECD countries almost doubled their production, while developing countries more than trebled theirs. Since the mid 1970s, world production of crude steel has stagnated around 700 million tones per annum, despite rapid growth in developing countries. From 1975 to 1993, growth in world crude steel production averaged 0.7 per cent per annum. This strong growth in steel production over the past two decades, particularly in East Asia, China and South Asia, was largely a result of rising incomes and strong demand for steel. In the last 30 years, technological development in the iron and steel industry has been characterised by the dominance of integrated steel production followed by the increased use of the electric-arc-furnace (EAF) which accounted for respectively 60 per cent and 32 per cent of the world production of crude steel in 1994.[4]

Steel is manufactured by “integrated” and “non-integrated” producers (see Table 1). Integrated producers generally make steel from iron ore, coal, and limestone as the basic ingredients, using coke ovens, blast furnaces (which produce an intermediate product called pig iron), and basic oxygen furnaces (which are used to process pig iron into steel). Non-integrated producers make steel by melting and refining ferrous scrap at generally smaller scale EAF facilities (often referred to as minimills). Basic oxygen furnace (BOF) facilities are generally used to produce high volume and/or high quality flat-rolled carbon steel products, while EAF facilities have traditionally focused on producing either carbon steel bars, rods and structural shapes, or high value speciality steels (such as stainless and tool steel).

When making steel with BOFs, cokemaking and ironmaking precede steelmaking. Coke, which is the fuel and carbon source, is produced by heating coal in the absence of oxygen at high temperatures in coke ovens. Pig iron is then produced by heating the coke, iron ore, and limestone in a blast furnace. In the BOF, molten iron from the blast furnace is combined with flux and scrap steel and high-purity oxygen is injected. Conversely, the input material for the EAF is primarily scrap steel, which is melted and refined by passing an electric current from the electrodes through the scrap. In both processes, the molten steel is then formed into ingots or slabs that are rolled into finished products. Rolling operations may require reheating, rolling, cleaning, and coating. Iron and steel products include unfinished items such as bars, strips, sheets and formed products such as steel nails, spikes, wire, rods and pipes. Depending on the equipment used, saleable products may also include by-product coke, and products derived from chemical recovery in the coking process such as coal tar and distillates.

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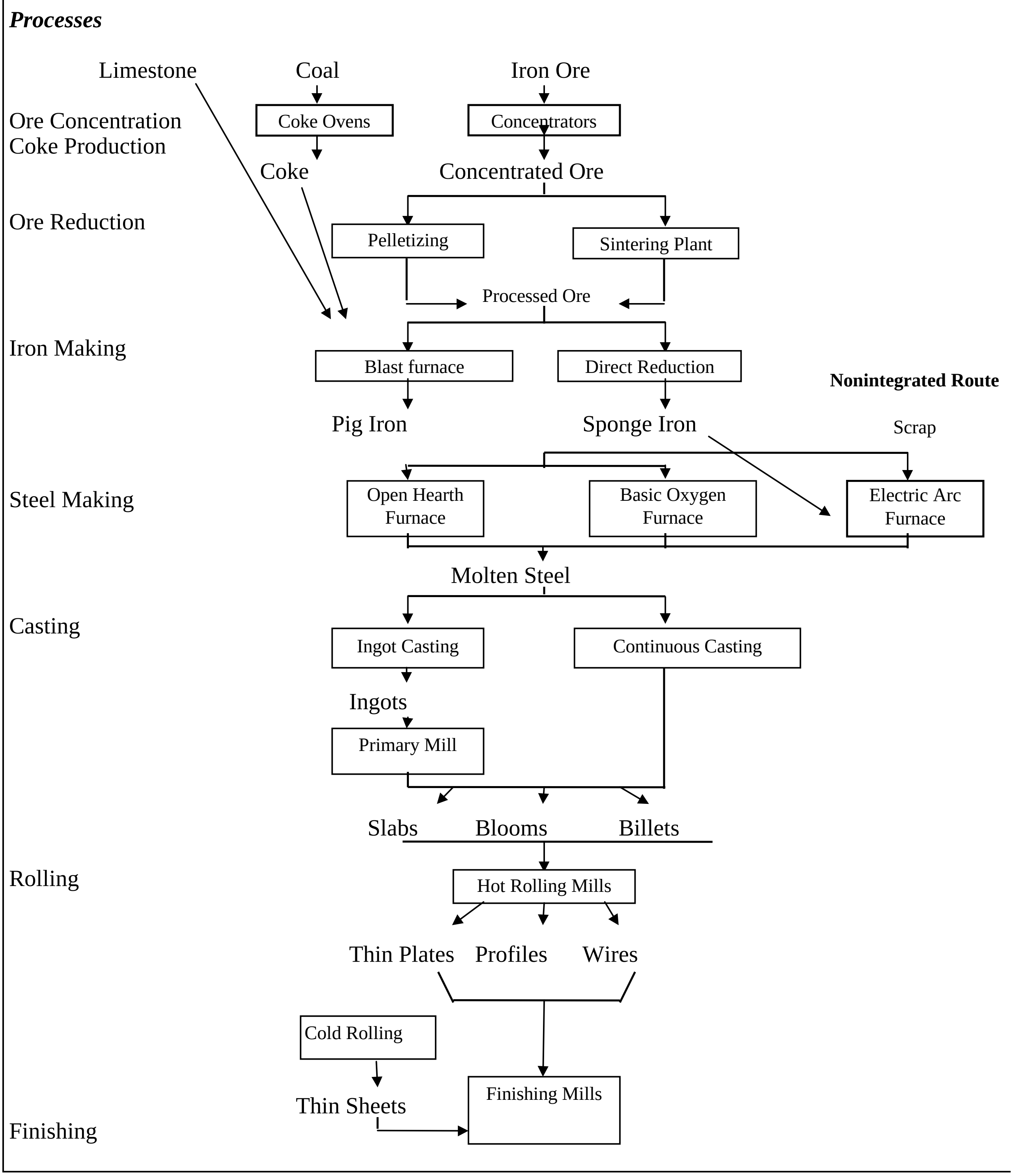
3. Christmas, I., “The Steel Industry’s Central Role in Sustainable Development”, Main Presentations at the First Global Consultation on Environmental Management/Cleaner Technologies in the Metallurgical Industry, UNIDO, Vienna, Austria, 16-18 October 1995, pp. 5-9.

4. Angulo, F., “Implications of the Globalization Process in the Metallurgical Industry (Issue Paper)”, Ibid.

Table 1. **Main production routes in the iron and steel industry**



Note: The table has been taken from Levine, M.D., Martin, N., Price, L., Worrell, E., "Efficient Use of Energy Utilizing High Technology", World Energy Council, London, September 1995.

The major oil shocks of the 1970's and the subsequent increasing cost of energy have prompted the industry to improve its operational efficiency by investing in new technologies and shutting down old plants. In view of the high cost of new equipment and the long lead-time necessary to bring it into line, changes in production methods and products have usually been made gradually. The introduction of new equipment and the necessary retrofitting of other processes impose direct and indirect costs on the industry. Even proven technologies that improve productivity, such as the continuous casting process, have only been adopted over long periods of time, indicative of the fact that steel producers have had difficulties in financing major investments.

Since the 1970s a reduction of nearly 20 per cent in total specific energy consumption has been achieved. These results were reached directly by innovations such as continuous casting which eliminates a reheating step and, indirectly, by reducing the amount of crude steel needed for each tonne of finished steel products. The percentage of continuous cast steel in market-based economies rose from under 10 per cent in 1970 to over 80 per cent in 1995.[5] Furthermore, the growing use of continuous casting, combined with other increases in process and product efficiencies, improved the yield of crude steel for steel products. One tonne of crude steel yielded 0.78 tonne in 1974, 0.84 tonne in 1990, and 0.86 in 1994.[6] Also, energy intensity in 10 OECD countries, i.e. energy use per unit of manufacturing value added, declined by an average of 1.9 per cent annually between 1971 and 1991 in the iron and steel sector.[7]

Another major cause of the reduction in energy needs by the iron and steel industry is related to the use of scrap as raw material. Increasingly, recycled metals are becoming a major part of the total metal supply of this industry. In 1993, total world consumption of scrap was 435 million tonnes per year (TPY) which corresponds to the world crude steel production in 1964. Of this total, 385 million tonnes of scrap were used for steel production saving 640 million tonnes of iron ore. Steel produced from scrap requires 60 per cent less primary energy than steel produced from ore. Over 40 per cent of total steel production is now based on recycled rather than virgin materials, which makes it the most recycled of all materials.[8]

Despite the growth of scrap-based steelmaking, iron ore remains the principal source of iron for steel production. In 1994 production of pig iron was 511 million tonnes world-wide and provided the principal basis for the 724 million tonnes of crude steel produced.[9]

According to some experts, the demand for steel will probably exceed supply estimates in the next decade. Following a minor recession in 1996, where steel production fell by 0.4 per cent, a strong recovery in demand was expected to take place in 1997 in most OECD countries, of the order of 3.5 per cent.[10] Therefore, the substantial improvements experienced in global markets would have continued. By 1997, the annual steel production was projected to peak at 796 million tonnes. Steel production will continue to experience strong growth of EAF plants. In 1993, BOF production accounted for 65 per cent of the Western world steel production (504 million tonnes) while the EAF and the open-hearth furnaces

5. Christmas, I., Op. cit.

6. Angulo, F., Op. cit.

7. Levine, M.D., Martin, N., Price, L., Worrell, E., Op. cit.

8. Christmas, I., Op. cit.

9. "The World Market for Iron Ore", Steel Information, International Iron and Steel Institute, Brussels, July 1995.

10. "Outlook for the Steel Market in Countries Participating in the OECD Steel Committee in 1997", OECD News Release, Paris, 5 March 1997.

(OH) production amounted to 34 per cent and 1 per cent respectively. For the year 2000, the forecast is expected to be at 58 per cent, 41 per cent and 1 per cent respectively.[11]

2.2 Environmental Protection Perspectives

The iron and steel industry is a major source of air and water pollution, generates large quantities of waste materials, occupies large tracts of land, and gives rise to vast mining and waste disposal areas. The immediate environmental challenges for this sector are the control of air pollution (in particular CO_x, SO_x, NO_x, particulate matter and metals), solid waste disposal and recycling (especially slag and collected dust), and waste water treatment. More recently, dioxin emissions have become an issue of concern with the growing use of scrap as input material.

Environmental regulations in OECD Member countries usually affect industry throughout all stages of the manufacturing and forming processes. The increasing cost of energy and the introduction of stricter environmental regulations have pushed industry to monitor its level of pollutants required by law and to minimise their impacts on the environment. Regulatory pressures have led to investments in cleaner technologies, improving operational efficiency and product yield, the increasing use of scrap and by-products as input material, and the shutting down of old, inefficient plants.

During the 1950s and 1960s, the steel industry's environmental concerns focused primarily on air pollution. Approximately 50 per cent of total expenditure on environmental control was devoted to this problem and resulted in significant improvements over the last two decades. For example, in Germany, air emissions dropped from 9 kilograms per tonne (kg/t) of crude steel in the early 1960s to 2.4 kg/t by the end of the 1970s. According to the International Iron and Steel Institute, emissions have been further reduced to 1 kg/t in 1995.[12]

Nevertheless, the iron and steel industry continues to be a major source of pollution. Both integrated and non-integrated production facilities emit significant quantities of heavy metals into the atmosphere. Dust from primary processes may contain several heavy metals such as cadmium, lead, chromium, nickel, zinc, copper and arsenic. Mercury is also emitted from coke plants. Dust from stainless steel production can contain 4-5 per cent nickel and chromium and dust from merchant iron production may contain 20-40 per cent zinc and 3-5 per cent lead. These emissions occur at different stages during storage, handling, crushing, sieving and transport of metal-containing materials. For industry, the stringency and timing to meet requirements for coke ovens (particularly in the United States' Clean Air Act (CAA)) is of particular concern since to date there is no alternative process available for attaining compliance. The industry has either to pay fines when exceeding the limits or is forced to shut down operations. Indeed, the closing of some plants in the US and subsequent opening of minimills have been reported.[13] However, at this time, minimills cannot produce the full range of products made by integrated

11. Krouzek, J.V., "Trends of the Iron and Steel Industry in the Developing Countries", UNIDO Conference, Op. cit.

12. Christmas, I., Op. cit.: The given data are gross estimates provided by the representative of IISI during the UNIDO Conference. A more elaborated description of the progress of the German iron and steel industry in abating discharges/emissions can be found in: THYSSEN STAHL AG, Umweltbericht 1995, Duisburg, Germany.

13. Communication with R. Di Carlo, Industrial Programs Branch, Environment Canada, October 1995. According to USEPA, this observation is not fully correct, as the mills that claim to have been forced to close down their plants due to stringent regulations, were actually operating uneconomically.

steelworks. More than half of the market for quality steel products remains beyond minimill capability.[14] In order to achieve compliance, pollution prevention activities in cokemaking have focused on two areas: reduction of coke oven emissions and development of cokeless ironmaking techniques. The former is being followed by changing the method by which coke is added to the blast furnace or by substituting a portion of the coke by other fuels. The latter is being investigated by looking for means to eliminate the need for cokemaking, e.g. substituting coal for coke in the blast furnace.

In 1993, 30 million tonnes (28 per cent) of the steel produced within the contracting parties to the Oslo and Paris Commission (OSPARCOM) came from scrap melted in EAFs; the quantity and percentage produced with EAFs is expected to increase in the future.[15] As the composition scrap varies according to its origins, the content of the emitted dust changes from plant to plant. In addition, the scrap composition has been shown to influence the oxygen content in the furnace and, subsequently, the formation of volatile organic compounds during the operations.[16] At EAF steel plants, heavy metals and toxic organic substances such as polycyclic-aromatic hydrocarbons (PAH) and dioxins are emitted together with the process gases during the melting of scrap. Toxic metals are either alloy elements like nickel and chromium or contaminating elements like lead, mercury and cadmium. Mercury is emitted mainly in gaseous form. Emissions of heavy metals also occur from the cutting of scrap, from the converters and from casting. The content of metals in dust varies widely according to the type of steel produced.

A rough estimate of secondary steel plant emissions reported by the Contracting Parties to OSPARCOM shows that approximately 15 000 tonnes of dust are emitted per year. The estimate is made assuming dust emission of 0.5 kg/t melted steel. Annual emissions are significant for some metals. Based on a correlation between dust emissions and metal content, emissions from secondary plants have been estimated for both mercury and cadmium as 6 tonnes per year. For lead the amounts were estimated to be 550 tonnes, and for zinc 3 500 tonnes per year. In Sweden, between 15 per cent and 30 per cent of total industrial emissions of metals (Cr, Hg, Ni and Zn) are generated by minimills. The emissions of organic components from steel plants are not fully determined but some components are well known. Approximately 25 per cent of dioxin emissions in 1989 were related to secondary iron and steel facilities. The emissions of dioxins from the secondary iron and steel industry within the Contracting Parties to OSPARCOM are estimated to be 0.5 kg/year. Chlorobenzenes and chlorophenols are emitted by steel plants as well.

In both the integrated and non-integrated processes, control devices such as fabric filters, electrostatic precipitators and scrubbers are used to capture and reduce the amount of dust emitted. However, when using these techniques, environmental trade-offs such as the generation of increased quantities of toxic waste need to be considered, e.g. a wet scrubber uses about 3 800 litres of water per tonne of steel. The principal pollutants removed from the waste gas are total suspended solids and metals (mostly zinc and lead). Any further reduction of emissions, however, can only be achieved by using an increased amount of energy, which will result in increased emissions from power stations.

14. Common Sense Initiative (CSI), United States Environmental Protection Agency, October 1995.

15. Estimates of emissions for the secondary iron and steel industry of the contracting parties to OSPARCOM are taken from: "Environmental Impact from the Existing Secondary Iron and Steel Industry (Presented by Sweden)", Working Group on Point Sources OSPARCOM, The Hague, 14-18 November 1994.

16. Lindblad, B., "Effect of Scrap Preparation on Emissions and Steel Composition", Jernkontoret Forskning, Stockholm, February 1994.

In addition, the iron and steel industry generates large quantities of solid by-products and waste materials. Conventional integrated steel plants produce 500 kg of solid waste per tonne of crude steel whereas minimills generate 20 kg/tonne.[17] Almost 90 per cent of the solid by-product generated in steel production can be recycled, either as recuperated raw materials or as saleable products. Indeed, the slag generated in ironmaking processes is reused extensively in the construction industry. BOF slag can be processed to recover its high metal content for use in sintering or blast furnaces, but its application as saleable construction material is more limited than the blast furnace slag (used for road aggregate and cement).[18]

But despite progress, environmental problems related to toxic releases as well as material and energy intensity remain significant. In the United States, although on-site releases reported by the steel industry dropped by 42.7 per cent between 1988 and 1992, the total amount of reported toxic waste has not declined because the waste transferred off-site has increased from 3.7 billion pounds in 1991 to 4.7 billion pounds in 1993.[19] Fugitive emissions, i.e. accidental escaping of dust and particles during operations, are also significant and occur from multiple sources, numerous production units as well as from handling and storage of minerals. The iron and steel industry is also one of the largest energy-consuming industry sectors, accounting for 10 to 15 per cent of the global industrial energy consumption.[20] Emissions of large quantities of CO_2 from steel production, as the inevitable by-product of the reduction of iron ore to pure metal in the blast furnace, are likely to become a major concern in the light of their impact on the global climate. No feasible economic alternatives to blast furnaces exist today for the bulk of iron production and, therefore, according to the International Iron & Steel Institute (IISI), the ability of the industry to reduce CO_2 emissions below the levels achieved over the last 20 years is very limited.[21]

17. Angulo, F., Op. cit.

18. Christmas, I., Op. cit.

19. Toxic Releases Inventory, United States, 1993.

20. “Energy Statistics and Balances (OECD 1960-92; non OECD 1971-92)”, Paris, International Energy Agency, 1994.

21. Christmas, I., Op. cit.

3. THE PERMITTING PROCESS

3.1 Regulatory Framework

All countries stress that national legislation is the framework for developing industry-specific regulations and defining the permitting procedure. Pollution prevention and control is legally defined through specific laws that relate to individual media and, therefore, provide guidance to permitting authorities (see Table 2). The implementation of environmental policies for industrial sources involves four main activities: standard-setting, environmental permitting, monitoring and enforcement. Environmental permitting plays a key role since it entails the decision-making process in which pollution limits and other environmental conditions are adopted, including monitoring programmes. Obviously, the success of permitting programmes must be based on strong, far-sighted requirements that are predictable and enforceable.

Table 2. **Main environmental legislation of countries in the case study**

Country	Legislation	Permitting approach
Finland	Air Pollution Control Act Water Act Waste Management Act	Integrated permit for air, waste and noise Segregated for water
Germany	Federal Immission Control Act Federal Water Act Waste Management Act	Media specific for air, water and waste
Japan	Air Pollution Control Law Water Pollution Control Law Waste Disposal and Public Cleansing Law	Media specific for air, water and waste
Korea	Air Quality Preservation Act Water Quality Preservation Act Noise and Vibration Control Act	Media specific for air, water and waste
Sweden	Environment Protection Act Act on Chemical Products Natural Resources Act	Integrated for air, water and waste
United Kingdom	Environment Protection Act	Integrated for Part A processes Air permit only for Part B processes
United States	Clean Air Act Clean Water Act Resource Conservation and Recovery Act	Media specific for air, water and waste

Two regulatory approaches are used for setting technology- and environmental quality-based objectives which will influence both pollution limits and permit conditions:

- on the one hand, the environmental quality approach is used to set maximum concentration pollutant loads which must not be exceeded. The purpose of ambient limit values (i.e. environmental quality standards) is to provide regulatory authorities with safety margins against which they can set pollution limits for permits. The level of stringency and the policy nature of EQSs and EQOs, i.e. whether they are binding requirements or voluntary guidelines, will usually vary according to policy needs, i.e. protection of public health and/or a sensitive ecosystem, long-term environmental targets, etc.;

- on the other hand, the technology-based approach is used for identifying numerical performance-based standards which are set at levels based on the results achievable with available technologies or techniques (i.e. the BAT approach). Technology-based emission limits are often considered as the most appropriate means for controlling and reducing environmental releases since it is easier to determine the nature and quantity of environmental releases and to check compliance through end-of-pipe monitoring. Their increasing use has been associated with the implementation of the Precautionary Principle in cases of scientific uncertainty about the risk of pollutants to humans and the environment.

Permitting systems in OECD countries address large scale industrial point sources but the procedure and level of responsibility may vary. Permits are issued at the national level in Finland, Korea and Sweden, and by local authorities in Japan, Germany, and the United States. In the United Kingdom, this responsibility is split between Her Majesty's Inspectorate of Pollution (HMIP) and the Local Authority Air Pollution Control (LAAPC) according to the status of the facility. Only Sweden and the United Kingdom run an integrated permitting system. However, in the United Kingdom, integrated permits apply only to industrial facilities which emit to air, water and land (designated as Part A processes). Processes which emit mainly to air are ruled by air permits under local authorities (Part B processes). In Finland, air quality, waste and noise requirements are specified in one permit, but water quality is regulated through specific permits. The iron and steel sector, which typically entails major environmental impacts, must seek a permit from the relevant authority in all countries.

3.2 The Application Procedure

Permits are generally required for new facilities, for major changes to existing plants, and in cases where some new conditions would substantially alter the quality or quantity of emissions. A revision of permits may also be required following changes in environmental laws, breach of permit limits, or evolving conditions in the receiving environment. It appears that the major difference between permitting new and existing industries is the time frame for implementing permit conditions. New industries are required to implement them immediately while, for financial reasons relating to the installation of equipment, existing plants are allowed a period of time to implement the changes. Countries may refuse to grant an authorisation if expected releases from an applicant's proposal would breach EQSs/EQOs.

The duration of permits among the participating countries ranges from 2 years to no specified time (Korea). In Sweden, the duration of permits is unlimited. However, the conditions for the permits can be reviewed after 10 years. Generally, the date of expiry lies between 3 to 10 years. In Germany, the duration of permits is not limited and a granted permit may only be revoked by the licensing authority in cases where the conditions that were the basis for the permit have changed.

The information required by countries generally includes raw materials and input, process information, quantification of effluent/emission releases, pollution control plans, and studies to predict environmental effects. The participating countries require an environmental impact assessment at some stage of the permitting procedure. For new plants, an environmental impact assessment is normally required during the licensing procedure.

The application period is expected to lead the applicant towards state-of-the-art operations and practices. The operator should be aware of the permit conditions in similar facilities (e.g. ELVs, monitoring programme and requirements for environmental investigations) and should strive for similar or better environmental performance.

An applicant may appeal against a permitting authority's decision in all jurisdictions, but only at the standards-setting level in Japan and Korea. European countries will accept an appeal only if it does not lead to a breach of European Directives or nationally-set binding requirements. In the United States, which is characterised by a highly legalistic system, any individual may appeal against a decision on permit conditions that could lead to the violation of the regulation requirement or if the procedure was not followed as legally stipulated.

All permitting authorities will normally tolerate the negotiation of the phase-in period for existing facilities to reach compliance with the newly adopted requirements. However, in Korea, after accepting the permit conditions, the operator must pay emission/discharge charges if he fails to meet the standards.

3.3 Negotiation of Pollution Limits

As mentioned, two approaches are used to set pollution limits and conditions in permits. Permitting authorities used EQOs and EQSs and/or technology-based standards either as guidance or binding rules, in defining the final outcome of permit conditions on the basis of nationally-set standards which usually represent minimum requirements that cannot be altered at the local level.

In Finland, Sweden and the United Kingdom, requirements could deviate theoretically from national guidelines in some circumstances. However, local authorities would not be allowed to set conditions which would breach national standards or environmental obligations related to international treaties. The United Kingdom may accept less stringent requirements than BATNEEC if the operator's proposal does not breach any EQSs. Finland and Sweden may also relax BAT-based limit values within the locally-set environmental quality requirements.

In Germany and the United States, national BAT-based limit values are binding requirements which the operator must comply with whatever the local circumstances. Moreover, Germany states that pollution limits cannot be negotiated on health related issues. However, in the United States, economic considerations may allow some deviation from EQOs or BATs. Permits can be tailor-made to satisfy local EQOs or to determine the level of stringency of technology-based standards if the applicant (or state) is able to demonstrate that standards are not achievable either technically or economically (see Section 3.6 on economic considerations). In Japan and Korea, EQSs are minimum requirements not to be exceeded in any cases; any exceedence of EQSs will lead to stricter conditions on the operator.

Significant differences may be found in the benefits and shortcomings of "top-down" approaches and case-by-case permitting. The former involves national binding standards that serve as minimum binding requirements and are typical of the regulatory system in Japan, Korea, Germany and the United

States. The latter concerns the permit requirements that are set locally and are practised in Sweden, Finland, and the United Kingdom. One issue is the extent to which the integration of local considerations may influence the environmental performance of plants and the cost-effectiveness of permit conditions. The debate on this issue is likely to continue as the implications of EU Directives, which set minimum binding standards and procedures for all Member states, are assessed.

3.4 Integrated Media Permitting

Sweden and the United Kingdom presently use an integrated permitting system. Finland, whose permitting procedure is partly integrated (all releases except water), and Germany, which uses a segregated media permitting approach, are in the process of moving toward integration in the context of the upcoming EU IPPC Directive.

Thus, nowadays, Germany, Japan, Korea and the United States (and Finland to a lesser extent) use a media-specific permitting system. However, they indicate in their reply that an applicant's proposal is always considered in the light of an assessment of the environmental impacts to all media before a final decision is reached. In addition, the United States specified that an integrated approach is used to explore the most optimal measures to be applied for the iron and steel sector through the Common Sense Initiative.[22]

There was no mention of any disadvantages associated with integrated permitting except for managing the change to integration. However, the procedure to carry out cross-media analyses still remains to be fully understood.

3.5 Other Similarities in the Approaches of Participating Countries

The four Member countries of the EU share many common elements as most legislation in Western Europe can be traced back to three EU Directives which have been derived from the Community environment policy established in the Council Declaration of 22 November 1973.[23] These Directives are:

i) The Air Framework Directive (84/360/EEC) which made provision to control emissions from industrial facilities by a permitting system under each Member State. This framework Directive is complemented by specific Directives which set the air quality limit values for suspended particulate matter, sulphur dioxide, nitrogen dioxide and lead. These are Directive 80/779/EEC and amendment 89/427/EEC for sulphur dioxide and suspended particulate matter; Directive 85/203/EEC for nitrogen dioxide; and Directive 82/884/EEC for lead;

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22. CSI, Op. cit.: Under the Source Reduction Review Project (SRRP), the United States considered multi-media issues when developing air, water and solid waste standards. The iron and steel industry has been identified in the SRRP as an industry for which a more integrated (across environmental media) approach to rulemaking is warranted. Efforts such as the Office of Water's review of the need for revised effluent guidelines for the industry and the technology-based standards for coke oven emissions under CAA Amendments will be co-ordinated among several media offices.

23. Hatch Associates Ltd., "Releases and Control of Priority and other Substances of Concern from the Iron and Steel Industry in Canada", Environment Canada, 9 March 1995.

ii) The Dangerous Substances Directive (76/464/EEC) which provides the framework for the elimination and abatement of water pollution. Pollutants are categorised according to their properties (toxicity, persistence and bioaccumulation). In the case of the iron and steel sector, carcinogenic substances such as mercury and cadmium are included in the priority list (“black list”) while less dangerous substances such as zinc and copper are found in a secondary list (“grey list”). Compliance with EU standards is checked by the two main methods of control, either the BAT or EQS approaches;

iii) The Waste Disposal Directive (75/442/EEC) requires that Member States shall adopt a waste disposal plan which ensures the integrity of human health and the protection of the environment. The Directive also lead to a classification of waste material according to its toxicity. To qualify as inert, the total concentration of lead, cadmium, zinc, chromium, copper, nickel and mercury in the leachate must be <5 mg/litre. To qualify as non-hazardous, the leachate concentrations must be <2 mg/litre for lead, <0.5 mg/litre for cadmium and 10 mg/litre for zinc. If exceeded, operators must treat the waste in order to render it non-hazardous or it will be disposed of according to a defined set of rules.

In Japan and Korea, emission/effluent discharges are regulated on a regional basis according to the specific uses of the local environment (classification of water bodies) and surroundings (urban areas). Key parameters for the iron and steel sector follow from respective environmental laws which govern the standard-setting procedure for each separate media.

The United States has also developed sector-related standards for the iron and steel sector as well as National Ambient Air Quality Standards (NAAQS) which covers all of the substances included in EU Directives. Albeit some differences, the American approach for industrial permitting is quite similar to the German approach where BAT-limit values are usually binding requirements, even if EQOs/EQSs are met. There are some shared responsibilities between the federal authorities and the states, both in setting permit requirements and EQOs. However, federal statutes represent minimum levels which cannot be altered by local authorities.

3.6 Economic Considerations

In principle, economic considerations should not influence the determination of EQOs and EQSs. They should be strictly based on the definition of safe levels for ensuring the protection of public health and the environment. Germany’s reply indicates that distinctions are made between health hazards and pollution causing disadvantages and impairments. The former must lead to pollution limits not to be exceeded in any case, while the latter may allow less stringent measures.

Economic considerations are more likely to play a major role in the setting of technology-based standards where considerations such as technological capability and the financial situation of a particular industry will take part in the negotiation of achievable standards. Germany, Japan and Korea indicated that economic considerations are incorporated into the standards-setting procedure. The main advantage claimed is that economic considerations do not need to be reconsidered for each permit authorisation. The emission limits are binding requirements that cannot be weakened in permit negotiations. If there is no continuous revision clause on BAT, this approach has limitations in cases where nationally-agreed standards are less stringent than BAT-based requirements and may become obsolete within 3 to 5 years compared to the level of performance achieved through the ongoing technological development. In principle, economic considerations take part in technology assessments. Moreover, all countries weigh the costs of measures when defining the timetable for compliance with the newly adopted requirements.

Except for the United States, the replies of most countries minimised the importance of economic considerations in setting both BATs and EQOs. As such, it would be more appropriate to talk about economic efficiency as a rule which the authority tries to follow in setting requirements either in the national standard-setting procedure or during permit negotiations.

Conversely, in the United States, some decisions may use cost considerations as a factor for deviating from EQOs. For hazardous pollutants, the permitting authority considers costs under maximum achievable control technology (MACT) for sources that apply technology which achieves a greater emission reduction than the average among the best performing 12 per cent of the industry. Considerations will take into account the average and incremental cost-effectiveness based on $/tonne of emissions reduced, as well as the overall economic impacts such as product cost. In the case of water pollution where EQOs are use-based, economic considerations may also lead to less stringent requirements. However, the public or private operator will have to show that attaining the designated use would result in “substantial and widespread” economic impacts or would interfere with important social and economic development.

In such situations, the possible economic effects will include:

- impacts resulting from measures more stringent than BAT-based regulations;
- the incremental cost of meeting required standards.

In addition, to deviate from EQOs, it must be demonstrated that:

- the polluting entity, whether privately or publicly owned, will not be able to afford necessary pollution control measures;
- the affected community will bear significant adverse impacts if the plant is required to meet existing or proposed water quality standards.

Thus the United States will address economic considerations at the implementation stage by taking into account the diminishing returns, both in terms of economic and environmental aspects and in the upgrading of standards.

In the United Kingdom, Finland and Sweden, a sector-related approach is used in the development of BAT. In Sweden, the financial situation of a company representative of the sector will serve as the basis for the assessment rather than that of the individual company being examined. In the three countries, decisions will be based on an assessment of the reasonableness of the costs of the applicant’s proposals. As permits are negotiated on a case-by-case basis, operating requirements are tailor-made so that environmental, technical and economic aspects are taken into account.

Finally, the influence of economic considerations on technological innovation has not been explored in the countries’ replies. However, some countries have mentioned the use of pollution fees, either in the form of taxes (Sweden, Finland) or emission/effluent charges (Korea, the United States) as incentives for promoting pollution prevention and control in the industry.

4. REVIEW OF PERMIT SAMPLES

The permit samples and information provided by participating countries was supplemented with a description of the environmental overview of facilities and the rationale in setting some permit requirements. This information was used to analyse how BAT and EQOs interfere in setting pollution limits and permit conditions. Unfortunately, few comparisons between countries could be drawn due to a number of factors such as the lack of production data to normalise allowable discharges to a mass per tonne or concentration basis, the use of different analytical techniques and differences in measurement periods over which compliance is determined. In addition, the permit samples concerned different type and size of facilities. Only Sweden and the United Kingdom provided integrated permits, making it difficult to assess the relative benefits and shortcomings of media-specific permitting versus integrated approaches (see Table 3).

Table 3. **Permit data base**

Countries	Permits	Industrial process	Permitting approach
Finland	2	- EAF - minimill	- integrated permit for air, waste and noise - segregated for water - notification
Germany	1	- EAF	- provisional decision (air and noise)
Japan	2	- integrated plant - minimill	- segregated permits (air and water)
Korea	1	- integrated plant	- segregated permits (air, water, land)
Sweden	1	- integrated plant	- multimedia permits
United Kingdom	2	- blast furnace - iron foundry	- integrated permits for Part A processes - permit for air only for Part B processes (air)
United States	1	- EAF	- segregated permit for air

Thus, the analysis should be considered as impressions or trends, rather than statistically significant conclusions since they are based on a limited number of permits (8) which are not easily comparable, including a notification procedure (Finland) and a provisional decision (Germany).[24] However, many interesting comparisons can be made between the countries' permitting approaches for pollution prevention and control at source. In particular, various sets of parameters and monitoring requirements, as well as graduated timetables, are extensively used to bring about the continuous improvement of plant performance and to provide operators with more flexibility to adapt to new limits. Greater awareness of the cross-media dynamics of pollutant releases appears also to be a major contributory factor in the design of permit conditions.

The following subsections provide an overview of the content of permit samples as well as the technological response induced at the plant level. The presentation is divided according to media-specific issues in order to identify, if any, how potential cross-media pollution was handled. The technological response to permit conditions as well as the view of the operators on permitting procedures and requirements are provided at the end of Chapter 4.

4.1 Permitting for Water Discharges

Water Permit Limits

Six permit samples provide details on the conditions that are established for pollution prevention and control for water. In their reply, Finland, Japan, Korea and Sweden also indicated that professional judgement was the determining factor in setting permit limits. Case-by-case assessment has obviously been determinant in the outcome of permit conditions. Acceptable levels of environmental performance have been defined by balancing environmental, political and technical considerations. In some cases, EQOs have taken precedence over technical considerations, i.e. Finland, Korea and Sweden, in others, BAT has been the determining factor in setting ELVs, i.e. Japan:

- pollution limits set in both the Finnish permit and notification decision are reported as being more stringent than those of HELCOM Recommendation 11/5. The mill regulated under the permitting procedure is located close to the Russian border alongside River *Vuoksen* which discharges into Lake *Ladoga*. Thus, emissions/discharges may have transboundary impacts and the authority has imposed stringent pollution limits on the basis of both technological capabilities and desired environmental quality objectives;

- in both Japanese permits, priority is given to BAT considerations for setting pollution limits for the purpose of achieving EQSs because the amounts of allocation to individual companies could not be accurately calculated;

- the permit sample provided by Korea is for a facility located in a sensitive ecosystem and the standards and other conditions were set in accordance with the required EQOs for this type of environment, taking into account available technology and techniques;

24. The notification procedure is used in Finland when a facility is judged not to have a polluting impact on the receiving water. In Germany, a provisional decision covers only particular parts of the prerequisites for the granting of a license.

- likewise, limits for water discharges in the Swedish permit are based on both BAT and EQO considerations, with pollution limits for some metal discharges to water (e.g. lead and zinc) deriving from national targets.

The stringency of permit conditions is also determined by the type of control parameters and the time period over which compliance is determined. The permit samples show that regulatory authorities may determine compliance over different time periods, thereby emission limit values are often difficult to compare:

- in the Finnish permit, pollution limits (kg/d) for suspended solids and oil (hydrocarbons) are defined as a quarterly average taking into account by-passes. Analyses are made once a week from weekly composite samples collected with flow related samplers. In the case of the plant regulated under the notification procedure, pollution limits for suspended solids and oil in process waste waters, and for BOD_7 and P_{tot} in sanitary water, are defined as half year average. During that period, at least two composite samples are to be analysed;

- in the Japanese permit, limit values for COD, SS, oil, zinc and iron vary in stringency depending on the age of the facilities (there are nine pipes discharging in public water). In the permits, it is specified that the amount of waste water released and COD must be constantly monitored while measurements of other substances vary from once a week, once a month, every two months, to up to every six months. The frequency of measurements are related to the size of the facilities and, consequently, of the quantity of releases. Only major facilities are subjected to constant monitoring by automatic measurement;

- in the Korean permit, the measurement period varies according to the size of discharging facilities and types of pollutants, but will generally be at least once a week for water discharges. Permit limits have been set according to the concentration of pollutant releases;

- in the Swedish permit, compliance with pollution limits has been determined over different time periods. Limit values have been based on allowable average discharges per unit of production, day, or volume emitted, where the averaging period normally is a year or a month.

Table 4 summarises the frequency of use of different parameters in permit pollution limits and other conditions. It also includes substances/properties for which requirements were set both for pollution limits and measurement programs.

Table 4. **Substances and properties in permits on water pollution control**

Substance/Property	**Water Pollution Limits**			
	Finland	**Japan**	**Korea**	**Sweden**
	Electric Arc Furnace	Minimill	Integrated	Integrated
Zinc		x	x	x
Lead		x	x	x
Total Cyanide		x	x	x
Free Cyanide				x
Suspended Solids	x	x	x	x
COD		x	x	x
BOD		x	x	
pH	x	x	x	x
Oil	x	x	x	x
Ptot			x	
Waste Water	x	x	x	x
Total Hexavalent Chromium		x	x	x
Phenol		x	x	x
Dissolved Iron	x	x	x	
Dissolved Manganese		x	x	
Nitrogen		x	x	x
As		x	x	
Cd		x	x	

Other Water Permit Conditions

Permitting conditions will usually include additional conditions aiming at the continuous improvement of environmental performance, whether by requesting environmental study of environmental impacts of operations and/or proper environmental management and maintenance. In their permit samples, Sweden and Japan require investigations for reducing controlled substances. Separation of contaminated water from cooling water and its recirculation are also requested. Finnish and Japanese permits include obligation for the protection of groundwater by proper maintenance of substances such as oily sludge. In the Finnish permit, monitoring must be conducted on running parameters of treatment facilities and of impacts on the receiving watercourse. This will encourage the use of more efficient pollution control technology to reduce the levels of harmful contaminants in the environment. The Swedish and Finnish permits require that process waste water be recirculated as far as possible (in general up to 90 or 95 per cent), in accordance with HELCOM recommendations on BAT for this sector.

Investigations into the reduction of total phosphorus, total nitrogen, chlorine and stormwater runoffs are specified to assist in the improvement of the pollution control methods being used in the plants. Chemical sludge and hazardous pollutant handling techniques are also reviewed in order to lead to more effective pollution prevention techniques. Other requirements concern emergency plans, monitoring and reporting requirements related to substances referred to in the permit. Only two permits include reporting requirements for accidental spills and breakdowns.

Effluent Monitoring Requirements

Specific monitoring programmes are sometimes required by permitting authorities; in other cases the operators develop proposals and submit them for approval. Regulatory authorities may also conduct their own inspections and sampling activities from time to time. In Japan, local public bodies are responsible for monitoring the quality of water in accordance with the Water Pollution Control Law. Techniques used are formulated in a manual and made uniform. The prefectures disclose the results for public use every year. Monitoring results are used to plan and promote measures to ensure that the specified level of water quality is achieved. Business establishments are also responsible for monitoring activities in accordance with their pollution control agreement. The pollution control is the responsibility of the discharger who keeps a record of releases.

In Korea, industries are required to self-monitor the level of pollutant from their activities. Pollutants to be surveyed and the frequency of monitoring are determined in relation to the size of facilities and the nature (types of pollutants) of effluents.

In Finland, monitoring requirements are established by local authorities who have the responsibility for administering permits through a document called a “control program”. Results of the monitoring process provide important information that feeds into the permitting procedure and determines some of the permit requirements. As permits do not specify who must perform the sample analyses, it is usually up to the permittee to propose and up to the supervising authorities to approve a self-monitoring scheme or a consultant paid for by the applicant itself. The supervising authority reserves the right to make inspections, to take samples, to check diaries and to talk to the facility's staff.

In Sweden, the plant owner conducts monitoring according to a programme that has been determined by the County Administrative Board. The results are considered in the permitting process and made available to the public. One major task involved in the supervision is to check that the conditions stated in permit decisions are complied with by companies. For this purpose, the supervisory authority adopts a control programme. The authority's task is to ensure that the control programme is organised in a proper manner so that it can assess whether the specified conditions are being followed. The test results are then reported to the supervisory authority, which compares them with the specified conditions.

There are some similarities between the control systems of the monitoring of discharges to be found in the countries' replies. All of the countries which provide water permits reported automatic measurements of some of the major pollutants which have to be transferred to the regulatory authorities. The permits normally include an obligation to report the results on a regular basis, such as the month-end, or the end of a quarter year. In addition, countries require the operators to immediately notify the authorities of any breach of the limits, and to take actions to address the exceedence. In one of the Finnish and Japanese permits, a requirement has been made, respectively, for the continuous measurement of wastewater flow rates and of COD. Korea and Finland have also provided a procedure where effluent samples are collected on a weekly basis using composite samples with flow related samplers.

4.2 Permitting for Air Emissions

The seven participating countries have provided permits for air pollution control. Three permits concern both EAF facilities (Finland, Germany and the United States) and integrated iron and steel plants (Korea, Sweden and the United Kingdom), while two other permits relate to a hot rolling minimill (Japan) and an iron foundry (the United Kingdom). The countries have also provided specific values for the controlled substances covered by the permit.

One British facility is a typical iron foundry defined as a Part B process, thereby under the responsibility of the local authority. Limit values are based on a consideration of what BATNEEC for the process can achieve, as set out in the relevant process guidance note, and the specific situation of the plant. The purpose of the upgrading programme is to establish a firm timetable for achieving BATNEEC. However, the emphasis in the authorisation is less on limit values than on how the plant is operated. The second British facility is the first major iron and steel process to be given an authorisation under "Integrated Pollution Control". The permit sample applies to a blast furnace of the integrated iron and steel works. The blast furnace has been out of operation since December 1990 and is being refurbished.

The selected facility for Sweden is the only primary iron and steel plant of the country with conditions based on the technology of today. The permit was reviewed and requirements changed on 15 May 1992 (originally issued on 21 November 1972) because the conditions to which operations were subject were in many cases based on obsolescent technology and were generally out-of-date. The sinter plant was the largest single source of emissions of SO_2, NO_x, particulate matter and metals. The plant also consumed significant quantities of energy, with resulting large emissions of carbon dioxide.

The selected facility for Korea, engaged in both iron and steel works, is located in a sensitive area and so must comply with more stringent limits. The steelworks were built prior to the establishment of the Ministry of the Environment in 1980. Since then, environmental laws have been reformulated several times. Thereafter, the facility was required to amend the contents of permits.

The German permit applies to a plant that is undergoing a major change, namely the conversion of the metallurgical process. The top-blowing converters are to be replaced by EAFs. The submitted sample is a "Provisional Decision" in accordance with Article 9 of the “Federal Immission Control Act”. Provisional decisions cover only particular parts of the prerequisites for the granting of licenses, in this case for air emissions and noise. The content of the provisional decision, especially the limits set for the release of substances, will be part of the permit.

The Finnish facility under review is totally based on scrap materials and one out of two using EAFs. As mentioned previously, the mill is located close to the Russian border on the River *Vuoksen* which discharges into Lake *Ladoga*. Thus, emissions from this mill have transboundary impacts. The hot rolling mill is outdated but was modernised at the beginning of the 1990s. The discharge of wastewater since then has been treated in sand filters and recirculated. The modernisation of EAFs and air pollution control is underway.

The American air permit is for the construction of a new melt shop and Direct Current EAFs to replace an existing melt shop with three smaller Alternating Current EAFs. The old furnaces were removed from the facility. All new construction of emission units requires a construction permit in this state (South Carolina). The new furnace will be substantially different from the existing furnaces in its method of raw material input. The new process (Consteel Process) is being qualified as state-of-the-art. Plant modifications were subjected to the federal New Source Performance Standards for Steel Plant, Subpart AAa. Emission limits for particulate matter and opacity are defined by this regulation.

Permit Limits

The review of air pollution control parameters and requirements between countries indicates some converging trends in permitting approaches. Permit conditions appear to be established on the basis of technical considerations, although this may entail significant differences in term of the stringency of environmental performance that is required from plant operators. Differences in stringency are related to different BAT levels between countries, the type of compliance monitoring or the selection of control parameters that are established. However, these differences may also be linked to the complexity and costs associated with air pollution control and monitoring.

All of the participating countries use particulate matter (or total dust, total suspended solids) and opacity as sum parameters for air pollution control and monitoring. Indeed, it has been shown that toxic metal emissions can be efficiently controlled by particulate matter standards except in the case of mercury (approximately 10 per cent of the mercury can be captured in dust by fabric filters[25]). Thus, in the Finnish permit, emission limit values for particulate matter are the only standards set in the permit, the rationale being that the limits set are low enough to guarantee that metal and organic compound releases are not in need of separate limit values.

The limit values in permits are generally given as mass of emitted material related to the waste gas volume, and compliance is measured over a specified period (from hourly, weekly, monthly, half-yearly and up to one year). In the Swedish permit, different numerical standards are used such as allowable average discharge per unit of production, day, or volume emitted. In the Korean permit, concentration-based limits are still used although limit values per tonnage of production are more likely to ensure that dilution cannot be used as a means of attaining compliance.[26] However, the frequency of spot-checking by the regulatory authority probably provides better insurance that the industry is not using dilution as a way to attain compliance.

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25. Communication with André Ulmgren, Swedish EPA, October 1995.

26. Hatch Associates Ltd., “Releases and Control of Priority and Other Substances of Concern from the Iron and Steel Industry in Canada”, Environment Canada, 9 March 1995.

The stringency of limit values for dust has to be understood in relation to the protection of human health. The effective toxicity of small particles may be greater than of larger particles since the concentration of toxic substances such as lead, zinc, chromium, mercury and nitrates will augment with decreasing particle size.[27] Sub-micron particles are known to penetrate more deeply into human lungs. In the Swedish case, the company argued that it was difficult to set the minimum particulate concentration standard at 20 mg/m^3 because of the difficulty of achieving good enough readings at a lower figure. However, in the view of the Swedish Board, it is possible to measure post-filter concentrations of 10 mg/m^3 to an accuracy of 80 to 90 per cent; the reliability of measurements will only fall below 50 per cent at concentrations of 1 mg/m^3. Thus, the final decision was to set the limit values for particulate matter at 10 mg/m^3.

Opacity is another sum parameter used in both British and American permits. This parameter may also be defined as smoke and classified as “black” or “dark” as in the case of the United Kingdom’s iron foundry permit. Assuming that the opacity factor is related to the emission rate, the latter can be controlled by setting a limit at an appropriate degree of opacity. Visual standards have the advantage of simplicity and low administrative costs.

Emissions of SO_2 and NO_x are regulated in most permits, except for the iron foundry in the United Kingdom. NO_x is not stipulated as a regulated parameter in the Korean and Swedish permits, but is being monitored. In Sweden, taxes and charges on NO_x and SO_2 emissions have been used in recent years as an incentive for abatement measures. The Swedish regulatory authority does regulate as well the amount of sulphur in fuel oil used at the ironworks by specific legislation. The American permit does not cover SO_2 emissions, but has established pollution limits for NO_x and carbon monoxide. Germany and Korea have provided pollution limits for several heavy metals and the United Kingdom, Sweden and Germany have also included provisions regarding the releases of dioxins. Table 5 provides the parameters used for which emission limit values have been set in the permit samples.

Other Conditions for Air Pollutants

Other conditions required by countries relate to the maintenance of facilities, emergency procedures, contingency plans, and regular monitoring and reporting of controlled substances. Practically all permits identified monitoring and investigative requirements which will encourage a reduction of releases of controlled substances. Investigations into hazardous pollutant levels and sludge handling methods, efficient pollution control techniques and environmental management and practices to reduce the releases of NO_x, SO_2, mercury, dioxins and fugitive dust are important requirements aiming at pollution prevention and control, and the continuous improvement of plant operations.

The time periods for compliance with permit conditions vary between the permit samples. The American permit sets up compliance within 180 days of the start-up of the unit. The Japanese permit covering the minimill required compliance at the end of construction. In the case of the Korean permit, permit conditions must be complied with at start-up, if not the plant will have to pay emission/effluent charges. A graduated schedule of compliance was defined in most permit samples:

– in both British permits, with upgrading programmes that include firm timetables for achieving BATNEEC;

27. Godish, Thad., Air Quality, United States, Lewis Publishers Inc., 1988.

- in the German permit, including a testing phase on dioxin where emissions five time higher are allowed;
- in the Swedish permit, with a graduated schedule to assess and decide on pollution limits;
- in the Japanese permit in which guidance for SO_x control measures included a graduated schedule for compliance;
- in the Finnish permit, whereas conditions are based on the schedule for compliance, but also on the operator’s efforts to reduce/control emissions, e.g. conditions such as limiting fugitive dust emissions may be relaxed if new furnaces are installed.

The American permit illustrates a case where the operator decided to avoid an applicable regulation by limiting in production outputs. Thus, the plant agreed to limit yearly production to 840 000 tonnes of billet steel, thereby avoiding the review of its proposed project under the Prevention of Significant Deterioration Regulation. To demonstrate compliance, the applicant was required to submit quarterly reports listing the production for the quarter.

Table 5. **Control parameters in air permits**

Parameters	**Finland**	**Germany**	**Japan**		**Korea**	**Sweden**	**United Kingdom**		**United States**
	EAF	EAF	Integrated	Minimill	Integrated	Integrated	Ironwork	Blast furnace	EAF
Dust (particulate matter)	x	x	x	x	x	x		x	x
Smoke/opacity					x			x	x
Dark/black Smoke							x		
Sulphur Dioxide		x	x	x	x	x		x	
Carbon monoxide									x
Nitrogen Oxide		x	x	x	x			x	x
Fluorine		x			x				
Dioxin		x							
Cadmium		x			x				
Mercury		x			x				
Arsenic		x			x				
Cobalt		x							
Nickel		x			x				
Antinomy		x							
Chromium		x			x				
Lead		x			x				
Fluorides		x							
Manganese		x							
Arsine		x			x				
Chlorine		x			x				
Hydrocyanic Acid		x			x				
Ammonia					x				
Hydrogen Sulphide					x				

Note: UK limits for particles are maximum concentration in any period of 2 hrs; for smoke, exceptions are for first 15 min. of start-up; for dark smoke, no visible emissions to be emitted continuously for a period of 4 min. or more, nor for an aggregate period of 10 min. or more in any 8 hrs period, except in first 15 min. following start-up; for black smoke, no visible emission for more than 2 min. in any 30 min. period.

Air Emission Monitoring Requirements

Monitoring programmes play a significant role in ensuring compliance with permitting conditions and identifying problems. Since the achievement of environmental standards is the administration target, the emission standards are set up in principle so that environmental standards will be met, and monitoring results are thus very important. Self-monitoring by operators and reporting on mill conditions to permitting authorities is required by all countries. Different approaches can be used to determine emission rates for a given source. There are also several parameters monitored which are not necessarily identified as limiting factors in permits. In many cases, the authorities required that various parameters be monitored in order to observe whether or not there is a need to further control the current discharge level of these substances.

Continuous sampling systems for gaseous pollutants have come to dominate air quality monitoring programs and are generally used in the iron and steel industry. However, source monitoring is generally infrequent since it is costly and time-consuming. Beside constant measurement techniques, the Korean authority has reported grab sampling. This technique is not usually employed for day-to-day monitoring, but widely used to identify problem pollutants. Other types of measurement techniques reported by participating countries are related to visual parameters. Opacity measurements using Ringelmann charts (in UK permits) are used by air pollution control authorities to facilitate compliance checks. This technique has the "advantage of simplicity, low cost, and a long history of legal acceptability".[28] Emission factors are another means of assessing the level of release of polluting substances. They consist of average emission rates to be expected from individual processes under given operating conditions (generally used in *TA Luft*) or from the use of a given material or fuel. For example, emission of SO_2 can be calculated from the measurement of fuel sulphur content. Particulate matter emissions can also be determined by the weight loss associated with the processing of raw materials into finished products.[29]

In Japan, monitoring activities are under the responsibility of regulatory authorities (prefectural governors and mayors of designated cities for air pollution; local public bodies for water pollution). However, large-scale facilities monitor themselves in Japan. Monitoring results greatly influence the permit to be granted for the new site. Permits may be denied in the region where environment standards are not met. Even if the permit is granted, it may result in the introduction of the most advanced treatment technology or reduction in the size of the project.

In the United Kingdom, monitoring activities are performed by the permittee and the permitting authority. Monitoring results influence the establishment of permit conditions. This can be clearly demonstrated in the case of the permit for the integrated plant where Part 8 of the authorisation, i.e. the Improvement Programme, sets a series of obligations to the operator in order to improve the monitoring of regulated substances that may be emitted by the plant's operations.

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28. Godish, T., Op. cit.

29. Ibid.

In Germany, depending on the mass flow or the waste gas volume flow, some substances have to be measured continuously as specified in the *TA Luft*. The instruments used for the measurements have to comply with established standards, must be calibrated at regular intervals and must store the results in records. Three examples for classical continuously monitored substances are SO_x, NO_x and particles (dust). The agencies can check the emissions of a facility by evaluating the records. The provisional decision includes provisions for the installation and maintenance of the measuring instrument, especially for continuous measurements. The permit also provides regulations for the conduct of measurements and monitoring of emissions. A special measurement programme is required for dioxins during a 36 months testing phase, in order to find out the best way of operating the plant. The content and extent of the programme shall be defined in co-operation with the Federal Environmental Agency and the permitting authority. Depending on the results, the usage of some raw materials (especially scrap) may be restricted.

In Korea, industries are required to self-monitor the level of pollutants from their activities. The pollutants to be surveyed and the frequency of monitoring are determined by the size of the facilities and the nature of pollutant releases. Industries which emit large quantities of pollutants must install automatic stack monitoring equipment so that they can constantly check if discharging facilities are in normal operation. In the selected permit, monitoring (measurement period) varies according to the size of the discharging facilities and the type of pollutants, in the range from once a week to every six months. The measurements are based on discontinuous samples. Monitoring results do not normally influence the establishment of pollution limits.

In Finland, requirements for monitoring are established by local authorities who have the responsibility for administering permits through a document called a “control program”. As in the case of water permits, there are conditions concerning monitoring and reporting also in the integrated environmental permits (air, noise and waste). The application must submit a programme to the supervising authorities for approval. The results of the monitoring process provide information that feeds into the permitting procedure and determines some of the permit requirements. The supervising authority reserves the right to make inspections, to take samples, to check diaries and to talk to the facility's staff. As a rule, a permit requires the operator to participate in air quality monitoring programmes of the area.

In Sweden, the operator conducts monitoring according to a programme that has been determined by the County Administrative Board in the same way as already described in the section on effluent monitoring. The results are considered in the permitting process. One major task involved in supervision is to check that the conditions stated in permit decisions are complied with by companies. For this purpose, the supervisory authority adopts a control programme. This specifies which tests should be taken and how often, where and for how long the program should take place. The authorities' task is to ensure that the programme is arranged in such a way that they can assess whether the conditions are being followed. The test results are reported to the supervisory authority which compares them with the conditions. The programme therefore lays down regulations on the obligation to report to the supervisory authority. It is stipulated that as a rule an activity must be inspected annually by a consultant, who must be approved by the supervisory authority.

In the American permit, source testing to prove compliance with limit values for particulate matter, NO_x, carbon monoxide and opacity is a legal requirement. The permit also requires an operation and maintenance manual which outlines a non-binding maintenance schedule for the facility.

4.3 Waste Management Permitting

Permits covering land and waste issues were provided by Finland, Sweden and the United Kingdom (Part A process). The Swedish permit is the only one that has defined limit values for post-filter concentration emissions. These are given in Table 6. In general, a permit stipulates that the operator shall have a written management procedure including obligatory record-keeping on the quality, volume, storage and deposition of wastes by lot. Permits will often include an obligation to investigate measures and techniques aimed at the reduction, reuse, and recycling of wastes and by-products generated, and provisions with regard to the monitoring of waste.

Table 6. **Permit requirements for waste (SWEDEN)**

Limit values for post-filter emissions and waste management conditions
- The residual products currently used by the company for recycling, i.e. slag from blast furnaces and steel furnaces, dried BOF sludge, oxide scale, various material separated out in filters, slag from slitting and conditioning and fine-grade scrap, shall be reused as far as technically possible and financially reasonable.
- As from 1 July 1995, as a target value, emissions of particles from fabric filters for the manufacture of reinforced base courses and cement and from fabric filters for the handling of refractory compounds may not exceed **10 mg/m^3** NTP dry gas;
- As from 1 July 1995, as a target value, emissions of particles from fabric filters for air extracted from the slag dryer may not exceed **10 mg/m^3** NTP dry gas;
- Unless otherwise stipulated under the above provisions regarding conditions common to all emissions to air, the milling plant may not be operated when the treatment equipment is not operational due to freezing or similar circumstances. As from 1 July 1995, as a target value, emissions of particles from the mill's present extraction system may not exceed **50 mg/m^3** NTP dry gas;
- As from 1 July 1993, as a target value, the concentration of particles from the fabric filters for air extracted from admixture of coal ash in crushed products from slag may not exceed **10 mg/m^3** NTP dry gas;
- As from 1 July 1993, as a target value, the concentration of particles after the fabric filters for air evacuated from the manufacture of expanded pearlite may not exceed **10 mg/m^3** NTP dry gas;
- As from 1 July 1993, as a target value, the concentration of particles in gas leaving the fabric filters in the powdered coal plant may not exceed **10 mg/m^3** NTP dry gas.

4.4 Requirements for Noise Control

Only Germany and Sweden provided examples of permit conditions aiming at the control of noise nuisance. General EQSs for noise were also provided by Japan, but were not specified in permit samples. Noise requirements in both permit samples were as follows:

- in the German permit, during the night (10 p.m. - 6 a.m.), levels of 37,1 dB (A) and 41,2 dB (A) must not be exceeded at fixed points of measurement defined in the permit. Specifications are made to the operator to perform an audit on noise disturbances in order to ensure that limits are complied with. An additional requirement has been made to investigate measures to reduce noise disturbances, in particular low frequencies (in the range of 100 Hz > 30 dB) in collaboration with the building contractor;

- in the Swedish permit, the noise from the company's operations must be sufficiently controlled that levels in residential areas do not exceed 55 dB (A) during the day (7 a.m. - 6 p.m.), 50 dB (A) in the evening (6 p.m. - 10 p.m.) and 45 dB (A) at night (10 p.m. - 7 a.m.). In addition, momentary noise levels should not exceed 60 dB (A) at night in residential areas.

In both cases, noise levels have to be monitored on a continuous basis.

4.5 Technological Response

Comments were received from all permittees selected for the case study. The questionnaire asked operators to describe how they had responded technically to permit limits and conditions, including the degree to which internal approaches versus external treatment had been applied. In addition, they were asked to provide their views on how permit requirements provided flexibility with respect to processes that can be applied and the balancing of BAT and EQO considerations in the permits issued.

In general, industry has responded positively to permit requirements through the development of newer, cleaner and more effective production and pollution control technologies. These have been progressively incorporated into permit requirements. Their use has also spread world-wide as different countries have adapted their regulatory frameworks to ongoing international developments. Thereby, the technological response of different facilities is comparable and illustrates converging environmental principles, strategies and practices in the industry. Pollution prevention and control is achieved by resorting to cleaner fuel and material, and by implementing environmental management and environmentally-efficient plant design. Additionally, as part of the environmental and economic optimisation of processes and products, new technologies are being introduced, such as continuous casting which saves energy and material by removing a complete process stage in the manufacture of steel and by reducing the amount of crude steel required for each tonne of finished steel. Moreover, technical developments reducing energy and material intensity, increasing recycling and reuse of by-products and waste materials as material input improve the environmental performance of the plants while decreasing production costs. Finally, end-of-pipe techniques play an essential role to ensure that emissions still occurring at harmful levels are eventually captured and treated appropriately.

State Assistance

In general, some form of assistance is provided to the industry, mainly in the form of supporting research into new technologies. Investigations on heavy metals and dioxin emissions from scrap-based production processes have been conducted jointly by trade associations and regulatory authorities in some countries. For instance, a joint project of the Swedish iron and steel industry and Swedish EPA on the environmental aspects of scrap as input material has increased knowledge on factors affecting the quality and quantity of emissions, most notably regarding mercury and dioxin emissions. The project has facilitated the implementation of more effective sorting and fine-tuning programmes, thereby avoiding the use of contaminated scrap material and reducing toxic emissions.

The Use of Internal and External Controls

Most pollution prevention activities in the industry have concentrated on heavy metals and chloro-organic compounds emissions, acid rain contributors, energy-use and wastewater management for the past two decades. As such, environmental investigation programmes aimed at better sustainable practices and operations have been prime contributors to the implementation of cleaner production processes and materials.

Considering the significant amount of particulate and gaseous releases that are generated as inevitable by-products of the reduction of iron ore and/or of the melting of scrap to pure metal, compliance with permit requirements requires also that pollution prevention approaches be complemented with appropriate control measures. Pollution control techniques and environmental management practices must complement in-plant measures and pollution prevention initiatives in order to achieve the highest rate of environmental performance. Indeed, effective pollution prevention and control strategies are usually based on the most optimal combinaison of preventative measures and control techniques to reduce pollutant releases and other environmental disturbances cost-effectively. Recent successes in achieving compliance with EQSs have been therefore the outcome of a mix of in plant measures and techniques such as material substitution (e.g. low sulphur ore and fuels), process changes (e.g. substituting pellet production for sinter, EAF for top-blowing converters, electric coreless melting technology for the cupola process), and pre-treatment of process materials (e.g. scrap sorting and pre-heating as cleansing practices).

Control techniques used in this industry are important element to ensure the attainment of pollution limits. Filtration is one of the most reliable dust collecting techniques, achieving an efficiency rate of greater than 99.5 per cent. Frequently used control techniques include fabric filters for dust emissions control which are used in bag-house systems designed to cover processes where dust loading is high, particles size are small, and high collection efficiencies are required. Fabric filters can handle gas volumes in the range of 10 000 to 50 000 acfm.[30] Also, electrostatic precipitators are used to remove solid and/or liquid particles from effluent gases. They are commonly employed to collect dust particles from blast, basic oxygen and open hearth furnaces, sintering plants, and coke ovens. This technique is particularly suited for small particles, including those of submicron dimensions. Dust collection can also be achieved by wet scrubbers, such as the venturi scrubber using liquids to capture particles. However, there is a trend toward dry quenching since wet scrubbers generate waste water that have to be disposed of.

30. Godish, T., Op. cit.

Gaseous emissions are more difficult to control. Control techniques widely used in the industry include adsorption and absorption techniques that remove contaminant gases by physical adsorption to solid surfaces or using liquid media (e.g. scrubber). Combustion technologies are commonly used for pre-treatment and control of raw materials, such as low- NO_x burners, and thermal and catalytic incineration. In addition, new techniques for removing sulphur oxides have come to play an important role in abating SO_x emissions. These include coal beneficiation and gasification, fluidized-bed combustion and flue gas desulphurisation.

As indicated in the overview section, the iron and steel sector has implemented pollution prevention measures that, in many instances, have simultaneously improved cost efficiency and minimised environmental impacts. Environmental approaches have been based on a mix of prevention and control strategies aiming at better, cost-efficient measures to achieve compliance while improving productivity. As a result, higher productivity rates are achieved by a better yield ratio of raw materials into finished products, demonstrating that environmental quality can go hand in hand with improved productivity.

Internal approaches and measures such as material inputs reduction, the replacement of toxic chemicals and dirtier fuels by more environmentally preferable material, re-engineering of processes to rationalise productivity and reuse by-products, and improvement of environmental management have been reported by the plant operators under review. The main pollution prevention strategies and related measures that were reported include:

A. Substitution Strategy

i) Substituting pellets for sinter as raw materials in blast furnaces (Swedish mill)

The replacement of sinter by pellets as raw materials provided substantially lower emissions of metals, carbon monoxide and organic compounds. Annual quantity of dioxins is less than 0.1 g/year, compared with approximately 4 g/year from the sinter plant. The following table provides emissions reduction which result from the change in raw material production.

Pollutant	**Annual emission - quantity - tonne/year**	
	Pellet manufacture	Sinter manufacture
Sulphur	180	650
Particulate matter	250	700
NO_x	180	435
Carbon dioxide	20 000	250 000

ii) Substitution of cleaner fuels and materials (Japanese mill)

- Fuels used in the steel plant are mainly desulphurised coke oven gas and by-product gas such as blast furnace gas and basic oxygen gas, which are of low sulphur content. Gas fuel occupies 95 per cent in the overall fuel of the plant; and

- Fuel NO_x is reduced by using the mix gas blended with low-nitrogen by-product gas. Thermal NO_x control is reduced by using the low NO_x burner, exhaust gas recirculation and multi-stage combustion, including the low-oxygen ratio controlled combustion, independently or in combination.

iii) Preventing the use of dirtier materials and water contamination (Finnish, German, Swedish, and Korean mills)

- Scrap sorting to reduce the use of dirtier types of metal waste used as input materials;

- Limiting the use of calcium fluoride;

- Separation of clean and waste water systems; and

- Hazardous waste recovery system to prevent mixing of different types of waste.

B. Process Modification and Cleaner Technology

i) Denitrification and Desulphurisation Technology (Japanese mill)

- Research and development for sintering plant exhaust gas desulphuriser. An ammonium sulphate method has been implemented with a high desulphurising efficiency of 99 per cent or more. It also features a denitration efficiency of 70 per cent or more.

ii) Substituting Cleaner Technology (American, British, and German mills)

- Introduction of a DC EAF and Consteel scrap conveyor system allowing the roof on the EAF to stay closed while adding scrap for melting, whereas conventional scrap bucket systems require that the roof of the EAF be swung open to add scrap, thereby increasing emissions;

- Minimisation of pollutant releases through the replacement of the cupola melting process with an electric coreless induction technique. The new unit has proved to be more efficient enabling energy savings (and labour savings) such that payback has been achieved on investment within two years; and

- Replacement of top-blowing converters by EAFs.

C. Reduction, Reuse and Recycling (All participating permittees)

In general, operators have implemented practices and techniques which reduce environmental releases by reusing by-products and waste either as input materials or saleable products, by introducing closed-loop systems for full recovery of waste water, and by plant design which enables the recapture of fugitive dust emissions (e.g. L-shaping of facilities for protection against wind dispersal of minerals and dust, planting of trees to capture dust, etc.). These measures are complemented by the separation of contaminated water systems and materials from cooling water and cleaner grades of scrap and waste. In addition, the industry have initiated monitoring programmes that aim at developing further techniques and practices to further reduce noxious pollutants (e.g. dioxin).

The Views of Industry on the Permitting Process

Generally, plant operators recognise the permitting process to be quite flexible as pollution limits and permit conditions allow them to choose the most appropriate measures to comply with the requirements. In some instances, the operators indicated that the permits did specify which technology and/or techniques should be used. However, this was preceded by extensive dialogue involving the mill and the state authorities. Increasing flexibility is claimed to have facilitated voluntary actions leading to environmental performance that go beyond pollution limits established in permits.

The industry in most countries indicated their preference for this approach whereby the state establishes performance standards and the industry is left to choose the appropriate compliance techniques and measures. However, some trade associations have criticised the multiplication of international and national fora working on BAT definitions, fearing that differences in requirements would put at risk the industry's choice of environmental technologies and could lead to trade barriers. But it must be noted that the harmonisation of environmental requirements is a likely trend, at least in Europe where the implementation of the IPPC Directive is taken place.

Regarding the interaction between BAT and EQO in permitting, the operators generally felt that the permit limits were generally in accordance with accepted BAT considerations. However, two permittees, i.e. the American and Swedish operators, indicated their disagreement with the procedure that were used by permitting authorities to set permit conditions.

The American permittee disapproved most of the permit requirements as being "[un]appropriate measures for determining how the facility needs to operate in a sound environmental manner": the negative furnace pressure, daily visual opacity of the bag house, bag house fan amperage, damper positions, hourly tonnage, etc., were among the conditions that the operator believed to be inappropriate. Permit requirements were perceived as being too specific, not allowing "room for deviations" or "different operating scenarios". According to the mill spokeperson,"[t]here is a direct correlation between even more specific requirements and less flexibility as well as efficiency and cost effectiveness". The permittee believed that a greater co-operation between the permitting authority and the industry is needed to ensure better crafted regulations.

The Swedish sample illustrates a case where the plant operator disagreed with the procedure leading to BAT-based limits used by the permitting authority. The operator appealed the decision, arguing that their requirements derived from strictly BAT considerations, not from a technology assessment in the light of EQOs and economics according to the legal rule. In addition, the operator complained that the limits were based on BAT limit values for pellet production, thereby imposing a particular technology in place of the sintering operations of the plant. According to the operator, this would not achieve significant results in terms of improving the quality of the local environment (an opinion which was not contested by the permitting authority). Modelling of atmospheric deposition of SO_2 and NO_x by the operator showed that the investment would not yield a significant reduction of the overall pollutant concentration in the vicinity of the plant.

A major factor influencing the authority was that sintering operations generate higher level of dioxin emissions compared to pellet used as input material. In recent years, steelworks have been investigated and identified as the potentially largest industrial source of dioxins. While temperatures of over 1 000°C are reached in the process, experts believe that dioxins still arise because of the poor combustion process.[31] The authority's decision clearly indicated that sintering operations were not suited for BAT determination due to the level and toxicity of the emissions. The appeal was ultimately dismissed and the plant operator found it more cost-efficient to close the sinter plant, and import externally manufactured pellets.

In this case, the BAT approach in Sweden differs from the United Kingdom whereas BATNEEC guidelines provide achievable release levels for dioxins by blast furnaces. Sintering operations are therefore allowed under BATNEEC if appropriate end-of-pipe techniques are used. The difference may be related in part to a different environmental objective that, in turn, influences the interaction between BAT and EQO considerations. It is obvious that Sweden has implemented environmental programmes, such as the Action Plan on Marine Pollution (1987, 1990), aiming at the virtual elimination of persistent pollutants, e.g. mercury and toxic chlorinated compounds. Therefore, it is common for the Swedish EPA to override local considerations that take place in case-by-case permitting. In this respect, the question of flexibility cannot simply be left to the freedom of technological choice vis-à-vis prescribed performance levels, since it may very well favour control technologies in place of more preventive approaches and innovative technologies.

In addition, the problem of dealing with existing sources may be at the core of such issues. Phasing out technologies may be costly from an economical and social standpoint, e.g. job losses. In some cases, it might be possible to find new ways of improving current operations at acceptable levels. As standards for controlling dioxins are continuously strengthening, operators are looking for different ways of coping with the problem. Indeed, the modernisation of the steel industry has tended to substitute the direct reduction process[32] for sintering. Other operators are trying to reduce the toxicity and quantity of emissions by controlling the quality of input material through better management and techniques such as scrap sorting and cleansing. As already mentioned, the United Kingdom, Sweden and Germany have reported initiatives and investigations aiming at ways to curb certain types of emissions. In some instances, industry has also taken a pro-stance by asking for a ban on chlorinated cutting oils.[33] Nevertheless, the above example shows that political will and wisdom play a fundamental role in setting the stringency of permitting requirements, thereby influencing the environmental level playing field for current and future industrial operations.

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31. "British Steel under suspicion as UK's largest dioxin source", ENDS REPORT, January 1995: "Furthermore, [Mr. Lahl] says electrostatic precipitators (ESPs) used to abate particulate emissions from the process can provide an ideal environment for dioxin recombination in the flue gas."

32. Ibid.

33. Ibid.: "The British Non-ferrous Metals Federation is already lobbying for a ban (...) in an attempt to tackle emission problems from its member smelters."

5. EQO AND BAT IN PERMITTING STRATEGIES

5.1 The Use of EQO and BAT for Pollution Prevention and Control

Environmental quality is the main goal of pollution prevention and control policies. In order to ensure that this is being achieved effectively, regulatory authorities must therefore define a dividing line between harmful and harmless inputs, a major policy issue which involves several social interests, i.e. science, economics, technological innovation, and public rights.

Despite differences in national policies, the permit samples and information provided by participating countries show that both technology-based and environmentally-based approaches have been used for setting environmental requirements. The trend toward the combined use and legal status of both approaches is further illustrated in Table 7. Although technology-based assessment and performance-based limits (i.e. BAT) appear to be a common, immediate driver for setting permit requirements, they are themselves driven by the need that environmental quality be preserved at some agreed level. In addition, as countries are increasingly moving toward the implementation of environmental targets, either nationally or through international agreements (i.e. waste minimisation targets, ozone depleting substances phase-out, etc.), short-term performance requirements need to be defined in relation to the attainment of long-term environmental objectives.

The development of primary measures, such as in-process modification, the substitution of less-hazardous substances for toxic compounds and the implementation of closed-loop systems, is key to ensure an adequate balance between environmental protection, economic efficiency, competitiveness, and technological innovation. As such, integrated approaches such lifecycle assessment appear to promote the combined use of BAT and EQO to ensure environmental protection while promoting sustainable industrial operations.

The Role of International Conventions

EQOs and EQSs are usually established on the basis of the scientific research in each country with a strong input from the international community. They appear to be derived from a combination of scientific inputs from individual countries with surveys of international objectives and scientific work (e.g. World Health Organisation, Conventions on Marine Environments, etc.). Indeed, international conventions on transboundary air pollution, regional sea conventions and on the North American Great Lakes, i.e. OSPARCOM, the Helsinki Commission on the Baltic Sea (HELCOM) and the International Joint Commission (IJC), have played a prominent role in shaping and harmonising the permitting strategies of OECD countries, most notably through the exchange of information, the identification of relevant large scale impacts, and the development of environmental approaches for restoring and/or protecting international and regional ecosystems.

Table 7. **Major pollution control regulations and guidelines**

Country	Technology-based emission limits	EQSs and EQOs
Finland	– BAT (as locally set)	– **EU Directives** – Locally set EQOs
Germany	– **BAT**	– **EU Directives** – **Nine Air EQSs** – Water EQOs
Japan	– Technology assessment	– **EQSs**
Korea	– Technology assessment	– **EQSs**
Sweden	– BAT (as locally-set)	– **EU Directives** – Locally set EQOs
United Kingdom	– BATNEEC (guidance in the setting of local conditions)	– **EU Directives** – **EQSs for water and air** – Water EQOs
United States	– **BACT** – **LAER** – **NSPS** – **MACT** – **BPT**	– **NAAQS** – **Water quality standards** – Water EQOs

Note:

- Parts in bold character indicate binding approaches when issuing permit requirements;
- In the United Kingdom, integrated permits apply only to major polluting sources (see Section 3.1);
- BAT-based requirements in the United States are determined according to different situations, such as the type of pollutants and local environment, whether the application for a permit relates to an existing or new facility, etc. The several definitions are given in sub-chapter 4.1.2.

The role of international conventions has been paramount in the adoption of ambitious environmental objectives and targets, themselves being a recognition of the need for addressing environmental problems on an international scale. Table 8 includes some major international and regional conventions which have had a significant influence on the adoption of environmental standards and targets for participating countries (participating countries national targets, objectives and guidelines are also included).

Probably the most significant contribution of international co-operation has been the introduction of the precautionary principle in the North Sea and the Baltic Sea conventions. As a result, the BAT approach and its implementation at major point sources have been promoted and developed through international agreements and subsequent work between contracting parties. The implementation of BAT guidance addressing major industrial point sources has led to comprehensive pollution prevention and control guidelines. Nowadays, BAT guidance notes encompass performance-based limits and include plant design, monitoring and environmental management guidelines. Table 9 on OSPARCOM recommendations for the iron and steel processes provides a good example of the thorough work that has been achieved in these conventions. In the following subsection 5.3 on BAT, Tables 11, 12 and 13 provide technology-based guidance that are proposed by HELCOM for iron and steel processes. Together, these two conventions had had significant influence on national permitting programmes of their contracting parties and are likely to influence the future work of the EU on the implementation of the IPPC Directive.

In the following sub-chapters, the use and interaction between EQO and BAT is further examined through the review of permit samples.

5.2 Environmental Quality Approach

All of the countries have reported EQOs and EQSs for air and water. EQSs represent minimum requirements not to be exceeded in all jurisdictions while EQOs are generally used as guidelines. EQSs provide overriding constraints on permit requirements which must be met irrespective of the capabilities or costs of the available pollution control technology. Together, EQSs and EQOs may often lead to more stringent permit requirements than nationally-set BAT-based ELVs if the latter does not ensure compliance with set levels of environmental protection.

Each country may set more stringent standards depending on specific circumstances. The determination of both EQOs and EQSs is usually related to a system of classification of environmental quality which may lead to a variation in the stringency of requirements for similar activities in different locations. Thus, the level of EQSs may depend on whether the polluting activity takes place in an urban area, a sensitive ecosystem or near freshwater intakes. The classification system and related EQSs used by participating countries can be found in their country profiles which are annexed to this report.

In the United States, EQOs and EQSs have been established for air and water limit values where the former are nationally-set binding requirements and the latter are adopted as a minimum rule at state level. They may differ among states, but when there are national EQOs, standard-setting at state level must be at least as stringent as federal standards.

Japan and Korea typically derive numerical values for pollution limits in permits by measuring the expected releases against the pollutant concentration loads in the concerned environment. Standard-setting is under the responsibility of national authorities and based on scientific readings of what is deemed necessary to ensure the protection of human health and the environment. In cases where pollutant loads exceed the EQSs, the area may be defined as severely polluted (e.g. “Area of Total Pollutant Load Control” in Japan) and will usually lead to more stringent pollution limits in permits. However, in their replies, Korea and Japan recognise that determining pollution limits on the basis of EQSs is highly complex in areas of multiple polluting sources and may often lead to an exceedence of appropriate environmental levels. In both Japanese permit samples, the Environmental Agency explicitly recognised that BAT-based requirements were used to set pollution limits (see Chapter 4).

Table 8. **International and regional conventions, and national targets influencing EQOs/EQSs**

EQOs/EQSs	**Finland**	**Germany**	**Japan**	**Korea**	**Sweden**	**United Kingdom**	**United States**
Regional and International Conventions	EU Directives HELCOM LRTAP (UNECE) BASEL (UN) WHO	EU Directives HELCOM OSPARCOM LRTAP BASEL WHO	BASEL WHO	BASEL WHO	EU Directives OSPARCOM HELCOM LRTAP BASEL WHO	EU Directives OSPARCOM LRTAP BASEL WHO	WHO IJC BASEL
National Targets and Objectives	Air Quality Guidelines: Long term accepted goal for sulphur deposition of 0.3 g/m^2 Water Quality Guidelines: equal to the original or natural background Waste Management Guidelines Noise Abatement guideline	Ambient Air Quality Standards EQOs for water Classification system for water	EQSs for water and air Special areas: Area of Total Pollutant Load Control Classification system for water and urban areas	EQSs for air and water Special zones for sensitive areas Classification system for water	EQOs (water): nutrients, BOD, pH, metals EQOs (air): SO_2, NO_x (separated values between north and south regions) EQOs (noise) Bill 1990/91:90: Reduction of pollutant emissions to safe environmental levels 30-40 kronor principle (SEK 30 per kg/SO_2 - SEK 40 per kg/NO_x	EQSs for air and water EQOs for water Classification system for water	EQSs for air and water EQOs for water Classification system for water Great Lakes Water Quality Initiative (implementing the 33/50 program) Common Sense Initiative

Table 9. **List of BAT Recommendations for iron and steel by OSPARCOM**

Definition of BAT for the secondary iron and steel plants (OSPARCOM 90/1)

• Fume collection by dog-houses, local moveable hoods or total building evacuation at EAFs and converters; • Fabric filters or equally efficient arrestment system for dust cleaning of process gases and secondary gases from EAFs and converters; • Fabric filters for dust cleaning or equally efficient arrestment system at cutting, grinding and scarfing operations;
• Regeneration of pickling baths and closing of rinse water systems; • Addition of hydrogen peroxide to pickling baths containing nitric acid or any equivalent measure which enables reduction of NO_X to the atmosphere; • Sedimentation combined with filtration of waste water from continuous casting and rolling. Recirculation or re-use of the water; • Metal recovery from filter dust.

Definition of BAT in primary iron and steel industry (OSPARCOM 91/2)

• **Non-specific emissions**: 1. Dust emissions from handling, conveying, etc., should be enclosed, extracted and treated by fabric filters. Where this is not possible, electroprecipitation can be applied. Scrubbing should be avoided whenever possible. 2. Fugitive emissions should be treated by damping, use of crust-formers and road paving/cleansing. 3. Waste water should be avoided or recirculated as much as possible. 4. Solid wastes should be recycled or commercialised as much as possible.
• **Sinter plants**: 5. Flue gas should be preferably subjected to dry methods. If feasible, fabric filters should be used. 6. If sulphur dioxide is removed from the flue gas, dry methods are preferred. 7. In addition to waste water avoidance, sulphide precipitation and activated carbon filtration are recommended as treatment techniques.
• **Pellet plants**: 8. Dust emissions from grinding should be collected and treated, if applicable, by fabric filters but at least by electroprecipitation, or equally effective methods. 9. Gases from drying, cooling and palletising should be dedusted by fabric filters, or equally effective methods. For the removal of sulphur dioxide, nitrogen oxides and fluorides, dry methods are preferred.
• **Coke plants**: 10. Dust emissions during charging should be combated by keeping all gases in the oven or in coke oven gas system. Extraction and fabric filtration or equally effective methods. 11. During coking, "good housekeeping" should be applied in order to prevent clouds of dust. 12. During pushing, dust should be combated by enclosure and extraction including full coke side arrestment. Coke should not be pushed before being fully carbonised. 13. Dry quenching is preferred. If wet quenching is applied, grit arresters should be present in the quench tower. If dry quenching is applied, dust sources should be enclosed and extracted. 14. Waste water arising from coke oven gas condensation should be subject to ammoniac removal by high pH steam stripping and aerobic biological treatment, including nitrification and denitrification stages; polycyclic aromatic hydrocarbon removal by filtration; chemical oxygen demand/phenol removal/cyanide removal.

Table 9, Ctd.

• **Blast Furnaces**: 15. During blast furnace charging, a pressure equalisation system should be applied to reduce dust emissions from the sluice. 16. Dust emissions during tapping (in the casthouse) should be extracted and treated in fabric filters or equally effective arrestment systems. 17. If blast furnace gas is subject to scrubbing, the bleed discharge should be subjected to precipitation of metals followed by sand filtration or equally effective methods.
• **Basic Oxygen Furnaces (BOF)**: 18. BOF gas should be subjected to dust arrestment, at least by electroprecipitation. 19. If BOF gas is subject to scrubbing, the bleed discharge should be subjected to sand filtration. 20. Dust emissions from charging and tapping operations should be extracted and treated in fabric filters or equally effective arrestment systems.

Measures to be taken and investigations to be carried out in order to reduce pollution from secondary iron and steel production (OSPARCOM 91/3)

a. Cadmium and mercury in all products that can end up as scrap. Plans and measures and timetable for further reduction by 1 January 1994; b. Chlorinated compounds in used scrap. Proposals to reduce the use of chlorinated oils and emulsions and timetable by 1 January 1994; c. The situation regarding mercury and dioxins emissions should be presented by Contracting Parties by 1995; d. Further research and development should be carried out to achieve suitable technologies for reducing emissions of mercury and dioxins. The current state of development of such technologies should be presented by 1996. A timetable for the reduction of such emissions using these technologies should also be presented by the same date.

Limitation of pollution from new primary iron and steel production installations (OSPARCOM 92/2)

This recommendation applies for new and substantially modified primary iron and steel production installations that have been granted a building license after 1 January 1993).
A. General Requirements: 1. Waste gases containing dust should be collected and be subjected to dedusting. After dedusting, the gases should not contain more than **50 mg dust/m^3**. If the dust contains hazardous waste, more stringent standards should be achieved (Levels of dust in the order of 10 mg/m^3 can be achieved by the use of fabric filters). 2. Water used for scrubbing, for instance for the removal of dust, HF, SO_2 and NO_X and rinsing purposes should be subject to recirculation. The bleed from these recirculation systems, as well as storm water, should not contain more than 10 mg suspended solids/l before discharge. Where possible, discharges should be avoided by using dry operations.
B. Sinter Plants: 3. Sintering flue gas dust emissions should not exceed 100 mg/m^3 (corresponding to 200 g/tonne sinter).
C. Coke Plants: 4. During charging, visible emissions should not occur during more than 10 per cent of the charging period. Considerable clouds of dust or vapour (about 20-40 per cent opacity) should not be present at any time. 5. During coking, clouds of vapour should not be visible at more than: a) 2 per cent of charging hole lids; b) 2 per cent of ascension pipes; c) 5 per cent of doors. 6. Cokes should be quenched preferably by dry methods. Dust sources should be enclosed and extracted with fabric filtration or equally effective methods. Dust emissions should not exceed 20 mg/m^3 (20 g/tonne coke). If wet quenching is applied, grit arresters should be present in the quench tower. 7. Waste water from coke oven gas treatment should comply with the following value: Total-N = 100 mg/l (30 g/t coal at 10 per cent water content); COD = 200 mg/l (60 g/t coal at 10 per cent water content);
Phenol = 0,5 mg/l (0,15 g/t coal at 10 per cent water content).

Table 9, Ctd.

D. Blast Furnaces: 8. All waste gases containing dust should be collected and be subjected to dedusting. This in particular applies for gases from charging, from tapping and from pig iron desulphurisation. 9. Waste water discharges should be minimised.
E. Basic Oxygen Furnaces (BOF): 10. Due to gas conditions, primary gases from BOF should not contain more than 50 mg/m^3. 11. All waste gases containing dust should be collected and be subjected to dedusting. This in particular stands for gases from pig iron decanting, charging, tapping, refining (ladle metallurgy) and desulphurisation.

Limitation of pollution from new secondary iron and steel production and rolling mills (OSPARCOM 92/3)

These provisions are effective from 1993 for new steel plants and for new installations in existing plants which have been granted a building license after 1 January 1993).
A. Atmospheric Emissions: 1. As much dust as possible, including fugitive dust, should be collected from process gases. Dust concentrations less than 20 mg/m^3 after filtration should be achieved by using fabric filters, or equally efficient arrestment system, for dust cleaning. If dust contains hazardous substances, more stringent standards should be achieved. 2. Electric arc furnace shops should be constructed and maintained in such a way that total dust emissions, including dust escaping through skylights should not exceed 150 g/tonne produced steel for each steel plant. 3. Measures should be taken to reduce NOx emissions at pickling plants where nitric acid is used and NO_x emissions (as NO_2) exceed 5 tonnes/year. The measures should aim at a reduction rate of at least 70 per cent.
B. Aqueous Discharges: 4. At least 95 per cent process water (i.e. water from direct cooling) should be recirculated from hot rolling and continuous casting machines. 5. The discharges of suspended solids (SS) and oil in bleed from process water systems should not exceed the following values (in g/tonne processed steel): continuous casting (SS = 10 and oil = 5); hot rolling (SS = 50 and oil = 10); cold rolling (SS = 10 and oil = 5). For plants with integrated wastewater systems, the total annual discharges should not exceed the sum of the annual production multiplied by the values above for each process. 6. Waste water flow from pickling and plating should be reduced as far as possible. Discharges of metals from pickling plants should be limited as follow: Ni = 1 mg/l; Cr-tot = 1 mg/l; Cr (VI) = 0,1 mg/l; Zn = 2 mg/l; Cd = 0,2 mg/l. 7. In pickling plants using more than 20 tonnes of nitric acid per year, measures should be taken in order to reduce the nitrate discharges by applying acid regeneration, or an equally efficient method.
C. Waste: 8. Recovery of metals from all zinc-rich (zinc concentration above 16 per cent) filter dust and filter dust from all stainless steel production should be carried out.

Considering that EQOs and EQSs are based on the determination of safe environmental levels under which industrial facilities must operate, it implies that the carrying capacity of the environment is a significant determinant in establishing pollution limits. However, in their replies, Germany, the United States and Finland have indicated that the available assimilative capacity cannot be used to relax pollution limits which have been established at a more rigorous level using technology-based requirements.

5.3 Best Available Technology

Regulatory approaches in Finland, Germany, Sweden, the United Kingdom and the United States legally stipulate BAT for setting pollution limits. In Finland, Germany, Sweden, and the United Kingdom, the definition of BAT is quite similar, i.e. it is technology which has been proved elsewhere and is economically feasible. Although BAT notes may include suggestions in terms of preferred techniques to be used, the guidelines are generally specified by a prescription of performance levels rather than by defined technologies. BAT guidance serves as a minimum basis by the permitting authorities when negotiating the conditions to be inscribed in the permit. In practice, it is up to the operator to show that its proposal will achieve the same level of environmental performance. BAT definitions for European participating countries are given in Table 10.

But there are differences in the use of BAT as a regulatory principle. Germany considers BAT-based limits as binding requirements which will not be relaxed even if EQOs and other factors would permit such relaxation. Although not legally stipulated, Finland tends also to favour BAT as minimum requirements since “water protection is set approximately at the level of the natural quality of the environment (...)”. Sweden reports that permit requirements may be less stringent than BAT-based limits depending on the quality of the environment and the cost of remedial measures. Accordingly, in the United Kingdom, the quality of the environment may affect the determination of BAT marginally. However, the relaxation of BAT-based limits in cases where EQOs and/or EQSs are met is usually the exception, thus confirming the rule. BAT-based approaches may also vary between participating European countries, depending on regulatory provisions. In Finland, the “efficiency criterion” introduced in the new Waste Act stipulates that the plant shall save raw materials and use waste instead of virgin raw materials. In Sweden, the Chemical Act includes the substitution principle which seeks the replacement of pollutants by less hazardous ones.

In the United States, technology requirements are embodied at the highest level of the decision-making process of government and in very explicit and precise terms. Thus, the permitting authorities have less discretion and may be bound by court decisions. The BAT approach is more rigid as the degree of technological performance is specified in the permit on the basis of different considerations such as the type of application (new or existing sources), the industrial category, the area in which the operation takes place (attainment area [AA] or non-attainment area [NAA]) or the pollutant under review. Some BAT requirements are developed at the Federal level whereas others are defined on a case-by-case basis. They are generally media-specific:

- for criteria air pollutants, "Best Demonstrated Technology" (BDT) is required for major new sources regardless of attainment status; for existing facilities, "Best Available Control Technology" (BACT) is required in attainment areas, but more stringent limits or "Lowest Achievable Emission Rate" (LAER) in non-attainment areas are applied; for the control of hazardous air pollutants (HAPs), "Maximum Achievable Control Technology" (MACT) is required in all cases;

- for water, new facilities must meet BDT on effluent limitations (New Source Performance Standards - NSPS) or pre-treatment (Pre-treatment Standards for New Sources - PSNS) in all areas; technology-based standards are set according to pollutant types and industrial category for existing sources (including Pre-treatment Standards for Existing Sources - PSES). In cases where a BAT standard is not developed, the permit writers must use their best professional judgement (BPJ) in setting requirements; this applies in particular to "non-conventional" pollutants;

- for the environmental control of waste, BAT is required in all areas.

Albeit literal differences in legislation, the EU Member states and the United States have the discretionary power to extend the scope of BAT on any activity/substances perceived as a potential threat to the environment. Moreover, the EU IPPC Directive is likely to harmonise the setting of permit requirements in EU Member states through its integrated BAT provision. As such, the Ministerial Declaration of the Fourth International Conference on the Protection of the North Sea may have set the stage for the future work in setting BAT requirements[34]:

i) further improvements of BATs and BEPs (best environmental practices) should pay attention to all aspects of a product's life cycle including possibilities for use of cleaner technologies, environmentally-sound products and substitution of the use of hazardous substances by the use of less-hazardous substances or preferably non-hazardous substances where these alternatives are available;

ii) the dynamic nature of BATs and BEPs implies the need to establish procedures for regular reviews of specific sectors - at least every 10 years, the first time not later than 10 years after their adoption - with the aim of further improvement, if suitable new technologies or practice have become available;

iii) BATs and BEPs should be such as to ensure flexibility in developing and describing BATs and BEPs and should include product and performance standards where appropriate;

iv) BATs and BEPs definitions need to take account of discharges, emissions and losses to all media as well as waste, energy, and raw material consumption, as appropriate; and

v) the establishment of procedures is needed in order to assess adequate compliance and reporting as regards the application (legal implementation or application in practice) of internationally agreed BATs and BEPs.

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34. "Ministerial Declaration of the Fourth International Conference on the Protection of the North Sea, Oslo and Paris Conventions for the Prevention of Marine Pollution Working Group on Point Sources (Point), Koblenz, 11-15 December 1995.

Table 10. **Definitions of BAT in some European countries**

Finland (BAT)	"(...) This means the most effective and technically and economically feasible production and cleaning methods developed, their management and control system and other courses of action, by which the environmental pollution can be prevented or decreased in the most effective way. This further means available techniques that can be implemented in the concerned sector at a cost which is reasonable with respect to the prevention of the pollution otherwise caused." (Water Act, Section 2a)
Germany (State-of-the-art BAT)	"State-of-the-art, as used herein shall mean the state of development of advanced processes, of facilities or of modes of operation which is deemed to indicate the practical suitability of particular technique for restricting emission levels. When determining the State-of-the-art, special consideration shall be given to comparable processes, facilities or modes of operation which have been successfully proved in practical operation." (Federal Immission Control Act, Article 3, para. 6) "According to the principle of proportionality, laid down in the German Constitution, the costs of BAT have to be reasonable with respect to the health and environment damage caused otherwise."
Sweden (BAT)	"Anyone performing or intending to perform an environmentally hazardous activity shall take such protective action, tolerate such restriction of the activity and take such other precautionary measures as may reasonably be demanded for preventing or remedying detriment. (...) The extent of the obligation imposed by the provisions of paragraph 1 above is to be assessed on the basis of what is technically feasible for the activity in question, and taking both public and private interests into consideration." (Environment Protection Act, Section 5)
United Kingdom (BATNEEC)	"Best" must be taken to mean most effective in preventing, minimising or rendering harmless polluting releases. There may be more than one set of techniques that achieves comparable effectiveness - that is, there may be more than one set of "best" techniques. "Available" should be taken to mean procurable by the operator of the process in question. It does not imply that the technique has to be in general use, but it does require general accessibility. It includes a technique which has been developed (or proven) at pilot scale, provided this allows its implementation in the relevant industrial context with the necessary business confidence. It does not imply that sources outside the UK are "unavailable". Nor does it imply a competitive supply market. If there is a monopoly supplier the technique counts as being available provided the operator can procure it. "Techniques" is defined in section 7(10) of the Environment Protection Act. The term embraces both the plant in which the process is carried on and how the process is operated. It should be taken to mean the components of which it is made up and manner in which they are connected together to make the whole. It also includes matters such as numbers and qualifications of staff, working methods, training and supervision and also the design, construction, lay-out and maintenance of buildings, and will affect the concept and design of the process. (Integrated Pollution Control: A Practical Guide)

Similarities both in BAT principles and fixed ELVs are also related to the fact that four of the seven participating countries are members of the EU, and contracted parties to OSPARCOM and HELCOM, working jointly on BAT guidance notes for several sectors of industry. Although BAT notes from OSPARCOM or HELCOM are recommendations with no obligation on countries to implement them:

> “failure to comply with a decision which binds the Contracting Parties, or some of them - and is thus similar to an international agreement - gives rise to international liability on the part of the party concerned.”[35]

Thus, parameters, pollution limits and permit conditions implemented by contracting parties to these conventions are expected to be similar to OSPARCOM and HELCOM BAT-based limits and guidance. Indeed, parameters and related conditions inscribed in permit samples provided by these countries are basically in accordance with OSPARCOM and HELCOM BAT notes. Some of the ELVs for iron and steel processes in Germany, Sweden and the United Kingdom can be found in their country profiles. BAT notes for the iron and steel industry for HELCOM are provided in Tables 11, 12 and 13.

Table 11. **HELCOM Note 11/5 on total discharges for iron and steel industry**
Objectives for total discharges (mg/l) for water and waste*

Type of Process	**SS**	**Oil**	**Zn**	**Pb**
Blast furnace including sintering plant	20	-	1	0.1
Open-hearth furnace	70	-	-	-
Converter	20	-	-	-
EAF	20	-	-	-
Continuous casting	20	5	-	-
Hot rolling	100	10	-	-
Cold rolling	50	10	-	-

* Closed systems should be developed to circulate process and polluted cooling water to at least 90 per cent; Cyanide = < 0.1 mg/l.

35. “Relations between PARCOM agreements and Community Legislation” (presented by the EC), Working Group on Point Sources (OSPARCOM), The Hague, 14-18 November 1994.

Table 12. **Restriction of discharges from the iron and steel industry (HELCOM)**
(Draft Recommendation to supersede Recommendation HELCOM - 11/5)
BAT to reduce waste water discharges from the iron and steel industry

1. discharges should be avoided where possible by using dry operations (e.g. gas cleaning techniques which cause no discharges to water);
2. process water, polluted cooling water and polluted stormwater should be treated separately from unpolluted cooling water at each plant;
3. installation of closed water systems should be developed for process water, polluted cooling water and polluted stormwater;
4. production processes, utilisation of by-products, waste- and stormwater technology should be developed in order to minimise discharges (e.g. slag granulation by process water);
5. internal and external measures should be taken to minimise accidental discharges;
6. sludge should be disposed of in a manner causing minimal environmental hazard.

Objectives for total discharges

Type of process	**Suspended solids**	**Oil**	**CN vol.**
Blast furnace	10 mg/l	5 mg/l	0.1 mg/l
Sintering plant	10 mg/l	-	-
Open-hearth furnace	10 mg/l	5 mg/l	0.1 mg/l
Converter	10 mg/l	5 mg/l	0.1 mg/l
EAF	10 mg/l	5 mg/l	0.1 mg/l
Continuous casting	10 g/t	5 g/t	-
Hot rolling	50 g/t (or 1 t/a)**	10 g/t (or 0.2 t/a)*	-
Cold rolling	10 g/t	5 g/t***	-

** For existing plants only. *** Figure questioned by Poland.

Table 13. **HELCOM Note 11/7 on air emissions from iron and steel industry**
Measures for the reduction of air emissions

1. fugitive emissions from all processes should be avoided as far as technically feasible (e.g. by encapsulation, evacuation hoods combined with good housekeeping practices);
2. fabric filters or technology environmentally equivalent should be used for dust cleaning e.g. in sintering plant, for secondary gases from blast furnaces and basic oxygen furnaces, in EAFs and at cutting and grinding operations;
3. low emissions coke cooling techniques, preferably dry quenching, should be used for new installations and from 1995 for existing coke plants;
4. filling gases from coke plants are to be conveyed to the crude gas as far as possible. Filling gases which may not be passed on shall be burned;
5. waste gases from coke oven pushing shall be captured and passed through a dust collector.

Objectives for controlling emissions to the atmosphere

Particulate matter content of filtered gases (when suggested technologies are used)	< 10 mg/m^3 (ndg)
Particulate matter content of filtered gases (in any case)	< 50 mg/m^3 (ndg)
Dust emissions from dry quenching	< 20 mg/m^3 (ndg)
Dust emissions from wet quenching from: - new plant - existing plant	 < 20 g/t of coke < 50 g/t of coke
Particulate matter in the combustion waste gas	< 25 mg/m^3
Dust content of waste gases from coke oven pushing	< 5 g/t coke

National Emission Standards

Emission standards, as differentiated from pollution limits which appear in permits, have been mainly established in Germany, the United Kingdom and the United States. In Germany and the United States, the technology-driven approach is used to set binding emission/discharge/waste standards for individual pollutants as well as for source categories (e.g. iron and steel processes). These technology-based standards must also ensure compliance with air quality standards which are binding rules. Additionally, there are EQOs for water which may lead regional authorities to set stricter pollution limits. Under the Integrated Pollution Control Act (IPC), the United Kingdom has also set achievable release levels for industrial processes which require permits.

For air emissions, USEPA has established New Source Performance Standards (NSPS) for more than 60 source categories that include steelworks. These standards apply to new facilities or major modifications of existing plants and have been adopted to ensure that the "best" pollution control technology will be implemented. Depending on the environmental state of the area, the plant may be subjected to technology-based standards under attainment or non-attainment areas. The Clean Water Act also provides technology-based effluent limitations which are minimum binding requirements regardless of the quality of the water body. These standards are set by industrial category and address specific pollutants (conventional, priority and non-conventional pollutants).

With regard to limiting emissions In Germany, each facility subject to licensing has to comply with emission limit values (ELVs) for a large number of substances in accordance with the State-of-the-art, the Technical Instructions on Air Quality Control of 27 February 1986 (First General Administrative Regulation Pertaining to the Federal Immission Control Act, *TA Luft*). These ELVs do not depend on environmental quality standards (EQSs) and are applied uniformly all over Germany. However, there are ambient air quality values for nine substances laid down in the *TA Luft*. Applicants have to measure the quality of the environment of the area in which they want to locate or operate. They have to model the pollution that they will generate and include it into the broader emission pattern. The results of local air quality measurements and the modelling of pollution are taken as a basis for the decision concerning the application for operating a facility. If an air quality value laid down in the *TA Luft* is breached, the facility must use further control measures.

The United Kingdom's IPC requires the operator of a Part A process to obtain from HMIP an integrated permit to operate by demonstrating that its proposal will equal in terms of environmental results what BATNEEC can achieve. Under IPC, emission limits are not fixed at the national level. While Process Guidance Notes are prepared for industrial processes to assist the permitting authority, emission limits in permits are site-specific which leave the decision on the appropriateness of the operator's proposal to the professional judgement of the Inspector.

Finland, Japan, Korea and Sweden do not have any specific standards for the iron and steel sector. In Finland and Sweden, there is no national emission standards. However, there are general guidelines for major industrial processes which have been based on national considerations as well as derived from international conventions (e.g. OSPARCOM and HELCOM). Sweden has developed guidelines for EQOs (SO_2 and NO_x) as well as specific BAT guidance which concern the iron and steel sector. Finland has adopted some national guidelines for atmospheric emissions. Target values also affect noise. Finland reported that guidelines from international conventions such as HELCOM are usually used to determine permit requirements.

In Japan and Korea, there is no stipulation of BAT although technological considerations influence the setting of EQSs. Japan reported that national common emission standards might be defined at technically-acceptable levels. In cases where local environments cannot be protected merely by national standards, the local governor can set more severe standards. Thus, pollution limits may be set on the basis of technological assessment and be tightened if discharges/effluents lead to the exceedence of EQSs. Permit samples provided by Japan show that permitting decisions can be based on BAT-type requirements.

5.4 Other Considerations for Setting Pollution Limits

Pollution Prevention

Germany, Finland and Sweden have introduced environmental principles aimed at favouring pollution prevention in the permitting procedure. The "substituting principle" in Sweden, the "efficiency criterion" in Finland and the "precautionary principle" in Germany have a legal status which enables the standard-setting and permitting authorities to push for the best environmental options. In the United States, voluntary initiatives such as the 33/50 programme (pollutant reduction targets) or the Common Sense Initiative have been created as means to foster pollution prevention and cost-efficient industrial practices and better craft regulatory approaches. Another major instrument aiming at more environmentally-sound practices is the Toxic Release Inventory (TRI), a public information system which gathers data on the annual releases of top pollutants by source categories. Pollution taxes and effluent/emission charges are also in use to varying degrees but it is difficult to assess the influence of such instruments on pollution prevention activities.

Pollution prevention will often be implemented through a mix of legislation (the prohibition of substances), administrative action (new conditions attached to a permit) and voluntary action by the industry (e.g. environmental management in the handling and sorting of scrap to avoid hazardous compounds such as cadmium and chloro-organics). The banning of substances or processes is a powerful instrument used in several jurisdictions, as illustrated by the BAT approach used in the Swedish permit sample that led to the phase-out of sintering operations.

Economics and Environmental Quality

Finland, Sweden and the United Kingdom set permit conditions on a case-by-case basis by assessing economics, local environmental conditions, and technological capabilities. In the United States, MACT and NSPS determination may also take into account economic considerations in setting permit requirements (see section on economic considerations in Section 3.7). Germany, Japan and Korea do not allow economic considerations to influence the determination of pollution limits in permits, stating that they are taken into account upstream in the setting of nationally-set standards.

5.5 Interaction of EQOs and BAT

As mentioned previously, five of the seven participating countries, i.e. Finland, Germany, Sweden, the United Kingdom and the United States, establish national standards and/or pollution limits for industrial sources and for different types of pollutants on BAT. Where EQOs and EQSs are in place, BAT-based limits may be strengthened if needed to ensure compliance. In principle, a new permit will not be allowed for a stationary source if the applicant is unable to meet existing EQSs.

However, the review of permit samples indicate that the technology-based approach is increasingly used to set permit conditions in all participating countries. While BAT is formally absent in their regulations, Japan specified that BAT was the main determinant for setting pollution limits in both permit samples to ensure that EQSs were not exceeded, due to the complexity of deriving discharge/emission limits directly from EQSs. Similarly, Korea indicated that technology assessment was a determining factor in establishing appropriate environmental requirements in environmental impact assessments (EIAs) which must be performed for all major industrial point sources.

In turn, the permit samples show that the combined use of BAT and EQO is a prerequisite for setting the most appropriate, far-sighted pollution prevention and control requirements, as well as taking into account local conditions. As such, technological and environmental considerations have been incorporated into permitting decisions according to no pre-established or uniform sequence. Technology-based requirements appear to be a common, immediate driver for setting pollution limits and other permit conditions, but are themselves driven by the requirement that environmental quality be preserved at some agreed level. Some of the main environmental examples of permit samples which illustrate this trend are:

- in the Finnish notification procedure, oily effluent discharges have been prohibited on both BAT considerations and environmental quality objectives related to international obligations (i.e. avoiding transboundary pollution in Lake *Ladoga*);

- in both the Swedish permit and the German provisional decision, investigative programmes on the relationship between scrap inputs and pollutant outputs from EAFs (e.g. mercury and dioxins) are based on end-of-pipe monitoring of emissions, sorting of scrap and monitoring of heavy metals and hazardous organic materials in marine environments (i.e. North and Baltic Seas);

- in the Swedish permit, the authority’s decision to set emission limit values for sintering operations based on BAT for pellet inputs was mainly influenced by environmental national targets for reducing heavy metals and hazardous organic compounds in the environment;

- pollution limits in the Japanese permits have been set on the basis of BAT for ensuring compliance with existing EQSs since both plants operate in a multiple point sources zone.

In addition, it must be noted that discussions on environmental issues and related guidance developed in the context of regional conventions, such as OSPARCOM, HELCOM and IJC, are mainly based on the complementary assessment of environmental quality and technological capabilities in different industrial and manufacturing sectors. A general trend towards the harmonisation of environmental quality standards is being foreseen both in Europe and North America (e.g. with the implementation of the EU IPPC Directive and the proposed USEPA harmonised water quality standards for the Great Lakes States).

5.6 Impact of Permitting on Pollution Control and Cleaner Technologies

All the countries provided a list of innovative actions which have been implemented in the selected facilities. Permit requirements have most obviously influenced pollution control technology and the development of cleaner process technologies in the following ways:

- permit limits have been set in performance terms considering what pollution prevention and end-of-pipe treatment technologies can achieve. The actual approach for achieving compliance was left to the operator. Pollution prevention was also used as a principle for optimising economic efficiency. For example, the substitution of continuous casting for ingot teeming has reduced substantially both the quantity of releases and energy needed for making steel by eliminating a whole sequence of the manufacturing process;

- the principle of reduction, reuse and recycling (3Rs) of waste, raw materials and energy has been incorporated in BAT-based limits and requirements, leading to in-plant measures and cost-effective complying techniques. Consequently, wastes requiring treatment are minimised, thereby treatment cost and environment loadings are reduced. An example is the recycling of about 90 per cent of solid by-product waste generated in steel production, either by treatment or recharging to the process, or through the sale of the material.[36] All permit samples included provisions aiming at the recycling of outputs;

- concerns over the acidification of water courses and forests, and its effect on public health, resulting from atmospheric emissions of steelworks, have resulted in more stringent requirements being set by international, national and local authorities. In-plant measures such as the introduction of cleaner fuels and minerals (the substituting principle) are increasingly used as cost-efficient techniques for complying with stringent standards;

- stringent EQOs and EQSs have caused the tightening up of many plant circuits resulting in the almost entire recycling of the steelworks outputs, products or wastes. Emission limit values and solid waste national target plans have contributed significantly to the ongoing increase of scrap as input material. One consequence is that recycled metals are becoming an increasingly major part of the total metal supply, and in some cases, exceed the value of metals mined by around 10 per cent;[37] both integrated and non-integrated plants are striving to close the loop by recycling most input and output materials. This is achieved by optimising operating practices, improving environmental management, and by using cleaner materials and fuel;

- limits on air emissions have been achieved through improved control techniques and treatment technologies, such as the introduction of baghouses, high efficiency cyclones, scrubbers, and electrostatics precipitators, to control airborne dust releases;

- emissions of dioxins/furans and mercury are being reduced and controlled by better management and control programmes and end-of-pipe techniques, such as scrap metal sorting and cleansing, and the uses of high efficiency control devices.

As mentioned, some permits include requirements for investigations into various areas which may lead to the development of new, cleaner production technologies. The results of these studies are used continuously by permitting authorities. Examples include: investigations on the relationship between scrap composition as material inputs and resulting pollutant releases; studies on energy use; and studies on opportunities to recover and reuse materials.

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36. Christmas, I., Op. cit.

37. Angulo, F., Op. cit.

6. CONCLUSION

The four industrial case studies, among which is that on the iron and steel industry, have been initiated to shed light on the relationship between regulatory approaches and the industry's technological response. It was one of the project objectives to determine which regulatory approaches and instruments can potentially stimulate innovative pollution prevention measures and techniques. The permits provided by the participating countries cover various processes and some did not address all media. Therefore, it was difficult to draw any firm conclusions on some questions of the project. But the permit samples did exhibit similar permitting approaches and technological responses by permitted facilities. In turn, the similarities between individual facilities and the general trends in the iron and steel sector illustrate some key factors and issues which govern in part the way permit requirements are defined and how industry reacts to them.

But despite these inherent limits, the conditions and emission limit values contained in the permit samples do reflect current trends in term of environmental regulations and environmentally-oriented technological development. Permitting conditions provide by participating countries are as such typical of conventional and current environmental approaches. Thus, two different approaches have been reported for setting pollution limits and permit conditions that affect the iron and steel sector:

- firstly, pollution limits or emission limit values (ELVs) may be set on the basis of the best available technology/techniques (BAT) for reducing the discharges/emissions, taking into account the economic feasibility of those means. However, BAT-based limits and conditions may vary between countries, being influenced by other considerations, such as the status of a given local environment, political conditions related to international obligations or social pressures. Although this is being put into practice in most countries, the use of BAT as a regulatory principle is made explicit in the legislation of only a few of them, i.e. United States, Germany and the United Kingdom. In practice, it is implemented as well in Finland and Sweden, but on a case-by-case basis.

- secondly, environmental quality standards (EQSs) are used to define the permit limits not to be exceeded at particular locations. The carrying capacity of the environment will be determined by taking into account different factors such as the protection of public health, the protection of ecosystems, the avoidance of transboundary pollution, water uses, and cost/benefit trade-offs of the activities under review. Permitting systems in Japan and Korea are typically based on such an approach. However, both countries indicated that they had used BAT considerations in setting permit conditions because of the complexity of devising appropriate pollution limits in areas of multiple point sources.

Both approaches provide regulatory authorities with different degree of discretion, depending on the specificity of the regulations. In the United States, the permitting authorities have a more limited discretion when establishing BAT-based limits as divergence from legal rules may lead to court actions. In Europe, the general definition of technology-based rules leaves more margin of manoeuvre and interpretation to the authorities. This is even truer in countries such as Japan and Korea where environmental regulations are governed by environmental quality principles. However, in all jurisdictions, meeting EQSs remains an overriding regulatory principle.

It appears that permitting authorities have to balance environmental and technical consideration to ensure that permit conditions will lead to acceptable environmental performance and will be based on ongoing state-of-the-art techniques. On the one hand, a trend towards similar permit requirements for major industrial sectors such as the iron and steel industry is perceivable in OECD Member countries. Moreover, technology-based regulations exist in all of the 18 countries surveyed in the project. On the other hand, EQOs and EQSs have been widely used to define targets and levels not to be exceeded for the sake of a safe environment. As was illustrated in the Swedish and German permit samples, selective requirements may be needed to ensure the protection of the environment and public health if a sum parameter is unable to control all types of priority substances. Regulations tackling substances which have a purpose in production (chlorinated cutting oil, solvents, etc.) give producers and suppliers a clear incentive to replace the substances and/or to introduce environmentally-sound ways of producing their goods. In many countries, bans on certain substances or restrictions on some industrial processes have triggered preventive approaches throughout the industry.

In its reply, Germany rightly pointed out that an important shift has occurred in environmental approaches among OECD countries whereas more preventive efforts, based on environmental quality objectives, are taking over from pollution control strategies. Early environmental regulations have been successful in getting the industry to reduce the high volumes of by-products being released by establishing end-of-pipe ELVs. However, while achieving some success, pollution control strategies have often shifted pollution across media resulting in no net environmental improvements and the subsequent high waste treatment costs. In addition, control technology has often been rendered obsolete in view of new environmental problems and technology innovation. Therefore, recent regulations have been characterised by more selective efforts to limit the release of harmful substances that balance technical and environmental considerations. This new trend in regulatory effort has also been fuelled by international and local public concerns about the health effects of a wide variety of synthetic chemicals accumulating in the environment. As a case in point, the new Great Lakes Water Quality Guidance singles out 22 chemicals, mainly organochlorines and mercury, as bioaccumulative chemicals of concern for which virtual elimination strategies are warranted.[38]

These regulatory initiatives are well illustrated in the permit samples, notably in the case of dioxin and metal emissions. Permit requirements leading to investigative programs aimed at the identification and minimisation of pollutant sources have been defined in all of the permits provided. This clearly illustrated the new trend in regulatory thinking whereas environmental management and a cradle-to-grave approach are increasingly used to find better ways of reducing and/or eliminating harmful substances and releases. In the iron and steel industry, life cycle assessment approaches are likely to play a prominent role in the future. It must also be remembered that these efforts are necessary since sum parameters such as particulate or smoke standards do not have the potential to ensure the control of some substances such as mercury.[39] In terms of pollution prevention approaches, it emphasises the importance of permit conditions related to monitoring activities in order to identify problems at source, thereby

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38. Renner, R., "EPA Great Lakes Guidance Hits a Squall", Environmental Science & Technology, 1995, Vol. 29, No. 9.

39. Fraunhofer-Institut für Umweltchemie und Ökotoxikologie, "Application of a Selection Scheme for the Identification of Hazardous Substances Relevant to the Aquatic Environment", German Umweltbundesamt, September 1995: "For substances being released from point sources it has to be proofed by the individual EEC Member States if releases are already reduced to a minimum by application of BAT and if a (potential) reduction could be sufficiently controlled by "sum parameters" such as AOX and BSB/CSB. If a control by "sum parameters" is not achievable, individual chemicals should be controlled in order to reach compliance."

enabling the development of cost-efficient solutions as a substitute to costly control techniques and the inescapable treatment and storing of waste.

Towards a More Integrated Approach to Permitting

In the wake of the upcoming European Union (EU) Directive on Integrated Pollution Prevention and Control (IPPC), co-ordination of the issuing of licenses for air, water and hazardous waste emissions represents only a transitional period towards an integrated, multi-media permitting system to avoid transfer of pollutants from one medium to another. Such a system would be more likely to treat steel producers, smelters and refiners as whole entities, thereby eliminating opportunities to transfer pollutants across media. Moreover, an integrated approach to pollution prevention and control could allow for the identification of factors upstream and downstream of industrial processes that would involve other actors, such as materials and energy suppliers and waste treatment providers. This would encourage the development of pollution prevention approaches through the introduction of cleaner processes and materials, waste minimisation and the recycling of pollutants. This trend toward an integrated approach to permitting is not limited to Europe. Indeed, in the United States, the Source Reduction Review Project has identified, among others, the iron and steel industry as a legitimate candidate for which a more integrated approach to rulemaking is warranted.[40]

Considering that few countries provided permits on all media, it was rather difficult to evaluate the influence of an integrated approach on future regulations and technological responses. Nevertheless, an integrated approach has been raised as preferable for the iron and steel industry. A cradle-to-grave approach to reused materials such as scrap and other waste is more likely to lead to substantial abatement of harmful emissions, extensive recycling of by-products and more environmentally-sound products. In this context, flexibility in regulations could be achieved by integrating the whole chain of producers, suppliers and customers.[41]

In conclusion, the permit samples suggest that the combined use of both technology-based and environmentally-based approaches and instruments are a prerequisite for the design of optimal permit conditions. The combined use of BAT and EQO considerations also represent a converging trend embraced by most OECD Member countries. Moreover, it emphasises the importance of the professional judgement of permitting authorities, and the need for political will, for pushing industrial operations toward sustainable development.

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40. CSI, Op. cit.

41. Communication with R. Di Carlo (Environment Canada): A percentage of more than 40 per cent scrap cannot be used as raw material mainly because of some of its toxic content (coatings, PVC, etc.); therefore this means that a pledge to use tools such as life cycle assessment and management in the iron and steel industry is to be made.

ANNEX

COUNTRY PROFILES

FINLAND

1. THE PERMITTING PROCESS

1.1 Constitutional Responsibilities for Environmental Protection

In Finland, environmental regulation is effected under a number of pieces of legislation, including: the Water Act, the Waste Management Act, the Air Pollution Control Act, the Chemical Act, the Public Health Act, the Public Water and Sewerage Systems Act, the Noise Abatement Act, and the Environmental Permit Procedure Act.

The Ministry of the Environment provides the co-ordination and direction of environmental protection. This includes control of air and water pollution and the management of solid waste. The ministry is responsible for the preparation of legislation and regulations for the general supervision of administration of these by local authorities. Requirements are implemented through thirteen Regional Environmental Centres located throughout the country. These were established in March 1995 and they amalgamate the organisations that previously dealt with separate media (water, air and waste), into a single operating unit.

With respect to water, ownership of surface waters resides with the owner of the adjacent land. The Government's legal status as an owner is the same as that of a private landowner. General usage rights as well as the Water Act govern the use of surface water. 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.

Finland is a party to several international agreements, which have the same value as a legal basis as domestic legislation. For instance, the Water Act specifies that:

> *In addition to the provisions of this Act, the provisions of any international convention binding on Finland on the protection of water bodies and the sea shall also be complied with to prevent pollution of a water body.* (Section 19)

Among the relevant international agreements to which Finland is a party:

- Convention on Long-Range Transboundary Air Pollution (1993);
- Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989);
- Convention on the Protection of the Marine Environment of the Baltic Sea (1992);
- Convention for the Protection of the Marine Environment of the Northeast Atlantic (1992);

- Convention on the Protection and Use of Transboundary Watercourses and International Lakes (1992);
- The European Economic Area Agreement (1992);
- Bilateral agreement with Sweden.

In addition to the judicial binding conventions, Finland has made bilateral agreements with the Russian Federation and the Baltic countries in order to promote the co-operation in the environmental field. The agreements include environmental targets and programs.

1.2 Permits

The Water Act prohibits the closing, diverting and polluting of surface water unless the Water Court grants a permit. Legal conditions for a permit demand that the project will not cause extensive harmful changes and that the benefits will outweigh the damages caused. Permits related to the discharge and control of liquid effluents are issued by the Water Courts, of which there are three located throughout the country. These comprise of a judge assisted by at least two specialists expert in engineering and environmental science. They conduct public hearings and decide on the content of permits on a case-by-case basis. Permits related to air pollution and solid waste management are issued through the thirteen Regional Environmental Centres. The permitting system includes a notification procedure according to which the water authority must be notified in advance regarding any plans for the discharge of waste water. The Regional Environment Centre assesses the notification and determines whether the activity will cause water pollution. If pollutant discharge is unavoidable, the polluter must apply for a permit to the Water Court.

Installations mentioned by the Air Pollution Control Decree, the Waste Management Decree and/or the Public Health Decree are required to submit an application to the Regional Environment Centre or, in specified minor cases, to the local Municipal Environment Board. An integrated permit covering waste management, air pollution control and noise abatement is then issued according to the Environmental Permit Procedures Act by the Regional Environment Centre or Municipal Environment Board. Since 1995, these integrated permits are issued by the 13 Regional Environment Centres.

A typical feature of the licensing procedure in Finland is the case-by-case deliberation of applications and the tailor-making of permit conditions. Permits are issued based on review and analysis of the application by the facilities. Permit applications require descriptions of the manufacturing process, raw material and chemical use, measures for controlling pollution, control strategies and equipment specifications, estimates of the quantities and characteristics of the emissions, a description of the receiving water and state of the environment, and the prediction of the possible impact of the proposed activity on the environment and the air quality. The authorities may request whatever additional information they consider necessary. Applications for a new activity are generally submitted at an early stage since environmental considerations may affect the siting of the activity. The quality and details of the applications vary considerably.

The applicants are free to select the control technology, but their selection is subject to scrutiny by experts hired to support the permitting authority. Environmental effects are also assessed. In making their decisions, the permitting authorities consider environmental, technical and economic factors. Decisions are made on the principles that the fundamental target is to prohibit pollution; that the polluter pays principle is adhered to; and that the requirements set on different polluters are based on equal and impartial assessment of the environmental impacts as well as technical and economic possibilities.

The public is notified of the application, documents are publicly available, and comments can be made on them. Following the normal procedure, the authority and judicial courts make decisions on limits and other restrictions. Those concerned have a right to appeal.

1.3 Permit Renewal Process

Permits granted by the Water Court specify a renewal period, which varies between three to ten years. Permits have to be revised/reissued whenever there is a change in production volume, processes or use of raw materials or chemicals, which may affect emissions or waste management. Additionally, they may be revised if conditions assumed in the permit issue process are not realised 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 harmful effects do not need re-application. However, in circumstances where the permit conditions have changed, or where the water body has suffered significant damage, the Water Court may require an application for a new permit to be filed before the normal expired date.

Decisions by the Water Court can be appealed to the Superior Water Court. In cases of principal importance or calling for precedent, special permission can be obtained to appeal to the Supreme Administrative Court. This applies as well for decisions by the Provincial Government.

1.4 Multi-Media Permits

According to the Environmental Permit Procedures Act, an integrated permit procedure is applied for atmospheric emissions, waste management and noise abatement. Finland intends to integrate wastewater discharge permits with other emission permits. Preparation of the pertinent legislation is underway.

A multi-media and «from cradle to grave» approach is an urgent task on which Finland is paying much attention. Criteria for weighing different impacts and for decision-making methods must be developed and adapted to the special Finnish features in nature and culture.

A Bill concerning the conduct of environmental impact assessment (EIA), corresponding to the European Communities (EC) Directive, is proposed and assessment methods are under development. The ongoing change in administration also aims at an integration of the environmental protection and surveillance. The new administration is assumed to be more effective than the earlier, and partly current one, both with regard to the polluter's and the authority's interest. The expected benefits are associated mainly with the aim to optimise the pollution control measures with regard to overall environmental impacts, with savings of manpower during the application and supervision procedures, and with the better use of expert knowledge. The aim to optimise pollution control measures with regard to multi-media impacts provides for environmental impact assessment and well-developed decision systems. This includes modelling of emission distribution and impacts, risk analyses, methods to weigh impartially non-comparable impacts, modelling of production processes and their influence on emissions, and estimates of costs and other economic impacts. Furthermore, the «cradle to grave» aspect should be included.

1.5 Environmental Assessment

Limit values are based both on an environmental impact assessment and on an evaluation of what the performance of available technology to control releases can achieve, and how improvements can be made to the performance of the technology. Environmental assessment is an important part of the inquiry and permitting procedure. It is based both on running monitoring programs and on special investigations. 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 programme approved by the Water and Environment District Office (now the Regional Environment Centre). The monitoring programmes are made specifically for each plant according to guidelines given by the National Board of Waters and the Environment (now the Finnish Environment Agency). The importance of biological 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 water course are assessed and the present and potential use of the water is investigated. Mathematical modelling may be used to ensure that the water quality does not deteriorate or prohibit future needs. In principle, targets or EQOs for waters in Finland are equal to the original or natural background quality, which varies with the geology and morphology of the different parts in the country. Because of the sensitivity of the watercourses and their status as private property, a comprehensive compensation system is connected to permits for discharge of wastewater. Thus, although BAT is required, the polluter must pay significant compensation for the water pollution according to certain criteria affecting the value of the owner's shore or his income from fishing etc. Modelling may also be used to determine the water area affected to enable the calculations of compensations to water owners and fishermen. However, payment of compensation does not affect the requirement for pollution control measures.

The impacts of atmospheric emissions are evaluated during the application procedure using distribution models and the permit conditions are set to prevent violation of air quality targets. Consequently, violation of EQO from point sources is expected to result mainly from process failures and breakdowns, while the real air quality is methodologically difficult to supervise. As a rule, there is also an obligation to participate in the air quality monitoring in the area, a program usually carried out by the municipality. A most important air quality problem in Finland concerns acid precipitation.

2. BAT, EQO AND ECONOMICS

2.1 Standards Setting and Targets

Limit values are based on an assessment of both BAT and an environmental assessment. The specific norms derived from the BAT or EQO concepts (see Sections 2.3 and 2.4) are not nationally standardised except in the case of some regulations concerning sulphur dioxide (SO_2) emissions from coal-fired power and boiler plants and some guidelines on air emission limit values and targets.

For wastewater discharges, there are no emission standards, but there are internal guidelines as well as the recommendations of the Helsinki Commission. These provide guidance for decision by the authorities. For atmospheric emissions, the Council of State Decisions stipulates limit values as well as target values from which the permit conditions may deviate only for special reasons. Council of State Decisions also regulates noise. For waste management, there are not yet binding numerical norms, but these are under rapid development. The following emission standards adopted by Finland affect the iron and steel sector:

- Restricting Emissions of Sulphur Compounds from Kraft Pulp Mills;

- Restricting Emissions of Sulphur Compounds from Oil Refineries.

Noise is also regulated by the Council of State Decisions on target values, which 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 licensing for siting. For waste management, there are as yet no binding numerical standards; however, this is under rapid development.

Guidelines embodying standards are prepared by the Ministry of the Environment, their experts or advisory boards. Often, an expert working group or committee is established which may include experts from other authorities, from universities and institutes and from the private sector. The preparation of guidelines 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 comments by authorities, institutions and associations in the private sector and, depending on the issue, by non-governmental environmental organisations (NGOs). Proposals are generally publicised before the final decision. Final documents and proposals are publicly available.

2.2 Cleaner Technologies

Financial aid is available from the Technology Development Centre for applied research in the field of energy and raw material savings as well as environmental protection. Risk Loans are provided for product development. Aid is also available from the Ministry of Trade and Industry, and the Ministry of the Environment.

2.3 Environmental Quality Objectives

There are very few EQO standards prescribed in Finland. Instead of using EQO as a normative approach, a system of water quality classification has been developed and applied since the 1970s. The water quality classification is based on national research and knowledge and is quite stringent because of the special features of the Finnish lake systems. It has served both public information, physical planning, planning of water protection targets and licensing. The classification takes different criteria into account depending on actual and potential use of the watercourse. There are also several programs and decisions on 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 the land use and localisation of activities.

Most guidelines follow international agreements (see Section 1.1). To some extent, health criteria, the cold climate, and public satisfaction (especially in the case of malodorous compounds) has motivated the choice of the authorities. Also obsolete international norms are reconsidered. While the eutrophication effects of phosphorus are well known in Finland, an ongoing research deals with the assessment of the impact of nitrogen (N) on eutrophication. Finnish experts are actively participating in the international working group under UN/ECE Convention on Long-Range Transboundary Air Pollution, developing criteria and methodologies for determining the critical load and targets for acidic air bore deposition. Critical loads in different regions have also been determined on a national level within a comprehensive Finnish research program.

In the water protection sector, the most important evaluation of EQOs takes place case-by-case during the licensing procedure. In predicting the environmental effects of an existing polluter under new permit conditions, the gathered extensive monitoring data is used in the calibration and verification of water quality models and other calculations.

Finland uses a set of target limit values on air quality. Ambient quality objectives have been set covering SO_2, nitrogen dioxide (NO_2) and noise. The iron and steel mills are touched by the national air quality guidelines on SO_2, NO_2 and particulate dust, and by guidelines on noise.

The following list covers the EQOs adopted in Finland, either in the form of guidelines, limit values, water quality classifications, or recommendations:

EQOs for Air

- Air quality guidelines (Council of State Decision 537/1984, attachment 1);

  A generally accepted long-term goal for sulphur deposition of 0.3 g/m^2; malodorous sulphur and thoracic particles are included in a new proposal (attachment 2).

- Limit values for air quality in work places (Council of State Decisions);

  Maximum concentrations as 8 hours mean.

- Concentrations in air known to be harmful in work places (Ministry of Labour Decision).

EQOs for Water

- National water quality classification (National Board of Waters and the Environment, attach. 3);

  > The classification is neither a norm nor a target, but has an informative character serving both public information, physical planning, planning of water protection targets and licensing. The classification, based on different criteria, takes into account the actual and potential use of the water course.

- Household water quality guidelines (Ministry of Welfare and Health Decision, 1994);

- Bathing water quality guidelines (National Board of Health Circular, 1988).

EQOs for Land

- Guidelines for assessment of soil contamination (under preparation).

EQOs for Noise

- Noise level recommendations (Council of State Decision 993/1992, attach. 5);

- Noise abatement guidelines (by the former National Board of Health - to be reconsidered and issued as a Ministry of Welfare and Health Decision).

The existing EQOs apply for the whole country. In the Council of State Decision on air quality guidelines, Section 2, SO_2 concentration in the air should not exceed an annual average of 25 $\mu g/m^3$ (40 $\mu g/m^3$ in the whole country) in large agricultural and forestry districts important in terms of environmental conservation. In the new proposal, this is deleted as being of no relevance since annual average concentrations are in practice lower. Instead more stringent values, 20 $\mu g/m^3$ for the whole country and 15 $\mu g/m^3$ for the cold northern part of Finland are proposed.

A recently elaborated proposal will probably extend the set of target limit values for air quality to concern malodorous sulphur compounds, thoracic particles and a long-term goal for sulphur deposition. The latter has already in practice been accepted and set on the level of 0.3 g/m^2, expressed as sulphur. Another proposal is given to guide the prevention and evaluation of ground pollution. This also includes limit values for metals in sludge. The renewed Waste Act will make it possible to issue detailed Council of State Decisions in this sector.

There are not yet any multi-media EQOs in Finland. The proposal for assessment of soil contamination covers concentration values for soil and groundwater. The proposal for the long-term goal for sulphur deposition is based on multi-media criteria (biodiversity in forest land areas and water systems). The quality classification for fishing waters takes water and fish criteria into account.

2.4 Best Available Technology

Finland requires that the adverse effects of pollution caused by an activity must be minor compared to the benefits gained from the activity. To this end, a clause was added to the Water Act to the effect that BAT must be considered in developing the permit conditions:

> *In the permit, in order to protect the waters and the sea from pollution, attention shall be paid to the best available technology. This means the most effective and technically and economically feasible production and cleaning methods developed, their management and control systems and other courses of action, by which environmental pollution can be prevented or decreased in the most effective way. This further means available techniques that can be implemented in the concerned sector at a cost which is reasonable with respect to the prevention of the pollution otherwise caused.* (Chapter 10, Section 2a)

Moreover, the Acts on air pollution and waste management refer to BAT. The concept of BAT is used to set the level of limit values for emission; however, evaluation of the technology represented by BAT takes place on a case-by-case basis during the licensing process. The technology proposed by the applicant is compared to the best existing plants in Finland and to new foreign technology. The feasibility of replacing old technology and harmful chemicals is evaluated by the permit granting authority. The level of emissions and their impacts are estimated. The evaluation and licensing process include negotiations with the applicant and requests for information on the applicability of alternative technologies, processes, raw materials and chemicals. Energy, water and raw materials have not as such been included in the evaluation, although the issue is often covered as part of the emission evaluation and requirements. The new Waste Act, however, introduces this efficiency criterion, stipulating that the enterprise shall save raw materials and use waste instead of energy.

Obligations to investigate and develop technology, processes and use of chemicals are often included in the permits. Since such investigations, including cost estimates, become obsolete quite quickly, 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. With respect to water permitting, authorities apply environmental risk analysis in order to assess ways to improve the current situation at plants. This is done on a plant-by-plant basis, and has not only improved risk management at the plants, but, in some cases, has resulted in continually decreasing emissions as well. The risk analysis also helps to define BAT.

A renewed permit has so far always been more stringent than the old one. For new and renewed production capacity, the permit conditions are stringent and presume new, environmentally sound technology. An old plant's permit conditions depend partly on to what extent production facilities are renewed. The authorities may also require renewal. 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 of 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 emergency. Many big firms are also expected to join the EU/EMAS regulation and/or use relevant audit standards. BAT is required of all polluters in the same receiving area, although the share of a particular polluter's impact cannot be measured or can be assumed to be smaller than the impact of other, larger sources. This is consistent with the principle of equal requirements within one sector of industry and with the polluter pays principle.

Elaboration of guidelines and reviews on BAT are often based on consultant work (funded and supervised by the authority), literature surveys and research. The Finnish Environment Agency plays an important role in co-ordinating environmental research. For some sectors, investigations on BAT have been published, both nationally and in co-operation with the Nordic countries, but these publications have more an informative rather than normative character. In the Nordic investigations and some investigations administered by the Ministry of the Environment, a multi-media approach has been applied. The National Board of Waters and the Environment has also issued internal guidelines for some sectors and for municipalities on the water protection requirements to be recommended to the licensing authorities, and on supervision. The most recent guidelines concern metal plating, storage of chemicals and fish farming. In the future, the status of the guidelines, meant to direct the authorities within the environment sector, will be more binding as they will be issued by the Ministry of the Environment.

Finland will naturally accept the definitions of BAT (and EQO) given by the Helsinki Commission and the Paris Commission as well as by the EC. The list of hazardous wastes formally defined by a Decision of the Ministry of Interior will also follow the EC-definitions and lists.

2.5 Negotiations of Standards and Emission Limits

The habit of negotiating environmental questions is typical for Finland. Laws under development, international recommendations, research programs and regional plans are negotiated as well as individual permits and monitoring programs. The main aim of the negotiations is to exchange information in order to base decisions on best available knowledge.

In the case of permitting, discussions are often started early about the content of the application and necessary investigations. However, after discussions, the enterprise prepares the application documents independently. The authority should never be used as consultant as it is not a specialist on the circumstances at the facility which will affect costs and application, and it 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 at the stage of agreement and the competent body makes its decision on permit conditions independently.

The rules for secrecy are important for the psychology of negotiations. It is not allowed to disclose so called business secrets or other economic facts given with confidence to the authority. Documents under preparation are not public, but examples of application documents and the results of impact assessments are public.

2.6 Economic Considerations

As a rule, economic considerations are not taken into account when setting EQOs. One reason is that internationally agreed EQOs mostly are adopted as such; another reason is that economic criteria are hard to define and economic consequences difficult to evaluate. However, the proposed EQOs for cleaning up contaminated soil are clearly affected by BAT and thus by economic considerations. The same kind of consideration is true for the proposed guidelines on the use of sludge in agriculture and for the proposed long-term goal for sulphur deposition.

The costs of water pollution control in the industry have been registered by the National Board of Waters and the Environment since the early 1970s. The data cover investments in internal and external measures as well as wastewater treatment. It also covers running costs for the wastewater treatment and monitoring. The costs of other environmental pollution control have been surveyed a couple of times in the 1980s and 1990s. This has given the authorities a good overview on cost levels and cost criteria.

In requesting a permit, an enterprise is obliged to include cost estimates for measures needed to prevent and/or control pollution. In practice, the applicant gives cost estimates for the proposed pollution control measures. In addition, the authority obtains advice from the supervising authority or independent experts on these factors.

Anyhow, costs are as a rule thoroughly discussed. The question of a plant's affordability is however much more complicated. It may also be questioned whether affordability should be taken into account at all. It is more accurate to talk of cost effectiveness instead of affordability. Cost effectiveness covers both aspects of reduced amounts of emissions, reduced risks and reduced environmental impacts.

Decisions by the permitting authorities are based on an assessment of the reasonableness of the costs of the applicant proposals. Its decision is based on the concept of reasonable cost considering cost efficiency as well as decreased emissions and environmental impact. As permit conditions are negotiated on a case-by-case basis, operating requirements are tailor-made so that environmental, technical and economic aspects are taken into account and the most efficient solutions are chosen.

It should also be remembered that the polluter pays principle is strictly followed in Finland, with regard to costs for pollution control measures. Some environmental protection related taxes are in use but not yet emission charges.

2.7 Interaction of BAT and EQOs

Limit values are based on an evaluation of both BAT and an environmental assessment. 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 to pollution. 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 receiving environment. As long as this is the case, the requirements are likely to become more stringent. In the case of several polluters in the same receiving area, BAT has been required, although the share of the polluter's impact cannot be measured or can be assumed to be smaller than the impact of other sources. This is coherent with the principle of equal requirements within one sector.

Since EQO in Finland within the sector of water protection is set approximately on the level of the natural quality of the environment, the phenomenon of pollution control requirements achieving better water quality is almost unknown. In such cases, requirements may ask for BAT referring to non-measurable long term effects, the precautionary principle, risk minimising and planning for emergency. In the case where an EQO would not be met, permit requirements are gauged on a case-by-case basis. Permit conditions are stipulated as to continuously strengthen BAT. In addition to BAT, the polluter has to pay a compensation to polluted parties and for the restoration of the environment (e.g. restoration of fish stock) if damage is done (only for water). Compensations do not affect requirements for pollution control measures.

The regulations and guidelines for atmospheric emissions are in most cases considered to be coherent with BAT and as they are strictly followed, an air quality much better than the EQO normally predominates. In the case of parameters, the emissions of which are not regulated, it is sometimes difficult to find arguments for the need of BAT when there seems to be no risk of violation of EQO. In this case, Finnish authorities are more or less dependent on the willingness of the enterprise. When achieving BAT requirements is not sufficient to meet EQO for air, the requirements have been more stringent. However, in some cases, the problem can be solved by a sufficiently high chimney. In practice, the impacts of the emissions are evaluated during the application procedure using distribution models and the permit conditions are set to prevent violation of air quality targets. Consequently, violation of EQO by the impact of atmospheric emissions from point sources is expected to occur mainly in connection with process failures and breakdowns, while the real air quality is methodologically difficult to supervise.

There are two examples of principal importance within the sector of water protection where requirements have not so far been set according to BAT, but rather to quality objectives and principles of economic efficiency. The first is common for all countries and concerns the very small enterprises, of numerous in Finland. The emissions are rather small with local impact only if any, and the economic possibilities and know-how are limited. Even if BAT might have a dimension taking these circumstances into account, it has been difficult to fulfil the requirements of BAT in this sector.

The other example is more recent and associated with the requirements for nutrient removal. Eutrophication is the most severe threat to the Finnish watercourses as well as the Baltic Sea. For this reason, phosphorus, known as the minimum nutrient (growth factor), has been effectively removed since the 1970s. Increasingly stringent demands and growing know-how have brought down the concentrations of phosphorus in municipal sewage to a national average of 0.7 mg/l (>90 per cent reduction). At the same time about 30 per cent of the nitrogen is removed, while the outgoing concentration is about 30 mg/l.

During the last years, due to the damage caused by algae blooms, the question of nitrogen reduction has become an important environmental policy issue in Finland as well as in other countries. There are also significant economic and marketing interests associated. The need for multidisciplined research and the understanding of the specificity of Finland’s cold climate on the phenomenon of nitrogen pollution and removal will require some time before an overall policy can be defined. So far, the Gulf of Finland and the Archipelago Sea have been proved to be sensitive to nitrogen as well as phosphorus. But for areas north of the heavily eutrophicated Gulf of Finland, the situation is not yet clear. To find the most cost effective solutions, more research will be require as well as special investigations on the need and premises for nitrogen reduction on a case-by-case basis.

3. TRENDS IN PERMIT LIMITS

3.1 Cleaner Technology

The wastewater problems having been largely solved by the iron and steel industry, air pollution, hazardous wastes and solid waste storage and utilisation are the main concerns in Finland. The Finnish surface watercourses and coastal waters are very shallow and sensitive to eutrophication and other pollution. Small lakes, bogs and fens as well as forests are sensitive to acidic precipitation. Exceptionally stringent performance is required in especially protected areas. One steel mill is situated in such an area. Mathematical modelling has been used in this sector for prognoses of air quality and deposition.

Sensitive ecosystems and thereto connected public awareness also put some pressure on the enterprises, which, at least in some cases, take this into account when planning for the future. This is true also for the environment of the selected facilities and the impacts can clearly be seen. Due to the settlements, special attention is given to the problem of smell and noise.

As said previously, the typical feature of the Finnish permitting system is the case-by-case deliberation of applications and the tailor-making of permit conditions. It is recognised that this approach covers an assessment of the environmental, technical and economic aspects, leading to the selection of the most efficient solutions. When considering the requirements for pollution control, at least the following principles are taken into account:

- the fundamental target is to prevent pollution of the environment;
- the required measures must be paid by the polluter and the polluter must have the right to choose the acceptable technical means;
- the requirements set on different polluters must be based on equal and impartial assessment of environmental impacts and technical and economical possibilities.

As shown in the permits for Mill A and Mill B, permit conditions do not limit themselves to emission limit values and may cover topics such as emission/discharge and waste collection and reutilization, reduction targets throughout the permit time period, and good management practices that reuse by-products from the waste stream as raw materials. Similar to the general technological trends of the iron and steel sector, the Finnish permit samples give evidence of the increasing use of preventative measures combined with pollution control techniques aimed at complying with increasingly stringent limits. Cleaner fuels, selection of the cleanest scrap metals as raw materials, separation of wastewater from clean cooling water, and environmentally designed plant for impeding fugitive dust are some of the measures that have allowed emission/discharge reduction. These means are then complemented by control devices such as fabric filters and bag house.

Cleaner Technology and Policy Instruments

In assessing trends in the development of cleaner technologies, concepts such as BAT, EQO and the setting of norms become increasingly important. For example, BAT being more and more a central factor in the selection of technologies, its impact on innovation depends, in part, on the interpretation of the concept and the consequent means of implementing it. Finland will implement the provisions set by the EC, but there is no intention to go further in introducing BAT as a received or normative technology, which would retard innovative ambitions. However, a common tendency is to link descriptions of accepted technologies to normative emission levels to be reached by BAT. This tendency is also reflected in the elaboration of PARCOM and HELCOM recommendations. Its informative value is indisputable, but there is a risk that such a link delays innovation. The industry is likely to stick to «safe» and «accepted» technologies rather than to develop or apply new ones.

The concept of BAT should be referred by definition (e.g. as adopted by the new EC-directive on integrated pollution prevention and control) to merely set the level of limit values for emissions. On the other hand, there are some problems with normative limit values as such, which also partly have a negative effect on innovation. Since normative limit values cannot be set as kg/day and values for kg/tonne can be applied only for certain sectors, norms are mostly set as concentration values. This does not take the characteristics of the receiving watercourse or the polluter into account, neither does it promote decrease of water consumption. Norms are also mostly valid for long periods thus rather retarding than promoting aspirations to decrease emissions. Furthermore, limit values can be set only for selected pollutants, which will favour techniques and innovations in a direction which may not be optimal from an overall and multi-media point of view. Norms used as a dominating policy instrument create a rigid system, difficult to understand and time-consuming to develop and update. However, it may be a rational policy instrument on a federal level and in big countries with numerous similar polluters.

Finland will follow the EC Regulations and Directives, but, especially in the water sector, a case-by-case licensing system as the major policy instrument for pollution control will probably remain. It gives all the opportunities to implement BAT in a flexible, cost-effective and innovative way.

With regard to innovative incentives, economic instruments are, in principle, likely to be as effective, however with the same limitations concerning the choice of parameters as for norms. The innovative impacts of the licensing system and the economic instruments on pollution control measures depend on how they are implemented and the level of information, knowledge and requirements. Several policy instruments have their benefits and applications, and a rational combination of some of them could obviously give an optimum solution also with regard to innovations. In addition, Finland provides financial assistance to applied research, development and investments in the field of energy saving and environmental protection. Financial incentives are, however, modest.

3.2 Monitoring

The Water Act stipulates that permits granted by authorities for the discharge of industrial and municipal effluents have to include, *inter alia*, a condition for monitoring and reporting. The plant is ordered to make a proposal on a monitoring program to the Regional Environment Centre. The authority may require amendments before approving the monitoring program. The program can also be amended later on without a new permit procedure. If the plant and the authority cannot agree on the program or amendments, the Water Court will give a final decision. The monitoring obligations covers:

- Internal operation control:
  - for the quantity and quality of wastewater from different parts of the processes;
  - for treatment plant performance and efficiency.
- External discharge control:
  - the quantity and quality of wastewater discharged (for both process wastewater and other discharge sources like waters from storage and yard areas, cooling waters, etc.).
- Monitoring of the effects on the recipient:
  - effects on the water quality;
  - effects on the biota.

The results of the monitoring must be reported to the supervising authorities (the municipal environmental board and the regional environment centre). Violations of emission limit values must be reported immediately. As an element of the monitoring plan, the reporting of breakdowns and process failures is required, which allows for the opportunity to discuss environmental management efficiency. The results of effluent monitoring are also often examined with the aim of finding unaccountable discharge fluctuations.

The requirements for monitoring are established by the local authorities which have the responsibility for administering the permits through a document called a «control program». The results of the monitoring process provide important information that feeds into the permitting procedure and determines some of the permitting requirements. As the permits do not specify who must perform the sample analyses, it is usually up to the permitted plant to propose and up to the supervising authorities to approve a self-monitoring scheme or a consultant paid by the permittee itself. The supervising authority reserves the right to make inspections, to take samples, to check diaries and to talk to the facility's staff.

As in water permits, there are conditions concerning monitoring and reporting also in the integrated environmental permits (air and solid wastes). As a rule, the permits contain an obligation to participate in the air quality monitoring of the area.

Monitoring of waste waters is well established in Finland and is regulated more closely than monitoring of air emissions. The competence of consultants determining air emissions is variable at present and quality assurance is still being developed. All monitoring results as well as the monitoring programs are available to the public. The monitoring results provide important information to the permit granting procedure and have a clear influence on conditions. The monitoring programs are also negotiated and revised depending on the activity and options of the regional authorities.

Today, there are more than 40 Finnish SFS-standards for physical-chemical determinations, roughly half of which are applied to wastewater. Many of the SFS-standards are identical to standards used in the other Scandinavian countries. In some cases, other methods than those included in the SFS-standards may be used.

3.3 Trends in Limits

As said in the previous section, the permits given for discharging industrial effluents include conditions for wastewater treatment, for monitoring and investigations. Internal process measures are evaluated before requirements are set. The conditions expressed as limit values for the discharge do not specify the techniques to be used, but set the level to be reached. The limit values are mostly given as total load per time unit. In some cases, limits are given in addition as specific load per tonne of product or as concentration and removal efficiencies. In general, the limits must be attained as mean values for one, three or six months, depending on the size and type of the plant.

Finland being a party to the Helsinki Convention, permit limits are affected by the recommendations pertaining to the iron and steel sector (HELCOM Recommendation 11/7, 1990), as well as the introduction and/or revision of environmental laws (the Air Pollution Control Act came into force in 1982).

In the case of the two Finnish facilities selected for the iron and steel case study, only one has to request permits because of its volume of emission/effluent and solid wastes. The first case, Mill A is the only Finnish facility totally based on scrap materials and one out of two using an electric arc furnace (EAF). The mill is located close to the Russian border at the big river Vuoksen that discharges into Lake Ladoga. Thus the emissions have had/may have transboundary impacts. The mill is old but the hot rolling mill was modernised in the beginning of the 1990s and the waste waters are since treated in sandfilters and circulated. The modernisation of the electric arc furnace and air pollution control is underway.

Permits for air, water and solid waste are mandatory. The limits for air emissions (mg/m^3) are based on the HELCOM Recommendation 11/7, judged to represent the sectoral BAT at that time. Limits are also judged to be stringent enough from the environmental point of view. For water discharges, the limits (kg/d) are based on professional judgement considering the technical possibilities and environmental needs. The requirements are more stringent than the HELCOM Recommendation 11/5.

In the second case, Mill B is a non-integrated hot rolling minimill, and the smallest steel mill in Finland. Production in 1994 was less than 100 000 t/a. Limits for water discharges have been set under the Finnish's notification procedure, an alternative to the Water Court's permit when a facility is judged not to have a polluting impact on the receiving water. The limits are not binding in the same sense as are limits prescribed by the Water Court. If the emissions exceed the limits or if the polluter does not agree with the supervising authority on the self-monitoring program, the enterprise may after negotiations be forced to apply for a permit to the Water Court. As a rule, the enterprise wants to avoid this and to fulfil the requirements set in the authority's statement to the notification.

The only limits (kg/d) set concern water discharges and are based on professional judgement considering the technical possibilities and environmental needs. The limits are far below the HELCOM Recommendation 11/5. However, since the mill's use of fuel oil exceeds a limit stipulated in the Air Pollution Control Act, it will be requested to apply for a permit according to the Environmental Permit Procedures Act.

Air Emissions

Mill A:

- The only stipulated limit value is for particulate emissions. Prohibition of particulate emissions is judged to be the most important target from the environmental point of view. The limits are set low enough to guarantee that other emissions, such as metal compounds, are sufficiently small and thus judged not to be in need of separate limit values. Indirectly this and other permit conditions prohibit also fluoride emissions and emissions of polychlorinated dibenzodioxins and dibenzofurans (PCDD/PCDF);

- Valid limits (mg/m^3) shall not be exceeded. The emissions shall be monitored on-line where possible. However, control samples, which normally are taken manually, must, at this low emission level, cover at least 2 hours. In addition to the limit normally valid, there is a limit value 5 times as high for breakdowns (see HELCOM 11/7 in the case study report on iron and steel).

Mill B:

- No limits for air emissions were judged to be needed.

Water Discharges

Mill A:

- Limit values are given for suspended solids and oil (IR, hydrocarbons);

- Limits (kg/d) are defined as a quarterly average. Analyses are made once a week from weekly composite samples collected with flow related samplers. Additionally pH and Fe (total and soluble) are monitored.

Mill B:

- Limits are given for oil (IR) and suspended solids in process wastewater, and for BOD_7 and P_{tot} in sanitary waters;

- Limits are defined as a half-year average. During that period at least two composite samples are to be analysed.

Additional Requirements

<u>Mill A</u>:

- Air:

  - particulate emissions must be collected and treated;
  - the mill yard must be kept clean from dust and borders arranged to the greatest extent possible;
  - the scrap material must be sufficiently clean from chlorinated organic and other material causing hazardous emissions;
  - obligatory supervision of processes, monitoring of emissions and reporting to authorities;
  - obligatory monitoring of air quality (together with the municipalities);
  - obligatory participation in a wide environmental impact monitoring program, including assessing effects on human health aspects.

- Water:

  - process wastewater shall be recirculated as far as possible and the overflow discharged separately from cooling waters;
  - sanitary wastewater shall be connected to the municipal treatment plant;
  - emissions shall be kept as small as possible by proper operation and maintenance;
  - oily sludge must be treated and stored without causing hazard to ground- or other waters;
  - materials and chemicals must be stored and handled properly;
  - accidental emissions and threats must be notified to the supervising authorities immediately and steps must be taken to combat damages and to prevent similar accidents in the future;
  - obligatory monitoring of wastewater flow and emissions, running parameters of treatment facilities and impacts on the receiving watercourse.

- Waste:

  - obligatory record-keeping on quality, volumes, storage and deposition of wastes by lot;
  - the scrap material must be sufficiently clean before use;
  - investigations shall be made to judge the quality of slag and of ash from the new dustfilters;
  - investigations shall be made on the possibilities to reduce waste volumes;
  - hazardous waste shall be set to the pertinent treatment plant;
  - a plan shall be made for the landfill.

<u>Mill B</u>:

- treatment of sanitation waters;
- maintenance of wastewater treatment and conducting facilities;
- storage and disposal of waste sludge;
- monitoring program; reporting of breakdowns and occasional emissions.

4. TECHNOLOGICAL RESPONSES TO PERMIT REQUIREMENTS

4.1 Equipment Installed/Measures Taken

Mill A

In order to comply with the conditions set for the control of emissions/discharges and the management of waste, Mill A uses a combination of preventative approaches and techniques as well as control technologies. Many conditions beyond the limit values set for air, water and land pollution control also impose responsibilities to the plant in terms of reduction, reutilization and good management of emissions/discharges and solid wastes.

- Water pollution control:

Limit values were set for suspended solids and oil in water discharges. The process water treatment system has been developed in several phases over the last 30 years. The first objective of the plant is to reduce the emissions of the pollutant substances and/or process water volumes, where it is possible, by:

- Reducing the volume of pollutants in the water:
  - keeping oil out of sewers by technical means;
  - controlling the systems for the use of lubrication and hydraulic oils;
  - training and guidance of staff.
- Reducing the volume of waste water:
  - separate drains for clean cooling water;
  - recirculation of rolling mill waste water (sand filtering, cooling as necessary).
- Waste water treatment:
  - sedimentation basins;
  - collection of oil and solid matter in aluminium hydroxide flock, sand filtering.
- Sewage:
  - separate sewerage to city treatment plant.

- Air pollution control:

Limit values for air emissions were set for particulate only. As in the case of water pollution control, the plant's strategy is based on a combination of preventative measures and control techniques in order to reach compliance. The main focus in the prevention of particle emissions is on methods external to the process. Measures concerning the raw material or process technology have aimed mainly to reduce emission of toxic and gaseous substances. Work safety is also an important aspect of raw material control.

A steel mill (EAF shop) under construction will include a flue gas treatment system. The flue gas evacuation system for existing secondary metallurgy will also be connected to the system. The facility includes the following features:

– closed EAF shop;

– direct evacuation from the 4th hole of EAF;

– canopy hood;

– direct evacuation from ladle furnace, injection station and vacuum tank;

– common bag house and fabric filter.

Moreover, the implementation of environmental management practices and a special attention to specific operations increase the prevention and control of environmental releases:

– Use of raw materials:

  – limiting the use of the dirtiest scrap grades;

  – limiting the use of calcium fluoride.

– Handling of alloying elements:

  – exhaust air from process for drying alloying elements cleaned by cyclones;

  – local fabric filters in the system for conveying alloying elements.

– Billet conditioning and rolling mills:

  – cyclones used in sand blasting and billet grinding.

– Further treatment:

  – cyclones or fabric filters depending on the case.

- Other considerations:

  - asphalting and cleaning of the roads and yards;

  - limited binding of dust with salt;

  - reducing the effects of wind in the mill area and preventing the spread of dust with trees.

- Waste disposal:

In addition to the measures mentioned above that lead to the recirculation of air and water, separation of clean and waste water systems, and the collection of particulate, the following measures have been authorised by the company or were implemented prior to the current permit requirements:

- hazardous waste recovery system and storage;

- controlled use of landfills;

- landscape management.

The main purpose of the hazardous waste recovery system is to prevent mixing of different types of waste, i.e. internal measures. The required investment is low. Specific official regulations governing the handling of major process waste types (slag, rolling scale) did not cause any changes in the methods chosen on grounds of economic considerations.

Mill B

As mentioned previously, conditions pertaining to Mill B are part of the Finnish notification procedure, an alternative to the Water Court's permit system. In this case, limits are given for oil and suspended solids in process wastewater and for BOD_7 and P_{tot} in sanitary waters.

Prior to more extensive improvements in process water treatment, there was only a system for removing the coarse rolling scale and some of the oil and grease. The water was then discharged directly into the river. This system was later complemented with a wooden basin fitted with intermediate stages that retarded the flow before discharge into the river and retained some of the finer solid matter in the basin. In response to official emission limits, the company started to plan various technical devices that would be suitable to the circumstances. These included:

- oil filters for oil recovery;

- magnetic precipitation;

- a superconductive magnetic device;

- magnetic boards that could be scraped clean;

- the DYNA-SAND method which has allowed the present treatment results.

After introducing the DYNA-SAND system, the company adopted a partially closed water circuit from which about 10 per cent of the total water volume is discharged into the river after treatment. The present treatment system functions in the following sequence:

- an oil trap which removes the coarse rolling scale, oil and grease;
- a wooden basin (the A-basin) where much of the solid matter is sedimented and transferred by slag pumps to collection vessels;
- pumps that transfer the water to a sand filter where a polymer is automatically added and the finest solid matter in the water is flocculated. The flocculated solid matter is then taken to the compressing unit and the treated water to the B-basin from which high-pressure pumps pump it back to the rolling process;
- annual maintenance keeps the equipment running smoothly.

4.2 Flexibility Considerations

Mill A

For water pollution control, the plant's representatives acknowledge that they have the authority to choose and/or influence the detailed contents of the measures. However, they estimate that, as the permit conditions get more stringent from the previous time, the authority must know the general contents of the required measures. In some cases, proposed measures such as an external treatment plant, were refused by the authority which left no other alternatives than a separate drain system for sewage from the plant.

For air pollution control, as for the collection of flue gases from the mill's electric-arc-furnace, the permit conditions take account of the implementation method (the casing required for a new facility would not have been necessary for existing furnaces). But the decision left no alternative as to the cleaning method for the collected gases (see HELCOM Recommendation 11/7/1990), although a fabric filter was not formally required. As to other cleaning technology, there is more choice; the required level can be obtained with several techniques.

Mill B

The authorities did not specify the equipment to be used. They only set the emission limits for solid matter and oil and grease.

4.3 Views of Industry Surveyed

Mill A

The development of the Finnish legislation has been the dominant factor regarding the order of implementation (Water Act, Air Pollution Control Act, Waste Act). However, the detailed conditions of the permit to conduct waste water were determined more by the vicinity of the Russian border than by immediate environmental considerations.

The first measures required (sedimentation basins) are most directly associated with environmental impact, and so are those stages of the later phases intended to reduce the risk of acute oil discharge. The air pollution control permit basically concerns emissions from the steel mill and is based on BAT as far as those emissions are concerned. Except for the implementation time, the provisions converge with the HELCOM recommendations. The waste management permit, more clearly than the other authority decisions, is based on environmental quality objectives (EQOs) and local conditions.

Mill B

For representatives of Mill B, technology considerations and objectives are well balanced in the setting of conditions.

5. CONCLUSION

A case-by-case approach in the definition of permit requirements is a typical feature of the permitting system in Finland. While concepts such as BAT and EQO are being used by the authorities in assessing the existing and/or future installations' potential environmental impacts and performance, the decision making process is ultimately based on professional judgement and involves the integration of local environmental conditions. Thus Finland recognises the importance of a good combination of policy instruments in developing a level playing field for industrial innovation.

There are few national norms or standards that affect the iron and steel industry. In this respect, international conventions to which Finland is a party, such as OSPARCOM and HELCOM, are important to the setting of permit requirements since they provided some BAT emission limit values. However, while the technologies employed are assessed on the basis of BAT, each new or renewed permit is judged according to its specific environmental setting. Permits could deviate from these provisions only in special circumstances.

The permits sample represents examples of the possibilities offered by the Finnish permitting system to industrial activity. One steel mill is regulated under the permit system authorised by the several acts that govern the protection of the environment. The second case provided is an example of the notification procedure, as an alternative to the permitting system, when a facility is judged not to have a polluting impact on the surrounding environments. Nevertheless, these two examples illustrate how BAT and EQOs influence the setting of requirements. In both cases, preventative measures and control technologies employed by the two mills are similar to the general trends observed in the international industry. Reduction, reutilization and recycling of raw materials are binding conditions that govern the industry's proposal and implementation. Final compliance is assured by the introduction of control technologies. The facilities recognise that the Finnish system allows a certain level of flexibility in choosing the technologies to be employed, but, at the same time, they acknowledge that the setting of conditions by the authorities are in line with the «international standards» as they are defined in the international fora (such as HELCOM).

Over the years, Finland has developed a unique expertise in the field of water quality monitoring. This is crucial not only from the point of view of assessing the quality of surface and ground water, and the impacts of permitted activities upon these bodies of water, but monitoring has also an impact on the assessment and setting of permit requirements. However, the same does not hold true in the case of air monitoring where substantial improvement in terms of quality insurance and training needs to be achieved in order to reach the level of performance required. Nevertheless, Finnish experts are actively participating in the work of the Convention on Long-Range Transboundary Air Pollution in order to update the standards.

Finland is in the process of integrating its permitting activities under the umbrella of a multi-media approach. This is already performed in the case of air, waste and noise pollution control. Finland will adopt the EC definition of BAT and EQOs, but, in order to keep the desired level of flexibility offered by the unique features of its permitting system, the case-by-case approach to water environmental protection will probably remain.

GERMANY

1. THE PERMITTING PROCESS

1.1 Responsibilities for Environmental Protection

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 the 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 *immission* is defined as including 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 *immission* control. That means, the *Länder* may only legislate on that subject insofar as the *Bund* does not regulate parts of the subject or where the federal law provides legislation of the *Länder*.

The Federal Immission Control Act demands that industrial plants must 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 lays down requirements concerning the avoidance and utilisation of residues generated in a plant.

The Federal Immission Control Act requires federal authorities to: (a) issue ordinances identifying the types of facilities which are subject to licensing; (b) set licensing requirements for those facilities; and (c) impose emission limit values and technical control requirements for all facilities, whether licensed or non-licensed. The act itself just sets the statutory framework for environmental standard setting. The details and substantive legal requirements for the 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*).

Analogous to air pollution control, the legal instrument of water management is the Federal Water Act (*Wasserhaushaltsgesetz*) of 1976 (last amendment 1986). This Act provides the main legal framework for the protection of surface and ground waters and each of the 16 *Länder* has its own law which repeats and adds to the Federal Law. The competence for implementing the law is with the *Länder*. Water discharges are mainly dealt with in Article 7(a) of the Federal Water Act, which allows laying down of specific discharge rules for water polluting sources. The water protection legislation is implemented through the Ordinance on the Sources of Water *(Abwasserherkunftsverordnung)* and through General Administrative Regulations concerning minimum requirements to be met by discharges everywhere in Germany, irrespective of the quality of the water in which the waste water is discharged. Federal regulations have been passed covering 54 types of industrial operations, including iron and steel as one sector.

The legislation for waste is ruled in the Waste Avoidance and Waste Management Act (*Abfallgesetz*) of 27 August 1986. Again, the *Bund* and the *Länder* were given competing legislative competence. For the implementation of the Waste Law the *Länder* have enacted Länder Waste Laws. The Act on Waste Prevention and Treatment and the Ordinance on the Determination of Waste apply to the use and storage of waste, i.e. substances to be disposed of by the possessor or whose proper treatment is necessary to protect the environment. The treatment of waste must be accomplished pursuant to the provisions of the Act. There are additional requirements for waste from commercial enterprises that have been categorised as requiring supervision owing to possible hazards. The prevention of waste and the use of residual substances have priority over waste treatment. An administrative instruction (*TA-Sonderabfall*) regulates the handling of special waste.

The requirements laid down in ordinances and administrative regulations are subject to discussions between the Federal Government and the Federal States which take place within the Conference of the Ministers of the Environment. In recent years this Commission decided for example to tighten up some emission limit values in order to take into account the progress in technological development and/ or newly identified environmental risks, e.g. emissions of dioxins. It should be asserted that there are no specific environmental statutes relating to the iron and steel sector. However, some ordinances and regulations adopted under framework laws are of particular relevance to this sector, see Sections 1.2 and 2.1.

1.2 Permits

In compliance with the Federal structure of Germany, the implementation of the environmental laws and decrees is under the responsibility of the *Länder*. The administrative procedure of practical implementation differs somewhat among the *Länder*. Within each of them, a number of local authorities are set up, each responsible for the granting of authorisations within a special subregion.

Installations in the iron and steel industry require approval pursuant to the Federal Immission Control Act insofar as they are listed in no. 3 of the Annex to the Fourth Ordinance of the Federal Immission Control Act Enumerating all Installations Subject to Licensing. The authorities may grant approval under certain conditions necessary for fulfilling the obligations arising from the Act. The principal obligations are as follows:

- prohibition of the construction and operation of installations 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 State-of-the-art;

– residues must be avoided unless they are used without damage for the environment or - if they can not be avoided or used because of technical or economical reasons - disposed of in manner that causes the least possible harm.

This is the legal framework. Details and substantive legal requirements for the plant and its operator are defined in a number of ordinances and administrative regulations. In the course of the licensing procedure the competent authority (this is always a state authority) defines the requirements for emission control, particularly emission standards. Emission values from the TA Luft become legally binding emission standards when adopted in the licensing document. For the implementation of the requirements concerning the avoidance and utilisation of residues a number of General Administrative Regulations/ Master Regulations (*Musterverwaltungsvorschriften*) have been elaborated by the *Bund-Länder*-Pollution Control Committee. They can be adopted by the Federal States for their licensing and supervision procedure.

With regard to limiting emissions in accordance with the State-of-the-art, it is especially the Technical Instructions on Air Quality Control (First General Administrative Regulation Pertaining to the Federal Immission Control Act, *TA Luft*) of 27 February 1986 that provides further details. Each facility subject to licensing has to comply with emission limit values (ELVs) for a large number of substances covered by the *TA Luft*. These ELVs do not depend on environmental quality standards (EQSs) and are applied uniformly all over Germany. However, there are ambient air quality values for nine substances laid down in the *TA Luft*. Applicants have to measure the quality of the environment of the area in which they want to locate or operate. They have to model the pollution that they will generate and include it into the broader immission pattern. The results of ambient air quality measurements and the modelling of pollution are taken as a basis for the decision concerning the application for operating a facility. If an air quality value laid down in the *TA Luft* is breached, the facility must use further control measures.

In case the iron and steel plant operates a large firing installation the Thirteenth Ordinance on large Combustion Plants of 22 June 1983 becomes relevant. The Ordinance is applied in relation to the construction, nature, and operation of firing installations with an output of 50 megawatts and higher, including auxiliary equipment. The Ordinance basically sets ceilings for dust emissions, carbon monoxide (CO), the emission of nitrogen oxides (NO_x), sulphur oxides (SO_x), and halogens compounds. The limits vary according to whether solid, liquid or gas fuels are used or whether the emissions are caused by existing plant.

The Technical Instruction on Noise Abatement of 16 July 1968 is applied to all facilities that must be licensed and could cause noise pollution. This administrative order basically sets the limits for noise emission permitted in various areas in connection with the operation of a facility. The permission to construct, operate, or alter a facility is granted only if the emission limits allowed for a specific area are not exceeded and if state-of-the-art noise protection measures are provided for.

In the case of water management, each discharge, wherever it is located, has to comply with techniques based on minimum requirements specified for 54 industrial branches and municipal waste water in administrative regulations. The legal statutes are applicable for the use of surface, coastal, and ground waters in the form of extraction or the discharges of substances or sewage. The use of waters requires the approval of the competent authority. This is to be denied if an endangerment of the public water supply is to be anticipated. Minimum requirements are placed on sewage lines from certain legally fixed sources, among which iron and steel production are included (Twenty-fourth General Administrative

Regulation on Minimum Requirements for Waste Water Discharged into the Aquatic Environment (Iron and Steel Production) of 19 May 1982). If these values are not observed, approval for the discharge of waste water is denied. Within defined water protection areas, certain activities may be partially or fully prohibited. Here follows some of the significant obligations for the user of waters:

- submission of an application to use the water source;
- co-operation with the supervisory authority;
- permission for the authorities to have access to the buildings and site of operations;
- provision of information;
- making manpower, documents, and tools available;
- making technical investigations and tests possible;
- water protection officials are to be appointed if more than 750 m^3 of waste water per day are discharged.

Practically, the permits are based everywhere first on the technique-based minimum requirements, which could be made in a second step more stringent if the local situation of the water body demands for it.

The treatment of waste must be accomplished pursuant to the provisions of the Act on Waste Avoidance and Waste Management. The most important obligations for the owners of waste requiring supervision are:

- the waste may be transferred only to the operator of a waste treatment plant if the latter is suited for handling such waste;
- a log book is to be kept on the type, amount, and treatment of the waste;
- the condition that requires the keeping of a log book must be notified to the competent authority;
- the supervisory authority must be given information on the operations, systems, and facilities connected with the treatment of the waste;
- the representatives of the supervisory authority must be given access to the rooms or sites and allowed to inspect the documents and to undertake technical tests.

The operator or the owner of the plant has the duty to fulfil all obligations and requirements of the environmental regulations or the license. The decision of the granting authority can be appealed against to a higher administrative authority and then to special administrative courts either by the applicant or by every person that has a personal substantial interest in the decision.

As a general principle, the permit requirements for existing and new facilities should be of the same kind. However, in some cases, for several facility types, the *TA Luft* makes a distinction for new and existing facilities concerning ELVs because of special technical conditions. There is also a distinction concerning the periods within which an existing facility has to be brought up to the emission limits required for new facilities. In Western Germany, the requirements for existing facilities have been implemented since 1994. Special regulations apply to Eastern part of Germany where, for existing facilities, the requirements of the *TA Luft* have to be implemented before 1996 or in special case before 2000. For new plants, the requirements have to be implemented at once.

1.3 Permit Renewal Process

The permit renewal process in Germany is similar to the initial permit issue process. According to Article 15 of the Federal Immission Control Act a new permit is necessary for a major change of the site, the condition or the operation of the facility. In the case of the facility covered in this study, the submitted sample is a "Provisional Decision" in accordance with Article 9 of the Federal Immission Control Act which is valid for a period of 2 years. It is within the normal permitting procedure, in this case for a major change in operation. The content of the provisional decision will be part of the permit.

1.4 Multi-Media Permits

At present, laws and decrees to minimise the effects of industrial activities on the environment exist in relation to the different media (air, water, waste management; a soil protection law has been proposed recently). The media are ruled by separate laws or decrees but for most effects on the environment only one authority deals with these effects and the permit contains requirements for each medium. In this sense it can be considered as a kind of integrated media permit. There is, however, an exception concerning permits for the use and sewerage of water. It is granted separately by the competent authority. This procedure leads to a high level of environmental protection in Germany, which is, however, a result of the ambitious level of ELVs contained in ordinances and administrative regulations. Nevertheless, in the future, a central point of governmental activities will be the discussion on how to intensify the evaluation of cross-media effects in the authorisation procedure. As a first step, most *Länder* are now reorganising their different media-oriented agencies in such a manner that cross-media effects are dealt with a more optimised approach.

1.5 Environmental Assessment

An environmental impact assessment may be required under the Environmental Compatibility Assessment Act (*Umweltverträglichkeitsgesetz*) prior to issuing a permit. A test of environmental compatibility must be carried out for the projects listed in the Act. Among these are also the construction and operation of the facilities that are named in the Annex to the Act and that require licensing. These include steel producing facilities. The Act basically requires prior testing of projects with impacts on people, animals, plants, ground, water, air, climate, landscape, culture, and other items of value. A negative evaluation of the project has to be taken in consideration for the permit. For the applicant, the most important obligations are:

- to inform the competent authority prior to the planned project;
- to submit all of the documents on the impact on the environment;
- to discuss the questions of importance for the implementation of the environmental compatibility test.

2. BAT, EQO AND ECONOMICS

2.1 Standards Setting and Targets

Emissions to Air

The standards for air emissions fixed in the permit for the iron and steel sector are mainly established in the *TA Luft* and are technology-based emission standards. The ELVs are based on the precautionary principle and hence on the decision concerning the choice of state-of-the-art technologies. The ELVs contained in the *TA Luft* thus represent BAT of technical measures for reducing emissions. Each category of substances (except for total dust) is divided into different classes relating to the level of toxicity. Class I substances are most toxic while Class III or IV are least harmful. In addition, there are specific regulations for certain types of facilities and these apply only to those types which are particularly mentioned. These facilities relating to the iron and steel industry include:

- iron ore sintering plants;
- steel production in converters, electric arc furnaces and vacuum melting systems;
- electroslag remelting plants.

Usually the emission limits related to the specific facilities are more stringent and take precedent. The limits for different substances for certain types of facilities in the iron and steel industry sector are given in Table 1.

Table 1. **ELVs for iron and steel processes**

Process	**Substance**	**Limit**
Iron ore sintering	NO, NO_2 as NO_2 in waste gas	0.40 g/m^3
Steel production in converters, EAF vacuum melting systems	***particulate matter***	
	(i) from EAF, induction furnace or cupola furnaces with upper blast furnace gas-outlet	20 mg/m^3
	(ii) cupola furnaces with lower blast furnaces gas-outlet	50 mg/m^3
	carbon monoxide	
	(i) hot-blast cupola furnaces utilising a downstream self-heated recuperator	1.9 mg/m^3
	(ii) for other melting plants and for converters, waste gas containing carbon monoxide shall be, as far as possible, utilised or burned	-
Electroslag remelting plant	Gaseous inorganic fluoride compounds in waste gas, as hydrogen fluoride	1 mg/m^3

Note: In case no specific emission limit values is given for Iron and Steel Processes, the general emission limits of the TA Luft (see Chapter 2. General Provisions on Air Quality Control) are applied.

Tables 2, 3, 4 and 5 provide limit values for several substances in accordance with the different classes relating to the level of toxicity.

Table 2. **Limits for carcinogenic substances in air emissions**

Category	**Substance**	**Limit**
Class I	Asbestos (chrysotile, crocidolite, amosite, anthophylite, actinolite, tremolite) as fine dust Benzo(a) pyrene Beryllium and its compounds in respirable form - indicates as Be Dibenz(a,h)anthracene 2-Naphtalamine at a mass flow of 0.5 g/h or more	0.1 mg/m^3
Class II	Arsenic trioxide, arsenic pentoxide, arsenious acid and its salts, arsenic acids and its salts (in respirable form) - indicated as As Chromium (VI) compounds (in respirable form), as far as calcium chromate, chromium (III) chromate, strontium chromate and zinc chromate - indicated as Cr Cobalt (in the form of respirable dust/aerosols of cobalt metal and cobalt salts of low solubility) - indicated as Co 3.3-Dichlorobenzidine Dimethylsulphate Ethyleneimine Nickel (in the form of respirable dust, aerosols of nickel metal, nickel sulphide and pyritiferrous ores, nickel oxide and nickel carbonate, nickel tetracarbonyl) - indicated as Ni at a mass flow of 5 g/h or more	1 mg/m^3
Class III	Acrilonitrile Benzene 1,3-Butadiene 1-Chlroro-2,3-epoxipropane (epichlorohydrin) 1,2-Dibromomethane 1,2-Epoxipropane Ethylene oxide Hydrazine Vinyl chloride at a mass flow of 25 g/h or more	5 mg/m^3

Table 3. **Limits for organic substances in air emissions**

Substance	Limits
Substances in Class I at a mass flow of 0.1 kg/h or more	20 mg/m^3
Substances in Class II at a mass flow of 2 kg/h or more	0.10 g/m^3
Substances in Class III at a mass flow of 3 kg/h or more	0.15 g/m^3

If organic substances in several classes are present, mass concentration in the waste gas shall not exceed a total of 0.15 g/m^3 at a total mass flow of 3 kg/h or more (Organic substances are broken down into Class I through III).

Table 4. **Emission limits for inorganic dust particles**

Category	Substance	Limit
Class I	Cadmium and its compounds, indicated as Cd Mercury and its compounds, indicated as Hg Thallium and its compounds, indicated as Ti at a mass flow of 1 g/h or more	0.2 mg/m^3
Class II	Arsenic and its compounds, indicated as As Cobalt and its compounds, indicated as Co Nickel and its compounds, indicated as Ni Selenium and its compounds, indicated as Se Tellurium and its compounds, indicated as Te at a mass flow of 5 g/h or more	1 mg/m^3
Class III	Antimony and its compounds, indicated as Sb Lead and its compounds, indicated as Pb Chromium and its compounds, indicated as Cr Cyanides easily soluble (e.g. NaCN), indicated as CN Fluorides easily soluble (e.g. NaF) indicated as F Copper and its compounds, indicated as Cu Manganese and its compounds, indicated as Mn Platinum and its compounds, indicated as Pt Palladium and its compounds, indicated as Pd Rhodium and its compounds, indicated as Rh Vanadium and its compounds, indicated as V Tin and its compounds, indicated as Sn at a mass flow of 25 g/h or more	5 mg/m^3

Note: Inorganic dust substances which are strongly suspected to cause cancer shall be assigned to Class III. If substances of several Classes are present the mass concentration in the waste gas shall not exceed 1 mg/m^3 for coinciding Class I and II substances and 5 mg/m^3 for Class I and III or Class II and III.

Table 5. **Emission limits for vaporous or gaseous inorganic substances**

Class	Substance	Limit
Class I	Arsine Cyanogen chloride Phosgene Hydrogen phosphide at a mass flow per material of 10 g/h or more	1 mg/m^3
Class II	Bromine and its vaporous or gaseous compounds, indicated as hydrogen bromide Chlorine Hydrocyanic acid Fluorine and its vaporous and gaseous compounds, indicated as hydrofluoric acid Hydrogen sulphide at a mass flow per material of 50 g/h or more	5 mg/m^3
Class III	Vaporous or gaseous inorganic chlorine compounds, if not in Class I, indicated as hydrochloric acid at a mass flow of 0.3 kg/h or more	30 mg/m^3
Class IV	SO_X (sulphur dioxide and sulphur trioxide) indicated as sulphur dioxide NO_X (nitrogen monoxide and nitrogen dioxide) indicated as nitrogen dioxide at a mass flow per material of 5 kg/h or more	0.50 mg/m^3

Releases to Water

Concerning releases to water, discharges of harmful substances have to be minimised by the use of the general rules of technology and for the discharge of hazardous substances by the use of BAT. Standards are established in the Twenty-Fourth General Administrative Regulation on Minimum Requirements for Waste Water Discharged into the Aquatic Environment (Iron and Steel Production).

Waste

Given in the special General Administrative Regulations for the iron and steel sector is a list of possible avoiding and utilisation measures for residues from the iron and steel industry. If these regulations are adopted by the *Länder* for their licensing and supervision procedure, the plant subject to licensing can be checked whether it operates according to these regulations.

2.2 Cleaner Technologies

There are several programmes to support the development of cleaner technologies or abatement techniques. The aim of these programmes is to obtain information on the application of new technologies under real world conditions. These programmes are carried out by both the state and the *Länder*. For example since 1979 model projects financed by the Federal Government have demonstrated how and by what economic efforts existing facilities can be adapted to an advanced state of air pollution control technology and thus be optimised with respect to their environmental compatibility. From 1987 on, even advanced processes at new facilities have been supported. The results of these projects have provided important information in particular for the updating of the emission standards in the amendments of the *TA Luft* and are utilised for the further development of the laws and decrees.

2.3 Environmental Quality Objectives

In the Federal Republic of Germany, the protection of the environment is regulated through the application of BAT to polluting sources. However, the application of BAT does not necessarily mean that all sites will be adequately protected. Thus targets are adopted and help to identify areas where more stringent standards than the standardised emission limits will be necessary to ensure the protection of the environment.

In the field of air management, the general legislation as well as the main implementing regulation contain requirements both in term of BAT and EQSs. In the evaluation area surrounding a facility, the initial load must be assessed on the basis of measurement values obtained in intermittent measurements. The results of ambient air quality measurements are taken as a basis for the decision concerning the application for the operation of a facility. If a characteristic value for the initial load of a substance exceeds an air quality value laid down in the *TA Luft*, measures have to be taken on existing facilities of the applicant or third parties; such measures must be suitable to reduce the initial load. Furthermore, the emissions arising from a facility have always to comply at least with the ELVs laid down in the *TA Luft*.

The ambient air quality values (*immission* limit values) laid down in the *TA Luft* were developed referring to scientific findings and research taking into account toxicological, bioaccumulative and epidemiological aspects. There are ambient air quality values for nine kinds of substances in the *TA Luft*.

For the protection against health hazards (indicated as mass of the air-polluting materials related to the volume of the polluted air, e.g. g/m^3, mg/m^3, $\mu g/m^3$):

- suspended particles;
- lead and inorganic lead compounds;
- cadmium and inorganic cadmium compounds;
- chlorine; hydrochloric acid;
- carbon monoxide;
- sulphur dioxide;

– nitrogen dioxide.

For the protection against considerable disadvantages or substantial impairments (indicated as mass deposition related to time, e.g. $g/(m^2d)$ or $mg/(m^2d)$:

– dust deposition (non-hazardous dusts);

– lead and inorganic lead compounds;

– cadmium and inorganic cadmium compounds;

– thallium and inorganic thallium compounds;

– hydrofluoric acid and inorganic gaseous fluorine compounds.

Regarding water pollution control, *immission*-related provisions are laid down to guarantee that certain types of water user take additional measures for water quality protection. It is the aim of water protection to preserve or restore ecologically intact waters as many places as possible in Germany. Therefore, the emission principle is complemented by the formulation of objectives in order to better recognise pollution sources and to develop efficient clean-up programmes. An important objective is the achievement of water quality Class II (moderately polluted) for all water bodies. This multi-grade class-rating system for water quality is based on biological aspects (saprobic system). A further instrument is the derivation and application of objectives for hazardous substances. The natural commodities to be protected include drinking water, aquatic biotopes, fisheries and sediments.

The *Länder* have the authority to establish distinct EQSs, although quality targets for surface waters have been issued by a joint working group of the *Bund* and the *Länder*. The emission limit standards are complemented by the adoption of «*immission* values» (environmental quality standards). EQSs for water are established by the *Länder* and are non-binding.

2.4 Best Available Technology

Pursuant to the 1974 Federal Immission Control Act, installations that are of particular importance for the environment are required to obtain a license in order to operate. The application of the best available technology (BAT) for emission reduction is a binding requirement for these installations. By way of definition, the Act stipulates that:

> *«State-of-the-art, as used herein shall mean the state of development of advanced processes, of facilities or of modes of operation which is deemed to indicate the practical suitability of a particular technique for restricting emission levels. When determining the State-of-the-art, special consideration shall be given to comparable processes, facilities or modes of operation which have been successfully proved in practical operation.»* (Article 3, paragraph 6)

Thus, in German law, «State-of-the-art» (*Stand der Technik*) constitutes the basis for establishing emission limit values. The Technical Instruction on Air Quality Control (*TA Luft*) establishes «best available» control technology requirements and emission limits specific to individual industries (e.g. refineries, iron and steel mills, cement factories, fuel storage facilities and chemical factories). Standards are binding requirements set for the individual installations.

In addition to imposing ELVs corresponding to state-of-the-art technologies, the *TA Luft* seeks to encourage pollution prevention, recycling and reuse of waste gases and energy efficiency in production processes. According to Article 7(a) of the Federal Water Act, the discharge of harmful substances into water has to be minimised by the use of the generally acknowledged rules of technology and for the discharge of hazardous substances by the use of BAT. If the waste water contains hazardous substances, it must undergo a treatment corresponding to the level of the BAT. However, there is no official definition of BAT for water pollution control. Regulators have used the definition contained in the Federal Immission Control Act.

BAT does not only include the setting of concentration or load-based limit values for special waste water streams and end-of-pipe, but also general requirements with regard to the production process, the abatement and recycling of waste water, the minimisation of waste generation and the use of environmentally sound substances. The ELVs are contained in the administrative regulations and orders. BAT is expressed in terms of general ELVs which have to be applied by all kinds of facilities subject to licensing. Therefore, BAT does not depend on special circumstances and conditions of an individual facility.

2.5 Negotiations of Standards and Emission Limits

The standards are not subject to any negotiation in the permitting process in Germany. The requirements are set as a minimum and can be made more stringent if the particular situation calls for it. Only the deadlines within which the requirements must be met may be negotiated.

2.6 Economic Considerations

Economic evaluations were carried out while the *TA Luft* was elaborated. In that phase, the industry got the opportunity to bring forward arguments concerning economic aspects of the proposed measures. Where necessary the proposed measures were modified in order to meet economic aspects. The advantage of this procedure is that economic aspects do not need to be reconsidered in each single authorisation procedure.

Economic considerations should not be taken into account as independent aspects. Distinctions have to be made between *immission* values for the protection against health hazards, which must not be exceeded in any case, and *immission* (guide) values for the protection against considerable disadvantages and substantial impairments which, after balancing of other interests, may possibly be exceeded.

2.7 Interaction of BAT and EQOs

ELVs set by the *TA Luft* are based on the evaluation of the state-of-the-art technologies (BAT) and the concerned industries must comply with the binding standards. These limits do not depend on EQSs and are, for the defined types of facilities, the same all over Germany.

However, as mentioned in Section 2.3 on Environmental Quality Objectives, a number of non-binding objectives have been developed to further water protection measures to a wider set of criteria beyond technical considerations.

In Germany, the pollution prevention principle takes precedence over the principle of dispersion. Underlying this concept is the principle of anticipation, which requires that the hazardous substances load in wastewater be kept as low as possible by meeting the requirements which are derived from an evaluation of BAT. Moreover, due to local conditions, more stringent requirements may be adopted.

As mentioned in the section on EQO, requirements more stringent than BAT and EQO may be necessary for all water bodies due to their sensitive conditions. This procedure is under the jurisdiction of the permitting authorities, as EQO targets are designed to apply throughout the Federal Republic.

3. TRENDS IN PERMIT LIMITS

3.1 Cleaner Technology

The permitting approach is based on avoiding the release of pollutant through both cleaner technologies and external treatment, rather than using the dilution capacity of the receiving medium. Consideration is given to minimising the releases of pollutants by using cleaner raw materials and processes (low sulphur ore and cleaner fuel), and recycling wastes (such as scrap metals, slag, etc.) within the process in order to recover their values. Use of external treatment technologies is also extensive to further minimise the release of emissions/discharges.

The permit requirements do not stipulate a specific abatement technology. The owner of a facility has to comply with the ELVs and it is up to him to select the most appropriate technological solution. To some extent, this procedure is also promoting the development of new more cost-effective technical solutions. Provisions of the monitoring programme also play a significant role in the identification of the sources and substances, and magnitude of emissions, providing information to the authorities and the permittees on the materials and processes of concerns. Thus, monitoring is an important factor in the development of preventative approaches and control measures.

Especially within the last ten years, the legislation concerning the protection of the environment has been developed to the high standards Germany enjoys today. This effort implied that the German industry and, particularly, the producers or facility equipment (abatement technology) had to develop techniques to minimise emissions. Now the industry and the producers of facility equipment have at their disposal a high level of know-how in environmental techniques which is an important precondition for further measures. To achieve a fast reduction of emissions, in the 1980s especially, secondary measures (e.g. scrubbers, filters) were used to reduce emissions. In the last years, a trend has been recognised in the use of process related technical measures (primary measures) which try to avoid the occurrence of emission problems and that are more cost effective in relation to emission reduction. This trend is also valid for water protection and waste prevention and treatment.

3.2 Monitoring

In the German Federal Immission Control Act (*Bundes-Immissionsschutzgesetz*), it is laid down that the emissions from facilities have to be monitored by measurements. Depending on the mass flow or the waste gas volume flow, some substances have to be measured continuously as specified in the *TA Luft*. The instruments used for the measurements have to comply with established standards, must be calibrated at regular intervals and must store the results on records. Three examples for classical continuously monitored substances are SO_x, NO_x and particulates (dust). The agencies can check the emissions of a facility by evaluating the records.

A lot of other substances are monitored by measurements made at regular intervals of at least three years. If relevant and hazardous emissions are expected, the local authorities are empowered to insist on a measurement campaign at any time. The measurements have to be made by professional licensed institutions.

The sample permit provides information on regulations for the installation and maintenance of any measuring instrument, especially for continuous measurements. Reports on the outcome of these following activities must be submitted to the responsible authority:

- Continuous measurement instruments shall be calibrated at the time of their installation;
- Calibration shall be repeated in case of substantial alterations or otherwise every 5 years;
- Functional tests of the measuring instruments shall be done once a year;
- Measuring devices shall be connected to the *Fernüberwachungs-System* (long distance surveillance system of the Federal State).

The permit also provides regulations for the conduct of measurements and monitoring of emissions:

- Results of the continuous measurements shall be reported to the authorities within 3 months after the end of each calendar year;
- Measurements results are kept on file by the operators for 5 years;
- Any interruption or failure in operation of instruments shall be reported to the authorities.

If the mass flows of the following substances exceed the level set in the permit, emissions shall be monitored by continuous measurements:

- Sulphur dioxide > **50 kg/h**;
- Total dust > **5 kg/h**;
- Nitrogen dioxide > **30 kg/h**;
- Hydrofluoric acid > **0.5 kg/h**;
- Hydrogen sulphide > **1 kg/h**;
- Carbon monoxide > **100 kg/h**.

Measurements shall generally be used to form half-hourly mean values for each successive half hour. Half-hourly mean values shall be converted to the respective reference units, classified, and kept on file as a frequency distribution. For each calendar day, a daily mean value, related to the daily operating time, shall be calculated from the half-hourly mean values and shall be kept on file as a frequency distribution.

In case of individual measurements, an initial measurement shall be made, not before 3 months and no later than 12 months after the start of operation. Measurements shall be repeated every 3 years. Reports are to be submitted to the authorities and kept on file by the operators for 5 years.

According to the *TA Luft* provisions, the duration of individual measurements shall not exceed half an hour, results of individual measurements shall be assessed and indicated as mean half-hourly values. For measurement of some particle emissions, a longer sampling time may be necessary to ensure that the samples taken amount to 1/1000 of the weight of the filter, in general, but at least to equal to more than 20 mg. The results have to be put into relation to the sampling time.

The above mentioned regulations, except those related to the long-distance surveillance system, are set in the *TA Luft* and are generally valid, not only for the facility dealt with in the sample permit.

Under the Provisional Decision provided for this case study, a special measurement programme is required for dioxins during a 36 months testing phase, in order to find out the best way of operating the plant. Content and extent of the programme shall be defined in co-operation with the Federal Environmental Agency and the permitting agency. Depending on the results, the usage of some raw materials (especially scrap) may be restricted.

3.3 Trends in Limits

The permit sample applies to a plant that is undergoing a major change, namely the conversion of the metallurgical process. The top-blowing converters are to be replaced by electric arc furnaces. In Germany not only the installation of a new plant is subjected to permitting procedure, but also major changes to existing plants require a permit. An increase in emissions of dioxins is expected from the change of the production process due to the 100 per cent use of scrap as raw material. Therefore special prerequisites concerning dioxins were set in the permit.

The submitted sample is a "Provisional Decision" in accordance with Article 9 of the Federal Immission Control Act. Provisional decisions cover only particular parts of the prerequisites for the granting of licenses, in this case for air emissions and noise. They become invalid if the applicant does not apply for a full license within 2 years. This term may be extended to a maximum of 4 years. The content of the provisional decision, especially the limits set for the release of substances, will be part of the permit.

The content of the permit is partly innovative as some emission limits are more stringent than the limits laid down in the *TA Luft*, for example, in the case of total dust, fluorine, sulphur dioxide and nitrogen oxides. The limitation of dioxin emissions for this kind of facility is new as well. Some of the measures taken are also innovative, such as the introduction of a waste gas cleaning device which improves the reduction of hazardous substances emissions.

An extensive monitoring programme has been developed in order to monitor the content of dust emissions and the efficiency of the control technologies (such as the combustion and filtration efficiency). A three year monitoring programme have been adopted in the case of dioxin emissions allowing the operator to exceed the limit set during the trial period (as much as five times higher than those set as emission limits). This allows some flexibility in the selection and setting of operations necessary to reach compliance with the permit requirements.

An environment impact study was commissioned by the plant operator, even though the permitting authority had decided that a formal environmental impact assessment was not necessary. The licensing procedure involved the participation of the public.

The controlled substances/properties and limits set in the provisional decision are:

1. *Noise* (concerning scrap storage, dedusting units, slag and water management facilities, and transportation):

   – at point of measurement A: during night time (22 p.m. - 6 a.m.) a level of 37.1 dB (A) must not be exceeded (compliance is proved if, between 30 September 1992 and 3 December 1992, a long term level of 41 dB (A) is not exceeded);

   – at point of measurement B: during night time (22 p.m. - 6 a.m.) a level of 41.2 dB (A) must not be exceeded (compliance is proved if, between 7 October 1992 and 3 December 1992, a long term level of 51 dB (A) is not exceeded);

   – in addition, the plant operator shall perform an audit on the noise disturbances in order to ensure that limits are complied with. In collaboration with the building contractors, the operator shall develop an expertise to reduce noise disturbances, in particular low frequencies (in the range of 100 Hz > 30 dB).

2. *Total dust* > **10 mg/m^3**

3. *Inorganic dust particles*:

   – Class I (e.g. cadmium and mercury) > **0.2 mg/m^3**;
   – Class II (e.g. arsenic, cobalt, nickel) > **1 mg/m^3**;
   – Class III (e.g. antimony, chromium, lead, fluorides, manganese) > **5 mg/m^3**.

4. *Vaporous or gaseous inorganic substances*:

   – Class I (e.g. arsine) > **1 mg/m^3**;
   – Class II (e.g. chlorine, hydrocyanic acid) > **5 mg/m^3**;
   – Fluorine > **2 mg/m^3**;
   – Class IV (e.g. sulphur dioxide, nitrogen dioxide) > **0.10 g/m^3**.

5. *Organic substances*:

   – Class I to III according to the annex E of the *TA Luft*

     Class I > **20 mg/m^3**;
     Class II > **100 mg/m^3**;
     Class III > **150 mg/m^3**.

   – Polyhalogenated dibenzodioxins / dibenzofurans > **0.1 ng-TE/m^3**(ITEQ)

6. *Special measuring programmes for a toxicological assessment*:

   - Arsenic, chromium VI, total chromium, cadmium, nickel, PAH, Polyhalogenated dibenzodioxins/dibenzofurans.

As far as air pollutants are concerned, the setting of emission limits serves a precautionary purpose as laid down in law and as substantiated by *TA Luft* (or decisions of the *Land* as far as dioxins are concerned). The limits are given as mass of emitted material related to the waste gas volume. Priority has been given to BAT in setting emission limits since studies and evaluations of the *immission* situation show that there will be an improvement by changing the method of operation as applied for in the permit. Moreover, EQOs are not breached in the area where the plant is located.

4. TECHNOLOGICAL RESPONSES TO PERMIT REQUIREMENTS

4.1 Equipment Installed/Measures Taken

The content of the permit was affected by the necessity to reduce emissions, in particular dioxins. As expected in the voluntary environmental impact assessment, the conversion of the metallurgical process, substituting electric arc furnaces (using 100 per cent scrap metals) for top-blowing converters, is expected to give rise to increased emission levels of dioxins.

In order to prevent/control the release of hazardous substances an extensive monitoring programme has been put in place involving continuous monitoring and analyses of emissions, gauging of the combustion efficiency of the control technologies and analyses of filtration efficiency. In the case of dioxin, the monitoring programme will be performed during a 36 months period. As mentioned in the previous section, ELVs for dioxins may be exceeded by the operator during the trial phase in order to test the best operating practices to achieve compliance.

The sample permit has set a limit for the emission of dioxins of 0.1 ng TE/m^3 (ITEQ) in analogy to the limit set for incinerators by the Seventeenth Ordinance Implementing the Federal Immission Control Act. This is expected to be complied with by installing a combustion chamber, heating gases to a temperature of 1 200 degree centigrade, followed by an air dry quenching device.

Following is a list of measures taken by the plant operator to handle the different environmental disturbances expected from the operations of the facilities. As said previously, conditions set in the Provisional Decision will be transferred to the final renewed permit.

Air Pollution Control

- collection of waste gas from electric arc furnace and ladle furnace;
- collection of fugitive emissions from the facilities;
- dedusting (suction hoods or encapsulation) of installations for storing and transporting dusty materials;
- post-combustion of furnace's waste gas;
- fast cooling of the waste gas at the output of post-combustion system (dry airquenching);
- dedusting of all waste gas and exhaust air in fabric filters;
- if necessary, injection of an adsorption agent (for example, activated carbon).

Water Pollution Control

– closed-cycle water cooling system (no sewage).

Noise Pollution Control

– soundproofing of walls and roofs;

– soundproofing of the exhaust gas ventilator;

– soundproofing of the ventilation systems of the buildings;

– vibration-proofing of relevant installations (like waste gas ventilator and transformers).

Other Measures

– utilisation of slags as road-building materials and filler;

– pelletising of filter dust for non-ferrous metal recycling.

4.2 Monitoring

– continuous measuring of dust emissions;

– intermittent measuring of hazardous substances contained in the dust;

– intermittent measuring of gaseous emissions, such as NO_x, SO_2, HF, CO and halogenated hydrocarbons;

– examination of noise disturbance in the vicinity of the plant.

4.3 Flexibility Considerations

In principle, the permit requirements are set in terms of emission limits to comply with. The plant operator is free to choose the technologies available to reach the standards/conditions set by the permitting authorities.

4.4 Views of Industry Surveyed

The permitting procedure under public scrutiny cannot be realised without technical considerations of the state-of-the-art techniques available (BAT). Thus, EQOs may be taken into considerations, but within the limits imposed by BAT requirements.

As BAT requirements are set in terms of the performance to be achieved, this allows some flexibility to the operator in the selection of the appropriate techniques to reach compliance.

5. CONCLUSION

At present, laws and decrees to minimise the effects of industrial activities on the environment exist in relation to the different media (air, water, waste management; a soil protection law has been proposed recently). The media are ruled by separate laws or decrees but for most effects on the environment only one authority deals with these effects and the permit contains requirements for each medium. To some extent it can be considered as a kind of integrated media permit.

The sample permit provided for the iron and steel case study is a provisional decision. It is within the normal permitting procedure, in this case for a major change in operation: the conversion of the metallurgical process of the steelworks, namely the substitution of top blowing converters for electric arc furnaces. In this case, only permit requirements for air and noise were considered. The content of the decision is partly innovative as some emission limits are more stringent than the ones in *TA Luft*, for example, for total dust, fluorine, NO_x and sulphur dioxide. The limitation of dioxin emissions for this kind of facility is new as well.

An assessment of the potential emissions associated with the conversion of the metallurgical process was an important factor in defining permit conditions. The use of 100 per cent scrap metals in electric arc furnaces is believed to increase the level of emissions and to generate certain substances of concern. Thus, permit requirements laid down in the Provisional Decision set stringent emission limit values which have led to the introduction of pollution prevention measures and end-of-pipe techniques in order to reach compliance. In addition, a monitoring programme has been defined in order to assess the efficiency of the measures introduced by the plant operator. The operator has been granted the permission to exceed the dioxin emission limits during the trial test phase.

The provisional decision requirements set emission limits not to be exceeded, leaving the selection of the appropriate techniques and measures to the discretion of the plant owner. The measures taken represent the BAT of the sector, such as the introduction of closed-loop systems for wastewater, collection, reuse and commercialisation of industrial waste (dust transformed into pellets, slag as road building material), and post-combustion of gas emissions in order to destroy organic compounds. Additional measures include the design of the plant in order to capture fugitive dust emissions.

The licensing procedure was executed involving the participation of the public. Although the permitting authority decided that it was not necessary, the plant operator commissioned a voluntary environmental impact assessment. This ensures that permit requirements were debated by considering the state-of-the-art techniques (BAT) associated with these types of industrial processes and environmental disturbances as well as the state of the environment (EQO) in the vicinity of the plant.

JAPAN

1. THE PERMITTING PROCESS

1.1 Constitutional Responsibilities for Environmental Protection

The framework of environmental policies was established through an intensive process of adoption of legislation and implementation from the end of the 1960s through the 1970s. This process started with early laws such as the Basic Law for Environmental Pollution Control (1967) and the Air Pollution Control Law (1968). These policies were later supplemented by the enactment of 14 laws related to the environment following the *Environmental Pollution Session* in 1970. Among others, they included amendments to the Basic Law for Environmental Pollution Control, to the Air Pollution Control Law, to the Waste Disposal and Public Cleansing Law, and enactment of the Water Pollution Control Law.

The principal aim of the Basic Law for Environmental Pollution Control is to protect human health and conserve the living environment by controlling air, water, and soil pollution, noise, vibration, ground subsidence and offensive odours. Its measures include regulations on emissions, regulations on land use and facility location, development of pollution control facilities, monitoring, research and study, and subsidies. The law also provides for planning and measures in areas of the country with serious pollution problems. Categories of facilities to which emission standards are applied have been extended, such as in the case of the control of nitrogen oxides (NO_x). Other innovative measures include examples such as the area-wide control of sulphur oxides (SO_x). Other laws aimed at regulating the examination of hazardous chemical substances prior to production and import were adopted following accidents involving chemical poisoning (PCBs, Mercury, etc.).

In the 1980s, problems such as air pollution by NO_x in urban areas and water pollution by organic materials were at the forefront of the environmental agenda. In 1982, the area-wide pollution control system was applied to reduce NO_x. The Water Pollution Control Law was amended in 1983 and the area-wide pollution control system for organic materials was adopted for Tokyo Bay, Ise Bay and the Seto Inland Sea. The Law on Special Measures for the Conservation of Lake and Reservoir Water (1984) led to the designation of important water use and to the adoption of comprehensive plans for lake restoration. Moreover, to prevent groundwater contamination, a guideline on intrusion of waste water was adopted in 1984 and was followed by an amendment to the Water Pollution Control Law (1989) to ban intrusion of waste water containing hazardous substances. More recently, new regulations have been adopted in relation to domestic issues. Legislation was enacted to promote measures aimed at the reduction of NO_x emissions from motor vehicles in metropolitan areas, to promote appropriate management of industrial and hazardous waste and to encourage recycling and waste reduction.

The Environment Agency was established in 1971. The mandate of the Environmental Agency is to promote policies for pollution control, nature conservation and other environmental issues. Implementation of the environmental laws under the responsibility of the Environment Agency are principally delegated to prefectures and in some cases to municipalities. Prefectures are authorised to establish more stringent regulations for air and water pollution control. All prefectures have enacted ordinances for pollution control and 545 municipalities have local pollution control ordinances.

1.2 Permits

In Japan, the issue of permits is performed by the prefectural governments. Permit procedures are followed according to the municipal ordinance. An environmental protection agreement is concluded between the local government and business establishment of the plant, in addition to the provisions of the different national laws. The permit-writing authorities have no latitude for weakening the regulation. When the local environment cannot be protected merely by the standards stipulated in the national laws, stricter emission standards can be set up by the municipal ordinance.

In the case of the iron and steel industry, permit registration is stipulated under both the Air Pollution Control Law and the Water Pollution Control Law. The former stipulates the blast furnace, melting furnace, sintering furnace, electric arc furnace (EAF) and coke oven as soot and smoke facilities. Furthermore, the coke oven, mineral dumping yard, belt conveyor, crusher, miller and sieve are specified as dust particles emitting facilities. The latter identifies the tar, gas and liquid separation processes, the gas cooling and washing operations, the rolling facilities, the hardening facilities, and the wet type dust collector systems as operations under its control. Information to be submitted by the applicant for registration include:

- Name of the soot and smoke facility, size and capacity of the facility, amount of discharged air pollutant, air pollutant treatment method, discharge method, fuels to be used, type, quality and quantity of the material;

- In addition to the above, environmental impact assessment and pollution control agreement may require the following information: need for the new construction, production overview, soot and smoke emitting facility in the case of a new construction, process overview, situation of air pollutant release, air pollutant treatment method, air pollutant prediction and result.

A permit has to be issued even prior to the beginning of the construction of an installation. The permit has no specific duration. However, when modifying the structure of the specific facility, way of use, waste water treatment method, degree of contamination of waste water, etc., are planned, description of the planned modification must be submitted.

1.3 Permit Renewal Process

The assessment process followed for permit renewal or permit revision is similar to the description given in Section 1.2. There is no specific time. When the plant plans to modify its facility, applicable standards may be reviewed upon the request of the plant. When the applicable standards are received and modified, the agreement can be modified accordingly.

1.4 Multi-Media Permits

Environmental protection is regulated through a media-specific approach. National standards are specified as to protect the public health and the living environment. Local governments have the authority to set up more stringent standards if environmental quality standards (EQSs) are not met.

However, it should be noted that, in the environmental impact assessment (EIA) and agreement, situations of all media are described in the application form. Impacts on the environment are evaluated for each medium, and permits will be granted, by considering the attainment of environmental standards as well as the capacity of state-of-the-art treatment technologies. The abatement of emissions may result in the increase of other environmental releases. In such cases, instruction is given so that the amount (for each medium) will be minimised. In the final phase, top priority will be given to the substance which poses the greatest problem to the surrounding area. However, in the area where the situation is so severe that priority among media cannot be given, the applicants are required to use the most advanced technology for each medium. Permits will be granted only when items reviewed for each medium have met the requirements in the final phase.

1.5 Environmental Assessment

EIAs were developed during the period following their introduction for public works by a Cabinet decision in 1972. In the absence of a comprehensive law on EIA, environmental impact assessments are carried out according to individual laws, under a 1984 Cabinet decision and related guidelines, and under ordinances and guidelines issued by local governments.

Environment impact assessment is part of the permitting procedure. Section 1.2 outlines the information that the applicant must provide following his submission for a new, or renewed permit. In addition to the information regarding the type of industrial process and expected production data, the applicant must provide the permitting authorities with a preliminary assessment based on a study of potential impacts on the environment, and the capacity of the applicant to meet the emission standards. The environment impact assessment is thus, in part, determined through negotiation between the applicant and the permitting authority. Consequently, it is also an important aspect of the negotiation of permit requirements.

2. BAT, EQO AND ECONOMICS

2.1 Standards Setting and Targets

The Basic Environment Law provides the legislation for the State's imposition of emission limits. According to the statute:

> *«The Government shall take the following regulatory measures to prevent interference with environmental conservation: (1) Regulatory measures necessary to prevent environmental pollution, inter alia, by setting the standards with which corporations must comply regarding such activities as emission of substances causing air pollution, water pollution, soil contamination or offensive odours; generation of noise or vibration; and the taking of underground water causing ground subsidence [...].»* (Article 21)

Several types of Emission Limit Values (ELVs) are used in Japan. ELVs for SO_x for instance, are determined by the central government. The Prime Minister has the exclusive authority to set the standards, which vary from one region to the next. Likewise, ELVs for NO_x are determined by the Prime Minister. But each prefectural governor has the authority to implement stricter standards to meet the requirements imposed by the applicable EQSs. Most air ELVs are of the latter type. The procedure is principally similar in the field of water pollution.

When these regulations are insufficient to achieve the EQSs, additional pollution reduction efforts are undertaken at the regional level. In such cases, areas where ELVs are insufficient to maintain the prevailing air EQSs are designated by the State as Area-wide Total Pollutant Load Control Regions. These geographic regions are specified by the national government. However, it is up to the prefectural government to formulate remedial plans. Each of these control plans is centred around particular polluting substances. Within the designated areas, and based on scientific data, an allowable amount of total emission is calculated for each pollutant and distributed to each factory in the area.

In the case of air pollution, the Basic Environment Law sets environmental standards with respect to SO_2, NO_2, SPM, CO, photochemical oxidant, which are uniformly applied in Japan. Water quality environmental standards are specified for the following items: cadmium, total cyanide, lead, hexavalent chromium, arsenic, total mercury, alkyl mercury, PCB, dichloromethane, carbon tetrachloride, 1, 2- dichloroethane, 1, 1- dichloroethylene, cis-1, 2- dichloroethylene, 1, 1, 1- trichloroethane, 1, 1, 2- trochloroethane, trichloroethylene, tetrachloroethylene, 1, 3- dichloropropene, thiram, simazine, thiobencarb, selenium.

Parameters related to the protection of the human health and the living environment are used in the setting of ELVs, with considerations given to the general use (for instance, household, industrial, or recreational uses of water) and the dilution factor. The parameters of the environment standards for protection of human health are selected on the basis of the knowledge and information of the impact on health and the detection results in the water area for public use. A study is made based on scientific knowledge and related standards, and the standard values are determined by taking into account the impact via drinking water and impact via foodstuff due to water pollution. For parameters on the protection of living environment, the standard values are determined according to the purposes of use, such as natural environmental protection, water supply, fisheries, industrial water, agricultural water, bathing, environmental protection, etc., for each of the river, lake and sea areas. The particular environmental conditions of the regions and the feasibility of pollution treatment technology are also considered. At the prefectural and local levels, twenty-four out of the 47 prefectures have the reinforced standards regarding the items relating to human health. All of them have the reinforced standards regarding the items relating to the living environment.

The need to develop better technologies is stipulated in the Basic Environment Law. Regarding technologies to reduce various emission substances, R&D budgets for environmental protection technology and various development aids are available.

2.2 Environmental Quality Objectives

Environmental Quality Standards (EQSs) are the main instrument of environmental protection in Japan. They are introduced at the highest level of the legislation. The 1993 Basic Environmental Law stipulates that:

> *«With regard to the environmental conditions related to air pollution, water pollution, soil contamination and noise, the Government shall establish environmental quality standards, the maintenance of which is desirable for the protection of human health and the conservation of the living environment.»* (Article 16.1)

The Basic Environment Law is implemented through several media-specific pollution control laws such as the Air Pollution Control Law and the Water Pollution Control Law, or laws geared towards the regulation of ambient standards for specific substances and parameters (Noise Regulation Law, Offensive Odour Control Law, and Vibration Regulation Law). In these laws and regulations, the framework for media-specific EQSs is laid out. The Air Pollution Control Law, for instance, specifies that it is the government's responsibility to set EQS for the atmosphere in Japan in relation to the substance covered. Table 1 provides national EQSs that have been established for air pollutants.

The Environmental Agency sets the EQS for particular substances and parameters after consultation with the Central Environment Council. EQSs are uniform, minimum required standards that apply throughout the country. EQSs on air, water, and noise pollution have already been established. Investigations related to soil pollution are now being conducted. Table 2 provides the list of substances (and related standard) that are regulated under the different national laws. EQSs are determined on the basis of the protection of the human health (23 parameters) and of the living environment (9 parameters).

Table 1. **EQSs for ambient air**

Substance	**Ambient air limit values (concentration)**
Sulphur dioxide	0.04 ppm or less for daily average of hourly values, and 0.1 ppm or less for hourly value
Carbon monoxide	10 ppm or less for daily average of hourly values*, and 20 ppm or less for average of hourly values of every 8 hours
Suspended particulate matter	0.10 mg/m^3 or less for daily average of hourly values*, and 0.20 mg/m^3 or less for hourly values
Nitrogen dioxide	Between 0.06 ppm and 0.04 ppm or less for daily average of hourly values*
Photochemical oxidants	0.06 ppm or less for hourly values

* Achievement of EQS is based on the lowest 98 per cent for NO_2; for CO, PM_{10} and SO_2 values within the highest 2 per cent are excluded.

In the case of water protection, standards are set for each category (river, lake, marsh, sea areas, etc.). The water area category is designated by the head of the Environmental Agency or prefectural governor. Standard parameters and values are set on a case-by-case basis. The water area of the river is classified into six categories according to the object of using the water area (natural environmental protection, water supply, fisheries, industrial water, agricultural water, bathing, environmental protection). Standard values for five parameters (pH, BOD, SS, DO, and the number of coliform groups) are determined for each category.

The water area of the lake is classified into four types according to the object of using the water area (natural environmental protection, water supply, fisheries, industrial water, agricultural water, bathing, environmental protection). Standard values for five parameters (pH, BOD, SS, DO, and the number of coliform groups) are set for each type, and standard values for five types and two parameters (total nitrogen and total phosphor) are determined from the viewpoint of eutrophication.

The sea water area is classified into three types according to the object of using the water area (natural environmental protection, fisheries, industrial water, bathing, environmental protection). Standard values for five parameters (pH, BOD, DO, the number of colibacilli and extracts of n-hexane) are determined for each type, and standard values for four types and two parameters (total nitrogen and total phosphorus) are determined from the viewpoint of eutrophication. Table 3 provides category standard values for rivers and lakes (BOD) and sea areas (COD).

Table 2. **Water related EQSs to protect human health**

Substance	Standard values
Cadmium	0.01 mg/l or less
Total Cyanide	Not detectable*
Lead	0.01 mg/l or less
Chromium (hexavalent)	0.05 mg/l or less
Arsenic	0.01 mg/l or less
Total Mercury	0.0005 mg/l or less
Alkyl Mercury	Not detectable*
PCBs	Not detectable*
Dichloromethane	0.02 mg/l or less
Tetrachloromethane	0.002 mg/l or less
1,2-Dichloroethane	0.004 mg/l or less
1,1-Dichloroethylene	0.02 mg/l or less
cis-1,2-Dichloroethylene	0.04 mg/l or less
1,1,1-Trichloroethane	1.0 mg/l or less
1,1,2-Trichloroethane	0.006 mg/l or less
Trichloroethylene	0.03 mg/l or less
Tetrachloroethylene	0.01 mg/l or less
1,3-Dichloropropene	0.002 mg/l or less
Thiram	0.006 mg/l or less
Simazine	0.003 mg/l or less
Thiobencarb	0.02 mg/l or less
Benzene	0.01 mg/l or less
Selenium	0.01 mg/l or less

* “Not detectable” means that “this item shall not be detected by the prescribed method”.

Table 3. **EQSs related to the water classification system**

Category	Rivers BOD (mg/l)	Lakes BOD (mg/l)	Sea areas COD (mg/l)
AA	1 or less	1 or less	2 or less
A	2 or less	3 or less	3 or less
B	3 or less	5 or less	8 or less
C	5 or less	8 or less	--
D	8 or less	--	--
E	10 or less	--	--

As said previously, local ordinance may set more stringent standards if EQSs are not met in local areas. Other EQSs provided by Japan concern noise requirements and are given in the Table 4.

Table 4. **EQSs for noise**

Area category	Day-time	Morning/evening	Night-time	Applicable areas
AA	45 dB (A)	40 dB (A)	35 dB (A)	Areas designated for each classification by prefectural governor based on the provision of Article 2 (Cabinet order on Water and Land Areas for EQSs)
A	50 dB (A)	45 dB (A)	40 dB (A)	
B	60 dB (A)	55 dB (A)	50 dB (A)	

Note:

- Areas coming within category AA are those where quiet is particularly required such as where there is a concentration of convalescent facilities.
- Areas coming within category A are those which are used mainly for residential purposes.
- Areas coming within category B are those which are used considerably for residential purposes and which are also used for commercial and industrial purposes.

2.3 Best Available Technology

In the Japanese regulatory system, the Prime Minister or the Director General of the Environment Agency have the authority to establish ELVs for the pollutants of concern. The legislation itself contains no direction for deriving precise figures. Nor does it provide any definition of Best Available Technologies (BAT). No official reference whatsoever is made to BAT.

As a rule, the minister in charge solicits the opinion of the Central Environment Council. It is composed of highly experienced experts drawn from the scientific community, from industry, from the mass-media. Former government officials and representatives of consumer advocacy groups also sit on the Council. In order to facilitate the examination of the issues, the minister in charge produces reports on the environmental situation at hand. The reports usually address the following key elements: the configuration of pollution sources, the economic situation of polluters and the BAT (technology assessment). Technology assessment may very well be the most influential factor in the final decision.

The Air Pollution Control Law stipulates facility standards for dust discharge facilities, with consideration given to a concept similar to BAT. Furthermore, in NO_x and smoke emission standards, the emission standards are put into numerical values with consideration given to the technological feasibility, according to the year in which the facility is installed, as well as the size of the facility.

Moreover, the concept of BAT is used in the provision of guidance notes for environmental impact assessment (EIA) and pollution control agreement. Accordingly, applicants who plan to construct new facilities are guided to use BAT through the permitting process. However, the BAT level may differ according to the extent that the environment standards are met. Similarly, prefectural governments use a concept similar to BAT when setting additional discharge/emission standards.

2.4 Negotiations of Standards and Emission Limits

The permit-writing authority have no latitude for weakening the regulation. As said previously, the local ordinance generally results in more stringent standards so as to ensure compliance with local EQSs. In the case of large enterprise, voluntary agreement may be negotiated. In such cases, the large enterprises commit themselves to more stringent EQSs than those required by the laws.

2.5 Economic Considerations

Economic considerations are discussed during the debate within the Central Environment Council. The capacity of an industrial sector to bear and respond to the anticipated costs is thus integrated directly into the regulatory process. During this process, the various agencies and ministries concerned by the regulation put forward their own perspective. No leeway for negotiation on the basis of economics is granted in this regard at the permitting stage. Consequently, the relevant ministries provide occasional financial support to assist industries in the installation of the abatement or prevention equipment needed to meet the standards.

2.6 Interaction of BAT and EQOs

Applications and reports submitted under the Air Pollution Control Law are reviewed from the viewpoint of ensuring strict observance of the emission standards. The emission standards have been set forth by taking into account a concept similar to BAT, while making efforts for achieving the EQO level. Permit requirements are often determined, through the pollution control agreement, by considering EQO and BAT and their balance.

However, registration under the Water Pollution Control Law is reviewed from the viewpoint of ensuring strict observance of the effluent standards. Environmental standards are set forth according to the impact on human health and the purposes of use, irrespective of BAT.

3. TRENDS IN PERMIT LIMITS

3.1 Cleaner Technology

The standards and permits applied in Japan are determined on the basis of the protection of the human health and the living environment. Though this is not specified in the Air Pollution Control Law, use of BAT is advised through EIA and the pollution control agreement. ELVs are set taking into account what the pollution prevention measures can achieve, as well as the use of control pollution devices in cases where in-plant measures cannot comply with the required environmental and health quality requirements. These limits can be made more stringent by local authorities if local conditions cannot be secured.

Ambient air quality must be constantly monitored by prefectural governors and mayors of designated cities according to the Air Pollution Control Law. Applications are reviewed from the viewpoint of ensuring strict observance of the emission control. It should be noted that the result of constant monitoring of the ambient air quality provides means for reinforcement of emission control in combination with an advance of control technology. Furthermore, through the environmental impact assessment, prediction and assessment are made in advance on how the substances released affect the environment. The relevant information is submitted and is assessed according to the environmental standards. Guidance will be given to introduce the treatment facilities, thereby meeting the environmental standards wherever possible. The same procedure is followed for water protection.

In areas where intense industrial activity or high population densities can cause pollution problems, designated prefectural governments are required, under the Basic Law for Environmental Pollution Control, to develop pollution prevention plans. These plans not only address emissions from industrial operations but also deal with land use, transportation and urban development issues. Such plans are being implemented in 34 areas.

Between October 1991 and September 1992, about 220 agreements on fuel use and 630 on emission control were made between industrial corporations and local authorities or citizens' groups. Although the texts of these agreements are not generally available to the public, it appears that this system has encouraged the introduction of advanced pollution control technology, improved combustion technology, high quality fuel and energy efficient measures.

Significant investments have been made in industrial stationary source pollution control. Particulate collection technology, the most common air pollution abatement technology, is used in a wide range of industrial activities. A major effort has also been made to develop desulphurisation and denitrification technologies: Japan's average SO_2 and NO_2 emissions per unit of thermal electric power generation are well below those of other major OECD countries.

Flue gas desulphurisation capacity in 1991 totalled 205 million cubic metres per hour in normal conditions (Nm^3/h), compared with 5.4 Nm^3/h in 1970. Exhaust gas denitrification capacity in 1991 totalled 216 million Nm^3/h, compared with 0.1 Nm^3/h in 1972. Ammonia-based selective catalytic reduction is the most commonly used process. Technologies that would allow simultaneous desulphurisation and denitrification are being developed. Particulate collection capacity totalled 883 million Nm^3/h in 1991. Electrostatic precipitators accounted for half the total capacity, though the cyclone type is the process most commonly used.

Alongside clean technologies, notably those concerning coal combustion, significant energy efficiency measures adopted in the industrial sector have resulted in energy savings that have contributed to the overall reduction in air pollution emissions.

The Air Pollution Control Law specifies the items related to atmospheric quality. It should be noted that, in the environmental impact assessment and agreement, situations of all media are described in the application form. The review is carried out for each medium; therefore, during the process of review, emission/discharge to one medium may result from reduction to another medium. In such cases, instruction is given for each medium so that the increased amount emitted to each medium will be minimised. In the final phase, top priority will be given to the substance which poses the greatest problem to the surrounding area. However, in the area where the situation is so severe that priority among media cannot be given the applicants are required to use the most advanced technology for each medium. The same process goes for water pollution control.

Regarding the technologies to be developed, research and development as well as the use of technology after development are sometimes included in the permit requirements. For example, in the authorisation consent to Mill B, the permit provides for certain technology relating to soot and dust, pursuant to the prefectural regulations. In this case, priority is given to BAT in terms of setting permit limit values because the amounts of allocation to individual companies for the purpose of achieving EQS cannot always be accurately calculated.

Emission standards are based on an assessment of pollution prevention measures and treatment technologies. In order to achieve compliance, the facilities must use high quality fuels and improve their combustion technologies. Control technologies such as the exhaust gas desulfurizer have been installed to meet the requirements. One prominent area for pollution prevention has been in terms of energy saving through rationalisation of production processes, recovery of waste heat, and recycling of scrap materials (and waste water).

In the case of water pollution control, stricter emission standards and the obligation to apply the BAT are often negotiated through voluntary agreements with the industry. These agreements are of limited duration so they can be adapted to changing technology. There is no special policy favouring a shift from end-of-pipe techniques to in-process technology.

3.2 Monitoring

Environment monitoring is conducted by the permitting authority (i.e. prefectural governors and mayors of designated cities), and the monitoring results are made public on a periodic basis every year. This is stipulated in the Air Pollution Control Law. The monitoring technique is formulated in a manual and is made uniformly. Local monitoring stations, created since the 1970s form an extensive network: approximately 1 700 stations monitor SO_2 and NO_2, 500 monitor CO and non-methane VOCs, 1 100 photochemical oxidants and 1 500 suspended particulate matter (SPM). In line with the air pollution trends, the number of stations monitoring NO_2, SPM and oxidants are still increasing. Measuring non-conventional pollutants, such as hydrogen sulphide, ambient ozone concentrations and SPM components, has become an important function of the national stations. Acid precipitation monitoring stations have been established nationwide since 1983. Some municipalities operate a centralised monitoring system that gathers continuous data on SO_2 emissions and fuel consumption at major sources. Permitting authorities conduct on-the-spot inspection whenever appropriate, thereby checking whether or not the emission standards are met.

It should be noted that large-scale business establishments monitor the environment surrounding their own facilities themselves. The results are often not disclosed. The quality and quantity of the smoke released from the soot and smoke emitting facilities are monitored by the business operators in order to meet the emission standards.

The judgement according to the monitoring results as to whether environmental standards are met greatly influences the permit to be granted for the new site. A permit may not be granted in the region where the environment standards are not met. Even if the permit is granted, it may result in the introduction of the most advanced treatment technology or reduction in the size of the project. Furthermore, monitoring results greatly influence emission standards. Since the achievement of environmental standards is the administration target, the emission standards are set up in principle so that environmental standards will be met, and monitoring results are thus very important.

In the case of water protection, local public bodies are also responsible for monitoring the quality of water, in accordance with the Water Pollution Control Act. The techniques used are also formulated in a manual and made uniform. Prefectural governments disclose the quality of water for public use every year. The monitoring results are utilised to plan and promote the measures for protection of the water quality. As in the case of air pollution control, business establishments are responsible for the monitoring activities in accordance with their pollution control agreement. Emission control is the responsibility of the discharger, who keeps a record of emissions.

3.3 Trends in Limits

In the iron and steel industry, emission standards based on the Air Pollution Control Law are applied with respect to SO_x, NO_x and smoke. Emission standards of SO_x vary according to the particular atmospheric quality of the specific region. More stringent standards are imposed in the more seriously contaminated areas. In more specific terms, the permissible emission volume is determined by backward calculation from the maximum ground concentration allowed in that area. Furthermore, fuels are placed under control in cases where many facilities are concentrated in a particular location.

For NO_x and smoke, the standards are set up with consideration given to a concept similar to BAT where measures can be taken which conform to the year of installation and size of the emitting facilities. These limits can be made more stringent by local authorities as well. For SO_x and NO_x, regulation of total emission is adopted in the area where the environmental standards cannot be met by these controls alone. For soot and dust particles, the facility standard is set for each type of facility using a concept similar to BAT.

Water quality control is carried out according to effluent standards. Prefectural governments have power to set up more severe effluent standards (reinforced effluent) to be applied instead of the uniform national effluent standards, when the latter are insufficient for protecting the human health or for preserving the living environment. The reinforced effluent standards stipulate the values according to the region and type of the business, with consideration given to particular environmental conditions and the feasibility of waste water treatment technology. Prefectures facing the Tokyo Bay, the Ise Bay and the Seto Inland Sea are placed under the Area-wide Total Pollutant Load Control on COD. In addition to the effluent standards, the total amount of pollutant load discharged from the specific business establishments is set out. This stipulation is based on the consideration given to the feasibility of waste water treatment technology.

Pollution control is implemented according to the Air Pollution Control Law, the Water Pollution Control Law and the Prefecture Pollution Control Regulation. Permit procedures are followed according to the municipal ordinance. An environmental protection agreement is concluded between the local government and business establishment of the plant, in addition to the provisions of the different national laws. The following tables describe the details of the pollution control agreements that were selected as part of the case study. Table 5 provides permit requirements for Mill A, an integrated steel mill; Table 6 describes the details of the pollution control agreement for Mill B, a mini-mill.

Table 5. **Mill A**

Substance/property	Rationale for selection	Measurement period
Air pollution	Improvement of ambient air quality	Constant monitoring (automatic measuring instrument)
Sulphur oxides (SO_X)	Improvement of ambient air quality	Constant monitoring (automatic measuring instrument)
Nitrogen oxides (NO_X)	Ambient air concentration at building and facility outlets	Measured once a year
Dust particles (smoke, dust)	Additional discharge/emission standards set by prefectural governments for dust particles	Legally stipulated number of times
Water pollution		
Amount of waste water released	Reduction in pollution load	Constant monitoring (automatic measuring instrument)
COD	Improvement of water quality	Constant monitoring (automatic measuring instrument)
SS	Improvement of water quality	Every other week or monthly
Oil content	Improvement of water quality	Every other week or monthly
Zinc Dissolved iron Dissolved manganese Cyanide Phenol Total hexavalent chromium	} } }Reduction in the load of process }waste water } } }	} } }Every other week or monthly } } } }

Note: Only major facilities are subjected to constant monitoring by automatic measuring instrument.

Table 6. **Mill B**

Substance/property	Rationale for selection	Measurement period
Air pollution		
Nitrogen oxides (NO_X)	Environmental criterion and improvement of ambient air quality	Continuous monitoring (as per the agreement)
Soot and dust	Standards of emission at discharging ports - Equipment standards based on the Prefectural Pollution Prevention Regulations	Once every 2 months
Pb, Cd	Standards of emission at discharging ports - Equipment standards based on the Prefectural Pollution Prevention Regulations	Once every 2 months
Water pollution		
Amount of waste water	Reduction in pollutant load	Continuous monitoring
		Continuous monitoring
COD	- Env. criterion and improvement of ambient water quality	}
pH	- Env. criterion and improvement of ambient water quality	} }Once a month
BOD	- Env. criterion and improvement of ambient water quality	}(as per the agreement) }
SS	- Standards of emission at discharging ports	} }
Oil content	}	}
Fe	}	} Once a month
Nitrogen	}	} (as per the agreement)
Phosphorus	}	}
As	}	}
Cd	}	}
Pb	}	}
Zn	}	}
	}	}

4. TECHNOLOGICAL RESPONSES TO PERMIT REQUIREMENTS

4.1 Equipment Installed/Measures Taken

As noted in the previous section, 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 provide the level of control required. Environmental legislation is challenging the industry to develop cleaner and more efficient steelmaking processes while interfirm rivalry and competition from substitute materials are forcing steelmakers to invest in cost-saving and quality enhancing technologies. These trends are clearly shown in evaluating the two permit samples.

MILL A (integrated facility)

The facilities were prominent works located in the Keihin Industrial Belt. In order to rationalise the facilities which were dilapidated and extensively distributed, it was planned to reclaim part of the sea front of the existing works and to move major facilities such as blast furnaces into the new site. During the relocation of Mill A, state-of-the-art environmental measures and energy-saving technology were introduced as much as possible. Approximately 20 per cent of the total relocation/construction cost was spent on environmental measures, including air and water pollution control, solid waste treatment, and tree planting on the site. In terms of energy saving, technologies and facilities for rationalisation of production processes (seriating them, improving line availability, recovering waste heat) were introduced. The most important prevention and control techniques and measures implemented by the operator are:

- Basic pollution control measures:

  (1) Consideration to the layout of facilities:

  - Replacing the major sources of release of pollutants in the new site;
  - Centralising point sources and laying out facilities for the ease of pollution prevention.

  (2) Control of generation of pollutants:

  - Seriating production processes and recycling resources and energy;
  - Using the resources and energy that minimise pollutants;
  - Developing and applying the facilities that minimise pollutants.
  - More than 90 per cent of the amount of emissions of major pollutants, such as SO_x, NO_x, COD, and waste water, is measured automatically and computerised through a centralised management system. About 100 data items among all those which relate to the emission of the pollutants mentioned above are also transmitted to the local government at the same time for monitoring purposes.

- Air Pollution Control:

(1) SO_x control:

– The fuels used in the steel plant are mainly desulfurized coke oven gas and the by-product gases such as blast furnace gas and basic oxygen gas, which are low in sulphur contents. Gas fuel occupies about 95 per cent in the overall fuels of the steel plants;
– Efforts have been made for the research and development of the sintering plant exhaust gas desulfurizer since the early 1960s. In a joint research with Industrial Test Laboratory of Kanagawa Prefecture, an ammonium sulphate method was developed, and the exhaust gas desulfurization facility was installed on the sintering plant in 1976. This method provides a high desulfurizing efficiency of 99 per cent or more.

(2) NO_x control:

– Fuel NO_x is reduced by using the mix gas blended with a low-nitrogen by-product gas in the plant. Thermal NO_x control is reduced by using the low NO_x burner, exhaust gas recirculation and multi-stage combustion, including the low-oxygen ratio controlled combustion, independently or in combination, in conformity with the particular characteristics of the equipment;
– As mentioned, the development of the sintering plant exhaust gas desulfurizer goes back to the 1960s, and was added to the sintering equipment in the relocated plant in 1979. It is based on the catalytic reduction method by ammonium selection where ammonium is blown into sintered exhaust gas, and NO_x is decomposed into nitrogen and water using iron ore as the catalyst. It features a denitration efficiency of 70 per cent or more.

(3) Dust control:

– To prevent dust from spreading from the materials (iron ore, coal) yard, the building and conveyor group are enclosed in an L-shape to protect against wind. The yard is provided with a travelling type water sprinkler which allows the water to be sprinkled directly from the top. Water sprinklers are installed in the transport phase for unloading material from the material carrier vessel, storing material in the yard and moving it to the specified position. Belt conveyors are provided with covers, and the transfer areas are equipped with dust collector hoods. Furthermore, the blast furnace and electric arc furnace are provided with building dust collectors.

- Water pollution control:

(1) Reduction in the volume of polluted waste water:

– The use of water at Mill A is based on the principle of recirculation and recycling. Thus, industrial water used as indirect coolant is reused as direct coolant, washing water and water for dust collection. The water is also used for sprinkling the material yard or is reused after having been purified and treated at the purification facility. The waste water released into the sea is below 5 per cent of the total volume of water used.

(2) Treatment of waste water by separation:

- The industrial waste water, domestic waste water and rain water are separately collected to improve treatment efficiency. Treatment of the industrial waste water is made in conformity with the particular characteristics of waste water in each plant. To treat ammonia liquor (coke oven gas), for example, the activated carbon adsorption method is added to the final process, in addition to treatment by activated sludge, coagulation, sedimentation and quick filtering, thereby ensuring complete COD removal.

MILL B (mini-mill)

The company was established in the southern industrial area of Nagoya City in 1957 and started operation as the only rolling mill in the Tokai region. After initial operation in 1959 with two 30 tonne EAFs, the full-scale operation started in 1962 with the addition of one 200 tonne EAF. Intensification of environmental issues prompted the Company to sign the Pollution Control Agreement with Nagoya City. A series of measures was taken by the operator to comply with the new requirements.

1) Steelmaking processes using electric and ladle furnaces:

- Under these processes, air, noise, industrial wastes, and other related items become the major objects of control. Legal and/or regulatory permit requirements relating to air quality are: installation of building dust collectors under the prefectural regulations; the concentrations of soot/dust and heavy metals (Cd and Pb), and the amounts of NO_x emission, at the outlets of electric arc furnace/dust collectors. Substances are removed by using three filtration-type dust collectors (1 000 kW, 1 100 kW, and 1 250 kW). More than 99 per cent of the soot and dust is captured by dust collectors. For NO_x, the company uses a plant-operating method that reduces the hot-refining time at high temperature for minimal thermal NO_x.

2) Slab-casting processes using continuous casting equipment:

- The direct cooling water for continuous casting and the noise associated with slab cutting become the objects of control. Waste water is recovered and recycled. Part of the water overflow, however, is discharged during water processing (sedimentation, filtering, and cooling). For such effluents, it becomes important to control the amounts of occurrence of suspended solids (SS) which contain iron oxide.

3) Heating furnaces and rolling mills:

- Gas emissions during slab heating, direct cooling water for rolling and cooling, sludge, and the noise during product transfer and cutting become the objects of control;
- Under the low-rate finance "Promotion of Introduction of Industrial-Use Certified Equipment for More Effective Use of Energy" based on an energy-saving and recycling support law, the company replaced the existing equipment with a heating furnace of the energy-saving and low-NO_x type of 1994. Also, the city gas was replaced by kerosene, as the fuel source, in 1983, to satisfy the control standards

for gas emissions and the emission standards for SO_x, NO_x, and soot/dust. Petroleum-based fuels have almost entirely been eliminated, except for transport purposes;

– The effluents from these processes are recovered and recycled; only water overflows that have been treated by coagulating sedimentation followed by filtration are discharged into the public waters. Items of concerns which are controlled using the processing method described in Point 2 are pH, COD and SS. During steelmaking and rolling, effluents are recycled to minimise discharges which account for less than 2 per cent of the water amount used.

4.2 Flexibility Considerations

For the individual companies, the permit requirements are not flexible since the central and local governments have uniformly established them for each sector and each type of equipment. The permit requirements relating to new equipment are much more stringent than for existing equipment of the same type. However, there is flexibility in choosing the method and/or equipment.

4.3 Views of Industry Surveyed

The two permittees recognise that a certain amount of flexibility exists for choosing the type of technology to meet the requirements. However, the specified values allow only limited flexibility. Even if the facility has some room for manoeuvre with respect to specified values, it is considered difficult to improve further the performance of the facility. Accordingly, in setting up the management target, specifications of pollution control facilities are designed to comply with the average value taking into account variations of the process during production periods with maximum load.

Both operators feel that BAT and EQO are well balanced in setting the permit requirements. It is particularly noted that permit conditions relating to a provisional time period for new regulations or reinforcement of the regulations, which require time allowance for modification of the existing facilities or some technological development, are good examples of the excellence balance managed by the Japanese authority between BAT and EQO considerations.

5. CONCLUSION

In Japan, environmental requirements are a shared responsibility between the national and local jurisdictions. Pollution control requirements are based on environmental quality considerations. These are set at the national level for some priority pollutants, but they may be more stringent depending on the environmental conditions of the different regions. However, a concept similar to BAT is used in environmental impact assessment procedures performed by national and local authorities, and they can be quite influential on the outcomes.

In setting permit requirements, the authority considers the circumstances of the plant, including current and planned production and pollution control technologies, and the economics. The permit grants flexibility with respect to the time to install control measures. Implementation schedules are included within the permit.

Control of pollutant generation is a basic concept of environmental protection measures in the steel works. It can be broadly classified into the following three categories:

1. Continuation of production processes and recycling of resources and energies;
2. Use of resources and energies generating less pollutants;
3. Development and introduction of the facilities to minimise pollutant generation.

These principles have led to the introduction of processes such as the continuous casting facility, which eliminated the ingot making process which generated a great deal of dust particles; use of low-sulphur iron ore and coal, and conversion of fuels from heavy oil to natural gas; control measures to prevent the generation of NO_x such as two-stage combustion and self-exhaust gas circulation system. Measures have also been implemented to prevent the dispersion of dust particles, among them, the use of water sprinklers, design of the facility to protect against the wind, and covering of the belt conveyors. Finally, recirculation and recycling of waste water have led to 95 per cent of the total water being reused. These pollution prevention practices and techniques have been complemented by control technologies, such as filters and secondary treatment, to achieve maximum environmental performance.

The permit requirements allow the industry to choose the appropriate technology to meet the standards. This is done through the registration procedure where the applicant must show how he will meet the expected norms. The approaches to new and existing plants are similar. However, existing facilities are granted time to meet the limits.

A multi media permitting system is not being currently used. However, the cross-media effects of the requirements are identified and must be justified. This may lead to the imposition of the "best available technology" for all media if environmental conditions may be jeopardised by the pollution generated. Thus, there are some multi-media considerations in setting the requirements.

KOREA

1. THE PERMITTING PROCESS

1.1 Constitutional Responsibilities for Environmental Protection

The first comprehensive environmental law in Korea was the Environment Preservation Act which was enacted in 1977 to replace the Public Nuisance Prevention Act of 1963. The Environment Preservation Act introduced many new features of environmental regulation, such as the environmental quality standards (EQSs), environmental monitoring, emission/effluent standards and various administrative sanctions for violation. Environmental Impact Assessment (EIA) was also introduced to mitigate potential environmental damage due to large-scale development projects implementation.

The Korean government declared that "*people have the right to live in a clean environment*" in the Constitution of 1980. One way for securing environmental rights was the establishment of the Environment Administration (EA), a vice ministerial level agency, under the Ministry of Health and Social Affairs. The EA was responsible for establishing and implementing national environmental policies and programs. The Constitution of 1987 specified the environmental rights more clearly and provided that "*people shall have the right to live in healthy and decent environment, and state and people shall endeavour to preserve the environment*".

In 1990, the National Assembly passed completely new environmental statutes which replaced the Environment Preservation Act. These included the Environmental Policy Act, the Air Preservation Act, the Water Preservation Act, the Hazardous Chemical Substances Control Act, and the Noise and Vibration Control Act. The following year, the Solid Waste Management Act and the Marine Pollution Act were thoroughly amended and the Natural Environment Preservation Act was promulgated. For effective enforcement of these laws, the EA was upgraded in 1990 to become the Ministry of Environment (MOE), and the Minister assigned to Cabinet-level status.

The MOE has six regional environmental offices which are in charge of environmental monitoring, of issuing permits, and of on-site inspection of pollutant discharging facilities (mainly industries). Inspections of facilities are also conducted by local governments in accordance with guidelines issued by the MOE.

Criminal enforcement of environmental statutes is undertaken by the public prosecutor's office. Wilful violation of emission standards and unlawful dumping of waste materials is subject to prosecution. The Criminal Code of 1992 classifies any act of environmental pollution as a new crime.

1.2 Permits

The regional environmental offices under the Ministry of Environment are responsible for issuing permits for facilities located in industrial complexes. Local governments issue permits for all facilities except those located in industrial complexes. Applicants must seek a permit from the relevant authority in the case of new plant construction or an expansion of existing industrial facilities. Applicants should provide the following information to the relevant permitting authority:

- amount of raw material to be used for production;
- production flow diagram (PFD);
- predicted amount of emission/effluent, noise;
- type and size of control facilities.

If a permit is granted, it usually contains conditions, including the permissible amount of pollutants discharged. When anyone wants to change the permit conditions, he/she should report it to the corresponding permitting authority for relatively small changes or must follow the same procedures as mentioned above, and which are specified in the relevant laws.

If facilities are to be installed in a plant located in an area designated as a «special area» (severely polluted areas, water supply sources or protection zones), stronger emission/effluent standards are applied than those to be installed in other areas. In circumstances where a facility finds it difficult to meet the emission/effluent standards for economic and/or technical reasons, the MOE could revise the requirements. However, if the industrial activities are likely to violate the emission/effluent standards, the Ministry could ask for the adjustment and/or modification of the proposed industrial activities.

There is neither a specified duration of the permit or of the renewal process. In cases where industries fail to meet the emission standards, payment of emission/effluent charges as well as improvement of the facilities are required by the MOE. In principle, decisions by the permitting authorities cannot be appealed against. However, revised application materials may be resubmitted.

1.3 Permit Renewal Process

See previous section.

1.4 Multi-Media Permits

Segregated permitting systems are used for air (under the Air Quality Preservation Act), for water (under the Water Quality Preservation Act) and for noise and vibration (under the Noise and Vibration Control Act).

However, it should be noted that the permitting authorities use a multi-media approach in considering emission/effluent to air, water and noise. As a mean of reducing potential releases to different media, a multi-media approach helps to identify the consequences of the proposed application. Industries are free to select any emission/effluent control facilities to meet emission/effluent standards for air, water, and noise. For example, if an industry chooses facilities such as a wet scrubber or a venturi scrubber, the plant should obtain additional permission for the wastewater likely to be generated from the use of these facilities.

1.5 Environmental Assessment

The Environmental Impact Assessment (EIA) System was first formulated in the Environmental Preservation Law of 1977, and started to be implemented in 1981. When new construction or expansion of plants are subject to EIA, which is prescribed in the Environmental Impact Assessment Law, they are required to complete the EIA procedure before applying for a permit.

The objective of the EIA system is to seek harmony between economic development and environmental preservation so that those responsible for the project can determine and assess the environmental impact and formulate effective measures to cope with it during the course of the project planning. The assessment results and the MOE review should be reflected in the project plan. Before the project is approved by the administrative agency in charge, it should be checked that the results of the consultation have been properly reflected in the project. In other words, implementation of the project should begin only after all of these procedures have been completed.

One of the most important procedures of EIA is the incorporation of the views and opinions of local residents. This procedure was introduced together with the implementation of the Basic Environmental Policy Act of 1990. Under the system, the draft assessment had to be disclosed to the public, and a presentation session or public hearing had to be held, if necessary. The Environmental Impact Assessment Act, which was enacted in 1993, stipulates that the draft assessment should be held at the same time. In particular, in the case that there is a request from more than half of the residents who have submitted opinions, or from 30 or more residents, the public hearing must be held with the attendance of experts.

Reviewing the EIA, the MOE recommends the project planner to keep stricter emission/effluent standards than those prescribed in the relevant laws. The recommendation of the environmental authority usually makes project planners propose strengthened limits in drafting an EIA, which would help them not only to facilitate the consultation with the environmental authority, but also give a good impression to local residents. In this sense, project planners are very likely to adopt the most efficient and updated technologies to meet the suggested emission/effluent standards.

2. BAT, EQO AND ECONOMICS

2.1 Standards Setting and Targets

The emission/effluent standards for the iron and steel industry processes are set in accordance with the Air Quality Preservation Act, the Water Quality Preservation Act and the Noise and Vibration Control Act. The standard setting process follows a three steps procedure:

1. The Ministry of Environment prepares drafts for each pollutant considering environmental quality standards, pollution level, regional characteristics, and BAT;

2. Comments from related industries/companies, NGOs, and all the related government departments such as Ministry of Trade and Industries, and Ministry of Economic and Finance;

3. Negotiation between the above related government departments (in the negotiation, the Ministry of Trade and Industries acts as a representative of the industries).

The professional judgement of individuals engaged in the permitting process is paramount to the final setting of emission/discharge limits of the plant considered. The final decision is based on an evaluation of discharge and emission impacts (measured against BAT for the industrial processes of concern) on the environmental quality of the area. Thus, factors such as local environmental conditions, and the type, size and age of the plant may influence the setting of emission/discharge limits.

2.2 Cleaner Technologies

When industries develop new technologies, install new control facilities, or adopt clean technologies, the MOE may provide long-term and low interest loans. The MOE has also introduced an «Environment Friendly Business Management System» with the aim to increase environmental consciousness in industry. Enterprises discharging less that the level prescribed in emission standards with the introduction of newer, cleaner technologies are appointed as an «Environment Friendly Business» by the MOE, and may benefit from site inspection exemption and positive advertisements.

2.3 Environmental Quality Objectives

As a target of environmental conservation, the MOE has established environmental quality standards (EQSs) for ambient air, water, and noise. There are six quality standards for ambient air, and the standards for water quality have been established for eight specific water quality indicators and nine chemical pollutants. In addition, there are standards for offensive odours and noise.

Emission and effluent standards in Korea are one of the tools by which the environmental standards are met. The standards are applied to every facility that generates certain amount of air and water pollutants and noise and they have been gradually strengthened. Emission standards for air have been established for 25 substances. For water, the standards for 28 criteria have been set forth (figures are given for both environmental releases in the iron and steel case study report in Table 1).

Table 1. **EQSs for pollutant releases in KOREA**

Air emissions				**Water discharges**	
Particulate matter (mg/m^3)		**Gaseous pollutants** (ppm)		**All units are expressed in mg/l**	
Dust	70	NH_3	200	BOD (80)	Pb (1)
Cadmium compounds	1.0	CO	400	COD (90)	Chromaticity (400)
Lead compounds	20	HCl	6	SS (80)	Temperature (40°C)
Chromium compounds	1.0	Cl_2	10	pH (5.8-8.6)	Total nitrogen (60)
Copper compounds	10	SO_2	700	Oil (5)	Total phosphorus (8)
Nickel and compounds	20	NO_2	350	Phenol (5)	Trichloroethylene (0.3)
Zinc compounds	10	CS_2	30	CN (1)	Tetrachloroethylene
Fugitive dust	1.0	Formaldehyde	20	Cr (2)	(0.1)
Smoke	-	H_2S	15	Fe (10)	Number of E-coli
		Fluoride	3	Zn (5)	(3 000)
		HCN	10	Cu (3)	ABS (5)
		Bromine compounds	5	Cd (0.1)	Cr^{+6} (0.5)
		Benzene compounds	50	Hg (0.005)	Mn (10)
		Phenol compounds	10	Organic phosphorus (1)	F (15)
		Arsenic compounds	3	As (0.5)	PCB (0.003)
		Mercury compounds	5 mg/m^3		

Different standards are applied according to the type and size of facilities. Table 2 shows the standards which the Pohang Iron and Steel Co. (POSCO) are required to meet.

Table 2. **Selected emission standards for air pollutants at POSCO (Korea)**
(in ppm)

Pollutants	Standards for 1994	Standards for 1995-98	Standards after 1999
SO_x	1 200	700	500
Dust	200	70	50
NO_x	350	350	350

Facilities discharging 3 000 m^3/day or more face stricter standards. They are also supplemented by a regional classification system where lands surrounding water sources are designated as Clean A, or B considering the local sources of pollution, topographical factors, uses of river water, etc. Different standards are applied to each zone. Selected limits are shown in Table 3 (the POSCO plant is categorised in zone B).

Table 3. **Selected effluent standards for water in KOREA**

ZONE	BOD (mg/l)	COD (mg/l)	SS (mg/l)
CLEAN	50 - up to 1996 30 - after 1996	50 - up to 1995 40 - after 1996	50 - up to 1995 30 - after 1996
A	80 - up to 1996 60 - after 1996	80 - up to 1995 70 - after 1996	80 - up to 1995 60 - after 1996
B	100 - up to 1996 80 - after 1996	100 - up to 1995 90 - after 1996	100 - up to 1995 80 - after 1996

Under the current emission/effluent standards system, enterprises are required only to keep the qualitative standards. The problem of this kind of approach is that it is not suitable for areas with many industrial facilities. The MOE is trying to establish quantitative standards for industrial facilities which discharge certain amount of pollutants which, in turn, would encourage enterprises to reduce pollutants or wastewater discharged.

The environmental standards of Korea do not have any binding effects. They are mere criteria which the government should observe. Emission/effluent standards are legally binding action-forcing criteria which the industrial facilities must measure against. Environmental quality and emission standards are set by the MOE after a consultation with the civilians, scholars, and engineers of the Environmental Adviser Committees of the Ministry. Consultations between the ministries and the regulated business are also made during the announcement period of the relevant laws concerned.

2.4 Best Available Technology

There is no written definition of BAT. However, there is a generally accepted definition of BAT which can be identified in environmental laws:

- The Environmental Technology Development and Promotion Act states that the Minister of Environment retains the right to ask for the use of BAT for severely polluted areas and water supply sources and protection zones;

- The Air Quality Preservation Act is to be reformulated in a way that any industries producing over certain amounts of pollutants should pay emission charges. However, the industries that apply BAT will be exempted from the payment of emission charges.

A concept similar to BAT is used when reviewing application/permits for installing or expanding emission/effluent facilities, and in carrying out an environmental impact assessment (EIA). In issuing a permit for a new facility or in reviewing permit conditions, the concept of BAT may vary depending on the plant size, age, and location.

2.5 Negotiations of Standards and Emission Limits

There is no negotiation of standards in the permitting process. Economic considerations and the technological status of the industrial sectors likely to be affected by environmental standards are decided at the national level (see Section 2.1).

2.6 Economic Considerations

Economic considerations take place during the standard setting procedure. In principle, none of the economic factors is considered when issuing permits. The emission/effluent standards are established based on technologies which are commonly used by industries, thus having incorporated the economic dimension up-stream.

2.7 Interaction of BAT and EQOs

Both BAT and EQO concepts are applied in the permit process. EQO and BAT are interrelated in procedures such as environmental impact assessments and/or standard-setting negotiations, but EQO will generally be the overriding requirement. Ultimately, however, technology-based emission/effluent standards may take priority over EQO.

3. TRENDS IN PERMIT LIMITS

3.1 Cleaner Technology

In Korea, big enterprises like the one selected for this case study are very much concerned about their image. As public awareness is growing, business (especially big companies) place much emphasis on environmental conservation. Any violation of environmental regulations faces blame from citizens as well as local residents concerns. In order to keep good relations with the neighbourhood, the selected facility has paid much attention to the environment. For this reason, the industry has gradually increased investment in pollution control. Examples of environmental activities of the facility are as follows:

- the installation of desulphurization facilities for hydrogen sulphide and its recycling from coke furnace emissions;
- the replacement of high sulphur iron ore (mainly imported from Peru) by low-sulphur minerals to reduce SO_x emissions;
- the recycling and reuse of up to 98 per cent of wastewater.

Furthermore, the selected facility has recently established an environmental policy for securing systematic environmental management in all of their plants. The main targets of the environmental program of the facility are:

- to comply with all legislative and regulatory requirements;
- to discharge pollutants much lower than the permissible limits;
- to use raw materials and energy efficiently and try to save them as much as possible;
- to reduce and recycle solid wastes;
- to adopt BAT as much as possible; and
- to establish and maintain environmental targets and detailed implementation plans to accomplish the environmental policy.

This kind of approach is quite similar to the Environmental Management System (ISO 14001) which is being developed by the International Standards Organisation (ISO) as part of the ISO 14000 series.

The pollution prevention objectives of the company call for the development of new technologies and processes for environmental protection which, in turn, will necessitate continuous investment in cleaner technologies and pollution control facilities. The development of a catalytic process for eliminating NO_x emissions, research on a biological treatment for condensed water of the Coke Oven

Gas (COG), and on increasing the reuse of sludge are among the main projects of the selected facility for improving the environmental performance of their plants.

Another route for reducing the environmental impact of iron and steel production consists of improving the energy efficiency of the different processes. The reduction of global warming gases and conservation of energy are being targeted through the development and installation of innovative steel making processes, such as the direct reduction of iron and the thin slab casting process, by increasing the use of clean energy like LNG, and by research and development projects on recovering and fixing CO_2.

Table 4 outlines the main environmental targets which the selected facility intends to achieve for further pollution abatement. Table 5 provides data on the main anti-pollution facilities employed at the works.

Table 4. **Objectives and measures for pollution abatement**

Item	**SO_x**	**Dust**	**COD, SS**
Objective	1 625 (1994) 1 100 Nm^3/h (1996)	Free of visible pollutants	No discharge of waste water
Scheme	Use lower sulphur fuel and raw material* Install desulfurization facilities	Reform process of plants Remodel and optimise anti-pollution facilities	Install reverse osmosis to reuse the whole quantity of treated water

* Stop using high sulphur iron ore: 1997; Start using low sulphur bunker-c (1.6% to 1%): 1996.

Table 5. **Main anti-pollution facilities**

Item	**Capacity**	**Quantity**	**Established period**	**Cost (Mil. US$)**
COG Desulfurizer	133 m^3/Min	3		45.0
E.P.*, Bag Filter	1 000-19 000 m^3/Min	58	87/4 - 92/9	203.9
Waste Water**			1st: 87/3 - 88/5	11.9
Treatment Facility	41 000 m^3/day	2	2nd: 90/7 - 92/10	24.5
Incinerators	# 1: 41 T/day	1	86/3 - 87/2	2.0
	# 2: 59 T/day	1	90/6 - 91/4	4.3
Landfill site	40 000 m^3	1	93/12	1.4

* E.P.: Electrostatic precipitator.
** Activated Carbon Adsorption System is adopted in the Wastewater treatment.

3.2 Monitoring

In accordance with the environmental laws, regional environmental offices under the MOE or local governments should make sure that industries do comply with the emission/effluent standards as well as environmental laws by taking regular/frequent inspection. For severely polluted areas, strict and frequent supervision is enforced. Monitoring results are frequently announced to the public via mass media.

In the environmental laws, industries are required to self-monitor the level of pollutants emitted by their activities (Self Monitoring System). The pollutants to be surveyed and the frequency of monitoring are determined in terms of the size of the facilities and the nature (types of pollutants) of emission/effluents. It is compulsory that industries which emit large quantities of pollutants into the air or discharge specified toxic substances should install automatic stack monitoring equipment such that they can constantly check if discharging facilities are in normal operation. In POSCO, the most typical investment in environmental facilities has been the installation of a telemetering system, built 8 years ago in Kwangyang Works. The aims of this system are as follows:

- To observe the emission of pollutants and the operation of anti-pollution facilities;
- To observe the pollution state of the vicinity and to prepare for an emergency;
- To send the measured data to the MOE and to each plant.

The main parameters being monitored by the telemetering system are weather observation (direction & speed of wind), water observation (10 points of measurement), air observation (6 points of measurement), stack observation (46 points of measurement), and visual observation (4 monitors for dust). The substances/properties monitored for air and water are:

Air

- SO_2, NH_3, CS_2, H_2S, dust, smoke, CO, NO_x, and hazardous air pollutants (for the selected facility: HCl, Cl_2, HF, Zn, Ni, and Pb).

Besides the pollutants required by the Law, the POSCO is monitoring several pollutants such as dust fall and fugitive dust, and BOD, Chromaticity, Total Nitrogen, Total Phosphorus for their own purpose. In addition to these items, the POSCO is conducting ambient air quality monitoring activities in the vicinity of the POSCO.

Water

- pH, COD, SS, Oil (as normal hexane), Cd, Pb, Cr^{+6}, As, Hg, Mn, Zn, Cu, Phenol, F, CN, Fe, Organic phosphorus, PCB, TCE, PCE, Number of E-coli, Temperature.

In the case of the selected permit, monitoring (measurement period) varies according to the size of the discharging facilities and the types of pollutants: once a week to every six months for air emissions; at least once a week for water discharges. The measurements are based on grab samples. For the selected facility, the monitoring period is for every month.

Monitoring results do not normally influence the establishment of standards and the negotiation of permits. However, for any industries violating emission/effluent standards, penalties in the form of emission/effluent charges are imposed and coercive actions are also pursued according to the environmental laws.

3.3 Trends in Limits

The selected facility, engaged in both iron and steel works is located in a sensitive area, and must as a result comply with stricter limits. The steelworks were built prior to the establishment of the MOE in 1980. Since then, the environmental laws have been reformulated several times. Thereafter, the facility was required to amend contents of permits (e.g. control facilities, fuel use, etc.) to comply with the newly formulated environmental laws and amended emission/effluent standards. In the sample permit, the controlled substances/properties are:

– Air: SO_x, TSP (total suspended particulates), hydrogen sulphide, NH_3, toxic pollutants;

– Water: pH, COD, SS (suspended solids).

The air pollutants are the major substances and must be controlled with great care. Depending on the specific characteristics of the facilities, the emissions are itemised and checked. For water discharges, effluents are representative of water pollutants and are appropriate for monitoring control facilities. Limits in the permit have been set according to the concentration of emission limits. However, when performing an environmental impact assessment, limits are determined based on the permitting authority’s professional judgement, considering the plant size, location, meteorological factors, emission/effluent prediction, etc. Tables 6 and 7 provide emission/discharge standards for the relevant area as well as the concentration of pollutants in the local environment.

Table 6. **Discharge levels of pollution**
(average of 1994)

Item	Parameters	Unit	Legal permission	Discharge
Air	SO_X	PPM	800 - 1 200	106
	Dust	mg/m^3	70 - 200	36
Water	COD	mg/l	80	4.7
	SS	mg/l	80	1.6

Table 7. **Pollution state of the local area**
(average of 1994)

Item	Unit	Emission Standard	Measured Values	Reference
TSP	μg/m^3	150	Kwangyang City: 44	-
SO_x	ppb	50	Kwangyang City: 11	
COD	mg/l	2.0	Kwangyang Gulf: 1.9	1984: 3.2 1993: 2.0

4. TECHNOLOGICAL RESPONSES TO PERMIT REQUIREMENTS

4.1 Equipment Installed/Measures Taken

In 1973, only the standards based on emission/effluent concentration (emission/effluent standards) were applied. Since then, the emission/effluent standards have been becoming gradually more stringent. In order to meet these revised standards, the selected facility adopted advanced processes by installing technologically advanced control facilities. Current emission/effluent control facilities being used are as follow:

Air pollutants	Equipment/measures taken
Total Suspended Particles	Electrostatic precipitator Bag filter
Sulphur oxides	COG desulfurization plant Use of low sulphur ore for sinter plant
Toxic gases	Scrubber

In the case of the control of wastewater, physical, chemical, and biological treatment processes may be used depending on the specific circumstances. Both final treatment and wastewater reusing facilities are installed at the end of the drain-pipe.

Most of the control facilities were already installed and processes were carried out within the plant where pollutants were produced. Emission/effluent control facilities are, according to a plant size and facilities, customarily selected (for instance, an electric furnace is for an electrostatic precipitator, scrap iron melting furnace is for high-performing bag-filter).

As far as environmental monitoring is concerned, the automatic pollution monitoring equipment and stack samples installed in the entire plant are included. Following changes in the government permit policy, the facilities that have been influenced by the Environmental Impact Assessment Policy or by the review of the permit application must address new conditions as well as stricter emission/effluent standards. The following conditions are now required to obtain a permit:

- installation of measuring holes for air emission facilities;
- installation of a flow meter for effluent facilities.

As a condition of the installation of landfill facilities, the facility is also required to measure and report periodic concentration of environmental pollution for the neighbouring sea side.

4.2 Flexibility Considerations

Basically, any control processes meeting emission/effluent standards can be applied. However, the measures and techniques proposed by the applicant to comply with the permit conditions must be accepted by the permitting authority.

4.3 Views of Industry Surveyed

In the process of reviewing the permit for construction or modification of pollution discharging facilities, BAT concept is not applied. The permits are issued on the basis of emission standards which are prescribed in the relevant laws. Although a concept similar to BAT is applied in limited areas, strictly speaking, it does not reflect the BAT. Some examples are as follows:

- the industries which applied technologies designated by the MOE are exempted from the payment of emission charges (Emission charges were imposed when industries emit effluent pollutants exceeding the permissible emission/effluent limits. The Air/Water Quality Preservation Act is being reformulated in a way that any industries generating over certain amount of pollutants should pay emission charges);

- the power generating facilities which used clean fuels like LNG (Liquefied Natural Gas) are exempted from the installation of pollution control facilities; and

- for fugitive dust generating facilities, some conditions or technologies for control equipment are regulated.

In order to apply the concept of BAT in the permitting process, the BAT inventory should be conducted and updated. Otherwise, the development or introduction of new technologies might be impeded. When facilities adopt newly developed technologies, which are not known to the environmental authority, in some cases, the permit applications are rejected, because the permitting authority is not sure that the technology works properly in local conditions.

Concerning the EQO, it is considered in the Environmental Impact Assessment (EIA). EQO is not considered in issuing permits for industrial activities which are not subjected to EIA. The Environment Minister designates the areas where air quality exceeds the environmental quality standards as Special Control Zones, and can set forth stricter emission standards or introduce total emission control system. These, however, are not directly related to the permitting procedure.

5. CONCLUSION

There are no specific standards for the iron and steel sector in Korea. The emission/effluent limits for the iron and steel industry are set in accordance with the relevant national laws. Authorisations are issued through a segregated permit system for air, water, noise and vibration. However, the permitting authority uses a multi-media approach in considering emission/effluent and conditions to be set.

Korea does not legally apply the BAT nor the EQO concepts in defining permit requirements. As mentioned above, they are set accordingly with the standards adopted in the national laws. But, a concept similar to BAT may be used by the permitting authorities when defining conditions for facilities located in «special areas» (severely polluted, water supply areas, or natural protection zones) or in assessing the potential releases of pollutants from a particular facility. Moreover, industries may adopt BAT in order to avoid payments of emission/effluent charges in cases where the releases are expected to exceed the national emission/effluent standards.

According to Korea legislation, EQOs do not directly influence the permit requirements. However, in cases where a facility is subjected to an Environmental Impact Assessment, EQOs are considered and may influence the ultimate decisions of the authorities. Moreover, EQOs are considered when standards are defined at the national level, particularly in the case of the so-called «special zones» where stringent requirements may be adopted.

Permit requirements allow for some flexibility in the selection and implementation of technologies adopted by the concerned facility to comply with the standards. This flexibility may lead to a discrimination of control technologies in favour of preventative approaches, as in the case of the use of clean fuels, such as LNG, an option which exonerates the industry from installing pollution control facilities.

The selected facility for this case study gives a good illustration of the general environmental policies implemented in the iron and steel sector. It mainly consists of a combination of control technologies and preventative methods aimed at complying with the emission/effluent standards set. Substitution of substances for less toxic materials (such as the use of cleaner fuels and low-sulphur iron ore), filtration and reutilization of some compounds released (desulphurization facilities for hydrogen sulphide recycling, close-loop system for wastewater), and subsequent control techniques for capturing residual emissions are comparable with leading edge environmental strategies adopted elsewhere. In addition, the facility runs a wide monitoring program in order to assess the types and sources of emissions/effluents, and also support on-going research and development projects for new innovative environmental technologies. As such, the reduction of greenhouse gases and the improvement of energy efficiency rank high in the industry's environmental targets.

In conclusion, the steelworks in Korea must comply with standards negotiated at the national level. The negotiating process is based on professional judgement and the consideration of several factors such as the state of environment, the technological state-of-the-art and economics of the sector, and other social factors. Thus, conditions such as the state of the local environments and economics of the sector concerned play a key role in the degree of stringency of the standards adopted by the permitting authorities.

SWEDEN

1. THE PERMITTING PROCESS

1.1 Constitutional Responsibilities for Environmental Protection

There are more than one hundred laws and other statutes in the environmental sector that are directly binding. There are also a large number of general recommendations issued by the various authorities. These define how legislation should be applied. Finally, in the international area, there are a number of agreements that are binding for Swedish environmental works. Some of the following laws are of fundamental importance for the work of environmental protection:

- the Environment Protection Act, aimed at preventing disturbances in the natural environment and at restoring environments already damaged; the Act governs the issuance of permits for a large number of activities (fixed disturbance sources);

- the Act on Chemical Products, which requires that precautionary measures shall be taken to prevent or counteract adverse effects of chemical products on people or the environment. One starting point in the Act is the "substitution principle" which aims to replace products with less hazardous ones;

- the Natural Resources Act, aimed at preserving a good natural and cultural environment; it contains provisions stating that certain facilities may not be erected without authorisations.

The 1969 Environment Protection Act provides the basis for the regulations adopted to prevent disturbances to the environment. This covers operations on property and in permanent plants that are a source of disturbance to the neighbourhood. These include disturbances due to air and water pollution and noise. Activities causing disturbances require permission. The Act introduces the obligation to obtain a permit for a large number of activities.

At the government level, responsibility is largely vested in the Ministry of the Environment. The Swedish Environmental Protection Agency (SNV) is the central authority for environmental control. It is responsible for the delivery of decisions by the Parliament (Riksdag) and the Government in the field, including permitting, and keeps informed of new developments in processing so as to be able to propose necessary control measures. The 1989 Environment Protection Ordinance lists all the environmentally hazardous activities which require a permit. The Ordinance also specifies whether the permit has to be obtained from the National Licensing Board for Environmental Protection (the Franchise Board) or from the relevant county administrative board. For an activity that typically entails a major environmental impact, as in the case of iron and steel works, a permit has to be secured from the Franchise Board. Activities with less impact on the environment have to be licensed by a county administrative board. Sweden is divided into 24 counties, each with its own administrative board. The SNV, in addition to providing advice to the Franchise Board on permits, is also the central supervisory agency of government, and supervises the activities of county and local administrative authorities, providing assistance as necessary. Continuous supervision is mainly carried out by the county authorities for most polluting activities, including iron and steel works, and by the local administrations for other activities which are not covered by the latter category.

The Franchise Board is a central autonomous authority and has a status similar to that of a court, with the principal task of implementing permissibility assessments. It has its official premises in Stockholm but the whole country as its sphere of activity. For decision-making, the Board comprises four permanent members: a chairman, who is a lawyer and judge; a technical member; a member with experience of the SNV's sphere of work; and a member with industrial experience. If the matter relates mainly to local-authority concerns, the industrial member is replaced by a member with experience of municipal work.

1.2 Permits

In order to ensure that the permissibility rules of the Environment Protection Act are complied with, a large number of environmentally hazardous activities are subject to permit obligation. The Environment Protection Ordinance contains a list of activities or measures requiring permits before they may be carried out. For an activity that typically entails a major environmental impact, a permit is required from the National Licensing Board for Environment Protection.

The permits issued by the Franchise Board consider the views of various stakeholders including the SNV, industry, environmental groups and the local community. After the assessment and the review process, the permit is delivered, specifying the discharges and the quantities of pollutants allowed. The permit indirectly prescribes certain technologies by referring to the applicant's description of what measures the company plans to take.

Permits are issued for a specified period of time not exceeding ten years (Environment Protection Act, Section 18). The permitting process is triggered by new plant construction, plant expansion or modification which may affect the environment. Applicants must provide the following information to the permitting authority:

- Description of the surrounding;
- Environmental impact;
- Maximum annual production;
- Technical description of the plant;
- Equipment to reduce emissions;
- Proposed maximum emissions to air and water;
- Waste handling;

- Noise disturbance;
- Transportation.

1.3 Multi-Media Permits

Sweden uses a multi-media permitting system which considers effluents to air, water, land and noise. The applicant engaged in an environmentally hazardous activity is, under the permissibility rule, obliged to undertake the protective and other precautionary measures required to prevent or remedy detriments. The requirements contained in the Environmental Protection Act are worded in general terms. With an evaluation of BAT as a starting point in the permitting process, the measures that an applicant may be obliged to take may relate to both the installation and implementation of purification devices, but also to changes in the manufacturing process itself.

One example of a regulatory basis to multi-media permitting is the substitution principle, a central concept of the Act on Chemical Products. It calls for the substitution of dangerous chemicals by other compounds that are less hazardous to the environment or health. Thus, consideration is given to achieving the least possible impact as a whole. Preference is given to alternatives of in-plant measures, as opposed to end-of-pipe treatment, taking into account the generation of waste and/or consumption of energy.

1.4 Environmental Assessment

The assessment procedure follows the submission by a person engaged in an environmentally hazardous activity of an application to the permitting authority. This application contains a description of the activity and its resulting environmental impacts as well as the protective measures that the applicant is prepared to take. The results of the monitoring conducted by the plant owner (as it has been determined in the current permit by the County Administrative Board) are available to the public. They are also considered in the permit renewal process.

The assessment authority requests the view of other authorities and instances that may be concerned by the submission. The application is also being published in the newspapers of the locality where the activity is being conducted, so as to inform and invite the public to express their view. The meetings of the Franchise Board are generally held in the vicinity of the applicant’s installations. These meetings are public, and all those who have views on the activity may express their opinions on the application as well as to the measures that should be taken to reduce the environmental impacts concerned.

The assessment authority’s decision is in writing. It contains an account of the activity and its environmental effects, and also the authority’s attitude towards the application. If a permit is granted, the decision contains an account of the conditions applying to the permit. These conditions specify exactly which discharges and what quantities of pollutants may be allowed. Other restrictions on activities are specified in the conditions.

2. BAT, EQO AND ECONOMICS

2.1 Standards Setting and Targets

The Swedish administrative regulation is characterised by individual assessment of installations. Requirements are not adopted until after an installation has been inspected. Accordingly, they are not identical for an entire sector; rather, circumstances in the individual case have a significant bearing on which requirements are imposed on an installation by the authorities. General requirements relating to a whole sector have been adopted only to a limited extent (related mainly to prohibitions on the use of certain substances, i.e. cadmium, PCBs). For sources of discharges that are identical and numerous, a trend towards general requirements may be foreseen. Individual circumstances will thereby come to play little or no part at all.

Sweden has no standards for the iron and steel industry. However, the government has provided guidance on the expected environmental releases from this industry. Environmental quality objectives (EQOs) have been established for example for nutrients, oxygen concentration, oxygen consuming material, pH, metals in lakes and rivers. There is also a guideline for noise. EQOs have also been set for air quality, for instance, sulphur dioxide (SO_2) and nitrogen oxides (NO_x) in urban areas. Most of the EQOs are applied uniformly in the country. Exceptions are the targets for critical loads for SO_2 and NO_x which differ between southern and northern Sweden. The SNV has established figures for critical loads of NO_x and sulphur in various areas. Dioxin emissions are also being examined by the SNV for negotiating protective measures for their abatement.

Sweden uses a multi-media permitting system. Consideration is given to achieving the least possible impact as a whole. As a consequence, priority goes to in plant measures compared to end-of-pipe treatment which produces sludge and consumes energy. Under the permissibility rules, an entrepreneur's obligation to take protective and other measures is limited to "reasonable" measures. To assess what measures are reasonable, the following concepts are highly important: the "best available technology", what is economically feasible, and what is environmentally justified.

Thus, permit requirements are set on a case-by-case basis. Emission limit values are adopted individually for each plant and are subject to negotiations in the permitting process. The SNV uses its evaluation of BAT as a starting point in the assessment of the permissibility of the activity and the conditions of the permit. The costs associated with control measures and impacts in the environment are also considered. The results of these negotiations may very well be less stringent limits compared to BAT, depending on the assimilative capacity of the receiving environment, the economics associated with the technology and the financial condition of the facility.

A central factor in this context is that the Government has set an environmental target involving a reduction of pollutant emissions by the year 2000 to levels at which the environment is not harmed (see Bill 1990/91: 90, JoU, rskr 338). A further consideration is the international agreements concluded or planned in the environmental field. It is worth noting that Sweden is a party to the Long Range Transboundary Air Pollution Convention (LRTAP) and, as such, has committed itself to a protocol on the reduction of sulphur and NO_x. Sweden is also a party to the Baltic Sea Declaration of 1987 which included an obligation to reduce inputs of nutrients by 50 per cent by the year 1995. The iron and steel works are also being reviewed for a BAT note under the auspices of the Oslo and Paris Commissions (OSPARCOM).

Moreover, statements made in bills and practices over the 20 years or so that the rules in force have helped to determine a number of rules in setting permit requirements:

- basis for abatement measures should be BAT;

- the "30-40 kronor principle" (measures should be taken to a cost of SEK 30 per kg of sulphur and SEK 40 per kg of nitrogen oxides - the principle also applies to the tax on sulphur and the charge on nitrogen dioxide); however, measures costing more than this may be justified in some cases (if it leads to reduction of other environmental disturbances);

- the government statement for the reduction of pollutant emissions to levels at which the environment is not harmed by the year 2000 (see Bill 1990/91: 90, JoU, rskr 338).

As may already be seen from the statements referred to above, they are in some respects contradictory and incompatible. For example, the 30-40 kronor principle represents a departure from the BAT principle. Nor is the 30-40 kronor principle binding on the Licensing Board when it considers permit applications and review permit conditions pursuant to the Environment Protection Act. However, the Licensing Board considers that the principle may serve as a basis for the Board's judgement of the reasonableness of the proposed conditions and measures.

But there is scope for departures from this principle where this is called for in view of the circumstances. These include particular sensitivity of the surroundings to acidification or nitrogen leakage. However, this fact may be attributed less importance if only a slight improvement in the surroundings is expected to result from a challenged measure. Another factor may be that there is competition with regard to steps which may be taken to combat various types of emission. This is a question which is not taken into account by the 30-40 kronor principle. Abatement measures taken at industrial processing plants to reduce a given type of emission may need to be given priority at the expense of reductions of other emissions or discharges. As a case in point, certain particulates, for example metals or dioxin emissions, may need to be given priority irrespective of the 30-40 kronor principle.

2.2 Environmental Quality Objectives

As stated in Section 2.1, EQOs have been established for nutrients, oxygen concentration, oxygen uptake, pH and metals in fresh water. Standards have also been set for air quality in urban areas. These are applied uniformly throughout the country, except for targets for SO_2 and NO_x which differ between northern and southern Sweden. These standards have been established by the SNV in conjunction with universities and laboratories. There are no separate EQOs for sensitive environments. With respect to permitting decisions, more stringent limits will be set for the relevant pollutants if emissions/discharges would exceed the EQOs.

2.3 Best Available Technology

When considering measures to be taken to limit emissions, the Licensing Board, as in the case with other applications and reviews, is under a duty to implement the provisions of the Environment Protection Act (Section 5). Under this provision, the Licensing Board requires that extensive abatement action and precautionary measures shall be taken, taking into account what is reasonable from a technical and financial point of view; in doing so, the Board should bear in mind public and private interests concerned. Certain statements have been made in bills and other work preparatory to legislation in order to serve as a guide for the purposes of implementing the provisions of Section 5. Practical experience has also been developed over the past 20 years since the inception of rules (see Section 2.1).

One such auxiliary rule is that the basis for abatement measures should be «best available technology» (BAT). This is defined by Sweden as the best technology used on a commercial scale at a similar plant anywhere in the world. The central BAT requisite is that the operators of environmentally hazardous activities must take measures that are technically and economically feasible as well as environmentally justified. The measures that manufacturers may be obliged to take may relate to both the installation and implementation of purification devices, but also to change in the manufacturing process itself. As indicated previously, a central concept contained in the Act on Chemical Products, the substitution principle, provides guidance for seeking the replacement of pollutants by less hazardous ones. The substitution principle can be understood as a subset of the BAT principle.

No general or sectoral law on BAT has been adopted, particularly for large, stationary sources. As indicated in Section 2.1, costs of remedial measures and effects on the environment are also taken into account by the Franchise Board in reaching decisions on permits. Consequently, permit requirements may well be less stringent limits than BAT.

Decisions on permits are reached through a negotiating process where, as stated previously, the Franchise Board used their interpretation of BAT as a starting point in evaluating the relevancy of the applicant's proposal for protective measures. The BATs are generally developed for the different technologies employed in the iron and steel works, by experts working for the SNV. Table 1 provides BAT standards and related conditions for the primary and secondary iron and steel industry in Sweden. Conditions in the permit are most often prescribed in terms of mass emissions per unit of production or as mass emission per day related to an admitted production level. Treatment technologies can also be described. The permit indirectly prescribes certain technologies by referring to the applicant's description of what measures the company plans to take.

2.4 Negotiations of Standards and Emission Limits

As the limits indicated in permits are set on a case-by-case basis, these are subject to negotiation during the permitting process. The professional judgement of the permitting authority’s experts is based on principles such as the 30-40 kronor principle, which may represent a departure from the BAT concept. A balance is being sought between economic, environmental and technological considerations for the purpose of the effectiveness of the measures proposed as opposed to strict financial considerations (see Section 2.1 and 2.4).

Table 1. **BAT for particulate emissions by iron and steel processes in SWEDEN**

Sinter plants	40 - 120 g/tonne
Pellet plants	40 g/tonne
Blast furnace	35 - 50 g/tonne
Basic oxygen furnace	35 - 50 g/tonne

Sinter plants

Best available technology	**Concentration: mg/m^3**	**Specified emissions: g/tonne**
A. For flue gases:		
- Fabric filters	10	20
- Electrostatic precipitators	50	100
B. At product handling:		
- Fabric filters	10	20

Pellet plants

Best available technology	**Concentration: mg/m^3**	**Specified emissions: g/tonne**
A. At grinding/drying:		
- Fabric filters	10	20
B. At pelletising:		
- Fabric filters	10	20

Blast furnaces

Best available technology	**Concentration: mg/m^3**	**Specified emissions: g/tonne**
A. Sluice: Pressure equalisation	-	25
B. Tapping: Fabric filter	10	12

Steel works

Best available technology	**Concentration: mg/m^3**	**Specified emissions: g/tonne**
A. Charging/tapping:		
- Encapsulation or hoods and fabric filters	10	15
B. Converter gas:		
- Fabric filters	10	5
- Electrostatic precipitation	50	20
- Scrubbers	50	20
C. Alloying and temperature adjustment:		
- Fabric filters	10	

Secondary steel works

Best available technology	Concentration: mg/m³	Specified emissions: g/tonne
A. Electric arc furnace: a. 4th hole evacuation, local hoods or doghouse or total building evacuation and fabric filter b. 4th hole evacuation, roof hoods and fabric filter	5 - 10 5 - 10	
B. Allowing station and converter: - hoods and fabric filter	10	
A.(a. + B)		50 - 100
A.(b. + B)		200 - 300
C. Casting and hot rolling: (hoods and fabric filter)	10	

Secondary iron and steel facilities (PARCOM 90/1)

- Fume collection by dog-houses, local movable hoods or total building evacuation at electric arc furnaces and converters;
- Fabric filters or equally efficient arrestment system for dust cleaning of process gases and secondary gases from electric arc furnaces and converters;
- Fabric filters for dust cleaning or equally efficient arrestment system at cutting, grinding and scarfing operations.

2.5 Economic Considerations

The Environment Protection Act contains language relating to the assessment of economically justified measures:

> *«In assigning priorities between various interests, particular attention shall be paid, to the nature of the area that may be subjected to disturbance and the severity of the effects of the disturbance and, on the other hand, to the usefulness of the activity, the cost of protective action and other financial implications of the precautionary measures concerned.»* (Section 5)

As indicated in Section 2.4 on BAT, the Licensing Board is under the provisions of the Environment Protection Act to determine extensive abatement action and precautionary measures in the light of what is reasonable from a technical and financial point of view. Another policy instrument which incorporates economic consideration is the SEK 30-40 principle where the Government's permit in accordance with the National Resources Act prescribed that measures to reduce emissions, such as NO_x, should be taken up to a cost of SEK 40/kg NO_x reduced.

The basis for consideration is what a typical company of the industry can manage. In principle, the financial position of the company examined will be disregarded. Therefore, a company that is experiencing some difficulty must not be given a competitive advantage in relation to one that is performing well. This rule applies to new enterprises in particular. For older business operations to be maintained in an unchanged state, or modified only to a small extent, the rule is that greater attention should be paid to the company's current financial situation.

2.6 Interaction of BAT and EQOs

In Sweden, permits are developed on a case-by-case basis considering technical, environmental and economic factors. The decisions that are reached involve a balancing of the three factors. They depend, in part, on the individual circumstances of the plant. Based on environmental quality considerations, release limits may be more or less stringent than BAT, depending on the sensitivity of the receiving environment as well as the effectiveness in reducing discharges. If there are uncertainties in assessing the effectiveness of measures to be taken a trial period can be established for the conditions in question. For such a period, certain provisional limit values will be given. After the trial period, the final, binding, limit values will be set. The reason for getting a graduated schedule is thus not economic feasibility of the measures but their effectiveness in reducing discharges.

3. TRENDS IN PERMIT LIMITS

3.1 Cleaner Technology

In Sweden, the iron and steel sector is composed of 14 facilities, among which 2 are integrated plants and 12 are secondary iron and steel works. Emissions of dust (containing heavy metals), SO_2 and NO_x, and discharges of heavy metals, nitrates, suspended solids, oil, PAH, COD, BOD and ammonia are the main environmental topics of concern. Accordingly, the main industrial processes of interest for the permitting authorities are:

- Electric arc furnace;
- Blast furnace;
- Sinter plant;
- Coking plant;
- Basic oxygen steelmaking;
- Continuous casting;
- Ingot casting;
- Hot rolling and cold rolling mills;
- Pickling.

The primary iron and steel industry emits significant quantities of heavy metals to the air. As both the composition of the iron ore varies depending on its origin and varying types of scrap is added at the steel-making, the composition of the emitted dust will vary from plant to plant. Emissions of dust from primary iron and steel plants may contain the following heavy metals: cadmium, lead, chromium, nickel, zinc, copper and arsenic. In addition to these metals, mercury is emitted from the coke plants. These emissions occur at several places due to storage, handling, crushing, sieving and transport of metal-containing materials.

Similarly, the predominant source of heavy metals leaking to air in the secondary iron and steel industry is dust formed during melting and refining. However, as scrap metals constitute the basic raw materials for this industry, recycling saves huge amounts of energy, conserves mineral resources and helps to solve growing waste disposal problems. As in the case of varying quality of iron ore used in the primary iron and steel works, various types of iron and steel scrap and alloying metals used by the secondary iron and steel industry lead to significant differences in the quality of dust being emitted.

While national standards have not been developed for the iron and steel industry, the Swedish government has provided guidance on the expected environmental releases from this industry. As BAT is a central concept in the development of these guidelines, permit requirements have led to the introduction of state-of-the-art techniques and technologies which prioritise pollution prevention over treatment technology. Emission limit values are based on considerations of what best available techniques/technologies can be achieved in terms of pollution prevention and control technologies. This have led to the introduction of less environmentally-benign materials, technological innovation, reuse, commercialisation and recycling of waste material, and environmental management practices. Treatment/control technologies are then used to reduce further the amount of pollutants generated.

One of the main features of environmental control is to prevent and control the generation of heavy metals-containing dust (as fugitive emissions and as a component of gases). This is generally achieved by concentrating the dust-emitting facilities, covering and containing the processes responsible for its emission and by using doghouse, fabric filters, electrostatic precipitators and scrubbers to capture it. Humidifying techniques (sprinklers) and/or design of storage facilities against wind dispersal are also currently used. Selection of environmentally benign materials and fuels have also led to an important reduction in NO_x and SO_2 emission.

In the case of water pollution control, recirculation and reuse of waste water have achieved a high rate of reutilization (around 95 per cent). This is generally achieved by preventing direct contact between the polluting activities and uses of water as a cooling and washing agent. Dry techniques such as electroprecipitation is an example of measures which prevent the contamination of water.

3.2 Monitoring

The plant owner conducts monitoring according to a programme that has been determined by the County Administrative Board. The results are considered in the permitting process. They are available to the public.

One major task involved in supervision is to check that the conditions stated in permit decisions are complied with by companies. For this purpose, the supervisory authority adopts a control programme. This specifies which tests should be taken and how often, where and for how long the testing should take place. The authority’s task is to ensure that control is arranged in a proper manner so that they can assess whether the conditions are being followed. The test results are then reported to the supervisory authority which compares them with the conditions. The control programme therefore lays down regulations on the obligation to report to the supervisory authority.

Another important question regulated in the control programme is inspection. As a rule, it is stipulated that an activity must be inspected annually by a consultant, who must be approved by the supervisory authority. Besides the frequency of the inspection, its content is also regulated. In the case of the selected permit, the Licensing Board refers the matter to the supervisory authority pursuant to the Environment Protection Act, *section 20, second paragraph*, for the issuance of conditions in the following respects.

The concentration of particulates - in order to facilitate ongoing monitoring of the above emission conditions, specific to production and on the basis of the emission quantities specified therein, - for gases:

1. from the treatment/purification equipment for the blast furnace tapholes, tapping into torpedo cars and tapping into slag ladles, and via the blast furnace skylights;

2. from the treatment/purification equipment for the sinter mill process gas system, vacuum cleaning system, cooling system, crushing unit, transport of sponge iron ash and lime transport, as well as via the sinter mill skylights;

3. from the treatment/purification equipment for the BOF furnace primary gas extraction system and for the system for secondary gas extraction from the furnace and other connected units, as well as via the BOF works skylights (the BOF skylights and skylights nos. 160-8).

3.3 Trends in Limits

The selected facility for the case study is the only Swedish primary iron and steel plant with conditions based on the technology of today. The permit was reviewed and requirements changed on 15 May 1992 (originally issued on 21 November 1972) because the conditions to which operations were subject were in many cases based on obsolescent technology and that they were generally out-of-date. The limit values set in the permit have been based on allowable average discharges per unit of production, day, or volume emitted, where the averaging period normally is a year or a month. These types of limit ensure that dilution cannot be used as a means of attaining compliance as can be done with concentration-based limits. The term «target value» used in permit requirements means a value which, if exceeded, gives rise to a duty for the permit holder to take measures necessary to ensure that the target value is not exceeded.

Another central factor in this context is that the Government has set an environmental target, involving a reduction of pollutant emissions by the year 2000 to levels at which the environment is not harmed. A further consideration is the international agreements concluded or planned in the environmental field, such as the Protocols on reduction of emissions of sulphur and nitrogen oxides under the LRTAP-Convention and the obligation to reduce nutrient inputs by 50 per cent between 1987 and 1995 under the Baltic Sea Declaration of 1987.

The permit indirectly prescribes certain technologies by referring to the applicant's description of what measures the company plans to take. If a major deviation from this is planned for some reason, then the permittee must inform either the Licensing Board or, for minor changes, the County administration, for endorsement of the proposed changes.

Conditions for Emissions to Air

The sinter plant was the largest single source of emissions of SO_2, NO_x, particulates and metals from the selected ironworks. The works also consume large quantities of energy, with resultant large emissions of carbon dioxide. There were only two courses of action open to achieve a substantial reduction in emissions of these substances from the ironworks, either by an extensive treatment system, primarily for sulphur and particulates, or by closing the works and substituting pellets for sinter as a raw materials in the blast furnaces (pellets already constituted 40 per cent of the raw material used in the blast furnace at the time of the permit review process). A complete changeover to pellets would eliminate all emissions from the sinter plant and bring about a reduction in some emissions of metals from the blast furnaces. Pellet manufacture also gives rise to substantially lower emissions of metals, carbon monoxide and organic compounds. The annual quantity of dioxin is less than 0.1 g/year, compared with approximately 4 g/year from the sinter plant. The substantial reduction in carbon dioxide emissions is of particular interest from a general environmental protection point of view.

It was the Licensing Board's view that the circumstances described above could result in the closure of the sinter plant (which the company decided after its appeal of the new conditions was rejected). The circumstances of the plant and the assessment of up-to-date technologies called for abatement measures in order to bring about a significant reduction in the difference between emissions for sinter production and those from pellet manufacture. In the light of the above, the Licensing Board found that a significant reduction of emissions of sulphur and particulates was required. Such reductions were also justified in view of the local and regional pollution load.

Emissions of sulphur dioxide and particulates from the selected plant are very great: approximately 3 400 tonnes and 1 700 tonnes per year, respectively. Permit conditions related to atmospheric emissions address the following industrial facilities and processes:

- Sinter plant:

The sinter plant is the largest single source of emissions of SO_2, NO_x, particulates and metals from the ironworks. Permit requirements pertaining to the sinter plant are as follows:

  - as from 1 September 1995, total mean annual emissions of sulphur from sinter operations may not exceed 0.20 kg per tonne of prime quality sinter produced;

  - as from 1 September 1995, total mean annual emissions of particulates from treatment equipment, skylights and other sources at the sinter plant may not exceed 0.20 kg per tonne of prime quality sinter produced;

  - in addition, the company was ordered to examine the possibilities of reducing the formation and emission of dioxins by making changes in processes and taking other steps; the results of this examination are to be reported to the Swedish Environmental Protection Agency (EPA) by the end of 1993 at the latest.

- Blast furnaces:

  - as from 1994 total mean annual emissions of particulates from melting in blast furnaces 2 and 4 (tapholes, tapping into torpedo cars, tapping into slag ladles as well as cast house skylights and the like) may not exceed 0.07 kg per tonne of pig iron;

  - as from 1994, as a target value, the concentration of particulates in air emitted from treatment equipment for weighing vessels, charging of skips, handling of raw materials and sinter screening may not exceed 10 mg per m^3 NTP dry gas;

  - as from 1 September 1994, screens must be installed on three sides around the skip emptying facility in order to limit dispersal of particulates during charging;

  - by the end of 1992, equipment for checking the level in the torpedo must be installed.

- Steelworks:

The company is to have taken the following additional abatement measures by the above mentioned dates:

  - separate fabric filter(s) for purification of the flue gases from the desulphurisation unit, the ladle furnace, removal of the tundish liner and gunning of the tundish liner as well as enclosure of the desulphurisation facility on three sides (1 September 1994);

  - devices for extraction of the flue gases from transfer of crude iron to the BOF furnace secondary treatment (1 January 1994);

  - improved extraction of the flue gases from deslagging to the BOF furnace secondary treatment system (1 January 1994);

  - increase of the capacity of the BOF furnace secondary treatment system (1 January 1995);

  - installation of screens above the charging position for the BOF furnace, designed so as to minimise the emission of particulates into the surroundings (1 September 1993);

  - as from 1 September 1994, as a target value, the concentration of particulates from flue gas filters from desulphurisation, ladle furnace, removal of the tundish liner and gunning of the tundish liner may not exceed 10 mg per m^3 NTP dry gas;

  - as from 1 January 1995, mean annual emission quantities of particulates from the steelworks BOF furnace primary and secondary extraction, BOF skylights and skylights nos. 760-8 may not exceed 0.15 kg per tonne of steel.

- Rolling mill:

  - as from 1 January 1993, as a target value, particulate emissions from treatment/purification equipment in the rolling mill, including the paint shop but not including the slitters, may not exceed 10 mg per m^3 NTP dry gas;

  - as from 1 January 1994, as a target value, particulate emissions from the fabric filter for Slitter 1 may not exceed 10 mg per m^3 NTP dry gas;

  - emissions of solvents from the sheet metal painting facility may not exceed 15 tonnes/year, calculated as total carbon.

- Liming works:

  - as a target value, the concentration of particulates after the fabric filters for air extracted from Furnace 1, Furnace 2, the limestone conveyor, the crushing chamber and tracked loader may not exceed 50 mg per m^3 NTP dry gas.

- Conditions common to all emissions to air:

  – the concentration of sulphur in the fuel oil used at the ironworks (apart from injection into the blast furnaces) may not exceed the limits set by specific legislation in this area;

  – the processes in the sinter mill, blast furnaces, steelworks, Merox department and other facilities may not be operated without extraction of the exhaust gases through the treatment devices (otherwise necessary to ensure that production equipment is not damaged and materials ruined);

  – the company shall take continual abatement measures to deal with fugitive dust dispersal in the ironworks area, including Merox, caused by transport, storage and so on. The company shall consult the supervisory authority when planning and deciding the form of these measures. The company shall keep itself up-to-date with developments in Sweden and abroad as regards technologies and techniques for abating the nuisance caused by dust dispersal from the operations in question.

Conditions for Discharges to Water

Under the operating conditions when the permit was reviewed, several hundred tonnes of zinc and a hundred kilograms or so of lead was assumed to be discharged with the sludge water and bleed water from the circulation system. In the light of the government's stated target for emissions of metals to water, among other things, these emissions were required to be reduced.

- Blast furnaces:

  – all sludge water from the sedimentation basin in the blast furnace gas treatment water system and treated water from the same system shall undergo filtration, either through the wall of the sludge basin or through separate sand filter or by a combination of the two. This is to be done by 1 September 1994, at the latest. From this date, as a target value, monthly mean values for concentrations of contaminants in the collected waste water may not exceed the following:

zinc	0.5 mg/l
lead	0.2 mg/l
total cyanide	1.0 mg/l
free cyanide	0.1 mg/l
suspended solids	10 mg/l
pH	8

- Steelworks:

  – the mean annual concentration of suspended solids in bleed water from the circulation system for the BOF furnace scrubber unit may not exceed 3 kg suspended solids per 24-hour period.

- Rolling mill:

  – the circulation system for rolling mill water shall be entirely self-contained. However, the county administrative board is empowered to grant temporary permission for discharges into the receiving body of water if this is necessary for technical/operational reasons.

Conditions for Residues and Waste Management

The residual products currently used by the company for recycling, i.e. slag from blast furnaces and steel furnaces, dried BOF sludge, oxide scale, various material separated out in filters, slag from slitting and conditioning and fine-grade scrap, shall be reused as far as technically possible and financially reasonable.

– as from 1 July 1995, as a target value, emissions of particulates from fabric filters for the manufacture of reinforced base courses and cement and from fabric filters for the handling of refractory compounds may not exceed 10 mg m^3 NTP dry gas;

– as from 1 July 1995, as a target value, emissions of particulates from fabric filters for air extracted from the slag dryer may not exceed 10 mg m^3 NTP dry gas;

– unless otherwise stipulated under the above provisions regarding conditions common to all emissions to air, the milling plant may not be operated when the treatment equipment is not operational due to freezing or similar circumstances. As from 1 July 1995, as a target value, emissions of particulates from the mill's present extraction system may not exceed 50 mg m^3 NTP dry gas;

– as from 1 July 1993, as a target value, the concentration of particulates from the fabric filters for air extracted from admixture of coal ash in crushed products from slag may not exceed 10 mg m^3 NTP dry gas;

– as from 1 July 1993, as a target value, the concentration of particulates after the fabric filters for air evacuated from the manufacture of expanded pearlite may not exceed 10 mg m^3 NTP dry gas;

– as from 1 July 1993, as a target value, the concentration of particulates in gas leaving the fabric filters in the powdered coal plant may not exceed 10 mg m^3 NTP dry gas.

Conditions for Noise Disturbance

– the noise from the company's operations shall be limited so that the equivalent noise level it causes in residential areas does not exceed 55 dB (A) during the day (7 a.m. - 6 p.m.), 50 dB (A) in the evening (6 p.m. - 10 p.m.) and 45 dB at night (10 p.m. - 7 a.m.). In addition, the momentary noise level at night in residential areas may not exceed 60 dB (A).

General Conditions and Other Considerations

- a duty on the part of the company to install screens above the charging position for the BOF furnace;

- a duty on the part of the company (depending on particulate emissions and operating time) to arrange for treatment of the exhaust gases from Slitter 2 and limit particulate concentrations and/or particulate quantities;

- a duty on the part of the company to enclose the Merox milling plant and conveyor, as well as to limit particulate concentrations and/or particulate quantities from the extraction positions on the enclosure housing;

- a duty on the part of the company insofar as is technically possible and financially defensible to reuse particulates from the blast furnace cast houses, and also from "holiday cleaning" of the BOF works sedimentation basin, BOF furnace secondary gas extraction and all falling oxide scale;

- a duty on the part of the company to take reasonable treatment measures with regard to emissions to water from the workshop, laboratory, power plant no. 2, the cement unit and Merox.

4. TECHNOLOGICAL RESPONSES TO PERMIT REQUIREMENTS

4.1 Equipment Installed/Measures Taken

The closure of the sinter plant and crossing to use 100 per cent pellets in the blast furnace have been among the major changes to comply with the new permit requirements. Installation of a new cleaning facility has been adapted to the change in processes during different production conditions. New equipment for dust reduction and treatment of bleed from the blast furnace gas cleaning system must be installed.

4.2 Flexibility Considerations

The flexibility to meet permit requirements has been sought in the choice of treatment technologies.

4.3 Views of Industry Surveyed

The first reaction of the company on the new permit conditions was to appeal to the Swedish Government on the basis that the requirements on dust and sulphur reductions were not established for ecological reasons but strictly on BAT rationale. With the help of dispersal calculations and observations, the company has been able to show that the load on soil and the health of the population were relatively low. It could also be shown that the ironworks area is not one of the area of Sweden suffering the most from sulphur, nitrogen and acidification, even if the "critical load limits" were exceeded. In the light of these circumstances, the company thought that only limited abatement action was necessary.

The rejection of the appeal led to the decision of the company to close the sinter plant. In the views of the company, the authority has set the requirements only from BAT considerations, not from an assessment of BAT in the light of EQO and economics as the law stipulates. This may be explained by the contradiction between the national reduction programme of the government (i.e. for sulphur and nitrogen oxides) and the law.

Another point of disagreement concerned the efficiency of filtration for separation of particulates and for monitoring purposes. In support of its proposal to set the minimum particulate concentration standard at 20 mg/m^3 (subject to some exceptions), the company has argued that it was not possible to take accurate enough readings to set a lower figure. This argument ran contrary to the Board's view which kept the requirements at 10 mg/m^3.

5. CONCLUSION

Sweden has not adopted national standards for the iron and steel industry. Emission limit values are set individually for each plant in the permit. They are subject to negotiations in the permitting process. BAT is the starting point in the assessment of the permissibility of the activity and the conditions of the permit. The costs for remedial measures and the effects in the environment are also considered. The result of these considerations may very well be less stringent limits compared to BAT.

While reasonableness of costs is an important principle in decision-making on environmental conditions and may sometimes contradict the BAT concept, departure from the principle is possible and generally left to the professional judgement of the permitting authority. This is the case, for example, in the context of the continued presence of persistent and bioaccumulative toxics, such as dioxin and heavy metals.

Even if this has been a point of disagreement between the selected facility's representative and the permitting authority, the permit requirements have been argued as being based on an evaluation of what BAT can achieved, on the impact of emissions on EQO, and on an assessment of the reasonability of costs. However, in some cases, there has been a margin for interpretation where, for example, decision for the reduction of dioxin emissions has led to more stringent limits and has resulted in the closure of the sinter plant. It can be argued that the several advantages, in terms of environmental performance, offered by substituting pellets as a raw material for sinter production have been an important aspect in the review of the permit conditions. This is in accordance with the multi-media approach practised in Sweden. It is also a reflection of the priority for in-plant measures over treatment technology. In this regard, the requirements set in the renewed permit are in accordance with up-to-date technologies and practices (BAT) being used in the iron and steel sector internationally.

Pollution prevention, triggered by the permit conditions, has resulted in raw materials substitution (100 per cent pellets as a raw material), process modification and rethinking of production processes (closure of the sinter plant, new cleaning facility adapted to production changes). In plant measures have been complemented by treatment technologies and waste recycling and reutilization in order to meet the standards.

The company has had some flexibility in choosing the measures to attain the required standards. After the rejection of the company's appeal of the conditions set, the decision to close the sinter plant was taken as the "best practical solution" in complying with the authority's demands.

THE UNITED KINGDOM

1. THE PERMITTING PROCESS

1.1 Constitutional Responsibilities for Environmental Protection

Since 1970, environmental protection has primarily been the responsibility of the Department of the Environment (DOE), together with the corresponding department in the Welsh Office, the Scottish Office and the Northern Ireland Office. The Secretary of State for the Environment is supported, on environmental matters, by a Minister for the Environment and Countryside and a Junior Minister, both with their own areas of responsibility. The DOE has overall management responsibilities which includes developing the Government's policies, exerting financial control over executing agencies, including local authorities, and ruling on appeals against local authority decisions. The Environment Protection Deputy Secretary is responsible for five directorates:

- Her Majesty's Inspectorate of Pollution (HMIP);
- air, climate and toxic substances;
- pollution control and waste, including the project team for a proposed Environment Agency;
- environment policy and analysis, including environment statistics and reporting;
- water, including Drinking Water Inspectorate.

Under the system known as integrated pollution control (IPC), HMIP is the enforcement agency responsible in England and Wales for regulating releases to air, water and land from the most polluting industrial processes. The permits, known as authorisations, are issued by the Chief Inspector. Control of other, less polluting industrial processes not covered by IPC falls to the National Rivers Authority (NRA) for releases to water, and to local authorities for releases to air and land.

As a Member State of the European Community (EC), much of the legislation relating to environmental pollution control in the United Kingdom has been enacted following EC directives. Legislation in EC Member States can be traced back to three EC Directives:

- The Air Framework Directive (84/360/EEC). This made provision for Member States to control emissions to air from industrial plants by a system of authorisation;

- The Dangerous Substances Directives (76/464/EEC). This Directive created a framework for the elimination or reduction of pollution of inland, coastal and territorial waters by dangerous substances. These are categorised in terms of their toxicity, persistence and bioaccumulation properties. List I ("black list") substances include mercury, cadmium and certain known carcinogens. List II ("grey list") substances comprise less toxic substances such as compounds of zinc, copper, lead, arsenic and other non-ferrous metals;

- The Waste Disposal Directive (75/442/EEC). This required the drawing up by Member States of waste disposal plans and required holders of waste to dispose of it through a duly authorised waste collection agency or company, without causing pollution of the environment or harm to human health.

The Air Framework Directive is supported by the following Directives on air quality limit values for suspended particulates, sulphur dioxide, nitrogen dioxide and lead:

- Directive 80/779/EEC and amendment 89/427/EEC for sulphur dioxide and suspended particulates;

- Directive 85/203/EEC for nitrogen dioxide;

- Directive 82/884/EEC for lead.

Discharges of List I substances to water must comply with agreed EC-wide standards. There are two methods of control:

- the limit value approach consists of fixed emission limits to be complied with irrespective of the size of the plant or the nature of the receiving water. Limit values are derived from an assessment of the best technical means for the reduction of discharges, taking into account their economic availability;

- the use of environmental quality standards (EQSs). These are concentration limits not to be exceeded at particular locations in the receiving water. For List I substances, the EQS is determined in order to protect the aquatic life.

The Waste Disposal Directive establishes the definition of waste. The nature of the waste is assessed on the basis of the type of activity generating waste and the constituents that determine its properties.

1.2 Permits

The 1990 Environmental Protection Act (EPA) introduced two regimes of pollution control for so-called prescribed processes:

- Integrated Pollution Control (IPC) for large scale, multi-media polluters operated and enforced by central pollution inspectorates (Her Majesty’s Inspectorate of Pollution [HMIP] in England and Wales);

- Local Authority Air Pollution Control (LAAPC), which focuses on air emissions and is enforced by the local authorities.

Processes served by these two control regimes are known as Part A and Part B processes, respectively. The EPA stipulates that an operator of a prescribed process will require an authorisation in order to carry out the process (EPA, Part I, Section 6(1)). The 1991 Environmental Protection (Applications, Appeals and Registers) Regulations (S.I. 1991/507) lays out the procedure that has to be abided by in the application for, and the delivery of, an authorisation under the EPA.

For the iron and steel sector, the processes subject to central, integrated pollution control (Part A) and to local authority air pollution control (Part B) are:

Processes Subject to Central Control (Part A)

a) Loading, unloading or otherwise handling or storing iron ore except in the course of mining operations;

b) Loading, unloading or otherwise handling or storing burnt pyrites;

c) Crushing, grading, grinding, screening, washing or drying iron ore or any mixture of iron ore and other materials;

d) Blending or mechanically mixing grades of iron ore with other materials;

e) Pelletising, calcining or sintering iron ore (except as part of a smelting process);

f) Making, melting or refining iron, steel or any ferro-alloy in any furnace other than a furnace described in Part B;

g) Any process for the refining or making of iron, steel, or any ferro-alloy in which air or oxygen or both are used unless related to a process described in Part B;

h) The desulphurisation of iron, steel or any ferro-alloy made by a process described in this Part;

i) Heating iron, steel or any ferro-alloy (whether in a furnace or other appliance) to remove grease, oil, or any other non-metallic contamination (including such operations as the removal by heat of plastic or rubber covering from scrap cable), if related to another process described in this Part;

j) Any foundry process (including ancillary foundry operations such as the manufacture and recovery of moulds, the reclamation of sand, fettling, grinding and shot blasting) if related to another process described in this Part;

k) Any process otherwise falling within a description in Part B, if the process involves the use of a furnace with a designated melting capacity of 25 tonnes or more per hour and the carrying on of the process by the person concerned at the location in question is likely to produce 4 000 tonnes or more of special waste in any 12 month period;

l) Handling slag in conjunction with a process described in paragraph f) or g).

Processes Subject to Local Authority Air Pollution Control (Part B)

a) Making or refining of iron, steel or any ferro-alloy in an electric arc furnace with a designated holding capacity of less than 7 tonnes; or in a cupola, rotary furnace, induction furnace or resistance furnace;

b) Refining iron or making iron, steel or any ferro-alloy where air or oxygen or both are used, if related to another process described in paragraph a) above;

c) Desulphurisation of iron, steel or any ferro-alloy, if the process does not fall within paragraph h) in Part A;

d) Any such process as described in paragraph i) of Part A above, if not falling within that paragraph;

e) Any foundry process (including ancillary foundry operations such as the manufacture and recovery of moulds, the reclamation of sand, fettling, grinding and shot blasting) if related to another process described in this Part.

Applicants must submit an application for an authorisation if they want to operate a new process or according to a timetable laid down in regulations for processes existing before 1 April 1991. There is a review of all authorisations at least every four years. This does not trigger an application for an authorisation, but may result in a variation of an authorisation. In their application, the applicants must provide the following information:

– Applicant's details;

– Location of the premises where the process will be carried on;

– Process information (including the prescribed substances which will be used or produced, and the techniques which will be used to prevent, minimise and render harmless any releases);

– Releases to the environment from the process;

– Environmental effects of releases from the process;

– Proposals for monitoring releases and their environmental effects;

– How compliance with authorisation conditions will be demonstrated.

The authorisation controls the techniques used in the process and the releases from the process in several ways:

– it can place limits on the concentrations and/or masses of substances released;

– it can impose conditions on raw materials, which, *inter alia*, limits the releases of some substances (e.g. limiting the sulphur content of fuels);

– it can impose conditions which specify techniques which can or cannot be used;

- it (always) includes a condition which specifies that the process shall be operated in accordance with the application, so that it effectively specifies in a very detailed way the options for pollution prevention and abatement that must be used.

Conditions are attached to each authorisation for the control of pollution from the process. The objectives of the conditions are to ensure that, in carrying on a prescribed process, the best available techniques not entailing excessive costs (BATNEEC) will be used:

- for preventing the release of substances prescribed for any environmental medium into that medium or, where that is not practicable by such means, for reducing the release of such substances to a minimum and for rendering harmless any substances which are so released; and

- for rendering harmless any other substances which might cause harm if released into any environmental medium.

Where the process involves the release of substances into more than one environmental medium, there is an additional requirement that BATNEEC will be used for minimising the pollution to the environment as a whole having regard to the best practicable environmental option (BPEO). A list of prescribed substances is given in Table 1.

In addition, conditions should be placed within an authorisation to ensure that releases do not cause or contribute to the breach of:

- any directions given by the Secretary of State to implement EU or international obligations relating to environmental protection;

- any statutory environmental quality standards or objectives prescribed or other statutory limits or requirements.

Appeals against refusal to grant an authorisation and against the conditions attached to an authorisation can be made to the Secretary of State for the Environment. Appeals cannot, however, be made against decisions which implement a direction from the Secretary of State, for example, those given for the implementation of EU legislation or international law relating to environmental protection.

Table 1. **Prescribed substances**

Release into air

Oxides of sulphur and other sulphur compounds;
Oxides of nitrogen and other nitrogen compounds;
Oxides of carbon;
Organic compounds and partial oxidation products;
Metals, metalloids and their compounds;
Asbestos (suspended particulate matter and fibres);
Glass fibres and mineral fibres;
Halogens and their compounds;
Phosphorus and its compounds;
Particulate matter.

Releases into water

Mercury and its compounds;
Cadmium and its compounds;
All isomers of hexachlorocyclohexane;
All isomers of DDT;
Pentachlorophenol and its compounds;
Hexachlorobenzene, Hexachlorobutadiene, Aldrin, Dieldrin, Endrin, Polychlorinated Biphenyls, Dichlorvos,
1,2-Dichloroethane;
All isomers of trichlorobenzene, Atrazine, Simazine, Tributyltin compounds, Triphenyltin compounds, Trifluralin, Fenitrothion, Azinphos-methyl, Malathion, and Endosulfan.

Releases into land

Organic solvents, Azides, Halogens and their covalent compounds;
Metal carbonyls, Organometallic compounds, Oxidising agents;
Polychlorinated dibenzofuran and any congener thereof Polychlorinated dibenzo-p-dioxin and any congener thereof Polyhalogenated biphenyls;
Terphenyis and naphthalenes;
Phosphorus;
Pesticides, that is to say, any chemical substance or preparation prepared or used for destroying any pest, including those used for protecting plants or wood or other plant products from harmful organisms; regulating the growth of plants; giving protection against harmful creatures; rendering such creatures harmless; controlling organisms with harmful or unwanted effects on water systems, buildings or other structures, or on manufactured products; or protecting animals against ectoparasites;
Alkali metals and their oxides and alkaline earth metals and their oxides.

1.3 Permit Renewal Process

The conditions contained in all authorisations should be reviewed at intervals of not more than four years. If new information becomes available, for example, on the potential for harmful effects, or on new technology or techniques, then a review of an authorisation may be undertaken sooner.

1.4 Multi-Media Permits

Integrated (multi-media) pollution control applies to Part A processes. Part B processes are authorised on the basis of releases to air only. For these processes, permits to discharge to other media, if required, would be dealt with separately.

Operators of Part A processes likely to result in releases to more than one environmental medium need to demonstrate that their proposed option represents the best practicable environmental option (BPEO). This is defined as the option which, in the context of releases from a prescribed process, provides the most benefit or least damage to the environment as a whole, at acceptable cost, in the long term as well as the short term. Applicants need to compare the impacts on the environment of alternative pollution control options. They can either chose to implement the option with the lowest overall environmental impact, or demonstrate that another option has cost advantages which outweigh the additional environmental benefits of the option with the lowest environmental impact.

1.5 Environmental Assessment

Applicants are required to provide an environmental assessment of releases. This should take into account the characteristics of the receiving environment, including ambient levels of pollutants released and sensitive receptors. For Part A processes, the assessment should consider the concentration in air resulting from releases to air, the concentration on land resulting from deposition from the air, and the concentration in water from releases to water. For the purposes of comparing possible control options, account also needs to be taken of other factors, such as the contribution to global warming, the creation of photochemical smog (ozone), and the hazardous nature of any wastes produced which are not released to air or water.

The objectives of the conditions set in an authorisation should ensure that releases to the environment are rendered harmless. This will be achieved by taking into account site specific pollution receptors, including any particularly sensitive pollution receptors in the receiving environment. The environmental assessment in support of the application for authorisation needs to include an assessment of the impact of proposed releases from the process on the sensitive environment and needs to show that no harm would result. If necessary, further control options should be considered to ensure that releases are rendered harmless to the ecosystem. Statutory consultees include English Nature and the Countryside Council for Wales for processes operated close to sites of special scientific interest. These organisations may provide information on specific habitats during the consultation process, e.g. potential damage to lichen communities by acid gas deposition.

2. BAT, EQO AND ECONOMICS

2.1 Standards Setting and Targets

The United Kingdom's current approach to environmental pollution control has evolved over a long time. The first pollution control measures were introduced in the late 18th century as a result of the industrial revolution. Until recently, the concept of "best practical means" (BPM) has for some 150 years been the basis for pollution control legislation.

With the Environmental Protection Act (1990) requirements are now framed in terms of BATNEEC and BPEO. General performance levels achievable by the use of BATNEEC in each category of processes are established following reviews by independent experts of the general standards and techniques appropriate for the control of pollution from processes in the sector. These general performance levels are then published as guidance notes issued either by the Chief Inspector or by the Secretary of State. The guidance sets out the achievable release levels for new processes applying the best combination of techniques to limit environmental impact. Less stringent release levels may be appropriate for existing processes. The release levels are not uniform release standards, but guidance to be taken into account in framing conditions in particular authorisations. Release levels achievable for new processes applying BAT are given in Section 2.4. The reviews are repeated at intervals of not more than four years. In addition, conditions should be placed within an authorisation to ensure that releases do not cause or contribute to the breach of:

- any directions given by the Secretary of state to implement EU or international obligations;
- any statutory environmental quality standards or objectives or other statutory limits or requirements.

Relevant statutory environmental quality standards for substances which may be released from processes in this sector are given in Section 3.2 on Environmental quality Objectives.

2.2 Cleaner Technologies

The primary objective of the control regime in the Environmental Protection Act (1990) is the control of the process, and therefore of any polluting releases at source, rather than end-of-pipe treatment. BATNEEC is generally expressed (in guidance notes and specific permit conditions) in terms of achievable release levels, rather than in technological terms, so as not to constrain the development of cleaner techniques nor to restrict unduly operators' choice of means to achieve a given standard.

Development of clean technology for industrial processes has been promoted by the DOE and the Department of Trade and Industry through their Environmental Technology Innovation Scheme and the Department of Trade and Industry's Environmental Management Options Scheme. When the programmes came to the end of their three-year trial in 1993, they were replaced by a joint programme on Environmental Technology Best Practice, launched in December 1993 with a budget of £16 million over five years. It emphasises reducing and eliminating waste and pollution at source, and concentrates on providing information rather than financial assistance.

2.3 Environmental Quality Objectives

The EQOs are based on the standards and objectives set out in European Union (EU) Legislation. These levels are negotiated and agreed between all the Member States of the EU on the basis of scientific advice and the recommendations of relevant international bodies, such as the World Health Organization (WHO). The EQO corresponds to the concentration of a substance in the receiving environment which must not be exceeded if the environment is to be suitable for a particular purpose or use, or to achieve a given level of protection for a particular receptor. Thus, different values are specified according to the specific circumstances. For water, in particular, values are specified according to whether the receiving environment is freshwater, estuarine water or coastal water, and whether it is a source of drinking water or supports sensitive aquatic life.

The 1990 Environment Protection Act gives the Secretary of State the power to set environmental quality objectives or standards for any medium in any area:

> *Regulations [...] may establish for any environmental medium (in all areas or in specified areas) quality objectives or quality standards in relation to any substances which may be released into that or any other medium from any process.* (Part I, Section 3(4), emphasis added)

The 1991 Water Resources Act allows the Secretary of State by regulations to prescribe a system for classifying the quality of controlled waters. Water quality objectives may be set for any waters by means of such classifications (which may also transpose the directives of the EU) and by serving a notice to the National Rivers Authority (NRA). The classification of waters will provide the framework for the establishment of statutory quality objectives to replace the administratively-set existing ones. The water quality objectives which have statutory force in the United Kingdom are those which are the result of requirements adopted in EU Directives (e.g. the dangerous substances Directive 76/464/EEC and its daughter directives or the bathing waters Directive 76/160/EEC). Table 2 of the iron and steel case study lists the substances which may be released from processes in this sector which are covered by an EQO. These are applied uniformly throughout the UK. Table 3 provides EQSs for substances discharged from iron and steel processes.

Table 2. **EQSs for air pollutants**

Substance	**Reference period**	**Calculated from**	**Limit value μg/m³**	**Associated value for suspended particulate μg/m³**
Sulphur dioxide (SO_2)	Year	Median of daily means	80 120	>40 <=40
SO_2	Winter (1 Oct - 31 Mar)	Median of daily means	130 180	>60 <=60
SO_2	Year	98% of daily (24h) means	250 not to be exceeded 350 on >3 days	>150 <=150
Total suspended particulate (TSP)	Year	Median of daily means	80 (150-gravimetric)	
TSP	Winter (1 Oct - 31 Mar)	Median of daily means	130	
TSP	Year	98% of daily (24h) means	250	
TSP		(95% - gravimetric)	(300-gravimetric)	
Nitrogen dioxide	Calendar Year	98% from mean values per hour or lesser period	200	
Lead (atmospheric particulate)	Year	Annual mean	2	

Table 3. **EQSs for substances discharged from iron and steel processes**

Substance	**EQS (µg/l)**						
	Freshwater					Estuary	Coast
	Abstraction for drinking water			Aquatic life			
	DW1	DW2	DW3	Salm.	Cypr.		
Suspended solids	-	-	-	< 25 mg/l	< 25 mg/l	-	-
Cadmium	**5 (total)**	**5 (total)**	**5 (total)**	-	-		**2.5 (diss'd)**
Chromium	50 (total)	50 (total)	50 (total)	(see below)			15 (diss'd)
	Total hardness (mg/l $CaCO_3$)	< 50		5	150		
		50-100		10	175		
		100-150		20	200		
		150-200		20	200		
		200-250		50	250		
		> 250		50	250		
				(annual average diss'd)			
Lead	50 (total)	50 (total)	50 (total)	(see below)			25 (diss'd)
	Total hardness (mg/l $CaCO_3$)	< 50		4	50		
		50-100		10	125		
		100-150		10	125		
		150-200		20	250		
		200-250		20	250		
		> 250		20	250		
				(annual average diss'd)			
Mercury	**1 (total)**	**1 (total)**	**1 (total)**	-	-	**0.5 (diss'd)**	**0.3 (diss'd)**
Nickel	50 (95%)	50 (95%)	-	(see below)		-	30 (diss'd)
	Total hardness (mg/l $CaCO_3$)	< 50		50	50		
		50-100		100	100		
		100-150		150	150		
		150-200		150	150		
		200-250		200	200		
		> 250		200	200		
				(annual average diss'd)			
Zinc	3000 (total)	5000 (total)	5000 (total)	(see below)		-	40 (diss'd)
	Total hardness (mg/l $CaCO_3$)	< 50		8	75		
		50-100		50	175		
		100-150		75	250		
		150-200		75	250		
		200-250		75	250		
		> 250		125	500		
				(annual average diss'd)			
Cyanide	50	50	50	-	-	-	-

Note: For water, **bold** denotes EQSs which represent an absolute constraint on an authorisation; others cannot be interpreted as providing an absolute constraint, but are used as targets, and by other regulators consulted on the application for authorisation who use the values in framing their requirements.

2.4 Best Available Technology

One of the objectives to be achieved in the conditions attached to an authorisation under Part I of the Environmental Protection Act is the use of BATNEEC (Best Available Technique Not Entailing Excessive Cost). In the guidance document, ”Integrated Pollution Control: A Practical Guide”, BATNEEC is defined as follows:

> *"**Best**" must be taken to mean most effective in preventing, minimising or rendering harmless polluting releases. There may be more than one set of techniques that achieves comparable effectiveness-that is, there may be more than one set of "best" techniques.*
>
> *"**Available**" should be taken to mean procurable by the operator of the process in question. It does not imply that the technique has to be in general use, but it does require general accessibility. It includes a technique which has been developed (or proven) at pilot scale, provided this allows its implementation in the relevant industrial context with the necessary business confidence. It does not imply that sources outside the UK are "unavailable". Nor does it imply a competitive supply market. If there is a monopoly supplier the technique counts as being available provided the operator can procure it.*
>
> *"**Techniques**" is defined in section 7(10) of the Environmental Protection Act. The term embraces both the plant in which the process is carried on and how the process is operated. It should be taken to mean the components of which it is made up and the manner in which they are connected together to make the whole. It also includes matters such as numbers and qualifications of staff, working methods, training and supervision and also the design, construction, lay-out and maintenance of buildings, and will affect the concept and design of the process.*
>
> *"**Not entailing excessive cost**" (NEEC) needs to be taken in two contexts, depending on whether it is applied to new processes or existing processes. Nevertheless, in all cases BAT can properly be modified by economic considerations where the costs of applying best available techniques would be excessive in relation to the nature of the industry and to the environmental protection to be achieved. As objective an approach as possible to the consideration of what is BATNEEC is required. The concern is what costs in general are excessive; the lack of profitability of a particular business should not affect the determination. In relation to existing processes, the regulatory authorities are concerned additionally with establishing timescales over which old processes will be upgraded to new standards, or as near to new standards as possible, or ultimately closed down.*

In General Guidance Notes 1 (GG1), Introduction to Part I of the Act, for LAAPC, a general explanation of BATNEEC identical to the one provided by the IPC Practical Guide is included. Specific guidance on the performance levels achievable by the use of BATNEEC in the iron and steel sector is given in guidance notes IPR 2/1, 2/2 and 2/3 for IPC processes and in PG 2/3, 2/4 and 2/5 for LAAPC processes (see Table 4).

Table 4. **Release levels achievable for new iron and steel processes**

(a) Part A Processes (IPC)

(i) Iron and Steel Making Processes in Integrated Iron and Steel Works: Releases into air

Process	**Emission**	**Typical loading kg/tonne**	**New process - abated release**		
			Average concentration mg/m^3	Peak concentration mg/m^3	Typical mass emission g/tonne
All raw materials handling dust collection	Particulate			10	
Coal pulverisation			10	20	
Sintering	Particulate	<5		60	100
	SO_x (as SO_2)	<1.2	250 (25)		1200
	Dioxins (ITEQ)		1 ng/m^3		
Sinter dedusting	Particulate			30	75
Blast furnace	Particulate	<4	10		
Stockhouse	Particulate			10	
Casthouse	Particulate			20	50
Hot blast stoves	Particulate		10		
Slag granulation	Particulate		20		
	SO_2		200		
	H_2S		100		
Desulphurisation	Particulate			20	
	SO_2				70
BOS Gas cleaning	Particulate	<20	50	80	100
	CO		*		
Charging and tapping	Particulate			30	40
Ladle steelmaking	Particulate			20	
Roof extraction	Particulate			20	
Machine scarfing	Particulate		30		
Oxy-gas cutting	Particulate			10	
Rolling and pickling	Particulate		20		
	Oil mist		20		
	VOC as total C			50	
	HCl		10		
	NO_x		300		
All processes	Fluorides		5		
	Lead		1		
	Chromium		2		
	Nickel		1		

Notes: Figures are based on measurements taken at the point of discharge. For batch operations the average concentration figures refer to measurements taken over a complete process cycle. For continuous processes, releases are based on an hourly average figure over a rolling 24 hour period taking into account only the hours when the plant is operating, including start-up and shut-down. Start-up and shut-down conditions may be excluded from release limits subject to the provision of acceptable reasons by the operator.

* When employing a suppressed combustion and gas recovery system, primary emissions occur only at the beginning and end of the cycle. In this case the average concentration and mass emission will be reduced. When gas recovery is not employed the release of CO gas must be minimised by flaring. Typical raw dust loadings have been provided which indicate the levels of total particulate released from the process prior to abatement. When used with figures for abated release concentrations and mass emissions, together with the abatement equipment efficiency figures given elsewhere in the guidance, Inspectors may be able to assess the efficiency of fume capture systems or the quality of fugitive emissions.

(Table 4 continued)

Releases to water						
Discharge concentration (mg/litre) of effluent based on a 24 hour flow proportional sample						
Cadmium	Mercury	Cyanides	Chromium	Lead	Nickel	Zinc
50	20	500	200	200	500	500

(ii) Ferrous Foundry Processes : Releases into air				
Process	**Emission**	**New process - abated release**		
		Average concentration mg/m^3	Peak concentration mg/m^3	Mass emission g/tonne of product
EAF primary	Particulate	20	30	200
EAF secondary	Particulate	10	20	50
EAF combined extraction	Particulate	15	30	
Roof extraction	Particulate	10	20	20
Ladle treatment	Particulate	10	20	
General local extraction	Particulate	10		
Leaded steel processes	Lead	3		
Stainless steel & special alloy processes	Chromium	4		
	Nickel	2		
All processes	Dioxins (TEQ)	1 ng/m^3		
	Cadmium	0.2		
	Lead	1		
	Chromium	2		
	Nickel	1		
	VOC* as total carbon	50		
	Fluorides	5		

Notes: Figures are based on measurements taken at the point of discharge - The average concentration figures refer to measurements taken over a complete process cycle for batch operations. - For continuous processes, releases are based on an hourly average figure over a rolling 24 hour period taking into account only the hours when the plant is in actual operation, including start-up and shut-down.

* The term “Volatile Organic Compounds” includes all organic compounds released to air in the gas phase.

(Table 4 continued)

Releases to water

Discharge concentration (mg/litre) of effluent based on a 24 hour flow proportional sample

Cadmium	Mercury	Chromium	Lead	Nickel	Zinc	Suspended solids	Oil
50	20	200	200	500	500	50 000	10 000

(iii) Processes for Electric Arc Furnace and Secondary Steelmaking, and Special Alloy Production

Releases into air

Process	**Emission**	**New processes - abated release**		
		Average concentration mg/m^3	Peak concentration mg/m^3	Mass emission g/tonne of product
EAF Primary	Particulate	20	30	200
EAF secondary	Particulate	10	20	50
EAF combined extraction	Particulate	15	30	
AOD primary	Particulate	20	30	
Roof extraction	Particulate	10	20	20
Ladle treatment	Particulate	10	20	
Machine scarfing	Particulate	30		
Oxy-gas cutting	Particulate		10	
General local extraction	Particulate		10	
Leaded steel	Lead	3		
Stainless steel & special alloys	Chromium	4		
	Nickel	2		
All steels	Dioxins (ITEQ)	1 ng/m^3		
	Cadmium	0.2		
	Lead	1		
	Chromium	2		
	Nickel	1		
	Fluorides	5		
Rolling and pickling	Particulate	20		
	Oil mist	20		
	VOC as Total Carbon		50	
	HCl	10		
	NO_x	300		

Notes: Figures are based on measurements taken at the point of discharge. - For batch operations the average concentration figures refer to measurements taken over a complete process cycle. - For continuous processes, releases are based on an hourly average figure over a rolling 24 hour period taking into account only the hours when the plant is in actual operation, including start-up and shut-down. - Start-up and shut-down conditions may be excluded from the release limits in the authorisation subject to the provision of acceptable reasons by the operator.

Releases to water							
Discharge concentration mg/litre of effluent based on a 24 hour flow proportional sample							
Cadmium	Mercury	Chromium	Lead	Nickel	Zinc	Suspended solids	Oil
50	20	200	200	500	500	50 000	10 000

(b) Part B Processes (LAAPC - UK)

(i) Electrical and Rotary Furnaces: Emission Limits for Releases to Air

- All emissions to air other than steam or water vapour should be colourless and free from persistent mist. All emissions to air should be free from persistent fume and free from droplets. The aim should be that all emissions are free from offensive odour as perceived by the local authority Inspector outside the process boundary. Emissions in normal operation should not exceed the equivalent of Ringelmann Shade 1 as described in British Standard BS 2742:1969.
- For all plants, there should be no persistent visible emissions from the building housing the furnace or from any process vents or chimneys; if this cannot be achieved, the emission limit for particulate matter should be 100 mg/m^3.
- The introduction of dilution air to achieve emission concentration limits is not permitted. Exhaust flow rates should be consistent with efficient capture of emissions, good operating practice and meeting the requirements of the legislation relating to the workplace environment.

(ii) Iron, Steel and Non-Ferrous Metal Foundry Processes: ELVs and Controls for Releases to Air

- Emissions to air, other than steam or water vapour, should be essentially colourless and free from persistent mist. All emissions to air should be free from persistent fume and free from droplets. The aim should be that all emissions are free from offensive odour outside the process boundary, as perceived by the local authority Inspector. The concentration of pollutants in any emission to the air should not exceed the values detailed in the table below:

Emission	**Concentration mg/m^3 ***
Total particulate matter	50
Copper and its compounds (as copper)	20
Lead and its compounds (as lead)	2
Cadmium and its compounds (as cadmium)	0.2

* Expressed as copper/lead/cadmium.

The concentration of pollutants in any emission to the air (expressed as concentrations of a measurement period of 15 minutes) should not exceed the values detailed in the table below:

Emission	Concentration
Amines and amides	5 ppm v/v
Volatile organic compounds (as total carbon excluding particulate matter)	50 mg/m^3
Hydrogen sulphide	5 ppm v/v
Ammonia	18 mg/m^3

- These emission limits should not be applied to emissions from casting operations.
- Emissions in normal operation from combustion processes (excluding casting fume) should be free from visible smoke and in any case should not exceed the equivalent of Ringelmann Shade 1 as described in British Standard BS 2742:1969.
- The use of odour-masking agents and counteractants should not be permitted, except in the case of counteractants where they are used at existing processes and where (in such cases) it can be demonstrated that their use is to secure compliance with the above requirements.
- The introduction of dilution air to achieve emission concentration limits should not be permitted. Exhaust flow rates from emission capture and process plant should be minimised and consistent with efficient capture of emissions, good operating practice and meeting the requirements of the legislation relating to the workplace environment.

(iii) Hot and Cold Blast Cupolas: Emission Limits and Controls for Releases to Air

- For all fan-powered arrestment processes with the exception of multicyclone plants, emissions to air, other than steam or water vapour, in normal operation (including start-up and shut-down) should be free from colour, persistent fume, and droplets.
- The aim should be that all emissions are free from offensive odour as perceived by the local authority Inspector outside the process boundary.
- For all new hot and cold blast cupolas the concentration of total particulate matter in the emissions to air should not exceed 100 mg/m^3. (Particulate matter is defined as meaning grit, dust or fumes.)
- Smoke emissions in normal operation should not exceed the equivalent of Ringelmann Shade 1 as described in British Standard BS 2742:1969, except in the case of lighting up when smoke emissions should not exceed Ringelmann Shade 1 for more than 15 minutes. Smoke emissions should at no time exceed Ringelmann Shade 2.

2.5 Negotiations of Standards and Emission Limits

The BATNEEC concept is applied in the specification of conditions attached to an authorisation. General performance levels achievable by the use of BATNEEC for each category of processes are developed and published in the form of guidance notes. These are the levels expected to be achieved by new processes. Existing processes are expected to move towards the achievement of these levels. The same general BATNEEC concepts and the same general performance levels apply uniformly across the sector. However, the precise performance level accepted as the basis for the conditions in an authorisation is set on a case-by-case basis according to a judgement of what is BATNEEC.

2.6 Economic Considerations

The concept applied is BATNEEC rather than BAT; the meaning of the terms "not entailing excessive cost" is described above. Considering this, the concern is to determine what are excessive costs for the respective industry. However, lack of profitability of a particular business and the particular financial situation of an individual firm seeking authorisation should not affect the determination. For existing plant, the judgement that usually needs to be made is over the timetable for upgrading to new plant standards and the balance between the needs of the environment and the costs of upgrading. Decisions about the upgrading timetable rely on the professional judgement of the inspector and are made on a case-by-case basis.

2.7 Interaction of BAT and EQOs

The requirements of EQOs and BATNEEC are complementary, in that EQOs focus on ensuring the quality of the receiving environment, whereas BATNEEC requirements derive from a consideration of what performance levels are achievable by the use of available techniques in the specific process. An operator applying for an authorisation would need to show that the techniques proposed for the process were in accordance with the relevant general guidance on BATNEEC as applied to the specific circumstances, and that releases from the process had been rendered harmless. Releases which lead to exceedences of EQOs would be considered harmful, and thus, would not be authorised. EQOs therefore represent overriding requirements.

3. TRENDS IN PERMIT LIMITS

3.1 Cleaner Technology

Air Pollution Control

The United Kingdom is undergoing a major change in terms of its legal framework, regulatory instruments, enforcement mechanisms, administrative procedures and institutional arrangements for the prevention and control of atmospheric pollution from industrial sources. Until 1990, the regulatory framework for air pollution control was fragmented and had remained largely unchanged for many years. The Environmental Protection Act of 1990 marked an important shift towards a more structured and centralised approach to industrial pollution control, with the introduction of integrated pollution control (IPC).

The general objective of the United Kingdom air management policy is to prevent, as far as possible, or to minimise, releases into the air of harmful substances and thereby protect human health, natural ecosystems and quality of life. For many years, the United Kingdom resisted pressures, from both within and outside the country, to set quantitative targets for reducing air pollutant emissions. The United Kingdom has nevertheless signed international agreements on atmospheric emissions, key targets being:

- a reduction of SO_2 emissions from large combustion plants of 20 per cent by 1993, 40 per cent by 1998 and 60 per cent by 2003, compared with 1980 levels (EC Directive on Large Combustion Plant);

- a reduction in total sulphur emissions of 70 per cent by 2005 and of 80 per cent by 2010, over 1980 levels (second UN-ECE Sulphur Protocol);

- a reduction of NO_x emissions from large combustion plants of 15 per cent by 1993 and 30 per cent by 1998, compared with 1980 levels (EC Directive on Large Combustion Plant);

- stabilisation of total NO_x emissions at 1987 levels by 1994 (Sofia Protocol);

- a 30 per cent reduction of VOC emissions by 1999, compared with 1988 levels (Geneva Protocol).

Historically, the United Kingdom has opposed the notion of setting ambient air quality standards. This policy changed, albeit very gradually, in the 1980s, particularly in response to rising international and domestic concern over acid rain. The United Kingdom has now fully incorporated into its legislation all EC directives relating to ambient air quality, with standards for SO_2, NO_x, black smoke and lead. Reports on the possible revisions of standards for SO_2, NO_2 and smoke, as well as for carcinogenic substances such as 1,3 butadiene, will be produced over the next two years.

The United Kingdom has also played an important role in developing and applying the concept of critical load in international agreements on acid deposition. It hopes to extend the critical load approach to other pollutants, not only for determining ambient air quality and emission standards for domestic purposes, but also for assigning national quotas in international agreements on transboundary pollution.

Water Pollution Control

Integrated pollution control (IPC) was introduced from 1990 for major processes. In addition, the local land-use planning system examines the location of potentially polluting developments. Discharge consents by the NRA include requirements for effluent treatment and monitoring. The principle of BATNEEC is applied to determine treatment levels, but more stringent restrictions may be imposed according to receiving water conditions. Effluent discharged to sewerage is restricted through contracts with sewerage management entities. A survey has reported a substantial reduction in the concentration of heavy metals in sewage sludge over the last decade.

Waste Management

Policies for waste minimisation are so far not very developed. The IPC concept and the promotion of clean technology are the principal measures. However, IPC has so far focused on air and water pollution, largely because of the greater difficulty involved in integrating waste in pollution control efforts.

Environmental Permitting and the Iron and Steel Industry

The iron and steel sector's potential for environmental disturbances is great. The different industrial processes used in the primary and secondary categories of the iron and steel industry emit significant amounts of pollutants. In addition, this industry is a big energy user and produces substantial amount of hazardous and solid wastes. For example, blast furnace and steel slag (6 million tonnes) account for a large part of all industrial wastes produced (around 70 million tonnes) in the country.

3.2 Monitoring

Requirements for monitoring by the operator are included as conditions in the authorisation. Methods to be used will often be specified. Monitoring is also carried out by the permitting authorities. The National Rivers Authority (NRA) has a duty under Section 84(2) of the 1991 Water Resources Act to monitor the extent of pollution in controlled waters. This is to ensure, among other things, that the water quality standards are achieved at all times. The Department of the Environment has a programme of air quality monitoring, carried out by its own experts or by consultants.

Monitoring results do influence the establishment of standards and the negotiation of permits. In some cases, an authorisation (Improvement Programme) sets a series of obligations to the operator in order to improve the monitoring of prescribed substances as well as other parameters that may be emitted by these processes (i.e. dioxins).

The results of operators' monitoring are placed on the public register. The results of authorities' monitoring are also published in an aggregated form.

In the case of the national water monitoring programme, rivers and lakes are routinely monitored. Since the early 1970s, surveys have been carried out every five years throughout the United Kingdom. Rivers are classified as "good", "fair", "poor" or "bad" according to criteria based on dissolved oxygen (DO), biological oxygen demand (BOD) and ammonia. Water quality monitoring is also carried out in compliance with EC directives.

National ambient air monitoring for smoke and SO_2 started in 1961 at several hundred sites. Networks have been created to monitor compliance with EC air quality standards for SO_2 and smoke (166 sites), NO_x (7 sites) and lead (11 sites). Networks recently created include: the Enhanced Urban Network (12 sites for NO_2, CO, ozone and airborne particulates); the Hydrocarbon Network (6 sites for benzene, 1,3 butadiene and other hydrocarbons) and the Toxic Organic Micropollutants Network (4 sites for PAHs, PCBs and dioxins/furans). A network was established in 1993 to monitor NO_2 in urban areas at over 1 100 sites, with the participation of local authorities.

Monitoring systems for ambient air quality and emission levels are well developed in the United Kingdom. Several monitoring networks are in operation and the DOE maintain a detailed inventory of sources of air pollution. A major effort is made to ensure that the information collected is available to the public. The scientific base for understanding and analysing air pollution issues is strong.

3.3 Trends in Limits

The two facilities have been selected for the case study since they represent examples of the new permitting system, the "Integrated Pollution Control", introduced in the 1990 Environmental Protection Act. In both cases, the statutory environmental quality standards are met, and the main consideration is the achievement of BATNEEC standards.

- **Plant A:**

Plant A is an existing facility that was undergoing no changes at the time the authorisation was issued. The reason for issuing the authorisation was that it was required as part of the implementation of the Environment Protection Act of 1990, which introduced the new system of pollution control. All facilities such as this were required to submit applications for an authorisation under the new system by a certain date (31 March 1992). The facility is a typical iron foundry regulated as a Part B process by a local authority. The permit was issued in accordance with the relevant process guidance notes issued by the Secretary of State for the Environment. The guidance notes set out in general terms the techniques which are considered to be BATNEEC for each category of processes.

The 34 conditions of the authorisation are all legal requirements. Only two of these deal with limit values in the relevant guidance note. The conditions address the inspection, testing, monitoring and maintenance of equipment, corrective action, the keeping of records, specific repairs or improvements that must be carried out with dates for their completion, as well as specific operating practices and issues which must be addressed in the upgrading programme. The limit values are based on a consideration of what BATNEEC for the process can achieve, as set out in the relevant process guidance note, and the specific situation of the plant. The purpose of the upgrading programme is to establish a firm timetable for achieving BATNEEC. However, the emphasis in the authorisation is less on the limit values than on how the plant is operated.

The permit prescribes a number of specific techniques, including technologies. These techniques include the inspection and monitoring of the existing emission control system, the use of a particular, "sticky board" test for exhausts, the maintenance of specific items of plant, and the use and sealing of sealable bags or containers for particle collection and disposal. These techniques are representative for the sector.

The operator of Plant A is required to prepare an upgrading programme within 12 months of the date of the authorisation. This should identify the areas where the existing process does not meet new process standards, the steps to be taken to meet the standards, and the dates by which the steps are to be implemented. Upgrading must be completed by 1 April 1997. The upgrading programme will then be added as a condition to the authorisation by means of a variation notice. An Explanatory Note attached to the authorisation includes guidance on the upgrading programme.

Table 5. **Control parameters in Plant A permit**

Substance and property	Rationale for selection	Measurement period
Dark smoke*	Particular impact of the process	**Continuous** (no dark smoke to be emitted continuously for a period of 4 minutes or more, nor for an aggregate period of 10 minutes or more in any 8 hours period, apart from the first 15 minutes following start-up from cold of a furnace)
Black smoke**	Particular impact of the process	**Continuous** (no black smoke to be emitted for an aggregate period of more than 2 minutes in any 30 minute period)

* Dark smoke means smoke which, if compared in the appropriate manner with a Ringelmann chart as described in British Standard BS 2742:1969, would appear to be as dark as or darker than shade 2 on the chart.

** Black smoke means smoke which, if compared in the appropriate manner with a Ringelmann chart as described in British Standard BS 2742:1969, would appear to be as dark as or darker than shade 4 on the chart.

- **Plant B:**

Plant B is the first major iron and steel process to be given an authorisation under "Integrated Pollution Control". The sample permit applies to a blast furnace of the integrated iron and steel works. The blast furnace has been out of operation since December 1990 and is being refurbished. The blast furnace operation and related raw materials and waste handling processes have been authorised separately ("ring fenced") to enable refurbishment to proceed and to be completed on schedule by January 1996. The permit was issued in accordance with the relevant process guidance note issued by the Chief Inspector.

The precise performance level accepted as the basis for the conditions in the authorisation has been set according to the professional judgement of the inspector about what is BATNEEC for this specific process. All of the conditions of the authorisation are legal requirements. Only Parts 2 to 6 of the authorisation deal with releases from the process and the limit values shown in the following table. These and other parts also address requirements for the operation of the process, including written management procedures, the treatment, storage and disposal of all releases from the process, maintenance of the plant and equipment, the qualifications, experience and training of the staff, sampling and monitoring, records, notifications and improvements. There is also a general requirement that the BATNEEC must be used to prevent, minimise and render harmless any releases of prescribed substances into an environmental medium for which they are prescribed and any releases of other substance which might cause harm if released.

No release from the authorised process shall be made into controlled waters and into any public sewer. In addition, Part 6 of the authorisation specifies the conditions which the operator shall follow in the handling, treatment and management of all releases other than releases into the air, controlled waters or any on-site effluent treatment plant. Other requirements are provided in the Improvement Programme (Part 8 of the authorisation). These relate to the improvement of the monitoring programme (scope of substances surveyed and improvement of data collection), set obligations for the investigations of techniques and measures for the abatement and/or recycling of substances and materials.

Table 6. **Control parameters in Plant B permit**

Parameters	**A1 Cast house bag filter plant**	**A2 Stoves stack**
Smoke	-	No visible smoke emitted except during the first 15 minutes of starting up from cold
Particulate matter (maximum concentration in any period of 2 hours (mg/m^3)	No visible releases of dust with no evidence of deposition in the vicinity of the release point	25
Sulphur dioxide (mg/m^3)	-	250
Oxides of nitrogen (mg/m^3)	-	150

4. TECHNOLOGICAL RESPONSES TO PERMIT REQUIREMENTS

4.1 Equipment Installed/Measures Taken

Plant A

The principal area that had to be reviewed was that of melting. It is currently done by cupola and to continue to do so would require some £500 000 of investment to arrest fume and grit. The response of the plant was to evaluate the costs and benefits of improving the fume arrestment against that of alternative melting techniques. The company decided to invest in electric coreless induction melting which would give them control and flexibility advantages with 50 per cent higher investment costs. A shot-blast plant had also to be replaced in order that the discharges could be controlled within specified limits. However, although the change was a result of environmental pressures, the new unit has been much more efficient, enabling savings on labour and energy such that payback was achieved on this investment within 2 years. With the exception of melting, most actions being taken are external treatment measures, e.g. filtration. However, a project to review water based paints and mould coatings has begun though this is much longer term and therefore external filtration of the existing process will have to be improved in the interim period. In the main, actions and requirements aimed at controlling emissions from processes rather than changing technologies.

Plant B

The permit requirements are complex and comprehensive. They contain an improvement programme with a timetable for implementation against tightening standards. The three main areas where a response was necessary were increased monitoring and assessment, changes to operating practices and the installation of additional abatement equipment. In most cases, the requirements of the Authorisations were already being met or could be met by changes to practices/materials. In few cases it was necessary to install external treatment measures.

4.2 Flexibility Considerations

Plant A

Processes generally require non-flexible approaches with few exceptions, such as the implementation of the plant's project on paints and coatings. Ultimately, external treatment measures may provide some flexibility in attaining the limits set.

Plant B

There is flexibility in the approach that can be used to meet the requirements of IPC permits. However, this has to be within the constraints of justification against BATNEEC.

4.3 Views of Industry Surveyed

The permittees replied that there is not much flexibility under the IPC system. One permittee considers that the flexibility is measured between permit requirements and the technological response within the constraints of justification against BATNEEC. Flexibility is mainly due to the level playing field of external treatment techniques with few exceptions where companies may explore ways of reducing pollutant loads by substitution programs in practices/materials. One permittee considered that BAT and EQO considerations were realistically balanced in the IPC Authorisations.

5. CONCLUSION

The Environmental Protection Act of 1990 marked an important shift towards a streamlined, integrated approach to industrial pollution. It established two parallel pollution control systems. Industrial processes that are potentially the most polluting (Part A processes) are subject to a system of IPC that requires that releases to air and water, and of solid waste, be considered together. To obtain this integrated authorisation, the requesting operator must provide to the permitting authority an evaluation of the environmental impact of all releases, determine the "best practicable environmental option" (BPEO) and apply the principles of "best available techniques not entailing excessive cost" (BATNEEC) for pollution prevention and abatement. Eventually 5 000 industrial processes will be covered under this system, with full implementation by 1996. Minor polluters (Part B processes) must obtain their authorisation from local authorities and apply the principles of BATNEEC for abatement of emissions to air only. All 13 500 existing Part B processes had applied for authorisation by 1993, and 10 000 authorisations have been issued.

Authorisations are required to operate a polluting process, rather than to release polluting substances into the environment. This provides the operator and the regulatory authority with the opportunity to consider the process and its environmental implications as a whole when applying for or granting an authorisation. Conditions are attached to authorisations in order to ensure that best available techniques will be used to prevent, minimise and render harmless releases of polluting substances. Conditions also need to ensure that any statutory environmental quality standards are met. In addition, where the process involves releases of substances into more than one environmental medium, the operator needs to demonstrate that the proposed combination of process and pollution abatement techniques represents the best practicable environmental option (i.e. the option which minimises pollution of the environment as a whole at acceptable cost). The procedure by which an operator applies for, and an inspector determines, an authorisation therefore requires consideration, on a case-by-case basis, of relevant environmental quality standards, best available techniques for operating the process and abating releases and the economic implications of their use, and, in many cases, impacts on the environment as a whole.

While UK pollution control legislation has undoubtedly been shaped by EC Directives on emission limits and EQS, the United Kingdom in turn has been influential in further developing EC policy in this area, taking the lead in the adoption of IPC. The EC has prepared a draft directive on integrated permitting that reflects provisions of the UK Environmental Protection Act.

THE UNITED STATES

1. THE PERMITTING PROCESS

1.1 Constitutional Responsibilities for Environmental Protection

The United States of America Congress enacts statutes, and the Executive Branch carries them out. Congress usually does not establish all the substantive or procedural details of the programs it establishes in the laws it writes. In these cases Congress delegates the power to implement laws to Executive Branch agencies, giving agencies the power to fill in the gaps and impose specific requirements, in the form of rules. Congress may explicitly order agencies to make rules, leave rules to agencies' discretion, or set up procedures for citizens to initiate rules. The Administrative Procedure Act of 1946 defines a rule as: "...the whole or a part of an agency statement of general or particular applicability and future effect designed to implement, interpret, or prescribe law or policy or describing the organisation, procedure, or practice requirements of an agency..."

The US relies on rulemaking by agencies for most of the technical, operational and legal details of all public programs. This is especially true for regulatory programs with large-scale goals and objectives such as those administered by the Environmental Protection Agency (EPA). The EPA decision-making process includes the following:

- Advanced Notice of Proposed Rulemaking - used to obtain general comment on issues before specific rule language is proposed;

- Proposed Rules - EPA proposed rules always contain actual rule language; EPA often provides for public hearings as an additional way to obtain public comment; often EPA provides 60 days or more for public comment;

- Final Rules - some final rules are made effective more than 30 days after publication.

Air

The US air pollution control effort encompasses a joint effort between three levels of government: federal, state and local. The Federal government establishes national standards and then provides overall direction and guidance to the States and local government who develop control programs, rules and regulations. The Federal government approves, through formal rulemaking State/local control plans. Once enforceable rules/regulations are in place, State/local agencies have the primary responsibility for implementing and enforcing, with the Federal government providing technical support and "backup" enforcement authority as necessary.

Through this partnership, State/local agencies and the Federal government codify regulations which emitters are legally required to meet. This is a public process which allows for public comment and participation. Affected groups have the opportunity to submit their comments to the regulatory agencies. Under a public rulemaking process, the government is obliged to respond to all comments. If their comments are not satisfactorily addressed, environmental groups and industry have the right to bring suit in the Federal courts to force action.

Water

EPA is responsible for developing regulations, policy and guidance to assist the States, Territories and Tribes in the development and adoption of water quality standards regulations to meet the goals of the Clean Water Act (CWA). States have flexibility in setting and developing their water quality standards, provided that they will protect the uses of their water bodies and maintain the goals of the CWA. The EPA is also responsible for the development of chemical specific national water quality criteria for the protection of aquatic life and human health. These criteria are intended as guidance and are not binding unless a State, Tribe or US Territory adopts them directly or if EPA formally promulgates them for a state, territory or tribe. Many states have adopted EPA's national criteria as their state standards. Once formally adopted the criteria are no longer considered guidance but are called standards which are legally binding requirements. Standards are legally enforceable numerical endpoints which are applied within a designated water body. Discharge permits are written to comply with applicable standards.

Once water quality standards are adopted by the States, they must be submitted to EPA for review. In its review, EPA must ensure that the water quality standards meet the requirements of the CWA and that they do not interfere with the attainment of standards in the waters of another state. Industry, environmental groups and other stakeholders supply comments to all proposed criteria developed by EPA and when a state proposes to adopt a particular standard. States must hold public hearings for the purposes of reviewing and revising their water quality standards regulations.

Waste

The Resource Conservation and Recovery Act (RCRA) is the primary federal law governing hazardous and municipal waste in the US. Subtitle C is the section of RCRA governing hazardous waste management requirements. The EPA issues the regulations that implement RCRA. The issuing body for State regulations varies from one State to another. The States must issue regulations that are at least as stringent as the RCRA requirements. RCRA permits may be issued by the permitting authority of an individual State or one of the ten US EPA Regional offices, with some permits issued jointly by the two agencies.

1.2 Permits

Air

The permit system for air pollution in the US was comprehensively altered by the Amendments to the Clean Air Act (CAA) in 1990. This new system is still being implemented. All major sources of "criteria pollutants" and "hazardous air pollutants" (HAPS) (see below for details) must obtain a permit to operate. Major sources are generally defined as emitting more than 100 tonnes per year of criteria pollutants or 25 tonnes per year of HAPS. The CAA also requires that new major stationary sources obtain an air pollution permit before commencing construction. This process is known as the new source review (NSR) and is required whether the source is planned for an area where national ambient air quality standards (NAAQS) are exceeded (nonattainment areas) or an area where the air quality is acceptable (attainment or unclassifiable areas). Permits for sources in attainment areas are referred to as prevention of significant air quality deterioration (PSD) permits; while permits for sources located in nonattainment areas are referred to as nonattainment area (NAA) permits. Permits are generally issued and managed at the State or local government levels. However, if a State fails to establish a program which meets the federal minimum requirements or fails to run such a program properly, the federal EPA is required to run the permit program in that State.

A source is generally required to comply with the permit requirements (emission limits) upon start-up. Existing sources, that are covered by maximum achievable control technology (MACT) standards for hazardous air pollutants, have up to three years to comply.

Water

State adopted water quality standards are implemented in the National Pollutant Discharge Elimination System (NPDES) permit program. This program is administered by EPA, but many states have been delegated the authority to administer it with EPA oversight. All point source dischargers, including industrial facilities and domestic sewerage plants, must have a NPDES permit before they can discharge treated waters into navigable waters. The NPDES permit contains limitations and monitoring requirements that a facility must comply with. If a permitting authority determines that a discharge causes, has the potential to cause, or contributes to an exceedence of the water quality criteria, permit limits must be developed to control the discharge and meet water quality standards. The facility must submit the results of its monitoring to the EPA (or the State if it has delegated authority).

Waste

Owners or operators of facilities that treat, store or dispose of hazardous waste must obtain an operating permit under Subtitle C of RCRA, except for generators that store hazardous waste in certain containers, tanks, or buildings for less than 90 days. These permits define the conditions and requirements that apply to treatment, storage and disposal facilities to ensure that hazardous waste is treated, stored and disposed of safely and in a controlled manner. Permits are issued by EPA, by authorised states, or both. A permit is site-specific and can cover one or more units within a facility. Hazardous waste permits under the RCRA do not distribute "rights to pollute". In most cases, the permit does not allow any pollution to be emitted from the regulated facility. One exception is for combustion devices. Site-specific permit conditions are used to implement regulatory standards. These standards may be based on management practices, such as waste analysis, site security, inspections and monitoring, and personnel training or technical criteria, such as material standards for land disposal liners and integrity measures for tanks and containers. The regulatory standards cannot be made less stringent when they are written into a permit. The general public can review and comment on permits before issuance, and specific forums for this purpose must be established. The permitted facility must comply with the permit conditions when the permit becomes effective. Any deviation from the permit conditions must be incorporated in a compliance schedule, which would include specific milestones and is subject to public review and comment as part of the permit. Appeals against permit decisions can be made to the Environmental Appeals Board, a panel of three senior environmental judges.

1.3 Permit Renewal Process

Air

Modifications are required to permits when the air emission associated with a physical change or a change in the method of operation results in a significant net emissions increase. In addition, permits are required to be re-issued at least every five years.

Water

Water permits generally run up to 5 years, although the term for new sources is 10 years.

Waste

For wastes, permits may be issued for a term no longer than 10 years. EPA can issue a permit for less than the allowable 10 year term, EPA is required to review permits for land disposal facilities five years after the date of permit issue or reissue. The permit can be modified at that time if necessary. A permittee may request a modification of any permit condition. Examples of modifications include the management of new wastes, new waste management units and changes in waste management practices.

1.4 Multi-Media Permits

Current legislative language does not allow for the trade-off of emissions into one medium against those into another. Experimental integrated media permits have been recommended by EPA for certain facilities, such as the extensively analysed Yorktown, Virginia, Amoco facility, but the permitting authorities have not acted on this recommendation. The State of New Jersey has recently implemented integrated permits at several facilities. Under the Iron and Steel Bubble 420.03, it may be possible to trade pollutant releases between discharge points at the same site.

Under the Source Reduction Review Plan (SRRP), multi-media issues are considered when developing air, water and solid waste standards. As such, the iron and steel industry has been identified in the SRRP as an industry for which a more integrated (across environmental media) approach to rulemaking is warranted. One minimill has been under review for a potential multi-media permit. Moreover, efforts such as the Office of Water's review of the need for revised effluent guidelines for the industry and the technology-based standards for coke oven emissions under the CAA Amendments will be co-ordinated among several media offices.

1.5 Environmental Assessment

Environmental impacts are considered when evaluating technology-based standards. Further details are given below.

2. BAT, EQO AND ECONOMICS

2.1 Standards Setting and Targets

Air

The EPA applies formal exposure/risk assessment methodologies in assessing the protection afforded by different standard alternatives. The primary standards are set at levels, in the judgement of the Administrator, allowing an adequate margin of safety as requisite to protect public health. Seasonal variations in pollutant levels and transboundary pollution are considered, as appropriate, in developing control strategies to attain and maintain the national ambient air quality standards (NAAQS).

Planning to meet NAAQS begins with a formal finding by the Federal government that an area has not achieved the NAAQS. Areas with measured violations of the NAAQS and areas which contribute to violations of the NAAQS are designated "nonattainment". This is accomplished by Federal rule. All control requirements to meet EQOs (or NAAQS) are directly related to an area's nonattainment designation.

Industrial sources located in a nonattainment area with the most serious ambient air pollution problems generally have the strictest control requirements. These areas also have very stringent requirements for new or modified stationary source construction. All new sources or existing sources in nonattainment areas wishing to increase their emissions must "offset" or "net" their planned emissions with reductions from another source within the same area. Also, existing industrial emitters may install innovative controls that are in excess of those required by regulation and then "trade" or "sell" the extra emission credits to other companies that are required to control their emissions.

All governmental regulatory agencies utilise technical tools to link emissions from industrial plants (as well as mobile sources) with EQOs. Often, based upon very complex dispersion modelling actions, regulatory agencies determine the level of control needed for a nonattainment area and then establish emission limits which sources are required to meet. Control plans must not only ensure attainment of the NAAQS, but also ensure maintenance, factoring in growth.

In instances where air quality standards are not being exceeded, the law requires a basic plan to be in place focused towards maintenance of the NAAQS. It must encompass several important activities. First, it must contain a permitting program for new industrial sources to ensure controls during construction so that the NAAQS are not violated in the future. In addition, continuous ambient air monitoring is required based on population, not attainment status. Finally, a permitting program for existing industrial sources is mandated by the Federal law.

For hazardous air pollutants under the 1970 CAA, EPA considered toxic effects in the setting of standards. Beginning in the late 1970s, EPA performed detailed risk assessments for carcinogens emitted from industrial facilities. The Human Exposure Model was created and used for this purpose. Depending on the pollutant and the industry being regulated, EPA performed assessments of various levels of detail.

The 1990 amended CAA regulates the pollutants that steel mills add to the air. Title I of the Act addresses requirements for the attainment and maintenance of NAAQS (40 CFR, §50). The EPA has set NAAQS for six criteria pollutants, which states must plan to meet through state implementation plans (SIPs) which are provided in Table 1. NAAQS for lead particulate matter frequently affect the industry. The most significant impact of the CAA on the iron and steel industry is tied to the requirements dealing with regulation of toxic air emissions. Under the CAA, EPA is to establish Maximum Achievable Control Technology (MACT) standards for a list of 189 Hazardous Air Pollutants (HAPs) listed in §112(b). Table 2 provides some air emission limit values which concern the iron and steel sector.

Table 1. **National EQS for ambient air quality**

Pollutant	**Standard**
Ozone	0.120 ppm (235 $\mu g/m^3$) - (1 hour average)
Carbon Monoxide	9 ppm (8 hour average)
	35 ppm (1 hour average)
Particulate Matter (PM_{10})	150 $\mu g/m^3$ (24 hour average)
	50 $\mu g/m^3$ (annual arithmetic mean)
Sulfur Dioxide	0.140 ppm (365 $\mu g/m^3$) - (24 hour average)
	0.03 ppm (80 $\mu g/m^3$) - (annual arithmetic mean)
Nitrogen Dioxide	0.053 ppm (100 $\mu g/m^3$) - (annual arithmetic mean)
Lead	1.5 $\mu g/m^3$ (3 month arithmetic mean)

For the steel industry, the stringency and timing of requirements for the industry's coke ovens is of particular concern. During the legislative process, it was recognised that there was no known technology that would reduce risks of emissions to the level mandated by the Act. Specific provisions have been introduced by Congress which mandate a multistakeholders group to negotiate acceptable rules to implement the terms of the Act. In exchange for a standard that is structured to give operators certainty and flexibility in the manner they demonstrate compliance, the industry agreed to daily monitoring, to install flare systems to control upset events, and to develop work practice plans to minimise emissions.

National Emission Standards and Standards of Performance currently in effect that pertain to the iron and steel industry are as follows:

- National Emission Standards for Coke Oven Batteries (40 CFR, §63);

- National Emission Standards for Benzene Emissions from Coke By-product Recovery Plants (40 CFR, §61, Subpart L). Regulates benzene sources in coke by-product recovery operations (see Table 3);

- Standards of Performance for Steel Plants: Electric Arc Furnaces (40 CFR, §60, Subpart AA). Regulates the opacity and particulate matter in any gases discharged from EAFs constructed after 21 October 1974 and or before 17 August 1983. Also requires a continuous monitoring system for the measurement of the opacity of emissions discharged from control equipment;

Table 2. **Some performance air standards for iron and steel processes**

Regulations	**Process**	**Parameter**	**Standards**	
			After 6/11/73	**After 1/20/83**
CAA - 40 CFR 60.140 Subpart N	Basic Oxygen Furnaces (primary emissions)	Particulate	**50 mg/dscm**	- **50 mg/dscm** (for which open hooding is primary emission control method) - **68 mg/dscm** (for which closed hooding is primary emission control method)
		Opacity	**10% ***	**10% ***
CAA - 40 CFR 60.140 Subpart Na	Basic Oxygen Furnaces (secondary emissions)	Particulate		**23 mg/dscm** (for which a control device is applied solely to the secondary emissions from a top-blown BOF or from hot metal transfer or skimming for a bottom-blown BOF)
		Opacity		**10%*** (for secondary emissions exiting the shop roof monitor or other building openings during the steel production cycle of any top-blown BOF or from hot metal transfer or skimming for a bottom-blown BOF) **5%** (for the exhaust from that control device)
			After 10/21/74 - Before 8/17/83	
CAA - 40 CFR 60.270 Subpart AA	Electric Arc Furnaces	Particulate	**12 mg/dscm** (for emissions exiting the control device)	
		Opacity	**3%** (for emissions exiting the control device) **6%** (for emissions exiting the shop and due solely to EAF operations, with these exceptions: (1) limit of **20%** during charging periods; (2) limit of **40%** during tapping periods; (3) the limit applies only when pressures and control system fan motor amperes/damper positions or flow rates are being established for monitoring operations and production cycle **10%** for dust handling equipment	
			After 8/17/83	
CAA - 40 CFR 60.270a Subpart AAa	Electric Arc Furnaces & Argon-Oxygen Decarburization Vessels	Particulate	**12 mg/dscm** (for emissions exiting the control device)	
		Opacity	**3%** (for emissions exiting the control device) **6%** (for emissions exiting the shop and due solely to EAF and AOD operations. **10%** for dust handling equipment	

Note: The above standards are complemented by requirements for emissions and operations monitoring, and for reporting and record keeping.
* With an exception of one 20% period once per steel production cycle.

- Standards of Performance for Steel Plants: Electric Arc Furnaces and Argon-Oxygen Decarburization Vessels (AODs) (40 CFR, §60, Subpart AAa). Regulates the opacity and particulate matter in any gases discharged from EAFs and AODs (used to blow argon and oxygen or nitrogen into molten steel for further refining) constructed after 7 August 1983. Also requires a continuous monitoring system for the measurement of the opacity of emissions discharged from EAF and AOD air pollution control equipment;

- Standards of Performance for Ferroalloy Production Facilities (40 CFR, §60, Subpart Z). Regulates the opacity, particulate matter, and carbon monoxide emissions from electric submerged arc furnaces (used to produce ferroalloys) and their air pollution control devices;

- Standards of Performance for Primary Emissions from Basic Oxygen Furnaces (40 CFR, §60, Subpart N);

- Standards of Performance for Secondary Emissions from Basic Oxygen Process Steelmaking Facilities (40 CFR §60, Subpart Na).

Table 3. **National emission standards for Benzene from Coke by-product recovery plants**
(CAA § 112 40 CFR 61.130)

Standards and Monitoring Requirements
– Requires that tar decanters, tar intercepting sumps, flushing liquor circulation tanks, light-oil condensers, light-oil decanters, wash oil decanters, wash oil circulation tanks, and tar dewatering and storage tanks in furnace coke by-product recovery plants be enclosed and the emissions be ducted to an enclosed point in the by-product recovery process where they are recovered or destroyed. Requirement is based on use of a gas blanketing system. Monitoring requirements: semi-annual visual inspection accompanied by monitoring to detect and repair leaks; annual maintenance inspections.
– Above requirements for process vessels and tar storage tanks also apply to storage tanks for excess ammonia-liquor, benzene, benzene-toluene-xylene mixtures and light-oil in furnace coke by-product recovery plants.
– Light-oil sumps must be completely enclosed (requirement based on use of a permanent or removable cover equipped with a gasket). Semi-annual visual inspections and monitoring for leak detection and repair required for this emission source.
– Zero emissions limit for naphthalene processing, final coolers, and associated cooling towers at furnace and foundry by-product recovery plants (limit based on use of wash-oil final cooler, although other systems can be used).
– Pumps, valves, exhausters, pressure-relief devices, sampling connections, open-lines, and other equipment in benzene service are to be controlled and monitored via the leak detection and repair requirements of 40 CFR 61, subpart V. Exhausters have additional quarterly leak detection and repair requirements.

Water

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). Water quality standards establish the EQOs for protecting the water environment. Water quality standards are laws or regulations that consist of use designations of water bodies, numeric and narrative criteria which protect water quality, and an anti-degradation policy which will maintain the existing uses of water bodies. These components are defined in the federal water quality standards regulation and in EPA guidance documents. States and tribes generally have flexibility in setting and developing their water quality standards, provided that they will protect the use of their water bodies and maintain the fishable/swimmable goal of the CWA. Most states and tribes adopt EPA's water quality criteria guidance in their water quality standards. States may also adopt site-specific criteria by modifying EPA's criteria guidance, or adopt criteria based on other scientifically valid approaches. Where a state fails to develop a required standard or where EPA determines that a revised water quality standard is needed to support the goals of the CWA, the EPA may formally promulgate a standard for the state.

Part 420 of the CWA contains production-based effluent limitation guidelines and standards for 12 distinct processes: cokemaking, sintering, ironmaking, steelmaking, vacuum degassing, continuous casting, hot forming, salt bath degassing, acid pickling, cold forming, alkaline cleaning, and hot coating.

The CWA requires each State to develop Total Maximum Daily Loads (TMDLs) for water bodies that are not attaining or projected to attain water quality standards. The TMDL prescribes the amount of a pollutant that can come from point sources and diffuse sources. The TMDL also includes a safety margin. Limitations from the TMDLs are included in discharge permits to ensure that the water quality standards will be attained.

The steel industry is a major water user; production of a tonne of steel requires an estimated 75 000 gallons of water. Iron and steel facilities are thus subject to categorical effluent limitations guidelines under CWA. Zinc is the predominant metal found in process wastewater. Other metals that may be present include cadmium, chromium, lead, iron and nickel. Oil and grease in wastewater from forming and finishing operations are a major concern in the industry.

Moreover, the Storm Water Rule (40 CFR 122.26(b)(14) subparts (i,ii) require the capture and treatment of stormwater at primary metal industry facilities including iron and steel manufacturing. Required treatment of stormwater flows will remove a large fraction of both conventional pollutants, such as suspended solids and biological oxygen demand (BOD), as well as toxic pollutants, such as certain metals and organic compounds.

Waste

The RCRA of 1976 gives the EPA authority to establish standards and regulations for handling and disposing of solid and hazardous wastes. The Act also requires companies to establish programs to reduce the volume and toxicity of hazardous wastes. It was last amended in 1984 when Congress mandated some 70 new programs for the hazardous waste (Subtitle C) program. Included were tighter standards for handling and disposing of hazardous wastes, land disposal prohibitions, corrective action (or remediation) regulations, and regulations for underground storage tanks. These regulations strongly affect the iron and steel industry. Several RCRA-listed wastes are produced during coke, iron, and steelmaking, forming, and cleaning/descaling operations. These wastes are identified below by process.

Coke Manufacturing:

- Tar residues (KO35, KO87, K141, K142, K147);
- Oil (K143 and K144);
- Naphthalene residues (K145);
- Lime sludge (KO60);
- Ferroalloys (KO90 and KO91).

Iron and Steel Manufacturing (including forming metals):

- Emission control dust and sludge, and rinse or cooling water (KO61);
- Wastewater sludge from cooling, descaling, and rinsing (D006, D007, D008, D009, D010, D011);

Finishing:

- Wastewater sludge from cooling, descaling, and rinsing (D006, D007, D008, D009, D010, D011);
- Wastewater sump residues containing benzene and polynuclear aromatic hydrocarbons (K144);
- Spend pickle liquor sludge (K062). An exemption for this waste is detailed in 40 CFR 261.3(c)(2)(ii)(A). Sludge from lime stabilised waste pickle liquor is not considered hazardous unless it exhibits one or more of the characteristics of hazardous waste.

2.2 Best Available Technology

Air

Two terms are used to describe control technology in the CAA: best available control technology (BACT) and lowest achievable emission rate (LAER). Their use depends on whether the source is located in an area where NAAQS are attained or not. A source locating in an attainment area is required to install BACT, whereas a source locating in a nonattainment area is required to install LAER. The two terms are defined in the 1990 CAA as shown in the following table. Each BACT and LAER determination is made on a case-by-case basis. The EPA manages a computer system which contains all of the relevant data on each of these determinations so state air pollution agencies can see what determinations are being made in other states.

New Source Performance Standards (NSPS) are technology-based emission standards for criteria pollutants based on best demonstrated technology that is economically feasible for a particular source category or process. The 1990 CAA included a new timetable for completing the NSPSs by November 1996. The 1990 CAA also created two new types of technology standards: the maximum achievable control technology standards (MACT) for hazardous air pollutants and maximum control technology standards for solid waste combustion. The definitions of NSPS and MACT are also given below.

For a source located in an attainment area, the BACT is required to ensure new emissions are kept to a minimum by the application of the best technology and consequently provide for additional economic growth. For a source located in a nonattainment area, LAER technology is required to ensure that the source achieves the lowest possible emission rate for the pollutants emitted.

The purpose of the NSPS program was precautionary in nature, based on the principle that all new stationary air pollution sources should be required to control or reduce emissions to the highest degree. In addition, it was the goal of this program to reduce emissions from all industries over the longer term as the industrial base of the country would be replaced and rebuilt. The MACT requirements were established to obtain substantial reductions in HAP emissions as quickly as possible and to require all new sources of HAPs to install state-of-the-art controls as they are constructed.

Water

For discharges to water, effluent guidelines are based on best available technology that is economically achievable (BAT). The guidelines are developed separately for individual industries and by pollutant types, and the economic impacts are assessed for each industry. Facilities must meet BAT on effluent limitations or pre-treatment in all areas. In the case where a BAT standard is not developed, the permit writers must use their best professional judgement (BPJ) in setting requirements; this applies in particular to «non conventional» pollutants.

Term	Definition
BACT	An emission limitation based on the maximum degree of reduction of each pollutant subject to regulation under this Act emitted from or which results from any major emitting facility, which the permitting authority, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such facility through application of production processes and available methods, systems, and techniques, including fuel cleaning, clean fuels, or treatment or innovative fuel combustion techniques for control of each pollutant.
LAER	For any source, that rate of emissions which reflects: (A) the most stringent emission limitation which is contained in the implementation plan of any State for such class or category of source, unless the owner or operator of the proposed source demonstrates that such limitations are not achievable, of (B) the most stringent emission limitation which is achieved in practice by such class or category of source, whichever is more stringent. In no event shall the application of this term permit a proposed new or modified source to emit any pollutant in excess of the amount allowable under the applicable new source standards of performance.
NSPS	A standard for emissions of air pollutants which reflects the degree of emission limitation achievable through the application of the best system of emission reduction which (taking into account the cost of achieving such reduction and any non air quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated.
MACT	The maximum degree of reduction in emissions of the hazardous air pollutants subject to this section (including a prohibition on such emissions, where achievable) that the Administrator, taking into consideration the cost of achieving such emission reduction, and any non air quality health and environmental impacts and energy requirements, determines is achievable for new or existing sources in the category or subcategory to which such emission standard applies, through application of measures, processes, methods, systems or techniques including, but not limited to, measures which: (A) reduce the volume of, or eliminate emissions of, such pollutants through process changes, substitution of materials or other modifications, (B) enclose systems or processes to eliminate emissions, (C) collect, capture or treat such pollutants when released from a process, stack, storage or fugitive emissions point, (D) are design, equipment, work practice, or operational standards (including requirements for operator training or certification) as provided in subsection (h), or (E) are a combination of the above.

Waste

For solid waste being placed on land or land disposed, requirements are expressed as best demonstrated available treatment (BDAT) standards. A BDAT treatment standard can be a numerical standard or a standard requiring the use of a specific treatment technology. The EPA is required to set "levels or methods of treatment, if any, which substantially diminish the toxicity of the waste or substantially reduce the likelihood of migration of hazardous constituents from the waste so that short-term and long-term threats to human health and the environment are minimised". Wastes that meet BDAT treatment standards are not prohibited and may be land disposed. BDAT standards are set for specific RCRA listed wastes as well as RCRA characteristic wastes.

The technical staff at EPA develop a proposal for BDAT. During the development of the proposal, the staff may conduct treatment evaluations of several different technologies and meet with industry representatives, academic experts and environmental groups. After the proposal is published, there is a public comment period. Interested parties are invited to provide comments and data on the proposed treatment standards. After reviewing these comments, EPA publishes a final rule containing the BDAT standards.

The first step in the development of treatment standards may be to divide the wastes to be regulated into groups based on similar physical and chemical properties. The EPA initially decides how wastes should be grouped by examining whether wastes are generated by similar industries or from similar processes. The next step is to identify the BDAT for each treatability group. A treatment technology is considered to be "demonstrated" if a full-scale facility is known to be in operation for the waste or similar wastes. Although pilot- and bench-scale operations are to be excluded from the identification of "demonstrated" treatment technologies, treatment performance data from pilot- or bench-scale technologies may be used in evaluating the performance of demonstrated full-scale treatment operations for certain wastes if data from full-scale operations are not available. Once the "demonstrated" technologies have been identified, the EPA determines whether these technologies may be considered "available". To be "available" the technology itself or the services of the technology must be able to be purchased, and the technology must substantially diminish the toxicity of the waste or reduce the likelihood of migration of the waste’s hazardous constituents. The technology must also not present a greater risk than land disposal of the untreated waste and must not be prohibited because of air emissions. EPA prefers to base BDAT on technologies that further the statutory goals of waste minimisation and recycling. Treatment data from "demonstrated" "available" technologies are then screened with regard to the design and operation of the equipment, the quality assurance/quality control analyses of the performance and operating data, and the accuracy and precision of the analytical tests used to assess treatment performance. Once BDAT is identified, EPA establishes the treatment standard as maximum constituent-specific concentrations allowed in the waste, as a specific technology (or group of technologies), or as a combination of these.

Where BDAT is specified as a specific technology, that treatment technology must be applied to the waste before it can be land disposed. When BDAT is expressed as a numerical level, the waste can be treated by any legitimate treatment appropriate for the waste as long as the treated waste does not exceed the numerical levels.

Table 4 illustrates the prescribed BAT regulatory approaches for air, water and waste according to different types of activities, pollutants and the state of the environment in which industrial operations take place.

Table 4. **Air, water and waste pollution control through BAT approaches**

Air Pollutant	Sources	Attainment Areas (AA)	Non-attainment areas
Criteria	New	New Source Performance Standard	
	Existing	Best Available Control Technology	Lowest Achievable Emission Rates
Hazardous Air Pollutants	New	Maximum Achievable Control Technology - MACT ≥ top single performer	
	Existing	MACT ≥ average of 12% of top single performer	

Water Pollution Control for New Sources	
Effluent limits: NSPS	In all areas: PSNS
Best Available Demonstrated Control Technology (BDT)	Best Available Demonstrated Control Technology (BDT)

Water Pollution Control for Existing Sources		
Best Available Technology Economically Achievable (BAT) for toxic and non-conventional pollutants	Best Conventional Pollutant Control Technology (BCT) for conventional pollutants	Pre-treatment Standard for Existing Sources (PSES): Best Available Technology Economically Achievable (BAT): toxic and non-conventional pollutants
Best Practicable Control Technology Currently Available (BPT) (all pollutants)		

2.3 Environmental Quality Objectives

Air

A number of different types of EQOs have been used for air pollution in the US. The main ones are: national ambient air quality standards (NAAQS) for criteria pollutants and national emission standards for hazardous air pollutants (NESHAP). The definitions of criteria pollutant, NAAQS, hazardous air pollutant (HAP) and NESHAP that were included in the 1970 Clean Air Act are as follows:

Term	Definition
Criteria Pollutant	Emissions of which, in the judgement of the EPA Administrator, cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare and the presence of which in the ambient air results from numerous or diverse mobile or stationary sources.
NAAQS	National primary ambient air quality standards shall be ambient air quality standards the attainment and maintenance of which in the judgement of the Administrator, based on such criteria and allowing an adequate margin of safety, are requisite to protect the public health. Any national secondary ambient air quality standard shall specify a level of air quality the attainment and maintenance of which in the judgement of the Administrator, based on such criteria, is requisite to protect public health from any known or anticipated adverse effects associated with the presence of such air pollutant in the ambient air. An air pollutant to which no ambient air quality 'standard is applicable and which in the judgement of the Administrator causes, or contributes to, air pollution which may reasonably be anticipated to result in an increase in mortality or an increase in serious or incapacitating reversible illness. The Administrator shall establish any such standard at the level which in his judgement provides an ample margin of safety to protect the public health from such hazardous air pollutant. EPA's policy has been to consider that "welfare" as included in the definition of criteria pollutants includes protection of the environment, and where appropriate has considered environmental effects when establishing secondary NAAQS. There are six criteria pollutants: carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter less than 10 microns in diameter, and sulfur oxides. The EPA's NAAQS are reviewed periodically, independent of special control circumstances. The reviews are undertaken on a fixed schedule prescribed in the Clean Air Act.
HAP	In 1990, the Clean Air Act was revised. Significant changes were made to the definition of HAP and a new two-tiered approach to HAP standards was established. The definition of HAP now includes adverse environmental effects in addition to health effects. The 1990 Clean Air Act lists 189 compounds as HAPS. For regulating these HAPS, EPA is firstly to establish best available technology standards and then to establish residual risk standards, as appropriate.
NESHAP	Primary (health based) standards must be attained within prescribed deadlines. Secondary (welfare based) standards must be attained as expeditiously as practicable. The attainment and maintenance of NAAQS are binding requirements. States which fail to meet the deadlines are subject to mandatory sanctions. For NESHAPs set under the 1970 CAA, an existing industrial facility must comply with the standards no later than 2 years after the standards were set. The same is true of residual risk standards under the 1990 CAA. New HAP sources under both the 1970 and 1990 CAA must meet the new standards upon start-up.

Water

Under the CWA, EPA develops chemical specific national criteria for the protection of aquatic life and human health. These criteria must be considered by States and Tribes when they are adopting water quality criteria as parts of their water quality standards. The aquatic life criteria are applied with three major components: magnitude, duration and frequency of exceedence. The magnitude is the numerical concentration of a chemical in the water column and consists of an acute value for short term exposure and a chronic value for long term exposure. The duration is the period of time over which the instream concentration is averaged, and frequency is how often the criteria can be exceeded. Acute values are applied with a duration and frequency of one hour in three years; chronic values are applied with a duration and frequency of four days in three years. The human health criteria are grouped into two categories: those that have the potential to cause cancer (carcinogens) and non-carcinogens. The criteria are designed to protect human health from harm through the consumption of contaminated fish and shellfish alone, and through the consumption of contaminated fish and shellfish and drinking water. The human criteria guidance developed by EPA is used by States in developing their water quality standards. These are based on protecting an "average" adult individual. However, States may adopt more stringent human health criteria to protect more sensitive or highly exposed individuals. States are also allowed to consider site specific aspects when developing their aquatic life and human health criteria.

Waste

EQOs for solid waste (including municipal waste, hazardous waste, and other wastes such as from mining processes) are to protect public health and the environment from releases of chemical constituents in the wastes that are hazardous.

2.4 Negotiations of Standards and Emission Limits

Air

There can be no negotiation of EQO requirements. Best Available Control Technology determinations are made on a case-by-case basis and some negotiation is therefore possible, although emission limits corresponding to maximum achievable control technology (MACT) standards and new source performance standards (NSPS) must be met in all cases. In addition, all permits issued are subject to public review and comment.

Water

Negotiation between all affected parties is a part of the permit process, but the regulatory standards must be met.

Waste

Basic design and operation standards for hazardous waste treatment, storage and disposal facilities are discussed in Volume 40 CFR 264. These standards are usually not subject to negotiation during permitting.

2.5 Economic Considerations

Air

Cost and technological feasibility are not considered in setting NAAQS. To a limited degree, cost and technology can be taken into account when developing the implementation program. For HAPs under the 1970 CAA, by court order, EPA was firstly to select a safe level for a pollutant without considering the cost or economic impacts. The EPA could then consider the cost and economic impacts in deciding which level provided an ample margin of safety.

During each BACT or LAER analysis, which is done on a case-by-case basis, the reviewing authority evaluates the energy, environmental and economic and other costs associated with each alternative technology, and the benefit of reduced emissions that the technology would bring. The EPA's current "top-down" BACT determination process provides that all available control technologies be ranked in descending order of control effectiveness. The applicant first examines the most stringent or "top" alternative. That alternative is established as BACT unless the applicant demonstrates, and the permitting authority in its informed judgement agrees, that technical considerations or energy, environmental, or economic impacts justify a conclusion that the most stringent technology is not "achievable" in that case. The next most stringent alternative is then considered, etc.

In developing NSPS and MACT standards, a similar process is followed. However, the focus of these standards are technologies which are applicable across the entire range of an industrial source category. Economic and energy impacts are also considered in setting the standards. In the case of MACT standards, there are additional requirements that the standard for new sources be at least as stringent as that achieved in practice by the best single source, and for existing sources be at least as stringent as the average of the top 12 per cent, in terms of emission reduction of existing sources.

Average and incremental cost effectiveness (C/E) are the two economic criteria that are considered in the BACT analysis. C/E is the dollars per tonne of pollutant emissions reduced. Incremental C/E is the difference in the cost per tonne of emissions reduced between an emission reduction alternative under consideration and the next less stringent option. Average C/F is the incremental difference in cost per tonne between the current or baseline conditions and the alternative under consideration. Unlike BACT, the LAER technology requirement does not consider economics. Both C/E and economic impact or viability are considered in setting NSPS or MACT standards.

Water

The Clean Water Act establishes a goal of "fishable, swimmable water quality" -- that is water quality which provides for the protection and propagation of fish, shellfish, and wildlife, and provides for recreation in and on the water -- wherever that water quality is attainable. The Water Quality Standards Regulation specifies circumstances, however, under which States may modify the designated use of a water body and dischargers may obtain a variance from the standards set for a water body. The State or discharger must show that attaining the designated use would result in substantial and widespread economic and social impacts or would interfere with important social and economic development. The economic impacts considered are those that result from treatment beyond that required by technology-based regulations. Because water quality resulting from technology-based limits are considered the baseline, all economic impact analyses of water quality standards should address only the incremental cost of meeting water quality standards.

Waste

Economic analyses are completed when setting treatment standards under the RCRA, but are not used in the setting of the standard which is technology-based. Economic considerations are input to the decision making process as regulations are developed. A thorough Regulatory Impact Analysis (RIA) should be performed for all "significant" regulations. RIAs should account for all direct and indirect costs borne by the regulated community and effects "downstream". For regulations not deemed "significant" a less intensive cost or economic impact analysis should be performed. In addition, there are requirements to assess the impact of a regulation on small entities (e.g. small businesses) and the "burden" for regulated entities. In establishing treatment standards for waste, economic considerations including costs are assessed in such a regulatory impact analysis. This analysis includes an assessment of the costs and benefits of potential options in fulfilling a regulatory need. The analysis also investigates the impacts of significant regulations on an enterprise level and industry level basis.

2.6 Interaction of BAT and EQOs

Air

NSPS and MACT standards are national standards that must be satisfied regardless of the attainment status of the area or the need for additional BAT requirements. In attainment areas, a source subject to new source review is required to install best available control technology (BACT). In nonattainment areas, a source subject to NSR rules is required to install control technology that qualifies as lowest achievable emission rate (LAER).

Water

EQOs are binding at the state level and are administered through the National Pollutant Discharge Elimination System (NPDES) for water effluent. EQO requirements cannot be negotiated. This may lead to stricter standards for certain point sources (for effluents) or for whole areas (e.g. prevention of significant air quality deterioration permits).

Waste

During the RCRA permitting process, the imposition of BAT is not affected by whether EQOs are being met. The EQOs must be met in all cases.

3. TRENDS IN PERMIT LIMITS

3.1 Cleaner Technology

The US has many programs to promote increased use of environmentally cleaner technology. The President of the United States announced the Environmental Technology Initiative (ETI) in February 1993. EPA, the Commerce Department and the Energy Department have been particularly active in implementing this initiative. In 1995, 500 peer reviewed private sector projects were funded under ETI, including a Small Business Innovative Research Program, a project administered by the National Science Foundation on 'green chemistry' to incorporate the consideration of environmental effects into the process of synthesising chemicals, and several climate change projects that are mainly focused on energy efficiency. After a phase of focusing on investment in technology development projects, ETI will increase efforts on reforming federal and State policy and regulations, including efforts to alter the permit approval process so that it does not discourage innovative technology, to change regulations that "lock-in" existing technologies, and to incorporate technology innovation into compliance and enforcement practices, on capacity building, and on diffusion projects. As an example, ETI funded a Massachusetts project and a State Innovative Technology Co-ordinator to guide six new pollution prevention technologies through the State's permitting process. However, the US Government is reducing its support for the development of clean technologies. The House of Representatives recently voted to eliminate the Advanced Technology Program and has proposed that EPA's clean technology and Energy Star programs be abolished.

Moreover, the EPA's Common Sense Initiative was announced in November 1993 to encourage pollution prevention in a few pilot industrial sectors including: iron and steel, electronics, metal plating and finishing, automobiles, printing, and oil refining. The programme shifts regulatory focus from concentrating on individual toxic chemicals and media, to industry-wide approaches to environmental problems. An EPA team was assigned to each industry and a strategic plan was developed to identify opportunities to co-ordinate rulemaking and to streamline recordkeeping and permitting requirements. The industry teams are also working with industry to identify innovative approaches in pollution prevention and environmental technology.

Air

Both the "top-down" BACT policy and the LAER technology for nonattainment areas are technology forcing: neither policy establishes specific emission limits, either on a pollutant or source specific basis.

Under the CAA, new sources are given additional compliance time related to meeting NSPS requirements if they wish to experiment with an innovative technology. Unfortunately, the bureaucracy associated with reviewing and approving individual requests has discouraged many companies from making use of this provision. However, the format of emission standards used in most NSPS still provides flexibility to the source in choosing how to meet individual NSPS.

Waste

The RCRA permits contain in some instances technology specific treatment requirements and, in others, performance based treatment requirements. In both cases, it is generally recognised that these end-of-pipe requirements are very stringent. EPA regulations which specify these requirements also set relatively short compliance deadlines after the regulations have been promulgated. The cost of compliance and regulatory burden associated with meeting these strict requirements provide a strong incentive for industry to identify less expensive and cleaner technologies. Many large companies are able to plan and implement such changes while simultaneously meeting end-of-pipe compliance requirements. However, other companies do not have adequate in-house expertise, financial capital or access to information on clean technology. Many companies claim that EPA's regulations are written in a way that emphasises the use of end-of-pipe technologies as the preferred way to meet end-of-pipe requirements, which causes them to invest in end-of-pipe solutions in order to avoid compliance problems. Finally, many companies claim that the compliance period after a regulation is promulgated is so short that they do not have sufficient time or capital to install clean technologies that might avoid having to obtain a permit.

There is provision within RCRA for research, development and demonstration permits to be granted to hazardous waste treatment facilities using innovative and experimental treatment technologies for which no standards exist. These permits are issued for a period of up to one year, and may be renewed up to three times, with each renewal not exceeding one year.

3.2 Monitoring

Air

Monitoring required in permits depends on specific regulatory requirements. Construction permits issued under the PSD or NSR programs will include monitoring developed for the individual source as necessary to show compliance with the BACT or LAER required, respectively. Operating permits under the 1990 CAA will include "periodic monitoring" in addition to monitoring required by the underlying standards. All monitoring results are considered public information, unless they qualify as confidential business information. Compliance is assured through review by EPA, States and affected industry of monitoring, record-keeping and reporting, and through on-site inspections.

Water

Each NPDES permit sets specific monitoring and reporting requirements. These reports are public documents. Both Federal and State agencies review monitoring data to determine compliance with standards.

Waste

Most monitoring under RCRA is conducted by the regulated community. The types of self monitoring a permittee is required to conduct vary with the type of regulated device. They range from reports of self-inspections, to groundwater monitoring samples, to monitoring of certain emission parameters from a combustion device. Waste generators often test their wastes to determine whether they are hazardous, while waste treatment and disposal facilities test hazardous waste to determine whether they comply with treatment standards. In addition, facilities often conduct site monitoring as part of their "corrective action" (clean-up) programs. The monitoring results are placed in an administrative file and are subject to public review, unless they are claimed to be confidential business information. Permittees are required to report instances of non-compliance with permit conditions. Regulatory agencies conduct compliance and enforcement monitoring and periodically conduct inspections of permitted facilities, including any documents the facility may have developed. The agency may also take samples of, for example, groundwater from a land disposal facility. Any violations uncovered by the government agency are also subject to public disclosure. EPA also conducts waste monitoring to determine whether wastes should be listed as hazardous and to develop appropriate treatment standards.

3.3 Trends in Limits

The MACT definition provides that emission standards for existing sources shall not be less stringent than:

(A) the average emission limitation achieved by the best performing 12 per cent of the existing sources (for which the Administrator has emissions information), excluding those sources that have, within 18 months before the emission standard is proposed or within 30 months before such standard is promulgated, whichever is later, first achieved a level of emission rate or emissions reduction which complies, or would comply if the source is not subject to such standard, with the lowest achievable emission rate applicable to the source category and prevailing at the time, in the category or subcategory for categories and subcategories with 30 or more sources; or

(B) the average emission limitation achieved by the best performing 5 sources (for which the Administrator has or could reasonably obtain emission information) in the category or subcategory for categories or subcategories with fewer than 30 sources.

These standards will therefore become more stringent as performance at existing sources improves.[42]

In addition, the permits include requirements relating to the throughput of the plants, technologies to be used, testing and monitoring to be carried out, operating procedures, training of staff, record keeping, reporting and notification. The permit also includes requirements relating to the handling, and storage of materials, products, wastes, operation and management of activities, particularly those with the potential to cause pollution of water or soil, monitoring, sampling, reporting, training, record-keeping, inspections, and pollution control measures and technologies.

Air

The CAA's air toxic provisions will ultimately have major impacts. Included on the list of chemicals under the air toxics program are compounds of chromium, nickel, manganese, cadmium and other heavy metals. Many of these metals can be found in raw materials that are processed in iron and steel plants. EPA's priority list of source categories calls for the development of regulations for most of

42. Information on BAT can be obtained via EPA Internet home page. All CAA, CWA and RCRA regulations can be accessed at this site.

these sources by 1997, but until EPA identifies the appropriate MACT for these sources, it is difficult to evaluate the subsequent impacts and costs for the industry.

Under the CAA 1990 Amendments, EPA will also be reviewing the basis for existing ambient air standards for particulate matter. A lower standard would lead to a multiplication of non-attainment areas, getting the states to impose more stringent emission control standards for sources of particulate matter.

Hydrochloric acid and chlorine are among the pollutants listed as hazardous air pollutants in §112 of the CAAA. Steel pickling processes that use hydrochloric acid have been identified as potentially major sources of hydrochloric and chlorine air emissions, and should be the subject of revised national emission standards.

Title III of the CAAA requires EPA to develop national emission standards for hazardous air pollutants (NESHAP) from specific stationary sources, including iron and steel mills and foundries. In integrated mills, air emission of HAPs may include compounds of chromium, lead, manganese, and polycyclic organic matter, in quantities sufficient to designate these facilities as major sources.

Water

Since approximately 80 percent of the nation's integrated steelmaking capacity is located in the Great Lakes states, the current efforts to develop uniform water quality standards under the Great Lakes Water Quality Initiative (GLI) may have a significant impact on the industry. According to the American Iron and Steel Institute (AISI), the industry is concerned with the establishment of uniform water quality guidance for all waters. The EPA is currently revisiting the CWA need for rulemaking concerning the iron and steel industry discharges. A two-year study was completed in late 1996 for reviewing the existing regulations to determine what changes have been made in the industry since the 1982 regulations were promulgated. One focus of the project is to assess the types of pollution prevention measures that have been implemented.

Waste

Under RCRA, dust and sludge from electric arc furnaces (EAFs) are listed as hazardous wastes and subjected as such to land disposal restrictions. EPA’s treatment standards were originally based on high temperature metals recovery (HTMR), but they have been revised to generic treatment levels for HTMR residues (i.e. slag). As a result, an operator may choose among the various options available, such as stabilisation as an alternative to recycling. However, according to several steel industry trade associations, some of RCRA’s rules have discouraged metal recovery of hazardous wastes generated in steel production, such as the 90-day storage limit rule for generators which lead to increased transport costs.

Steel companies involved in Superfund sites would be affected by changes under impending CERCLA reauthorization. Questions of liability, funding mechanisms, selection of remedial actions, and application of risk concepts are all of concern to the steel industry.

4. TECHNOLOGICAL RESPONSES TO PERMIT REQUIREMENTS

4.1 Equipment Installed/Measures Taken

The permittee has addressed the questionnaire as it pertains to air permitting issues since this is the only permit under which it operates. Nucor's current permit allows the facility to operate at 110 tonnes per hour. Nucor recently submitted its Title V Air Permit Application in October 1995 and allows the facility to operate at 150 tonnes per hour for 8 760 hours with a potential of 1 314 000 tonnes of steel due to the potential-to-emit requirements under title V regulations. Nucor had a NPDES permit due to its onsite wastewater treatment plant, but has been since then on-line with the county sewer. All of the other process water determined to be "contact" (comes in contact with the hot steel) and "noncontact" (does not come in contact with hot steel) is completely recycled throughout the facility and therefore, a NPDES discharge permit is not required. This facility is a large quantity generator of hazardous waste due to the generation of air pollution control dust from EAF. However, Nucor falls under generator status only and is not a Treatment, Storage, or Disposal facility which requires a permit to operate.

Nucor Steel, which began operations in 1969, was one of the first minimills in the United States. It is considered as a leading edge plant. All of the current permit requirements have been attainable. The DC EAF and Consteel scrap conveyor system allows the roof on the EAF to stay closed while adding scrap for melting, whereas, conventional scrap bucket systems require that the roof of the EAF be swung to add the input materials, thereby increasing the emissions significantly because it lowers the efficiency of the direct evacuation system for collecting the emissions. Canopies were also installed over the EAF and Caster to collect fugitive emissions from these operations. A Positive Pressure Baghouse was installed with a rated capacity of 550 000 ACFM to insure that all emissions may be captured and to ensure compliance with the regulations.

A Programmable Logic Control (PLC) system controls and monitors the entire air pollution control operations. Various dampers, EAF pressure, duct pressure, baghouse pressure, temperature, fan amperage, poppel valves, reverse air fans, etc. are controlled and monitored by the PLC system. Low NO_x burners were installed on all natural gas burners for preheating refractory lined ladles and tundishes. The Reheat Furnace for Bar Mill #1 incorporates recuperators to help preheat the air prior to mixing with natural gas for a more efficient heating of the billets. The Reheat Furnace for Bar Mill #2 incorporates Low NO_x and regenerative burners to reduce the emissions and increase efficiency. Various bin vents were installed to prevent fugitive emissions. An enclosed truck loading facility was installed to prevent fugitive emissions during loading of EAF dust. A facility was installed to eliminate the off-site disposal of EAF dust and convert the hazardous material into useful products. A wet scrubber had to be installed for allowing this equipment to operate within the regulations.

4.2 Flexibility Considerations

According to the operator, some of the permit requirements do allow flexibility, but a majority of them do not. “[S]ome of the requirements are not appropriate measures for determining how the facility needs to operate in a sound environmental manner”. These are very specific and do not allow for deviations or different operating routes. Consequently, in the view of the operator, “there is a direct correlation between even more specific requirements and less flexibility, and efficiency and cost effectiveness.”

CONCLUSION

Over the last 20 years, environmental policies in the United States have mostly been directed toward clean-up and pollution control and abatement. Laws and regulations have addressed the most urgent problems, on an issue-by-issue basis, and have been characterised by a command-and-control approach. Thus, environmental regulations have been governed by a series of media-specific laws such as the CAA, the CWA and the RCRA covering respectively air, water and waste issues.

In turn, these regulations are usually translated at the federal level in very explicit and precise terms. Technology-based regulation is largely imposed in the US, as to stationary source air and water emissions, through numerical performance-based standards, but not through regulations that directly command use of a specific technology. This leaves a limited discretion to permitting and enforcement authorities in dealing with pollution sources. Although environmental quality standards exist for many pollutants and different types of environments, BAT approach, in its different definitions, generally represents the minimum requirements imposed on polluters.

Another distinct and important feature of the regulatory framework in the US is the implication of the public in environmental issues. Environmental legislation requires public participation from the earliest stages of policy. This also includes the right of citizens to sue federal or state governments for not implementing environmental laws and regulations. Public participation is also enhanced through informational instruments, such as the Toxic Release Inventory, which have proven powerful tools in spurring pollution prevention initiatives in the industry.

In recent years, a debate has taken place on the relative merits and shortcomings of the command-and-control, media-specific approach. The current licensing program has been criticised for its fragmentary approach and its burdensome procedure which may require hundreds of permits from the different governmental agencies. Another problem is related to the adversarial characteristic of the law. To overcome these problems, recent initiatives aim at involving the different stakeholders in environmental programs, harmonising the programs between state and federal levels, and by promoting voluntary initiatives ahead of regulations. As such, the 1990 Pollution Prevention Act is now gearing governmental agencies towards integrating pollution prevention principles in their approaches and programs. As a result, a multi-media approach, seeking pollution prevention initiatives, is being increasingly developed for major polluting sources, such as the iron and steel industry. In addition, these new programs (e.g. the Common Sense Initiative) aim at addressing the specific needs of sectors, such as the iron and steel industry, and are expected to provide more flexibility to the industry in choosing how to comply with environmental objectives.

This trend toward integrated approaches and policy mixing (assessing cost-benefit results of regulations and combining technology-based approaches with an evaluation of the environmental results achieved) is likely to continue in the future. Although this case study only benefits from one air permit, the US approach to environmental permitting in the iron and steel industry illustrates this ongoing trend toward multi-media and multi-stakeholder approaches for promoting pollution prevention and control.