Methodology for carrying out
Working Groups

Regional Activity Centre for Cleaner Production (RAC/CP)
Mediterranean Action Plan

UNEP

Regional Activity Centre
for Cleaner Production

Ministry of the Environment
Spain

Government of Catalonia
Ministry of the Environment

If you consider that some part of this study could be improved or there is any lack of precision, we would appreciate if you could notify it to us.

Study finished on November 2000
Study published on March 2001

Additional copies or information could be requested to:

Regional Activity Centre for Cleaner Production (RAC/CP)

C/ París, 184 – 3rd floor
08036 Barcelona (Spain)
Tf. 00 34 93 415 11 12 - Fax. 00 34 93 237 02 86
e-mail: cleanpro@cema-sa.org
Web page: http://www.cema-sa.org

TABLE OF CONTENTS

1. INTRODUCTION 7

2. GLOSSARY 9

3. CLEANER PRODUCTION 13
3.1. From end-of-pipe treatment to cleaner production 13
Cleaner production is an integral management strategy 16
Cleaner porduction as a source of opportunities 16
Cleaner production as an adaptable strategy 16
Cleaner production and economic profit 16
Cleaner production and the environmental benefits 17
Cleaner production as an integral policy of involvement 17
Cleaner production and the corporate image 17

4. WORKING GROUPS 19
4.1. What is a Working Group? 19
4.2. Types of Working Group 20
4.3. Actors that are involved and the Collaboration Agreement 22
The companies 22
The expert(s) 22
The Authority 22
The business association 23
4.4. The Co-operation Agreement 23

5. METHODOLOGY AND FEATURES OF THE WORKING GROUP 25
5.1. Prior procedures 25
Initial meeting 25
Selection of the expert 26
Adhesion of the companies 28
5.2. Individual MOEDs 28
Initial visit and meeting 28
Definition of the basic guidelines 28
Presentation of the work proposal 28
Work visits 29
Treatment of the information 29
Evaluation of the opportunities for minimisation 30
Study of the alternatives for minimisation 30
Presentation of the final document 31
5.3. Meetings 31
Preparing the meetings of the Working Group 31
Subjects to be dealt with 32
Follow-up and assessment of the Working Group 32

5.4. Final report 34
The type of sample 34
Description of the industrial processes 35
Waste flows generated 35
Applicable alternatives for minimisation 35
Conclusions 37
Appendices 37

6. BENEFITS AND ASPECTS TO BE CONSIDERED 39
6.1. Benchmarking 39
6.2. Best Available Techniques (BATs) 39
6.3. Sectorial indicators 40
6.4. Group effort 40
6.5. Dissemination of cleaner production 40

7. EXAMPLE OF FINAL REPORT 41
7.1. Type of sample 41
7.2. Production processes 43
7.3. Description of the waste flows generated 52
7.4. Description of minimisation alternatives in the sector 55
7.5. Table summarising the options for minimisation 64
7.6. Table summarising the options for minimisation 65
7.7. Conclusions 67

8. BIBLIOGRAPHY 71

1. INTRODUCTION

In this document, the Regional Activity Centre for Cleaner Production (RAC/CP) of the Mediterranean Action Plan presents the “WORKING GROUPS” handbook, with the aim of providing a practical guide for the application of the methodology developed by the *Centre per a l’Empresa i el Medi Ambient* (CEMA) for drawing up the Working Groups[1]. The aim of this guide book is to offer Environmental Authorities and Business Associations, Chambers of Commerce and other business groups, as well as experts in the environment and cleaner production in the countries involved in the Mediterranean Action Plan, a practical instrument, applied in Catalonia since 1997, to promote the incorporation by companies of pollution prevention at source.

Since 1997, CEMA has collaborated in the execution of six Working Groups in the following industrial sectors in Catalonia[2]:

- Electroplating (17 companies).
- Textile (7 companies).
- Paint application (6 companies).
- Paint manufacturing (6 companies).
- Graphic arts (19 companies).
- Metallurgy (6 companies).

The methodology of the Working Groups is not complicated, however, certain aspects need to be considered during its development in order to make the most of it. These are the aspects that CEMA has identified over the time as it has been carrying out different Working Groups and which it now hopes to transmit to any organism, association, expert, etc. with an interest in carrying out a Working Group.

It is possible that, depending on the country in which the methodology is applied, the function of the different actors involved in the Working Group, as explained in Chapter 3, may suffer variations. These variations will mainly affect the roles played by the environmental authority and the business association. In the specific case of Catalonia, the CEMA provides the methodology and, whenever possible, and involves sectors that are considered to be a priority, it co-finances the expenses with the companies. Despite this, there are no reasons why this function should not be adopted by the Business Association, the Chamber of Commerce, Guild or similar. In the same way, all the previous proceedings given in this Guide (Collaboration Agreements, Adhesion of Companies, etc.) may be different in each case, in function of the legislation applicable in each country or the actors involved on each occasion.

---

[1] To draw up this document, the Regional Activity Centre for Cleaner Production (RAC/CP) contracted Olga Villacañas Beades (ECOASSIST).

[2] At the moment, CEMA is taking part in several Working Groups in other industrial sectors, such as the wine and cava sector and the printing ink manufacturing sector.

The experts should specialise in Cleaner Production and in the industrial sector being studied to ensure the correct development of the Working Group. In countries in which it is difficult to find experts in both subjects at the same time, the necessary knowledge of Cleaner Production can always be provided by the Environmental Authority or another association (Technology Institutes, Universities, etc.)[3].

Before explaining what the Working Groups are, we will give a brief introduction of the concept of Cleaner Production, as the Working Groups are some of the instruments that exist for the introduction and application of this concept in companies. All the different actors who intervene in Working Groups should know and be familiar with this option of environmental management.

Once we have established the framework of Cleaner Production, we will define the instrument that the Working Groups are, the objectives desired in their application and the actors that participate in their development. We will also explain the different kinds of Working Groups that can exist, according to whether the object of the study is a specific industrial sector or a determined geographical area.

The central point of the guide will describe, step by step, the methodology of the Working Groups, commenting on the aspects to be taken into consideration so they can be developed successfully, from the presence of the instrument in the company to the writing up of the final report.

After explaining the methodology, we will present the advantages of having a Working Group for each of the actors that take part in its execution.

Finally, we will present a practical example of some Working Groups that have been carried out in Catalonia, to get a deeper understanding of the instrument.

[3] On occasions, the expert must be previously trained in the concept of Cleaner Production. This is why the supervision of the work by an expert is so important, to ensure that the focus the Work Group should have is not lost.

2. GLOSSARY

Good Housekeeping Practices. The set of correct ways in which staff should act and in which industrial activities should be managed and controlled to favour the minimisation of waste and emissions. Good housekeeping practices are usually carried out at very little expense and therefore offer a fast return on investment and are, in addition, very effective. In many cases, to be able to apply good housekeeping practices, a change of attitude is required that involves the entire company personnel, from the machine operators to the directors, informing them about the project that it is hoped to carry out as well as the objectives proposed and, as these are met, making them participants of the results achieved.

Change of materials. Substitution of the raw materials and/or auxiliary products that have a significant impact on the environment for other less harmful materials or ones that can be reused in smaller quantities, but which preserve the same use as the first ones.

Change of technology. Modification of processes and equipment with the aim of reducing waste flows at source. The changes cover from small changes that can be introduced in a few days at a reduced price to the substitution of processes that involve a high cost. They can consist of changes in the production process, changes of equipment, sequences or conductions, automation, changes in the conditions of operating the processes (flow of water, temperature, pressure, time of residence, etc.), new technologies (data transmission, domotics (home automation), biotechnology, etc.).

Waste flows. Waste emissions in any physical state (gas, solid, liquid) into any receiving medium (water, air, soil).

MOED. Minimisation Opportunities Environmental Diagnosis. Assessment of the possibilities of minimising waste and emission produced or generated by a certain industrial activity.

EMAS. Environmental Management and Audit System. A system that allows for the voluntary participation of companies that develop industrial activities to assess and improve the results of these industrial activities with regard to the environment and that, at the same time, facilitates the corresponding information to the public (Regulation 1836/93 of the European Council).

Emission. The discharge of substances, vibrations, heat or noise into the atmosphere, the water or the soil, either directly or indirectly, by one-off or diffuse sources of the installation (Directive 96/61/EC of the Council, of 24th September 1996, about Integrated Pollution Prevention and Control).

Minimisation. Operations of reducing and recycling at source, which allow the emission generated in a production process to decrease in quantity and/or in hazardousness and with a favourable environmental balance, that is generated in a productive process.

Process modification. Adaptation of the processes that take place in a company so that they will be more efficient. This means potentiating savings in water, energy, materials, etc. by means of changes in the strategy of production, so as not to waste resources, reduce waste flows and carry out production in the most efficient way.

Product modification. Adaptation of the properties and uses of the products made so that, with a broad perspective covering the moment in which the product is manufactured until its final disposal, the environmental impacts are considered as well as the resources, such as energy, water and materials, that these products require in order to make them as efficient as possible. This means that the number of *inputs* that are required for the product to be manufactured are reduced, and at the same time, its useful life is extended (e.g. with parts that can be re-used and disassembled, with a multi-purpose function, etc.).

BATs (Best Available Techniques). Set of techniques, activities, procedures and work methods developed and tried at an industrial level, designed so that they can be applied in a certain industrial context, under economically feasible conditions for the company, put into practice to prevent, or if this is not possible, at least to reduce the emissions to the minimum.

BATNEEC. Best Available Techniques Not Entailing an Excessive Cost. Technical Improvements available as long as they have been shown to be economically viable, once applied to the corresponding environmental sector.

Prevention. Set of measures aimed at preventing the generation of waste flows or at leading to their reduction as well as the reduction of the number of dangerous or contaminating substances they contain.

Cleaner production. Continuous application of a integrated strategy of environmental prevention to the processes, the products and the services, with the aim of increasing global efficiency and reducing risks to humans and the environment. As far as the processes are concerned, the cleaner production includes the preservation of raw materials, water and energy, the elimination of toxic raw materials and the reduction of the amount and the toxicity of all the emissions into water and into the atmosphere, as well as the reduction of the waste. With regard to the products, the object of the strategy is to reduce all the impacts during the life cycle of the product, from the extraction of the raw materials to the final waste. As far as services are concerned, it entails the inclusion of environmental aspects in the design and distribution of the services. Cleaner production is achieved by applying knowledge, improving technology and changing attitudes (United Nations Environment Programme).

Recycling at source. Option for valorisation that implies re-using waste flows in the same production centre where they were generated, either in the same process or in another one.

Reduction at source. Any modification of processes, facilities, procedures, composition of the product or substitution of raw materials that leads to a decrease in the generation of waste flows —in quantity and/or potential danger—, both in the production process and in the later stages of its manufacturing.

Waste. Any substance or object which the owner disposes of, or has the obligation to dispose of.

Special waste. Waste which is explosive, a combustion agent, easily inflammable, irritating, harmful, toxic, carcinogenic, corrosive, infectious, teratogenic, mutagenic or eco-toxic; substances or preparations that emit toxic or very toxic gases on contact with the air or water or with an acid; substances or preparations that are likely, after being eliminated, to give rise to another substance in any environment, for example, a leachate that has some of the previously mentioned characteristics (Directive 91/689/EC).

Environmental management system. Any system that a company implements to organise and control its environmental management.

By-product. The waste that may be directly used as a raw product from other productions or as a substitute for commercial products, and that can be recovered without needing to be subjected to treatment operations.

End-of-pipe treatment. Treatment of the waste flows, downstream of the production process that has generated them, normally in the same industrial establishment where the process takes place, with the aim of preparing them for discharge.

Valorisation. Procedure that allows the resources contained in the waste to be used without endangering human health and without using methods that can cause damage to the environment.

3. CLEANER PRODUCTION

Cleaner production[4] is an option for environmental management that is available to business activities. It includes pollution prevention at source and the minimisation of waste flows[5], which are alternatives that seek to avoid pollution generation as a preferable strategy to end-of-pipe treatment.

Cleaner production follows this strategy and applies it to processes and products.

With regard to processes, cleaner production includes the conservation of raw materials, water and energy, the elimination or the reduction of toxic raw materials or the quantity and toxicity of superfluous waste flows[6].

With regard to products, the aim of the strategy is to reduce all impact during the product's life cycle, from the extraction of the raw materials to end waste.

3.1. From end-of-pipe treatment to cleaner production

The paradox caused by the limited availability of resources and the need for growth and progress in society (to which industrial activity responds decisively by furnishing it with goods and services) requires the reappraisal of processes and mechanisms of management in business. Too often, industrial activities accompany the provision of goods and services with the undesired generation of refuse material and impacts on the environment, the quantity and hazardousness of which businesses are unaware of.

Historically speaking, there are three stages that characterise the attitudes and responsibilities of industry towards the environment.

1. Initially, there was a long period of industrial production that put any environmental consideration to one side. This context changed when new concerns appeared involving the protection of the environment together with the awareness of the limitations of the planet's resources and the effects derived from the impact produced by industrial activities, amongst others, on the environment and man's quality of life. At the same time, environmental legislation[7] that was related with

---

[4] The expression *clean production* has been used in an extreme way as an idealised end stage. We prefer the expression *cleaner production* because it illustrates a more dynamic characteristic that in business denotes a trend.

[5] In Catalonia, minimisation was initially orientated especially towards reducing the volume and toxicity of the most hazardous waste, but the concept subsequently broadened to cover all waste flows.

[6] Waste flows that can be realistically avoided or reintroduced into the productive process.

these concerns also appeared, which gave rise to a new scenario where business has had to respond to new demands and consider the old system of production, which was lacking in environmental criteria, as being a thing of the past and obsolete.

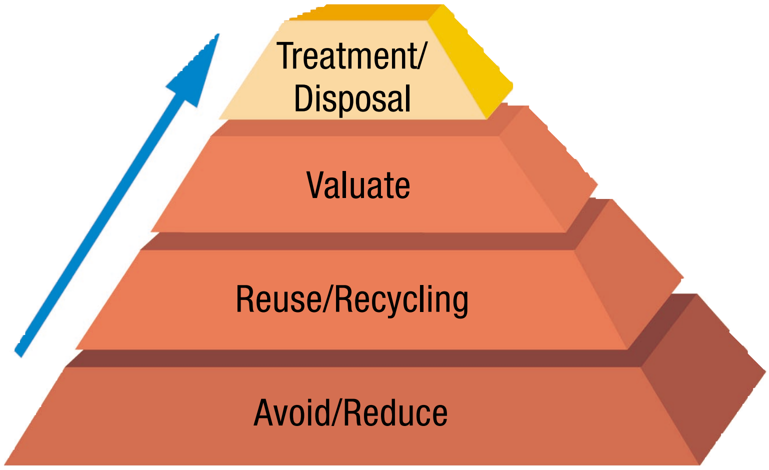
2. In response to the new demands for environmental protection and the incipient environmental legislation, businesses began to anticipate the internalisation of environmental costs brought about by their industrial activity by initiating environmental management with correction criteria aimed at the end-of-pipe treatment of waste flows. The first steps were aimed at constructing numerous equipment and premises (treatment plants, incinerators, stabilisation and disposal premises, etc.), with waste and industrial emission treatment systems that often favoured the transfer of pollutants from one physical medium to another, and are therefore not so effective from the point of view of the integrated reduction of pollution. These measures involve an economic expense; they don't "add any value"; they only act once pollution has been generated; and they have to be repeatedly put into practice because they do not treat the source of the pollution.

3. At the present time, a course is being set that will bring about a veritable change in the way the problem of pollution is approached and managed, as is the generation and treatment of waste flows in business activities that goes beyond the mere prescriptive nature of legislation by offering new opportunities for optimisation and saving in business. Although we obviously cannot consider installations that are merely corrective, and which are complementary, as being a thing of the past, unnecessary or out of date, the trend is towards cleaner production. Prevention is a working hypothesis and the first option that needs to be studied, both economically and environmentally speaking, and is much less expensive than correction.

This order of priorities when approaching environmental management in business should follow the sequence appearing in the following diagram *(Figure 1)*.

[7] According to *Waste Minimisation. Environmental Quality with Economic Benefits* (April 1990. EPA / 530 - SW-90-044), a publication by the United States Environmental Protection Agency, it wasn't until the mid 1970s that the problems associated with toxic and hazardous waste (a name that varies according to local legislation), parallel to which, at the same time, the Resource Conservation and Recovery Act began to develop extensive legislation on the subject. In relation to this, the *Toxic Release Inventor*y was developed in the USA, which were emission inventories of over three hundred controlled toxic substances.

Figure 1
PRIORITIES OF ENVIRONMENTAL POLICY



It must be said that despite the new trends towards cleaner production, which are already firmly established as an idea, there are still businesses that have to get over this initial hump, along with a series of basic obstacles because their imperatives have more to do with the classical concepts of competitiveness and productivity, the level of sales, etc., than with impact minimisation and waste flows that they generate. When it comes to guiding programmes and implementing cleaner production policies in business activities, the obstacles can be summarised as follows:

I. Environmental management is considered to be an economic burden and not an opportunity to optimise processes and reduce costs.

II. Many businesses have no organised or structured information about their environmental situation, either from an in-house or an external point of view.

III. Established systems, tradition, routine, day to day work and production needs all add up to a lack of information in many businesses on prevention and pollution reduction, on the technology and techniques that make these possible, and the competitive advantages that they generate.

IV. There are still few businesses with specialised, in-house experts to deal with the environmental questions generated by their production and organisational processes.

V. The main aim to be considered nearly always tends to be the achievement of emission or disposal thresholds laid down by legislation and to not go any further, which is precisely where one finds the true marginal benefit of environmental management.

VI. For many environmental experts and consultants, it is easier to resort to corrective end-of-pipe solutions than channel actions to prevent and reduce pollution at source for this means getting deeply involved with production processes.

VII. The integral costs of environmental management (recovery, storage, transportation, disposal, taxes, etc.) are generally unknown and incorrectly assigned to the product as a general expense.

Cleaner production offers a series of advantages when compared to end-of-pipe pollution treatment that make it preferable as a strategy for environmental management in business, although we should not forget that end-of-pipe treatments, as corrective measures, are a complement.

Cleaner production as an integral management strategy

Cleaner production is a business management strategy that goes beyond any specific goals that may arise on occasion and entails a policy that takes all of the productive process of a business into account. End treatment, on the other hand, does not take the whole productive process into account and only deals with specific effects without confronting the origin. It also adopts a position that just tags along behind any problem that arises.

Cleaner production as a source of opportunities

Cleaner production optimises processes taking place in the company, it enhances the adaptation to new trends towards process efficiency and facilitates the company's growth and competitiveness through improvements to its operating conditions. End-of-pipe treatment, on the contrary, offers no new opportunities to the business, as it only responds to mitigating the waste flows that are generated. Cleaner production can be said to promote the software, and provides an analysis, opportunities and a more efficient way of operating within the business, whereas end-of-pipe treatment is based only on the hardware, on actions with no added value, such as investment in equipment and premises, or external treatment processes.

Cleaner production as an adaptable strategy

As a strategy incorporated within the production process as a whole, cleaner production automatically responds to the variations that this process may produce (increase in productivity, increase in the use of certain materials, etc.), and can be applied to a specific process or all of the processes in a business, to different stages of a process or it can be started in stages according to the needs and possibilities of the company.

End-of-pipe treatment is less adaptable as it is only conceived as a supplementary phase of the production process and can therefore not respond so easily to changes occurring within that process.

Cleaner production and economic profit

Through the application of viable cleaner production measures, savings are made in the cost of waste flow treatment while the fostering of more efficient measures leads to savings in the consumption of water, energy, raw materials, etc. At the same time, the optimisation of production processes brought about by cleaner production can lead to an increase in a business' productivity[8] due, for example, to time-saving which can be reinvested in the same process, or, with cleaner technology, to production being increased at the same time. End-of-pipe treatment does not an-

[8] The combination of a more efficient use of resources together with an added increase in productivity is called eco-efficiency.

ticipate any saving in costs for the business while, on the contrary, **it does involve an additional cost that is constant and which grows as business production increases and as the result of any new regulation that may appear.**

Cleaner production and the environmental benefits

Cleaner production is a more positive option for the environment in that it prevents the generation of pollution and brings about a more efficient use of resources. End-of-pipe treatment is also an option that reduces the pressure of contamination on the receiving medium, although it acts only after this has been generated and does not bring about the more efficient use of water, energy, raw materials, etc.

Cleaner production as an integral policy of involvement

Cleaner production improves and optimises the working structure and level of technical development in a business. Moreover, it is a strategy that is adopted by the entire workforce of a company, from machine operators to the managing director, and involves a prior learning and awareness process that is reflected in better environmental and production practices.

End-of-pipe treatment involves the conscious action of the company director who proposes the measure and of the specialist who implements it but it does not promote responsible actions that include the involvement or benefits that derive from the entire workforce.

Cleaner production and the corporate image

Any strategy that incorporates environmental criteria is beneficial to the corporate image. Cleaner production and the treatment of waste flows comply with this requirement, although present trends show that prevention is better than correction, in both environmental and economic terms. Pollution prevention is thus the best option for the corporate image of a business.

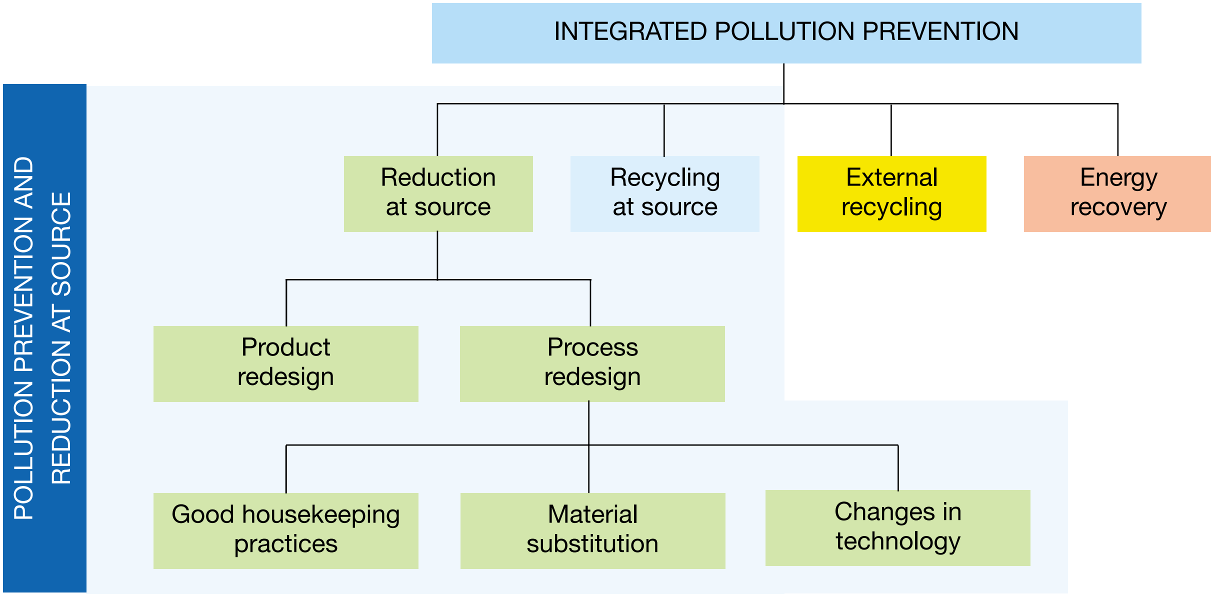
The following diagram clearly sets out the actions needed to promote cleaner production in a business activity. *(Figure 2)*

Once it has been accepted in principle that pollution prevention at source has advantages for the production process, it is necessary to move on from theory to practice. How can the opportunities to reduce pollution at source be detected in each specific case? And, something that is fundamental for businesses, how does one distinguish the options (of prevention or treatment) that are more viable and recommendable?

One obviously cannot correctly manage something that is unknown and/or insufficiently identified or measured, in short, undiagnosed.

A diagnostic tool is thus necessary for enabling a business that is designing its environmental policy to decide which options are open to it and to what degree. The MOED is one of these tools.

Figure 2
POLLUTION PREVENTION AND REDUCTION AT SOURCE



4. WORKING GROUPS

4.1. What is a Working Group?

A Working Group, as its name indicates, consists of the creation of a **group made up of a group of companies and one or several experts, with the aim of defining alternatives for preventing and reducing pollution at source in the sector or geographical area represented by the companies that make up the group**. Apart from the analysis and work with a specific number of companies, it aims to extract information applicable to other similar companies (same sector or same problem) who were not a part of the Working Group. Thus, working with a reduced number of companies, alternatives for minimisation can be found for a specific industrial or geographical sector.

The number of participating companies is variable, but it should never be less than six, as the fewer companies that participate the less representative of the sector they are. The upper margin is more difficult to establish as it depends greatly on the complexity of the processes of the industrial sector being studied, in the case of the sectorial Working Groups, and on the diversity of the industrial sectors present in the geographical area covered, in the case of territorial Working Groups. However, more than 10 companies would make the development of the work too slow and impractical. The duration of the Working Group should be no longer than six months.

The methodology of the Working Group consists of carrying out an individual Minimisation Opportunities Environmental Diagnosis (MOED)[9] for each of the companies[10] that make it up and a series of periodical meetings between the representatives of the companies and the expert who is directing the Working Group to deal with matters for preventing pollution that are suitable for the interests of the sector or the territorial area the Group represents.

The final result will be a report that will bring together the pollution prevention alternatives applicable to the sector or geographical area represented and the important points discussed and presented at the meetings and an individual MOED for each of the participating companies. The information contained in the final report will be of an anonymous nature and will not include the names of the participating companies.

---

9 See Guide to "MOED: Minimisation Opportunities Environmental Diagnosis", published in English, French Spanish, and Arabic by the Regional Activity Centre for Cleaner Production of the Mediterranean Action Plan. ISBN 84-393-5126-7 May 2000.

10 In Catalonia, the information contained in the MOED is totally confidential and can only be accessed by the company being diagnosed, the expert (who signs a confidentiality clause in the contract) and the CEMA. The CEMA guarantees not to disseminate the information and to maintain absolute confidentiality about the data.

Unlike other tools, such as some sectorial audits carried out without any direct contact with the company, **the Working Groups are based on interactive work between the participating companies, which provide real information on their situation and expose the weak and strong points of the sector or geographical area being studied with the expert, who studies and presents suitable solutions for the existing problems.** Thanks to this work in which the companies are so directly involved that the Working Group manages, on many occasions, to cover other subjects apart from pollution prevention at source, as other environmental problems that concern the companies are talked about (for example as a result of the analysis of the waste flows, a lack in the authorised management for a specific waste in the sector may be detected). This close collaboration with the companies allows the Authority to get to know perfectly well, the characteristics and concerns of the sector or geographical area being studied and to be able to work at finding solutions to the problems detected.

The MOED carried out in each company belonging to the Working Group detects the opportunities for minimisation and proposes alternatives for each of them. **Each participating company will therefore have a made-to-measure diagnosis of minimisation, but in addition it will be able to make the most of the exchange of knowledge with other companies during the meetings.** Therefore, this is the added value of participating in a Working Group for the companies interested in doing the MOED. For example, it may be that one of the alternatives proposed in the MOED of some of the participating companies has already been implemented in another company in the Working Group. In the meetings of the Working Group, this company will be able to share their experience with the rest of the companies interested and explain why they implemented it. Without doubt, one of the reasons that most motivates a company, when redesigning a product or modifying a process (apart from the economic and environmental benefits foreseen) is knowing that the alternative has already been implemented successfully in another similar company.

The final report presents the industrial processes studied and the opportunities for minimisation of the processes detected and collects all the alternatives for the sector(s) being studied, avoiding the specific alternatives of a particular company that are difficult to apply to the rest of the companies in the sector. For example, in the case of a company that carries out a process that is not carried out in any other company in the country.

Once the Working Group is finished, the final report will be put at the disposal of the other companies that have not participated so that they can find out about the alternatives for minimisation that are technically and economically viable in their sector, as well as the other matters dealt with during the meetings (presentation of technologies, interests and concerns of the participating companies, etc.) and the conclusions of the Working Group.

4.2. Types of Working Group

A Working Group has different objectives, depending on whether it is a sectorial or territorial type. **The objective of the sectorial Working Group is to define the alternatives for minimisation in a given industrial sector,** extracted from a group of companies that are representative of the sector. The result of the Working Group will be, therefore, a series of alternatives for minimisation applicable to the companies in the sector.

In a **territorial Working Group** the companies can belong to the same industrial sector or to different sectors, however, **the area of the study is a geographical area with a specific problem.** In this case the result must be a series of alternatives for minimisation to solve the environmental problem of this specific geographical area.

Let us imagine the case of a hydrographical basin deeply affected by the industrial activity in the area. An action in the industries will be required to reduce the impact on the river into which the wastewaters are poured. Let us imagine that the degradation of the river is due to a high concentration of organic matter. In this case, the Working Group will focus on finding alternatives for preventing and reducing at source the wastewater with a high content in organic compounds, whatever the sector to which the companies in the area being studied belong[11].

It may happen that the territorial Working Group does not focus on a specific problem but covers all the waste flows generated in the area being studied. Whether it concentrates on a specific problem, or one of a general nature, a territorial Working Group needs to make a previous analysis of the problem present in the territory in question in order to find out about the following points:

- The environment affected (water, soil, air, ...).
- Pollution present in the environment affected.
- Industrial sectors responsible for the pollution.

From this analysis they will be able to define the companies that should form part of the territorial Working Group. Normally there is more than one company from each industrial sector/sub-sector in the area (although this will depend on the size of the area covered) and a series of companies must be chosen that adequately represent the problem of the sector and the territory to which they belong. It is also possible that a single company in the geographical area being studied represents an industrial sector. In this case, it should be included as long as its participation is necessary because it is directly related to the problem being studied.

In the case of the territorial Working Groups, the final report may assess the reduction in pollution that could be achieved in the territory being studied if the companies participating were to implement the pollution prevention alternatives proposed. It is difficult to extrapolate the evaluation to the rest of the companies in the geographical area covered that have not participated in the Working Group, as they do not know their minimisation potential (without a previous minimisation diagnosis of the companies or a declaration from the company, it is impossible to know what alternatives are already implemented and whether the ones that have not been implemented are feasible or not)[12].

[11] Although in this example the focus is very specific, the generation of other waste flows in the companies must be taken into account, to prevent passing the pollution from one medium to another.

[12] The Working Group offers alternatives that are applicable to the same industrial sector, but the parameters that define whether or not an alternative is viable in the companies that have not participated in the Working Group are not known: space, budget, quality of products, etc.

4.3. Actors that are involved and the Collaboration Agreement

When CEMA designed the methodology of the Working Groups it defined the following actors[13]:

- The companies.
- The expert(s).
- The Environmental Authority.
- The business association.

Herein is a list of the functions that are assigned to each of them when a Working Group is made.

The companies

The companies are the object of study and provide real information on the degree of implementation of pollution prevention at source. In addition, their participation is vital to be able to contrast the feasibility of the alternatives and propose the best ones for each case (sometimes companies show that some of the “by-the-book” solutions cannot be applied in practice).

The expert(s)

The expert provides the knowledge of pollution prevention in the industrial sector or sectors being studied and directs the Working Group. In the same way, he must be familiar with the MOED methodology. The expert is the person who will carry out the MOEDs in the different companies, prepare the Working Group meetings, look for minimisation alternatives applicable to the sector being studied and draw up the final report.

The Authority

The function of the relevant Authority in environmental matters and, if it exists, in cleaner production[14], is to disseminate the concept of cleaner production between companies and present the tool of the Working Group and the advantages of carrying it out. It also proposes the carrying out of a Working Group to industrial sectors that are potential contaminators or companies in a vulnerable area when it considers it could be particularly beneficial for the environment[15].

During the setting up of the Working Group it collaborates with the companies, making sure that the expert follows up on the methodology established.

It is obvious that the administrative organ that participates in the Working Group cannot have functions of inspection or sanctions or control, as it must collaborate closely with the com-

[13] The actors and their functions can vary according to the modality of implementation of the Working Group.
[14] In Catalonia this is done from CEMA.
[15] In Catalonia the adhesion of companies to the Working Groups is completely voluntary.

panies. It will be much easier to create an atmosphere of trust if its functions are exclusively those of assessment and help and guarantee that it will not disseminate the company information[16].

Once the Working Group has finished, the function of the Administrator consists in the dissemination of the information collected in the final report[17] to promote the implementation of cleaner production among the rest of the companies[18].

In addition, it is recommended to carry out a follow up on the state of the implementation of the alternatives to periodically check the efficiency of the Working Groups. Therefore, it would be advisable, whilst the Working Group is being carried out, to establish environmental indicators suitable for facilitating the follow up.

The business association

During a first stage of contact, the business association usually acts as intermediary in the communication between the Authority and the Company. The business association convenes the companies to the initial meeting in which they present the methodology of the Working Group and ensures the participation of the right number of companies, to ensure the correct function of the tool.

Once it has been decided to go ahead with the Working Group, the business association co-ordinates the bureaucratic tasks (the joining of companies, convening meetings, etc.) and, usually, provides the facilities for the meetings.

However, its most important role is that it represents yet another means of disseminating the information contained in the final report amongst its associates.

4.4. The Co-operation Agreement

In the case of Catalonia, the Working Groups are based on signing a Co-operation Agreement between the CEMA and the corresponding business association. Each company adheres to the Agreement through an individual document.

In the case of Catalonia, the Co-operation Agreement contemplates the following points:

- Objective of the agreement.
- Obligations of the signatories.
- Methodology of the Working Group.
- Financing.
- Confidentiality of the CEMA and of the expert.

---

[16] In Catalonia, CEMA carries out these functions and maintains the confidential nature of the information provided by the companies.

[17] The information gathered in the final report is anonymous and does not refer to any specific company.

[18] The Ministry of the Environment of the Government of Catalonia collaborates economically in carrying out the Working Groups in the sectors that are considered to be a priority, providing, depending on the case, between 50% and 80% of the budget. In addition, once CEMA, has finished the individual MOEDs, it informs the companies of the different lines of aid that are available from the Authority to carry out the necessary investment.

In the case of the territorial Working Groups, there may not be a territorial business association that represents all the participating companies. In this case, it would be rather slow and complicated to sign an agreement with each of the business associations of the sectors represented. Two options will be considered:

- Signing a Collaboration Agreement between all the participating companies and the relevant environmental authority.
- Not signing any Collaboration Agreement and to individually contract each of the MOEDs and the elaboration of the final report.

In this case, the environmental authority will take on the functions of the business association.

In table 1 there is a summary of the functions of each of the actors.

Table 1: Functions of the actors

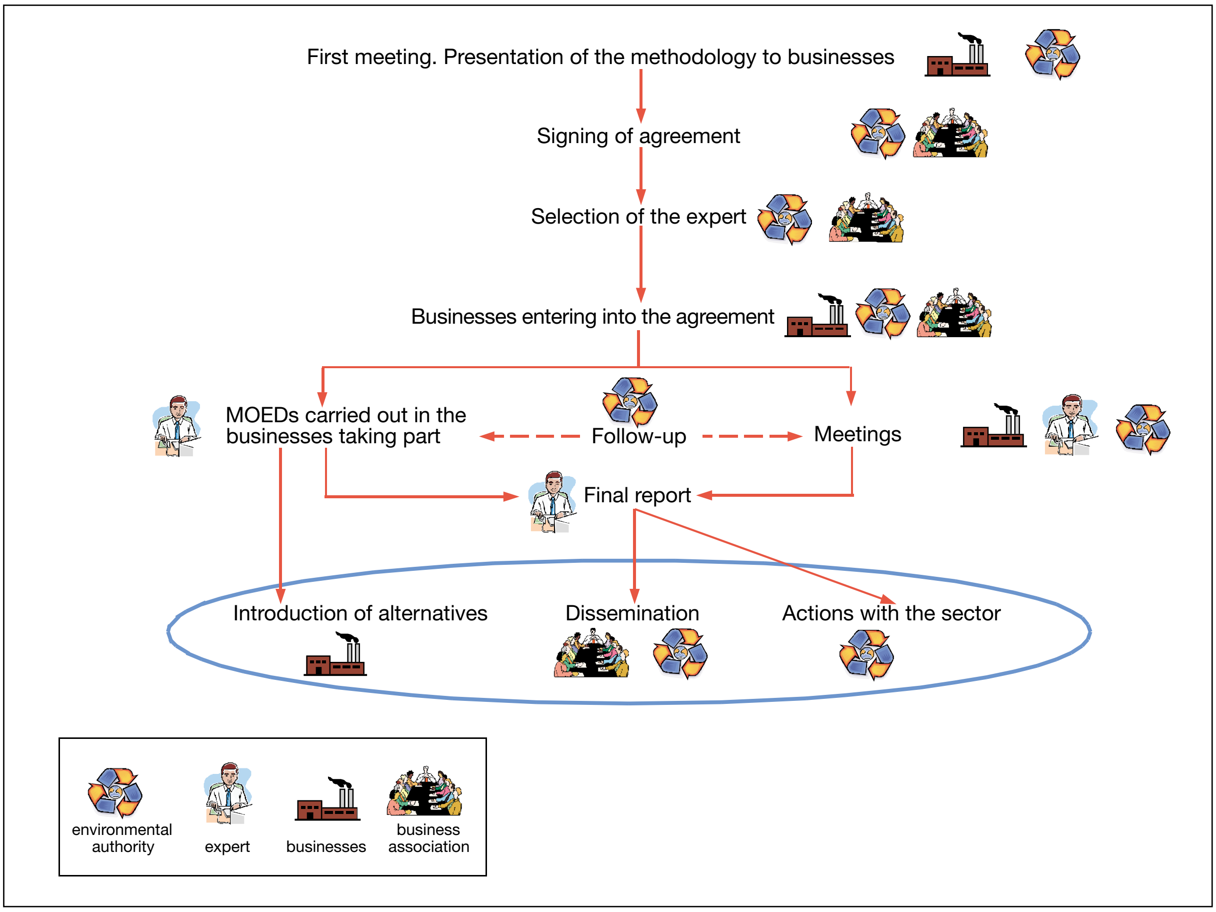
Function	Actor
Summoning of the companies	Business association
Methodology presentation to the companies	Authority
Signing of the agreement	Business association and Authority
Joining of the agreement	Companies
Carrying out of the individual MOEDs	Expert
Preparation of the meetings	Expert
Attendance at the meetings	Expert, Companies and Authority
Writing up of final report	Expert
Dissemination of final report	Business Association and Authority
Introduction of the alternatives[19]	Companies
Follow-up of the implementation of alternatives	Authority

[19] In Catalonia, the implementation of the alternatives proposed in the MOED is voluntary.

5. METHODOLOGY AND FEATURES OF THE WORKING GROUP

Before starting with the execution of the Working Group, a series of previous procedures must be carried out to ensure that it is set up correctly. These procedures, as well as the methodology used in setting up the Working Groups themselves (MOEDs, meetings and writing up the final report), will now be presented:

Figure 3
METHODOLOGY OF THE WORKING GROUPS



5.1. Prior procedures

Initial meeting

As previously mentioned the initiative for the Working Groups can come from different actors. It can come from the companies themselves, the Authority, the expert, the business association, etc. Independently of who the promoter is, the methodology will be presented to the companies at the initial meeting[20] (*fig. 4*). In this meeting the following aspects will be made clear:

- Environmental, economic and competitive advantages of applying cleaner production.
- Methodology of the Working Group and its positive aspects.
- Tasks and functions that correspond to each of the actors.
- Confidentiality that will be maintained throughout the whole Working Group and after it has been formed.
- Existing possibilities of financing.

This is the moment to clear up any doubts that may arise and therefore it must be a participative meeting with an open and cordial question and answering session. One must not forget that in many cases the companies and the Authority are not in frequent contact and that the development of the initial meeting depends to a great extent on the companies adopting a participative attitude and being well disposed to taking part of the Working Group.

Figure 4
INDEX OF THE WG METHODOLOGY PRESENTATION

Index of the presentation of the WG methodology at the initial meeting (CEMA)
• What is cleaner production? • Advantages of cleaner production • Presentation of the CEMA • What can CEMA do for the companies? • Working groups: —Definition —Composition —Objectives —Obligations of the different actors —Minimisation Opportunities Environmental Diagnosis (MOED) —Possibilities of economic aid

To avoid bureaucratic procedures making the beginning of the Working Group last too long, during the initial meeting the companies that wish to participate can be asked to inform of their decision as soon as possible. It is a good idea to give a maximum date by which companies should present their applications. This can be decided on the day of the initial meeting.

Selection of the expert

One of the most important aspects of the development of the Working Group is the selection of the expert. The expert must meet the series of characteristics listed below:

[20] In Catalonia, the CEMA is in charge of presenting the methodology to the companies.

- *Technical ability to carry out the MOEDs.* This means knowing the industrial sector(s) to which the participating companies belong and being up to date with the pollution prevention alternatives that exist for each of them. If the expert does not have a clear understanding of the concept of minimisation he will create confusion between the companies and fail to achieve the objective of the Working Group[21].

- *Ability to lead and organise a group*. Whilst the Working Group is active, the expert, with the help of the person responsible from the Authority, will lead the meetings and redirect the subjects dealt with when necessary. Poor leadership could give rise to meetings with limited or incorrect content.

- *Ability to make the group participate*. In any meeting, if after the presentation of the information, the intermediary does not manage to make the others participate actively and generate comments and questions, it very probably means that the subject was not of interest to them and therefore the meeting will not have served its purpose. The expert has to know or find out about what concerns the companies and deal with these subjects at meetings. In addition, he has to create an atmosphere of confidence that encourages a high participation. In this way he will obtain first-hand information that will enable him to assess the different alternatives for improvement. Nobody can help the expert to assess the feasibility of an alternative better than the companies themselves. For example, the expert might know about an alternative that consists in a raw material change at one stage of the process that would create less waste and that would also have a cheaper price than the one that is usually used by the companies in the Working Group. He may even have information about the introduction of this alternative in other companies that are similar to those in the Working Group. At first sight, this seems to be a technically and economically feasible alternative. On the other hand, maybe the quality of the finished product decreases compared to the raw material used to date and the quality requirements of the clients of the participating companies do not allow its use. If the expert does not achieve the participation of the companies in the meeting, when it ends, he will know that they will not implement the alternative, but will propose it nevertheless in each of the MOEDs[22].

- *Ability to synthesise*. Once the MOEDs have been written up and the Working Group meetings have finished, the expert must prepare a final report, that brings together the alternatives applicable and the conclusions of the work taken from the MOEDs and the meetings that were held. If the expert is not able to synthesise all the information obtained he risks the final report being a mere compilation of alternatives for minimisation and minutes of the meetings. The expert needs to analyse all the information and present the conclusions, as this report will be used later for working with other companies in the sector or in the area being studied and to carry out actions from the Authority to help implement cleaner production.

[21] Although these kinds of warning can seem obvious they are decisive when ensuring the success of the Working Group. Bring together a group of companies to work on a subject as “novel” as cleaner production is not an easy task and we must be sure that they can get something out of it and that we help the implementation of cleaner production with actions of this kind. An unwise choice of the expert would be a wrong move in the effort to introduce the concept of cleaner production into industry.

[22] As we have already repeated several times, the expert must know the industrial sector and the existing alternatives for minimisation, but he cannot be expected to know all the variables of the alternative that make it feasible, as on many occasions only the company can provide all the information necessary.

Adhesion of the companies

Before contracting the expert and starting the Working Group the participation of sufficient companies must be ensured for it to be a representative Group. Only in this way can we guarantee that the information obtained corresponds to the reality of an industrial sector or a specific territory. Forming a Working Group means that the companies and the Authority must assign a part of their human and economic resources to the activity. By signing the agreement (if it exists) or a contract, the participation of the companies is assured.

The greater added value that a Working Group affords the companies is the exchange of experiences with other companies. Therefore, if the number of companies willing to participate does not ensure the representative nature of the Working Group, it is better to recommend these companies have an individual MOED done and to wait until there are enough participating companies to form a Working Group at a later date.

5.2. Individual MOEDs

We do not aim to repeat in the handbook everything that was previously written in the guide to "MOED: Minimisation Opportunities Environmental Diagnosis"[23]. However, as it is part of the setting up of the Working Group, below is a summary of the methodology for carrying out a MOED.

Initial visit and meeting

Before starting the diagnosis the expert must visit the company. Although, in the case of a Working Group, during the initial meeting they will have already clearly defined the objectives of the work, this first visit will serve to prepare later work visits better and to know the areas where it will be necessary to place most emphasis.

Definition of the basic guidelines

The first stage of planning a MOED requires the following aspects to be well defined:

- Scope of the study.
- Significant areas and processes.
- Key questions to be focused on.
- Aspects that can be excluded.
- List of people who will need to be visited and their position.
- Methods of collecting information (internal and external).

Presentation of the work proposal

In the case of the Working Group, many of the points will already have been established in the initial meeting and in the contract drawn up with the expert. However, this is the moment to make

[23] This Guide was published in English, French Spanish, and Arabic by the Regional Activity Centre for Cleaner Production of the Mediterranean Action Plan in May 2000.

the objective of the work quite clear, the degree of participation that is expected from the company and to explain to all the interlocutors the purpose of the work and the importance of their participation.

Work visits

Depending on the complexity of the processes and the size of the company, a greater or lesser number of visits will be held for collecting information and reviewing the processes and the installations. Normally, between two and four visits to the company are enough.

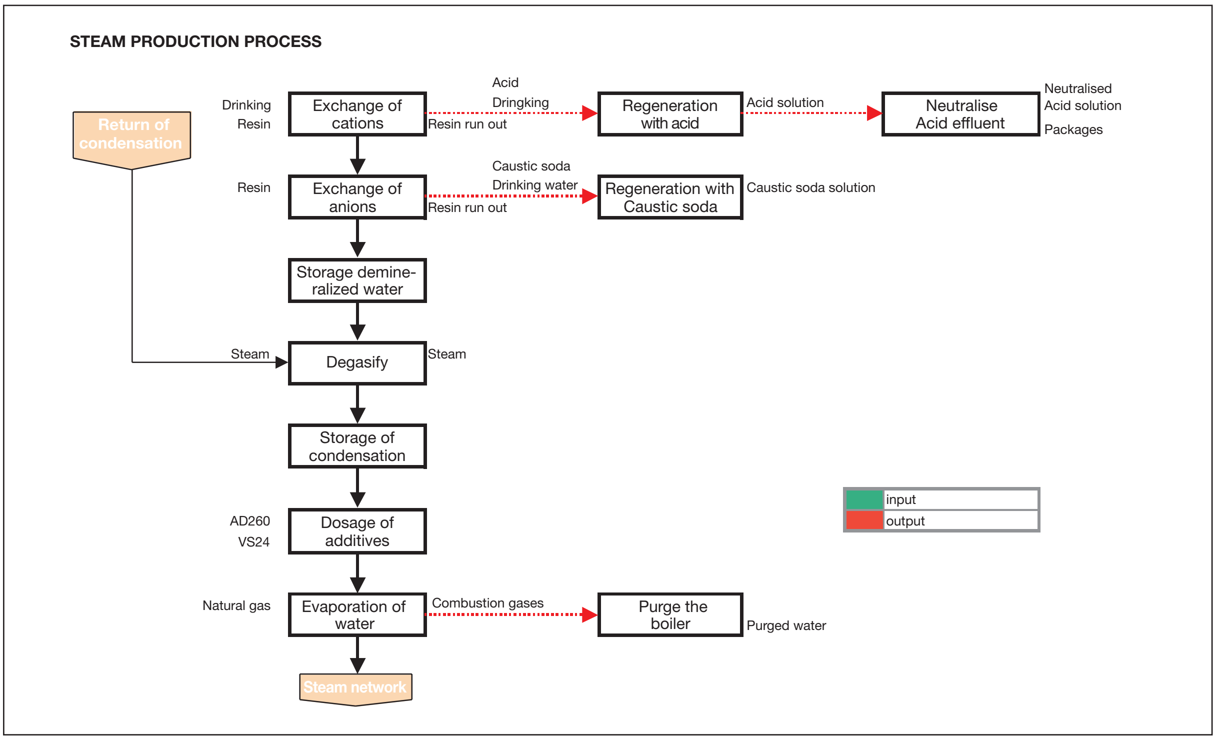
To collect information, interviews with the personnel and visits to the facilities are carried out. To facilitate this task, it is a good idea for the expert to prepare an ordered and structured system for industrial processes, as later the different processes will be analysed by the black box method[24]. Therefore, the more information that can be obtained segregated by process, the more tailored the analysis will be. This can also be structured according to waste flows, however, in our opinion, it is better to do it by process. However, on many occasions the information available is general company information and is not segregated by process (this is the case, on many occasions, of the consumption of natural resources and the generation of waste flows). In this case, we must try to quantify it as much as possible, remembering that this is not a project of details and that empirical calculations or estimation of information can always be done if it is impossible to obtain fast and simple real and precise data.

Treatment of the information

As we have already mentioned, a treatment of the information gathered structured in black boxes is carried out, until the required degree of detail is obtained. It is at this stage that the missing information is requested in order to be able to define the resources involved in the different processes (raw materials, auxiliary materials, water, energy, etc.) and the origin and quantity of the waste flows. In other words, it is a question of analysing materials until the most significant losses in the processes and activities are defined. *(fig. 5)*

[24] Each industrial process or sub-process (depending on the degree of detail desired) is represented by a box in which there is a flow of material (input: raw materials, energy, consumption of water; output: products, by-products, waste flows, heat...). The inputs and outputs of materials must be quantified in order to offer a balance of the material and detect from the analysis of the balance the opportunities for minimisation for each process.

Figure 5
DIAGRAM OF PROCESS INPUTS AND OUTPUTS



Evaluation of the opportunities for minimisation

For each waste flow we need to study:

- Quantity generated.
- Process in which it is generated.
- Environmental impact.
- Expenses incurred that can be attributed to the generation of the waste flow.

In this way the specific opportunities for improvement will have been identified.

Study of the alternatives for minimisation

For each opportunity for improvement the alternatives that exist must be studied, valuing their environmental benefit and their technical and economic feasibility. The proposed alternatives will be reducing or recycling the pollution at source, giving priority to reduction over recycling.

First, we will analyse the technical feasibility of the alternative to check that is can be implemented in the company studied, as there could be a multitude of technical conditioning factors that make it impossible to do so (lack of space, quality problems, incompatibility with other processes, etc.).

Later, we will analyse the economic feasibility calculating the net saving that the implementation of the alternative would mean and the investment payback period. As a general rule, an alternative is considered economically feasible when payback period is less than three years and unfeasible when it is greater than ten years. In intermediary cases, it is recommended to carry out a closer economic analysis calculating the NPV[25] and the IRR[26].

Presentation of the final document

Before presenting the final document a rough draft is presented to the company. Once the company has checked that the data included in the MOED is correct, the final document is presented and handed over. At this moment, a meeting will be held with the company to comment on the options for improvements detected and the alternatives proposed.

This meeting will have nothing to do with the Working Group meetings as, with the aim of maintaining the confidential nature of the work carried out and the information obtained, only the person responsible for the company being diagnosed, the expert and the representative of the Authority will be present.

5.3. Meetings

Preparing the meetings of the Working Group

Before holding the first meeting, it is a good idea for the expert to have carried out a prior visit to each of the participating companies. In this way, he will have the information necessary (type of company, processes used, technology used, raw materials used, extent of implementation of good housekeeping practices, etc) to adjust the contents of the meetings to the measure of the participating companies. In fact, it could be that once the expert has visited the companies he finds it a good idea to divide the Working Group into two or three sub-groups. This could occur, for example, in the case of the sectorial Working Groups, because the degree of technological development is very different or the size of the companies is too unequal and the subjects need to be treated in a different way for each of the sub groups.

Another advantage of having carried out a prior visit to the companies is that during this first contact some of the concerns of the company can be detected (such as new technologies with which they are not sufficiently familiar, or the lack of knowledge of the possible advantages of adjusting a previously existing process).

With all the inputs received from the companies and with his intrinsic knowledge of the matter, the expert will prepare the content of the meetings.

The number of meetings to be carried out during the Working Groups is variable and should be defined when contracting the expert. In any case, it is recommended to have at least one meet-

[25] NPV: Net present value. It is the updated price of the differential benefits that are generated each year. It represents the benefits that are generated during the life of the investment, measured at the beginning. A positive NPV means that the investment is feasible and the greater the value, the more interesting the investment is.

[26] IRR: Internal rate of return. It is the interest at which the present value of the differential benefits accumulated each year equals the value of the investment made. It is calculated by equalling the NPV to zero.

ing a month, as a longer period between meetings would make them too sporadic to facilitate comprehension and assimilation of the concept of cleaner production by the participants.

Subjects to be dealt with

The subjects of the meetings will be defined according to the knowledge the Working Group has of cleaner production. In fact, on occasion it will be necessary to give a brief explanation of the most fundamental concepts and explain the different legal requirements applicable to the participating companies in environmental matters. However, the objective of the Working Group should not be forgotten, and therefore, these explanations should be short and not take up more than one or two sessions.

The subjects to be dealt with in the meetings are:
- Waste flows generated in the sector(s) and their environmental impact.
- Applicable alternatives for minimisation.
- New technology and new materials. The expert can count on the help of the supplier of the technology or material, who can reply with exactitude to the companies' questions. If some of the participating companies have implemented the alternative presented in their company, it would be of great interest if they could explain the experience to the rest of the companies.
- Good housekeeping practices applicable[27].

In some of the Working Groups created in Catalonia, a practical experiment was carried, in which each of the participants provided the data from their company necessary for the study of implementing a specific alternative and they did a feasibility study. At first sight, this experiment could seem too easy to be interesting, but it must not be assumed that all companies are used to carrying out this kind of calculation and balance with regard to the environment and that they know that they obtain economic advantages by applying cleaner production.

Matters of great interest to the entire group, apart from the present programme, can arise through the interventions of the participating companies. These subjects are as important as, or even more important than those listed in the programme (we have already mentioned that companies have some information that the rest of the actors do not have). In some cases, the number of subjects contributed by the companies is so great that the number of sessions needs to be increased.

It is a good idea for the expert to write up the minutes of each meeting, to ensure that all the subjects are later included in the final report.

Follow-up and assessment of the Working Group

The representative of the environmental authority must ensure the correct functioning of the Working Group. It is a good idea to carry out a questionnaire or other kind of survey during the time it is active *(fig. 6).* In this way, any problem that is detected can be solved in time (changing the programme for the meetings, way of carrying out the MOEDs, etc.). Both the beginning and the end of a meeting are good moments for doing this.

[27] See the Guide "Design and Application of a Good Environmental Practices Programme in Industry" published by the Regional Activity Centre for Cleaner Production of the Mediterranean Action Plan.

On the other hand, to favour a relaxed atmosphere and the confidence of the companies, during the interventions of the companies it is advisable that the representative of the authority does not take notes. Should he consider it necessary to do so at any given moment, it would be advisable for him to explain the reasons openly. At first sight, this recommendation may seem rather shocking for technicians of environmental authorities who consult this guide. However, if we have said that the success of the meetings depends to a great extent on the good choice of the expert, it does not depend any less on the attitude of the representative of the authority, who must be friendly, collaborative and at no time inquisitive or controlling.

Figure 6
SAMPLE QUESTIONNAIRE FOR THE FOLLOW-UP OF THE MEETINGS

EVALUATION OF THE MEETINGS OF THE WORKING GROUP

Please circle the answer you consider being most suitable

1) PROGRAMME - DOCUMENTATION

a) Have the subjects dealt with been appropriate?

0	1	2	3	4	5
very poor	could be improved	regular	good	very good	excellent

b) The duration of the subjects dealt with was:

0	1	2	3	4	5
very little	insufficient in general	sufficient sometimes	correct	excessive	very excessive

c) Were the documents handed over adequate?

0	1	2	3	4	5
very poor	could be improved	regular	good	very good	excellent

2) LEVEL OF THE TRAINING SESSIONS

a) The level of the training received in the sessions was:

0	1	2	3	4	5
very poor	could be improved	regular	good	very good	excellent

b) The training received is of use to my company:

0	1	2	3	4	5
never	very little	sometimes	fairly	almost always	always

3) TEACHING STAFF

a) I think that the technical ability of the teaching staff was:

0	1	2	3	4	5
very poor	could be improved	regular	good	very good	excellent

b) I think that the professional experience of the teaching staff was:

0	1	2	3	4	5
very poor	could be improved	regular	good	very good	excellent

c) I think that the teaching staff was open to suggestions and comments:

0	1	2	3	4	5
never	very little	sometimes	fairly	almost always	always

d) Did they reply to questions and doubts exactly?

0	1	2	3	4	5
never	very little	sometimes	fairly	almost always	always

4) SUGGEST A SUBJECT FOR FUTURE MEETINGS: ....

5) POSITIVE ASPECTS OF THE MEETING: ....

6) ASPECTS THAT COULD BE IMPROVED: ....

5.4. Final report

Once MOEDs have been written up for each of the companies and the meetings have ended, the expert will draw up the final report. As we mentioned earlier, this is not just a compilation of the information on the MOEDs and of the meetings. The following aspects must be considered:

- Type of sample: size of the companies, sector and sub-sector to which they belong.
- Description of the industrial processes, ways of working and organisation.
- Waste flows generated.
- Applicable alternatives for minimisation.
- Analysis of feasibility of the alternatives and proposal for indicators to assess the minimisation achieved with its application.
- Conclusions.
- Appendices: didactic material used in the meetings, minutes of the meetings, information on technology, etc.

It is vital to remember that:

- Final report is of an **anonymous** nature, and for reasons of **confidentiality** at no time will the identity of the participating companies be revealed. In the same way, all the industrial processes will be explained, bearing in mind not to explain the aspects that companies consider to be their own and the disclosure of which could affect their competitiveness.

- It is not a question of describing each of the companies or providing quantitative information about each of them (although it is a good idea to provide relative percentage data, as explained later). Therefore, the processes carried out will be explained in a general way, as will the waste flows generated and the reason for their generation and the alternatives for minimisation applicable in the sector in general, however, **it will not transcribe step by step the MOED** carried out at each of the companies.

The **objective of the final report** is that it should be a useful tool for:
- Other companies interested in implementing cleaner production.
- Offering solutions from the Authority and the business associations to specific problems in the sector or territory being studied.
- Disseminating cleaner production.

The type of sample

The following data, at least, shall be included:
- Number of participating companies.
- Distribution of the size of the companies.
- Distribution of the sectors (territorial Working Group) or of the sub-sectors (sectorial Working Group).
- Information about the production of the participating companies.

The production information is especially important as it allows ratios of consumption of resources and of waste flow generation per unit of finished product to be obtained and thus have available an efficient environmental indicator. This indicator will serve for each company to know about its situation in relation to others, although this proposal of indicators must not be considered exclusive as in each case it must be determined which are the most appropriate to allow a simple and adequate follow up.

Description of the industrial processes

This part will include:
- Information on the consumption of raw materials.
- Information on the consumption of water and energy.

Whenever possible, the data presented will be relative to the unit produced, as the absolute data is of no use as a reference for the other companies in the same sector who wish to consult the final information and check whether they are managing their consumption correctly.

In addition, it should describe in detail each of the industrial processes carried out in the companies. If, for the same process, different types of equipment or technology are used, this should be mentioned in the description of the process, as it can vary enormously. This is the case, for example, of the process of pre-printing in a printing industry. A company with the c*omputer to plate* system will not develop the plates and therefore the waste flows and their environmental incidence may be very different from those of a company that does so.

Waste flows generated

In this part, the waste flows generated in each process will be described, with their characteristics and the reasons for their generation. In the same way, for the information on resource consumption, whenever possible, data on the unit of production will be provided.

Applicable alternatives for minimisation

For each alternative, its technical description will be given, and its advantages and disadvantages. It is very useful to provide data referring to the reduction of pollution that it is hoped will be achieved by implementing the alternative. Obviously, this will vary from one company to another, but guidance values can be given. Charts or tables are very useful as they allow you to quickly review the different alternatives and compare the feasibility of each of them. In the description of each alternative, the indicator of minimisation will be defined for its follow up *(figs. 8 and 9).*

Figure 8
ALTERNATIVES FOR MINIMISATION IN THE FOOD SECTOR

Pollution prevention opportunity: Decrease in the conductivity of wastewater
Alternative: Collecting the salt from salting fish
Category: Good housekeeping practices
Related process: Fish salting assembly line
Waste flow affected: Salt water

The alternative consists of collecting the dry salt, by aspirating the recipients and equipment and sweeping the floor before cleaning the facilities. This would reduce the amount of salt water that would end up in the clean water. In addition, some of the tables do not have trays meaning that salt falls to the ground easily. In this way the salt would be retained in the tray and could be collected easily and managed as valorizable waste.

Technical feasibility

The alternative proposal is easy and totally adaptable to the current process and installations of the companies studied.

Economic feasibility

INVESTMENT: Tray: 120.20 €

SAVING:
Reduction in water consumption 40-50%
Decrease in the costs of water treatment
Annual savings: 901.52 €

PAYBACK PERIOD: 1.6 months

Indicator of minimisation

m^3 water/kg fish processed
concentration of soluble salts in the water entering the wastewater treatment plant

Figure 9. CHART SUMMARISING THE FEASIBILITY OF THE ALTERNATIVES DETECTED IN THE WORKING GROUP OF THE GRAPHIC ARTS SECTOR

Technical feasibility	***Options for minimisation***
Fully feasible: installation of a serial system	Plates: water Films: chemicals and water Osmosis: pre-filtered
Fully feasible: installation of an independent apparatus	Dampening: filtered Offset scrapers: cleaning apparatus
Feasible “a priori”, depending on the characteristics of the company	Dampening: cooling Black inks: preparation Sanitary water: pedal taps
Feasible in large companies	Evaporator Distiller Solvents: automatic additives Flexo: closed chamber cartridges CTP System
Economic feasibility	***Minimisation options***
Fully feasible	Sheets: water Films: chemicals and water Dampening: filtered Offset scrapers: cleaning apparatus Black inks: preparation Solvents: automatic additions Flexo: closed chamber cartridges
Feasible “a priori”, depending on the characteristics of the co.	Dampening: cooling
Feasible in large companies or those with significant volumes of waste flows	CTP System Evaporator Distiller Osmosis: pre-filtered Sanitary Fittings: pedal taps

Conclusions

This part will summarise the current situation of the sector or territory, according to the information collected from the companies in the group, and it will give recommendations to follow for implementing cleaner production in the sector or territory being studied. This part will assess the reduction of the pollution (through the indicators) that will be obtained if all the participating companies implement the feasible alternatives proposed in their MOEDs.

It will also include the comments collected from the companies. This stage is a key point in the final report as it reveals the concerns and motivations of the companies and will allow future lines of work to be established.

Likewise, it will propose the most highly recommended alternatives for minimisation according to the current situation and its technical and economic viability[28] *(fig. 9)* and include the needs detected for the environmental development of the sector or territory being studied.

Appendices

This last part will include:
- Teaching material used in the meetings.
- Minutes of the meetings.
- Technical information on technologies provided by the suppliers.
- Technical articles that refer to minimisation alternatives.
- Any information that could be of interest and that has not been collected in the different parts of the report.

[28] In the part on minimisation alternatives, the proposal from the different MOEDs will already have been described, but in this part the most highly-recommended ones will be collected, in other words, the ones that can be applied to any company type. It is not necessary to repeat the explanation, it is enough just to list them.

6. BENEFITS AND ASPECTS TO BE CONSIDERED

Below are the main benefits that can be obtained through the action of a Working Group.

6.1. Benchmarking

Any work that entails a relationship between companies with a common objective is a good opportunity to exchange information.

As a result of the collaboration of the Working Group, information is obtained on the quantity of pollution generated in each process per unit of the product manufactured. This information helps the companies to carry out a comparative analysis and establish their competitiveness compared to other companies, as far as environmental management is concerned.

In addition, the meetings are a good opportunity to get new ideas from companies that are more advanced in implementing cleaner production and to obtain first-hand information that will help in the decision making on implementing alternatives.

On occasions, however, when there are conditions of high confidentiality with regard to the industrial processes of the participating companies, it can be complicated for the expert to achieve the complicity and participation required to allow this exchange of information to be really useful to the objectives of the group. Therefore, it is highly recommended that the common benefit of the sincere and open exchange of information be emphasised.

6.2. Best Available Techniques (BATs)

For the application of European Directive 96/61/EC on *Integrated Pollution Prevention and Control (IPPC)*, for each of the industrial sectors listed in Annex 1, a BREF reference document is being written that covers the best available techniques that are economically feasible for each of them (European IPPC Bureau, IPTS, Spain)[29].

These reference documents are being carried out by means of information exchange between experts appointed by the different countries of the European Union. The countries can present information of the sector in their country and proposals for technology, so that they are considered in the study and can thus adopt a competitive situation with regard to the BATs they define.

[29] Although this part refers to the regulation applicable in the member countries of the European Union, it can be adapted to other countries, with regard to the source of sectorial information that the Working Group represents.

The sectorial Working Group is a good source of information as it presents the feasible technologies for preventing pollution at source at the same time as it offers data on the situation of the sector at any given time.

6.3. Sectorial indicators

The environmental indicators of a particular industrial sector can be defined based on a theoretical study of it. However, it is possible that when applying the indicators to the companies in the sector, they need to be adjusted so that their application is really practical. A sectorial Working Group allows indicators of minimisation to be defined for the sector, based on the direct analysis of it, and a common position to be reached with the participating companies, with the aim of defining them more precisely.

These indicators, which are presented at the end of the final report, allow the companies to periodically analyse their environmental management and compare themselves to the rest of the sector to assess whether they are in a competitive position or whether, on the contrary, they need to make a greater effort in implementing cleaner production.

In addition, having these indicators is of great use for the companies that have implemented a system of environmental management according to the ISO 14001 standard or the European EMAS Regulation, and, therefore, have implemented a system of continuous improvement that they must assess.

6.4. Group effort

Working Group information is collected about the needs of a specific sector or territory and generally the companies ask for help in the aspects that they find they cannot achieve without the intervention of the Authority and/or Business Association. Both for the corresponding Environmental Authority and for the Business Association to which it belongs (if it exists) this information is of great interest when preparing plans of action.

6.5. Dissemination of cleaner production

The final report of the Working Group is at the disposition of any company, expert or association, etc. that is interested in the information it contains, both in the offices of the Administrative organism and/or the Business Association that have participated. In addition, the Authority will disseminate the information collected during the Working Group through conferences and talks with other companies.

Another means of dissemination is the teaching material that can be prepared from the information available, such as good housekeeping practice guides or case studies of cleaner production technology applicable to a specific sector, cleaner production handbooks focused on a specific territory, etc. This material can be prepared in a paper support or through a Web site belonging to the corresponding environmental Authority and/or the Business Associations.

7. EXAMPLE OF FINAL REPORT

Given below is an example of all of the parts that make up the final report of the Working Group. Points from the two Working Groups carried out most recently in Catalonia (others are being prepared) have been included. Preference has been given to this way of presenting the example instead of including the final report of just one Working Group as there are different ways of undertaking them and the aim is not to impose one single model to be followed, provided that the report includes at least the points defined in the manual.

The Working Groups[30] presented in the example are:

- Graphic Arts Working Groups. 1999.
  Expert contracted: RCC Ricard Casals Consultants, S.A.
- Metallurgical Sector Working Group. 2000.
  Expert contracted: DEPLAN S.L. (Development and Environmental Planning).

7.1. Type of sample
(Graphic Arts Working Groups)

The working group comprises a total of 19 businesses that are distributed in two large groups:

- ***Group A:*** 10 companies with over 100 workers or in the offset subsector.
- ***Group B:*** 9 companies with fewer than 45 workers or forming part of other subsectors.

General data	
Number of companies	19
Location	Province of Barcelona: 95% Other areas: 5%

Subsector

Broadly speaking, all of the businesses analysed specialise basically in printing, except for one whose main activity is pre-press (although it also does digital printing). Nevertheless, most of them also do other tasks connected fundamentally with pre-press and post-press (print handling).

The following table gives the percentage of businesses that, a part from the usual printing processes, also carry out processes involving pre-press, post-press and print handling, or that offer services to other businesses, such as photolyth and plate preparation.

[30] When reading through the examples, one should bear in mind the context (Catalonia) in which these Working Groups have been undertaken, for there are references to specific bodies of the Catalan Environmental Authority.

Subsector	Percentage of businesses
Pre-press	84
Printing	100
Post-press (print handling)	79
Services to third party companies	16

Workers

Workers	% Businesses Group A	% Businesses Group B
1-20	—	34
21-50	10	45
51-100	—	—
Over 100	90	21

Environmental management

Aspects under consideration	Percentage of businesses
Waste management	100
Training in environmental issues	42
Own environment department	37
Environmental Management System	37

7.2. Production processes

(Working Group in the Metallurgical Sector)

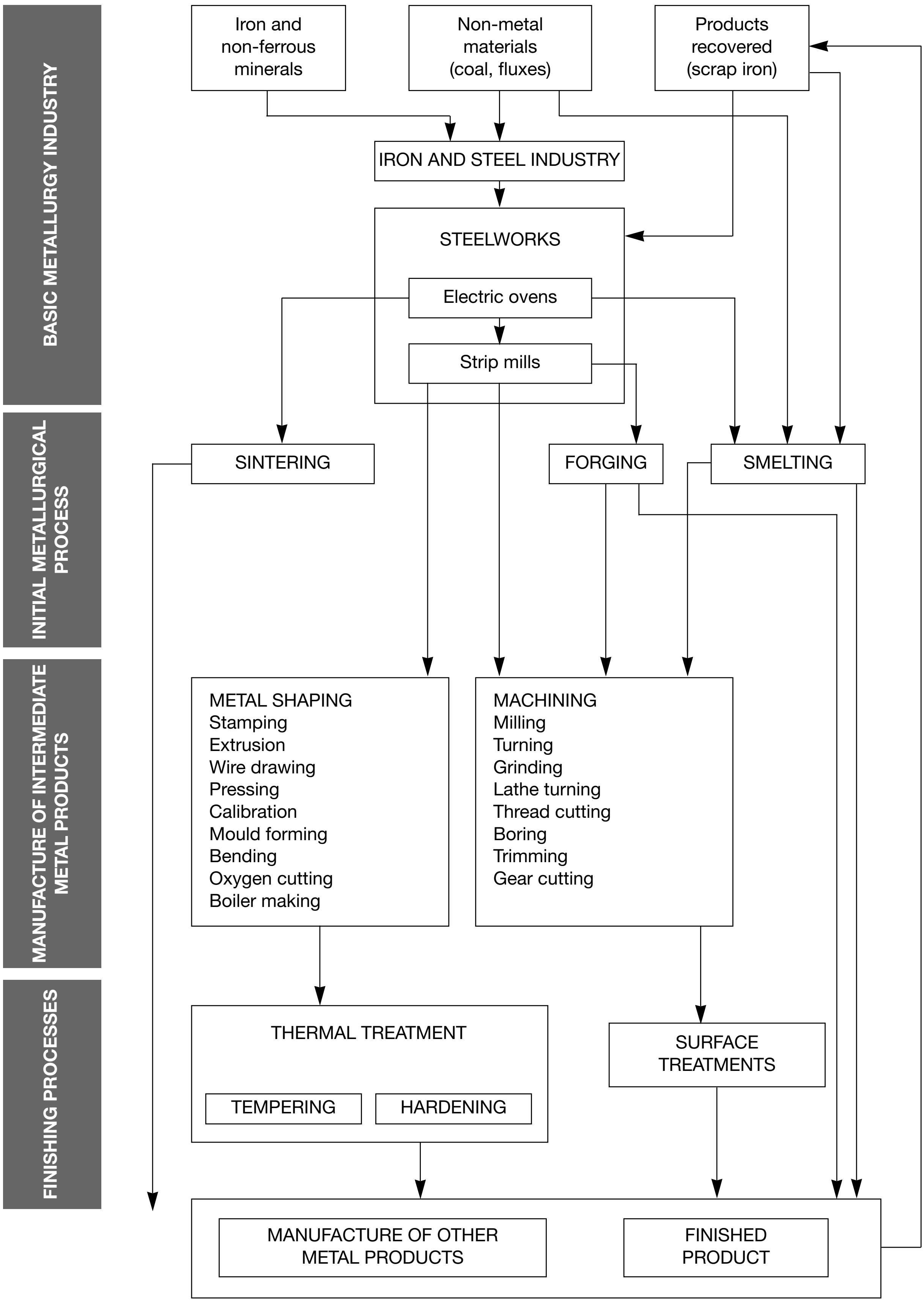
The different production processes in the metal industry sector can be grouped into four large blocks according to the stage of processing of the metal being carried out.

STAGE	DESCRIPTION
Basic metallurgical industry	This group comprises the activities of the iron and steel industry (steelworks), which extracts materials from the ground and transforms them into different forms of pure metal or alloy that are used as raw materials in the subsequent stages. This type of industry has little tradition in Spain.
Initial metallurgical process	This stage is made up of smelting, forging and sintering processes whereby metal parts are manufactured with the required geometric shape and composition through the use of moulds.
Manufacture of intermediate products	Most of the processes carried out in this stage comprise machining and metal-forming activities. The part obtained in the first metallurgical process goes through various transformations and is converted into a finished product, which alternatively can be subjected to metal finishing operations, as described in the following stage.
Finishing operations	Businesses in this stage apply thermal and surface finishing treatments to parts that have already been transformed.

A flow diagram of the different stages appears below.

Spanish companies in the metallurgical sector are distributed fundamentally in the last three stages: initial processing, intermediate products and finishing operations.

This study focuses on the description of processes, waste flows and alternatives for preventing pollution in the last three stages described. Mention is not made of the particular characteristics of the electroplating sector, since it is an industry that specialises in the finishing operations stage.


BASIC METALLURGY INDUSTRY
INITIAL METALLURGICAL PROCESS
MANUFACTURE OF INTERMEDIATE METAL PRODUCTS
FINISHING PROCESSES
Iron and non-ferrous minerals
Non-metal materials (coal, fluxes)
Products recovered (scrap iron)
IRON AND STEEL INDUSTRY
STEELWORKS
Electric ovens
Strip mills
SINTERING
FORGING
SMELTING
METAL SHAPING
Stamping
Extrusion
Wire drawing
Pressing
Calibration
Mould forming
Bending
Oxygen cutting
Boiler making
MACHINING
Milling
Turning
Grinding
Lathe turning
Thread cutting
Boring
Trimming
Gear cutting
THERMAL TREATMENT
TEMPERING
HARDENING
SURFACE TREATMENTS
MANUFACTURE OF OTHER METAL PRODUCTS
FINISHED PRODUCT

PRODUCTION

Products manufactured by the different companies in the sector can be grouped into two large blocks:

SECTOR	DESCRIPTION
Mechanical equipment goods	This is made up of activities by the manufacturers of mechanical equipment goods, which specialise in the production of machine tools that work by stock removal, metal-forming machinery, parts and accessories.
Motor vehicles	This consists of all of the activities involved in the construction of motor vehicles, trailers and semi-trailers, together with the manufacture of components for motor vehicles, mechanical traction equipment, steering, suspension and engines.

RAW MATERIALS

These follows a description of the main raw materials used in each of the stages specified above.

STAGE	RAW MATERIALS	OBSERVATIONS
Initial process	Pure metal powders (iron, bronze, aluminium, copper, etc.)	
	Chemical or green sand	Sand for the manufacture of moulds
	Scrap	Coming from other processes, or by-products of other companies
	Metal alloys, and Zamak of different compositions	Distributed mainly in the shape of ingots
	Additives (manganese sulphide, wax, calcium oxide, etc.)	These assist in the manufacturing process, as well as preparing the final composition of the part
Manufacture of intermediate metal products	Steel and aluminium plate	This material is only necessary in businesses where stamping, forming and cutting processes are carried out
	Crushed steel, grinding wheels, sand grit, ceramic sheaves, and surfactants	These are generally the materials used for peening and trimming the parts
	Halogenated solvents	Trichlorethylene and perchlorethylene are used the most in the cleaning process
	Petroleum, aqueous and non-aqueous oils	Used as lubricants in the machining stage
	Cutting and drilling oils	These act as lubricants in the machinery used in the different manufacturing processes of intermediate products
	Solvent-based paint	General use
Finishing processes	Tempering oil	
	Antioxidants	
	Nitrogen, methane, etc.	Gases for furnace processing
	Alkaline cleaners, acid dips, etc.	Baths for surface treatment

WATER USED IN THE SECTOR

The water supply comes mostly from the public mains network, which is supplied by the different public companies that provide this service.

There are marked differences in water use between one business and another, depending on the activities carried out. The main use for water consumption is sanitation (approximately 50-60%), with the remainder being used in processes, especially:
- Cooling water.
- The manufacture of intermediate products: vibrating, trimming, water-oil mixtures and emulsions.

ENERGY CONSUMPTION

Businesses in the sector usually have two sources of energy: electrical energy for general use, and gas oil and natural gas as a secondary form of energy for use in furnaces and boilers.

DESCRIPTION OF GENERAL PROCESSES

Below is a brief description of the most important processes carried out in the different business activities in the metallurgical sector, which are grouped under initial process, manufacture of intermediate metal products and finishing processes.

Initial process

The main processes involved in metal processing consist of sintering, forging and smelting. A brief description of these processes is given below.

Sintering[31]

A thermal heating and cooling process whereby parts are subjected to the recrystallisation of the metallic components.

The parts are first subjected to high temperatures inside a muffle for a period of time lasting between 15 and 25 minutes. They are then passed through water-cooled coils until they reach room temperature.

The baking temperature for the parts is between 800 ºC and over 1100 ºC according to the group of metals.

A gaseous mixture is injected into the muffle during this process and it forms an inert atmosphere that prevents surface oxidation on the parts while they are subjected to sudden changes in temperature.

[31] Although the sintering process is basically undertaken as explained, another type of similar process not described here may also be used.

Smelting

A process whereby a liquid metal or alloy is obtained from the smelting of the raw material in a furnace (ingots, metal, powder scrap). In this molten state, the alloy is poured into a mould where it cools and solidifies to give an object of the required size and characteristics.

There are different types of smelters:

- *Crucible induction furnaces:* The metal is melted down by an electric current that passes through an impedance coil. As they are a/c., operations are highly flexible and different high precision chemical compositions can be obtained according to the load materials selected.

- *Cupoles:* This is a D.C. return-flow type of furnace. It is used in smelting plants that have a high demand for liquid metal with no important variations in composition. They can be cold or hot air, and the metal load, together with coke and limestone, is introduced in the top. The coke burns with the air that is introduced through nozzles underneath, and provides the necessary energy to fuse the metal. The limestone is used to form slag where the impurities produced during the process can collect. Both the liquid alloy and the slag are removed from underneath the cupole while the combustion gases escape from above.

- *Rotary kilns:* These are horizontal furnaces that turn on their axis to aid the transfer of heat from the furnace walls to the load, once it is in a liquid state. They use gas-oxygen burners to heat the load and melt it down and work discontinuously. A disadvantage is that the load materials are limited, with regard to the use of steel scrap, due to the difficulty of adjusting the composition of the alloy.

- *Electric arc furnaces:* An alloy is smelted by sending an electric arc from graphite electrodes situated on top to the metallic load inside the furnace. Metallurgical refining operations, desulphurisation and desphosphorisation, which cannot be done in induction furnaces, are possible in this type of furnace.

Forging

Process whereby the shape of different metals is modified by plastic metal shaping produced by pressure or impact. The purpose of drop-forging is to obtain a solid shape through the forming of a piece of steel between two forging dies, each with the relief of half of the part to be manufactured.

The metallurgical quality is better using this operation, which is carried out at high temperature, and it improves the mechanical properties of the final product.

Heating the material makes it more plastic and this is done in various types of furnace with different types of fuel: induction furnaces, resistance furnaces, and gas and fuel furnaces. The heating temperature depends on the type of steel and can vary between 1,150-1,250 ºC.

Forges work by pitching a weight with one of the forging die-halves incorporated against another with the other die. This operation is controlled by guides set in the pillar supports of the forge hammer. Oil and lubricants are used to facilitate the extraction of the part.

Manufacture of intermediate metal products

The part obtained in the initial process is subjected to a series of metal shaping and machining processes that give it the required shape.

Metal shaping

Parts undergo one or several of the following operations:

OPERATION	DESCRIPTION
Stamping	Process in which the sheets of metal are cut using hydraulic presses or other types of cutting machinery.
Pressing	This operation consists of making holes where necessary in the sheets of metal. The size of the hole will depend on the part and its subsequent use, and different dies and stamp presses are used for this.
Mould forming	Forming and repair of moulds for stamping.
Wire drawing	Process by which the section of a wire is reduced to a pre-established value. This reduction increases the total length of the wire, so that the decrease in the surface of the section is inversely proportional to the increase in length. This transformation increases the hardness of the wire and also makes it more fragile; in order to avoid any possible breakage during the process, it must always be done with adequate lubrication. This is either done by using drawing oil or drawing soap.
Bending	This process is closely connected with stamping and consists of bending and shaping the cut parts.
Calibration	A dressing process based on the application of pressure on the sintered part in a mould of the exact size required for the final product. This process enables the part to be rectified according to the dimensions of its contour but not height. The calibration process is lubricated with drilling oils or similar lubricants.
Welding	Process by which parts are joined together and small cracks and pores repaired by welding.

Machining

The most frequent operations used for the machining of parts are as follows:

OPERATION	DESCRIPTION
Turning	Process where the parts are machined by rotation around a shaft.
Threading	Adaptation of the holes of a manufactured part to be used with a thread.
Grinding	Operation through which the contour of the parts is made to fit the required shape and size using grinding machines.
Static balancing	Test carried out following the manufacture of rotary parts, for these must be balanced with cones on both sides of the shaft.

There is widespread use in all of these operations of the use of cutting or drilling oils as the main raw material, as mentioned in the table under point 3.3 of the study.

Other Operations

Following metal shaping and machining operations, and even after the initial transformation processes, parts are subjected to the buffing and polishing processes specified below:

<table>
<tr><th>OPERATION</th><th>TYPES</th><th>DESCRIPTION</th></tr>
<tr><td>Vibrating and sieving</td><td></td><td>Parts obtained from the smelting process are mixed together with the cast; contact between one part and another in a vibrator causes the casts to break and eliminates small impurities that have adhered to the parts.
The parts come out of the vibrator mixed together with the casts, as a circular or linear sifter is used to separate them out.</td></tr>
<tr><td>Topping</td><td></td><td>Process by which parts coming from smelting are subjected to cut-offs in the tedges and sprues (channels and metal troughs in the mould cavity to feed the most problematic areas).</td></tr>
<tr><td rowspan="3">Buffing of the parts by vibration (deburring/ peening)</td><td></td><td>This process eliminates any irregularities in the parts, it smoothes sharp edges, and gives the part a general buffing over its entire surface. This process can be done by different mechanisms depending on the degree of buffing required.</td></tr>
<tr><td>Shot peening</td><td>Process of grinding the parts with crushed steel projected at high speed onto the parts to be polished. If this process is carried out after smelting, its function is to remove the layer of oxidised shot from the surface of the part and then giving its entire surface a homogenous finish. This is a dry process, with no water or additives being used.</td></tr>
<tr><td>Deburring</td><td>A process in which the parts are ground by abrasion as they rub against each other or with the help of an external agent (small ceramic rollers) that vibrate in a turning machine together with the metal parts. The different types of deburring most commonly used are as follows:
• Dry deburring, with parts rubbing against each other: Used to eliminate burrs and smooth edges. The metal parts can be put in the turning machine with no abrasive agent or lubricant.
• Dry deburring with sawdust and grindstones: Used for parts of increased hardness. The metal parts are put in the turning machine with sawdust and abrasive grindstones so that burrs are removed and the edges smoothed through friction.
• Water lubricated deburring: Used to give the part a finer and more homogeneous finish. The metal parts are put in the turning machine, together with rollers and water, and mixed with a surfactant agent as they turn.</td></tr>
</table>

Humidity is then removed from the parts by a drying process, using a combination of mechanical processes, heat and a humidity absorbent.

FINISHING PROCESSES

Following the metal shaping and machining operations, the parts are subjected to various processes detailed below:

Thermal treatment

The purpose of this process is to modify the molecular structure of steel, obtain certain mechanical characteristics, homogenise the structural characteristics of all the parts subjected to the same treatment, adapt the structure to the necessary conditions for subsequent processes and eliminate stresses and coarse structures from the previous process.

There are two types of thermal treatment: mass (thermal treatment of all of the part) and thermochemical (surface thermal treatment using chemical products in a gaseous state). The most common ones are described below.

MASS PROCESSES	
OPERATION	**DESCRIPTION**
Annealing	The parts are put into large furnaces in which the temperature, time and speed of heating and cooling can be adjusted. These processes are carried out in inert atmospheres or reducing atmospheres.
Tempering	Process whereby the parts are cooled at different rates depending on the mechanical characteristics required for the part. There are different tempering systems: • *Tempering with water:* The part is cooled suddenly, which increases both its hardness and fragility. Nitrate or nitrite salts are sometimes used for this type of tempering • *Tempering with air:* The part is left to cool at room temperature. • *Tempering with oil:* Intermediate form of cooling between the two above. The part is quenched in a tank of oil where it cools.
Drawing	Warm-air drying using forced air circulation to eliminate stresses in the parts from the tempering process.

THERMOCHEMICAL PROCESSES	
OPERATION	**DESCRIPTION**
Case hardening	A surface hardening process in which isopropyl alcohol or a mixture of natural gas and air (depending on the type of reactor where this is being done) is diffused into the surface to form a hard, wear and fatigue-resistant layer, etc.
Carbo-Nitriding	A surface hardening process in which a mixture of natural gas, air and ammonia (with more carbon than nitrogen) is diffused into the surface to form a hard, wear and fatigue resistant layer, etc.
Nitruration	Surface hardening process in which nitrogen (enriched with ammonia) is diffused into the surface to form a hard, wear and fatigue resistant layer, etc.
Nitrocarburation	Surface hardening process in which an ammonia mixture is diffused into the surface to form a hard, wear and fatigue resistant layer, etc.
Ionitruration	Surface hardening process in which nitrogen is diffused into the surface, together with electron bombardment, to form a hard, wear- and fatigue- resistant layer, etc.

Surface treatment

The general operations carried out in the sector are described below. Mention is not made of the particular characteristics of the electroplating sector, which specialises in the surface treatment.

The main operations are described below:

SURFACE TREATMENT		
STAGE	**OPERATION**	**DESCRIPTION**
Preliminary processes		These are processes to eliminate both organic and inorganic impurities from metal surfaces originating from previous operations such as cutting, polishing, storage, transportation, etc. The most important are degreasing and pickling, and there are different methods according to the type of surface being plated, the type of metal being plated, the type of plating and the degree of cleanliness required
	Degreasing	This operation is used to remove any substances that are impregnated on the surface of the part. Halogenated solvent baths (perchloroethylene and trichloroethylene) are used for this, as well as chemical degreasers, according to the type of substance to be removed.
	Pickling	This operation eliminates metal oxides from the surface of the part. It can be done using either chemical or physical processes.
Metal plating		The metal part is then immersed in a solution of metal salts and, through a process of oxidation-reduction process; a layer of metal oxide is deposited on the surface of the part, forming a layer of metal oxide. The main plating operations are as follows:
	Electrochemical plating	Copper plating, nickel plating, chrome plating, etc.
	Chemical and conversion plating	Anodised aluminium, phosphatation, chroming, etc.
Finishes	*Paint*	Following the conditioning processes, the parts are then painted either with powdered paint (epoxy) or solvent-based paint. Water-based paints are used less frequently.
	Seals	End-of-process treatment to prevent parts from oxidising using nickel salts that seal any pores.
	Steam treatment	Process used for parts manufactured by sintering. The purpose of this process is to enhance the surface resistance of parts to oxidising agents, as well as increasing their hardness by approximately 60%. Various furnaces are required and these are used to heat the parts to a temperature of around 500 °C. They are then quenched in superheated steam from boilers and a layer of ferric oxide forms on the surface of the part.
	Antioxidant treatment	This process, whereby a protective layer of antioxidant oil is applied by dipping, is only applied to a small percentage of the parts manufactured in the metallurgical sector.
	Impregnation	A process used mainly in businesses supplying the motor vehicle sector with products, for this operation enables part to self-lubricate during use. Manufactured parts must be highly porous for they need to retain the oil that impregnates the pores and then release it during use. An autoclave fed by an oil tank is normally used for this operation. The parts are put in the autoclave and the impregnation oil injected. This is then absorbed by the parts.

7.3. Description of the waste flows generated
(Working Group in the Metallurgical sector)

Current forms of effluent treatment

The businesses covered in this study generate a series of liquid, solid and gaseous effluents that must be treated and adequately dealt with according to their nature. Details are given below on the main forms of waste generated by business activities in the metallurgical sector and the treatment that they are given.

Industrial waste

The main form of waste in the metallurgical sector is the remains of the main raw material, i.e. metal in the form of scrap, slag, defective casts due to work stoppages and production start-ups, defective parts, etc. This is all usually managed by authorised companies that valorize this waste (except for slag), although oil-impregnated material often makes valorization difficult (especially of scrap).

Hydraulic oils and emulsions are also a common type of waste because they are necessary to operate plant machinery. They are managed by outside businesses.

Dirty halogenated solvents are regenerated by distillation for subsequent use in most businesses in the sector, with the solid waste generated being managed by outside businesses. In companies where the solvent is not valorised, it is stored as waste for subsequent treatment by outside businesses.

Materials used to package raw materials are often managed as non-specified waste, and only a few businesses in the sector have reached any kind of agreement with the supplier for this to be returned and recovered.

General factory waste is waste produced in cafeterias, changing rooms and offices. If a business activity has no authorised manager for pallets and packaging material, this waste is often included in the management of general factory waste.

Lastly, businesses that have a wastewater treatment plant produce a certain amount of sludge that is appropriately treated by the authorised manager. The metallurgical sector does not generate a large amount of treatment plant sludge (except for surface treatment business activities).

Wastewater

According to the type of processes carried out, the composition of wastewater leaving the plant will vary from one business activity to another. Nevertheless, most of the wastewater generated in the sector comes from sanitary use and the cleaning of installations.

As far as production processes are concerned, the highest use of water and wastewater generation occurs in the manufacture of intermediate products stage (cooling of the machining section, cleaning of parts) and the finishing processes stage (rinsing and cleaning of the baths in surface treatment finishing processes, tempering with water in thermal treatments, etc.).

A small part of the businesses in the sector has a wastewater treatment plant, and in all cases this is physico-chemical, due to the characteristics of the wastewater in the sector. The most common operations undertaken are effluent homogenisation, and the separation of dissolved metal through the use of a coagulant or flocculating agent. The sludge generated is often handled by outside businesses, following the reduction of the humidity percentage in a press filter or centrifuge.

Atmospheric emissions

The main atmospheric emissions are generated by the different types of furnace, both in the initial metal processing stage (smelting and sintering), and the finishing processes stage (steam treatment, drying, tertiary treatment burners —painting, tempering and annealing furnace, etc—). The most important pollutants produced are hydrocarbons, CO_x, SO_2, NO_x, and solid particles.

The use of halogenated solvents in degreasing operations produces emissions of volatile organic compounds (VOCs). Boiler bleeds are another source to be considered in business activities in the metallurgical sector, due to the emission of compounds such as CO, CO_2, NO_x, SO_x and solid particles.

Most business activities use dust collectors, extractors, aspirators, etc., which mainly collect particles given off in those sections where emissions are generated during the course of regular operations.

Initial process

In this stage, the most outstanding environmental aspect is the high consumption of energy due to the use of furnaces, either in processes involving smelting, forging or sintering. The most important effluents are the forms of waste and the atmospheric emissions described below:

1. Casts: These are defective parts and the first parts to come out at the beginning of a production batch or following a work stoppage.

2. Slag: Product of the cleaning out of smelting furnaces.

3. Atmospheric emissions: These include steam generated in the different types of furnace, the combustion of natural gas and compounds that have become volatised inside furnaces, etc.

Casts, scrap and defective parts that are produced are normally put back into the process or sometimes valorized, whereas slag is managed in controlled sites.

Some business activities employ corrective measures such as a bag filter to prevent emissions escaping into the air, although this is not common practice.

Manufacture of intermediate metal products

Due to the variety of different operations, there are different types of waste, the most common being metal waste, solvents, emulsions and cutting oils. A list of the most common types of waste is given below:

1. Dust, steel shavings, parts, and sheet metal waste: these are collected during the cutting, stamping, forming and vibratory processes.
2. Halogenated solvent (residual trichlor-ethylene and perchlorethylene): generated in the degreasing process.
3. Storage drums: plastic and metal containers for the different raw materials used.
4. Shot debris: this is waste produced by the breakdown of sand and shot, mixed together with components of the manufactured parts (graphite, etc.)
5. Abrasive substances: used in deburring.
6. Moisture absorber waste: used to dry deburred parts.
7. Emulsions and cutting oil waste: generated by machining, cutting and pressing machinery.
8. Pallets: these mostly come from the packaging of raw materials.
9. Wastewater: from operations where water is an integral part, or from cleaning.
10. Hydrocarbon emissions: trichlorethylene steam from the degreasing bath.
11. Emissions produced in different machining operations.

Most metal parts are valorised by an outside business concern although there are companies that do this in the plant, with the parts being put back into the process.

The different types of oil and solvent, together with treatment plant sludge, are mostly managed by outside businesses. Nevertheless, there are centres that recover drilling oils and halogenated solvent.

Pallets are usually treated the same way as general factory waste, although some companies separate them and valorise them.

Finally, most of the emissions generated from the different sources have no corrective measures and they are therefore emitted into the atmosphere.

Centres that have installed corrective measures often use a fabric filter for particle emissions.

Finishing processes

A list of the most common types of waste appears below:

1. Wastewater:
   —Discharge of water with oil generated in the process of steam condensation.
   —Wastewater from cleaning operations.

—Wastewater containing ion exchange resins: Water from the regeneration of the demineralisation columns.
—Cooling water.

2. Remains of surface treatment baths.

3. Emissions:
—Halogenated compound and VOC emissions.
—Natural gas boiler emissions.
—Furnace emissions.
—Extractions in the different sections: atmospheric pollutants generated in the section.

Wastewater is subjected to purification processes depending on the pollutant load that it contains and, according to the process where the water originated, it will either be treated in a wastewater treatment plant or disposed of directly into the sewer system.

One general practice in all metallurgical business activities is the management of the remains of surface treatment bath solutions by an outside business.

Emissions produced in the different processes are collected by extractors although it is not usual for businesses in the sector to have them installed. Emissions generated by boilers and furnaces are emitted into the atmosphere and in some cases corrective and emission source control measures do exist.

7.4. Description of minimisation alternatives in the sector
(Working Group in the metallurgical sector)

Introduction

Up until just a few years ago, the frame of reference for industrial development was set almost exclusively according to economic criteria, while the environmental criterion was either left out or was of secondary importance.

As a result of the increased awareness of the environment at the present time, environmental management has become increasingly important in business activities.

One of the basic ecomanagement strategies that a business can use is “cleaner production”.

Cleaner production is the continuous application of an integrated environmental prevention strategy in:

—processes
—products and
—services,

with the object of reducing risks to the environment and especially humans, it increases the competitiveness of the business and guarantees its economic viability.

The advantages of cleaner production are, amongst others:

—Saving in environmental costs.
—Improved corporate image from the authorities' point of view.
—Greater efficiency through improvements to the work structure.
—Setting up of innovations in the context of day-to-day work: procedures, new technologies, etc.
—Process optimisation.
—Elimination of end-of-pipe treatments.

Cleaner production entails implementing actions to prevent pollution, including:

—Changes in processes.
—Changes in raw materials.
—Good housekeeping practices.
—Introduction of new technologies.

One of the main objectives of the Minimisation Opportunities Environmental Diagnosis (MOED) is the detailed description of different minimisation alternatives that are possible in a business,

—Justifying the causes for their recommendation.
—Assessing the environmental benefits.
—Carrying out an analysis of both their technical and economic viability.

By this means, the technical and economic analysis of a minimisation alternative provides data on net savings produced as a result of the implementation of the alternative compared to the current process.

A series of minimisation alternatives for the metallurgical sector is given below. The alternatives are classified in general terms within the sector according to the following aspects:

—Modifications to the process.
—Good housekeeping practices.
—Change of raw materials.

Process modification

An economic analysis is made of all the available alternatives that involve modifying the process and adopting the BATs (best available techniques), enabling investment data, operating costs, maintenance, etc., to be obtained and compared with the data of the current process.

On the basis of the results, the return period on investment is calculated, together with the cost-effectiveness, which indicates the usefulness and viability of carrying out the project.

Details of minimisation alternatives for the metallurgical sector are given below, with the approximate cost and payback period of each alternative.

		MINIMISATION OPPORTUNITY DETECTED	ALTERNATIVE PROPOSAL	COST (for guidance purposes only)	PAYBACK PERIOD
INITIAL PROCESS	**Smelting**	Minimisation of chemical sand waste	Installation of a chemical sand extractor	60,101.21 €	3 years
		Optimisation of the mixture and dosage of silica sand	Installation of a mixer and automatic silica sand dispenser	66,111.33 €	3 years
		Minimisation of smelting slag	Replacement of fixed furnaces with tilting furnaces	42,070.85 €	5 years
		Minimisation of energy consumption in the smelting furnaces	Replacement of arc furnaces with induction furnaces	240,404.84 €	60 years
	Sintering	Minimisation of the wast ewater generated in the steam treatment process	Ultrafiltration	30,050.61 €	2 years
			Gas traps	3,005.06 €	3 years
MANUFACTURE OF INTERMEDIATE METAL PRODUCTS	**Metal shaping / Machining**	Recovery of the cutting oil from the parts	Centrifugation of the parts	30,050.61 €	10 years
		Minimisation of the sheet metal waste generated	Optimisation of sheet metal cutting	- €	Immediate
		Recovery of vibration / deburring wastewater	Centrifugation of wastewater	18,030.36 €	7 years
		Recovery/ regeneration of emulsions	Ultrafiltration	3,005.06 €	2 years
			Evaporation	36,06.73 €	1.5 years
		Recovery of halogenated solvent	Distillation	3,005.06 €	0.3 years
FINISHING PROCESSES	**Surface treatment**	Recovery degreasing baths	Ultrafiltration	18,030.36 €	1.5 years
		Recovery part activation baths (phosphatation, etc.)	Ultrafiltration	36,060.73 €	2 years
		Minimise the consumption of rinsing water	Eliminate continuous rinse draining	-	Immediate
		Minimise the consumption of water and raw materials for baths	Rinse recovery installation	1,202.02 €	0.2 years
	Thermal treatment	Recovery of wash water	Ultrafiltration of wastewater	18,030.36 €	1.5 years

Note: The figures for costs and return on investment are based on specific cases and information that has been gathered and, therefore, the economic viability of each particular case must be studied. These values are therefore for guidance only.

Details are given below of *some* of the alternatives mentioned above, with a distinction made between the process as it is currently applied and the processes that would be carried out with the alternative proposed:

Recovery of used chemical sand

Current situation: At the present time, a high percentage of moulds used for smelting are made of "chemical sand" or a mixture of silica sand and forging agents. Once this material has been used, it becomes extremely hard and recovery is difficult.

Alternative proposal: Installation of a sand extractor. This equipment crushes and sifts the used chemical sand. Once the blocks of used chemical sand have been crushed, it retains the fine particles and sends the recovered sand to raw material storage silos. In some cases (according to smelting), new sand must be added to the recovered sand. With this equipment, chemical sand can be recovered up to 10 times.

Replacement of an arc furnace with an induction furnace

Current situation: At the present time, electric furnaces are used in smelting to melt down different kinds of metal. These are either arc or induction furnaces.

Alternative proposal: Induction furnaces use less energy (approximately 12%) and generate fewer atmospheric emissions (approximately 75%) than arc furnaces.

The following table shows the difference in consumption and emissions between both types of furnace:

		Arc furnace	Induction furnace
Electricity consumption	Steel smelting (1,600 °C)	0.85 kW/Kg	0.75 kW/Kg
	Iron smelting (1,450 °C)	0.8 kW/Kg	0.7 kW/Kg
Atmospheric emissions		X	X x 0.25

Recovery of wastewater generated in the steam treatment process

Current situation: The process of steam treating parts generates wastewater as a result of the condensation of hot steam once it has been applied to the metal parts. This steam carries oils and lubricating agents contained in the parts from the calibration and machining processes that they have been subjected to. The presence of lubricating agents in the water prevents it from being reused in the production processes of the company.

Alternative proposal: Extraction of the oily stage of the wastewater using an ultrafiltration system (consisting of a mineral membrane with a pore diameter that can be selected as required) enables it to be recovered and steam generated again.
The main advantages are as follows:

- Reduction in water consumption.
- Reduction in the pollutional load disposed of in the sewer network.
- Reduction of the energy necessary for generating steam from water.

Provided that the oily fraction is not emulsified, the purification of the condensed water can be done using a grease separator system. The main advantages are as follows:

- Reduction in the pollution load disposed of in the sewer network.
- No energy cost in the facility.
- Reduced cost of equipment.

Recirculation of water generated in the vibrating/deburring process

Current situation: The process of washing the parts by wet method vibration in the finishing section generates wastewater that must be treated prior to disposal due to its high metal and detergent content.

Alternative proposal: The use of a high-powered vibratory separator installation for the deburring wastewater is proposed. This equipment has a centrifuge that separates out particles up to 0.5µm in size from water. These particles form a sludge that must be appropriately managed following its characterisation. The advantages are:

- Saving in raw materials.
- Reduction of water consumption.

Recovery/regeneration of emulsions

Current situation: In the normal process of machining parts, dirty emulsions are generated that must be managed by an authorised management agent.

Alternative proposal: Extraction of the oily stage of the wastewater using an ultrafiltration system may enable it to be recovered. Likewise, an evaporation process can regenerate the emulsion, because the water extracted can be reintroduced into the process.

Moreover, one strategy is to extend the useful life of the raw materials by using either a mechanical treatment such as filtration by using band filters or even a physical process like separation.

Mention should also be made of cross fluid venting as a means of achieving cleaner production as this operation can decrease the amount of waste generated by around 10%.

Recovery of halogenated solvents

Current situation: In the degreasing of parts following machining, solvents containing halogenated compounds are often used in the sector.

Alternative proposal: The used halogenated solvent can be recovered by using recovery equipment with a small distilling plant. The main advantages are as follows:

- Reduction in the use of solvent.
- Reduction in the amount of halogenated waste generated.
- Reduced stock of halogenated solvent in the factory.

Recovery from degreasing baths

Current situation: In the surface treatment process, degreasing baths are used to separate the oils and grease on parts prior to their being treated. These baths become progressively polluted with oil until they can no longer be used. The contents are then disposed of in the treatment plant.

Alternative proposal: A degreasing bath ultrafiltration unit regenerates these baths. This equipment is fitted with membranes that efficiently separate the emulsified oil and grease, allowing the water with dissolved salts to pass through. The oil that has separated is removed from time to time and the oil-free water recirculates to the degreasing bath. The advantages are:

- A reduction in the pollutional load disposed of and saving in the cost of treatment.
- The quality of the water in the baths is maintained (a constant concentration of oil).

Good housekeeping practices

Good housekeeping practices are defined as the set of correct actions for personnel and the management and control of industrial activities that contribute to the minimisation of waste and emissions.

Good housekeeping practices can be applied in general at very low cost and therefore with a fast return on investment. They imply a change in attitude where all personnel in the business activity need to be involved and they are considered to be one of the most effective ways of minimising waste and waste emissions.

The implementation of good housekeeping practices involves a constant analysis of processes which means reflecting on why a particular type of technology is used, the number of baths, rinses, filtration, etc. that a part needs, etc.

This reflection often leads to new technologies being adopted, changes in materials and products, etc., that enable the amount of pollution produced to be reduced.

Details of examples that can be applied in most companies are set out below:

Contain, collect and clean *This makes the valorisation of spilt products easier and minimises the need for water and/or cleaning products.*	**Maintain the installations in good condition**
Communication	**Cleaning** *The efficient cleaning of equipment helps to save resources.*
Everything in its place	**Comply with established procedures**
Order and management in storage areas	**Waste separation**
Handling, transporting and transferring *Good handling, transporting and transferring minimises waste.*	**Close it** *An open or badly closed container can lead to the unnecessary waste of resources and the generation of waste itself.*

The following good housekeeping practices can be applied particularly in the metallurgical sector:

		GOOD HOUSEKEEPING PRACTICES
INITIAL PROCESS	Smelting	Reduce the quotient between sand use and metal use: By using boxes that fit the size of the model, the consumption of chemical sand, i.e., silica sand and binding agents, can be reduced considerably.
		Install a retaining trough to store green sand in a controlled way in a clearly defined area and prevent it from being scattered on the floor.
		Avoid excessive temperatures in casting. An excessively high temperature in casting means an unnecessary use of electrical energy.
		Co-ordinate the stripping of the parts from the moulds with the peening and topping to avoid having to reheat the parts.
		Improve the separation of the sand heading for the deposit from that which is recoverable in cement works, in order to valorise the maximum volume possible of chemical sand.
MANUFACTURE OF INTERMEDIATE METAL PRODUCTS	Metal shaping / Machining	Improve the dosage of cutting oils in manual presses.
		Control the correct functioning of deburring installations and carry out appropriate maintenance to prevent particular unwanted effluents.
		All machine process waste in which emulsions are used is to be deposited in specified and duly identified containers, then characterised and managed.
		Assessment of the duration of deburring processes. Provided that it does not have negative effects on product quality, reducing the period of time that the process lasts can lead to savings in the consumption of energy and auxiliary raw materials.
FINISHING PROCESSES	Surface treatment	Install water renewal control systems in the rinses by using valve opening and closing systems based on the conductivity of the rinses, in order to reduce water consumption, the costs of purification treatment and waste production.
		Eliminate periodic continuous rinse draining.
		Increase the time of parts drainage, even though this is often limited by the time that the parts can be out of the baths and rinses, or for production reasons.
		For there to be good water renewal in the continuous rinses, water inlets and outlets need to be diametrically opposite each other. Aeration is also needed in the rinses in order for optimum renewal of the rinses.
		Establish a maintenance programme and periodically check furnace insulation.
		Ensure that actions are aimed at saving water: install water meters in the different sections, automatic push-button systems in showers and washrooms, water-saving awareness campaigns, etc.
	Thermal treatment	Replace or improve the cooling system on the closed water circuit for the structure of the furnaces.
		Seal as far as possible the process of unloading parts from the furnace oil quench bath by setting up some form of protection.

In general terms, the following are outstanding good housekeeping practices:

—Measures for improving the environmental management of a business activity:

1. Improvement of general factory waste management by separating the fractions of cardboard, plastic and dirty rags from the rest of the general waste.

2. Dirty rags and other absorbent products used in the activity and for cleaning the installations are to be deposited in special containers and then managed appropriately.

3. The separation of waste flows to prevent inert waste mixing with waste that may present risks for the environment and people's health.

4. Raising the awareness of personnel through information campaigns in order to prevent as many accidents from happening as possible.

5. Periodic cleaning in working areas where lubricating agents are used on a regular basis.

6. Carry out maintenance schedules for burners and furnace insulation.

—Measures to improve the storage and management of waste and raw materials:

1. A record is to be made of all items entering and leaving the waste storage area (amount, type and date).

2. Special attention is to be given to the correct placing of waste and raw materials and to prevent them blocking the way of personnel, vehicles, forklift trucks, etc.

3. The storage area must be insulated from sewer utility shafts. It must also have effluent retaining and drainage systems, with tanks and piping measured according to the amount of materials to be stored.

4. Maximum storage time in the storage area is 6 months.

Replacement of raw materials

In general, there is a series of raw materials used in the metallurgical sector (explained below) that could be replaced by others, taking into account the final quality of the part.

Raw material used	Pollutant	Alternative raw material
Degreasing using trichlorethylene and perchlorethylene	Halogenated compounds	• Non-halogenated degreasers • Water-based detergents
Cutting oil	Special waste	• Evaporative cutting oil
Solvent-based paints	Mainly toluene and xylene	• Water-based paints • Powder coating

The replacement of halogenated compounds

As things stand, trichlorethylene/perchlorethylene is the best degreaser that exists on the market for its quality and price.

However, due to its toxicity and harmful effects on the environment and people, business activities search for alternatives to degrease parts.

There are three systems available at the present time for replacing trichlorethylene:
—Non-halogenated solvents.
—Water-based degreasers.
—Chemical solvents.

The advantages are:
—Elimination of chlorinated solvents.
—Saving of raw materials.

The disadvantages are:
—High economic price.
—Low flash point.
—Adapting the existing machinery to the alternative product (for example, the arrangement of rinses).
—Low quality degreasing of the part.

The replacement of solvent-based paints

Solvent-based paints have a significant environmental impact due to their composition. Their replacement with water-based paints or powder coating minimises this impact.

Environmental advantages of water-based paints

Less environmental impact: Solvent emissions in the paint application and drying stages are reduced to a minimum.

Cleaning: The cleaning of tools and hands is done with water, which eliminates risks to health and reduces to a minimum the use of solvents.

Safety: As the use of highly inflammable solvents is reduced to a minimum, there is less risk of fire.

Economy: When paint is applied by spraying, mains water can be used as a solvent, without the need for any preliminary treatment. Moreover, as the risk of fire is reduced, the cost of fire protection, insurance premiums, etc. is minimised.

Use of installations: Water-based paint can be applied in existing installations for solvent-based paint application.

Environmental advantages of powder coating

Optimisation of raw materials consumption: Any raw material not deposited on the surface can be vacuum collected and put back into the process.

Decrease in pollution: The elimination of any possible water or air pollution.

7.5. Table summarising the options for minimisation

(Surface treatment Working Group)

Options for minimisation[32]:

Possible alternatives	Environmental aspect	Benefit
Recovery of the used chemical sand	Chemical sand waste	↓ Consumption of raw materials ↓ Solid waste
Induction furnace	Gas emissions from the furnace	↓ Gas emissions ↓ Energy consumption
Recovery of the wastewater generated in the steam treatment	Wastewater associated with the process	↓ Water consumption ↓ Pollutional load of wastewater ↓ Energy consumption
Recirculation of water from the vibrating/deburring process	Wastewater associated with the process	↓ Water consumption ↓ Consumption of raw materials ↓ Volume of water disposed of
Recovery / regeneration of emulsions	Dirty emulsions	↓ Emulsion consumption ↓ Residual emulsion
Recovery of halogenated solvent	Dirty halogenated solvents	↓ Consumption of solvent ↓ Waste flow of halogenated solvents
Recovery of degreasing baths	Depleted degreasing baths	↓ Consumption of raw materials ↓ Pollutional load of wastewater ↑ Quality of degreasing
Replacement of halogenated compounds	Dirty halogenated solvents Gas emissions of organochlorate compounds	Elimination of chlorinated solvents Elimination of chlorinated waste flows ↑ Safety at work
Replacement of solvent-based paints	Gas emissions of solvents	↓ Solvent waste flows ↑ Safety at work Cleaning with water ↓ Risk of fire

[32] See *applicable good housekeeping practices* in section 4.

7.6. Table summarising the options for minimisation
(Graphic Arts Working Group)

Options for minimisation:

Alternatives	Environmental aspect	Benefit
Film: minimisation of chemicals and water	Chemical and wash water waste flows with silver ions: special waste	↓ Consumption of raw materials ↓ Liquid waste Valorisation of silver
Plates: minimisation of wash water	Waste flow of wash water: special waste	↓ Water consumption ↓ Wastewater
Computer To Plate System (CTP)	Waste flows associated with pre-press and printing Quality of the production process	↓ Consumption of raw materials (pre-print + printing) ↓ Associated waste flows Better quality product and process
Dampening solution: cooling	Use of isopropyl alcohol	↓ Consumption of isopropyl alcohol ↓ Alcohol content in the liquid waste flow Better quality printed product
Dampening solution filtering	Waste flow consisting of the dampening solution	↓ Consumption of solution ↓ Liquid waste flow Better quality printed product
Black ink: manufacture	Waste flow of surplus ink	↓ Consumption of ink ↓ Waste flow of ink
Solvents: automatic addition	Evaporation of VOCs	↓ Consumption of solvents ↓ Evaporation of VOCs Better quality printed product
Flexography: closed-chamber ink pots	Quality of the production process	Better quality printed product ↑ Efficiency of printing machinery ↓ Evaporation of VOCs
Evaporator	Water-based liquid waste flows	↓ Water consumption ↓ Wastewater
Distilling plant	Solvent-based liquid waste flows	↓ Consumption of solvents ↓ Solvent waste flows
Waste ink containers: minimisation	Waste flow of ink pots	↓ Waste flow of ink pots ↑ Use of ink
Scrapers: cleaning apparatus	Waste flows associated with the cleaning of scrapers	↓ Consumption of rags and solvents ↓ Associated waste flows ↓ Time taken for cleaning
Sanitary sewage: pedal taps	Sanitary wastewater	↓ Water consumption ↓ Sanitary wastewater
Osmotic systems: prefiltering	Wastewater for regeneration	↓ Water consumption ↓ Associated wastewater ↓ Time taken for regeneration

Good housekeeping practices concerning the waste reduction:

Alternatives	Environmental aspect	Benefit
Soft system for receiving and control of orders	Errors in layout	↓ Film repetitions ↓ Plate repetitions ↓ Associated waste flows ↑ Operational efficiency
Preparation of offset plates: use of control scales	Errors in pre-print and printing	↓ Plate repetitions ↓ Printing stoppages ↓ Associated waste flows ↑ Operational efficiency
Offset plates + silk screens: area lighting	Errors in pre-print and printing	↓ Touching up ↓ Associated waste flows ↑ Operational efficiency
Offset plates prepared with CTP	Quality printing	↓ Consumption raw materials ↓ Associated waste flows Better quality product and process
Job planning	Printing errors Quality process	↓ Consumption raw materials ↓ Associated waste flows Better quality product and process ↑ Operational efficiency
Pantone cards + Colour control strips	Errors preparation of colour Printing errors	
Equipment for colour measurement	Errors preparation of colour Printing errors	
Colour measurement: lighting	Errors preparation of colour Printing errors	
Conductivity dampening solution: measurement	Printing errors	
Conditioning of the support prior to printing	Printing errors	
Elimination dust from support prior to printing	Printing errors	
Macules: reuse	Waste flow of wastage	↓ Consumption raw materials ↓ Associated waste flows
Colour preparation: improvements	Errors preparation of colour Printing errors	↓ Consumption raw materials ↓ Associated waste flows Better quality product and process ↑ Operational efficiency
Ishihara test	Errors preparation of colour Printing errors	
Record of wastage	Errors in the production process	
Stoppages for meals: elimination	Wastage in printing	
Print area: cleaning	Printing errors	
Machinery: maintenance	Printing errors	

Other good housekeeping practices:

Possible alternatives	Environmental aspect	Benefit
Procurement of materials	Associated waste flows	↓ Consumption raw materials ↓ Associated waste flows ↑ General process efficiency
Leakages and spills: prevention	Associated waste flows	↓ Consumption raw materials ↓ Associated waste flows ↓ Time taken to reset-up
Solvent-free surface: decrease	VOC evaporation	↓ Consumption solvents ↓ Emissions VOCs
Storage areas: general management	Associated waste flows	↓ Consumption raw materials ↓ Associated waste flows ↑ General process efficiency
General order and cleaning	Associated waste flows	
Control of the parameters of production	Knowledge of process	
Ozalid tests: change	Evaporation of ammonia Associated waste flows	↓ Associated waste flows
Hexane: elimination	VOC emissions Product toxicity	
Diesel fuel and petrol: elimination	VOC emissions	
Recovery of silver: control	Knowledge of process	↓ Associated waste flows ↓ Silver in solution

7.7. Conclusions[33]

The carrying out of this study, in which a Minimisation Opportunities Environmental Diagnosis (MOED) was carried out in 19 businesses in the graphic arts sector, and where meetings were held to work on the different aspects concerning the possible implementation of actions to prevent and reduce pollution at source. Thanks to this, a series of conclusions have been drawn, details of which are given below.

The best way for these to be described is structured fundamentally around two points: the first refers to the points mentioned by business concerns during the working group meetings, while the second includes the conclusions of the consultants themselves and refers not just to the points assessed during the study but also the current state of the sector in Catalonia and its foreseeable development in the coming years.

Appraisals by participating business concerns

A series of general objections that came out of the working group meetings were listed by the representatives from the different companies. These are described below:

[33] The conclusions presented in this example are just part of those contained in the final report of the Graphic Arts Working Group.

- Current legislation concerning the graphic arts sector and the environment is considered to be very complex. Business concerns find themselves faced with extensive legislation from different sources that is often complex to read and interpret, and which requires a lot of paperwork to have all the documents required by law concerning the management of waste flows at ones disposal.

  In this respect, it was proposed that the Guild participate in resolving this point by improving the existing information service to all guild members and by establishing an up-dated database on environmental legislation. The objective of this service needs to be to provide information on the legal provisions affecting business concerns in the sector. In general, business concerns point out that environmental legislation is not easily accessible and that problems can often arise simply because people are unfamiliar with the subject.

- With regard to liquid waste, there is a certain amount of ignorance concerning the impact caused by waste flows and people are becoming increasingly aware of this.

  On this basis, and in business concerns that more or less already manage their wastewater, there is the belief that the management of this type of wastewater and its pollution parameters depends largely on the attitudes of the workers themselves. This means that management needs to be based to a great extent on the voluntary separation of special liquid waste and in the good practices that are applicable in the matter.

- As for solid waste, various different points stand out. First and foremost, business enterprises consider that the management costs are high. That is to say, it would appear that separation at source with individualised management afterwards is more expensive than managing a large amount as general factory waste.

  In reference to this point, it was suggested that the Guild promote the gathering of information on the different managers on the market and for it to then make it available to the guild members. Many authorised managers do not collect certain types of waste, amounts of waste that are too small, or waste in a certain physical condition. For this reason the availability of a reliable database with specialised waste managers that collect specific types of waste is considered to be a very valid option.

- Again with regard to solid waste, there is some waste that is not managed in any specific way. This can be seen above all in small business concerns, which generate small amounts of waste that accumulates on the premises and which gets managed along with general factory waste or through non-authorised managers.

The most important types of this waste are:

—Special waste in small amounts: fluorescent light strips, batteries, machine parts, cables, tyres, vehicle batteries, glass, etc.
—Rubber from offset printing.
—Dies.
—Wood (pallets, etc.).

On this point, two possible solutions were proposed. On the one hand, it was again suggested that the Guild promote the task of finding managers to accept this waste and, logically, at prices that are competitive for smaller business concerns (by way of agreements if necessary, as has occurred in other cases). This option is especially necessary in the case of rubber, dies and wood, as managers of the materials cannot be found.

On the other hand, and especially in the case of special waste in small amounts, the idea was also made of collecting and managing all of this group of special waste together, so that a sufficient amount can be collected and managed by an outside manager at a competitive cost.

- A similar idea came up in the case of valuated waste. Large companies that generate this type of waste in large amounts can valorise it at an advantageous price, whereas small business concerns find that they often have to sell this waste at a loss due to the relatively small amounts that they produce and which they can no longer keep in storage due to lack of space or time limits (six months in the case of special waste, and one year in the case of non-specific waste) laid down by legislation.

  On this point, joint management also came up as an idea for improving the valorisation of this type of waste and, at the same time, of obliging companies to keep reliable statistics of the vaporisable waste that they generate, and to carry out the correct management of this waste (separation, collection, storage, etc.).

- One final point that stands out concerning the management of solid waste is the problem of how to manage rags. Rags are used in all sectors of the printing sector to clean printing machines and other accessories (scrapers, plates, screens, etc.), which generates an important flow of dirty rags that must be managed externally.

  On this point, some managers offer an “all-in rag service”, i.e. they supply the rags, they collect them once they have been used and then wash them, and so the business only has to worry about collecting them separately from the rest of the waste.

  This service has been very successful in business concerns in the graphic arts sector in general because it is easy and guarantees easy overall management. The workers seem to like using these rags more because they are good for cleaning purposes.

  Companies want more extensive listings of authorised managers with specialised business concerns offering these services.

- With regard to gas emissions, there is general agreement in that the impact of this waste flow is unknown for most businesses.

  Nevertheless, a European Directive has recently been approved (Council Directive 1999/13/EC of 11 March 1999 relating to limits on VOC emissions due to the use of organic solvents in certain activities and installations), which regulates VOC emissions into the atmosphere.

  This directive makes particular reference to emissions produced by business activities in the graphic arts sector and more specifically to those that produce larger amounts of solvent emissions, such as rotary offset.

On this point, it would appear essential for business activities to put more effort into adapting to this new regulation and, if necessary, resorting to Gradual Emission Reduction Programmes (GERP)[34].

- With regard to what was explained about good housekeeping practices in the meetings and suggested on an individual basis for each business in the corresponding diagnoses, the conclusion is that a considerable amount of training is required in business activities for workers to become aware of things that they do well and other things that they do not do well so that improvements can be made on a daily basis.

  In this respect, and there was also agreement that it is no easy task, people need to be trained in and made more aware of good practices, as well as incentives being provided, to the detriment of bad practices. Programmes on this matter would more than likely be highly successful, as it is very clear that this point has a very decisive influence on the generation of waste and its correct management.

  Also on this point, the help of the guild was suggested, which could be along the lines of training, with the design of a training programme that contemplates both the organisation of training courses and the publication of informative material on the matter.

- One aspect that was considered in the point referring to good housekeeping practices is that of facility cleaning operations. This is a particularly delicate matter because it would appear that more than one company has had problems due to the use of cleaning products that, when they get into the water, give excessively high values for certain parameters in the analyses.

  Furthermore, this is an operation that is generally subcontracted out to third parties where the companies really have little decision-making power.

  Nevertheless, and as a result of this study having been carried out, research has also been done on the matter to find some general cleaning product that is “cleaner” and does not lead to problems of this type.

- One final conclusion (apart from that mentioned in the previous points) is that a wide gap still separates a large proportion of the business activities from the environmental information that is necessary for good management (new managers, management systems, minimisation and treatment equipment, etc.). Environmental information is an essential tool for the correct working of any business and is necessary for business activities at the global scale to move ahead towards good environmental management.

[34] The gradual emission reduction programme forms part of a voluntary self-declaration system of businesses that needs to take account of the quality objectives that the business activity seeks to achieve, the means to be used and the schedule for implementation. In Catalonia, this is regulated by Decree 398/1996 of 12 December, which controls the system of gradual plans for reducing emissions into the atmosphere.

8. BIBLIOGRAPHY

ABAG-Abfallberatungsagentur. *Manual for making environmental management and auditing.* 1995.

European Environment Agency. *The effectiveness of environmental agreements.* Series on environmental issues, no. 3. Vol. 1. 1997.

Regional Activity Centre for Cleaner Production. Mediterranean Action Plan*. MOED. Minimisation opportunities environmental diagnosis*. 2000.

Regional Activity Centre for Cleaner Production. Mediterranean Action Plan*. Design and Application of a Good Environmental Practices Programme in Industry.* 2000.

European Commission. *Waste Prevention and Minimisation.* 1996.

European Commission. *Clean Technologies for waste minimisation.* 1998.

IHOBE, s.a. *Guide of environmental indicators for the industry.* Federal Environment Agency (Bonn), Federal Environment Agency (Berlin) 1999.

Institut Cerdà. *Manual de Minimització de Residus i Emissions Industrials*. 1992.

Junta de Residus. *Reducció de Residus. Guia per a l'avaluació d'oportunitats als processos industrials*. Government of Catalonia. 1991.

Ministerio de Industria y Energía. *Manual Media. Minimización Económica del impacto ambiental en la industria.* 1995.

OECD. *Strategic Waste Prevention.* 2000.

OECD. *Eco-efficiency.* 1998.

US EPA. *Business guide for reducing solid waste.* 1993.

US EPA. *Waste minimisation opportunity assessment manual.* 1988.

US EPA. *Environmental economics: profiting from waste minimisation: a practical guide to achieving improvements in quality, profitability, and competitiveness through the prevention of pollution.* 1998.