

Meeting of MED POL National Coordinators

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**PROJECT FOR THE DEVELOPMENT OF LIMIT VALUES FOR
LIQUID AND ATMOSPHERIC EMISSIONS IN THE
IRON AND STEEL SECTOR IN MOROCCO**

Introduction

With a view to accompanying the implementation of the legislative framework governing the protection of the environment, particularly in relation to combating water and air pollution, the Ministry of Land Planning, Water and the Environment (MATEE) has embarked upon the development of limit values for liquid and atmospheric emissions for several industrial sectors. In this context, technical assistance has been provided by the MED POL Phase III Programme (covering the monitoring of pollution of the Mediterranean coast) to the Ministry of Land Planning, Water and the Environment (MATEE) for the development of limit values for industrial liquid waste in the steel sector. The processes for the manufacture of iron and steel make use of complex technologies which are such as to seriously prejudice the environment if the emissions are not managed in an appropriate manner. Liquid, solid and atmospheric waste containing various pollutants must be covered by effective controls imposed by regulation.

The objective of this study is to enumerate the available data on the iron and steel sector in Morocco and to propose limit values for specific liquid and atmospheric emissions for the sector.

In this context, several activities have been undertaken and are described in this report in the following two parts:

Part 1: development of limit values for liquid and atmospheric emissions in the iron and steel industry in Morocco.

This part of the report describes, in respect of Morocco and at the international level, the manufacturing processes, the characteristics of waste (liquid, solid and gaseous), anti-pollution techniques and proposes limit values for waste water from the iron and steel industry. Of all the activities in the sector to be found in the world, two areas of activity have then been identified in the case of Morocco: hot rolling (SONASID) and cold rolling (Maghreb Steel), which are covered in Part II.

Part II: manufacture and processing of steel in Morocco.

This part presents the results of the assessments and data collection exercises in the iron and steel sector in Morocco. The study covered two major enterprises in Morocco:

- SONASID: manufacture of steel and hot rolling
- MAGHREB STEEL: cold rolling and treatment (chemical dipping, galvanizing, organic coating – pre-coating).

In each case, information and data are presented which have been provided by the two enterprises examined (SONASID and MAGHREB STEEL) or obtained on site visits. All the figures are reproduced faithfully, as communicated, with interpretations and comments. The enterprise sites visited were:

- SONASID – Nador;
- SONASID – Jorf Lasfar;
- MAGHREB STEEL – Casablanca;
- SOCODAM – Casablanca.

The SOCODAM company is not described in this report as the data was not received (questionnaire) and it was observed during the site visit that the waste, particularly liquid waste, is of a low quantity.

The availability and reliability of data are essential to classify the emissions. It should be noted that, while many elements were easy to identify (technologies available, sources of pollution, resources used, existing anti-pollution installations, production capacity, ...), the fundamental phase of the missions, which consisted of measuring the volume and characteristics of waste (waste water, emissions into the air, solid waste) suffered from shortcomings. In this respect, bibliographical data for the sector have been used in support for the development of emission limit values. The latter are based on the best available techniques that are most suited to the sector, with a good performance in terms of reducing pollution and ensuring compliance with the emission limit values imposed. The approach followed for the reduction and control of industrial pollution must give priority to eliminating or reducing pollution

at source before envisaging recycling or elimination at the end of the production chain. This is in accordance with environmental legislation. Evidently, this approach implies the use of the best available technologies that are economically viable with the best possible compliance with regulatory requirements.

The visits to all the industrial sites examined and contacts with all those responsible for SONASID and MAGHREB STEEL were indispensable and provided much information and data. In the following page, all the stages of the project are enumerated.

**PART I: DEVELOPMENT OF LIMIT VALUES FOR LIQUID WASTE
IN THE IRON AND STEEL SECTOR IN MOROCCO**

Stages of the study

Phase 1: Initiation of the study

01/02/2006

First meeting between the representatives of the MATEE and the consultant to identify the sector and indicate the nature and geographical scope of the study. At first the choice related to the sites of the SONASID company (Nador and Jorf Lasfar).

08/02/2006

Second meeting attended by the representatives of the MATEE, the Ministry of Trade and Industry, the consultant and a representative of SONASID. The objective of this meeting was to obtain the agreement and cooperation of SONASID on the subject and to make the launching of the study official through the signature of the contract between the National MED POL Coordinator and the consultant.

15/03/2006

Third meeting, with the participation of:

- Ministry of Land Planning, Water and the Environment (MATEE);
- Ministry of Trade and Industry;
- the FIMME;
- the General Management of SONASID; and
- the consultant.

Objective: to make the participation and cooperation of all the partners in the carrying out of the study official.

Results of the meeting:

- the total cooperation of SONASID was confirmed by its President for the provision of data, information and the results of analyses of waste and in authorizing site visits;
- cooperation of the FIMME in including other enterprises in the same sector, developing and completing the study with the available data and information.

Phase 2: Execution

Site visits/surveys/data collection

Objective: to collect data and information on the iron and steel sector in Morocco: units, production processes, consumption of energy and water, liquid waste, gaseous emissions, solid waste, existing anti-pollution measures, available results of analyses, savings options ... The results of the field visits were supplemented by an exhaustive questionnaire submitted to the enterprises covered in the sector.

The visits and expert consultations undertaken were planned as follows:

- SONASID Nador: 05/04/2006;
- SONASID Jorf Lasfar: 21/04/2006;
- MAGHREB STEEL: 18/09/2006;
- SOCODAM Casablanca: 30/10/2006.

Phase 3: processing and analysis of data

Following these visits, contacts were maintained with the management of SONASID and MAGHRED STEEL to supplement the study. The data and information collected on site and through the questionnaire were processed and analysed with a view to describing the environmental situation of each site covered (Part II of the report):

- Report on SONASID;
- Report on MAGHREB STEEL.

Phase 4: development of a proposal for limit values for emissions

Part I of this report contains a description of the sector and the development of a provisional proposal for limit values for liquid and atmospheric emissions.

Phase 5: organization of a workshop

A workshop bringing together all the partners concerned by the study was held on 15 March 2007 to discuss and debate the proposed limit values for emissions. The agenda and list of participants of this meeting are contained in Annex 1. The emission limit values (ELVs) on which the discussion focussed were the following:

- the iron content of waste water, in view of the nature of the activity and despite the good performance of the anti-pollution measures, the residual values in waste water remain well above those proposed;
- the quality of fuel oil No.2 used does not make it possible to use a technology for the treatment of atmospheric emissions which is economically viable to achieve the proposed ELVs for SO_x (50mg/m³N).

It was recommended that the two enterprises SONASID and MAGHREB STEEL should make proposals and indicate their wishes (see the conclusion of this report) with a view to submitting them to the Norms and Standards Board for negotiation.

Phase 6: finalization of the study and preparation of the final report.

I – STATE OF THE ENVIRONMENT IN THE IRON AND STEEL SECTOR

I-1 Introduction

As the processes for manufacturing iron and steel give rise to many sources of pollution and pollutants, it is necessary to focus on those that have a significant impact on the environment and the elimination of which would involve relatively significant costs for the protection of the environment.

These consist of:

- dust (including heavy metals);
- sulphur oxides (mainly SO₂) and nitrogen (NO_x);
- waste water; and
- hazardous solid waste.

I-2 Iron and steel manufacturing processes throughout the world

The traditional processes which play a role in the majority of global steel production make use of blast furnaces for the production of pig iron and pure oxygen ovens (converters) or electric furnaces for the manufacture of steel.

These processes are complex and can have consequences that cannot be neglected on the environment in the absence of effective measures for the management of the wastes and emissions produced.

The two most common types of processes for the manufacture of steel are the following:

- integrated production: pig iron is produced in the blast furnace from iron ore and then transformed into steel in oxygen converters;
- direct production of steel from scrap iron and iron reduced in the electric oven.

The main difference between the methods is that, in integrated steel works, the manufacture of coke and pig iron precede the production of steel. After its production,

steel undergoes a series of finishing processes: continuous casting, hot rolling and forming, cold rolling and folding, coating, chemical scarfing and dipping.

The great majority of global steel production is obtained through these processes, described in Figure 1, which provides a diagrammatic overview of the current processes for steel production and enumerates the inputs and products obtained at each stage, although it does not indicate the substances recycled during the process.

I-3 Steel production processes in Morocco

Table 1 contains certain data and the main companies in the iron and steel sector in Morocco, with particular reference to those which manufacture steel (hot rolling, cold rolling and processing).

Projects are currently being developed, illustrating that the sector is in full development. Figure 2 provides a schematic diagram of the processes currently used at the national level.

Table 1: Companies in the iron and steel sector in Morocco specialized in the production of steel

Figure 1: Current processes for steel production in the world

Figure 2: Current processes for steel production in Morocco

I-4 Waste products

The bibliography and the information obtained through the diagnostic exercise in a number of production units in Morocco (SONASID, MAGHREB STEEL and SOCODAM) show that the characteristics of untreated waste products vary from one company to another, depending on the quality of the raw materials, the age of the factory, the technology, the design of the process, the efficiency of the operations,

methods of work and maintenance. Waste products are generally characterized by their important volume and the high rate of pollutants where:

- waste products are neither measured nor monitored, and therefore practically not managed;
- production techniques are outdated and the installations are old;
- processes are not effectively managed and are badly monitored;
- prevention measures, including maintenance programmes, are neglected; and
- treatment installations do not exist.

The physical and chemical characteristics of waste products indicated in Tables 2, 3 and 4 are taken from reference works and are cited by way of illustration.

In view of the multiplicity of pollutants and of potential sources of pollution in iron and steel production, the study is confined to recalling the sources and pollutants which have significant environmental effects and which give rise to significant costs for environmental protection:

- the principal sources of significant pollutants are electric arc furnaces, boiler furnaces, preheating furnaces and all processing and finishing operations;
- with regard to the reduction of atmospheric emissions, the main pollutants are particles (including heavy metals), SO₂ and NO_x;
- hazardous waste, which require treatment before discharge, include sludge, waste water, slag and recuperated oils, greases and dust;
- in relation to the treatment of industrial waste water, the main pollutants and substances in suspension, toxic substances (heavy metals, phenol, cyanide), oils, greases and acid waste.

I-4-1 Technologies to combat atmospheric pollution

A synthesis of reference works provides a basis for an overview of the techniques most widely applied to the pollutants referred to above, as well as their effectiveness and consequences in terms of costs.

I-4-1-1 Particle emissions (dust and heavy metals)

Controlling the particles emitted by iron and steel manufacturing processes is one of the most complex problems facing the iron and steel industry in the environmental field. This is due to the high levels of particle emissions and their heavy loads of toxic substances (heavy metals and silica dust) and respirable dust (the critical size being between 0.5 and 7 μm).

In the iron and steel industry, the most important source of particle emissions are electric furnaces and pre-heating furnaces. Concentrations in untreated flows vary between 0.5 and 9 grams per standardized m^3 (Table 2), or a ratio of 5 to 25 kg/t of steel. By way of illustration, in integrated steel plants, it should be noted that gas emissions containing particles produced by the main processes vary between 15 000 and 25 000 m^3 standardized per tonne of steel.

Between 65 and 90 per cent of the particles are normally derived from these sources, are below 10 μm in size and therefore constitute respirable dust.

Table 2: Characteristics of gaseous emissions from the processing of scrap iron and steel

Table 3: Characteristics of waste from the processing of scrap iron and steel

Table 4: Characteristics of waste water from the processing of scrap iron and steel

Of the various techniques used for the removal of particles, reference may be made to centrifugal separation, electrostatic precipitation, fabric filtration and washing (washing towers).

Table 5 indicates the techniques for the elimination of particles that are most commonly used to treat the principal sources of particles in the iron and steel industry. It also provides indications of the effectiveness of each of the techniques.

The choice of a technique for the elimination of particles depends on the degree of elimination required, the size of the particles and their chemical characteristics, as well as the volume and temperature of the atmospheric emissions.

Cyclone separators do not reduce particle emissions to the level required by the regulations that are in force as they are ineffective for the small particles emitted by iron and steel production processes. However, they are much cheaper than bag filters, washing towers and electrostatic systems.

Table 5: Techniques for the elimination of particles from the principal sources of gaseous emissions

For the effective elimination of particles under 10 μm in size, bag filters and electrostatic separation are the best techniques applicable to the iron and steel industry developed in Morocco.

Wherever it is necessary to eliminate high concentrations in respirable dust, bag filters, washing towers and dry electrostatic dust removal systems remain the most appropriate technology. The investment and operating costs of bag filters and electrostatic dust removal systems are comparable, while the investment cost for high- and medium-pressure washing towers are relatively low, but their operating costs are high.

By way of illustration, for bag filters and electrostatic separation systems, investment costs may vary between \$6 per standardized m^3 per hour in a relatively small factory (600 000 standardized m^3/hour) and \$3 per standardized m^3 per hour in a larger steel plant (2 000 000 standardized m^3 per hour).

I-4-1-2 SO_x and NO_x gas emissions

Table 6 shows the principal sources of SO₂ and NO_x in the global iron and steel industry. Reheating furnaces (used for finishing) and boilers are the principal sources of NO_x emissions, whereas sintering units, boilers and reheating furnaces are the main sources of SO₂.

Table 6: Principle sources of SO₂ and NO_x emissions

It should be recalled that in Morocco reheating furnaces and boilers are the main sources of emissions of these gasses.

Concentrations of SO₂ in untreated gas emissions depend on the sulphur content of fuels. For the important sources (boilers and reheating furnaces), they vary between 200 and 2000 mg per standardized m³. The No. 2 fuel used in Morocco is of very bad quality and is a significant source of atmospheric pollution.

In contrast, the concentrations of NO_x in untreated gaseous emissions depend greatly on the categories of fuel, combustion temperature and burner design. According to estimates, they vary between 100 and 1500 mg/m³ for important sources (boilers and reheating furnaces).

In most countries, emission levels of NO_x and SO₂ are controlled through the careful choice of fuel and raw materials. With a view to controlling NO_x emissions, low-emission burners and modern combustion systems can also be used. Technologies to combat pollution by these gasses are not common, but could include wet or dry dust removal installations for SO₂ and reduction systems (catalysis or absorption) for NO_x.

I-4-2 Solid waste

The main solid wastes generated by the processing of iron and steel are indicated in Table 3. The quantities generally vary, according to the nature and type of the process, between 50 and 600 kg/tonne of steel.

It is possible to recycle slag in construction materials, but that depends on local demand. In many developing countries, slag is simply piled up in heaps.

Residual sludge from the treatment of waste water can be classified as a hazardous substance in view of its content in lixiviable heavy metals.

The manufacture of iron and steel also generates the formation of scale, essentially composed of iron oxide, as a result of the process of cooling steel when water comes into contact with the substance: a solid crust is formed and coats the steel, and is then detached upon contact with water. This waste is recuperated by simply decanting the cooling water.

The refractory waste and sludge from the treatment of waste water can also be classified as hazardous substances in view of their content of lixiviable heavy metals.

The costs of managing all these wastes depend on the regulations applicable to their treatment.

In Morocco, only grease and oily residues are recuperated through an oil removal system at the industrial waste water treatment plant and are sold for processing and recycling.

I-4-3 Waste water

I-4-3-1 Manufacturing processes

Figure 2 indicates the steel manufacturing processes in Morocco. A description of the various stages is contained in Part II of this report: steel manufacture (steel plant) and hot rolling in SONASID and cold rolling and processing (folding, coating, chemical dipping ...) in MAGHREB STEEL.

I-4-3-2 Water consumption

Estimates of the volume of water required for the production of a tonne of steel are fairly variable, depending on the management of the process: investment waste treatment and the recycling of treated water, the type of cooling circuits, ... The reference works consider that the need for water in cold rolling may be as high as 22 m³/t.

In the case of SONASID, the quantity of water consumed per tonne is fairly low in comparison with the usual requirements in the sector. Based on the annual production of billets by the steel plant in Jorf Lasfar (the raw material), the volume of water consumed by the steel plant is 0.93 m³/t. Rolling, in both Jorf and Nador, does not exceed a volume of 0.40 m³/t (Table 7). This performance in terms of water consumption at the two SONASID sites is due to the existence of closed circuits (the steel plant) and semi-open circuits (rolling plants), the physical and chemical treatment and recycling of cooling water.

Water is used by MAGHREB STEEL for the dilution of dipping acid, rinsing dipped plates, the preparation of coating and skin pass emulsions, cooling and for boilers. The volume of water consumed is indicated in Table 8.

Table 8: Water consumption and waste volume – MAGHREB STEEL

I-4-3-3 Waste water

The volume of industrial waste water tends to vary between 1 and 5 m³/t of steel, but can rise to as high as 20 m³/t of steel in certain countries due to the bad management of waste water. In this context, the World Bank, in its directives applicable to developing countries, considers that the objective of 1 m³ of water per tonne of steel is realistic. Indeed, the World Bank has established very complete guidance for the iron and steel sector, which covers preventing and combating pollution, objectives for pollutant loads, treatment techniques, emissions levels and monitoring. In particular, it recommends the reuse of 90 per cent of waste water and discharges of less than 5 m³/t of steel, and where possible less than 1 m³/t of steel.

In the case of hot rolling by SONASID, the only waste water running off into the environment consists of direct and indirect discharges, estimated at 24 000 m³/year at Jorf and 73 000 m³/year at Nador. Discharges of waste water at the Nador site are over twice as high as the Jorf site in terms of m³/t (Table 9), due to the fact that the latter site is more recent and uses more modern processes and plant.

Moreover, the cooling water circuit in the steel plant has negligible discharges of waste water as all of the water is recycled, although the quantities and quality of the waste water are not known.

Table 9: Discharges of industrial waste water – SONASID

With regard to MAGHREB STEEL, the volumes of the various discharges are given for each process (see Part II) and represent a total of 160 000 m³/year, of which 100 000 m³/year passes through the treatment plant, while the rest (the concentrate of inverse osmosis water and discharge of cooling water) is released directly into the municipal drainage system.

I-4-3-4 Composition of waste water

The main pollutants contained in industrial waste water in the iron and steel sector and substances in suspension, toxic substances (heavy metals, cyanide compounds), oils, grease and acidic products. The substances in suspension are eliminated without major technical difficulties by decantation. The toxic compounds can be eliminated through the combined use of secondary and tertiary systems.

A number of the characteristics of liquid waste in the iron and steel sector, and particularly pollutant loads, have been identified from reference works and are indicated in Table 4. For example, substances in suspension are sometimes found in large quantities in water that has been used for cooling (containing slag, scale, heavy metals, ...) and are estimated at 220 kg/t of steel, or a concentration that may be as high as 4000 mg/l, or a maximum volume of 55 m³/t. While these examples of values are extreme, reference works indicate for this parameter (substances in suspension) load values which do not generally exceed 2000 mg/l for a discharge which may attain 20

m³/t, or 40 kg/t in the case of hot rolling. The ratios for cold rolling are estimated at around 3 g/t. Estimates for oils and grease can reach around 200 mg/l for hot rolling and 270 mg/l for cold rolling (MAGRHEB STEEL).

Unfortunately, in terms of assessing the daily load of pollution and calculating Moroccan values in this sector, there are no analyses available or measurements of the volume of discharges from composite samples and/or hours relating to the discharge of untreated waste water outside the factories that we visited. Nevertheless, the volumes of hourly discharges are known.

I-4-3-5 Cleaning techniques and performances

With a view to complying with increasingly stringent regulation, companies have to give greater priority to preventive solutions and the reduction of discharges of waste water. Environmental management systems are making increasing use of non-polluting technologies and the improvement of processes so as to be in compliance with the standards that are imposed. Solutions applied at the end of the process, which are costly, are therefore only used for the recycling of treated water or, in the last resort, for the treatment of waste that cannot otherwise be eliminated.

Most plants make it possible to obtain treated industrial waste water of a satisfactory quality. Certain processes may require additional cleaning stages in the case of severe regulatory limit values or reuse, but that does not give rise to particular problems. In general, it is considered that if waste water is of sufficiently good quality to be able to be reused in the processes, it can be discharged into the natural environment.

The level of treatment required on site depends greatly on the destination of treated water: the natural environment (direct discharge) or municipal drainage system (indirect discharge). A primary treatment is sufficient for discharge into a drainage system, as in the case of MAGHREB STEEL, while secondary and tertiary treatment is necessary for direct discharges into the natural environment or for complete recycling, as in the case of SONASID. It should be noted that the current processes for the treatment of industrial waste water in the sector could be modified or adapted

(through projects for the renovation of treatment plants for waste water from the rolling process that are currently being implemented) to meet the new regulations.

Current processes for the treatment of industrial waste water in the iron and steel sector could be modified or adapted to meet the new regulations. Substances in suspension can be eliminated without any great technical difficulty through decantation and clarification. In general terms, traditional treatment may include: equalization, coagulation-flocculation, decantation, deoiling, filtration, ...

Toxic compounds (heavy metals), when their loads exceed certain limit values required by regulation, can be eliminated from specific flows through the combined use of secondary and tertiary systems (physical and chemical elimination, absorption, ...). Industrial sludge is filtered, dried and managed.

In the case of hot rolling, the industrial waste water essentially comes from the cooling of the rolling equipment and the finished product. Reference should be made to the system installed in SONASID, which consists of physical and chemical treatment processes. According to the results of analyses of treated industrial waste water carried out recently (the average values of the results of the analyses are provided in Tables 10 and 11), the values obtained demonstrate that it is a very effective treatment process and that the water discharged into the natural environment is of good quality.

In World Bank publications, the following values can be found for a volume of waste of 0.1 m³ per tonne of steel:

- Zn: 0.6 g/t of steel;
- Pb: 0.15 g/t of steel; and
- Cd: 0.08 g/t of steel.

In the case of SONASID, when examining discharges of waste of 0.06 m³/t of steel at Jorf and 0.14 m³/t of steel at Nador (Table 9) the results of the analysis shown in Tables 10 and 11 are as follows:

- Zn: 0.6 g/t of steel;
- Pb: 0.15 g/t of steel; and

- Cd: 0.08 g/t of steel.

As a system for the treatment of waste water in this sector, the following techniques are recommended (see the SONASID treatment plants and the figures in Part II):

Coagulation – flocculation – decantation

When it enters the treatment plant, a chemical product (coagulant) is added together with an anionic flocculant. The solids in suspension found in waste water from the rolling process are mainly composed of metal particles, slag, scale and dust, which will be flocculated and decanted. The dissolved metallic ions are transformed into hydroxides or salts with a low solubility which can then be separated. The separation of particles and flocculated substances is generally carried out by a gravity process (sedimentation). The concentration of materials in suspension and heavy metals can be reduced to very low levels (see SONASID's results).

De-oiling

Various methods can be used to separate the aqueous waste from oily residues, including thermal treatment, chemical treatment, floatation, absorption or membrane filtration. In the iron and steel sector, the recommended method is the simplest and most effective:

Separation by floatation (hot rolling, as in the case of SONASID)

In a quiet tank, oils are skimmed off the surface. The performance of the process is improved by the use of flocculants and by injecting small gas bubbles at the bottom of the tank to bring the oils to the surface. The quantity of oils recuperated from the decantation tanks has been reduced through the installation of a new air-oil system of lubrication. The de-oiling plant will be renovated during the course of the year so as to achieve very low concentrations of oil of around 50 tonnes a year.

Filtration

Very fine particles can then be removed through grit or sand filters with precise dimensions of the granules. Through the pressure created in the filter, the water passes through a filter bed removing the particles that it contains. When the difference in pressure reaches certain values, as indicated by manometers at the entry and exit of the filter, it is necessary to clean it. The resulting industrial sludge is filtered, dried and managed.

When waste water is discharged into sewage systems, preliminary treatment on site is sufficient: equalization, coagulation-flocculation, decantation and de-oiling.

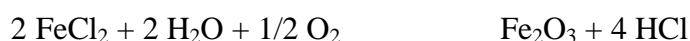
The use of acids for the chemical dipping of steel in cold rolling processes (in MAGHREB STEEL) has several disadvantages, such as the need to neutralize the acidic waste water, the difficulty of removing iron, the production of significant quantities of sludge, the cost of treatment and the high consumption of water. Two options may be recommended to resolve this problem.

(a) Regeneration and recycling of the used acid

The regeneration of acids is a clean and effective process used throughout the world to resolve these environmental problems: it is an anti-pollution measure and offers savings in resources.

Based on the practices used by MAGHREB STEEL, the regeneration of used acid results in the production of acid with a concentration of 18 per cent at a temperature of 80°C (very favourable parameters for direct and economic recycling). The process generates iron oxide, which is a product that can be used.

The principle: chemical dipping using hydrochloric acid results in the formation of ferrous chloride. The acid is regenerated from the latter at a temperature of between 800 and 900°C by pyrolysis through the reaction:



Through this reaction, the iron reoxidizes and the chlorine recombines with hydrogen to form acid vapour, which is purified and cooled, giving liquid acid.

(b) Treatment of acidic waste water

The stages of the treatment of the acidic water are as follows:

- pre-neutralization of the water through the addition of lime solution to raise the pH to around 7;
- oxidization through the injection of compressed air to oxidize the ferrous iron Fe^{2+} into ferric iron Fe^{3+} , which is in turn transformed into ferrous hydroxide, which is easy to decant;
- neutralization through the regularization of the pH at between 9 and 10 through the addition of lime solution;
- the flocculation of the hydroxide through the addition of a flocculant (increasing the size of the flocs);
- decantation and separation of the floating residue and the sludge;
- the treated water is discharged into the treatment network;
- filtration of the sludge through pressure filters to dehydrate them; and
- management of the sludge.

Tables 10 and 11

II Limit values of discharges

II-1 Limit values of liquid discharges

Regulations vary depending on whether waste water is discharged into sewers (indirect discharge) or into the natural environment (direct discharge). The limit values imposed for direct discharges are generally stricter than for indirect discharges so as to take into account health effects in the case of contact and the impact on water quality where it is intended for any further use. Indirect discharges generally require preliminary treatment to ensure that the quality of industrial waste water is close to that of household waste water.

II-1-1 International references for limit values for liquid discharges

The policy of the European Union is that Member States are free to develop their own programmes to achieve environmental protection objectives. Member States have to take into account Community policy, in which emphasis is placed on the fact, while environmental protection is a challenge for industry, it also offers an opportunity for companies to improve their competitiveness through the optimization of their resources.

In the case of the iron and steel industry, regulations have to determine the level of emissions that are acceptable for industrial waste water. The World Bank, in the guidance that it provides for developing countries, also proposes limit value applicable to waste water in the sector. Reference works show plenty of variation in the standards applicable to discharges from the iron and steel industry from one country to another. For example, the levels applicable to the industry in the United Kingdom are not the same as those for other Member States of the European Union, as each country has different priorities and objectives in relation to pollutants. By way of illustration, Table 12 compares the anti-pollution standards set by the United Kingdom, Egypt and the World Bank for the principal pollutants in waste water from the iron and steel industry.

Table 12: Comparison of standards applicable in the iron and steel industry in the United Kingdom, Egypt and those set by the World Bank

Although no direct comparison can be made, the standards set by the World Bank are between those of the United Kingdom and of Egypt for discharges into sewers and the natural environment.

The cases of a number of Mediterranean countries

Table 13 indicates the limit values for discharges in Algeria (general limits), Lebanon and Spain (discharges into surface waters) and shows that the differences between Algeria and Spain are insignificant. In certain cases, the limit values for Algeria are stricter, while Lebanon is increasingly tending to adapt new installations

to European Union standards. Algeria has set limit values without differentiating between the receiving environment and with making a distinction between new plants and those already in existence. Lebanon has structured its limit values for liquid discharges on the European Union model for environmental quality standards.

As MAGHREB STEEL discharges waste water into the municipal sewer, the values imposed by LYDEC are provided below for illustrative and comparative purposes.

Table 13: Limit values for water discharges in certain Mediterranean countries

It was indicated at the beginning of the report that the activities in the iron and steel sector existing in Morocco consist of: hot rolling (SONASID) and cold rolling (MAGHREB STEEL). The two companies are located on industrial sites where SONASID discharges into the natural environment (direct discharge) and MAGHREB STEEL into the municipal sewer (indirect discharge).

It is for this reason that all the analytical data for the two sites are determining factors in proposing limit values for discharges from the iron and steel sector. The average values of treated water at SONASID (Tables 10 and 11) are well below European standards, and particularly those of Mediterranean countries. The proposed limit values are a synthesis of all the standards in Mediterranean countries (Table 13) and the quality of the treated water from SONASID.

II-2 Limit values for atmospheric emissions

In the absence of in-depth analyses of the atmospheric emissions, limit values are proposed with reference to World Bank recommendations and the values in force in certain Mediterranean countries.

II-2-1 International references for limit values for atmospheric emissions

Table 14 compares the anti-pollution standards of the United Kingdom, Egypt, Germany, Denmark and the World Bank for the principal pollutants emitted into the air by the iron and steel industry.

For each of these pollutants and for each of the sources of pollution, Table 15 indicates links between the regulatory standards and the technologies used for their reduction. These data tend to show that, for most of the main pollutants, the severity of the standards imposed is an important criterion in the choice of technology for adaptation to the standards.

The World Bank has developed very complete recommendations for the iron and steel industry, based on the legislation of the United States, which cover pollution prevention and measures to combat pollution, objectives in relation to pollutant loads, treatment techniques and emission levels.

Table 14: Comparison between the standards of Arab and European countries and the World Bank (atmospheric pollutants from the iron and steel industry in standardized mg/m³)

Table 15: Relations between regulations, technologies and costs

For the principal pollutants, such as SO₂, national regulations in certain countries determine emission standards based on a formula that includes various factors, such as the height of the chimney, the product and the local climate. This introduces a certain flexibility so that limit values can vary according to source and location. For NO_x, minor variations are envisaged to take into account plant capacity, the type of fuels used and location.

Japan is one of the few countries in which SO₂ and NO_x emissions have been controlled through the strict regulations applicable to these pollutants. In that country, absorption systems have been installed following electrostatic removal of dusts for the removal of SO₂, NO_x and fluorides.

III Cost of combating pollution

In the iron and steel industry, both in developed and developing countries, the cost of measures to combat pollution constitute the majority of the environmental protection costs. As the treatment of industrial waste water is carried out in accordance with standardized procedures, the investment and operating costs depend mainly on volume and vary from one country to another, and even from one region to another within countries, and according to the receiving environment.

In the case of industrial plants that are already in service, the entry into force of new regulations on industrial pollution obliges companies to:

- invest in treatment plants at the end of the process; or
- modify their manufacturing processes to reduce or eliminate discharges.

It is generally considered that the option of adapting anti-pollution measures (that is adding them on to the end of the process) to existing plants is the most costly and generates the least added value, whereas modifications to manufacturing processes can lower costs and improve the cost/efficiency ratio.

The investment costs of the treatment of industrial waste water can be high. By way of illustration, the cost of a traditional treatment plant (equalization, neutralization, decantation, filtration) can be as high as \$1500 per m³/h for the highest volumes. Operating costs depend on the operating costs of the waste water treatment plant and the waste discharge fees. As an example, the operating costs vary between \$200 and 500 per year/m³/h for a traditional treatment plant. Waste discharge fees vary considerably from one country to another.

Technologies to combat SO₂ and NO_x pollution are not common, but could include wet and dry dust removal processes for SO₂ and systems for the reduction of NO_x (catalysis and absorption). The cost of this type of equipment varies greatly depending on the location, the specifications and the required rate of removal. By way of illustration, investment costs vary between \$300 and 700 per tonne of SO₂ removed and between \$100 and 200 per tonne of NO_x.

**PART II: PRODUCTION AND PROCESSING OF STEEL IN MOROCCO
STEEL PRODUCTION (STEEL PLANT) AND HOT ROLLING (ROLLING
PLANT) – SONASID**

SONASID – JORF LASFAR AND NADOR

SONASID was set up by the Government of Morocco on 1974 and privatized in 1997, as the first component of the Moroccan iron and steel industry to cater for national needs for steel products, principally for the housing, construction and public works sectors.

Production commenced in March 1984 at the rolling mill in Nador, located 18 km south of the town of Nador on the trunk road RN 2, El Aâroui. The principal activity of the Nador site is the production of smooth concrete reinforcing rods, ribbed concrete reinforcing rods and extruded wire in bars and mesh. Its production capacity is around 600 000 tonnes a year of concrete reinforcing bars and extruded wire.

In 1996, SONASID made 35 per cent of its capital available on the stock exchange and in 1997 the State sold 62 per cent of its capital to a consortium of institutional investors, headed by the SNI, in order to face up to the new market constraints and the need for competitiveness.

In 2000, SONASID launched a new production plant in Jorf Lasfar. The new rolling mill entered service in July 2002 and attains an annual production of 300 000 tonnes of steel reinforcing and rolled products.

In 2003, SONASID embarked upon an ambitious project to establish an electric steel works in Jorf Lasfar, which entered into service in August 2005 with a production capacity of between 625 000 and 1 000 000 tonnes of steel billets a year.

The SONASID site in Jorf Lasfar is located in an industrial zone, 1.5 km from the port, with a surface of 15 hectares.

I – DESCRIPTION OF THE ENVIRONMENT OF THE SITE

I-1 The Jorf Lasfar site

- Geographical situation: plant constructed at less than 1.5 km from the port of Jorf Lasfar and the OCP phosphate plant and near to an Arab village depending upon agriculture.
- Climate: varying between semi-arid and humid on the Atlantic coast, with an average annual precipitation of 390 mm, an average temperature of around 17°C and a water loss of around 320 mm. The prevailing winds are North to South, or North-east to South-west.
- Geological context: plant constructed on a layer of limestone from the Plioquaternary era (6 to 10 meters thick), lying on marno-calcaire layers of the Cenomanian era (secondary era).
- Soil: mainly very rocky and a thin layer, a mixture of sand and clay.
- Hydrology: absence of any permanent or temporary water courses in the area.
- Hydrogeology: ground water is found in the cracked limestone of the cenomanian era at a depth of over 12 metres on average. Underground water is generally brackish and mediocre in quality.
- Fauna and flora: little continental vegetation (clumps and bushes). The marine fauna is well developed.

I-2 Nador site

- Geographical situation: plant located less than 1.5 km from the Mediterranean Sea and 7 km from the El Arui airport.
- Climate: slightly wet in winter and dry in summer. The prevailing winds are from the South-west to the North-east in winter and from the North-west to South-east in summer.
- Geological context: plant constructed on a limestone formation (3 to 15 meters thick).
- Soil: generally rocky and very thin in the area.
- Hydrology: no water courses.
- Hydrogeology: ground water is found in the cracked limestone at an average depth of between 4 and 8 metres. Underground water is brackish with a salt content of between 2 and 4 g/l.
- Fauna and flora: little continental vegetation (clumps and bushes).

II-DESCRIPTION OF THE MANUFACTURING PROCESSES

II-1 The Jorf Lasfar site

SONASID-Jorf Lasfar has the following installations:

- **Electric furnace and ladle furnace:** liquid steel from molten scrap iron.
- **Continuous casting:** steel billets from the molten steel produced by the furnaces.
- **Bar mill:** concrete reinforcing bars and hot-rolled bars produced from billets.

II-1-1 The steel plant

Figure 3 indicates the inputs consumed by the SONASID steel plant at Jorf Lasfar. Figure 4 shows the steel production process.

Figure 3: Inputs consumed by the Jorf Lasfar steel works

The SONASID electric steel works is a production plant manufacturing billets from molten scrap iron. The normal capacity of the plant is around 800 000 tonnes a year.

The electric furnace is composed of a steel vessel with a refractory lining. The energy is provided by electric arcs between graphite electrodes. Annual consumption of electricity is around 300 GWh at a power of 80 to 100 MW. Energy needs are supplemented by chemical energy (injection of oxygen, coke and propane).

The scrap steel is loaded in a continuous process onto a special conveyer extended by a tunnel in which the scrap is pre-heated by the fumes from the furnace. The molten steel is refined through its reaction with lime slag.

Smelting is often accompanied by a process of decarburization and dephosphorization through the injection of oxygen. The decarburization has to result in molten metal with the desired carbon content. Through the release of carbon oxides it facilitates the elimination of dissolved gasses. The dephosphorization is

achieved through the addition of oxygen through the oxidization of phosphorous by the formation of P_2O_5 obtained from the lime slag.

Figure 4: Billet manufacturing process

After it has been deslagged, the metal is poured into ladles. To increase performance, additives are added during the pouring into ladles. The ladles are then transported by a rolling lift. Once the planned consistency has been obtained, the ladle is transferred to the continuous pouring plant.

The continuous pouring process consists essentially of:

- the continuous formation, in an mould that is open at both ends and cooled, of a metal crust that is sufficiently solid to contain the still molten metal;
- the progression of the crust which is detached from the mould through the contraction of the metal and an oscillation system which separates the solidified crust from the wall of the mould. The solidification is completed by the passage of the metal through a cooling system of vapourized water;
- the extracted product is straightened, cut with an oxygen based cutting system, marked and cooled on an air bed before being removed to a stockage area;
- the process for the removal of the billets (before they are marked) also allows them to be placed still hot in the furnace of the rolling mill.

II-1-2 Rolling mill – Jorf Lasfar

The rolling mill produces bars of between 8 and 40 mm and hot-rolled bars in a range of square sections, angle sections, u-sections and flat sections corresponding to the needs of the national market. It is equipped with:

- a furnace to heat the billets;
- a continuous belt of stands and all the mechanical and electrical equipment required for its proper operation;
- storage areas for the raw material and the finished product;
- equipment for the provision of fluid inputs;

- electrical information and a transformation station;
- workshops, laboratory and warehouses;
- rolling and mobile lifts;
- auxiliary and administrative buildings.

Figure 5 shows the process of the SONASID Jorf Lasfar rolling mill.

Billets are loaded into the furnace from the internal area by a 20 tonne rolling crane and a loading table in front of the furnace entrance, with a roller table. The latter is equipped with a system weigh each billet before it is loaded into the furnace. The furnace is a mobile overhead combustion oven with lateral and frontal burners. The billets are arranged in the furnace in 12 metre rows. The nominal capacity of the furnace with a cold load is 80 tonnes an hour.

When the billet reaches the ideal temperature for rolling, of over 1200°C, it is removed from the furnace and transferred to the rolling line to the East of the furnace.

The rolling line consists of 18 stands over a length of around 55 metres. The roughing mill, stands 1 to 6, is composed of vertical stands alternated by three horizontal stands. The plant is designed to achieve the continuous rolling of billets without twisting. A slab shear is installed at the beginning of the roughing mill for the shearing of billets in cases of emergency.

A multi-bar straightening machine is located at the exit of the cooling bed. For the manufacture of sections (mainly U, angle and flat), it is used to straighten bars. In the case of profile sections, a roller is located between the cooling bed and the straightening machine so as to withdraw the profile sections and transfer them to the straightening machine.

Figure 5: Jorf Lasfar rolling process

The layers of bars produced are piled up and transferred to the binder, which binds packs of bars using wire. The bound packs are then weighed and transferred to a conveyer belt, located after the binder, which takes them to the storage area.

Planned developments at the Jorf Lasfar site

- in 2006, welding of billets
- in 2006, loading of the hot billets directly from the steel works into the reheating furnace of the rolling mill
- replacement of cast iron cylinders by cylinders with carbide rings
- software for the optimization of furnace operation
- management and reuse of steel works byproducts

II-2 The Nador site

The production plant is a continuous rolling mill for high precision double strand wire, designed by Morgan Construction and Co. (United States) and constructed by Davy McKee (United Kingdom).

Operating parameters of the rolling mill:

- nominal production capacity: 420 000 tonnes a year (currently 530 000)
- roughing mill: 7 stands
- intermediary mill: 8 stands
- finishing mill: 10 stands per strand
- wire drawing block for diameters 16 to 25 mm
- rolling speed: 75 m/s for 5.5 mm diameter
- rocker bar furnace
- maximum capacity: 140 t/h
- average output: 97 per cent
- cooling system water air Stelmor, Hyqst.

Figure 6 shows the production process. The inputs and products are indicated in Table 16 and Figure 7.

Figure 6: Production process at the Nador site

Table 16: Inputs at the Nador site

Figure 7: Diagram of inputs and products at the Nador site

Development of the process at Nador

- **Weldability of the product** (end of 1999) resulting in an expansion of the range of SONASID finished products through the production of the FeE500S quality. The project consisted of replacing the Stemor processing line by the Hyqst process (dipping followed by an automatic return) necessitating a large volume of water to lower the temperature of the hot rolled rods from 1100 to 620°C.
- **Revamping the rolling mill** (end of 2004) which also allowed 140 x 140 mm billets to be rolled, an increase in annual production to 650 000 tonnes by raising the speed of rolling (the nominal hourly production rate rose from 120 to 145 t/h).
- **Replacement of cast iron cylinders by cylinders with carbide rings** for stands 12 to 15 (during the course of 2006), necessitating intense cooling due to their great hardness and sensitivity to thermal shocks.
- **Replacement of the cooling ramps in the stands** of the roughing, intermediary and finishing mills (during the course of 2006) by effective and well-designed ramps.
- **Revamping the water treatment plant**
- **Automation of the water treatment plant**

III WATER SUPPLY

III-1 Jorf Lasfar site

Based on the annual production indicated in Table 17, the volumes of water consumed respectively by the steel works and the rolling mill are 0.93 and 0.40 m³/t. In reference works, it is considered that the water requirements for hot rolling may be as high as 22 m³/t. The performance in terms of water consumption by the two

SONASID sites is due to the existence of closed circuits and the treatment and recycling of water.

Table 17: Water consumption – Jorf Lasfar site

Water economy measures

For the whole of its plant, SONASID has invested in:

- two waste water treatment and recycling plants;
- a reverse osmosis plant;
- a domestic waste water treatment plant.

The overall investment from 2002 to 2005 was 98 million dirhams to save 1.8 million m³ of water a year.

III-2 Nador site

The water supply is taken from the Bouareg irrigation canal at a volume of 40 litres a second. Based on an annual production of 530 000 tonnes, water consumption varies between a minimum of 0.27 m³/t to a maximum of 0.40 m³/t (Table 18). The volume of water consumed per tonne remains fairly low in comparison with the specific requirement of hot rolling, which may be as high as 22 m³/t.

Table 18: Water consumption – Nador site

IV – ENERGY CONSUMPTION

IV-1 Jorf Lasfar site

Fuel oil:

- Type: fuel oil No. 2 of very bad quality – S: 4 to 6 per cent
- Annual consumption: 31 kg/t of concrete reinforcing rods
- Chemical composition: Table 19 summarizes the chemical characteristics

Table 19: Chemical characteristics of the fuel oil – Jorf Lasfar site

Electricity

- 369 310 000 kWh are consumed by the steel plant for the production of 508 000 tonnes of billets
- 46 620 000 kWh are consumed by the rolling mill for the production of 444 000 tonnes (Jorf mill finished product)

Energy economy measures:

Table 20 indicates the measures to be adopted for each workshop and the savings achieved.

Table 20: Economy measures for energy at the Jorf Lasfar site

IV-2 Nador site

Electricity

The supply of electricity is provided by a 225 kV line of the National Electricity Office (Table 21).

Table 21: Electricity and fuel oil consumption – Nador site

Fuel oil (fuel No. 2)

- annual consumption: 31 kg/T (Table 21)
- chemical composition: summarized in Table 22

Energy economy measures

The energy economy measures adopted, planned and possible may be summarized as follows:

2004

Revamping the furnace with digital controls.

2005

- automation of the rolling line with the installation of digital controls.
- increase volume of air flow through the installation of new compressors.

2006

- automation of the CTI
- automation of the waste water treatment plant.

V – RANGE OF PRODUCTS

- steel billets of 140 x 140 mm² width and 12 and 13 m length (**steel works**)

- steel reinforcing rods (**rolling mills at Nador and Jorf Lasfar**)

- rods (1.5 to 2T): 6 – 8 – 10 – 12 mm
- bars (12m - 2T): 8 – 10 – 12 – 14 – 16 – 20 – 25 – 32 – 40 mm.

- hot rolled rods (**Nador rolling mill**)

- round and square sections 10 to 40 mm
- flat 25 x 3 to 60 x 6
- angled, U and T sections 25 up to 60 mm

- wire (**Nador rolling mill**)

- bobbins (1.5 to 2T) 5.5 – 7 – 8 – 14 mm
- rods for drawing (calmed and effervescent)
- wire for welded trellises (drawn and cold rolled)
- wire for soldering electrodes
- wire for cold heading

Tables 23 and 24 show the development in the production at the Jorf Lasfar and Nador sites.

Table 23: Development of production at the Jorf Lasfar site

Table 24: Development of production at the Nador site

VI – SURVEY OF DISCHARGES

VI-1 Liquid discharges

The cooling circuits are of two types:

- **Indirect circuit:** a semi-open circuit for the cooling of accessories to the furnace, the hydraulic plant and the compressors. This discharge generally contains substances in suspension in the case of bad treatment during the process. The circuit is continuously supplied with additional water so as to minimize the effect of certain parameters (temperature, TDS, materials in suspension, salinity, ...) responsible for the development of algae. The blow-off water from the (indirect) circuit is sent back to the direct circuit to save water.

- **Direct circuit:** a semi-open circuit for the cooling of the furnace joints, the cooling of the roughing, intermediary and finishing mills. It is also used for dipping (treatment of concrete reinforcing rods for welding). This discharge generally contains scale, greases, oils and pieces of finished product.

VI-1-1 Nature and volume of discharges/receiving environment

The data on which this analysis is based were provided by SONASID.

VI-1-1-1 Jorf Lasfar site

Table 25 indicates the types of discharges generated and certain of their characteristics.

Table 25: Liquid discharges – Jord Lasfar site

Steel plant

Figure 8 shows the water circuit for the steel plant. The steel manufacturing process does not require water as a raw material. However, the various installations

have to be cooled throughout the process and the cooling circuits concerned are closed circuits. The cooling of billets is the only point at which the water enters into contact with the material and the corresponding circuit is open to hydrocyclones for decanting.

The sludge retrieved from the hydrocyclones is the only discharge from the water circuit in the new steel plant. The volume of sludge is estimated at around 55 m³/day, with an annual volume of solids of 3 tonnes. The sludge is evacuated to the thickener in the rolling mill, without the final destination being specified.

The blow-off water, vaporization and leaks are compensated through the addition of around 80 m³/h to the cooling circuit of the steel plant.

VI-1-1-2 Nador site

Table 26 indicates the types of discharges generated and certain of their characteristics.

Table 26: Discharges of treated water

Figure 9 consists of a diagram of the flows of liquid and solid discharges and gaseous emissions produced by the production plants.

VI-1-2 Treatment of industrial waste water (rolling mill)

The industrial waste water produced essentially by the cooling of installations on the rolling line and the finished product undergo physical and chemical treatment.

The first stage of the treatment is coagulation-flocculation, when a chemical product and an anionic flocculant are added, followed by decantation, deoiling, filtration through sand filters, with the water finally passing through the cooling tower. During the cooling of these water discharges the corrosion and scaling inhibitor and a biocide are added (green products).

The industrial waste water treatment plants for the rolling mills on the two sites, Jorf Lasfar and Nador, are shown on Figures 10, 11 and 12, respectively.

Description of treatment techniques used at Jorf Lasfar

- pre-treatment: mechanical screening and neutralization
- coagulation-flocculation (addition of an anionic flocculant)
- decantation: two decanters of a capacity of 1000 m³ each (the volume of the circuit is 2000 m³)
- deoiling and degreasing
- filtration through sand filters
- addition of biocides and chemical treatment (amines) to combat corrosion
- cooling in the tower
- recycling to the plant

Reuse means that the water becomes concentrated in various elements and it is therefore necessary to let water out of the circuit. Blow-off water (3 m³/h) and evaporation (13 m³/h) are made up by the addition of water (municipal water supply). Direct and indirect blow-off water is discharged into the natural environment, mixed as a common run off.

The principal pollutants found are substances in suspension, oils, greases and heavy metals, which are removed without major technical difficulties by the treatment plants that are currently installed.

Figure 8: Steel works water treatment plant

Figure 9: Discharge flow chart

Based on the results of analyses (annexed) provided by SONASID, the treated waste water is of a sufficiently good quality to be reused in the processes or discharged into water courses. If the samples were taken at the outlets, at the point where the water is discharged into the natural environment, and are therefore accurate,

the results contained in annex show that the treatment system installed is effective, particularly at Jorf Lasfar. In general, the quality of the treated water is excellent. This would be explained by the fact that the Jorf plant is recent and benefits from modern techniques.

Figure 10: Treatment plant for the water from the rolling mill – Jorf Lasfar site

Figure 11: Indirect and additional water circuit

Figure 12: Treatment plant for water in the direct circuit

VI-1-3 Characteristics of the industrial waste water from the rolling mill (Jorf and Nador)

Sampling exercises and analyses of treated waste water have been carried out recently in November and December 2006. With a view to assessing changes in time in the quality of these discharges, 32 parameters were identified for several samples taken every 8 hours: 3 samples from Jorf Lasfar and 6 from Nador. The results are provided in annex. The results of the analyses communicated by SONASID for the treated industrial waste water (treated in the system described above) and discharged into the natural environment show that it is of good quality. In principle, blow-off water normally has a higher content in minerals. The objective of bleeding water is to add water so as to dilute the water contained in the circuit.

These recent analytical data are a determining factor in the proposal of limit values for discharges in the iron and steel sector. However, other essential information and data are missing for a coherent discussion of these results, with particular reference to:

- measurements of the volumes based on composite samples and/or per hour (12 to 24 hours), analysis of the untreated waste water (as it enters the treatment plant) and of the recycled treated water, which would indicate the global level of pollution each day;

- the quantity of sludge generated by the treatment plants and what happens to it.

In commenting upon the analyses, only the average values of the various parameters are used, as determined from the monitoring (Tables 27 and 28).

pH

The pH level indicates the aggressivity of the water. The average pH values measured in the industrial waste water are 7.6 in Jorf and 7.5 in Nador and do not show major variations. These values are within the general limit values (6.5 – 9).

Water conductivity

The conductivity of the water bled from Jorf Lasfar shows a fairly low average value (341 $\mu\text{S}/\text{cm}$), demonstrating that the water is of good quality. However, the conductivity values for the water bled from Nador vary between 2100 and 2500 $\mu\text{S}/\text{cm}$ (an average of 2346 $\mu\text{S}/\text{cm}$) are fairly high, probably due to the salinity of the water supply and therefore demonstrate an increase in the salinity of the water during recycling.

Materials in suspense sole criterion analysed

Materials in suspense are considered to be among the principal pollutants generated by the iron and steel industry. The measurements for materials in suspense at the entry to the treatment plant vary between 280 and 429 mg/l (280 mg/l when the sand filters are not washed and 429 mg/l during the washing process). The values measured as the water exits the plant are low and show that the materials in suspense are removed without major technical difficulties by the treatment plants currently installed. The average values do not exceed 11 mg/l (the efficiency of the treatment is between 97 and 99 per cent), demonstrating that the water is of good enough quality to be discharged into the natural receiving environment without any significant negative impact. They are very much lower than the limit values generally allowed for direct discharges.

Organic materials

The organic content of waste water is generally assessed on the basis of the measurement of its chemical oxygen demand (COD) and biological oxygen demand (BOD5). These two parameters, considered to be indicators of pollution, provide information on oxydisable organic matter and the biodegradable proportion and therefore make it possible to assess, for waste water discharges, the extent of their environmental impact and their self-treatment potential. The results provided in annex show the fluctuations in time for COD and BOD5 and indicate that the industrial waste water discharged into the receiving environment are characterized by a low level of organic content, particularly the discharges from Jorf Lasfar where the average values are even lower than the permitted variations (Tablew 27 and 28). For example, the Afnor assessment method for COD (NF T 90-101) is only valid and applicable for the analysis of water with a COD content higher than 30 mg/l.

Table 27: Average characteristics of industrial waste water – Jorf site (rolling mill outlet), samples taken on 29 November 2006

Table 28: Average characteristics of industrial waste water – Nador site (rolling mill outlet), samples taken on 5 and 6 December 2006

Total Kjeldahl nitrogen (TKN)

Nitrogen and phosphorous are present in very low quantities in the waste water analysed (Tables 27 and 28). The sources of pollution by these elements in the iron and steel sector are limited to the use of certain detergents and anti-corrosion products. These insignificant values present no particular problem for the receiving environment.

Oils and greases

The industrial waste water analysed used for the cooling of machinery contains oils and greases. The analyses carried out show that the treatment system, in this case the deoiling installation, is very effective as the oil and grease content does

not exceed 1.5 mg/l (Tables 27 and 28). These values are well below the limit values imposed by several European countries (these values are generally lower than 10 mg/l) and the general Moroccan limit values (30 mg/l for direct discharge into the natural environment).

Heavy metals

The results of the analyses provided in annex show that the water from outlets have a heavy metal content that is low or lower than the detectable levels. The exception is iron, for which the average values are 4.5 mg/l in Nador and 9 mg/l in Jorf Lasfar. The content in all other metals is well below the values for direct discharge. It would appear that the coagulation, flocculation, decantation, filtration system is effective in removing heavy metals.

VI-1-4 Treatment of domestic waste water (Jorf and Nador)

The treatment technique for the domestic waste water from the two sites is based on the use of active sludge, although many details are missing on the operating parameters, the quality and volume of untreated water (as it enters the treatment plant). The principal stages are:

- oxygenation by pumps
- decanting and drying of sludge
- evacuation of treated water into the natural environment

Basic data

Volume: 40 m³/day

Peak volume: 5 m³/h

Volume of BOD pollution = 16 kg/day

(A) Waste water lifting installation: in polyester reinforced with glass fibre equipped with a cover, with a reinforced base waterproofed with a polyester joint.

Diameter: 1.35 m; height: 2.9 m; water entry flow = -1.44 m/to the top of the tank

Control: control of the pumps is ensured by two regulation floats without mercury which indicate the level in the tank. They are connected to the control panel.

(B) Aeration tank: in polyester reinforced with glass fibre equipped with a cover. Cylindrical in form.

Diameter: 5.2 m; height: 30.8 m; volume of the tank: 46.5 m³; water entry flow = - 0.45m to the top of the tank.

Clarifier: in polyester reinforced with glass fibre equipped with a cover. Cylindrical/conical in form.

Diameter: 5.2 m; height: 3.8 m; surface: 12.5 m³; water entry flow = 0.87 m to the top of the tank.

Regulation: the aeration and the circulation to the aeration tank are controlled by two dual cam programmers the cycles of which can be configured easily on site so as to respond to the operational requirements of the plant.

(C) Treatment of sludge: in a low volume treatment system, the stay times are sufficient for denitrification to occur. This may therefore cause sludge to rise to the top of the clarifier. A surface cleaning operation is sufficient for this sludge to return to the bottom after the gas maintaining it on the surface has been eliminated by spraying water onto it from tubes on the side of the tank.

Automatic extraction can be programmed according to treatment requirements.

(D) Sludge silo: diameter: 2.8 m; height: 2.94 m; volume: 15 m³

VI-1-5 Characteristics of domestic waste water

Sampling and analysis campaigns were carried out of the domestic waste water on the two sites at Jorf Lasfar and Nador at the same time as those for industrial waste water in November and December 2006. The results are provide in annex.

The average values in Tables 27 and 28, calculated on the basis of the time analyses, are characteristic of domestic waste water and are acceptable for discharge into the natural environment. However, the variations in time are fairly significant for domestic waste water, which comes from human activities (the characteristics of domestic waste water do not normally vary much). In practice, data on the characteristics of the untreated water is lacking to indicate whether this is due to the nature of the water or the treatment system. Tables 29 and 30 indicate the average content of domestic waste water from the two sites at Jorf and Nador and, if only the parameters showing pollution are taken into account, the variations indicated in Table 31 can be noted.

Table 29: Average characteristics of domestic waste water – Nador site, samples taken on 5 and 6 December 2006

Table 30: Average characteristics of domestic waste water – Jorf Lasfar site, samples taken on 29 and 30 November 2006

Table 31: Chemical characteristics of domestic waste water (Jorf and Nador)

VI-2 Solid waste

The solid waste produced by the processing of steel, steel plants and hot rolling include slag, scale, refractory linings, sludge, oils, greases and recuperated dust (Figure 13).

The black slag from the smelting furnace and the white slag from the ladle furnace and continuous casting are stored and will probably be used to rehabilitate the former dump at El Jadida, following the conclusion of an agreement with the local authorities of the province of El Jadida.

Dust from smoke (fine particles) is stocked on site while awaiting the establishment of a controlled dump for which the environmental impact study is currently being undertaken. Another recycling possibility is also under examination by the Managem company in Guemmassa to make use of the copper and zinc.

Scale, essentially composed of Fe^2O^3 and Fe^3O^4 , which is produced by the continuous casting, is stored in the open air or sold to Oued Elhimer (Twisit) in Nador. In contrast, in Jorf Lasfar it is used by Lafarge in an attempt to use it in cement.

Figure 13: Diagram representing the production of solid waste by SONASID Jorf. Jorf Lasfar site

VI-2-1 Slag

The process for the manufacture of steel results in the formation of black and white slag. A byproduct of steel plants, they are formed by the electric arc furnace and the ladle furnace. They consist of the metallic oxides trapped in flux, such as lime and dolomite.

According to reports by the United Nations Environment Programme (UNEP) and the World Bank, oxygen furnaces and electric arc furnaces produce between 70 and 170 kg of slag per tonne of steel. The typical chemical composition of these by products is indicated in Table 32.

Table 32: Chemical composition of slag at the Jorf Lasfar site

VI-2-2 Scale

Steel manufacture also produces discharges of scale. It is produced from the cooling of billets when the water enters into contact with the material. A solid crust is formed and coats the still molten metal. Upon contact with the water, part of the crust is detached and centimetre thick plaques are found in the water. The water is decanted and filtered before being cooled and reused. Scale is mainly composed of ferrous oxide. It could be used as an additional raw material in cement works (a project is under study).

It is therefore envisaged that the equivalent of 2800 tonnes a year of scale will be recuperated. Its typical chemical composition is indicated in Table 33.

Table 33: Typical chemical composition of scale at the Jorf Lasfar site

VI-2-3 Refractory linings

The refractory linings of furnaces are subject to degradations that are diverse and vary according to the region:

- temperature (expansion, contraction)
- mechanical effects (collisions, erosion)
- thermal effects (thermal shocks, temperature gradient)
- chemical corrosion from gas and slag

All of these factors lead to the deterioration of refractory linings, which are stored in dumps alongside the slag. The production of refractory linings envisaged by the steel plant is around 7000 T/year.

VI-2-4 Sludge

The sludge produced is thickened, although no indication is given of its quantity or what is done with it in the environment.

VI-2-5 Oils and greases

Greases and oils are recuperated through a de-oiling system in the industrial waste water treatment plant and the maintenance service. They are sold for treatment and are reused. The total hydrocarbon content of water entering the treatment plant is between 14 and 100 mg/l.

Nador site

Table 34 indicates the various types of solid waste generated by the Nador site, their quantity and the manner in which they are managed.

Table 34: Solid waste from the Nador site

VI-3 Gaseous emissions

The smelting of scrap iron (steel plant) and the rolling of billets (rolling mill) give rise to the emission of dusts and gasses (CO, CO₂, SO₂, NO_x, ...).

VI-3-1 Steel plant

In the steel plant, the gasses given off are evacuated through a pipe installed at the level of the roof of the furnace (primary evacuation circuit for the smoke from the furnace). The temperature of the primary emissions from the electric arc furnace is around 1200°C and they include particles and gasses. DH 60 million have been invested in the installation of an air treatment plant for the steel plant. The content of the emissions from the plant have been estimated by an environmental impact study and by the constructor (Table 35).

Table 35: Results of analysis of the gas emissions from the steel plant

There is in principle a plant to treat smoke from the steel plant, the characteristics of which are: height 40 m and T° at exit 110°C.

Dust

Dust is generated principally by the emissions and gasses given off through decarburization. This process produces a large quantity of gas from the molten metal and the slag, resulting in violent emissions and smoke given off during the loading of the furnace.

The most important sources of the particles given off are the furnaces. Not only are the levels of emissions high, but they have a high content of several toxic

substances (heavy metals and silica dust), as well as respirable dust (critical size between 0.5 and 7 μm).

According to the impact study, carried out when the plant was installed, the electric steel plant should produce 8926 tonnes of dust a year. This figure appears low in comparison with those indicated in reference works, which would be around 30 000 tonnes a year. The chemical composition of the dust is indicated in Table 36.

Table 36: Chemical composition of dust at the Nador site

VI-3-2 Jorf Lasfar rolling mill

Number and size of chimneys (height and diameter)

Jorf rolling mill furnace:

height: 60 m

diameter: 2 m

T° exit: 300-400°C

The gas and dust content at the exit to the rolling mill is fairly high and greatly exceeds the limit values for discharges (Table 37).

The SO_2 concentration of untreated gas emissions depend on the sulphur content of fuel and raw materials. For the important sources (boilers and furnaces) its varies between a standardized 200 and 2000 mg/m^3 . The NO_x content of untreated gas emissions depends greatly on the category of fuel, the combustion temperature and burner design. According to estimates, it varies between a standardized 100 and 1500 mg/m^3 for the principal sources (boilers and furnaces).

The levels of NO_x and SO_2 emissions can be controlled through the choice of fuel and raw materials. To control NO_x discharges, low-emission burners and modern combustion systems can be used.

Table 37: Results of analyses of gaseous emissions from the rolling mill – Nador site

VI-3-3 Nador rolling mill

A single chimney:

height: 63 m

diameter: 3 m (conical)

The temperature of gasses leaving the chimneys is between 300 and 400°C.

The analyses of the gaseous emissions undertaken by LPEE and the SONASID monitoring laboratory in 2003 are indicated in Table 38.

Table 38: Results of measurements – Nador rolling mill

**COLD ROLLING AND PROCESSING OF STEEL (CHEMICAL DIPPING,
COATING, GALVANIZATION, PRECOATING)
MAGHREB STEEL**

Maghreb Steel

Presentation

Maghreb Steel is part of the Sekkat Group, which controls other industrial units, including Ingelec (production of electrical equipment), Plastima (manufacture of plastic products) and Imacab (production of electrical cables).

Maghreb Steel is an industrial company specializing in the manufacture and commercialization of cold rolled, galvanized and pre-coated steel plating intended for the manufacture of products for the construction industry, road equipment, metallic furniture, electrical equipment and electrical household goods.

The Maghreb Steel plant extends over an area of 30 hectares. The raw material used takes the form of hot rolled steel coil. They are first dipped (the chemical cleaning of the steel through the elimination of superficial oxides through the addition of hydrochloric acid), then rolled (to reduce their thickness), galvanized (consisting of the hot coating of the surface of the cold rolled coil with a fine coating of zinc to protect the steel from corrosion) and pre-coated (application of liquid organic matter adapted to non-aggressive atmospheres with a view to increasing resistance to corrosion and improving the aesthetic effect).

I – DESCRIPTION OF THE PRODUCTION PROCESSES

Table 39 indicates the characteristics of the raw material used in each plant.

Table 39: Characteristics of the raw materials used by Maghreb Steel

Dipping

Two dipping lines:

- first line with a capacity of 200 000 tonnes a year
- the second dipping line started operating at the end of March 2005 and has a capacity of 400 000 tonnes a year.

The chemical dipping lines remove the layers of oxides that cover the surface of the coil (the raw material).

The hot rolled steel coils that are treated in the dipping line are imported from abroad. The lines are composed of several sections: entry (uncoiling and welding), chemical treatment (dipping in hydrochloric acid), rinsing and exit.

Cold rolling

Two reversible rollers with an annual production capacity of 200 000 tonnes each.

Annealing

Ten traditional annealing installations in the form of ladle furnaces, also known as annealing furnaces, with a capacity of 150 000 tonnes.

Continuous hot galvanizing

A hot-dip galvanizing line with a capacity of 130 000 tonnes a year.

Galvanizing and pre-coating

A combined galvanizing and pre-coating line with a capacity of 100 000 tonnes a year.

Cutting

Two cutting lines and three slitting lines for cutting depending on the width and length of the coils.

All of the processes are summarized in Figure 14.

I-1 Dipping process

The hot rolled coils are attacked by layers of oxides, which constitute a barrier for subsequent operations. The chemical dipping line removes these layers of oxides covering the surface of the coil (Figure 15).

The dipping lines treat the metal continuously. The coils are imported from abroad and are between 1 and 4.5 mm thick and between 600 and 1500 mm wide. The lines are composed of several sections: entry, chemical dipping, rinsing and exit.

I-1-1 Entry section

Composed of an:

- uncoiler
- straightener
- welder

I-1-2 Chemical treatment section

This section is composed of three tanks linked by rolling conveyer lines and contain hydrochloric acid mixed with filtered water so as to achieve the desired dilution for each tank. The tanks are heated by heat exchangers and the acid tanks are equipped with pumps to ensure the continuous movement and regeneration of the acid.

The steel passes through three closed acid tanks in which a chemical reaction occurs between the acid and the oxide, forming ferrous chlorides (FeCl_3).

Figure 14: The various production operations of Maghreb Steel

Figure 15: Dipping line (PK No. 1) - Maghreb Steel

I-1-3 Rinsing section

This section is composed of four closed rinsing tanks joined by powered roller conveyers, preceded by drainage rollers and followed by a dryer.

The rinsing tanks are supplied with filtered and heated water. To prevent the pitting of the steel, a hot air dryer removes drops of water and acid on the band at a temperature of 90°C. An electronic pH tester is installed to monitor the acidity of the rinsing water.

I-1-4 Exit section

This section is composed of:

- **shear**: to cut the end of the dipped coil
- **slitter**: to make longitudinal cuts along the strip
- **roller of remains**: rolls the edges cut from the continuous strip
- **oiling unit**: this stage is designed to protect the steel plate against oxidization during storage and before rolling
- **coiler**

I-2 Cold rolling section

Cold rolling is an operation that reduces the thickness of the strip by means of two rollers each with four cylinders turning in reverse (Figure 16).

I-2-1 Pay-off reel section

This section is designed to manoeuvre the dipped and rolled coils. It is composed of:

- coil support skid to position the dipped coils
- cradle roll for the preparation of the coils
- coil car to move the coils between the coil support skids and the cradle rolls and insert them into the mandrel

- expansion mandrel with centring system which maintains the coil in position and moves it forward

Figure 16: Cold rolling line

I-2-2 Entry tension reel section

This section is composed of several elements:

- coil support skid
- cradle rolls
- coil chariot
- expansion mandrel
- thickness gauge which measures the thickness of the strip using X-ray technology

I-2-3 Rolling mill section

This is the most important part of the rolling mill and is composed of:

- two back up rolls
- two work rolls
- two hydraulic push up cylinders which create the rolling force
- four hydraulic cylinders to balance the upper back up roll
- an anti-crimping guide roll and a cross break roll to maintain the strip in position (only used in the skin pass section)
- work roll changer to change the work rolls
- a lubrication system

I-2-4 Delivery tension reel section

This is the exit section from the rolling mill, which is equipped with the following elements:

- two coil support skids to position the cold rolled coils
- expansion mandrel equipped with a coil stripper

- strip oiler
- thickness gauge
- coil car

I-3 Annealing

This operation is carried out in an annealing furnace and is intended to restore the final physical characteristics of the material and prevents it from hardening.

It is a heat process which consists of raising the temperature until the metal recrystallizes, followed by a slow cooling, as indicated in Figures 17 and 18.

Figure 17: Thermal processing cycle

Figure 18: Cooling system

I-4-1 Continuous hot-dip galvanization

The continuous galvanization of steel strips is an operation that consists of coating the steel strip with a protective coating of zinc alloy by dipping it in a tank of the molten alloy in a galvanization and pre-coating line.

The coating lines process the metal continuously. These production units, with an annual capacity of 230 000 tonnes, produce two types of products: galvanized and pre-coated.

The lines are composed of the following sections: entry, furnace, a central section and an exit section.

I-4-1 Entry section

This section is composed of:

- uncoilers

- shears
- welder
- accumulator

I-4-2 Furnace section

When it leaves the cold rolling section, the steel is heated to a temperature of around 800°C so as to restore its physical characteristics. The heating takes place in a horizontal furnace in a controlled atmosphere of nitrogen and hydrogen (15 per cent). The furnace is composed of heating areas, a maintenance chamber, cooling jets and the soaking pit.

I-4-3 Central section

This consists of the zinc tank, the drying of the coating and a cooling system.

I-4-4 Final section

This includes surface treatments, the accumulator, the shears and the coiler.

- zinc gauge
- chrome passivation
- skin pass (for pre-coating)
- straightening machine
- painting section (for the combined galvanizing and pre-coating line): this is an operation which consists of pre-coating the strip in a colour determined by the client. This section consists of: two primary rolls set horizontally between which the strip passes for a first coating; an electrical tank to dry the pre-coated strip; water cooling; two finishing rolls, which pre-coat the strip with a finished coat; and water cooling.

I-5 Straightening and slitting

Depending on the client, the final product may take the form of strips cut across or along their length by straightening and slitting machines.

II – WATER SUPPLY

Table 40 indicates the annual average water consumption (for 2006) for the site and each of the processes.

Table 40: Water consumption for the various processes

Treatment of the water used in the processes

The filtration unit (sand filters, microfilters, reverse osmosis membranes) produces treated water (filtered and demineralised) from the bore water. Its characteristics are:

- capacity: 40 m³/h
- use: dilution of dipping acids, rinsing of dipped strips, preparation of emulsions for rolling and skin pass, cooling, supply to boilers ...

III – ELECTRICITY CONSUMPTION

Table 41 indicates the electricity consumption for the site and its processes.

Table 41: Consumption of electricity

Fuel consumption

Table 42 indicates the annual consumption of LPG, with a comparison with oil consumption (figure 19).

Table 42: LPG consumption

Figure 19: Comparison of LPG and oil consumption

Steam: three boilers operating with LPG and one burning oil produce superheated steam from demineralized water. The quality of the oil raises the risk of the emission of pollutants into the atmosphere.

- capacity of the LPG boilers: 2 tonnes/hour
- capacity of the oil boiler: 6 tonnes/hour
- use: heating of the tanks for emulsion, dipping acid and rinsing the dipped strips.

IV PRODUCT RANGE

Table 43 indicates the production of each section for various years from 2004 to 2006. It can be seen that there is a certain continued development of production.

Table 43: Production of the various sections over several years

V – EXAMINATION OF WASTE

V-1 Liquid waste

Table 44 indicates the average volume of waste from each process on the industrial site. The total volume of waste is around 160 000 m³ a year, of which around 100 000 m³ passes through the water treatment plant. The rest is cooling water that is not contaminated as it is not in direct contact with the product and is discharged directly into the municipal sewers.

Table 44: Average volume of waste from each process

V-1-1 Treatment of industrial waste water

Maghreb Steel has an on-site treatment plant for the waste water from the various production processes (Figure 20). It only treats the following wastes: used emulsion, used acid and rinsing water, and used chromic acid.

Acidic waste water

The stages for the treatment of acidic waste water are the following:

- pre-neutralization of the water through the addition of lime solution to bring the pH to about 7;
- oxidization by bubbling compressed air to oxidize ferrous iron Fe^{2+} into ferric iron Fe^{3+} , which is in turn transformed into ferrous hydroxide, which is easy to decant;
- neutralization by regularizing the pH to between 9 and 10 through the addition of lime solution;
- the flocculation of the hydroxides through the addition of a flocculant (increasing the floc size);
- decantation and separation of the floating suspension and the sludge (final discharge to treatment system);
- filtration of the sludge through a filter press to dehydrate it.

Oily waste water

Treatment is undertaken by separating the oil from the water by chemical reaction (addition of hydrochloric acid) and then decantation. The resulting separated water undergoes the same treatment as the acidic waste water, while the oil is used outside the factory.

V-1-2 Analyses of waste water

- **Waste water entering the Maghreb Steel treatment plant**

Table 45 indicates the characteristics of waste water before treatment.

Table 45: Characteristics of waste water before treatment

- **Waste water leaving the Maghreb Steel treatment plant**

The pH of the waste water is measured continuously, while other principal parameters are analysed each day in the Maghreb Steel internal laboratory. A

complete analysis over a period of 8 hours is undertaken periodically (once a year). Table 46 shows the latest results of analysis of the Maghreb Steel waste water treatment plant.

Table 46: Results of analyses of liquid waste form Maghreb Steel

The percentage reduction is around 95-99 per cent for iron and 98-100 per cent for chrome IV.

Used acid recycling plant

The use of acids factories for dipping steel constitutes a significant environmental problem for the following reasons:

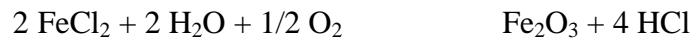
- the difficulties involved in neutralizing used waters and acids;
- the difficulties of removing iron from this water;
- the production of enormous quantities of sludge in the neutralization process;
- the high cost of treatment;
- the significant volume of water consumed;
- the significant volume of acid consumed.

The regeneration of acids is a clean and effective process used throughout the world to resolve these environmental problems and represents an anti-pollution and resource-saving measure.

The principle

Used acid (rich in iron: 50 to 200 g/l) from the dipping line are stored in tanks (180 m³ in total). The used acid is pumped from the storage tank to an acid filter to remove any solid particles. After filtration, the acid goes through a pre-concentrator with the help of a quantity of the hot gas coming from the reactor. The pre-concentrated acid is conveyed into the reactor by pulverization. The reactor is made of steel covered with refractory bricks and is heater by a boiler.

The FeCl₂ is composed according to the following equation:



The particles of iron oxide (Fe_2O_3) fall to the bottom of the internal cone of the reactor in the form of powder and are removed through a rotating valve which keeps the gasses inside the reactor separated for the external atmosphere.

The water vapour and hydrogen chloride (HCl) passes through a cyclone which separates the rest of the Fe_2O_3 dust. The oxide separated in the cyclone is returned to the lower part of the reactor, while the gasses enter the pre-concentrator, where they are cooled and cleaned through direct contact with the acid to be recycled. They are then transferred through absorption columns (running against the flow) where they are absorbed by the waste water used for rinsing the acid employed in the dipping line, thereby forming regenerated acid (Figure 21).

The regeneration of used acids results in the production of acid at a concentration of 18 per cent and a temperature of 80°C (very favourable parameters for direct and economic recycling). This process generates iron oxide, which can be put to other uses, and does not release liquid waste.

Figure 20: Diagram showing the used acid regeneration plant

Figure 21: Diagram showing the Maghreb Steel waste water treatment plant

V-2 Waste products

The various types of waste products and their volumes are indicated in Table 47. The data were provided without any indication of the manner in which special waste materials are handled: specific collection, other uses, treatment, dumping. The sludge produced by the industrial waste water treatment plant is very hazardous. It generally contains toxic organic substances and minerals extracted from the waste water.

Oils and greases are generally regenerated or used to produce energy.

Table 47: Average volumes of solid waste generated

V-3 Gaseous emissions

In view of the processes described above, there may be multiple atmospheric discharges, including dust, SO₂, NO_x, CO, heavy metals, volatile organic compounds, hydrochloric acid fumes, etc.

The sources of emissions into the air are chemical dipping (acidic vapours), pre-coating (volatile organic compounds), boilers (LPG and fuel oil) and thermal processing furnaces (vapours containing SO₂, NO_x, dust, ...). The physical and chemical characteristics of these gaseous emissions are not available.

Emissions of volatile organic compounds are caused by industrial processes involving the use of solvents (heavy and fine chemicals, para-chemistry, degreasing of metals, paint, etc.)

Treatment of gasous emissions

- acidic vapour treatment plant – scrubber (Figure 22)

There are two scrubbers, one for each dipping line, to treat the acidic vapour that escapes from the hydrochloric acid tanks. These vapours are treated by spraying filtered water (against the flow). The water is recycled in the dipping section by being used to dilute fresh acid.

Figure 22: Scrubber

- solvent incinerator (Figure 23)

During the drying of the paint applied to the metal strips (pre-coating line), volatile organic solvents are emitted. These vapours are burnt in a closed incinerator

where the energy given off by this incineration is recuperated while endeavouring to limit the environmental impact.

Figure 23: Solvent incinerator

VI – MAGHREB STEEL PROJECT UNDER CONSTRUCTION

VI-1 Hot rolling mill

An investment of 1.3 billion DH will be made in a mill with an annual production capacity of 1 000 000 T/year, which will be started in 2009. The mill will be composed of a hot rolling plant and a steel plant and its waste discharges will be similar to those of SONASID.

VI-2 A sandwich panel production line

Maghreb Steel is pursuing its development through the introduction of a range of sandwich panels into its production programme. These products are intended for industrial construction, the insulation of external walls, internal furnishing, commercial buildings, etc. It will commence operations in June 2007.

Conclusion

The activities in the iron and steel sector that exist in Morocco are hot rolling (SONASID) and cold rolling (Maghreb Steel). These two principal activities are located in industrial sites from which SONASID discharges into the natural environment (direct discharge) and Maghreb Steel discharges into the municipal sewer (indirect discharge). For this reason, the analytical data from these two sites are determining in the proposal of emission limit values for the iron and steel sector.

In the absence of in-depth analysis of the discharges, and particularly the atmospheric emissions, this report proposes draft emission limit values for liquid and atmospheric discharges on the basis of the available data gathered during this consultation and from reference works (standards in other countries).

1 – Proposed emission limit values (ELVs) for waste water

For liquid discharges, account has been taken of the results of analyses of treated waste water (SONASID) and not the efficiency of treatment (absence of analyses of untreated waste water). There is an absence of measurements of volumes from the composite and/or hourly samples and of untreated waste water (entering the treatment plant), which are essential for a coherent discussion and particularly for the selection of the major parameters to be regulated.

The average values of treated waste water for SONASID (Tables 10 and 11) are well below European standards, and particularly those of Mediterranean countries. The limit values for liquid discharges proposed at the conclusion of this study are a result of a synthesis of standards in Mediterranean countries (Table 13) and the quality of the treated water from SONASID. These provisional values will enable the Norms and Standards Committee to engage in discussions and dialogue with all the parties concerned before determining the definitive emission limit values.

Table 48: Proposed emission limit values for waste water in the iron and steel sector in Morocco

2 – Proposed emission limit values for atmospheric emissions

With regard to the proposed limit values for atmospheric emissions, there is a total lack of analysis of the principal pollutants of the air discharged by the iron and steel industry in Morocco. Reference is therefore made to the World Bank recommendations and to the standards in force in Egypt and certain European countries (Table 14). It is recalled that the World Bank has developed very full guidance for the iron and steel sector, based on United States legislation, which covers pollution prevention and measures to combat pollution, objectives in terms of pollutant loads, treatment techniques and emission levels.

Table 49: Proposed limit values for atmospheric emissions in the iron and steel sector in Morocco

3 – Emission limit values proposed by SONASID and Maghreb Steel

Following the discussions held on 15 March 2007, the two iron and steel companies in Morocco most directly concerned, SONASID and Maghreb Steel, formulated their wishes and proposals for limit values for liquid and atmospheric emissions, which are set out below:

Table 50: Limit values for discharges of treated waste water proposed by SONASID and Maghreb Steel

Table 51: Limit values for atmospheric emissions proposed by SONASID and Maghreb Steel