UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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FIRST GUIDE FOR UNIDO OFFICERS IN EVALUATING THE ENVIRONMENTAL IMPACT OF INDUSTRIAL PROJECTS*

prepared by

Sectoral Studies Branch
Industrial Policy and Perspectives Division

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Please send comments to:

Sectoral Studies Branch (Room D2065)
United Nations Industrial Development Organization
P.O. Box 300
A-1400 Vienna
Austria

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Introduction

Since the Stockholm Conference on the Human Environment in 1972 there has been an increasing awareness of environmental problems throughout the world. Many examples could be cited of environmental damage from improperly conceived and operated industrial projects. The careless development of a mining and smelting project has fouled a watershed. The indiscriminate dumping of toxic industrial wastes has wiped out a fishing resource. Brown smoke from a poorly designed iron and steel works has caused a health hazard and otherwise lowered the quality of life for all who live in the vicinity of the plant. To help avoid harmful side effects of industrialization, environmental impact analysis should be recognized as an important aspect of project formulation, construction, and operation which is applicable to industrial projects in both developed and developing countries.

The purposes of evaluating environmental impact are two fold:

(a) To prevent the deterioration of natural resources, such as the river which is to receive plant waste waters, so that these resources can continue to serve the population and provide a basis for further economic development; and

(b) To give ample warning of deleterious side effects of the projects which may result in economic or social costs, such as impacts on human health which might not be otherwise identified in the project approval procedure.

Part I of this First Guide sets out a series of steps designed to identify environmental problems which may occur during a project, beginning with the obtaining of raw materials and ending with the treatment and disposal of wastes produced from the factory. The ten-step checklist has been adapted and expanded from a set originally proposed by the World Bank.1/ The assessment procedure is presented through the posing of key questions to the officer who is responsible for project formulation or appraisal. These questions should be also noted by Chief Technical Advisers and experts in the field assisting developing countries on industrial sectors or subsectors that are likely to affect the environment at one phase or another of the project cycle. The officer or adviser should recognize that he may need to turn to a sectoral or environmental specialist within the organization in order to obtain answers to certain questions during the project formulation phase.

Not every project will require the comprehensive evaluation outlined here. The officer must judge himself or obtain expert advice when he believes a question is not relevant to the potential environmental impact of the particular project he is formulating. It is useful to distinguish between the "black list" areas and the "grey list" areas. For the black list areas, a set of minimum standards for hazard prevention and control ought to be observed at all costs - even in industrially nascent countries where environmental issues tend to receive minimal attention. In contrast, the grey list areas are those

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1/ "Environmental, Health and Human Ecologic Considerations in Economic Development Projects". The World Bank, Washington, D.C. (1974).

in which progressive action towards environment-friendly technological options in developing countries should be subjected to a careful benefit-cost analysis in the light of the economic and local ecological constraints in each country.

As an important guide, Part II provides a list of waste materials and substances that require great care in their disposal. Part III provides a listing of various pollution control parameters applicable to specific subsectors of industry that call for careful attention. These two parts are intended to give an overview of the technical aspects of the environmental and safety-related issues of industry. In the future, a further elaborated set of guidelines will be prepared using this approach of black-list and grey-list pollutants and by industrial subsectors.

A brief synopsis of the environmental guidelines issued by the World Bank, the Regional Development Banks and UNDP is given in the Annex, along with a list of selected publications for ease of the reader's reference.

This is admittedly a first guide, the primary purpose of which is to sensitize UNIDO officers at Headquarters and in the field on environmental problems, particularly those concerned with industrial project development and implementation. Care should be exercised in incorporating environmental considerations into the industrialization programmes of developing countries because there are different economic and ecological constraints. The First Guide has been prepared without a systematic evaluation of UNIDO's own experience in the field with respect to the varied needs and conditions in different developing countries. A Second Guide, incorporating such an evaluation and comments of UNIDO officers, will be developed. We hope this guide can be developed soon. This First Guide will hopefully be able to stimulate a further active interest in environmental problems in UNIDO and particularly UNIDO technical assistance operations.

Part I. A ten-step checklist for assessment of environmental impact at the level of specific industrial projects

Certain industrial sectors can cause pollution adversely affecting the air, the water, the land, and/or the natural resource base. UNIDO seeks to enhance industrialization but without destroying the environment. To ensure sustainable industrial development, environmental factors, both physical and social, need to be integrated into industrialization strategies and project formulation.

Step 1: Raw materials linkage:

This step includes environmental considerations from the original extraction of the raw material to the time it enters the projected plant. If the material is an import, the linkage may start with its arrival in the country. Included in addition to the raw materials required in processing would be all fuels.

Question 1a.

What raw materials will be required by the factory?

Question 1b.

How will these raw materials be obtained? If extraction operations are required these should also be covered by the environmental impact evaluation.

Question 1c.

Has the process of shipment of raw materials to the planned site been reviewed for possible environmental impacts? Specific attention should be given to transport and handling of hazardous materials.

Question 1d.

Does a comprehensive plan link the project to environmental aspects of raw materials extraction, shipping, unloading and storage?

Step 2: Site assimilative capacity:

The capacity of the site to absorb without harmful effects wastes discharged to the air, water and land cannot easily be determined. Objectively the site assimilative capacity may be considered as the capacity of the site to absorb waste discharges without short or long term damage to the environment either at the site or to whatever area in the vicinity the wastes might be transported through the air, water or soil. This capacity will vary for different wastes. A given site might have a zero capacity for assimilating the toxic polychlorinated biphenyls discharged into the water course flowing past the factory. However, that same water course might be able to receive a certain quantity of non-toxic, biodegradable waste waters without substantially lowering the levels of dissolved oxygen in the stream and without measurably affecting downstream users of the water course.

From a legal point of view the site assimilative capacity might be defined as the capacity of the site to receive wastes without raising the amounts of pollutants in the air, water and soil to levels which violate governmentally established environmental standards. Although it is the moral responsibility of the industry not to cause harm to the people and the natural environment through pollution, it is the responsibility of the government to establish air and water quality standards and regulations for the land disposal practices so that an acceptable level of environmental quality is maintained.

In practical terms the air quality at the site should be determined before the onset of project activities. The surface water body which is designated to receive treated water-borne sanitary and industrial wastes should be monitored for several water quality parameters before the project is completed. A survey should determine the appropriateness of areas within the planned site for land disposal of solid wastes. Hazardous wastes may require special procedures. Monitoring procedures should continue after the plant has begun operations to record the incremental environmental effects from the plant discharges.

If a housing project will be developed as a part of the industrial project, the analysis under Step 2 should be expanded to determine land suitablity for housing construction and to plan for suitable treatment and disposal of sewage and domestic solid wastes.

Question 2a.

Have alternative sites or locations of the plant been considered in an effort to avoid or mitigate environmental degradation?

Question 2b.

Have hydrological, geological and meteorological studies of the site been made to anticipate and minimize possible damage to humans, fish and wildlife resources and vegetation? More specifically, if effluents are to be discharged directly or indirectly into a water body, have studies been made of the physical and chemical properties of the receiving water, such as temperature, current patterns, flow rates, dissolved oxygen, biological and chemical oxygen demands?

Question 2c.

Will the wastes generated by the proposed plant be evaluated and waste treatment facilities designed so as not to exceed the site assimilative capacity?

Step 3: Project design:

This step includes the decisions on basic processes to be used in the projected plant, the source(s) of energy for power and heat, and the supply of air and water. The environmental aspects of any projected plant start with the decision to use a particular process. Unit operations of manufacturing processes should be designed to maximize recycling potential and minimize the generation of residuals. Analysis of sources of energy should consider materials available in the area in addition to the traditional supplies.

Industrialized countries have gained considerable experience in environmental measures and have practically the monopoly on newest technologies to reduce pollution for environmental control, recycling and for improvement of the environment. For example, new low- and non-waste technologies are being developed which result in reduced environmental impacts, resource conservation and a better working environment. These technologies, however, often require an enhanced level of operational skills.

Question 3a.

What features for environmental protection will be incorporated in the plant design?

Question 3b.

Will low waste technologies be considered for various process operations?

Step 4: Project construction:

This step includes all operations during the construction of the plant.

Question 4a.

Does the construction plan take into account ecological factors?

Question 4b.

Are road patterns, land excavation, fill sites and refuse disposal activities planned to minimize damage to the natural environment?

Question 4c.

Will construction personnel be exposed to unique local health problems, or might they introduce diseases?

Question 4d.

What provisions have been made for restoring sections after construction?

Step 5: Operations:

Emphasis should be placed on reuse of waste materials or sale as by-products whenever possible. Discharge to environment should be considered as a last resort. If discarded, adequate waste treatment should be provided.

An important objective is to develop and maintain an administrative framework to monitor the performance of process and control devices. Staff should include environmental engineers as necessary. A programme should be organized to ensure good maintenance of manufacturing process equipment and waste treatment units. This programme should include training in proper operation of all equipment. This will minimize spills and other accidents.

A surveillance and monitoring programme should be established to detect immediately any unusual problems which may cause environmental damage. The inflow and outflow from the waste treatment facility should be regularly monitored to be sure waste treatment standards are met.

Low- and non-waste technologies are employed mostly in the most modern plants. Efforts must continue with conventional processes to install cost-effective pollution control technologies. Well-designed lagoons can often satisfactorily treat non-toxic wastes, for example. Economic incentives may be necessary where environmental equipment must be installed. The most cost-effective actions should be taken first.

Environmental operations should also include continued worker education for safety and environmental awareness and evaluation of environmental implications of proposed changes in process technology or project expansion.

The project should insure that industrial managers analyze environmental operations, safety and energy aspects of all major project activities. The results should be translated all the way to the shop floor. Energy savings, a safe work record and reduction of material wastes are criteria for judging the effectiveness of environmental impact assessment.

<u>Question 5a</u>.

Will unloading and loading methods of handling chemicals or other hazardous raw materials incorporate human and environmental safeguards?

<u>Question 5b</u>.

What are the dangers of an explosion or spill of hazardous materials?

<u>Question 5c.</u>

Will contingency plans, including trained manpower and materials, be available to cope with accidents?

<u>Question 5d</u>.

Has adequate attention been given to the design and construction of safe storage facilities for hazardous materials?

<u>Question 5e</u>.

Will provision be made to prevent liquid losses during storage (utilizing, for example, floating roof tanks)?

<u>Question 5f</u>.

What types and quantities of effluents or particulate emissions will the plant produce?

<u>Question 5g</u>.

Has pollution control equipment been planned?

<u>Question 5h</u>.

Will the discharges of effluents into water bodies be compatible with other present and future uses of the receiving waters, particularly during periods of minimum stream flow?

Question 5i.

Will effluents enter into synergistic effects with other materials?

Question 5j.

Will effluents contain toxic materials?

Question 5k.

What are the expected effects of effluents on water supply sources downstream, algae growth, and invertebrate and fish populations?

Question 5l.

How will plant effluents and emissions be controlled and monitored?

Question 5m.

What control techniques will be employed to remove toxic materials from effluents?

Question 5n.

If solid wastes are produced, what disposition will be made of them?

Question 5o.

What special precautions will be made for disposal of liquid or solid toxic wastes?

Question 5p.

Has the recycling of solid wastes been considered?

Question 5q.

What provisions have been made for training plant operators in environmental protection?

Question 5r.

Will odours be controlled?

Step 6: Social and cultural aspects:

These include impacts of the project on the lives of those who live in the neighbourhood of the project. Also included are project effects on cultural, historic, or recreational sites in the vicinity.

Projects employing a large labour force during construction and/or operation cause in-migration of populations, thus affecting land-use patterns. Needs of the labour force and their families should be evaluated in the light of available food, water, shelter, medical services, and accessible transportation systems, based on local institutions and customs.

Question 6a.

How and to what degree will the presence and operation of the plant alter the size, economic and social activities of the local population? Will urban problems be created or accentuated?

Step 7: Health aspects:

This step deals with the need to monitor and maintain the health and welfare of project employees, and local and regional populations adjacent to the project facility. In-house safety procedures can be designed to include employee education. Job specifications should stress safe work habits. Clear and concise management policy statements should stress safety in operations.

Product safety hazards, implicit and explicit, should be clearly defined for consumer protection.

Question 7a.

Will the plant produce emissions that will directly or indirectly be detrimental to health?

Question 7b.

Could the water, land, or air transport of pollutants affect local or regional health?

Question 7c.

Are new health problems likely to occur?

Question 7d.

What measures have been taken to ensure a programme of employee safety and occupational health?

Question 7e.

Will plant employees and their families be provided with a system of health care?

Step 8: Final residues:

This step should be regarded as a check of the environmental management activities from Step 5 (Operations). An ideal plant would maintain records of wastes generated, materials recycled and savings thereby accrued, means of disposal of solid, liquid, and air-borne wastes, and efficiencies and costs of treatment or disposal methods.

If toxic wastes are generated by the plant these should be carefully destroyed; for example, incinerated. Even if a well designed, lined land fill is used, a long-term monitoring programme should assure that wastes are not escaping from the land fill to pollute the soil and ground water.

Every disposal technique has a cost associated with it. The disposal cost may be high because the waste is non-biodegradable and toxic. All these costs require evaluation.

Step 9: Long-term considerations: Plant expansions.

How will future projects fit into the environmental context of present plant operations.

Step 10: Review:

In this step the officer should review the viable alternative strategies for solving the overall wastes problem of the factory. He should choose the least cost solution which allows all environmental standards to be met and which will allow minimum cost expansion of waste treatment facilities if future plant expansions are likely.

The conversion of raw materials and resources into industrial products is never total and residues are formed, such as the large quantities of phosphogypsum produced concomitantly with phosphoric acid during fertilizer manufacture. If the residues are not utilized they will be wastes, and, if discharged into the biosphere, will be pollutants. Management should seek to improve the efficiency of industrial processes while minimizing their environmental effects. Processes have been found, for example, which improve the quality of the phosphogypsum enabling its utilization as a high quality building material and an additive to cement. The project officer should seek solutions which are both technologically and environmentally sound.

The officer should bear in mind that estimating costs for protecting environmental values and natural resources require some non-traditional costing procedures. For example, incurring the costs of avoiding river pollution may avoid the cost of a water treatment plant downstream to render water potable, or may allow the use of the ecological carrying capacity of the river for other productive enterprises, or for public recreation such as boating, fishing or swimming.

A qualitative example of applying the methodology

As an example, we consider means of dealing with the environmental impact of hazardous chemicals at an industrial project.

(a) Hazardous chemicals at industrial plants must be identified.

(b) These chemicals must be treated with proper precaution in production processes.

(c) When these chemicals or other hazardous by-products are present in the processes or as wastes they should be isolated whenever possible. In the case of raw materials they should be kept in a storage area well apart from the plant; in the case of wastes these materials should be kept separated from other waste streams.

(d) Several technical means exist to render hazardous wastes harmless. These can be:
   (i) Chemically treated to render them innocuous, for example neutralization is the simplest chemical treatment.
   (ii) Physically immobilized in a glassy matrix or a cement binder.
   (iii) Incinerated with appropriate treatment of gaseous effluents. For example, scrubbing will be necessary to remove hydrochloric acid fumes.

(iv) The hazardous materials can be incinerated at sea.

(v) Finally, the least desirable method also to be used as a final alternative is to store the hazardous wastes in containers in a lined, sealed and impervious landfill located in an uninhabited area.

(e) Knowledge of the kinds, amounts and locations of hazardous chemicals or wastes must be considered as part of the assessment that accompanies the environmental impact of a proposed industrial project.

(f) Precise data requirements, on chemicals and processes, should be analyzed with regard to the type of industry, personnel and infrastructure. Could the industry absorb and use data in a computerized format? Would printed data and information be more appropriate?

Some concluding remarks

Industrial process design, proper operation and maintenance of production processes and pollution control equipment, and monitoring of environmental parameters are necessary to ensure the effectiveness of environmental protection. However, plants and equipment as well as products causing environmental damage continue to be exported to the Third World. The developing countries need well formulated projects to resolve these problems. This calls for environmental impact information to industrial and Government decision-makers as well as specialized environmental training of technical and management personnel as a part of the project.

The environmental impact guidelines presented here include a broad array of concerns. The guidelines are designed to identify potential problems associated with the project which might result in undesirable side effects upon the human society and the natural environment. Such side effects might impair the future productivity of the country's natural resource base, for example. Evaluating the impact of an industrial plant on the human environment requires a focus on production processes within the plant and environmental effects outside the plant. The ten-steps attempt to provide this focus.

Proceeding through the ten steps from the raw materials linkage to the review calls attention to process alternatives and recycling or reuse potentials, plant location and urbanization issues, and waste management alternatives. Process design which minimizes waste generation is emphasized throughout. The project officer is urged to formulate a project which is efficient and sensitive to environmental needs.

In summary, practical environmental impact assessment during industrial planning, siting and operations, is needed. Environmental impact assessment must consider energy resources, technological developments and impacts on public and private expenditure. Training can improve industrial awareness of environmental issues. Environmental impact assessment is also a politically effective measure, which is favourably received by populations that are more and more sensitive to environmental concerns.

Part II. Black-list and grey-list materials and substances to be controlled for the protection of the environment against industrial pollution[2]

The dumping into the waterway of wastes or other matter listed in Table 1 should be prohibited.

Table 1. Prohibitive list

The following substances, families and groups of substances are listed mainly on the basis of their

Toxicity;
Persistence;
Bioaccumulation.

1. Organohalogen compounds and substances which may form such compounds in the marine environment.[3]

2. Organophosphorus compounds and substances which may form such compounds in the marine environment.[3]

3. Organotin compounds and substances which may form such compounds in the marine environment.[3]

4. Mercury and mercury compounds.

5. Cadmium and cadmium compounds.

6. Used lubricating oils.

7. Persistent synthetic materials which may float, sink or remain in suspension and which may interfere with any legitimate use of the waterway.

8. Substances having proven carcinogenic, teratogenic or mutagenic properties in or through the marine environment.

9. Radioactive substances, including their wastes, when their discharges do not comply with the principles of radiation protection as definded by the competent international organizations, taking into account the protection of the marine environment.

2/ Adapted from "Çonvention for the protection of the Mediterranean Sea against pollution and its related protocols" (UN Environment Programme, 1982).

3/ With the exception of those which are biologically harmless or which are rapidly converted into biologically harmless substances.

Table 2. <u>Less noxious materials, but requiring special care in their disposal</u>

The dumping into any inland waterway of wastes or other matter listed in Table 2 should require in each case a prior special permit from the competent national authorities.

The following substances, families and groups of substances, or sources of pollution, listed not in order of priority, have been selected mainly on the basis of criteria used for Table 1, while taking into account the fact that they are generally less noxious or are more readily rendered harmless by natural processes and therefore generally cause less environmental impact. The control and strict limitation of the discharge of substances referred to in Tables 1 and 2 must be implemented in accordance with Table 3.

1. The following elements and their compounds:

1. zinc	6. selenium	11. tin	16. vanadium
2. copper	7. arsenic	12. barium	17. cobalt
3. nickel	8. antimony	13. beryllium	18. thallium
4. chromium	9. molybdenum	14. boron	19. tellurium
5. lead	10. titanium	15. uranium	20. silver

2. Biocides and their derivatives not covered in Table 1.
3. Organosilicon compounds and substances which may form such compounds in the marine environment, excluding those which are biologically harmless or are rapidly converted into biologically harmless substances.
4. Crude oils and hydrocarbons of any origin.
5. Cyanides and fluorides.
6. Non-biodegradable detergents and other surface-active substances.
7. Inorganic compounds of phosphorus and elemental phosphorus.
8. Pathogenic micro-organisms.
9. Thermal discharges.
10. Substances which have a deleterious effect on the taste and/or smell of products for human consumption derived from the aquatic environment, and compounds liable to give rise to such substances in the marine environment.
11. Substances which have, directly or indirectly, an adverse effect on the oxygen content of the marine environment, especially those which may cause eutrophication.
12. Acid or alkaline compounds of such composition and in such quantity that they may impair the quality of sea-water.
13. Substances which, though of a non-toxic nature, may become harmful to the marine environment or may interfere with any legitimate use of the sea owing to the quantities in which they are discharged.

Table 3. Discharging industrial wastes

With a view to the issue of an authorization for the discharge of wastes containing substances referred to in Table 2, particular account should be taken, as the case may be, of the following factors:

A. Characteristics and composition of the waste

1. Type and size of waste source (e.g. industrial process).
2. Type of waste (origin, average composition).
3. Form of waste (solid, liquid, sludge, slurry).
4. Total amount (volume discharged, e.g. per year).
5. Discharge pattern (continuous, intermittent, seasonally variable, etc.).
6. Concentrations with respect to major constituents, substances listed in Table 1, substances listed in Table 2, and other substances as appropriate.
7. Physical, chemical and biochemical properties of the waste.

B. Characteristics of waste constituents with respect to their harmfulness

1. Persistence (physical, chemical, biological) in the marine environment.
2. Toxicity and other harmful effects.
3. Accumulation in biological materials or sediments.
4. Biochemical transformation producing harmful compounds.
5. Adverse effects on the oxygen content and balance.
6. Susceptibility to physical, chemical aned biochemical changes and interaction in the aquatic environment with other sea-water constitutents which may produce harmful biological or other effects on any of the uses listed in section E below.

C. Characteristics of discharge site and receiving marine environment

1. Hydrographic, meteorological, geological and topographical characteristics of the coastal area.
2. Location and type of the discharge (outfall, canal, outlet, etc.) and its relation to other areas (such as amenity areas, spawning, nursery, and fishing areas, shellfish grounds) and other discharges.
3. Initial dilution achieved at the point of discharge into the receiving marine environment.
4. Dispersion characteristics such as effects of currents, tides and wind on horizontal transport and vertical mixing.
5. Receiving water characteristics with respect to physical, chemical, biological and ecological conditions in the discharge area.
6. Capacity of the receiving marine environment to receive waste discharges without undesirable effects.

D. Availability of waste technologies

The methods of waste reduction and discharge for industrial effluents as well as domestic sewage should be selected taking into account the availability and feasibility of:

(a) Alternative treatment processes;
(b) Re-use or elimination methods;
(c) On-land disposal alternatives; and
(d) Appropriate low-waste technologies.

E. Potential impairment of marine ecosystems and water uses

1. **Effects on human health through pollution impact on:**
   (a) Edible marine organisms;
   (b) Bathing waters;
   (c) Aesthetics.
2. **Effects on marine ecosystems, in particular living resources, endangered species and critical habitats.**
3. **Effects on other legitimate uses of the waterway.**

Part III. Pollution control parameters listed by 28 industrial subsectors[4/]

The important pollution control parameters are summarized for 28 specific industrial subsectors. The reader may also wish to refer to the seven chapters in the World Bank Guidelines which are devoted to specific means of industrial pollution control, such as electrostatic precipitators.[5/]

Agro-based Industries:

1. Cane sugar industry
BOD[6/], TSS[7/], and pH.

2. Dairy products industry
The most significant pollution parameters are BOD, TSS, and pH.

3. Ethanol production
The air emissions to be controlled are sulfur dioxide, nitrogen oxides, and particulates. In the liquid effluent, important parameters are BOD, TSS, and pH.

4. Fish and shellfish processing
The important waste water parameters are BOD, TSS, and oils and grease. Substantial quantities of solid waste such as bones, innards, and skin are potentially reusable in such products as fish meal, fish silage and mince.

5. Fruit and vegetable processing
Most significant waste water parameters are BOD, TSS, and pH. However, caustic peeling produces much higher waste loads than does mechanical peeling.

6. Meat processing and rendering
The BOD, TSS, and oils and grease are the most significant pollution parameters.

4/ The Environmental Guidelines of the World Bank, 1984, and selected UNIDO environmental studies, 1978-1987.

5/ Specific means of industrial pollution control: 1. Dust emissions; 2. Effluents, disposal of industrial wastes; 3. Effluents, liquid, land disposal and treatment; 4. Electrostatic precipitators; 5. Nitrogen oxide emissions; 6. Nitrogen oxide sampling and analyses; 7. Noise; 8. Secondary environmental effects; 9. Sulfur dioxide ambient levels; 10. Sulfur dioxide emission standards; 11. Sulfur dioxide sampling and analyses.

6/ BOD: Biochemical oxygen demand. The 5-day, 20°C, BOD test is widely used to determine the pollution strength of waste water. The test measures the oxygen consumed by living organisms while utilizing the organic matter present in the waste water. The test is standardized and is one of the most important in pollution control of a waterway.

7/ TSS: Total suspended solids. Refers to solids which are physically suspended in the waste water.

7. Palm oil industry
A substantial quantity of solid waste is produced from shells and kernels. This can be utilized in some cases as a fuel. The most important water pollution parameters are BOD, TSS, oils and grease, organic nitrogen, and ash.

8. Plywood manufacturing
Air pollution problems arise if coatings are applied as part of the production process. Organic solvents such as methylethylketone, methylisobutylketone, toluene, xylene, butal acetates, propanol may be given off during coating and drying processes. Important waste water effluents are BOD, TSS, and pH.

9. Poultry processing
The most important effluent parameters of waste water are BOD, TSS, and oils and greases.

10. Slaughterhouses - Industrial waste disposal and design arrangement
The important waste water parameters are BOD, TSS, and oils and grease.

11. Tea and coffee production
Some gaseous pollutants may result from either tea or coffee production. The most important parameters are sulfur dioxide and particulates. Very little liquid waste results from processing of tea. In the coffee production a substantial amount of suspended solids can be anticipated.

12. Textile and synthetic fiber industries
There may be some dust and small pieces of fibres that result from the spinning and wheeling operations. The principle parameters to characterize waste waters are BOD, COD[8/], TSS, oils and greases, chromium, phenols and sulfides.

13. Wool scouring
For every kilo of scoured wool fibre, 1 to 1 1/2 kilos of wastes are produced. Measured by BOD, wool scouring produces more pollution than other sectors.

14. Leather tanning and finishing
Major pollutants are high concentrations of BOD, TSS, sulfides, oils and chromium (if the chrome tanning process is used).

Chemical Industries:

15. Cement industry
The major pollutant from cement factories is particulates. It may be dust from the cement but may also include oxides of sulfur and nitrogen plus small amounts of hydrocarbons and other chemicals. The major source of water pollution is the dust which, after coming in contact with water, becomes a problem of total suspended solids.

8/ COD: Chemical oxygen demand. The COD test should be used whenever one suspects the presence of materials which cannot be oxidized by bacteria. The test is a standardized chemical oxidation of materials in the waste water and requires only 3 hours to be conducted.

16. Chlor-alkali industry
The traditional process has involved mercury cells. In this case mercury is the major pollutant from the plant. Never plants do not use mercury cells. In those cases some TSS, chromium, copper, lead, nickel and zinc may be present in the waste water. In additicn, the pH may be alkaline.

17. Earthquake protection
Earthquake protection is important in design and construction of most industrial buildings. The World Bank believes a letter should be required from the structural engineering contractor certifying that certain basic earthquake protection measures have been taken such as locating the building away from any zone of seismic activity, and constructing the building in order to assure that it is earthquake-proof.

18. Fertilizer manufacturing
(A) Nitrogen-based fertilizers: The major pollutants here are particulates, sulfur oxides, carbon monoxide, photochemical oxygen sources, hydrocarbons, nitrogen oxides, and most substantially, ammonia. Organic nitrogen may also be present.
(B) Phosphate fertilizer plants: The manufacture of phosphate fertilizers requires a sulfuric acid plant next door. That plant may produce sulfur dioxide and acid mist if not properly designed and operated. The phosphate process itself can emit fluorides. Present in the waste water may be phosphorus, fluorides and TSS. The pH may be alkaline.

19. Glass manufacturing
Glass melting furnaces may give off nitrogen oxides, particulates, sulfur oxides, and small quantities of hydrocarbons. In the case of water pollutants, most significant are TSS, oil and COD.

20. Pesticide manufacture
A survey of materials manufactured should classify those in 3 classes according first to their inflammability. Class A. Flash point below 7°C; Class B. Flash point between 7° and 21°C, and Class C. Flash point above 21°C (flash point is the minimum temperature at which the vapour of a liquid will ignite under controlled test conditions). Toxic pesticides should be also divided into 3 classes according to their LD 50 (the lethal dose for 50 per cent of the tested animals; the smaller the value for LD 50, the more toxic the material, because less material will cause 50 per cent of the test animals to die). Class A - LD 50: less than 100[9/]; Class B - LD 50: between 100 and 800[9/]; Class C- LD 50: over 800[9/]. Within the plant, workers should avoid direct contact with the more toxic and highly volatile solvents in order to avoid exposure. Workers should also take special care of process conditions and process equipment when class A materials are being handled. Every plant waste should be classified as toxic or relatively less toxic. The industry should avoid discharging to the environment any toxic waste effluent regardless of its biodegradability. Various gas pollutants which are normally released in a pesticides plant are sulfur dioxide, chlorine, hydrochloric acid and mercaptans. These pollutants should be scrubbed before being discharged in the atmoshpere.

9/ Mg/kg of animal body weight.

21. <u>Pulp and paper industry</u>
The greatest environmental impact comes from bleaching and pulping to produce chemical pulp. The air emissions are not particularly serious except of sulfur compounds. These can be scrubbed. Liquid effluents are substantial and the parameters are BOD, TSS, and colour. In European parctice, COD is also used as a parameter. The waste may be highly coloured in spite of treatment and recovery processes. Many mills continue to discharge highly coloured wastes.

22. <u>Rodenticides</u>
Rodenticides should be separated into 3 classes. Class 1 is those products whose use requires only normal precautions. This includes the anticoagulants and examples are norbormide and zinc phosphite. Class 2 includes products which use should be discouraged or very carfully controlled. That includes sodiumfluoracetates and strychnine. Both of these are highly toxic to warm blooded animals. Class 3 is those products which are banned because they are too toxic for men and environment. These include arsenic dioxide, phosphorus, thallium sulfate, and naphtyl thiourea. Developing countries should be encouraged to manufacture class 1 rodenticides and stay away from the more hazardous materials of class 2 and 3.

23. <u>Natural rubber production</u>
Liquid effluents constitute the most important source of pollution from natural rubber production. The most important parameters are BOD, COD, TSS, total solids (TS), and ammonia based nitrogen. In some cases alkalinity may need to be changed by decreasing the pH. Although not thought to be heavily polluting, the BOD and COD may need to be reduced by 90 per cent in order to produce a satisfactory effluent from the plant.

24. <u>Pharmaceuticals production</u>
In the case of pharmaceuticals, the typical materials flow for a synthetic organic medicinal chemical process yields only 10 per cent of finished products based on the input of raw materials. Large quantities of solvents are required. Sometimes they can be recycled, otherwise the plant must be careful to not allow these to enter in liquid waste stream. The only exception would be in biodegradable solvents such as ethanol, otherwise those waste solvents which cannot be recycled should be disposed by careful incineration. In addition, the process wastes may require treatment by a biological means in order to reduce BOD and COD. There will be considerable biological sludge to dispose from this waste water treatment process. A large quantity of solid wastes may also result from the process and this can be incinerated with the waste solvents. One problem peculiar to environmental protection in the pharmaceutical industry is that certain organisms can restrict the biological organisms present in the waste water treatment plant; e.g. penicillin, streptomycin and auriomycin are 3 examples of antibiotics which can inhibit the organisms which grow in the waste water plants.

Metallurgical Industries:

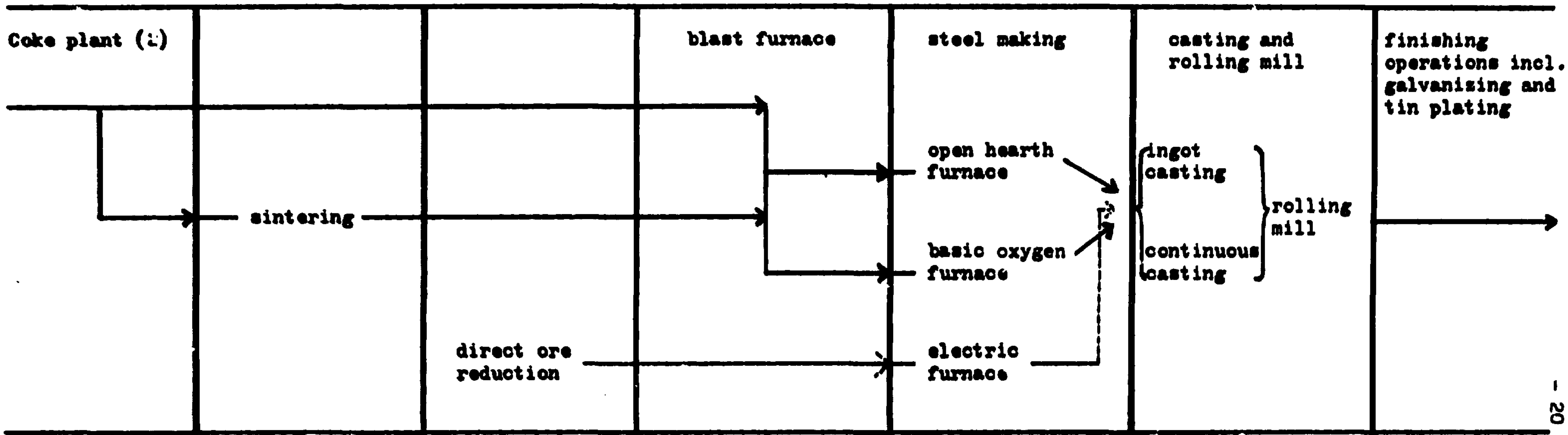
25. <u>Iron and steel industry</u>
Because of the number of operations within the iron and steel industry, the pollutants produced are best shown on a diagram (Figure 1). The following shows all of the unit operations in the production of steel from ore and coke. It is reproduced from a UNIDO study (UNIDO/IS.263, p. 14).

26. <u>Non-ferrous metals industry - Aluminum</u>
Major concerns in mining the raw material (bauxite) are erosion of the land, dust control, and in the processing of the bauxite to produce aluminum the major concern is the disposal of red mud (the bauxite residue). Typically, the red mud is discharged in a closed pond and the water from the residue is allowed to evaporate. In the matter of processing, air pollution can come from the fluorides, and to a lesser extent sulfur compounds and phenols. The significant water pollution parameters are total fluorides, TSS, and pH, which will be on the alkaline side.

27. <u>Non-ferrous metals industry - Copper and nickel</u>
In the case of copper, the main pollutants are the air emission of sulfur dioxide and parameters. An efficient copper smelter will capture all the sulfur dioxide and convert this into sulfuric acid, which can be sold. In the case of liquid effluents in the copper production, TSS and a number of trace metals are the primary pollutants. These include arsenic, copper, lead, cadmium, selenium and zinc. The pH will also be alkaline unless the effluent is neutralized. In the case of nickel, the ores will usually be of a sulfide origin and sulfur oxides be the main air pollutants. In the matter of water pollution, typical pollutants include TSS, copper, nickel and iron. As is the case in copper processing, the effluent is alkaline, and therefore the pH may need to be controlled.

28. <u>Non-ferrous metals industry - Lead and zinc</u>
In the production of zinc from ore, the major air pollution consideration is dealing with sulfur dioxide as well as varying amounts of volatile metals such as mercury, lead and calcium. In modern operations a highly concentrated SO_2-stream goes to a sulfuric acid plant. Liquid effluents from zinc production include varying concentrations of lead, arsenic, cadmium and zinc. Toxic heavy metals should be removed by neutralization from the liquid effluent. During the production of lead, air pollutants to be concerned are sulfur dioxide, particulates, arsenic, cadmium and lead. In the case of the liquid effluents, primary lead production yields an effluent which may contain substantial TSS, cadmium, lead, zinc and a pH substantially on the alkaline side. Secondary lead production (where batteries are used as the source of lead) yields an effluent which is high in TSS, cadmium, lead, arsenic and also alkaline solids which are physically suspended in the waste water.

Figure 1. Major pollution sources and types in the iron and steel industry (1)



WASTES PRODUCED

Coke plant		Sintering		Direct ore reduction		Blast furnace			Steel making			Casting and rolling mill		Finishing operations	
Air	Water	Air	Water	Air	Water	Air	Water	Solids	Air	Water	Solids	Water	Solids	Water	Solids
Dust(3) NH_3 Steam H_2S NO_x CO	NH_3 BOD Phenol Cyanide Acidity	Dust SO_x NO_x Fluorides	Susp. Solids (SS) BOD Phenols Cyanide Sulfides	Dust SO_x (4) NO_x	SS	NH_3 CO (5) SO_x	SS NH_3 Phenol Cyanide	Slag Spent refract-ories	Dust NO_x	SS	Sludge Slag	SS Oil + grease Chloride Sulfate Iron Acidity	Scale Sludge Spent refract-ories Spent oil + grease	SS BOD Cyanide Oil + grease Chromium Iron Tin	Scale

(1) Other sources of relatively minor contamination include the yards (ore, coal and scrap), power generation, lime kiln and cooling towers.
(2) By-product plants associated with coke plants produce benzol, tars, sulfuric acid and phenol, which are used by the chemical industry.
(3) Note: whenever dust is removed by means of a wet process, such as a scrubber, a water pollution problem in the form of suspended solids results. When removed by a dry process a solid waste results.
(4) Amount depends on sulfur content of fuel used.
(5) Waste gas containing CO is frequently collected and cleaned for use as a fuel.

Annex

A synopsis of the Environmental Guidelines issued by different international development agencies and some additional references

A. Guidelines available for study at the VIC library

Asian Development Bank, Environmental guidelines for selected industrial and power development projects, Environment Specialists, Infrastructure Department, 1987.

The Asian Development Bank's Environmental Unit, preferring not to have a formal instrument of assessing environmental effects but to analyse each project on a case-by-case basis, has specially designed over 20 environmental checklists for different types of projects. These checklists are for internal use only: the environmental adviser uses them as a means of alerting project staff to potential environmental problems and of stipulating the information needed to make an assessment of potential impacts. Providing the information stipulated in the checklist does not constitute an assessment, and the checklists should only be used in consultation with the Environmental Unit. The environmental adviser warns that mechanical deployment of the checklists can inhibit the assessment of potential direct and indirect impacts specific to a given site.

European Investment Bank, Model technical report - Industrial project, 3 April 1980 (English and French).

This document suggests a uniform scheme for presenting the results of industrial project appraisals by the technical and economic advisors of the European Investment Bank. A category within the technical section covers "environment and pollution".

Attached is a very brief checklist of environmental media, such as water or air, with more detailed list of relevant quality indicators or variables. These are provided as a guide to thinking about the possible environmental effects of different options. Finally, there is a short list of questions outlining the process of assessing the environmental effects, evaluating their significance and deciding on the economic and technical solutions.

FAO, Second expert consultation on environmental criteria for registration of pesticides, FAO, Rome, 1981.

These FAO guidelines have been prepared to draw attention to the environmental problems that have been encountered during recent years because of the use of chemical pesticides. It is a concise, readable booklet describing the direct effects on man, domestic animals and other life; unintended and unsuspected effects on the environment; diminishing returns from excessive and uncritical usage and the major problem areas.

The second part of the booklet is a detailed checklist of points to be considered when reviewing or implementing project proposals, i.e. general protection activities with industrial crops; developments involving treatments of food of plant or animal origin; safe handling and user practices; general needs for improving supervision and control of pesticides. These checklists are accompanied by useful explanatory notes.

Inter-American Development Bank, Environmental checklist for industry projects, undated.

This is one of a series of sectoral checklists adopted by the Inter-American Development Bank for the environmental analysis of project proposals. Others are mining and energy. Member country government staff seeking funding are advised to use this checklist in indicating the environmental effects and appropriate mitigation measures of projects.

There is some guidance offered on typical effects of projects in the particular sector, and on how to identify and assess the significance of effects. However, this advice is very brief. The checklists give no advice on how to collect or use the data in project preparation.

Inter-American Development Bank, Project Analysis Department, Guide for the preparation of loan applications - Industry, June 1979.

In this 3-page document, the Inter-American Development Bank states the following objectives in environmental management:
- systematic environmental assessment and mitigation of damage of Bank financed projects;
- Funding of projects to improve or preserve the environment;
- Technical, institutional and operational assistance to member countries for environmental management.

It indicates that assistance can take the form of environmental projects, environmental components of projects and technical co-operation. Broad environmental management criteria are stated for project appraisal.

Inter-American Development Bank, Project Analysis Department, Guide for the preparation of loan applications - Environmental Management, June 30, 1981.

This document provides guidance for making loan applications to the Inter-American Development Bank for environmental management projects. It advises on what information should be included, how the data furnished should be organized and presented, and offers a general guide on the needs of the Bank for the multidisciplinary analysis of the various aspects of the project. It also covers operating procedures of the Bank in determining the feasibility and approval of the project. Of particular interest is the chapter that establishes the basis for the evaluation of the social and economic benefits and costs of environmental management projects. Additional guidance highlights the potential environmental problems associated with certain sectors of development activities and possible environmental management strategies.

The National Environmental Board of Thailand, Guidelines for preparation of environmental impact evaluations, Part I, Introduction, Office of the National Environment Board, Bangkok, undated.

The National Environmental Board (NEB) of Thailand has a two stage environmental assessment system (Initial Environmental Examination [IEE] and Environmental Impact Statement [EIS]). This manual presents guidelines for preparing an EIS for review by the NEB, first addressing methodology and organization of the report; next it offers supplementary guidelines for project sectors (categories of impact, typical levels of impact and basic information needed). There are also guidelines for preparing IEEs. Finally the Manual suggests guidelines for terms of reference for IES consultants.

Overall guidelines emphasize procedural issues, categories of impact and format of reports. They reflect their derivation from US Army Corps of Engineers' guidelines and favour matrices on which environmental impact parameters are _ated numerically for different sectors, without explaining how to measure, predict or assess the significance of environmental effects, nor how to incorporate the results into project design and implementation.

These are essentially designed to assist project applicants to fulfill the procedural requirements of the NEB.

UNDP, Environmental operational guidelines, G3300-1/TL.1, 28 May 1981.

The UNDP's Environmental Operational Guidelines are incorporated into the Policies and Procedures Manual that is issued to Project Officers and other agency staff. These guidelines should be useful to UNDP staff in identifying likely environmental problems associated with particular sectors. They are also designed for distribution via UNDP resident representatives offices to the responsible ministries in developing countries to alert them to potential probelms. The text of the guidelines was prepared by UNEP in consultation with specialized UN organizations and they are also published as the UNEP Environmental Management Guidelines Series.

World Bank, Environmental guidelines, Office of Environmental Affairs, Washington, D.C., July 1984.

The World Bank environmental guidelines are a compendium of technical guidance on environmental effects, permissible pollutant levels and principal control measures for a wide range of industries and major pollutants. They are designed to help World Bank staff evaluate the adequacy and effectiveness of pollution control measures for industrial investments. The use of these guidelines should be tailored to individual situations, especially in the case of permissible pollutant levels, and requires technically trained personnel.

These guidelines are regularly updated, including more industries, more standards, technical advice on practical sampling and analysis methods and more references to sources of information.

World Bank, Occupational health and safety guidelines, Office of Environmental Affairs, Washington, D.C., June 1984.

The World Bank Occupational Health and Safety guidelines are a compendium of technical guidance on health effects, hazards and accidents and measures to reduce them for a wide range of industries and major pollutants. They are the equivalent of the World Bank environmental guidelines referring to harmful effects on the worker within the work place. They are designed to help World Bank staff evaluate the adequacy and effectiveness of pollution control measures for industrial investments. The use of these guidelines should be tailored to individual situations, especially in the case of permissible pollutant levels, and requires technically trained personnel.

These guidelines are regularly updated, including more industries, more standards, technical advice on practical sampling and analysis methods and more references to sources of information.

B. Other environmental guidelines

Albert, Lilia A. Plaguicidas, salud y ambiente. Centro Panamericano de Ecología Humana y Salud, Instituto Nacional de Investigaciones Sobre Recursos Bioticos, 1986.

Asian Development Bank. Environmental planning and management and the project cycle. ADB Environment Paper No.1, September 1987.

Asian Development Bank. Environmental guidelines for selected infrastructure projects. Environment Specialists, Infrastructure Department, June 1986.

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European Investment Bank. Environmental protection and EIB finance. Information No.30, May 1982 (English and French).

European Investment Bank. Annual Meeting of the Board of Governors. EIB-Information No. 53, July 1987 (English and French).

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Inter-American Development Bank. Environmental checklist for energy projects, undated.

Inter-American Development Bank. Operational policies manual, June 21, 1979.

Inter-American Development Bank, Environmental Management Committee. Conference on the Environment, Washington, D.C., 13-15 May 1987.

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