The Environmental Assessment Sourcebook (the EA Sourcebook) was published by the World Bank during its fiscal year 1991-92. It is expressed in the EA Sourcebook that the Bank's environmental assessments emphasize identifying environmental issues early in the project cycle; designing environmental improvements into projects; and avoiding, or mitigating or compensating for adverse impacts. Figure 12.5-2 shows the EA activities in a project cycle, which are required by the World Bank.

The EA Sourcebook also provided guidelines for environmental assessment on each sectorial basis, in which mitigating measures are suggested for various potential negative impacts. In addition to the mitigation measures, the EA Sourcebook also made recommendations as to what a Borrower should do, such as project management, training and environmental monitoring.

To understand the details of the requirements of the World Bank, it is recommended to study the contents of the EA Sourcebook and its related documents at initial stage of planning a project, if the World Bank's loan is intended.

12.5.3 Environmental Issues and Protection Measures

In this section, some typical environmental issues of thermal power and hydropower plant projects are discussed and concerned protection measures are described.

(1) Regarding thermal power projects

As every one knows, releases of fly ash, sulfur oxide (SOx) and nitrogen oxide (NOx) to the atmosphere are the key issues of thermal power plants. To limit the releases, permissible emission standards are set force and various flue gas treatment systems are being used in many countries. In addition, environmental standards of ambient air are also stipulated to protect against air pollution. As an example, the standards and flue gas treatment systems being adopted in Japan are described below for references.

(a) Environmental and permissible emission standards in Japan

Attached Table 12.5-6 shows the environmental quality standard for ambient air set force in Japan to protect the public health, and conserve the living air environment, and serve as the target to be achieved by the environmental administrations. On the other hand, permissible emission standard is stipulated to control the exhaust gas emissions from each facility, so that air pollution can be controlled.

In case of permissible emission standard, a term called "Soot and Smoke" is used to mean the following substances:

1) Sulfur oxide (SOx) generated as a result of the combustion of fuels
2) Soot and smoke generated as a result of the combustion of fuels
3) Soot and smoke generated as a result of the use of electrical heat as a heat source
4) Cadmium and other harmful substances generated as a result of the combustion, synthesis, decomposition and other treatment of matters (excluding mechanical treatment)

Attached Table 12.5-7 shows the overall table of maximum permissible standards of the soot and smoke. The following tables are also attached to show some details of the standards:

- Table 12.5-8 Regulation on Sulfur Oxides Emission (K Value)
- Table 12.5-9 Emission Standard for Nitrogen Oxides (abstract)
- Table 12.5-10 Examples of the Emission Standard for Soot and Dust

As shown in Table 12.5-8, the permissible emission standard for sulfur oxides is defined by using K values which are the factors to be used in the following equation:

$$q = K \times 10^{-3} \times He^2$$

q	=	the hourly volume of sulfur oxides emitted (in unit of Nm^3/h)
K	=	the factor as defined by the Table 12.5-8, which is classified into 16 areas
He	=	effective height of the stack emitting flue gas (m)

Therefore, the emission standard of sulfur oxides is different from one area to the other. This is called "K-value regulation". The special standard is applicable to some areas as shown for new projects only.

(b) Flue gas treatment systems

1) Dust collector system

The soot and smoke presented in the form of particles is called aerosol. Dust collectors are used to separate and collect particulates from the flue gas. There are several types of dust collectors as below:

- Gravitational dust collector
- Inertial dust collector
- Centrifugal dust collector
- Scrubbing dust collector
- Filtering dust collector
- Electrostatic precipitator

For thermal power plants, the ESP is commonly used. ESP with high performance can remove about 80% of unburnt carbon from oil-fired thermal power and about 99% of fly ash from coal-fired plants. The installation cost of such high performance ESP is about 3% of the total plant construction cost. Others like cyclone type centrifugal dust collector or bag filter type dust collector is also common, but their efficiencies are quite sensitive to various parameters, such as flow velocity, particle size, filter mesh and so on. To achieve higher performance of a bag filter type dust collector, electrostatic bag filter has also been developed, by which the particles with about 0.1 micron diameter can be removed more efficiently. Selection of the dust collectors will depend on manufacturer's recommendations and the cost allocations.

2) Flue gas desulfurization (FGD) system

There are mainly two types of FGD processes, i.e. wet type and dry type processes. There are various processes developed as wet type or dry type FGD system, respectively as below.

a) Wet type FGD process

- Lime/limestone gypsum process
- Magnesium hydroxide desulfurization process
- Basic aluminum sulfate desulfurization process
- Sodium sulfite desulfurization process

b) Dry type FGD system

- Activated carbon absorption process
- Metal oxide absorption process

As far as thermal power plants are concerned, lime/limestone gypsum process has been most commonly used in Japan, especially for coal-fired thermal power plants. Recently, dry type activated carbon absorption process is being introduced to new projects. Brief discussions on these two processes are provided below.

a) Lime/limestone gypsum process

Main chemical reactions of the process are as follows:

$$Ca(OH)_2 + SO_2 + Aq \rightarrow CaSO_3 \bullet 1/2\ H_2O + Aq$$
$$CaCO_3 + SO_2 + Aq \rightarrow CaSO_3 \bullet 1/2\ H_2O + CO_2 + Aq$$
$$CaSO_3 \bullet 1/2\ H_2O + 1/2\ O_2 + Aq \rightarrow CaSO_4 \bullet 2H_2O + Aq$$

or

$$CaSO_3 \bullet 1/2\ H_2O + SO_2 + Aq \rightarrow Ca(HSO_3)_2 + Aq$$
$$Ca(HSO_3)_2 + 1/2\ O_2 + Aq \rightarrow CaSO_4 \bullet 2H_2O + H_2SO_4$$

Where, Aq means water. The chemical reaction process is quite complicated and its details are not still very clear.

The advantage of lime/limestone gypsum process is that lime and limestone are available everywhere in most countries, and sulfur is recovered as useful by-products such as gypsum, sodium sulfate, sulfuric acid, elemental sulfur, etc. Disadvantage of lime/limestone gypsum process is that a lot of water is used and that large space for waste water treatment system will be needed. Scaling within the absorption tower and piping walls caused by crystallization of gypsum ($CaSO_4 \bullet 2H_2O$) was used to be a key problem of this process. However, this problem was resolved by manufacturers in Japan and therefore the process became a major SOx removal system.

Attached Figure 12.5-3 shows a schematic flow diagram of a limestone gypsum process system. To satisfy specific applications, many variations can be made to the system, such as adding magnesium sulfite to obtain appropriate low pH value in the process, and depending on what by-product will be produced, etc. Figure 12.5-4 shows the picture of an EPDC's coal-fired thermal power plant (Isogo Thermal Power Plant, 265 MWe), which is equipped with the limestone-gypsum desulfurization system.

In general, installation cost of a lime/limestone gypsum process being adopted in Japan is quite high and influenced by site characteristics, it reaches about 10% of the total plant construction cost. Therefore, the process being used in Japan may need to be redesigned and modified into some simplified system, if it would be applied in developing countries.

b) Activated carbon absorption process (dry type)

Activated carbon acts as a catalyst in the process, through which SO_2 is converted into SO_3 by combining with oxygen, and then into H_2SO_4 by reacting with steam. The reaction temperature needed is as high as 100 to 130°C, and therefore its outlet gas will not need to be heated again for guiding to the stack. The advantage of this process is that it is a dry type and no waste water treatment will be required. However, it is a solid-gas reaction and that it needs large volume for the reactor. Moreover, the price of activated carbon will be higher compared with that of limestone. Therefore, detailed tradeoff among various factors will be needed when making selection of a desulfurization system. EPDC's Isogo Thermal Power Plant will be upgraded in near future. The upgraded plant will utilize the activated carbon absorption system, which will be integrated into a combined system of having both functions of desulfurization and NOx removal. For the purpose of NOx removal, ammonia will be added to react with NOx. Again, activated carbon will also act as a catalyst for this reaction.

Besides the FGD system, fluidized bed combustion (FBC) method has also been developed to remove SOx in boiler. SO_2 is removed by adding powdered limestone into boiler bed. Usually, 60% to 80% removal of SOx can be achieved.

3) Flue gas NOx removal system

NOx is generated from oxidation of nitrogen included in fuel itself and in air. The amount of NOx will be rapidly increased when burning temperature becomes higher than 800°C. Improvement of burning method, use of fuel with low nitrogen content and so forth can reduce 5% to 10% of NOx in flue gas. The remained NOx in flue gas has to be removed by flue gas NOx removal system.

The method of "catalytic reduction of NOx with ammonia" is considered most effective and is most commonly used in thermal power plants. The chemical reactions in this process are as below:

$$6NO + 4NH_3 \rightarrow 5N_2 + 6H_2O$$
$$6NO_2 + 8NH_3 \rightarrow 7N_2 + 12H_2O$$
$$4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$$

There are various base metal catalysts, such as V_2O_5, CuO, Fe_2O_3, MnO_2 and Cr_2O_3, can be used for this purpose. Activated carbon is also useful as the catalyst. Actual application and selection of a catalyst will depend on the fuel and other factors of a power plant. As already indicated in the above, EPDC's Isogo Thermal Power Plant will install this process, using activated carbon as the catalyst, in its upgrade coal-fired thermal power plant in future.

Using the catalytic reduction of NOx with ammonia method, about 80% of NOx in flue gas can be removed. For more details, it is recommended to consult with the system manufacturers/suppliers.

(2) Regarding hydropower projects

There are various potential environmental issues which may be incurred in connection with hydropower developments. Use of agriculture and forest lands, potential impact to flora and fauna in project area, resettlement of people, potential conflict with the water uses needed by the people and industrial activities in downstream areas, eutrophication of the reservoir water and so on are all to be considered and evaluated. Necessary measures will have to be planned and taken for potential impacts. The extent of each potential environmental impact has to be investigated through EIA.

Based on the case studies made on Da River and Dong Nai River basins, as well as the field survey made during the site visits in the country, a few key existing environmental issues are discussed and some recommendations are provided as below.

(a) Resettlement issue

The case study report prepared on Da River Basin has described in details the resettlement issue of Hoa Binh hydropower plant. Discussions are made in the report regarding the causes of the existing problems and the further actions to resolve the problems being planned by the concerned governmental organizations. From the contents of the case study report, it is understood that the concerned governmental organizations are aware of the importance of the unresolved issue and preparing plans to resolve the problems. It is desirable that the following points are to be considered in the course of the problem resolution and for other development projects in future:

- Prepare an integrated program to cover the whole remaining issues and planned resolution measures, if such program has not yet been established. Also to organize a steering committee which is composed of the representatives from concerned governmental organizations, project owner and local authorities. The steering committee will be responsible for the whole program implementation. Enough budget shall be allocated for the program implementation. It is recommended that PC1 will take the key role and final responsibility for this issue.
- Taking the resettlement issue of Hoa Binh hydropower plant as the important lessons to be learned for future projects.
- It should be noted that resettlement program is one of key issues to be covered in the EIA of a project. A good and realistic resettlement program shall be established and

clearly described in an EIA. The program shall also cover the follow-up activities to monitor the livelihood of resettled habitants. Power companies shall be responsible for establishment of such a program. It is noted that the World Bank and other ODA donor countries are all paying much attentions to the resettlement issue of a project plan which will receive funding assistance from them.

(b) Eutrophication of reservoir water

Because of the inflow of large amount of substances having nitrogen and phosphorus from upstreams of a reservoir, water quality of the reservoir could degraded due to breeding a lot of aquatic organisms, such as plankton. BOD and COD values will gradually be increased. It was reported that water quality of the Tri An reservoir is getting degraded. In spite of not having water quality data available at the time of the site visit, this issue is usually expected. The issue of organic fouling to plant components is also an issue which is related with the water quality. However, key problem of the eutrophication is that no more fishes could survive at the ultimately degraded condition and offensive odor would be generated by the degraded water. If such condition would be reached, discharged water will raise severe negative impact to downstream areas.

This is an issue which can not easily be resolved and is also happening in industrialized countries. Many nature lakes are also suffering from this problem.

The countermeasures which can be taken to decelerate the progress of eutrophication are as below:

- Waste water treatment at the sources of upstream area
- Cut out the trees and clean up other organic substances existing in the reservoir area before water filling
- Forced circulation of reservoir water, if possible
- Perform periodic plant maintenance to clean up the plant components

(c) Water reduction area issue

Water reduction area will usually generated between the water intake point to the water discharge point of a hydropower station. If the distance between the two points will be long, significant negative impacts may occur in the water reduction area, including those on nature environment and agriculture. Figure 12.5-5 and Figure 12.5-6 show the pictures of the scenery of the water reduction area taken at the downstream side of the spillway of Tri An hydropower plant. These pictures were taken in July 1994, which is the beginning of raining season in this area. It can be seen that no any flowing water is existing in the areas and it was said that such water reduction section has about 7 km long.

To understand the extent of possible negative environmental impacts occurring in this section, it is recommended to perform an environmental survey covering both of nature and social environments. If it would be found that some significant negative impacts are existing or occurring, a certain amount of water discharge should be considered to mitigate the impacts.

In general, a certain amount of water should be discharged from spillway to protect the environment in such a water reduction area. The amount of the discharge water may be up to about 3% power reduction of a hydropower station. This is the current practice being recommended in industrialized countries.

Table 12.5-1 Checklist for Preliminary Environmental Study on Dam Construction Projects (JICA)

(page 1/2)

Environmental Factor					Evaluation	Basis
Social Environment	Population		1	Change of population in the region (including racial minority problems)		
			2	Resettlement (including racial minority problems)		
	Industry		3	Agriculture and forestry		
			4	Fisheries		
			5	Secondary industry (including mining, mineral resources)		
			6	Tertiary industry (including tourism, recreation)		
	Communications		7	Regional disruption (including racial minority problems)		
	Transportation		8	Impact on land transportation		
			9	Impact on water transportation		
	Water areas and their utilization		10	Impact on water and fishing rights		
	Sanitation		11	Water-born diseases and their spread		
			12	Deterioration of sanitation during work		
	Landscape		13	Deterioration of landscape		
	Cultural assets, etc.		14	Impact on cultural assets		
Natural Environment	Lithosphere	Geological phenomena	15	Induction of earthquakes		
		Topography	16	Slope collapse		
			17	Sedimentation in the backwater section		
			18	Impact on downstream waterways		
			19	Impact on coastal areas		
		Soil Condition	20	Soil erosion		
			21	Soil contamination		

Table 12.5-1 Checklist for Preliminary Environmental Study on Dam Construction Projects (JICA) (continued)

(page 2/2)

Environmental Factor					Evaluation	Basis
Natural Environment	Hydrosphere	Water phenomena	22	Inter-basin diversion		
			23	Impact on the groundwater		
			24	Change of flow regime		
		Water condition	25	Change in water temperature		
			26	Eutrophication		
			27	Turbidity		
		Bottom condition	28	Change in composition of bottom		
	Biosphere	Flora	29	Impact on flora		
		Fauna	30	Impact on fauna		
		Aquatic organisms	31	Impact on aquatic organisms		
		Ecosystem	32	Disruption of ecosystem		
	Atmosphere	Air	33	Air pollution		
			34	Changes in micro-climate		
		Offensive odors	35	Offensive odors		
		Noise, vibration	36	Noise and vibration		

Note 1: Evaluation Codes
- A: Great impact
- B: Moderate impact
- C: Little impact
- D: Unclear (Need for further study. It may so happen that the impact becomes clear as the survey progresses.)
- X: No impact and negligible impact

Note 2: When evaluating items, refer to the corresponding sheet of the explanatory notes

Note 3: Except in very large-scale dam projects, the induction of earthquakes is extremely rare. Furthermore, this evaluation is difficult in a feasibility study, so judgement should be made as carefully as possible.

Table 12.5-2 Study Items of a Full-scale EIA on Dam Construction Projects (JICA)

1. Outline of dam construction project

    1.1 Project name
    1.2 Location of the project
    1.3 Objective and necessity of the project
    1.4 Reasons for the selected project site

2. Details of the project

    2.1 Utilization plan
    2.2 Work plan and schedule

3. Environmental conditions of the region and project site area

    3.1 Social environment

        (1) Population
        (2) Customs and cultures
        (3) Industries
        (4) Transportation network
        (5) Land utilization
        (6) Water area and utilization
        (7) Public health and hygiene
        (8) Historical and culture assets
        (9) Landscape
        (10) Specific regulations on the above items

    3.2 Nature environment

        (1) Geosphere (topography, geography, soil, sedimentation)
        (2) Aquasphere (flow regime, water quality, sediment condition)
        (3) Atmosphere (weather, air quality, offensive odrs, noise, vibration)
        (4) Biology (flora, fauna, aquatic organisms, ecology)

4. Establishment of key environmental factors during costruction and operation

    4.1 Establishment of key environmental factors during construction
    4.2 Establishment of key environmental factors during operation

5. Predictions and evaluations of potential environmental impacts

    5.1 Process of predictions and evaluations, and environmental conservation goals
    5.2 Predictions and evaluations during construction work

        (1) Resettlement of residents
        (2) Customs and culture
        (3) Water and sediment qualities
        (4) Biology (flora, fauna, aquatic organisms, ecology)

    5.2 Predictions and evaluations for the time of operation

        (1) Topography and soil
        (2) Flow regime, water quality, sediment quality
        (3) Biology (flora, fauna, aquatic organisms, ecology)
        (4) Landscape

6. Environmental conservation measures, environmental monitoring and control plans
7. Comparison of alternative proposals
8. Overall evaluation

Remarks: The contents of this table have been slightly rearranged from the original JICA table.

Table 12.5-3 Environmental Checklist for Hydropower Projects (OECF,Japan)

	Check Items	Major	Small	None	Not Clear	Problems	Action & Countermeasures Planned	Remarks
Pollution	1. Deterioration of water quality (including detrimental changes in water temperature) in the dam reservoir and downstream							
Natural Environment	1. Effect of construction of the facility on the ecology 2. Effect on landscape							
Human Environment	1. Effect of construction of the facility on the historical and cultural heritage 2. Effect on existing infrastructure 3. Relocation 4. Effect on traffic 5. Effect on other downstream utilization 6. Occurrence of diseases, such as malaria, carried by insects or water							
Others	1. Effect on the environment during construction period 2. Environmental Monitoring							

Table 12.5-4 Environmental Checklist for Thermal Power Projects (OECF, Japan)

	Check Items	Major	Small	None	Not Clear	Problems	Action & Countermeasures Planned	Remarks
Pollution	1. Air pollution through the emission of soot and dust, sulphur oxides, and nitrogen oxides released in the combustion of fuel 2. Offensive odours 3. Effect of thermal effluent and land reclamation on aquatic organisms, fisheries, and other water utilization 4. Water pollution resulting from ordinary effluent 5. Noise and vibration 6. Ground subsidence 7. Effect on the water level of a lake, marsh or river 8. Effect of industrial waste							
Natural Environment	1. Effect of construction of the facility on the ecology 2. Effect on landscape							
Human Environment	1. Effect of construction of the facility on the historical and cultural heritage 2. Effect on existing infrastructure 3. Effect on land-use							
Others	1. Effect on the environment during construction period 2. Environmental Monitoring							

Table 12.5-5 Classification of Projects/Components for Environmental Assessments by the World Bank

BOX 1.1: CATEGORY A PROJECTS/COMPONENTS The projects or components included in this list are likely to have adverse impacts that normally warrant classification in Category A. • dams and reservoirs • forestry and production projects • industrial plants [large-scale] • irrigation, drainage, and flood control [large-scale] • land clearance and leveling • mineral development [including oil and gas] • port and harbor development • reclamation and new land development • resettlement and new land development • river basin development • thermal and hydropower development manufacture, transportation, and use of pesticides and other hazardous and/or toxic materials.	*Category A.* In general, certain types of projects either have or are likely to have "adverse impacts that may be sensitive, irreversible, and diverse." Category A includes projects which have one or more of the following attributes that make the potential impacts "significant": direct pollutant discharges that are large enough to cause degradation of air, water or soil; large-scale physical disturbance of the site and/or surroundings; extraction, consumption, or conversion of substantial amounts of forest and other natural resources; measurable modification of hydrologic cycle; hazardous materials in more than incidental quantities; and involuntary displacement of people and other significant social disturbances.
BOX 1.2: CATEGORY B PROJECTS/COMPONENTS The following projects and components may have environmental impacts for which more limited analysis is appropriate. • agro-industries • electrical transmission • aquaculture and mariculture • irrigation and drainage [small-scale] • renewable energy • rural electrification • tourism • rural water supply and sanitation • watershed projects [management or rehabilitation] • rehabilitation, maintenance, and upgrading projects [small-scale]	*Category B* projects often differ from A projects of the same type only in scale. Large irrigation and drainage projects are usually Category A; however, small-scale projects of the same type may fall into Category B. Similarly, a 50-meter hydroelectric dam is clearly large in scale and will usually require Category A classification, while low-head power dams are normally Category B. Construction of a 50-km expressway would also require thorough environmental analysis (Category A) due to scale, while rural road rehabilitation will tend to raise only minor environmental issues (Category B). Projects entailing *rehabilitation, maintenance* or *upgrading* rather than new construction will usually be in Category B. A project with any of these characteristics may have impacts, but they are less likely to be "significant" to the environment. However, each case must be judged on its own merits.
BOX 1.3: CATEGORY C PROJECTS/COMPONENTS These projects are likely to have negligible or minimal environmental impacts. No environmental assessment or analysis is required. • education • family planning • health • nutrition • institution development • technical assistance • most human resource projects	*Category C* projects generally do not require an environmental analysis because they have negligible or minimal direct disturbance on the physical setting. However, not all Category C projects are entirely devoid of environmental impacts. For example, in a health project, the design may have to provide for disposal of medical wastes.

Table 12.5-6 Environmental Quality Standard for Ambient Air (Japan)

Substance	Condition		Method of measurement	Remarks
	Content	Standard value		
SO_2	One hour value	Under 0.1 ppm	Electric conductivity method	
CO	Daily average of one hour value	Under 0.04 ppm		
	8-hour average of one hour value	Under 20 ppm	Absorption photometry using Saltzman reagent.	
	Daily average of one hour value	Under 10 ppm	(Saltzman coefficient being 0.84)	
Suspended Particulate Matter	One hour value	Under 0.20 mg/m^3	Weight and concentration method by filter collection, or light-scattering method by which values having a linear relationship with the former method.	Suspended Particulate Matter means the particulate matter suspended in air whose diameter is under 10 μm.
	Daily average of one hour value	Under 0.10 mg/m^3		
NO_2	Daily average of one hour value	with the range between 0.04-0.06 ppm or below	Absorption photometry using neutral potassium iodine solution, or coulometric method.	
Photo-chemical oxidant	One hour value	Under 0.06 ppm	Light absorption using neutral potassium iodine solution, or coulometric method.	Photo-chemical oxidants are oxidizing substances such as ozone and peroxyacetyl nitrate produced by photo-chemical reactions (only those capable of isolating iodine from neutral potassium iodine, excluding nitrogen dioxide).

Table 12.5-7 Maximum Permissible Emission Standards for Soot and Smoke (an overall table, Japan)

- Soot and smoke
  - Sulfur oxide
    - "K value control"
      K value is a specified value to be applied to calculate the sulfur oxides volume by knowing the stack height.
      Applicable K values are set for respective areas. K value : 3.0 - 17.5 (16 rank)
    - Fuel use regulation
      - Area designation
      - Seasonal designation
      - Sulfur content in fuel (0.5 - 1.2%)
    - Total emission control
      Applied to specified factories in respective regions. (24 regions)
  - Soots (emission dust)
    - Regulation value differs depending on the type and size of facility within the range of 0.03 - 0.50 g/Nm³.
  - Noxious substances
    - Cadmium and its compounds — 1.0 mg/Nm³ *
    - Lead and its compounds — 10 - 30 mg/Nm³ *
    - Fluorine and its compounds — 1.0 - 20 mg/Nm³ *
    - Hydrogen chlorine — 80 - 700 mg/Nm³ *
    - Chlorine — 30 mg/Nm³ *
    - Nitrogen oxides
      - Gas firing boiler — 60 - 150 ppm **
      - Liquid fuel firing boiler — 130 - 280 ppm **
      - Solid fuel firing boiler — 200 - 550 ppm **
      - Metal heating furnace — 100 - 200 ppm **
      - Total emission control is set for designated areas : 3 areas.

* : Value varies by the type of facility

** : Value varies by the size of facility and date of its installation

Table 12.5-8 K-value Regulation on Sulfur Oxides Emission (Japan)

a) General standards

	Area		K value
1	6 areas:	Central Tokyo, Yokohama-Kawasaki, Nagoya, Yokkaichi, Osaka-Sakai, Kobe-Amagasaki	3.0
2	21 areas:	Chiba, Fuji, Kyoto, Himeji, Mizushima, Kita-kyushu and others	3.5
3	1 area:	Sapporo	4.0
4	4 areas:	Hitachi, Kashima and others	4.5
5	3 areas:	Toyama-Takaoka, Kure, Tohyo	5.0
6	9 areas:	Annaka, Niigata, Okayama, Shimonoseki and others	6.0
7	3 areas:	Tomakomai, Hachioji, Kasaoka	6.42
8	6 areas:	Sendai, Fukui, Hiroshima and others	7.0
9	8 areas:	Asahikawa, Utsunomiya, Mihara, Tokushima and others	8.0
10	8 areas:	Akita, Kanazawa, Otsu, Fukuoka, Nagasaki and others	8.76
11	6 areas:	Takasaki, Urawa, Narita, Naha and others	9.0
12	4 areas:	Shizuoka, Sasebo and others	10.0
13	15 areas:	Hakodate, Gifu, Takamatsu, Minamata and others	11.5
14	6 areas:	Mishima, Kurume and others	13.0
15	20 areas:	Aomori, Morioka, Yamagata, Nagano, Kagoshima and others	14.5
16	Others:		17.5

b) Special standards

Area		K value
6 areas:	Central Tokyo, Osaka-Sakai, Yokohama-Kawasaki, Kobe-Amagasaki, Yokkaichi, Nagoya	1.17
8 areas:	Chiba, Fuji, Himeji, Mizushima, Kita-kyushu and others	1.75
14 areas:	Kashima, Toyama, Kyoto, Fukuyama, Ohmuta, Ohita and others	2.34

Note : Special standards are applied to newly constructed facilities only.

Table 12.5-9 Emission Standard for Nitrogen Oxides (Japan)

Type of facility		Stack gas volume (Unit: 1,000 Nm³/h)	Date of installation / On (%)	Standard value (ppm): before Aug. 9, 1973	after Aug. 10, 1973 before Dec. 9, 1975	after Dec. 10, 1975 before June 17, 1977	after June 18, 1977 before Aug. 9, 1979	after Aug. 10, 1979 before Sep. 9, 1983	after Sep. 10, 1983 before Mar. 31, 1987	after Apr. 1, 1987
Boiler	Gas firing	500 and above	5	130	130	100	60	60	60	60
Boiler	Gas firing	100 - 500	5	130	130	100	100	100	100	100
Boiler	Gas firing	40 - 100	5	130	130	130	100	100	100	100
Boiler	Gas firing	10 - 40	5	150	150	130	130	130	130	130
Boiler	Gas firing	5 - 10	5	150	150	150	150	150	150	150
Boiler	Gas firing	less than 5	5	from Aug. 10, 1984 : 150	from Aug. 10, 1984 : 150	from Aug. 10, 1984 : 150	150	150	150	150
Boiler	Solid material firing (including coal)	700 and above	6	400	300	300	300	300	300	200
Boiler	Solid material firing (including coal)	500 - 700	6	420	300	300	300	300	300	250
Boiler	Solid material firing (including coal)	200 - 500	6	420	350	300	300	300	300	250
Boiler	Solid material firing (including coal)	40 - 200	6	450	350	300	300	300	300	250
Boiler	Solid material firing (including coal)	5 - 40	6	450	380	350	350	350	350	350
Boiler	Solid material firing (including coal)	less than 5	6	from Aug. 10, 1984 : 480	from Aug. 10, 1984 : 480	from Aug. 10, 1984 : 480	380	380	350	350
Boiler	Liquid firing	500 and above	4			150	130	130	130	130
Boiler	Liquid firing	100 - 500	4	190	180	150	150	150	150	150
Boiler	Liquid firing	40 - 100	4	190	180	150	150	150	150	150
Boiler	Liquid firing	10 - 40	4	230	230	150	150	150	150	150
Boiler	Liquid firing	5 - 10	4	250	250	250				
Boiler	Liquid firing	less than 5	4	from Aug. 10, 1984 : 250	from Aug. 10, 1984 : 250	from Aug. 10, 1984 : 250				
Sintering furnace (excluding pellet backing furnace)		100 and above	15	260	260	260	220	220	220	220
Sintering furnace (excluding pellet backing furnace)		10 - 100	15	270	270	270	220	220	220	220
Sintering furnace (excluding pellet backing furnace)		less than 10	15	300	300	300	300	220	220	220
Calcination furnace			10	200	200	200	200	200	200	200
Roasting furnace			14	250	250	250	250	220	220	220
Blast furnace			15	120	120	120	120	100	100	100
Metal melting furnace			12	200	200	200	200	180	180	180
Metal heating furnace		100 and above	11	160	160	100	100	100	100	100
Metal heating furnace		40 - 100	11	170	170	150	130	130	130	130
Metal heating furnace		10 - 40	11	170	170	150	130	130	130	130
Metal heating furnace		5 - 10	11	170	170	170	150	150	150	150
Metal heating furnace		less than 5	11	200	200	200	180	180	180	180
Petroleum heating furnace		40 and above	6	170	170	100	100	100	100	100
Petroleum heating furnace		10 - 40	6	180	170	150	130	130	130	130
Petroleum heating furnace		5 - 10	6	180	180	180	150	150	150	150
Petroleum heating furnace		less than 5	6	200	200	200	180	180	180	180
Cement calcination furnace (excluding wet types)		100 and above	10	480	480	250	250	250	250	250
Cement calcination furnace (excluding wet types)		less than 100	10	480	480	480	350	350	350	350
Backing furnace used for manufacturing refractories and fire bricks			18	450	450	450	450	400	400	400
Melting furnace used for manufacturing plate glasses and glass fibers			15	400	400	400	400	360	360	360
Drying furnace			16	250	250	250	250	230	230	230
Waste incinerator (continuous type)		40 and above	12	300	300	300	250	250	250	250
Waste incinerator (continuous type)		less than 40	12	300	300	300	300	250	250	250
Nitric acid production facility			Os	200	200	200	200	200	200	200
Coke oven (excluding Otto type)		100 and above	7	350	350	200	170	170	170	170
Coke oven (excluding Otto type)		less than 100	7	350	350	350	170	170	170	170

Notes : 1. Reference to unit, the symbol "~" means "and above/less than" : e. g. a~b means a and above/less than b.

2. NOx emission concentration shall be converted through the following equation

$$C = \frac{21 - On}{21 - Os} \times Cs$$

C : Nitrogen oxides emission concentration
On : Oxygen concentration in flue gas (set values in the above table)
Os : Actual oxygen concentration in flue gas
Cs : Actual nitrogen oxides emission concentration

Table 12.5-10 Examples of the Emission Standard for Soot and Dust (Japan)

(Unit : g/Nm^3)

<table>
<tr><th colspan="2" rowspan="2">Name of facility (excerpt)</th><th colspan="12">Ordinary emission standard</th><th colspan="12">Special emission standard</th><th rowspan="2">On</th></tr>
<tr><th colspan="6">Large scale</th><th colspan="6">Small scale</th><th colspan="6">Large scale</th><th colspan="6">Small scale</th></tr>
<tr><td rowspan="3">Boilers</td><td>Gas</td><td colspan="6">0.05</td><td colspan="6">0.10</td><td colspan="6">0.03</td><td colspan="6">0.05</td><td>5</td></tr>
<tr><td>Oil</td><td colspan="3">0.05</td><td colspan="3">0.15</td><td colspan="3">0.25</td><td colspan="3">0.30</td><td colspan="3">0.04</td><td colspan="3">0.05</td><td colspan="3">0.15</td><td colspan="3">0.15</td><td>4</td></tr>
<tr><td>Coal</td><td colspan="4">0.10</td><td colspan="4">0.20</td><td colspan="4">0.30</td><td colspan="4">0.05</td><td colspan="4">0.10</td><td colspan="4">0.15</td><td>6</td></tr>
<tr><td colspan="2">Gas generating furnace</td><td colspan="12">0.05</td><td colspan="12">0.03</td><td>7</td></tr>
<tr><td colspan="2">Blast furnace</td><td colspan="12">0.05</td><td colspan="12">0.03</td><td>Os</td></tr>
<tr><td colspan="2">Cement kiln</td><td colspan="12">0.10</td><td colspan="12">0.05</td><td>10</td></tr>
<tr><td colspan="2">Waste incinerator</td><td colspan="6">0.15</td><td colspan="6">0.50</td><td colspan="6">0.08</td><td colspan="6">0.15</td><td>12</td></tr>
<tr><td colspan="2">Coke oven</td><td colspan="12">0.15</td><td colspan="12">0.10</td><td>7</td></tr>
</table>

Notes :
1. Prefectures may, by decree, set more stringent standards.
2. The gas emission rate of 40,000 Nm^3/h is the criterion used for scale classification. However, heavy oil boilers and coal boilers are classified into four and three scales respectively. The criteria for the former ones are 200,000 Nm^3/h, 40,000 Nm^3/h, and 10,000 Nm^3/h, 200,000 Nm^3/h and 40,000 Nm^3/h are for the latter ones.
3. The emission concentration shall be converted through the following equation. (except in the case of blast furnace).

$$C = \frac{21 - On}{21 - Os} \times Cs$$

C : Soot and dust emission concentration
On : Oxygen concentration in flue gas (set values in the above table)
Os : Actual oxygen concentration in flue gas
Cs : Actual soot and dust emission concentration

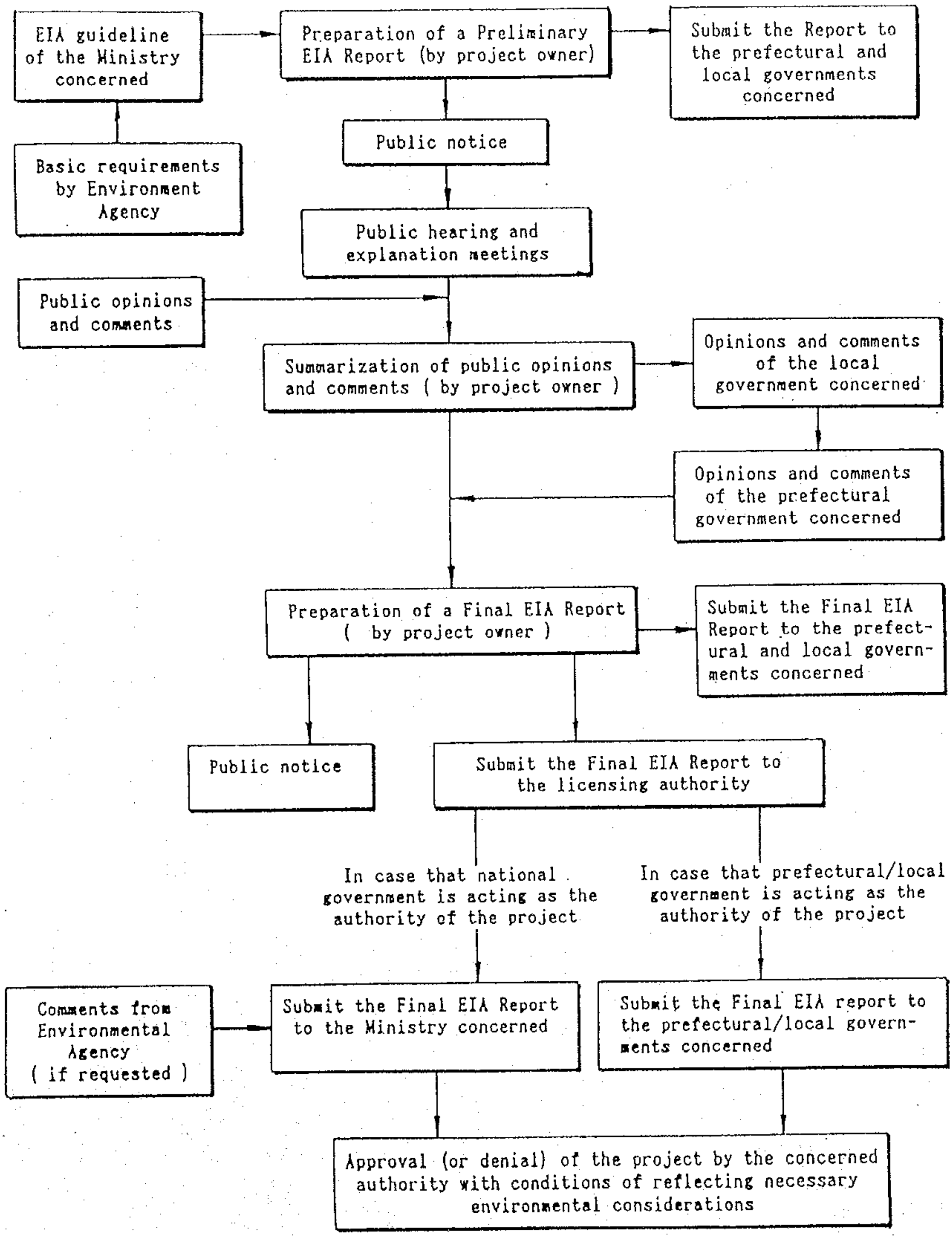


Figure 12.5-1 Licensing Procedure of Implementing an EIA in Japan
(based on the Cabinet Decision of August 1984)

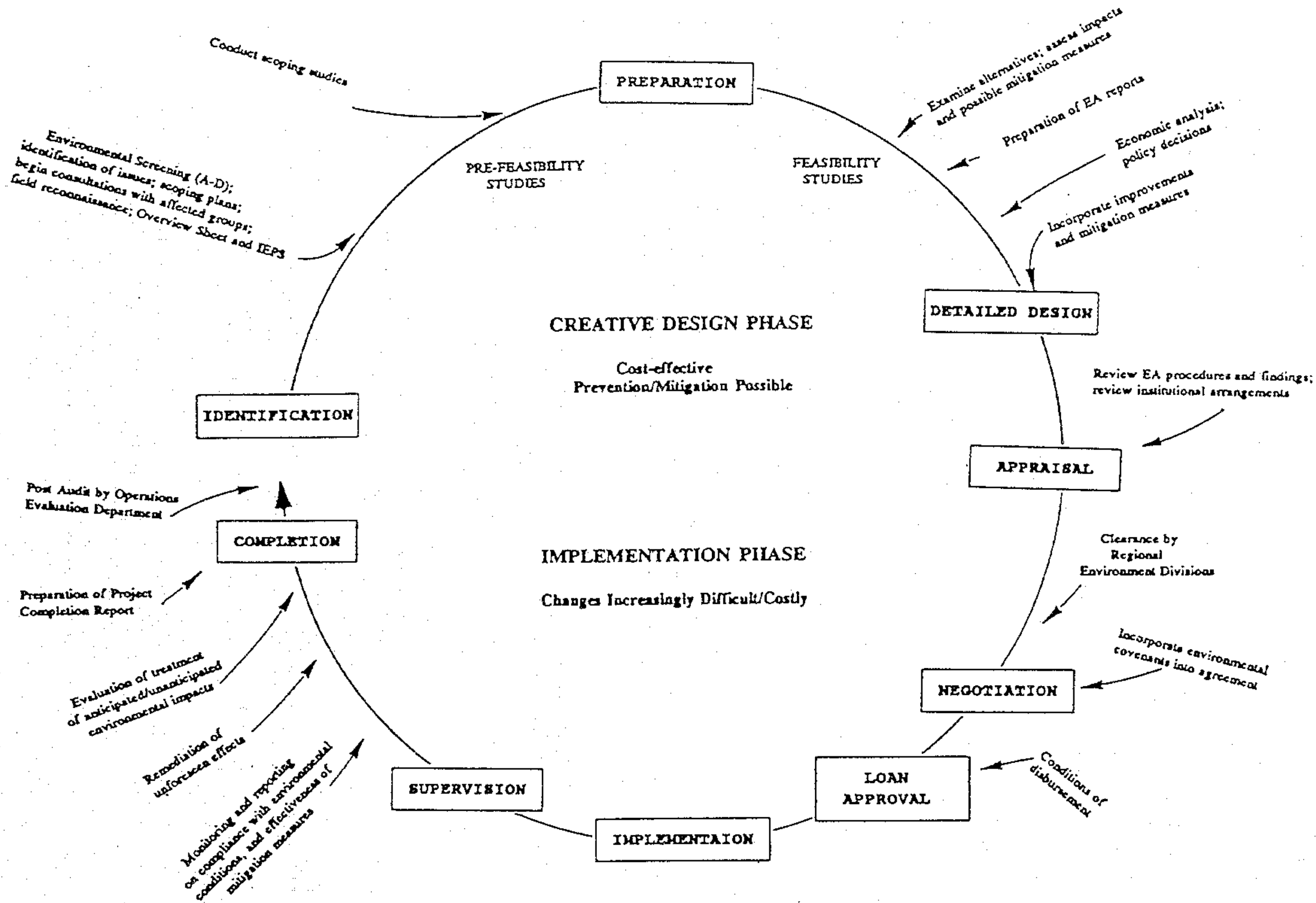
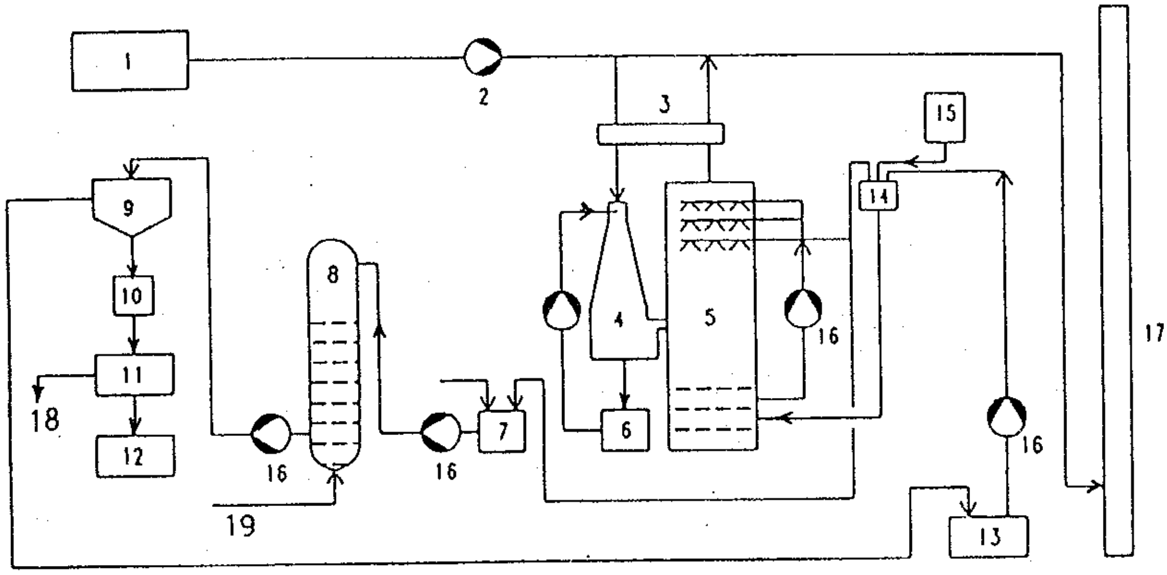
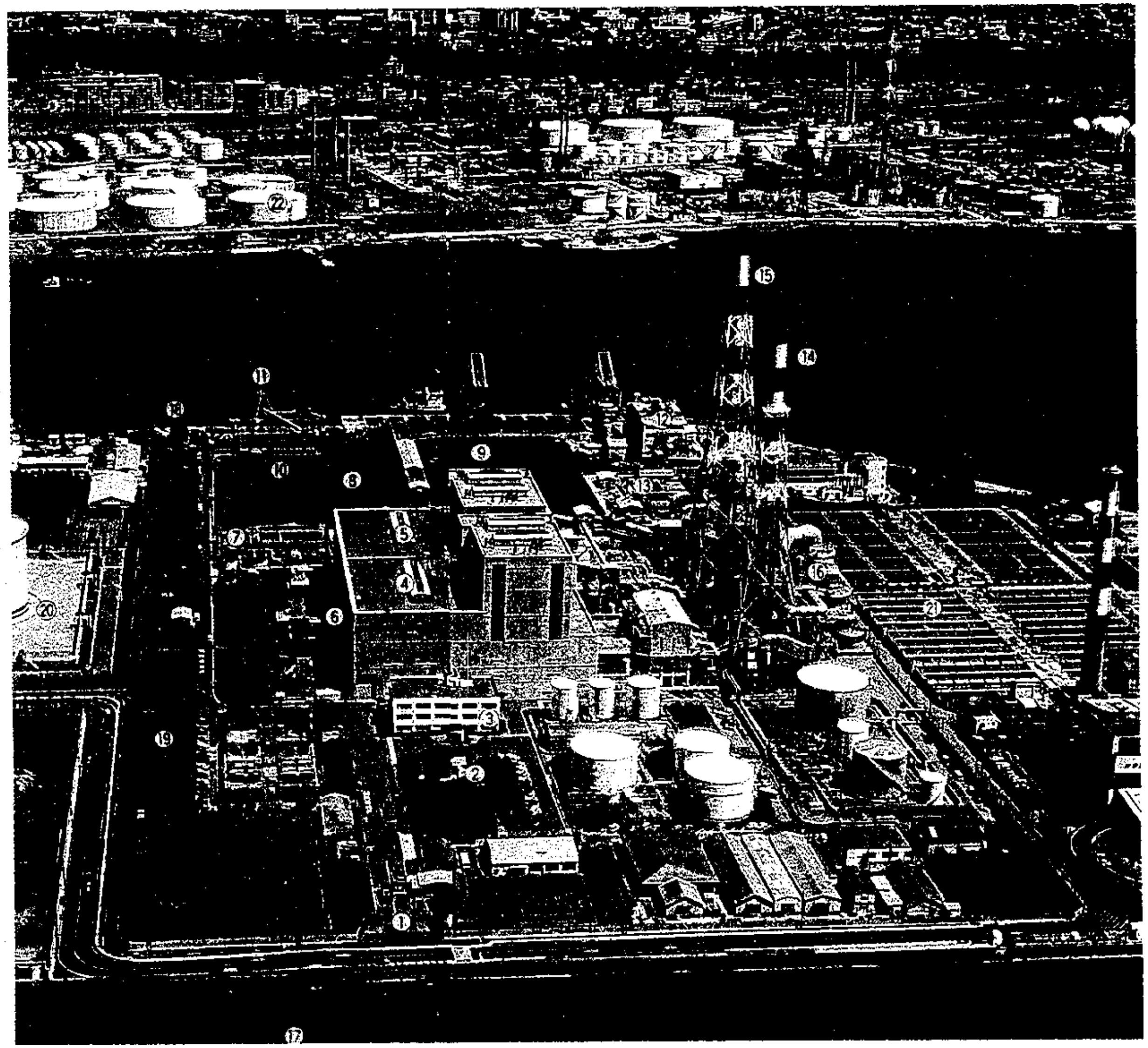


Figure 12.5-2 Envronmental Assessment Activities in a Project Cycle
(Source : EA Sourcebook of the World Bank)



1. Flue gas source
2. Blower
3. Gas to gas heater
4. Pre-scrubber
5. Absorption tower
6. Recirculation tank
7. pH adjusting tank
8. Oxidation tower
9. Sedimenting tank
10. Gypsum slurry
11. Centrifugal separater
12. Disposal tank
13. Returned water
14. Limestone slurry
15. Limestone powder silo
16. Pump
17. Flue gas stack
18. Produced gypsum
19. Air

Figure 12.5-3 Schematic Flow Diagram of a Limestone-gypsum Process for Flue Gas Desulfurization



1. Power station gate
2. Green hall
3. Service Building
4. Power plant unit No.1 (265 Mwe)
5. Power plant unit No.2 (265 Mwe)
6. Main transformer
7. Intefrated waste water treatment system
8. Coal stock yard
9. Coal unloading facility
10. Gypsum storage house
11. Gypsum loading facility
12. Fertilizer plant
13. Fly ash sedimentation pond
14. Flue gas stack(Unit 1: 120m)
15. Flue gas stack(Unit 2: 140m)
16. Flue gas desulfurization system (Two units)
17. Cooling water intake
18. Cooling water discharge
19. Green belt
20. TEPCO LNG thermal power plant
21. Sewerage treatment system of Yokohama City
22. Nisseki oil refinery plant

Figure 12.5-4 Picture of an EPDC's Coal-fired Thermal Power Plant

Figure 12.5-5 The Sceney of the Water Reduction Area at the Point Right after the Spillway of Tri An Hydropower Reservoir

(July 1994)

Figure 12.5-6 The Scenery of the Water Reduction Area at about 2 km Downstream Side of the Spillway of Tri An Hydropower Reservoir (July 1994)

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