ENVIRONMENTAL AND HEALTH IMPACT ASSESSMENT

The common characteristic of most of the nations of the developing world is the determination to improve the lot of its citizenry. In essentially all cases the pathway is that of development, especially industrial development, in order to achieve greater independence and freedom from the extreme fluctuations in the prices of basic commodities. This remains true even in an era when "biggest" is no longer necessarily regarded as "best" and more attention is being paid to appropriate technologies rather than exclusively the most advanced technologies.

Industrial development brings with it many benefits. It can also bring problems. While it has long been recognized that health influences development, the recognition that development can influence health--sometimes adversely--is more recent.

Assuming that development continues to be regarded as a desirable goal, the question becomes how can development be pursued with a maximum of benefits and a minimum of adverse effects. Unfortunately, we have many examples of how projects, including those of a most laudable nature, can produce serious adverse effects. Some could not have been foreseen. Some could almost certainly have been discerned or predicted with more exhaustive consideration of all aspects of the project.

The impact of the Aswan High Dam in Egypt has been well documented. Whatever benefits may be accruing from the admittedly magnificent engineering achievement, it has also resulted in a serious extension of the schistosomiasis problem and reduced food production in the Nile Delta. In the Sahel drought of the recent past, we can now see the adverse consequences of extending good water supplies to rural areas--one of the most basic and broadly accepted publ· health measures--and the imposition of programs for the control of animal diseases. Yet both of the improvements made major contribution to desertification in the sub-Sahara region.

It is now generally accepted that the health and environmental consequences of industrial development should receive at least as much consideration as the economic results. This was institutionalized as a requirement in the United States of America by the enactment of the National Environmental Policy Act of 1969. However, the mandate for what has become known as the "Environmental Impact Statement" was included in a very few sentences, requiring that the environmental impact be stated for actions significantly affecting the quality of the human environment. The question of how to do this, and what significant meant, was left undefined. Not unexpectedly, this engendered a substantial amount of confusion, but over the years a functional mechanism for the conduct of environmental impact assessments has evolved. It is the purpose of this paper to describe just what a health and environmental impact assessment of a development project should consider.

A necessary beginning in this discussion is the statement that an environmental impact assessment should be done only where there is an expectation that a "significant" impact on the environment may be produced by the proposed project. The term "significant" obviously lacks precise definition, but it can be said that a small project probably does not justify a major environmental impact analysis unless it is immediately obvious that an impact may result.

The intent of an environmental impact assessment may be summarized as being:

a) the prediction, insofar as possible, of the effects of a project, considering all of the effects on the air, aquatic, human, socioeconomic and other environments. Not all projects will be of sufficient scope to have major effects in all spheres, but all must be considered before a judgment can be rendered that a particular impact can be ignored.

b) the development of a monitoring and surveillance system to measure changes so as to avoid the development of adverse consequences of the project. Again, the monitoring system must be appropriate to all of the affected environments.

The requirement that a properly done environmental impact evaluation enables the detection of subtle changes dictates the third element of a comprehensive environmental impact assessment:

c) definition and characterization of all key elements of the environment prior to initiation of the project. This baseline definition does not apply only to "virgin" environments. Rather it must be done for any environment which has not already been characterized as a means of following the impact of the new project for which the environmental impact assessment is being conducted.

Given the purposes of an environmental impact study, it should be clear that the study cannot be regarded as an end unto itself or a single task with a defined end point, but rather as the beginning of a continuous process of monitoring environmental quality.

In terms of time sequence, the major elements of an environmental impact study are:

1. the baseline definition

2. the prediction of the impact of the project, broken into the two phases: a) the construction phase, and b) the operational phase

3. environmental monitoring and surveillance after project initiation.

1. <u>Baseline Definition</u>

The key environments should be identified and quantified. This process must be started well in advance of project initiation because it is necessary to make measurements over a period of time sufficient to discern natural variation and cycles, or variations induced by other influences. For natural systems, a minimum measurement time is one year; longer is desirable.

A. <u>Terrestrial environments</u>. These must be characterized and quantified in the following critical subsystems:

a) Animals. Trapping should be done to measure species diversity, population density, reproductive cycle, age composition, ectoparasite burdens, biomass, etc. Emphasis should be placed on those animals judged to be most significant.

b) Vegetation. Plant communities should be quantified, including grasses, shrubs and trees, based on measurements of coverage and canopy. For the purposes of future environmental measurements, "typical" community plots should be identified, designated and quantified, and reference markers be placed for future use. Again, the most significant species should be identified if possible.

c) Insects. Any economically important insects, such as pollinating bees should be identified and quantified, as well as disease vectors.

d) Endangered species. Any endangered species should be identified, especially in terms of critical habitats.

B. Aquatic environments. Any aquatic systems potentially impacted by the project should be identified and quantified. This covers both marine and fresh water systems. Key characteristics of the systems should be measured, including the following:

a) Chemical properties. Measurements should cover at least salinity, pH, BOD, COD, toxic metals (Pb, Cd, Hg, Mn and others which might be released from the candidate project), hydrocarbons, chlorinated hydrocarbons, and any special materials deemed pertinent. Bioconcentration possibilities should be considered.

b) Physical properties. Measurements should cover at least temperature, turbidity, suspended solids.

c) Biological properties. A comprehensive survey of plankton, fish and benthic organisms should be conducted, identifying key species and population densities, as well as total biomass. To the extent possible, species judged to be sensitive should be characterized in terms of a property such as reproductive efficiency for possible use as an indicator of subtle future changes.

In addition to the foregoing characterization of surface waters, any significant ground waters should be located and characterized, with emphasis on those aquifers which might serve as sources of potable water.

C. Atmospheric environment. The air environment in vicinity of the proposed project should be thoroughly characterized. Major concerns include the following:

a) Meteorology. Meteorologic parameters should be quantified including the wind rose, temperature, precipitation, inversion heights and frequency of occurrence, stagnation episodes, etc.

b) Air chemistry. Measurements of air pollutants should be made, including particulates, sulfur dioxide, sulfuric acid, oxidants, and any air contaminant recognized as toxic. Emphasis should be placed on those materials that might be expected to be released by the proposed project.

D. Human environments. The characteristics and quality of human life in the area of the proposed project should be defined, with consideration of the following elements:

a) demographic characteristics

b) health status

c) services, including water supply, sewage, schools, transportation, health care, etc.

d) recreational amenities

e) touristic amenities

f) economics

II. Environmental Impact Assessment

The estimation of potential effects of the proposed project may conveniently be divided into two phases: a) the construction phase and b) the operational phase.

A. Construction Phase. Major concerns during the limited construction phase requiring consideration are the following:

a) Disruption and or displacement of local populations.

b) Air quality degradation engendered by heavy vehicular traffic, construction and mobile equipment engine emissions, construction-induced debris.

c) Effects of the influx of large numbers of construction workers and possible overload on services such as water supply, sewage, police, schools, etc.

d) Water quality degradation produced by construction-related siltation of rivers and other aquatic systems.

e) Overload of medical and other health care facilities due to high accident rates during construction phase.

f) Possible loss of access to recreational and touristic amenities due to construction activities.

g) Possible adverse effects on non-human biological systems, such as disruption of bird nesting because of construction noise, impacts on fish and other aquatic organisms because of siltation, etc.

B. Operational Phase. The key concerns associated with the long-term operation of the project include the following:

a) Effects on air quality. Detailed consideration must be given to the emissions, both point source and fugitive, that may be expected from the process units. Both normal operating and upset conditions must receive due consideration. Special emphasis must be accorded to any toxic materials that may be emitted, especially suspect mutagens and/or carcinogens. In the event that such materials are involved in the proposed project, detailed toxicologic information must be available and evaluated. Where toxic discharges may occur a disaster plan should be prepared, including a dispersion model for a release to the air predicting how a "cloud" might move based on the amount released and the full range of meteorologic possibilities

b) Effects on water quality. Any discharges to aquatic systems must be defined in terms of both quantities and qualities. Chemical and physical properties of effluents should be quantified and controls established to limit discharges, both normal and upset. All waste waters must be considered, including process waters, cooling waters and site runoff from rain.

If toxic chemicals are produced or stored, a spill prevention and control plan should be developed and implemented if there is any possibility that an accidental or other release would result in the entry of the chemical to an aquatic system.

c) Effects on weather. If the project is such as to result in the release to the atmosphere of large amounts of particulates or acidic gases, possible effects on climate may require consideration. Such effects might be the production of acidic rains from releases of large amounts of acidic gases, induction of rain with large particulate discharges, etc.

d) Effects on the human environment. Consideration must be given to any potential changes to the human environment by virtue of long-term operation of the proposed project. Such alterations might include:

1) Drastic changes in population without concomitant changes in services such as police, fire, medical care facilities, water supply, schools, sanitary services, etc.

2) Significant overloading of human services.

3) Any changes in environmental elements that might influence human health, with special consideration to highly toxic materials introduced.

4) Production of occupational disease problems.

5) Drastic changes in the economic situation that might make it more sensitive to changes and upsets.

6) Changes in the availability of access to recreational amenities.

7) Drastic increases in vehicular traffic.

Historically, environmental impact assessments have accorded more attention to the non-human environment than to questions of impacts on human health. With the perspective provided by experience with materials

III. Monitoring and Surveillance

Given a determination that the environment has been adequately characterized and quantified, and the judgment that the project is acceptable in terms of health and environmental effects, it is necessary to design the long-term monitoring and surveillance programs. The primary objective of these programs is to assure that environmental and health impacts remain acceptable, i.e., to confirm the predictions, but especially to detect any unexpected impacts before they become serious. It must be stressed that acceptability does not mean zero impact; it requires that any effects produced will be acceptable or "safe."

Depending on the nature of the project, surveillance may be required in the following areas.

a) Epidemiologic evaluation to detect the appearance of any new patterns of morbidity or mortality that may be associated with the project operation.

b) Air quality monitoring, encompassing both measurement of emissions and ambient air quality to assure the maintenance of satisfactory air quality

c) Water quality monitoring, involving both discharges and the receiving waters, to assure the maintenance of water quality satisfactory for the intended use.

d) As part of monitoring programs, a permit system for air emissions, water discharges, water use and land use may be required and instituted. In such a case, compliance with permits will have to be monitored and enforced.

e) Monitoring of terrestrial and aquatic ecosystems for change.

It must be recognized that few major industrial projects remain static for very long. Changes in raw materials, processes, products and waste handling practices almost certainly will occur. These changes must be monitored, and an environmental impact assessment should be required for any change in the plant that portends a significant effect on the environment.

IV. Amelioration of Adverse Environmental Effects

A detailed analysis of the environment in which the project is to be located and the project itself may well disclose one or more adverse effects. The impact assessment should deal with the issue of how these effects are to be dealt with. Again, the issue is not to guarantee against impact--which is almost certainly impossible--but rather to show how the management process will keep change within acceptable levels.

The foregoing discussion should make it clear that an environmental impact assessment is a formidable undertaking, formidable in terms of the range of skills required and in the costs involved. Depending on the nature of the project being evaluated, expertise in areas such as biology, chemistry, meteorology, environmental sciences, chemical engineering, ecology, toxicology, industrial hygiene, epidemiology, sociology, anthropology, economics, systems analysis, and many others, may be required. An environmental impact study of a potential project of even a moderate scope and complexity may cost hundreds of thousands or millions of dollars. It does not seem unreasonable to suggest that a comprehensive environmental impact assessment may be beyond the capabilities, either technological or economic or both, of many of the developing countries of the world.

Nonetheless, the health and environmental consequences of development must be considered. Recent history has taught that this is an imperative if our Planet Earth is to survive. Consequently, the methodology for the conduct of environmental impact assessments is an important area of technology transfer from those areas of our world in which such activities have been highly developed to those areas of the world where they are needed.

Attached is an outline for a comprehensive course on health and environmental impact assessment of industrial development projects. For reasons previously noted, the emphasis on health is rather greater than has historically been the case for conventional environmental impact assessments. The course content includes the concept of risk assessment, which must be acknowledged to be an emerging technique, but an imperative consideration in cases where the proposed project involves cytotoxic chemicals. While we cannot claim to have, to this point, developed methodologies for truly quantifying risk, we at least have approaches to conservative estimation of risks. Surely where public health is concerned, conservative estimation is the only acceptable approach.

The material outlined in the attachment can be arranged and adjusted for three basic types of courses, courses "customized" to the needs and responsibilities of three general types of audiences:

1. A course for people who have the responsibility for the review of environmental impact assessments and the issuance of terms of reference and permits for the proposed action. This will presumably involve primarily government technical officers who must evaluate the appropriateness and adequacy of an assessment report but not necessarily require detailed knowledge of methodologies employed in the assessment.

Obviously this matter requires a great deal more detailed planning. Each course would almost be a "customized" treatment of the basic material. Further, careful thought should be given to obtaining literature resources that would be made available to the student groups in advance of each course, where the students would be strongly encouraged to study prior to course initiation.

Inasmuch as this course was designed primarily for the public sector, consideration is also given to legislative and regulatory matters. Many countries have a very limited legislative framework relating to health and environmental matters. In other countries, the legislative base may be comprehensive, sometimes too much so. Obviously the legislative and regulatory issues must be addressed if control and management are the objectives.

Clearly, environmental and health considerations must be part of the evaluation of any industrial development project. The only possible questions concern how formal and how comprehensive the evaluation shall be. Training in accordance with this proposal will afford many benefits, including:

1. Planning the assessment to stress elements of key concern and deemphasizing (or ignoring) those of limited significance. This will assure a study that deals with the key issues at the lowest possible cost.

2. Conducting the assessment with the most appropriate, methodologically correct and cost effective techniques and procedures.

3. Enabling sound review of an assessment by cognizant public authorities to detect both inadequacies and inaccuracies.

ATTACHMENT

Health and Environmental Impact Assessment of

Industrial Development Projects

A Course Outline

I. Introduction
   1. Historical development of assessment policies and processes
   2. Review and evaluation of current trends and practices in assessments
      A. National programs
      B. International programs
      C. Requirements of international funding agencies

II. Description of the proposed development project or action
   1. Definition of the process(es) and requirements
      A. Raw materials
      B. Intermediates
      C. Products (including impurities/contaminants)
      D. Physical process elements (heat, refrigeration, catalysts, etc.)
      E. Effluents
         a. Air contaminants
         b. Water contaminants
         c. Heat
         d. Noise
      F. Review of previous experience with similar projects (emphasizing discovered hazards).

III. Description of the existing environment (Baseline Definition)
   1. Physiographic features, measurement and description
      A. Topography (emphasizing influence on effluent flow, accumulation of air pollutants, etc.)
      B. Geology
      C. Climatology (emphasizing meteorologic influence on air pollution, flooding, etc.)
      D. Hydrology (emphasizing contamination of aquifers)
   2. Environmental quality definition and quantification
      A. Ambient air quality
      B. Water quality
      C. Land use
      D. Noise level
   3 Definition of ecological systems and resources
      A. Description of the terrestrial environment
         a. Floral resources, description and quantification
         b. Faunal resources, description and quantification
         c. Description of critical, threatened and endangered species

B. Description of the aquatic environment
 a. Physical description (current, tides, etc.)
 b. Description and quantification of aquatic fauna
 i. Pelagic organisms
 ii. Sessile organisms
 iii. Benthic organisms
 iv. Identification of food resources and critical systems
 c. Measurement of water quality
 i. Water chemistry
 ii. System productivity
 iii. Thermal factors
C. Other significant ecology resources and systems

4. Human resources
 A. Demographics (population, growth rate, age structure, migration)
 B. Health status
 a. Morbidity and mortality statistics
 b. Identification of environmentally related disease
 i. Infectious diseases with environmental vectors
 ii. Chemical exposure-related diseases (pollution, pesticides, etc.)

5. Socioeconomic resources
 A. Employment patterns
 B. Assessment of economic conditions
 C. Definition of housing quality
 D. Definition of quality and quantity of public services and recreational amentities
 F. Consideration of historic and archeologic values

IV. Land use planning, principles and procedures
 1. Industrial zoning and restrictions

V. Possible environmental and health effects of the proposed project or action (considering both construction and operating phases of the project)
 1. Impacts on air quality
 A Enmissions inventory (point, nonpoint and fugitive)
 B. Estimation of atmospheric air contaminant dispersion
 C. Estimation of human health effects based on ambient air quality criteria and standards
 D. Estimation of other effects (agricultural, material, esthetic, etc.)
 2. Effects on water quality
 A. Discharge inventory
 B. Estimation of impact on surface water quality
 C. Estimation of impact on ground water quality
 D. Estimation of health impacts
 a. Potable water
 b. Nonpotable water
 c. Food web penetration and bioconcentration
 E. Estimation of impacts on irrigation water quality

3 Effects on noise environment
4 Effects of radiation, ionizing and nonionizing
5. Effects on socioeconomic systems
   A. Population shifts
   B. Economic and cultural impacts
   C. Overloading of services
      a. Health/medical resources and delivery systems
      b Transportation facilities and systems
      c. Schools
      d. Water and waste disposal facilities
      e. Fire and police
6. Effects on ecologic resources and systems
   A. Biotic environment
      a. Terrestrial ecosystems
      b. Aquatic ecosystems
   B. Abiotic environment
      a. Weather and climatic change
7. Effects on human health and welfare
   A. Occupational setting
      a. Definition and evaluation of occupational toxicants
         i Irritants - respiratory and dermal
         ii. Systemic toxicants
         iii. Cytotoxic agents
      b. Risk estimation associated with toxicant exposures
      c. Engineering and operational risk reduction
   B. Community setting
      a. Definition of community contact with plant effluents
         i. Air
         ii. Water
         iii. Noise
         iv. Food
      b. Estimation of risk to the community
      c. Alleviation/mitigation of risk to the community
      d. Incidental risks
         i Population dislocation
         ii. New disease contacts
   C Quantification of human health risks and establishment of environmental quality standards
      a. Estimation of chemical intoxication risks
         i. In-vitro assays and significance
         ii Animal bioassays and significance
         iii. Human data
      b. Risk estimation
         i. Occupational exposures
         ii. Community exposures
      c. Standards for the protection of human health
         i. Occupational standards
         ii. Community standards
         iii Emergency standards
      d. Disposal of toxic wastes
      e. Surveillance techniques