CONCEPT PAPER
DEVELOPING AN AIR POLLUTION ENVIRONMENTAL PROGRAM FOR EGYPT

I. Introduction

The basic objective of an air pollution control program is to preserve the health and welfare of man, both now and in the distant future. Other objectives include the protection of plant and animal life, prevention of damage to physical property and interference with its normal use and enjoyment, and maintenance of an aesthetically pleasing and enjoyable environment. While these may seem to be lofty goals and often judged antithetical to economic growth and industrial development, many years of experience in industrialized nations has revealed that national environmental goals and economic well-being can be partners with benefits to all. Essentially the same description could be written for liquid effluents. However, only air pollution is addressed in this paper.

The purpose of this concept paper is to describe how the task of cleaning the Egyptian environment might be addressed. It briefly describes the nature of air pollution and its effects on man, vegetation and the artefacts man creates. The nature of the air pollution in Egypt is then described, first in general terms and then as specific problems related to the industrialization of the nation. Finally, alternative solutions are proposed involving short- and long-term goals along with approximate budgets for short-term projects with which the Egyptian government and people can indicate their resolve to begin to deal with their air pollution problem.

II. Problem Statement

A. What Are Air Pollutants and Why Control Them?

Although there are a large number of substances which, when present in even small quantities can prove to be hazardous to health in the extreme case, they can also be just plain nuisances to man and property, for example, materials which smell bad or reduce visibility or soil buildings and monuments. Almost all industrial sources of pollutants produce particulates, sulfur and nitrogen oxides (SOx, NOx) from fuel combustion for manufacturing operations, including electricity generation. Some manufacturing operations, such as the production of chemicals or the refining of oil, add other materials, such as nitric and sulfuric acids, hydrogen sulfide, and a host of other chemicals. Automobile transportation adds carbon monoxide (CO), hydrocarbons, lead and even more particulates and NOx to the list.

Particulates, whatever the source and composition, can cause respiratory problems (bronchitis, asthma, emphysema, pneumonia) and cardiac disease, particularly if they are sufficiently small (between about 0.1 to 3 micrometers). Larger particles soil the environment and corrode and erode materials. Small particles can be transported long distances by local winds and contribute to atmospheric haze and enhance naturally occurring fog, when present in sufficient quantities.

Sulfur oxides are emitted mostly as SO2 mainly from the combustion of fuels. SO2 is rather quickly oxidized to SO3 and then forms H2S> (sulfuric acid) in the presence water vapor. At concentrations as low as 0.1 ppm, SO2 can be tasted and some bronchial constriction occurs at about 1 ppm. Above 10 ppm, eye, nose and throat irritation occurs. Exposure to sulfur oxides for one year at levels as low as 0.02 ppm can cause morbidity in man, severely injure plant life by causing the loss of chlorophyll, and corrode materials.

Nitrogen oxides are emitted primarily as nitric oxide (NO) and converted to nitrogen dioxide (NO2) by oxidation in the atmosphere. NOx is generally not considered a hazardous substance but by reacting with volatile organic compounds in the air can produce ozone and peroxyacety nitrate (PAN) which are severe eye, nose and throat irritants. Severe coughing is induced at concentrations as low as 2 ppm. NOx can injure vegetation at concentration ranges of 2 to 10 ppm and can retard growth after prolonged contact at 0.5 ppm.

Carbon monoxide (CO) is one of the principal emittants of engine fuel combustion and is, of course, needed by plant life for growth. However, its affect on humans is severe, preventing oxygen transfer to hemoglobin.

Depending on the concentration and length of exposure, its effects can range from headaches to nausea to death.

Little need be said about the toxic effects of lead especially in children. Its almost sole source is from tetraethyl lead used as an anti-knock octane improver in auto fuels. The United States has required the phasing out of lead additives in fuels in favor of higher octane reformed benzene with no impairment of autoperformance. Lead in paints have also been banned in favor of titanium oxide as a white color agent.

These descriptions are not specific to Egyptian pollutants but are universally acknowledged throughout the civilized world as being so inimical to human, animal and plant life as to deserve special attention to prevent the deterioration of air quality. Egypt, however, does not seem to share a healthy fear of these and other substances, when present in life threatening amounts. This is the central argument for an affirmative air pollution abatement program.

B. The Egyptian Environmental Problem

Virtually all industrialized nations have gone through an initial phase of unconstrained economic growth with no concern for the adverse environmental conditions such growth brings. Egypt is no different than any other nation, in this respect. However, the rapid rate of industrialization, coupled with some naturally occurring conditions in Egypt, have intensified its current pollution problems. For example, Egypt's usable land area is restricted by desert and most of its people live in just a few centralized urban locations, principally along the Nile. Industrial plants are located near these population centers to ensure a labor supply and good transportation services with which to receive raw materials and to ship finished products. The result is a heavy concentration of industry and population in a small region of the country causing greater local pollution problems than if population and industry were more evenly distributed.

In its current state, Egypt's major industries are uninhibited polluters. Everyone talks about pollution but no one does anything about it. The few laws promulgated are weak, disjointed and unenforced. There are no objective goals, either short- or long-range, for cleaning the environment. Not only is the current state of air pollution a hazard to the general population and the workforce, it is nearing the condition where industrial growth could be forced to contract because of the danger and fear of yet more pollution.

C. Specific Air Pollution Source Problems in Egypt

Quantifying the extent of the air pollution problem in Egypt is difficult; there are virtually no data on emissions except in rare cases, no industrial plant emission measurements are made, no industry-wide data available. It is not difficult, however, to identify plants, processes, and industries that are the major contributors to Egypt's air pollution problems; they are the same as in any other industrialized nation. They include, among others, cement producers, metallurgical plants including iron and steel mills, chemical plants, petroleum refineries and electricity generation and, of course, pollution produced by automobile transportation. The latter category clearly differs from the others in that no manufacturing is involved. However, it is universally acknowledged that automobiles contribute seriously to air pollution in heavily populated areas which directly impacts on the quality of urban life in almost the same manner as emissions from heavy manufacturing operations.

Many plants in these industrial areas, when initially built, may have had air pollution control devices installed, but all too often maintenance has been so poor that most are not working today and there is no indication that plant management is at all interested in getting them to work. These include, for example, cement plants and chemical plants. In other cases, no pollution control devices were ever installed either because they were expensive (steel mills), traditionally never used in other nations for similar processes, or assumed not needed (electricity generation). For whatever the reason, industrial and automobile transportation air emissions are seriously out of control. Some specifics of the air pollution problem in selected Egyptian industrial areas follow.

1. Cement Manufacture

Some 7 cement manufacturing facilities in Egypt producing a total of 13.25 million tonnes of product in 1988 were surveyed for air pollution emissions. Design capacity for these plants totals 19.54 million tonnes/year (67.8% occupancy level in 1988). Although many of these plants contain emission control equipment, most are not functioning or are so poorly maintained as to be virtually useless. A single exception appears to be the Suez Cement Co. where dust emissions from operations are reportedly well controlled with well cared for emission control systems. The bulk of the other plants present serious emission problems due to both fuel burning and process sources.

The largest emission source in cement manufacture is the kiln with lesser amounts from grinders, driers and material handling. Emissions consist of combustion products (particulates, some SO_x and NO_x) and process dust, consisting mainly of alkalies (CaO, MgO) and CO_2 from calcination. Alkali emission is particularly serious since it affects the growth of vegetation in the vicinity of dust fall. The emission survey indicates that some 9 million tonnes per year of process dusts are emitted from these plants.

To give some perspective to the problem of process particulate emissions, consider that the Tourah plant, in the Helwan area, dumps in excess of 1,000 tonnes of dust each day to the southwest in the direction of Tebbin (assuming that the emissions estimated from this plant are reasonably correct). To this amount of dust fall must be added the dust emitted from Helwan Cement to the north of Tourah. Dust emissions from both plants are clearly visible as dense black stack plumes. A 99.3% reduction of process emissions at Tourah (Japanese standard) would reduce this emission to about 6.5 tonnes/day, still high but acceptable, compared with present emissions.

Cement operations invariably recycle captured dust from emission control devices thereby conserving raw materials as well as conserving energy because the dust is completely calcined. Care must be taken in recycling, however, so that the alkalinity of the kiln materials does not exceed standards set for high quality cement. This is a local problem and depends largely on the composition of raw materials used at each plant.

2. Electricity Generation

Installed electrical generating capacity in Egypt has grown at a compound annual rate of 11.8 % during the 5 year period 1982-1987. Hydroelectric power growth shows a modest 2.3 % compound growth rate, during this period, while generation from thermal energy sources, using steam-electric power plants and turbines, has grown at a compound annual rate of 18.3%. Hydroelectric generation is static and future growth will require increasing fuel burning facilities. Expansion of generating capacity using fuel combustion is not without its penalties however. The price in this case is the usual pollution caused by the combustion of fuels, namely emissions of particulates, sulfur oxides and nitrogen oxides at generating sites.

The pattern of emissions due to the generation of electricity from thermal sources was estimated for the period 1982-1987. Pollutant emission data developed was for the entire nation; individual generating station emissions are not known. Because of the increase in natural gas firing, emissions of particulates and SOx appear to be decreasing with increasing electricity generation. Natural gas is a clean-burning fuel virtually free of particulates and SOx emissions. NOx emissions are independent of the nature of the fuel fired but depend mainly on boiler design. Also contributing to reduced emissions is the rapidly improving efficiency of electricity generation from 24.7% in 1982 to 30.7 % in 1987. The less fuel burned to produce electricity, the less pollution there is for the same level of production.

The overall results of an emission survey for this industry are rather surprising, at least to anyone who is accustomed to the emission pattern in nations in which electricity generation is heavily dependent on base load plants burning coal. In 1987 annual emissions of particulates were about 4.5 million kg, 263 million kg of SOx and 47 million kg of NOx for all plants in this sector. With the exception of SOx emissions, both particulates and NOx emissions in Egypt are marginally larger than one finds in the United States for mainly coal fired power stations with emission control systems installed. The reason for this is that coal is an extremely dirty fuel producing large amounts of SOx, due to fuel sulfur, and flyash, as well as NOx. In order to control pollutants from coal burning electric plants, industrial nations have had to legislate strong restrictions on emissions. The large SOx emissions in Egyptian electricity generation is due solely to the large amounts of sulfur in mazout and sollar, the principal fuels used in thermal generating stations. However,these fuels emit far less particulates than coal. Thus, based on American standards, pollutants from electricity generation are satisfactory, except for sulfur oxides.

There are three methods for decreasing SOx from generating station stacks; (1) scrub the SOx from emitted gases, (2) reduce the sulfur in the fired fuel and (3) switch to a less polluting fuel. Switching to a less polluting fuel cannot be easily done in Egypt; mazout and sollar are the only plentiful fuels except for natural gas. Although natural gas use for electricity generation is increasing, it is not recommended that it be used to displace mazout and sollar for electricity generation without an extensive analysis. This decision can only be made after a thorough study of the relative costs, availability and distribution of these fuels, and the allocation of different fuels among the many industrial sectors making up the Egyptian economy.

Scrubbing generating station stack cases is quite expensive and probably not feasible except in isolated cases where extremely large SOx emissions are produced in heavily populated areas. Such a decision will require a more detailed plant-by-plant emission survey within the generating industry coupled with an economic analysis of the costs and benefits of SOx removal by scrubbing.

The most reasonable, though still costly, method to reduce SOx emissions is to remove sulfur from fuels at the refinery. This method would have three benefits:(1) it would centralize the sulfur removal process at the source rather than require a great redundancy of control equipment where the fuels are burned, (2)petroleum refiners already have desulfurization equipment in place, and (3) there fineries can make use of the fuel sulfur removed to sell to fertilizer plants.

3. Iron and Steel Production

Estimates of the air pollution problem in this industrial area is limited by a lack of data appropriate for an emission survey. What little information was developed came from company brochures, annual reports and contact with plant managers. With data from only six plants, total particulate emissions were estimated to be 48 million kg/year of which about 81 % is from one mill, Egyptian Iron & Steel. The vast majority of the 48 million kg/year mostly comes from electric arc steel furnaces, which is the predominant steel making equipment in the industry.

An opportunity to illustrate the effect of air pollution control equipment on emissions in this industry was presented at Delta Steel where one of its 25 tonne electric arc furnaces is being revamped for greater steel making productivity. At present, Delta produces about 110,000 tonnes of steel annually and an estimate of emissions from their steel furnaces is about 506,000 kg/year. When the revamped furnace is in operation, sometime in late 1990, steel production capacity will increase to about 177,000 tonnes annually, an increase of about 61%. However, emissions from steel making will drop to about 360,500 kg/year, a decrease of about 29%, due to the fact that the revamped furnace will include a baghouse to collect dust produced by the new high productivity furnace.

4. Glass and Ceramics Manufacture

The industrial segment considered here currently consists of 12 private sector manufacturing plants producing a broad variety of glass and ceramics with a total annual production of about 300,000 tonnes of material. Emissions consist of the usual fuel combustion products (particulates, SO_x, NO_x) and process emissions of mainly glass dust. Glass emissions are estimated as a modest 530 tonnes/year. Using Japanese emission regulations for glass furnaces would require about a 50% reduction which is easily achievable. Of more serious consequence in this sector are emissions of toxic and hazardous gases due to glass production processes that use fluxing agents to impart desirable properties to ceramics. These may consist of silico-fluorides, zirconium and titanium oxides and fluorspar. Emissions from these operations are often hydrochloric and hydrofluoric acids which are harmful to both humans and vegetation. These can be controlled but requires a careful emission testing program and analysis at each specific site.

5. Automobile Transportation

It was originally the purpose in this section to estimate emissions from gasoline powered light duty (LD) and heavy duty (HD) automobiles and trucks in Cairo and Alexandria, the most heavily populated areas in Egypt. The purpose was to examine the size of estimated vehicular emissions and to compare them with emissions from heavy manufacturing industrial sources. It was, therefore, a pleasure to find that an inventory of vehicular emissions by estimation methods was not necessary. There already exists in Egypt studies which include emission measurements, aerometric emission modeling, projections of future emissions, recommended emission reductions, and recommended means of achieving these reductions in the transportation area, mainly in the Governate of Cairo and including the close by governates of Giza and Shoubra. These studies were produced under the direction of Professor Mohamed El Kotb, Executive Director, FRCU (Foreign Relations Supreme Council of Universities) at Cairo University, in collaboration with Professor Gary Borman of the University of Wisconsin.

The studies to-date are extremely impressive. The inclusion of meteorological effects on the dispersion of automotive exhaust emissions in the Cairo vicinity, the statistical analysis of data determined by a large testing program using a significant sample size of vehicles, the measurement of background pollutants from industrial plants in the same area, the instrumentation and measuring techniques used, the inclusion of demographic data for the driving population, ensure adequate projection techniques, and suggest a well organized research plan producing first-rate data.

Data provided by the Department of Transportation, shows the number of vehicles in each Egyptian governate as of 1988. In Cairo, Giza and Shoubra alone there are about 570,000 LD vehicles (personal autos, taxis), about 135,000 HD vehicles (buses, trucks) and about 135,000 motorbikes. Emissions from these types of vehicles for the year 1983 in which there were about 65% fewer LD vehicles and motorbikes in the greater Cairo area than in 1988, were developed by Professor El Kotb. It was found that emissions from automobile transportation produced about 2.1 million tons of carbon monoxide (99.9%), 265 thousand tons of hydrocarbons (99.3%), 73 thousand tons of NOx (57.4%), and 1,600 tons of lead (100%) from tetraethyl lead added to auto fuel for octane improvement. The percentages shown are estimates of these auto emissions relative to these same emitted pollutants from all sources (industrial, electricity generation, refuse burning) in the Greater Cairo area.

These numbers are startling considering the harmful effects of carbon monoxide and lead on human health. NOx and hydrocarbon emissions are very reactive in sunlight and produce photochemical smog and ozone which are both harmful to health as well as contributing to the haze one finds in the Greater Cairo area.

It is also in this area that plans and recommended regulations for abating automobile emissions have been suggested by Professor El Kotb. Emission regulations recommended are based on American standards (4.5% carbon monoxide,800 ppm hydrocarbons) and are to be achieved by 1994/1995 in a carefully regulated program of annual reductions from initial limits of 9% carbon monoxideand 1,600 ppm hydrocarbons. The emission reductions are to be based on improved engine maintenance and periodic checks at authorized emission testing centers.

III. Proposed Solution to the Air Pollution Problem

It is recommended that two programs be started simultaneously, the first, a short-term program to demonstrate to the Egyptian government, Egyptian industry and the Egyptian people, what benefits are to be realized by joint energy conservation/air pollution activities and to show that it is the intention of the government to take firm and positive action to clean the environment. The second, a long-term program for the purpose of developing a comprehensive environmental capability which will reverse the current trend of ignoring the environment and ensure future industrial growth while preserving a healthy environment.

A. Short-term Demonstration Programs

There are several sources in, or close to, Cairo that are conspicuous polluters; cement plants at Tourah and Helwan, iron and steel production at Helwan Iron and Steel, and the coking ovens at El-Nasr Coke and Chemicals, Delta Steel in Abu Zaabal, and open refuse burning in Cairo. Of these, one of the cement plants and the open burning pits could be selected as demonstration sites for pollution control. For cement, the technology already exists in Egypt for the abatement of dust in the form of well operated pollution control equipment at Suez Cement. It is only necessary to convince management at Tourah or Helwan that refurbishing existing emission control equipment, or acquiring such devices, will not interfere with their manufacturing processes and will bring benefits in the form of energy conservation (cooling off-gases in waste heat boilers prior to cleaning) and the possibility of saving raw materials (by recycling some of the collected cement dust). A short-term study of how to accomplish this, which would identify the costs involved and the precise benefits to be realized, could begin almost immediately.

In place of open-pit refuse burning a study should be undertaken to evaluate the possibility of a refuse-to-steam/cogeneration plant, its costs and energy production benefits. (It is reported that the National Research Council has examined this concept and rejected it as unsuitable for reasons not clearly understood. The recommended project, however, would appear to have such merit that it deserves further examination.) Such technology is well developed in the United States, in places such as New England and Florida, and its transfer to Egypt should not be overly difficult. The Florida installation was visited by ECEP management in August, 1989.

The short-term demonstration programs should go further than simple "paper studies" and should include financing the implementation of the recommendations/results of the studies. Implementation financing should include engineering, procurement, construction, start-up, commissioning and, in the case of the waste-to-energy plant, possibly operation of the facility. A "study-to-results" approach would show the Egyptian industrial sector (uninhibited polluters) that the Egyptian government and USAID are serious about pollution reduction and that these pollution abatement projects have a sound technical and economic basis.

These two show-case projects, taken together, would be extremely visible and should convince the federal government, industry and the Egyptian people that a new phase of industrial development is beginning, one that does not impede economic growth but rather accelerates it in a healthy, beneficial manner. Based on the success of these two short-term projects, other such opportunities should be identified and analyzed while long-term programs are being developed.

B. Long-term Pollution Control Program

A mature environmental control program should be concerned with the maintenance of air quality and the prevention of air quality degradation. The air cannot be purified after it is polluted. The ultimate goal, therefore, is control and prevention not the correction of problems that were avoidable in the first place. This program is by far the most important because it commits the country to the development of a future, permanent, healthy industrial environment.

The organization of an air resource management program should include:

1. Development of a public policy on air conservation.
2. Creation of an independent organizational framework and staff capable of operating along functional lines (engineering, technical services, field services).
3. Delineation of realistic short-range goals that can reasonably be met in a reasonable time period, say 5 years. This should be followed by a more ambitious development for another 5 year period.
4. Development of an air testing program for the assessment, on a continuing basis, of air quality and the emissions of all existing pollution sources and those expected to exist in the future.
5. Development of necessary information about factors influencing the transport of air pollutants.
6. Establishment of ambient air quality goals.
7. Design of remedial measures and programs calculated to bring about the air quality desired, placing a strong emphasis on Egyptian views of proper enforcement methods. It is at this point that emission regulations should be promulgated for both existing and future pollution sources.
8. Development of long-range air use plans, fully integrated with community plans for energy supplies, land use, transportation, recreation, refusedisposal, etc., to cope effectively with changes expected in the community.
9. Development of methods for assessing the socio-economic impact of regulations concerning air pollution control and the effect of future patterns on air resource management.
10. Development of effective information and educational programs.
11. Development of an over-sight committee, possibly in one of the ministries,for the purpose of measuring the progress of the air management program, itssuccesses or failures.
12. Develop relationships with environmental agencies in other industrialized countries to keep abreast of new technologies pertinent to the Egyptian air management program.

An addendum to this paper contains a more detailed description of this long-range plan including the purpose of each step of the plan and the anticipated individuals and groups to be involved.

This strategy defines a logical, progressive plan of action that must be undertaken if a successful air management program is to be developed having the strength and flexibility to first, cope with the existing air problems in Egypt and second, to be able to sustain air quality whatever directions the future industrial growth of the nation might take. Some initial remedial activities, to relieve the worst currently existing air pollution sources, will probably be appropriate before the long-range program is in place. However, this should be done with caution. Proper emission regulations, for most industrial sources, except the worst, should await the development of long-range goals, promulgation of ambient air standards, and carefully developed emission testing programs.

It might be tempting for Egyptian authorities to try and short-cut this lengthy development plan, for example, by adopting another nation's ambient air quality goals or industrial emission standards, but this will not do. Egypt has its own specific air characteristics that must be fully understood before any kind of standards can be set. For example, dust will always be unavoidable in Egypt because of the deserts surrounding population centers, the lack of rainfall to cleanse the air, the constant light winds, and the apparent inability to clean the streets in heavily populated areas. For these reasons alone, the amount of background dust must be established by direct measurement so that realistic air quality standards for particulates can be determined and allowable industrial particulate emissions can be specified in relation to air quality standards and to air quality national goals.

IV. Program Implementation Options

In this section alternative methods of implementing short-term projects are examined. Some of these same methods may also prove viable for selected activities in the long-range program.

A. Service Organization

Considering the fact that Egyptian industry is apparently not knowledgeable in the air pollution area, it may be appropriate to attempt to acquire the services of a foreign (American) organization that can initialize short-range projects for a fee and eventually turn them over to Egyptians for the longer term. Such organizations might form a joint venture with an Egyptian company and together provide the services listed below. It is assumed that Egyptian authorities and USAID have agreed on the demonstration projects previously described, although other demonstration projects should not be excluded.

a. Cement Plant Emission Control Demonstration Project

1. Identify a cement plant for a combined air pollution control/energy conservation demonstration project. The plant selected should be a conspicuous polluter and close to Cairo or Alexandria for clear visibility of the results.

2. Inventory existing emission control equipment, if any, and decide whether such equipment can be placed back in service or whether an entirely new system must be installed.

3. Identify simultaneous energy conservation opportunities related to the control of emissions.

4. Inventory pollution control equipment manufacturers in Egypt and determine their capability to supply equipment, possibly with the assistance of American equipment manufacturers.

5. Perform emission control tests to develop data for equipment design.

6. Prepare initial rough design, procurement specifications, and submit data and material samples for bids and equipment guarantees.

7. Select vendor, finalize design and cost.

8. Supervise engineering, construction and installation.

9. Perform equipment tests and assist in system start up.

10. Operate equipment while training plant personnel and supervisors inoperating procedures, emission testing, equipment maintenance, data logging,emergency procedures.

11. Prepare scheduled transition from service organization operation to complete operation by trained Egyptian personnel.

b. Refuse-to-energy Demonstration Project

The use of a service organization for a refuse-to-energy demonstration project would function in a similar manner as that described above for the cement plant demonstration project. The only differences would be in the initial study to decide the technology to be employed (steam production, cogeneration, biomass or fertilizer) and a cost/benefit analysis to determine economic feasibility.

B. Implementation Similar to ECEP Structure

This option would create a sub-contractor directly responsible to USAID and would function in a manner similar to that employed for the ECEP program. Essentially, this means that the new organization (name it PCEC, Pollution Control and Energy Conservation, in this document) would employ American experts in pollution control and energy conservation to assist and guide appropriate Egyptian organizations in the tasks listed above for the service organization option. The PCEP would not be as involved in operating the facility after commissioning but would instead assure an appropriate continuity by intensive training of Egyptian personnel.

C. Implementation by Commodity Acquisition

To implement this option, USAID would engage American experts to develop a detailed pollution control plan for each demonstration project. After recommending how such a project should be carried out they would step aside and the program burden would be borne entirely by Egyptian personnel.

This plan is essentially a paper study with no guarantee of its eventual success primarily because it delivers so little, especially in the training and maintenance functions.

D. Build, Operate and Transfer (BOT)

The refuse-to-energy project would be an excellent candidate for a Private Sector BOT operation. The municipality would pay an agreed amount per ton of refuse and the utility would pay an agreed amount per prooduced kWh. This would provide an opportunity for U.S. and/or Egyptian investors. USAID could finance the project and be paid by investors over an agreed length of time.

V. Demonstration Program Budgets

A. Cement Plant Demonstration

The Tourah cement plant is reported to have electrostatic precipitators for dust control but not in working order. Although it might be possible to put these devices back in operation, costing was based on acquisition of all new equipment, a worst case scenario. Both dust control baghouses and precipitators were priced for kilns, milling and rotary driers and bagging and fugitive dust. Combined total cost for all wet and dry line cement processes using baghouses is estimated as US$ 6.5 million and estimated precipitator total cost on the same basis is somewhat higher at US$ 7.5 million.

B. Refuse-to-energy Demonstration Project

A rough estimate for this type of system, assuming that the plant will burn refuse and generate electricity, is about US$ 2,200/kW of generating capacity or about 30% more than a conventional coal based generating station. With the estimated quantity of refuse available, the plant could generate about 90 mW fora total cost of approximately US$ 200 million. At this extremely high price, it might be more appropriate to initially build a smaller plant using only part of the available refuse.

VI. Recommendations

In addition to funding the proposed short-term projects for demonstration with one of the alternative implementation plans described in Section IV, the Egyptian government will need assistance and funding to develop the long-range plan outlined previously. There are also some preliminary steps which should be undertaken before long-range planning progresses too far, related to remediation of the worst currently existing polluters.

A. Emissions and Control Equipment Inventory/Energy Conservation Opportunities

1. An inventory of industrial plants should be prepared, based upon rough emission factor methods, and a priority list of the worst polluters should be developed. This inventory should also examine each plant and process identified as severe polluters to determine if any opportunities exist for simultaneous energy conservation programs.

2. An inventory of existing air pollution control systems at these plants, their condition, and whether they can be refurbished and put back into operation.

3. Courses should be given to foremen and operators at plants currently having air pollution control systems on equipment maintenance, emissions testing methods, how to develop and maintain emission and equipment data logs, and the principles of operation of each system. These courses could become models for future new installations.

B. Air Pollution Management Organizational Structure Development

There currently exists an organizational structure for pollution management in Egypt. However, the ability of the present structure to undertake the air management program described should be reviewed. It appears to be highly bifurcated, consisting essentially of the Egyptian Environmental Affairs Agency (EEAA), which functions essentially as an advisory and coordinating body within the Prime Minister's cabinet, and the National Academy of Research and Technology (ASRT) which is responsible to the Ministries of Education and Science and Technology. The link between these two central organizations is the Environmental Research Council (ERC), headed by the EEAA director.

An indication that the present air management structure is inadequate is suggested by the fact that no industrial emission standards have been promulgated in Egypt; only hygiene standards which are supposed to protect industrial workers have been developed. However, there is little chance that such hygiene standards can be met without emission standards. The present air management structure needs a thorough examination to determine if indeed it is capable of developing the strong, responsible and accountable, independent air management organization required for success. If it is judged not capable of doing so, a new and effective organization should be developed or the present structure modified.

With these preliminaries at the head of the program accounted for, the resource management program can get under way. USAID funding for developing both long-range programs and demonstration projects will be needed for technical advisors, air measuring equipment, training and information source acquisition. There is every reason to believe that with proper motivation (which appears to exist) and with appropriate funding and technical assistance, an air management program suitable to Egypt's particular present and future needs can be implemented.