Task Order No. 832
USAID Csontract No. PCE-I-00-96-00002-00

Egyptian Environmental Policy Program
Program Support Unit

WORK ASSIGNMENT REPORT
Tranche 1, Objective 4

Considerations for Revising Air Quality Standards in Egypt

Alan P. Loeb

August 2000

PSU-21

for
U.S. Agency for International Development–Cairo

by
Environmental Policy & Institutional Strengthening
Indefinite Quantity Contract (EPIQ)

A USAID-funded project consortium led by International Resources Group, Ltd.

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Fact Sheet

USAID Contract No.:	PCE-I-00-96-00002-00 Task Order No. 832
Contract Purpose:	Provide core management and analytical technical services to the Egyptian Environmental Policy Program (EEPP) through a Program Support Unit (PSU)
USAID/Egypt's Cognizant Technical Officer:	Holly Ferrette
Contractor Name:	International Resources Group, Ltd.
Primary Beneficiary:	Egyptian Environmental Affairs Agency (EEAA)
EEAA Counterpart:	Eng. Dahlia Lotayef
Work Assignment Supervisor:	Harold van Kempen
Work Assignment Period:	August 2000

Preface

Through competitive bidding, the U.S. Agency for International Development (USAID) awarded a multi-year contract to a team managed by International Resources Group, Ltd. (IRG) to support the development and implementation of environmentally sound strategic planning, and strengthening of environmental policies and institutions, in countries where USAID is active. Under this contract, termed the Environmental Policy and Institutional Strengthening Indefinite Quantity Contract (EPIQ), IRG is assisting USAID/Egypt with implementing a large part of the Egyptian Environmental Policy Program (EEPP).

This program was agreed-to following negotiations between the Government of the United States, acting through USAID, and the Arab Republic of Egypt, acting through the Egyptian Environmental Affairs Agency (EEAA) of the Ministry of State for Environmental Affairs, the Ministry of Petroleum's Organization for Energy Planning, and the Ministry of Tourism's Tourism Development Authority. These negotiations culminated with the signing of a Memorandum of Understanding in 1999, whereby the Government of Egypt would seek to implement a set of environmental policy measures, using technical support and other assistance provided by USAID. The Egyptian Environmental Policy Program is a multi-year activity to support policy, institutional, and regulatory reforms in the environmental sector, focusing on economic and institutional constraints, cleaner and more efficient energy use, reduced air pollution, improved solid waste management, and natural resources managed for environmental sustainability.

USAID has engaged the EPIQ contractor to provide Program Support Unit (PSU) services to EEPP. The PSU has key responsibilities of providing overall coordination of EEPP technical assistance, limited crosscutting expertise and technical assistance to the three Egyptian agencies, and most of the technical assistance that EEAA may seek when achieving its policy measures.

The EPIQ team includes the following organizations:

- Prime Contractor: International Resources Group
- Partner Organization:
  - Winrock International
- Core Group:
  - Management Systems International, Inc.
  - PADCO
  - Development Alternatives, Inc.
- Collaborating Organizations:
  - The Tellus Institute
  - KBN Engineering & Applied Sciences, Inc.
  - Keller-Bliesner Engineering
  - Conservation International
  - Resource Management International, Inc.
  - World Resources Institute's Center For International Development Management
  - The Urban Institute
  - The CNA Corporation.

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Executive Summary

An assessment of the Egyptian air pollution control program was made in light of world air pollution control programs. The assessment found that improvements in the Egyptian system can be made. While most Egyptian ambient standards are comparable with other standards, some should be considered for tightening. The Egyptian program also includes standards for some pollutants one might consider inessential to an ambient air quality program and lacks standards for other pollutants that elsewhere have come to be considered essential for public health. Analysis of the Egyptian stationary source emission standards shows them to be quite vague and outmoded. While the existing stationary source standards may be maintained in the short term, there is a great need to replace them with more appropriate standards for specific industries. In addition, mobile source standards for new cars should be significantly tightened; Egypt should also complete the job of eliminating leaded gasoline, which will remove the obstacle to introducing modern vehicle technologies. In order to achieve additional emission reductions in the short term, a set of controls for existing vehicles, including fuel volatility, use of natural gas as a motor fuel, and vehicle tune-ups, should be considered. Overall, it will be necessary to institute a process to revise the standards and the administrative mechanisms that support them now and on a recurring basis. It is recommended that a regular process of review and revision be adopted. A phased approach is proposed to implement this process.

Introduction

Recent findings have established that air quality in Egypt causes considerable public health damage. Given the serious nature of the air quality problems, the United States Agency for International Development ("U.S. AID") has instituted a new project under the Environmental Policy and Institutional Strengthening Program ("EPIQ") to provide resources to address air quality problems in Egypt. As an important step, U.S. AID is providing funding to establish a system for periodic review and modification of air emission standards, in conjunction with the Egyptian Environmental Affairs Agency ("EEAA").

Tasks Covered

Under EPIQ, AID and the Government of Egypt ("GOE") have agreed to 15 policy objectives designed to improve environmental conditions in Egypt.[1] These objectives are to be completed within 18 months, starting June 1999.

This project is designed to complete objective 4, Tranche I, which calls for conducting an assessment of the existing air standards in Egypt.[2] The goal of this exercise is to provide analysis for EEAA to use in establishing a system of periodic review of emission regulations.

A team of two consultants has been assigned to conduct research and prepare materials for the required assessment. Dr. Mahmoud Nasralla is assigned the role of team leader and consultant. I am assigned the role of international consultant. Under my Terms of Reference, I am tasked to:

Review the existing air emissions standards established under Law 4/1994 and prepare a brief analysis (beginning work in the U.S.) comparing the Egyptian standards with comparable U.S. and selected international (e.g., WHO, EU) air emissions standards,

Working with the local consultant and using the above analysis, conduct a series of interviews with key stakeholders (including the Cairo Air Improvement Project) to identify (based on criteria agreed to with Dr. Ahmed Gamal) specific air emissions standards that should be the focus of the EEAA assessment,

- Assist in the preparation of a detailed questionnaire, using the above analysis and interviews and testing it with a small roundtable of key stakeholder/advocates, to be distributed to relevant stakeholders before the stakeholder consultation, and

- Following the stakeholder consultation, assist the local consultant in preparing the assessment of the effectiveness of existing air emissions standards in controlling priority air pollutants, recommending appropriate modifications and procedures for periodic review and modification.

[1] The source document for EPIQ in Egypt is the "Memorandum of Understanding Between the Arab Republic of Egypt and The United States Agency for International Development, Egyptian Environmental Policy Program."

[2] The outline does not set out a specific measure for the tranche, but footnote 1 indicates what steps and tools to do. It has been determined that the task calls for an assessment of the existing air pollution standards.

This draft report represents my contribution to the first two of these tasks. The method involves two phases. First, it is necessary to survey the standards adopted by leading national programs, including the U.S. and the European Union ("EU"), international organizations, and others to identify air quality standards for comparison. This is a necessary prerequisite for the analysis that follows. A key factor will be to discover if there are world norms in air pollution control that the Egyptian air pollution control system must meet in order to be at general parity with other countries. While the survey conducted here is intended to be comprehensive, so that all important programs can be identified, it is not exhaustive. Programs are summarized and some inessential aspects are not covered at all. The result, even after selective coverage, has produced an extensive collection of materials, which are set out in appendices to this report.

Once the survey materials were assembled there followed a second phase, which is to evaluate the existing Egyptian program to identify flaws or weaknesses in the regulations and make recommendations for addressing those deficiencies. The evaluation has taken account of not only the written standards themselves but also considerations relating to the Egyptian administrative system and the emission sources. Because the analysis naturally falls into two distinct processes, this step has been accomplished in two parts:

1. The analysis first compares the air quality standards that apply in Egypt with the standards that are applied by selected countries and international organizations. The report examines the strengths and weaknesses of the Egyptian program relative to these other programs to the extent such are possible given their incompatibilities. The examination focuses on the pollutants of greatest concern in Egypt so that public health priorities can be followed. The analysis identifies problem areas and offers some preliminary observations and recommendations.[3]

2. The analysis also evaluates other concerns about the functioning of the Egyptian air quality program, focusing on the administration and other relevant technical or policy considerations. This relies principally upon interviews in which I have participated, supplemented by a reading of the Egyptian environmental law, with its Executive Regulations and experience in solving similar problems in other countries.

While this report represents completion of the research part of this project, the analysis is more preliminary and should be taken as a platform for discussion rather than as final conclusions. Refinement of the analysis and the recommendations that come from it will result from the remaining tasks in the project.

Target Air Pollution Problems in Egypt

As an introduction, I begin by identifying the air pollution problems of concern in Egypt. Most of the concern with air pollution centers on Greater Cairo, where air pollution levels ranks among the highest in the world.

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[3] In order to complete the assignments within time and budget allocated, the analysis presented here includes secondary materials where they could be obtained. In some cases I have drawn from copyrighted materials, including my own, which remain subject to the proprietary protections they originally held. Material drawn from others has been referenced; not all of my own material has been referenced herein. Nothing in this document waives any right or claim in intellectual property held by any author whose material appears here.

Prior to 1994 it was believed that mobile sources were the biggest air pollution problem in Cairo. In that year U.S. AID released the PRIDE study, which provided a much more refined view of the problem.[4] It identified two primary public health concerns regarding air pollution in Cairo.

First, it determined that lead pollution is the single greatest single source of pollution damage to the Cairo population. It found the average blood lead levels among Cairo residents to be at 30, 27.5, and 22.5 micrograms per deciliter (µg/dl) of blood for men, women and children, respectively, among the highest ever recorded for a major city. Based on these levels, it found that every year lead pollution in Cairo alone causes: (1) 6,500 - 100,000 heart attacks, and 800 - 1,400 strokes, resulting in a total of 6,300 - 11,100 cardiovascular deaths; and (2) an average IQ loss of 4.25 points for every person raised in Cairo; the cost associated with the IQ loss is estimated at $13 billion annually. Virtually all of the lead in the environment starts in the air, principally from leaded gasoline. Thus, the PRIDE study did not disturb the belief that mobile sources were the source of the most significant air pollution problem, but it did change the sense in which that initial hypothesis was true. As a result of this information, and with advice that antiknock substitutes could be implemented quickly at reasonable cost, in 1996 the Government of Egypt acted quickly to remove the lead from the gasoline. Nevertheless, because of the dry climate, the lead that was used previously continues to contaminate Egyptian urban environments and reenters the air through re-entrainment. In addition, the current lead loading is increased by emissions from lead smelters that continue to operate in and around Cairo.

Second, it found that particulate matter ("PM") levels in air pollution in Cairo exceeded health-based standards by a factor of 5 to 10, with levels in Cairo higher than in any of the world's largest cities. It found that industrial emissions were the principal source of PM, though it had no inventory of emission sources for PM. It predicted that reducing PM concentrations to natural background levels might prevent 3,000 to 16,000 deaths and 90 million to 270 million days of restricted activity per year.

Among the other environmental health risks, it also noted high ozone levels, though its assessment was based on incomplete monitoring data. In addition, it found high levels of the conventional pollutants nitrogen oxides ("NO_x") and carbon monoxide ("CO"), as well as the probability of high concentrations of toxic air pollutants such as benzene, formaldehyde, cadmium, nickel, and benzo-a-pyrene. Even without time series monitoring data, it can be assumed that increases in road traffic since 1994 have also increased emissions of ozone precursors, resulting in corresponding increases in ambient ozone levels, as well as many of these other pollutants.

While new data, when it becomes available, will inform decision-makers better about current conditions, information that is now available indicates the presence of very high levels of air pollution in urban areas, especially in Cairo. These conditions create a significant public health problem that has high personal and economic costs. This project is intended to identify institutional means of reducing human exposure to such substances through revision of the air pollution standards and changes in administrative mechanisms.

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[4] "Comparing Environmental Health Risks in Cairo, Egypt," USAID, Project in Development and the Environment (Sep. 1994) ("the PRIDE study").

Comparison of Pollutant Standards

This section compares leading air quality standards used throughout the world with those that are established under the Executive Regulations in Egypt. The materials used for the comparison, along with additional information on the programs, is contained in the appendices. Of course, standards can only be compared with like standards. The survey indicates that the programs have fundamental differences that in some cases make absolute quantitative comparisons difficult or impossible. Nevertheless, even in these cases the exercise provides useful information and insight about the Egyptian program.

Survey of World Air Pollution Standards

A first step in carrying out the assigned tasks is to identify the various world standards and determine the kind of standards found in the various programs. The results of a preliminary survey of Egypt, the U.S., the European Union ("EU"), the World Health Organization ("WHO"), the World Bank, other financial organizations, and the International Organization for Standardization ("ISO") are summarized in Table 2.1.

Table 1 Summary of World Air Pollution Standards

standard or guideline	Egypt	U.S.	EU	WHO	World Bank	other financial	ISO14000
ambient	*	* (federal)	*	*			
emissions							
stationary sources	*		(not pursued)		*		
-existing sources		* (states)[a]					
-new sources		* (federal)				*	
mobile sources	*	* (federal)[a]	*				
technical methods		*		*		*	*
management practices			*		*	*	*

(* indicates existence)

[a] Regarding the U.S. program, this characterizes programs that are most developed and actively enforced. The exceptions that exist for stationary sources are in programs that are only recently pursued vigorously, such as for visibility protection, where federal authority to regulate existing sources exist. The exceptions that exist for mobile sources are the longstanding exception for California and the ability of other states to "opt-into" participation in the California standards.

Survey of World Ambient Air Quality Standards

Analysis of world air pollution standards begins with a survey of the standards that define air quality goals. Egypt, WHO, the U.S., and the EU have programs that approach air quality in conceptually different ways. As noted in the appendices, the U.S. program classifies air pollutants (other than global air pollutants) into two fundamental categories — conventional pollutants and hazardous air pollutants. The U.S. program is the anomaly. Other world programs do not make that formal distinction, providing instead for the differences in toxicity by assigning lower maximum ambient concentrations. Despite differences in organization, the programs are compatible enough to be analyzed for comparison, but the distinction of ambient pollutants and hazardous air pollutants is maintained here.

Conventional Pollutants: Traditional Ambient Pollutants and Visibility

Table 2.2 compares traditional ambient pollutant standards in Egypt with those issued by the WHO, the U.S. and the EU. The list excludes pollutants that are toxic at low thresholds and which may be considered hazardous air pollutants.

Table 2 Comparison of Ambient Air Quality Standards

pollutant	averaging time	maximum limit value			
		Egypt	**WHO**	**U.S.**	**EU**
black smoke	24-hour	150 µg/m^3	---	---	[250 µg/m^3
	annual	60 µg/m^3	---	---	[80 µg/m^3
TSP	24-hour	230 µg/m^3	---	[260 µg/m^3, rescinded]	[rescinded]
	annual	90 µg/m^3	---	[75 µg/m^3, rescinded]	[rescinded]
PM_{10}	Annual	---	---	50 µg/m^3	40 µg/m^3
	24-hour	70 µg/m^3	---	150 µg/m^3	50 µg/m^3
$PM_{2.5}$	Annual	---	---	15 µg/m^3	---
	24-hour	---	---	65 µg/m^3	---
SO_2	Annual	60 µg/m^3	50 µg/m^3	80 µg/m^3	20 µg/m^3
	24-hour	150 µg/m^3	125 µg/m^3	365 µg/m^3	125 µg/m^3
	1-hour	350 µg/m^3	---	---	350 µg/m^3
	10-minute	---	500 µg/m^3	---	---
CO	8-hour	10 mg/m^3	10 mg/m^3	10 mg/m^3	[proposed]
	1-hour	30 mg/m^3	30 mg/m^3	40 mg/m^3	
	30-minute	---	60 mg/m^3	---	
	15-minute	---	100 mg/m^3	---	
NO_2	annual	---	40 µg/m^3	100 µg/m^3	40 µg/m^3
	24-hour	150 µg/m^3	---	---	---
	1-hour	400 µg/m^3	200 µg/m^3	---	200 µg/m^3
NO_x	annual	---	---	---	30 µg/m^3
0_3	8-hour	120 µg/m^3	120 µg/m^3	157 µg/m^3	[proposed]
	1-hour	200 µg/m^3	---	235 µg/m^3	
Pb	annual	1 µg/m^3	0.5 µg/m^3	---	0.5 µg/m^3
	quarterly	---	---	1.5 µg/m^3	---

A number of observations about the Egyptian standards can be made on the standards compared in Table 2.2.

<u>**Standard level concentrations**</u>**.** First, the major point is that the ambient levels that are specified in the Egyptian standards, listed in the Executive Regulations at Annex 5, are not out of line with world standards overall. However, when taken individually, two of the pollutants, NO_2 and Pb, are assigned standards that are significantly less stringent the levels considered acceptable elsewhere in the world. Specific observations on the comparisons are as follows:

- *PM_{10}*. Annex 5 specifies a PM_{10} 24-hour standard of 70 µg/m^3, while the U.S. and EU standards are 150 and 50, respectively. Thus, the Egyptian standard falls within the range of other standards. However, Dr. Nasralla points out that the background level of PM_{10} from natural sources is already in excess of 70.

- *SO_2*. Annex 5 specifies a SO_2 annual standard of 60 µg/m^3, while the WHO, U.S. and EU standards are 50, 80 and 20, respectively. Thus, while higher than the WHO and EU standards, it is actually lower than the U.S. standard.

- *CO*. Annex 5 specifies a CO 8-hour standard of 10 mg/m^3, the same as the WHO and U.S. standards. The 1-hour standard of 30 mg/m^3 is the same as the WHO standard and less than the U.S. standard of 40 mg/m^3. Thus, it is at or below the world standard.

- *NO_2*. Annex 5 specifies a NO_2 1-hour standard of 400 µg/m^3, twice that of the WHO and U.S. standards, which are at 200 µg/m^3. Thus, it is twice comparable world standards. Egypt should consider revising this standard to bring it within the world norm.

- *O_3*. Annex 5 specifies a O_3 1-hour standard of 200 µg/m^3, slightly below the U.S. standard of 235 mg/m^3. It also specifies an 8-hour standard of 120 µg/m^3, which is the same as the WHO standard and slightly below the U.S. standard. Thus, the O_3 standard is on a par with the world standards.

- *Pb*. Annex 5 specifies a Pb annual standard of 1 µg/m^3, twice that of the WHO and EU standards, which are both set at .5 µg/m^3. The U.S. standard is not comparable, as it applies only quarterly. Because the Egyptian standard is set at twice comparable standards, Egypt should consider revising this standard and bringing it within the world norm.

Averaging times. Among the six pollutants listed by Annex 5 that are also listed by the U.S., EU or WHO, there are a number of pollutants that have multiple standards for distinct averaging times. While all of the averaging times used in Annex 5 (with the single exception of the 24-hour NO_2 standard) are used in one or more of these other programs, the question arises whether it is really necessary to maintain all of these standards. Especially in the case of SO_2, Annex 5 maintains three separate standards. But even where there are two standards, it remains an open question whether both are required, or whether those that exist now are the most appropriate averaging times for these pollutants. New knowledge may change not only the level considered to be toxic but also the temporal exposure scenario in which toxicity will arise.

Given the high particulate levels in Cairo, it is advisable to consider adopting a 24-hour standard for PM_{10} to control for episodes resulting from temporary conditions such as inversions because of mortality potential from acute exposures; high concentration episodes get washed out in the annual average.

Thus, as part of any review, Egypt should consider reexamining the averaging times for the ambient pollutants to determine whether current averaging times remain appropriate. Maintenance of more standards than is necessary costs resources that could be used for other purposes. Obviously, one can observe from Table 2.2 that there is no single approach that has been adopted by all. On the other hand, it may be that certain factors that are indigenous to Egypt should be taken into consideration and would affect the determination of the standards that are most appropriate.

<u>Considerations for de-listing two pollutants</u>. In addition to the listed pollutants that correspond to pollutants now listed by other regulatory agencies, Annex 5 includes two pollutants, both related to particulates, that are no longer commonly in use elsewhere. Egypt should consider deleting at least one of these:

- *<u>black smoke</u>*. The standard for black smoke has been made obsolete by the adoption of PM_{10} standards and has been dropped in other programs internationally. A strong argument can be made for dropping it in Egypt, as it duplicates the existing PM_{10} standard, and its administration and enforcement would drain scarce resources. Moreover, control of smoke emissions as nuisances can be accomplished more efficiently through the use of Ringelmann charts. If another health-based particulate standard is needed, it should be a $PM_{2.5}$ standard, which has become the other conventional form. The counter-argument raised by Dr. Nasralla is that a standard for black smoke should remain because incomplete combustion is a problem in Egypt.

- *<u>TSP</u>*. The TSP ambient standard has been dropped from most programs because of the growing understanding of the relationship between particle size and health effects. As indicated in the appendices, beginning in the early 1990s researchers using time series analyses began to see a strong association of health effects with smaller particles and to recognize that the larger particles found in ordinary airborne dust do not constitute a significant health concern. While the large particles create a nuisance, they do not enter the deep parts of the lungs. Moreover, while the TSP standard ostensibly measures *total* suspended particulates, in practice only the largest particles get measured and controlled, leaving the smaller particles that cause the health effects uncontrolled. Thus, use of a standard that includes the larger, benign particles results in uncontrol of the smaller, harmful particles. As with black smoke, it may be advisable to delete TSP as obsolete. However, Egypt may pose a special case because of the significant natural background levels of larger particles. It is at least debatable that it is desirable to retain the TSP standard in Egypt as a means of tracking the large particles because of the public interest in that information,[5] even if it is not a measure of health effects. Thus, indigenous circumstances in Egypt may warrant that use of resources.

<u>Additions to the list</u>. To come up to the state of the art, Egypt should also consider some additions to the lists. Three suggestions are considered here:

- *<u>particulates</u>*. The pollutant that is of greatest political visibility in Egypt is the PM standard. The aforementioned studies carried out in the 1990s identified the nature of health hazards from fine particulates as a much more significant health threat than previously realized. Studies have also pointed to fine particles, particularly $PM_{2.5}$, which is inhalable deep into the lungs, as the greatest source of human health risk. Currently Egypt has a standard for PM_{10} but not for $PM_{2.5}$. Any reconsideration of the standards should, in addition to examining the level of the PM_{10} standard, evaluate the costs and benefits of establishment of a separate $PM_{2.5}$ standard. The health concerns are not in doubt; the only question is whether attainment of the standard is economically feasible, assuming that the standard will be implemented if adopted.

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[5] To make a determination a better inventory of sources is called for. Limited data used in the PRIDE study suggests that only about one-third of the TSP measured in Cairo results from natural sources. Thus PM_{10}, which excludes the larger fraction most likely to be from natural sources, is most likely to result from anthropogenic causes. These issues will need to be sorted out in order to make a decision on the form of PM standards to retain.

- *volatile organic compounds*. In an interview Cairo environmental lab manager Nader Shehata Doas also suggested the addition of a standard for volatile organic compounds ("VOCs"). VOCs are pollutants that chemically combine in the ambient air to form ozone and other photochemical pollutants. While control of VOCs is important to reduce ambient ozone formation, VOCs as a class are not necessarily significant as health detriments. As discussed in Appendix B.3.1, the U.S. EPA initially had an ambient standard for HC but dropped it for this reason. The proper regulatory approach for HC and VOCs is to control them with emission standards, rather than through the ambient standard mechanism. Thus, the addition of a VOC ambient standard is not recommended.

Visibility impacts. While human health is universal, making consideration of ambient pollutant concentrations essential, it is also important to take into account the impact of ambient pollutants on other air quality factors in Egypt, such as visibility. Visibility is particularly important in Egypt for two reasons:

- *Value relating to tourism*. Visibility has a high economic value. Tourism is a large industry in Egypt, and tourists come to experience the antiquities visually. Because of their grandeur, they must be viewed from great distances. The impact of these monuments is substantially reduced (just as it is in the U.S. in the Grand Canyon) by visibility impairment. In addition, to the extent Egypt is seen as dirty and polluted, tourists may choose other options and stay away. Thus, visibility has a cash value.

- *Value relating to public awareness of air pollution*. By the same token, visibility is a condition that is by definition obvious to the public in Egypt, and any changes in air quality will be noticed. Since visibility impairment is caused by particulates and ozone,6 which are also ambient pollutants of great concern in Egypt, visibility acts as an indicator to the public of the level health hazards in the ambient air.

Because of these two values, it may be important in any consideration of conventional pollutants to take account of not only their health effects as ambient pollutants but also their impacts on visibility and other air quality values. Control of ambient pollutants for health reasons would not always reduce visibility-impairing pollutants to acceptable levels. For example, since TSP is more of a nuisance pollutant than a health threat, it could be de-listed as an ambient pollutant but still be subject to controls under a separate visibility program. Thus, consideration of visibility impacts is worth consideration as part of a complete examination of the air quality program.

Hazardous Air Pollutants

As noted above, in addition to the traditional ambient pollutants, there is a second class of air pollutants that are toxic at lower thresholds, which the various programs have treated differently. In most programs, including that of the EU, these are grouped with the ambient pollutants but controlled to much lower concentrations. By contrast, in the U.S. program these are treated as a distinct class of pollutants ("hazardous air pollutants") and controlled under a separate regulatory program.

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[6] Visibility degradation is caused in large part by precursor emissions that result in which are notoriously high in Egypt, especially in Cairo.

Table 2.2 provides a sample of substances that may be considered for control in Egypt as hazardous air pollutants but which are not currently listed by Annex 5 as air pollutants. These include the eight substances listed as hazardous air pollutants by the U.S prior to 1990 and the eleven substances listed (or under consideration for listing) as ambient pollutants by either the WHO or the EU. Some of these are listed in the Egyptian program under Annex 6 as substances subject to emission standards. A more complete list would include all 188 substances currently listed by the U.S. under section 112(b)(1) of the Clean Air Act.

Table 3 Comparison of Hazardous Air Pollutant Standards

pollutant	averaging time	maximum limit value			
		Egypt	WHO	U.S.	EU
benzene	[]	---	5.0-20.0 µg/m^3 [Table 3.3]	[regulated as NESHAP]	[proposed]
arsenic	[]	[Annex 6, Table 2]	(1-30)*10^{-3} µg/m^3 [Table 3.3]	[regulated as NESHAP]	[proposed]
mercury	[]	[Annex 6, Table 2]	---	[regulated as NESHAP]	[in research]
asbestos	[]	---	---	[regulated as NESHAP]	---
beryllium	[]	---	---	[regulated as NESHAP]	---
vinyl chloride	[]	---	---	[regulated as NESHAP]	---
radionuclides	[]	---	---	[regulated as NESHAP]	---
coke oven emissions	[]	---	---	[regulated as NESHAP]	---
cadmium	[]	[Annex 6, Table 2]	(0.1-20)*10^{-3} µg/m^3 [Table 3.2]	[Cd compounds regulated as HAP]	[in research]
nickel	[]	[Annex 6, Table 2]	1-180 µg/m^3 [Table 3.3]	[Ni compounds regulated as HAP]	[in research]
PAH	[]	---	(1-10)*10^{-3} µg/m^3 [Table 3.3]	[?]	[in research]

The absence of a program that recognizes the exposure concerns of these pollutants, either as part of Annex 5 or in a separate program, creates a gap in coverage. For most of these substances there is no control other than by the occupational standards listed in Annex 8 of the Executive Regulations ("Maximum Limits of Air Pollutants Inside the Work Place According to Type of Industry"). Regulation by occupational standards alone would raise the theoretical scenario that firms which use the eleven substances or any of the substances listed in Annex 8 could control occupational exposure levels by venting these substances to the exterior of the building, where no regulatory controls apply, rather than by pollution prevention (i.e., substituting non-toxic materials). Venting is one of the classic mistakes — it was the remedy adopted in the U.S. for controlling worker exposure to organo-metallic compounds of lead from the 1920s on, but which resulted in diverting attention from the exposure of the public to the lead emissions or accumulation of lead in the ambient environment. All these considerations argue for additional standards.

Survey of World Stationary Source Emission Standards

From ambient standards we next turn to emission standards, that is, direct controls on emissions into the ambient air. Various stationary source emissions control programs were reviewed in the survey. While the stationary source emission control programs are so fundamentally different that no quantitative comparison can be made, some useful qualitative observations are still possible.

Comparison of Programs

The stationary source programs reviewed start with three very different organizing principles.

The Egyptian standards, set out in Annex 6 of the Executive Regulations, is organized by the following logic: First, the categories of pollutants emitted are set out in two separate tables — one for particulates only, the other for other types of emissions. Then the categories of industries to which the standards apply are listed. Finally, if there is a further distinction between new sources and existing sources that is listed. Thus, the primary organizing principle for the standards is the pollutant emitted, rather than the category of source from which it is emitted.

By contrast, others have used the source category, rather than the pollutant, as the organizing principle. There are two variations on this approach. First, in its "Industry Sector Guidelines" (see Appendix D) the World Bank recommends a set of performance standards for control of emissions at specific categories of industrial sources. Since these are enforced as a precondition of financing a project, they are in effect sector-specific emission standards applied in a preconstruction review process. In addition to the Guidelines, the World Bank also provides a review of generic control technologies for specific pollutants.

Second, and at the far extreme, the U.S. standards are organized by type of equipment, rather than by industry. The program considers an individual piece of equipment in use at a facility (rather than the facility as a whole) to be the emission source that is the subject of regulation, and thus the rules apply to (and are arranged by) category of equipment. Thus, within a given facility or plant there will be numerous emission sources that are regulated individually, each with its own set of standards for emissions of each pollutant.

Because each of the programs is written around a different organizing principle it is impossible to make direct quantitative comparisons of the emission standards, since one cannot know in advance the equivalences that would allow translation from one set of standards to another. For a quantitative comparison to be made, standards for each industry would have to be analyzed individually using engineering judgment to determine those equivalences. Such a comparison far exceeds the resources contemplated in this task. In consequence, this report offers no opinion as to whether the Egyptian stationary source standards are more or less stringent than other world standards.

Qualitative Observations on the Egyptian Stationary Source Emission Standards

While direct quantitative comparisons are impossible, some useful observations on the Egyptian emission standards can be made.

First, there are many specific flaws in the standards as they are now written. For example,

- Annex 6 ("Permissible Limits of Air Pollutants in Emissions") contains two tables, Table 1 for "Overall Particles" and Table 2 for "Maximum Limits of Gas and Fume Emissions from Industrial Establishments." It appears that the Executive Regulations are designed to distinguish particulate emissions from gaseous emissions. However, Table 2 contains numerous substances that normally would be in particulate form, so there is not a clean and logical distinction. As a result, it is possible that both tables, and thus more than one standard, could apply simultaneously. In such instance the owner of the source cannot ascertain which standard would apply. This ought to be clarified by revisions in the Executive Regulations.

- Table 2 lists categories for "heavy elements (total)" and for "organic compounds." These are very unspecific and probably too arbitrary to be enforceable.

- Table 2 combines both conventional and hazardous air pollutants. If it is intended to be comprehensive, incorporating all air pollutants, there are numerous additional hazardous air pollutants that should be considered for addition to the list.

- The standards are denominated as mass per volume, but since no averaging periods are specified it is implicit that they apply as absolute standards. That is, emissions at no time may exceed the maximum. While that does provide a constraint on emissions of high concentrations at every moment, it does not limit the aggregate amount of emissions over a period of time. Thus, a facility is prohibited under these rules from emitting a high concentration for one instant, but a large volume of emissions within the standard that continues for a long period and results in many times more emissions to the environment is perfectly legal. In other words, the standards are written to prohibit nuisances, rather than air pollution generally.

Second, organizing the standards by pollutant, rather than by source category, is undoubtedly very difficult to administer. Since different industries have different equipment and varied emissions, the use of a single, uniform standard to apply a number of industries would be arbitrary. For some industries the standard would be easy to meet and present no burden; for others it would severely constrain operations and cause great financial hardship if it were enforced. As a result, equitable application would be impossible, and it would probably not be enforced. The result is that the emission reductions that are the purpose of the standards are unlikely to be achieved. In the distant future, when stringent levels of control for every industry become the norm, it may be economically feasible to have equal standards for all industries, but under present conditions this is not something that achieves the program goals.

Third, organizing by pollutant, rather than by source category, can lead to extraordinary inefficiency if the rules are enforced as written. For most pollutants the rules assign all sources the same standard. But it is well known that typically the cost of control varies widely across industries and even across types of equipment in the same industry. While the application of a single standard to all sources is in a sense equitable (since it places an equal responsibility on all parties), the burden of meeting the same standard is greater for some than for others, since the costs of control are higher.

Finally, and most importantly, organizing the standards by pollutant, rather than by industry, makes these rules extremely general. But any revision of these standards to achieve a reduction in emissions would have to be targeted toward the specific industries or source categories that emit them. Once the process of targeting industries for emission reductions is started, the organizing principle for the rules would quickly become the industry, rather than the pollutant. It is something that occurs naturally. Since these are *emission* standards, the controls would be on emissions by a source and would include all the emissions from that source. By contrast, organizing an emission control effort by pollutant, so that dozens of source categories have separate standards under each listed pollutant, would be an extremely unwieldy approach.

Even without a direct and quantitative comparison with other stationary source control programs, it is possible to conclude that the Egyptian stationary source emission standards are outmoded and unsuited to the task. The foregoing discussion suggests two improvements: (1) any program to amend the rules should start from the principle of assigning appropriate emission limitations to emission sources for each pollutant that source emits; and (2) the Annex 6 standards may remain while the process of replacement goes on so that regulatory oversight can continue, but ultimately they would be supplanted by the new process.

Views about the Egyptian Emission Standards

Finally, some views about the standards were obtained through interviews.

Stringency of the standards. Several individuals interviewed noted that the emission standards are not stringent enough. Dr. Ahmed Hamza, Sr. Technical Advisor, EEAA, observed that industry is complying with the standards, but the air is still polluted. "We can feel the pollution, we get complaints from all over, but we can do nothing about it." According to Nader Shehata Doas, Cairo environmental lab manager, the emission limits specified by Law 4 and the Executive Regulations are very lax. Some emission limits such as the SO_2 standard are so lenient that no facility will exceed them; these need to be more stringent. He noted complaints from individuals around the cement plant, smelters and foundries. He also noted that one can see the emissions from facilities that use heavy fuel oil, mazout, but when it is measured it is within the limit. Doas suggested that it would be better to limit the high sulfur content that gives the high sulfur emissions from the beginning than to measure it as emissions. He also noted that solid waste incineration in the streets without control needs to be controlled.

Article 42(C). A number of specific comments were directed at Article 42(C) of the Executive Regulations, which covers emissions from combustion sources. According to Dr. Ahmed Hamza, Sr. Technical Advisor, EEAA, among the standards that are too lax are those that provide limits for fuel-burning sources under Article 42(C). EEAA has already commissioned a study to revise these. Significant emission reductions are possible.

As a general matter, one can observe that Article 42(C) is obsolete in method. One obvious flaw is that it measures pollution from combustion sources visually using the ancient Ringelmann method. This measures the opacity of smoke, but it tells nothing about its volume, the chemical composition of the gaseous combustion products (such as SO_2, NO_x, or CO) or the size of particles composing it. Thus, the Ringelmann method is a crude and ineffective regulatory tool that should remain in the law only for the purpose of measuring the traditional smoke nuisance to downwind receptors, but not as a metric by which modern air pollution problems are measured. There is no substitute for a quantitative analytical approach.

<u>Standards for hospital waste incinerators</u>. It was suggested above that standards be adopted by classification of facility, as is the practice in the World Bank guidelines. There seems to be a natural tendency toward that approach. Already, without adopting this practice as a systematic approach, some in EEAA are developing standards for specific source categories. One example is the standards for hospital waste incinerators.

According to Dr. Nefisa S. Abo El-Seoud, EEAA, the Executive Regulations are not clear about standards controlling emissions from hospital waste incinerators. Moreover, the standards are for emissions from industrial establishments that are assumed to be located in industrialized areas, while in Egypt the hospitals are often located within residential areas. For this reason, the emissions have to be very strict. EEAA has developed its own air emission standards for these specific treatment units, guided by EU guidance materials, U.S. standards, and others. These apply technical specifications to incinerators, though details were not made available. She considers this change very important and has recommended that these standards be included in the Executive Regulations.

The approach taken with respect to hospital waste incinerators appears to have all the correct elements: it is developed based on a class of like-kind facilities, the standards are drawn from precedents established by advanced air quality programs, and the level of the standards is driven by air quality impacts.

Survey of World Mobile Source Emission Standards

Emissions from vehicles are affected by both emission controls and by the fuels. Though each effects the other, they are considered separately here.

Vehicle Emission Standards

Given the great number of standards for different classes of vehicles, direct comparison of emission standards for mobile sources is difficult. Thus, for comparison purposes I have assembled the standards only for the largest segment of the vehicle fleet, the gasoline-fueled passenger car. This should be taken as representative of other classes of vehicles.

Table 4 Comparison of Standards for Gasoline-fueled Passenger Cars

pollutant	Egypt		U.S.		EU
	existing vehicles	new vehicles	pre-1994 g/mi [g/km]	tier 1 (1994) g/mi [g/km]	2000 g/km
CO	7% vol. at idle speed (600-900 rotations/min.)	4.5% vol. at idle speed (600-900 rotations/min.)	7.0 [4.3498]	3.4 [2.1128]	2.3
HC	1000 ppm at idle speed (600-900 rotations/min.)	900 ppm at idle speed (600-900 rotations/min.)	1.5 [.9321]	---	0.20
NMHC	---	---	---	0.25 [.15535]	---
NO_x	---	---	1.0 [.6214]	0.4 [.24856]	0.15

pollutant	Egypt		U.S.		EU
	existing vehicles	new vehicles	pre-1994 g/mi [g/km]	tier 1 (1994) g/mi [g/km]	2000 g/km
smoke	65% darkness (opacity) or equiv. at max. acceleration	50% darkness (opacity) or equiv. at max. acceleration	---	---	---
PM	---	---	---	0.08 [.49712]	---

Sources: The Egyptian standards are those that are established under Article 37 of the Executive Regulations. The U.S. standards are those issued for gasoline-powered light-duty vehicles under section 202 of the Clean Air Act (1977) for emissions prior to 1994, and under the 1990 Amendments (tier 1) effective 1994. The EU standards are those applicable beginning 2000, as compiled in Michael P. Walsh, "Motor Vehicle Standards and Regulations Around the World," June 3, 1999, as revised.

Analysis. Several observations can be made on the information provided in the table.

- *Comparability of the standards*. From the outset it is clear that a direct comparison of the Egyptian standards with the U.S. and EU standards is impossible for several reasons:

- Denomination of pollutant. The Egyptian standards are written in percentage of pollutant in volume of emissions, while the U.S. and EU are denominated in grams of pollutant per distance traveled (either mile or km, respectively).

- Test protocol. Each regulation uses a different test procedure to measure emissions from the vehicles, so that the design of the driving cycle used in measuring emissions affects the quantity of pollutants actually emitted.

- Emission warranty. The regulations may apply to different lengths of warranties. That is, a vehicle required to meet the emission standard for only 50,000 miles has much greater emissions in its lifetime than a vehicle required to meet its standard for 100,000 miles. EU-certified vehicles have no emission warranty.

- Date of applicability. Of the two U.S. standards presented here the more stringent are those applicable to model year 1994, while the EU standards presented here are those from model year 2000. Both sets of standards are soon to be superseded with much more stringent standards in model years 2004 and 2005, respectively. However, presentation of these two future standards was impossible to accomplish in a simple table because the U.S. tier 2 standards are impossible to describe except by listing numerous conditions that apply with them. Thus, it should be understood in making the comparison that the table compare the old U.S. standards with the new EU standards, and while these are comparable now that condition will not pertain for long.

To make a comparison one would have to test individual vehicles certified to one standard on the test protocols applicable to the other, for example, by testing the emissions of a car certified with the U.S. test protocols under the Egyptian idle test.

Accordingly, one has to read Table 2.3 with the recognition that the absolute numbers stated there may not represent absolute comparisons of the relative stringency of the various rules. One acknowledges that because of these factors an absolute comparison is impossible and a more precise comparison than this would require considerable engineering judgment.

Since there is no standard methodology that would allow the extrapolation of the emissions performance of one test procedure to the other, there is no way to know with precision how the Egyptian vehicle emission standards compare with the U.S. or EU standards. However, it can be reasonably assumed that the Egyptian standards do not require vehicles to control emissions to the world standard. Indeed, in the absence of a standard, NO_x emissions are not controlled at all and may indeed be increased by designs implemented for control of HC and CO.

Other observations. Despite the lack of direct comparability there are some observations that can be made about the mobile source emission standards.

The use of a concentration-per-volume standard makes the Egyptian program suitable for tailpipe testing for an in-use vehicle. Measuring emissions at a single moment simplifies the approach by eliminating the need for a more complicated testing protocol. But by the same token, this testing procedure fails to capture a more representative sample of real driving conditions as part of the vehicle certification, and thus it is unlikely that vehicles in driving conditions actually have the emissions they are certified to. Emissions vary dramatically with cold start, road conditions, acceleration, etc. The certification protocols used in the U.S. and EU for new vehicles attempt (some would say without true success) to be representative of the whole driving cycle. By contrast, the emissions tested in the Egyptian standard are from a vehicle at idle, when emissions are lowest. The Egyptian standards should be changed to be in the same measures as other standards to conform to the world norm, which is written to capture the emissions during the whole driving cycle.

And even without a direct and quantitative comparison of the Egyptian vehicle emission standards with other standards, it is still reasonable to conclude that the Egyptian standards are obsolete and ought to be replaced. For example the vehicle emissions standards apply to any vehicle, including buses, motorcycles, tractors, etc. For larger vehicles this imposes heavy burdens that are not likely to be met; for smaller vehicles the standards are too lenient, losing the opportunity to make reductions that could be made easily. For other categories, such as diesel smoke, the standard is possibly too lenient given the high ambient particulate levels in Cairo and may need to be reconsidered. For other categories, such as diesel smoke, the standard is possibly too lenient given the high particulate levels in Cairo and may need to be reconsidered. Given these problems, the rules come to be treated as unenforceable as a whole. At a minimum, it is appropriate to rewrite the Executive Regulations to make clarifications and tighten up the language.

Given the air quality problems that currently exist, vehicle emission standards should be significantly tightented. Since vehicles are built to meet one set of standards or another, the only effective way to accomplish this it to adopt one of the sets of U.S. or EU standards,[7] which would harmonize Egyptian standards with one or another of the world standards. First,

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[7] According to David Fratt of Cairo Air, the Egyptian vehicle emissions standard from the Executive Regulations is the standard that is used as the pass/fail test for in-use vehicles. As such, it has a large impact on the ultimate success of the in-use vehicle testing program. Fratt expressed concern that tightening would cause many cars to fail their inspections. Since the median age of the cars in Cairo is around 1982 (and possibly older in other areas), and even recent vintage cars don't show better emissions because they don't have emission control systems on them, we don't see the decline in emissions that occurs elsewhere with turnover of the fleet. For social acceptability the rate of failure of in-use testing around 20 percent here; the fail rate is higher than that now. Currently Egypt is not testing the general public's cars, only testing captive fleets. These circumstances suggest that in the future there must be a separate test for in-use vehicles, apart from the standard to which vehicles are certified. In addition, waiver provisions are appropriate.

all the technologies are available to achieve such standards are available, and thus such a mandate would be technology-forcing only in the sense of forced utilization rather than forced advancement of the state of the art. Second, for some standards the technologies have been in use long enough that costs have been reduced to acceptable levels, and integration of the technologies for emission control into total vehicle design has made possible the concurrent improvement of other amenities such as fuel economy. Third, the elimination of gasoline lead additive, which is the predicate for use of catalyst-equipped vehicles, has already been accomplished in most parts of Egypt. Elimination of the remaining leaded gasoline would remove the last technical obstacle to tightening the Egyptian mobile source standards. It would also allow the introduction of more sophisticated vehicle technologies generally.

Fuel Standards

Comparison of the world fuel standards is much easier than a comparison of the vehicle emission standards. Fuel standards are product quality standards, directing refiners to produce fuels having certain characteristics that affect emissions.

Table 5 Comparison of Fuel Standards for Gasoline-fueled Passenger Cars

fuel requirement	Egypt	U.S.	EU
unleaded availability	yes	yes	yes
prohibition on leaded	yes	yes	yes
volatility controls	---	yes	---
reformulated gasoline	---	yes	---
oxygenated fuel	---	yes	---

Since 1973 the U.S. has had controls on gasoline quality, both to protect catalytic converters installed to reduce emissions and to reduce the lead itself. In the 1990 Amendments Congress banned leaded gasoline effective January 1, 1996, required the use of reformulated gasoline in certain ozone nonattainment areas beginning 1995, and required the use of oxygenated fuels in certain CO nonattainment areas. In 2000 EPA mandated significant reductions in the sulfur content of fuel, both to reduce sulfur emissions and to allow the tier 2 emission control devices to function as designed.

Like the tailpipe emission standards, the EU's standards for gasoline quality trailed the U.S. by many years. The rules that existed did not consolidate into specific requirements until 1989, when a mandate to supply unleaded gasoline was first implemented. Recent actions have moved the EU toward all unleaded. However, there is no indication that further controls on fuel quality, such as volatility controls, reformulated gasoline, or oxygenates have been required.

In gasoline quality controls Egypt does not lag as far behind as it does in vehicle emission controls. Unleaded is widely available in Egypt, though leaded gasoline is still used universally in upper Egypt and some locations in lower Egypt. Leaded gasoline should be completely eliminated so that programs on mobile source emission control can introduce vehicles that use catalytic converters to reduce tailpipe emissions. However, because changes in fuel quality can reduce emissions immediately, while requirement of vehicle emission controls on new cars relies on vehicle turnover and thus can take many years to have impact, changes in fuel quality are an expedient way to achieve mobile source emission reductions. Two advancements in fuel quality seem worthy of further investigation.

First, given the consistent warm temperatures in Egypt, the absence of onboard vehicle evaporative controls, and the persistence of ozone in urban areas, it seems appropriate to consider volatility controls for fuel sold in urban areas. While many engineering and economic considerations would govern the decision to develop such a program, the potential benefits could be large and rapid.

Second, given the development of new natural gas production in Egypt it also seems appropriate to consider examining the expansion in the use of this alternative as a motor fuel. Natural gas consists principally of methane, which does not contribute to ozone formation. It is for this reason that HC is no longer measured in the U.S. as part of HC emissions as a pollutant — the indicator pollutant has been changed to non-methane hydrocarbons, "NMHC". While the use of gas would require some changes in vehicles (by contrast with the usual relationship, in which the vehicle imposes requirements on the fuel), the costs of such changes are more than recovered in lower fuel costs.[8] Thus, at very little cost tailpipe emissions could be reduced. This option should be examined as part of any reconsideration of vehicle emission programs.

General Comments on the Standards

The foregoing discussion focuses on the specifics of the comparative analysis. Next, the discussion turns to considerations pertaining to the standards generally.

The Relationship of Emission and Ambient Standards

The development process for air quality regulation in the U.S., which is reviewed in Appendix B.1, provides concrete lessons for diagnosing problems in the Egyptian system. By enabling an observer to look at not only what is there but also at what is not, the account of the U.S. experience provides specific signals about what is missing from the Egyptian program.

EEAA staff that were interviewed complain that there are deficiencies in the Egyptian system that limit its effectiveness. One often-heard complaint is that it will be generally difficult to enforce more stringent emission standards, as emission sources often don't see the justification for costs they will be forced to bear. This reflects deeper problems in the structure of the law. Underlying the outcome is the absence of a clear justification for the standards: Why are they set at this level and not some other? Is there any reason why they could not be waived in this specific case, given the burden placed upon an individual business? Why now? The answers are not easily forthcoming from the Egyptian system, for something fundamental is lacking. One turns to the U.S. example to identify what is not there.

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[8] According to David Fratt of the Cairo Air Improvement Project, many taxicabs have recently been converted to run on compressed natural gas ("CNG"). There are now approximately 20,000 CNG taxis running in Cairo. Gas prices are low, and after paying the installment loan on the cab conversion cost the drivers are actually saving substantial amounts of money.

The U.S. experience shows that the use of emission standards by themselves is inadequate to address modern environmental problems. The success of the U.S. air quality control program has resulted from the recognition that the primary goal of a program has to be the protection of human health, and that therefore an ambient standard, which measures the quality of the air individuals breathe, must be the anchor of the program. Without an ambient level to act as a reference point, all the emission standards would have remained arbitrary, and there would have been no rationale to justify significant commitments to emission control. While the regulatory mechanisms used to achieve emission reductions should be selected on a pragmatic basis, and therefore can vary considerably with the cultural and legal context, the ambient standard is tied to human health and is therefore universal and completely transferrable to any context.

Of course, the use of ambient levels to set emission standards depends upon being able to determine quantitative relationships between emissions and ambient concentrations. If one starts with a desired ambient level, the methods require working backward from effect to cause to determine the level of emission reductions that would be necessary to achieve the ambient standards. The development of such methodologies was a major scientific breakthrough of the 1960s.

Thus, using this project only to determine if the existing emission standards were quantitatively comparable to the world norm would fall short. Such an inquiry would miss the point that for a program of air quality controls to be sustainable the process has to have a core rationale and methodologies implemented to achieve it.

Analysis of the Egyptian standards makes clear that one of the principal deficiencies in the Egyptian system is the lack of a working linkage between the ambient standards and the emission standards. The adoption of ambient and emission standards meets international expectations that it have standards in place, but even if the standards themselves meet the world norms the absence of linkage between the ambient and emission standards makes their enforcement very difficult.

This expresses itself in tangible ways. It has been observed that the new industrial areas do not achieve the ambient standard even if the emission standards are met.[9] It would appear that the concept of setting emission standards at levels necessary to achieve ambient standards is not being carried out in practice. But is the reason that the emission standards are not stringent enough, or that facilities that claim to comply with the emission standards are not in fact complying? Both arguments were expressed in interviews. Moreover, the law is not clear on what EEAA officials should do when they find ambient standards violated but emissions from facilities within their standards. Such issues will have to be clarified for a successful program to be carried out.

In order for the Egyptian system to function effectively and provide a rationale to motivate compliance it is necessary to link the ambient standards and emission standards logically and methodologically. Given the goal of this project to recommended a process for reconsidering and replacing the Egyptian standards, it is appropriate to set identify the framework within which such standards should be considered. Any process that is designed for revision of the air quality standards should use as its starting points two central premises: (1) ambient

[9] Interview with Yasser Sherif, May 2000.

standards should be set at levels that achieve protection of human health primarily, as well as the environment; and (2) following upon that, emission standards should be set at levels that bring ambient pollutant concentrations within the ambient standards. The process — i.e., being able to justify the standards as they are — is a critical feature of the final product.

In sum, an essential mission of the new process will be to establish a methodologically valid relationship between the ambient and emission standards. In modern air quality regulation there has to be an inherent tie, and the Egyptian process has to be designed to reflect it. This calls for a program with a more scientific approach to link the emission standards with the ambient standards.

Guidance for Formulating New Standards: Targets and Timetables

Defining air pollution as a problem raises the question of remedy. To translate environmental goals into actual improvement, the remedy has to take form of a set of defined responsibilities for emission sources. In the absence of a linkage between ambient levels and emissions, no one is responsible for the ambient air, since there would be no causal connection between emissions and their consequences. Once the policy has been clarified to establish functional roles for ambient and emission standards, emissions from one source can be formally considered to be causally related to pollutant levels in the ambient air, and then emission standards can be assigned as legal responsibilities.

The question thus turns to the process and the substance of determining the levels and deadlines for standards. The choice of these critical elements should not be made on an arbitrary basis; it should be pursuant to a consistent policy that has been determined in advance and cleared through a consensus process. A number of considerations were raised in interviews that would effect the design of the system.

Geographical distinctions. Dahlia Lotayeff of EEAA questioned whether the standards should be the same for facilities in the center of Cairo as for in the desert of Aswan? That is, should there be some sort of system that applies different standards for different areas? She suggested that the differences could be the basis for a permitting system.

Experience provides guidance on the potential pitfalls of geographic distinctions. For example, an early version of air quality control enacted in the 1967 under the Clean Air Act mandated a system for setting emission standards based on the relationships of emission sources and downwind receptors. The concept was that emission standards from individual sources would be linked to specific receptors.[10] While such a system is logically and economically appealing because it tailors emission reductions to specific needs, it requires too much information. For such a mechanism to be workable, one has to have an amount of information that is much too high and much too costly for a workable administrative system. Lacking information to run such a system, Congress turned three years later to a simpler system of nationwide ambient standards as a compromise. The nationwide approach was based on the conclusion that human health effects are universal and do not correspond

[10] The approach adopted by the 1967 Act has resurfaced in recent years under the LRTAP treaty, in which it is called an "effects-based" approach. While it is very attractive as a means of tailoring emission controls to specific "critical loads" at which environmental damage is thought to begin, it relies on an information-intensive mechanism that has failed in the past. Will it be possible to develop such a mechanism now, given much-improved information? It is difficult to know. Certainly, the kind of information needed to run such a system is not available in Egypt.

significantly to geographic location. The approach for ambient standards adopted under the 1970 Act does not rely on a source-receptor relationship; sources are contemplated only in the physical placement of monitoring devices, and receptors are disregarded completely. While the ambient standards are the same nationwide, local authorities can make the necessary emission reductions in any appropriate way that achieves the standards. This has resulted in a kind of national zoning in which areas that are "in attainment" of the ambient standards operate with very different procedures from those that are not.

Like the approach under the 1967 Act, the suggestion of differential standards for Egypt has the appeal of tailoring emission standards to the requirements of different regions. But given the success of the simple approach adopted in the U.S., what are the arguments for differential ambient standards in Egypt? Does Egypt present circumstances that warrant a different mechanism?

The main advantage, which is implied in the arguments made for differential standards, is that differential ambient standards would allow less stringent emission standards for industrial zones or areas that are not habitated, while populated areas such as cities would have more stringent standards. By not insisting on a single, universal ambient standard, it becomes possible to adopt more stringent standards for the populated areas. If enforced, this would provide an incentive for polluting industries to move from populated areas to industrial or unpopulated areas.

There are many downsides to this design. (1) The argument seems to suggest that industries located in areas that are not meeting ambient standards should not be forced to make additional emission reductions; instead, the ambient standards should be made less stringent so that additional emission reductions by industries will not be necessary. It is a way of conforming the standards to existing emissions. (2) By setting up classifications of air quality the GOE would acquiesce to allowing some individuals to be exposed to harmful levels of air pollution within these zones on a permanent basis. While the U.S. and other air quality control systems are organized to provide the means to meet the ambient goals whatever levels are adopted for the ambient standards must be met; air quality that is not completely safe for humans is intended to be eliminated. (3) It takes away incentives for industries to modernize. The current standards are not too stringent, since they are all being met by new technologies that are available internationally. Meeting the standards is now simply a matter of economics and resolve, and many industries may be at the point where their equipment needs to be replaced anyway. (4) Moreover, if less stringent emission standards is the goal it might not work as planned. For example, if such a program results in transferring all the lead smelters into one area, this would have the accumulative effect of concentrating their emissions to one place. Then reliance on existing emission standards would not be sufficient to meet even a less stringent ambient standard and a hot spot of concentrated pollution would result.

Given these downsides, a zoning of the country into categories of air quality is not a desirable program design on a permanent basis, though it is worth considering as an interim strategy. One proviso is necessary in the event such are adopted: the ambient target levels that meet the health criteria should be separated from the ambient standards, so that if standards for some classes of locations are adopted that do not achieve the ambient targets it will be clear that these are areas that will not meet the health targets.

Basis for emission standards. Various interviewees have asked what form the new standards will take.

One can observe from the appendices that traditionally two classes of emission standards have been applied:

1. *Performance standards* are applied when a target rate or mass of emissions is desired, but the means of achieving those levels are not specified in rules. Tailpipe standards for new vehicles have traditionally been in the form of performance standards. The current emission standards in Egypt are all performance standards.

2. *Technology standards* are applied when the rules specify a technology to be used. Despite their name, the new source performance standards in the U.S. have operated as technology standards, in that once a technology has been adopted as the best available technology its specifications become the de facto standard.

In the U.S. both kinds of standards are applied, since both have a functional role. First, to meet the ambient standards performance standards are applied to individual sources. In addition, because the most economical time to make emission reductions is when new sources are being built or major modifications are being made to existing sources, the technology-based standards are applied in these situations, regardless of the ambient air quality into which they will emit. The application of technology standards to new sources is also important for equitable reasons, since allowing them to avoid the burden of making reductions while existing sources are forced to build new equipment they would otherwise would not have built would be seen as unfair. In the long run, it has been expected that the regular turnover of equipment would provide an automatic upgrade of emission control equipment over time that would offset the expansion in the economy, though some have taken advantage of loopholes to avoid such upgrades.

Unlike the ambient standards, which are universal, there is no single best formula for determining which among the types of standards will be the most suitable for a program. As a general rule, if one expects to make progress a guiding principle would be to mandate the more stringent of either the best available technology standard or standards necessary to attain the ambient standards, though that is merely a rule of thumb. More importantly, the right answer is to give them a process with a list of alternatives on how to decide that question and let them work it out what decision rule they will use. We can list criteria.

Form of performance standards. For performance standards that are adopted there are two forms that the standards can take:

1. *Rate standards*. Rate standards are those in which compliance is measured in terms of concentration per volume or unit of output. This was the form many standards took initially in the U.S. It did not impede economic growth because it allowed emissions at a fixed rate. If a firm doubled the size of a plant the rate of emissions remained the same. Environmental groups began to criticize rate standards because they allowed total emissions to increase with economic growth, so that over time standards would have to be rewritten repeatedly so that a lower rate could be applied to compensate for higher volume. In addition, because such standards are measured by concentration they are easy for industry to comply with, since the actually concentration can be diluted with additional air until the standard is met.

2. *Mass emission standards*. Mass emissions are those in which compliance is measured in terms of total mass over a period. This approach enables one to measure the total environmental loadings; if the rate of production of a plant increases, the plant must find a

way to reduce the emissions per unit of production. By measuring load rather than flow you can overcome the dilution problem. This approach was suggested by Nader Shehata Doas, Cairo environmental lab manager.

Of the two approaches, the mass emission approach is more stable over the long term. Setting standards for the total amount of pollutant, rather than the rate of emissions per volume or unit, avoids the necessity of going through successive changes of standards as economic growth increases production with concomitant increases of emissions. An ideal approach that provides flexibility to industry is to set performance standards on a mass/year basis with limits on short-term peaks to assure that acute exposures do not reach acutely hazardous levels. If standards are desired for new sources, a supplementary requirement can mandate that they meet emission levels equivalent to those that would be met if the project were financed through one of the world financial bodies such as the IFC, African Development Bank, etc. The principal financial organizations that impact world air quality standards are identified, but not analyzed in any depth, in Appendix D.

In Egypt, Article 10 of the Executive Regulations, which applies to numerous facilities listed in Annex 2, requires an EIA.[11] If it works according to design this process would prevent the expansion of industry from increasing total load. This should be taken into account when considering the form of the standards.

Deadlines. Under Article 1 of President Mubarek's Order promulgating Law 4/1994, a final date for compliance with Law 4 is for February 2000. This date is fixed by the date of issuance of the Executive Regulations (1995), plus three years grace period, plus two years of extension, which yields the date February 2000.

Air Quality and Public Opinion

Another reason to examine the general background for designing a new system of standard-setting is the general perception of air quality in Egypt.

The U.S. experience, as reviewed Appendix B.1, shows that public opinion is a significant driver in the development of air quality regulation. In the U.S., air quality emergencies in Donora and London provided alarming examples that human health could be harmed by the accumulation of pollutants in the ambient air. Drawing from these examples, individuals began to recognize that they were being exposed to pollutants from sources over which they had no control and considered it an inequity that could not be corrected through voluntary market transactions. They turned to legislation to mandate relief.

While a scientific examination of public opinion was not made as part of this project, interviews, discussions of recent events, and observations suggest that public opinion in Egypt currently is in an ambiguous and transitional state.

On the one hand, there is the background of traditional views. In the long course of Egyptian history the experience has been, as it was in the U.S., that air pollution just blows away. The intermittent dust storms, while not welcome, created an expectation that air quality problems

[11] See Egyptian Environmental Affairs Agency, Environmental Management Sector, "Guidelines for Egyptian Environmental Impact Assessment," Oct. 1996.

are naturally caused and temporary. Accustomed as Egyptians are to seeing dust, they have been traditionally conditioned to look at poor ambient air quality without thinking of it as air pollution.[12] It is not clear how well understood is the relationship of air quality to human health. One can observe a certain degree of acceptance of existing air quality as if conditions are not polluted. With the exception of removing lead from gasoline, there does not seem to be a strong perception that the pollution is medically harmful and having a cost. That is, in a city that has significant public health problems resulting from poor air quality, air pollution is discussed as if it were a hypothetical problem.

On the other hand, consciousness of air pollution as a man-made and unnatural phenomenon may be growing now. In the fall of 1999 an inversion, which has come to be known as "the Black Cloud," raised public awareness about air pollution. Although an inversion had occurred the previous year, this was the first time the public became politically sensitive to it.[13] It was clear that the phenomenon was anthropogenic, and a concerned public turned to the government for explanations. Surveys of public opinion now report high recognition of air pollution as an issue, and especially of mobile sources as a cause of the pollution problem.[14] While actual ambient pollutant concentrations during the Black Cloud are subject to debate,[15] it is clear that as a matter of perception the event is analogous to the Donora incident in the U.S. and the London smog. The experience has raised public concern that may cause decision makers to reevaluate their views of the importance of air pollution control. This could result in elevating consideration of ambient air quality in policy decision making, such that control of emissions to ambient improve air quality becomes an active program.

The final measure of public opinion may depend to a large extent on the availability of air quality data, either that collected from ambient monitoring or that estimated by the U.S. EPA in its evaluation of the Black Cloud incident. If data are made available to the public that show high ambient concentrations, the demand for air pollution control in Egypt would increase markedly. On the other hand, if such data are not made available, the public would never know and would not be in the position to demand a remedy for the public health risk to which they are exposed.

The reason to consider these possibilities is that in the current state of flux one has to assess the degree of public approval for air quality programs. The program suggested in this project will to some extent shake up the status quo. In general principle, any program that has cost or involves perceived sacrifice — and certainly air quality control meets those two criteria — can only go as far as public opinion will allow. Is there the political will to implement a $PM_{2.5}$ standard? Could emission standards be enforced without being undermined by resistant industries? These outcomes depend upon the degree of concern expressed by the public. If a genuine review of the air quality standards and the implementation of a review process are to take place and be fully implemented, then there will have to be a considerable increase in commitment from both the GOE and the industries. For air quality programs to

12 I am given the impression that many in Egypt accept air quality as it is in the belief that the current conditions are not polluted. As it appears, stationary sources know that they are emitters, but they don't think of themselves as polluters. With the exception of gasoline lead, which was eliminated very quickly, no one in Egypt seems very motivated by the idea that the pollution is medically harmful and having a cost. Without an explicit expression of the connection between emissions and ambient concentrations, they don't make that connection themselves.

13 Pasarew Interview, supra.

14 Interview with David Fratt, Cairo Air, May 2000.

15 According to Dr. Nasralla, the concentrations in Cairo were much less than in either Donora or London, and not much above the standards.

have a tangible impact it is essential that they also attain a higher degree of acceptance among the professional and scientific communities.

Thus, public opinion is important to the success of the program, and the consensus-building processes that are planned for subsequent stages of this process will be important as means of developing legitimacy for the processes that are envisioned.

Process: The Need for Regular Review and Revision of Standards

As indicated in Appendix B, the prevailing notions about air quality standards have changed over time, and one can expect that in the future with the growth of information they will change again. Until world standards converge around a single set of precise norms, which will occur in the future only when long-term exposure/dose relationships have been completely studied, new information will continue to change our perceptions of the ambient hazard.

In the past, the addition of new information has generally caused standards to be made more stringent, as correlations of exposure levels to human health damage have been found at lower and lower levels. This will not necessarily be the rule in the future. As information becomes more precise, uncertainty factors will be reduced, allowing reductions in the margins of safety that now exist to cover uncertainty. Such will offset increases in stringency, potentially even causing the standards to become less stringent. Thus, one should think of the process as yielding more refined and targeted standards, not standards that necessarily become increasingly difficult to achieve.

Currently, the ambient air quality standards used in Egypt suffer from numerous deficiencies, some of them obvious. It is apparent from the review conducted here that enforcement of the standards as presently written could result in a less-than-perfect targeting of scarce air pollution control resources. Recognition of this problem calls upon Egypt to review its ambient standards to make them current with world standards, and to revisit them on a regular basis to stay current as additional changes in world standards are made.

A system of periodic review of the standards was advocated by Dahlia Lotayef of EEAA as part of a new system of science-based environmental targets. Precedents established in other countries suggest how this may be accomplished. In the U.S., for example, the ambient standards are required to be reviewed as a matter of routine every five years and may be reviewed more often as new information appears. This requirement has been less than rigorously applied in practice, resulting in a routine review of each standards every five to ten years, approximately. While a routine review more often than once every five years is undoubtedly a greater burden than Egypt will want to shoulder, a review cycle of longer than once every ten years is probably too great, given the rapid increase of information. In just the last ten years there has been a total revolution in the understanding of PM's health effects. Thus, a review cycle of five to ten years, inclusive, would be a reasonable approach in Egypt.

Dahlia Lotayef was the strongest advocate for a system of periodic review of the standards. She conceptualized it as part of an integrated strategy for air quality control in which decisions are made on a scientific basis, rather than as reaction to pressures. Programmatic goals would be translated into a strategic plan of action, then there would be a feedback system using indicators that measure the parameters used in the regulations. In other words, periodic review would function as part of a whole air quality management system.

Observations on Administration of the Air Pollution Program

In addition to comparing the current emission standards, a second phase of the analysis involves examining the administrative system in which the standards are implemented to make them tractable. Thus, the next task of this project will be addressed to correcting these deficiencies in the existing administrative and legal framework.

Administration of the Air Pollution Law

Interviewees identified several problems in the administration of the law or proposed administrative mechanisms that should be considered.

Procedures. An item mentioned consistently in interviews with EEAA officials was the need for clearer procedures and more authority for enforcement. Interviewees expressed deep conviction that one of the most pressing items is removing the constraints and limitations they confront in doing their jobs.

For example, as discussed above, Article 34 (requiring compliance with the ambient standards) is potentially unenforceable if read literally. No administrative mechanism is specified for enforcement and there is no legal tool to apply in case of noncompliance. The program works if a company volunteers to comply, but if it doesn't meet the standard no process for addressing that is stated. According to Dr. Ahmed Hamza, Sr. Technical Advisor, EEAA, the Executive Regulations don't specify the frequency of sampling or the statistical significance of violation. The Regulations don't tell when they should start legal action. Other examples include the absence of protocols for testing the emissions of sources, the difficulty in applying the standards to the various emission sources, the lack of definition in inspection procedures, clarity in the administrative decision structure, and training in specific inspection procedures and use of sampling equipment.

To have an enforcement program the law must specify how to distribute the burden. A goal of an overall administrative review will be to clarify responsibilities. According to Ahmed Ismael, consultant for EEAA environmental inspection, their work depends on branches. The efforts of the branches are not sufficiently coordinated, resulting in duplication. Sometimes they cooperate, sometimes not.

Article 5 of Law 4 describes the functions of EEAA, to develop strategy, action plan, standards, and operationalization of plans. A summary of relevant powers belonging to EEAA appears in Appendix A. The powers granted under the law are broad. Thus, in general principle it appears to be possible to achieve all the administrative changes, including issuance of new regulations, without statutory change. The regulations should be reviewed as a legal document to provide definitions and make sure all the essential elements are present.

Staff and resources. A frequent complaint was that the programs are understaffed and the staff lack resources for the job.

According to Nader Shehata Doas, Cairo environmental lab manager, the staff assigned to monitor air emissions is too small; he has three people, and while they are well trained he needs at least two more. He complained he does not have enough equipment or spare parts, and often lacks the cars to get people to do their work. Due to these limitations, inspections are not made by routine; they take measurements only when there is a complaint against a facility. Dr. Hamza says he lacks personnel, instruments, and political commitment to enforce against a violation. He notes that in Annex 8 there are more than 300 limits for indoor concentration of chemicals; he complains his staff cannot measure more than two or three of these. As a result, that rule is useless and has no meaning.

Any program that is developed to provide a more scientific, quantitative approach will have to rely on the resources needed to run such a program. At present, that is a clear deficiency.

Permit system. Esko Meloni, with the Egyptian Environmental Assessment Project, is a strong advocate for a system of emission permits to implement the ambient standards. In 1999 he delivered a conference paper that recounted the success of Finish authorities in use of a permitting system to reduce emissions from the pulp and paper industry there.[16] In Finland permits are granted for 7 years, and at the end of that period they negotiate a plan to go on when the permit is renewed. In the future the permit system will come under new EU legislation that integrates water and air permits.

The system he advocates is to have quantitative standards implemented by an operating permit system that states the amount of emissions from a specific facility. Such a permit system would consolidate all emission requirements for a facility into one document, so that distinctions such as type of equipment or geographical distinctions are clarified. The question is whether the industries in Egypt are ready for that. While a permit system works well in an advanced environmental culture, especially one in which reliable data are the norm and expertise is generally available, it may be difficult to get the industries to agree to such a system in Egypt. Another problem is that a permitting system is appropriate for major industries but does not cover emissions from sources such as trash burning, etc., which are a large source of particulate emissions in Cairo. The better argument is that a permit system in Egypt should wait until a better air quality system as a whole has been adopted.

Development of Sound Methodologies

Following closely from the previous discussion, a second complaint heard in interviews was that the methodologies for air pollution control are not on a sound technical basis.

Basis for the standards.. Interviewees consistently voiced a recognition that the standards did not have a solid scientific or medical basis and that what would make them meaningful would be to put them on a sound basis. As a matter of process, clearly there should be more science in the regulations and more planning in the policy.

Dahlia Lotayef emphasized that targets should be on a scientific basis to achieve air quality, and that these should be translated into a plan of action, standards, priorities strategy. She suggested that it would be appropriate to have a standing group to adopt the standards. She argued that Article 5 under Law 4 provides authority, although there needs to be appropriate linkage. Dr. Hamza says, also suggested a standing technical committee to review and put a long-term plan in place, based on scientific considerations and representing various communities that should work together.

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[16] Esko Meloni, "Development of Water Pollution Control in the Finnish Pulp and Paper Industry — A Case Study: Are There Lessons to Be Learned?"

Quantitative methods are essential to standard-setting and standard-enforcement, and more science could be used to link the emission standards with the ambient standards. Developing rigorous protocols must be part of the revision process. On the other hand, there is always the risk that more methodologies will put steps in the way and that in consequence progress will be slowed. The requirement of too much information, or information obtained with excessive precision, can become a means of postponing implementation of the standards.

Methods for testing and compliance. Interviewees had many complaints about the lack of clear methodologies for ascertaining compliance. In general principle, they argued that nothing in the regulations indicates how the compliance is to be measured or how testing protocols are to be conducted. The regulations lack procedures that set out the parameters for monitoring, the frequency of inspection, or other details.

For example, there were many complaints about implementing Article 42 of the Executive Regulations (regarding combustion emissions). Several deficiencies were identified:

1. Article 42(B) prescribes the use of chimneys for combustion sources that have total waste of 7000 kg/hour or more. However, many emission sources do not have a chimney to take emission measurements from, making it impossible to enforce the emission standards. The problem occurs mosly in small, unregistered industries that do not have adequate technology or facilities.

2. The lack of specific testing protocols enables the industries to produce compliance by changing the engineering parameters at the time of measurement. Given the low frequency of inspecting and the absence of specific protocols, companies have the chance to prepare stacks for inspections. One way the industries can create compliance is to dilute the emissions with oxygen to meet the standard.

The program needs to develop specific standardized procedures and sampling methods that have approved quality assurance or quality control practices. Any such program will find it useful to rely on the standard methodologies that have already been adopted and are in use by international financial organizations or the ISO. These are available, and their use simplifies the implementation of methodologies. As summarized in Appendix D, the world community is attempting to develop standardized methodologies. These will be critical for success of any standard Egypt adopts.

Conclusions and Recommendations

This project has great potential to stimulate fundamental change. It provides an uncontroversial mechanism to develop the air quality programs and move them forward. A number of suggestions have been made in this report which could provide a basis for progress. The next step would be to establish a process that rewrites the Executive Regulations and updates them on a regular basis. Two questions remain open: what sort of program will it be, and how fast should it proceed?

The cautious approach. Interviewees typically offered a cautious approach. Dahlia Lotayef suggested that developing the system would take time: Each new system of regulation needs some time in the field to be tested. Then you can start really judging any deficiencies or gaps. Unless we have a system to support regulation we cannot know whether the deficiency comes from the regulation or on the implementation. In sum, her judgment was that these things take time.

However, from the view of an outsider there is really nothing that is required in Egypt that has not already been worked out elsewhere, and no obstacle that has not already been encountered and overcome. Given the resources and the commitment, the obstacles are actually very few.

As important as it will be to establish a relationship between the emission standards and the ambient standards, the prospect for developing a reliable quantitative relationship of the two program elements is currently a long way off. Such a relationship on a quantitative basis would require obtaining high quality measurement of ambient concentrations, measuring emissions from all the significant categories of sources, and developing an inventory from these measurements the relative contribution of the various source categories. From that exercise the appropriate emission reductions can be decided for each category of sources and emission standards can be written.

Practical steps. One readily sees that delaying action until all these steps are completed would take far too long, and that the benefits of precision would be far outweighed by the costs of delay. Thus, an interim strategy seems appropriate. It would contain two elements.

First, the relationship of emissions to ambient air quality should be stressed as part of a new approach. As mentioned above, it is crucial that emission sources recognize that their emissions contribute to pollution, that pollution is a public health problem with economic consequences, and that every increment in emissions is an increment in ambient loadings. The historical example shows that the understanding of the relationship does not have to wait for complete information. While it will not be possible to quantify this relationship immediately, at least the program can be organized in this way so that there will be a tie between ambient and emission standards that can be made more quantitative as data becomes available.

Second, attainment of the health-based standards is unrealistic in the near term. Interviewees identified a number of constraints — lack of resources, competition with other priorities, lack of expertise and institutional capabilities, and lack of political will — that make attainment unattainable in any short-term scenario. At the same time, it is not appropriate to go to the other extreme and ignore the ambient standards. Thus, there has to be a way of working toward them in a reasonable and appropriate way.

Since most emissions in Egypt are at high to uncontrolled levels, resulting in ambient pollutant levels that cause significant damage to public health, it would be appropriate as an interim step to issue new emission standards without waiting for signals from ambient standards. Given the state of generally uncontrolled sources at present, one can assume that emission reductions in the short term will not result in a condition of wasteful overcontrol. Thus, various technologies and the source categories that use them should be targeted for application of new emission standards without regard to their specific impacts on ambient loadings. That will have to wait until later.

Two approaches for such a program suggest themselves. The first is a schedule of emission reduction targets for industries generally. This approach would apply a percentage reduction to all industries on an annual basis, for example, "reduce SO_2 emissions by 30 percent in three years, 50 percent in five years, and 70 percent in seven years." It sounds reasonable and moderate. However, such a program is indifferent to the relative costs of SO_2 reductions to the various industries. More significantly, for many capital-intensive industries a phased approach is anything but reasonable. Emission reduction equipment used to meet the three-year target might have to be scrapped to meet the seven-year target, long before its useful life is exhausted. Moreover, adding emission controls to some of the old-vintage equipment also does not make economic sense. Given the advances that have been made in other programs there is no technological obstacle in most industries that would require an interim step. The first suggestion is not viable.

A second approach would be to rewrite the emission standards one industry at a time, and at the effective date requiring that industry to move up to the world norm in a single step. Instead of reducing emissions from all facilities by a specific percent in a given year, this alternative would make large reductions in specific industries in given years. That way, instead of asking a company to reduce emissions in multiple small increments it can be reduced by replacing major equipment with new equipment. The efficiencies will offset the cost of emission controls, and they will get better products. Moreover, focusing on one industry at a time would avoid adverse competitive effects on any one firm, such as arguing that it has a burden others do not. Each industry will have subdivisions, for example, utilities will have several kinds of boilers. It would be a rolling process, moving from one industry to the next as years pass. The first task would be to look at all the source categories and set up a scoring of various industries in order to prioritize them into a schedule: industries emitting the problem pollutants (PM and its precursors) in the largest amounts; industries with obsolete facilities that would make good targets for renovation; industries that are capital-intensive and high profile. Emissions would fall as the process works through the list, industry by industry. Targeting the resources to move one industry at a time is a much more viable option.

The overriding concern will be the health and life potential of the Egyptian people. This report concludes that it is possible to start making positive steps now.

Appendix A – The Egyptian Air Quality Program

The review begins with a review of the existing Egyptian air quality program. I have included a review of background information, as well as the existing standards.

Background: Egyptian Environmental Laws

Like most law the Egyptian environmental law grew out of experience with prior legislation.

Prior Efforts to Address Environmental Issues

Prior to the early 1990s a variety of laws governed air pollution control in Egypt. This collection of mandates resulted in a widely dispersed approach to environmental programs. Earlier studies found authorities scattered among 17 ministries responsible for 81 laws, 34 Presidential decrees, 17 Prime Ministerial decrees, 287 Ministerial decrees, and 34 international environmental convention protocols. This system was ineffective because of:

- a lack of awareness of the seriousness of environmental pollution by policy makers;
- many outdated regulatory requirements (as of 1993 nearly 65 percent of the laws were at least 15 years old);
- penalties set at old rates and were trivial in size;
- the lack of a system to monitor, sample and detect pollution; and
- statement of standards for pollutants under existing laws as narrative rather than quantitative.[a]

On May 8, 1992, the GOE issued the National Environmental Action Plan (also referred to as the Egyptian Environmental Action Plan) calling for a comprehensive, long-term program to reverse the trend toward deterioration of Egypt's environment. Developed by EEAA with contributions from international experts, the Plan was designed along the lines of a World Bank document. The Plan identified several major environmental problems, including salinization of land, pollution of the Nile and air pollution.

The 1994 Environmental Law

Many provisions of law that had been adopted before were superseded by Law 4 of 1994, which enacted The Environmental Law.

<u>Powers of the EEAA</u>. Under the 1994 the EEAA is given the powers to do all the following:

- prepare draft laws and treaties;
- prepare studies and formulate the national plan for environmental protection;
- set criteria and conditions that owners of facilities must meet before establishing their projects and during operation;

- survey the national organizations and institutes in preparing plans for environmental programs;
- conduct field follow-up implementing the criteria and conditions and take action against violators;
- set rates and percentages to guarantee that the permitted limits for pollutants are not exceeded;
- gather data on the environmental situation in cooperation with data centers of other authorities and use them in planning;
- set the bases and procedures for evaluating the environmental effect of projects;
- plan for environmental emergencies;
- conduct environmental training;
- conduct the national environmental survey and benefit by its data;
- prepare periodical reports and publish them;
- conduct environmental education programs for citizens;
- propose economic mechanisms to encourage activities to prevent pollution;
- implement experimental projects;
- coordinate with the Ministry concerned with International Cooperation
- participate in preparing the plan to secure the country against leakage of dangerous materials;

Air Pollution Standards under the 1994 Law

Three kinds of standards are applied under the 1994 law and its Executive Regulations — ambient air quality, stationary source emissions (including hazardous air pollutants), and mobile source emissions.

Ambient Air Quality Standards

Under Article 34 of the Executive Regulations, "the total amount of pollution emitted by all the establishments in any one area must be within the permissible levels as indicated in Annex (5) of these Executive Regulations." Annex 5 sets out quantitative values for ambient air quality standards, as set out in Table A.1.

Table 6 Annex No. 5 – Maximum Limits of Ambient Air Pollutants[a]

Pollutant	Period of Exposure[b]	Maximum Limit (Ceiling)
SO_2	1 hour	350 μg/m^3
	24 hours	150 μg/m^3
	1 year	60 μg/m^3
CO	1 hour	30 milligrams/m^3
	8 hours	10 milligrams/m^3
NO_2	1 hour	400 μg/m^3
	24 hours	150 μg/m^3
O^3	1 hour	200 μg/m^3
	8 hours	120 μg/m^3
Suspended Particles (measured as black smoke[c])	24 hours	150 μg/m^3
	1 year	60 μg/m^3
Total Suspended Particles	24 hours	230 μg/m^3
	1 year	90 μg/m^3
Respirable Particles (PM_{10})	24 hours	70 μg/m^3
Pb	1 year	1 μg/m^3

Source: Annex 5, Executive Regulations, p. 53; footnotes to the table are original to this report.

[a] Standards are expressed in microgrammes per cubic meter of ambient air (μg/m^3), except for CO which is stated in milligrams per cubic meter.

[b] The averaging time is expressed as "period of exposure." It is assumed that these are calculated in arithmetic mean. The U.S. rule is that for any period other than an annual period, the applicable maximum allowable increase may be exceeded during one such period per year at any one location. It is not specified if such a rule applies in Egypt.

[c] The term "black smokes" as used in Annex No. 5 is not defined therein. However, it is described in the World Bank Handbook, at III-10, where it is stated: "Black Smoke (BS) is a particulate measure that typically includes respirable particles smaller than 4.5 μm in aerodynamic diameter, sampled by the British smokeshade method. ... Its use is recommended in areas where coal smoke from domestic fires is the dominant component of ambient particulates since this method is based on reflectance from carbon in elemental form.... ...BS is roughly equivalent to PM_{10}. ... The BS measure is most widely used in Britain and elsewhere in Europe."

It should be noted, however, that Article 34 does not directly require the attainment of the ambient air quality standards set out in Annex 5. By stating that "the total amount of pollution emitted by all the establishments in any one area must be within the permissible levels," it literally requires that the *emissions* in an area meet the standards. A requirement that ambient air quality meet the ambient standard would not have been stated in terms of emissions. Probably it can be inferred that what was intended was that the ambient air meet the ambient standard, but as stated it is possibly unenforceable if taken literally.

The Executive Regulations also include standards for occupational air quality within the section on air pollution. While these are interesting for comparison, they are not addressed in this report.

Stationary Source Emission Standards

The Executive Regulations prescribe both generally applicable standards and standards applicable to fuel combustion sources.

<u>Generally applicable standards</u>. Article 36 of the Executive Regulations requires that stationary sources for which emission standards in Annex No. 6 are applicable meet those standards.

Annex No. 6 Permissible Limits of Air Pollutants in Emissions

Annex 6 is expressed in two separate tables, one for particulates only, the other for other types of emissions. They are set out here in the same format.

Table 7 Overall Particles

Pollutant	Industry	Vintage	Maximum Limit (Ceiling) of Emission
Particulate Matter	carbon industry		50 mg/m^3
	coke industry		50 mg/m^3
	phosphates industry		50 mg/m^3
	casting and extraction of lead, zinc, copper and other non-ferrous metals		100 mg/m^3
	ferrous industries	existing	200 mg/m^3
		new	100 mg/m^3
	cement industry	existing	500 mg/m^3
		new	200 mg/m^3
	synthetic woods and fibres		150 mg/m^3
	petroleum and oil refining industries		100 mg/m^3
	other industries		200 mg/m^3

a Standards are expressed in milligram per cubic meter of exhaust mg/m3 unless stated otherwise. No averaging periods are specified in the regulations.

Source: Annex 6, Table 1, Executive Regulations, p. 54; footnotes to the table are original to this report.

Table 8 Maximum Limits of Gas and Fume Emissions from Industrial Establishments

Pollutant	Industry	Vintage	Maximum Limit (Ceiling) of Emission
Aldehydes (measured as formaldehyde)	all		20 mg/m^3
Antimony	all		20 mg/m^3
Carbon Monoxide	all	existing	500 mg/m^3
		new	250 mg/m^3
Sulfur Dioxide	burning coke and petroleum	existing	4000 mg/m^3
		new	2500 mg/m^3

Pollutant	Industry	Vintage	Maximum Limit (Ceiling) of Emission
	non-ferrous industries		3000 mg/m^3
	sulfuric acid industry and other sources		1500 mg/m^3
$SO_3 + H_2SO_4$	all		150 mg/m^3
Nitric Acid	nitric acid industry		2000 mg/m^3
Hydrochloric Acid (Hydrogen Chloride)	all		100 mg/m^3
Hydrofluoric Acid (Hydrogen Fluoride)	all		15 mg/m^3
Lead	all		20 mg/m^3
Mercury	all		15 mg/m^3
Arsenic	all		20 mg/m^3
Heavy Elements (total)	all		25 mg/m^3
Silicon Fluoride	all		10 mg/m^3
Fluorine	all		20 mg/m^3
Tar	graphic electrodes industry		50 mg/m^3
Cadmium	all		10 mg/m^3
Hydrogen Sulphide	all		10 mg/m^3
Chlorine	all		20 mg/m^3
Carbon	garbage burning		50 mg/m^3
	electrodes industry		250 mg/m^3
Organic Compounds	burning organic liquids	[details unclear]	50 mg/m^3 0.04% of crude (oil refining)
Copper	all		20 mg/m^3
Nickel	all		20 mg/m^3
Nitrogen Oxides	nitric acid industry	existing	3000 mg/m^3
		new	400 mg/m^3
	other sources		300 mg/m^3

a Standards are expressed in milligram per cubic meter of exhaust (mg/m3) unless stated otherwise. No averaging periods are specified in the regulations. These standards were derived from standards adopted by U.S. EPA, WHO and ILO; there is no indication of the method used to adopt them. Some details of the standards remain unclear in the unofficially translated version; they should be checked with the official Arabic text.

Source: Annex 6, Table 2, Executive Regulations, at p. 55-56; footnotes to the table are original to this report.

Standards applicable to fuel combustion sources. In addition to the general provisions, specific provisions apply to fuel combustion sources under Article 42 of the Executive Regulations:

(A) *Precautions to minimize pollutants*. Article 42(A) sets out several mandates to use sound engineering practices in combustion, to not burn coal or mazout in populated or residential areas, to limit sulfur content in fuel used near residential areas to 1.5 percent, and to dilute CO_2 emissions by use of smokestacks.

(B) *Chimney heights*. Article 42(B) specifies heights of various classes of chimneys.

(C) *Limits on Emissions*. Article 42(C) specifies emission limits from fuel-burning sources.

Table 9 Maximum Limits on Emission from Fuel-burning Sources

Pollutant	Maximum Permissible Limit
smoke	1 Using Ringelmann Card
dispersed ashes	1 Ringelmann - sources existing in urban regions, or close to residential areas 2 Ringelmann - sources far from habitation 2 Ringelmann - burning of wastes
SO_2	Existing, 4000 mgms/m^3 New, 2500 mgms/m^3
aldehydes	Burning of waste, 20 mgms/m^3
CO	Existing, 4000 mgms/m^3 New 2500, mgms/m^3

Source: Article 42(C), Executive Regulations, at p. 32; footnotes to the table are original to the Executive Regulations.

Mobile Source Emission Standards

As part of its environmental regulations Egypt has adopted the standards for passenger cars given in Table 5.1.

Table 10 Egyptian Vehicle Emission Standards

Pollutant	Existing Vehicles	New Vehicles
CO	7% vol. at idle speed (600-900 rotations/min.)	4.5% vol. at idle speed (600-900 rotations/min.)
HC	1000 ppm at idle speed (600-900 rotations/min.)	900 ppm at idle speed (600-900 rotations/min.)
Smoke	65% darkness (opacity) or equivalent at max. acceleration	50% darkness (opacity) or equivalent at max. acceleration

Source: Article 37, Executive Regulations, at p. 27; footnotes to the table are original to this report. Vehicle emission standards were previously set out by Law 66 of 1973, which dealt with traffic and vehicle exhaust regulation.

There are two important features listed in Article 37 regarding the applicability of the vehicle emission standards:

- The standards do not necessarily apply throughout all of Egypt. The rules specify their applicability is to be determined by a Decree of the Minister of Interior that will specify the Governorates in which these standards are applicable. The rules then become effective one year following that Decree.

- EEAA may reconsider the standards in coordination with the Ministries of Interior, Industry, Health and Oil three years after their issuance.

Overall, these provide that for the next three years Egypt will have emission control standards that are not technology forcing. In fact, they are described as being at a level that late-1960s control technologies would meet.

Appendix B – U.S. Air Quality Standards

The U.S. has been a leader in establishing air quality standards, policies and programs. The U.S. program is a well developed articulation of mechanisms for combatting air pollution problems, and thus it represents a set of approaches that must be considered in any comparative study.

The U.S. program is important for a second reason as well. Because many of the world's air quality conventions were first adopted in the U.S., the development of the U.S. program occurred on a blank slate. By contrast, other countries that have adopted the conventions that are already established do not need to consider the underlying fundamentals to the same extent. Such countries can simply adopt conventional program elements in order to comply with international pollution norms without going through the process of fundamental exploration and discovery that had taken place before. Thus, it is prudent, if one wants to reexamine an air pollution program thoroughly, to look at not only the quantitative standards in the U.S. program but also the policies and decision processes from which those standards were derived, since these provide a window into the complex dimensions of decision-making.

Development of U.S. Air Quality Regulation

Because of the current structure of Egyptian environmental regulations, it is relevant to examine selected aspects of the development of the U.S. air pollution program. The American experience provides useful comparisons with perceived obstacles to progress in the Egyptian program.

Traditionally, in the Anglo-U.S. legal tradition, common-law rules governed responsibility for air quality. These were principally liability rules for private legal action, supplemented with public nuisance ordinances of local governments. Generally, these were designed to reduce emissions that affected adjacent and downwind individuals. By contrast, no one gave serious thought to establishing standards for the *ambient* air, that is, the unrestricted open air outside buildings. Beyond the immediate proximity to a source, or a plume emitted from it, air pollution was assumed to disperse and not concentrate to levels of any concern.[17]

In the late 19th Century, with the grown of emissions from from new combustion sources such as steam engines and electric power plants, especially those using soft coal,[18] the incidence of urban smoke increased to new dimensions. Many municipalities adopted anti-pollution laws to combat the problem.[19] These legal programs recognized the accumulation of emissions into an aggregate that created an ambient pollution phenomenon, and early advocates for such laws even drove their publicity campaigns on health and beauty. But the health considerations they recognized were limited in two ways. First, they were limited to those that concerned sanitary health (cleanliness), rather than toxicological health (disease

[17] The 19th Century municipal smoke laws did not consider air pollution both toxicological and ambient. They might be considered toxic to receptors that are immediately adjacent to the source or within a plume, but not to unrelated individuals in the open air. Or they might be ambient in the recognition that smoke accumulates, but only as a nuisance in the sense that they are dirty or unhygienic and not chemically toxic. To show that this works I would have to show the absence in those laws of provisions for chemical toxicity in the open air.

[18] David Stradling, Smokestacks and Progressives: Environmentalists, Engineers and Air Quality in America, 1881-1951 (Johns Hopkins, Baltimore, 1999), at 1-2.

[19] Loeb, A.P. and T.J. Elliott, "Looking Backward and Forward: A Review of Particulate Emission Control in the U.S.," presented at the meeting of the Fine Particle Society, Chicago, Illinois, August 24, 1995.

caused by exposure to harmful or toxic chemicals). Second, while they recognized the unsanitary effects of ordinary smoke, they did not yet recognize the true extent of hazard resulting from exposure to it. To a large extent, they were concerned only with dense smoke, and it was considered to be mostly a contributing factor in other diseases.[20] Thus, they recognized that in some circumstances smoke could accumulate sufficiently to become ambient, and they recognized that it was unsightly and unhealthful, but they had very limited awareness of pollution toxicology, certainly not enough to drive public demand for controls.

The first modern air pollution controversy in the U.S. was the introduction of lead additive for gasoline in the 1920s. Leaded gasoline introduced the novel scenario that individuals could be harmed, *toxicologically* harmed, by inhaling pollutants in the ambient air. While concerns for lead emissions from vehicles forced the U.S. Surgeon General to consider the possibility of an ambient hazard, the concept was too novel to be readily accepted as real, and in the absence of a concrete finding of imminent harm the concern for ambient hazards was put aside.

The notion that the public health could be harmed in the ambient environment was reawakened a generation later in Donora, Pennsylvania. On October 25, 1948, a temperature inversion settled over the valley, trapping emissions from local industry. Over six days the inversion caused approximately 18 deaths out of a total population of 13,839; in addition, 26 percent of the population over age 55 suffered disabling illness. A second episode, an inversion in London in December 1952 that caused four thousand deaths, reinforced the lesson from Donora that emissions don't just blow away and disperse, they accumulate in the ambient air. These two episodes were a turning point in U.S. public opinion.

By the mid-1960s the concept of an ambient level had become accepted as a regulatory construct. It was decided that ambient standards should be set at levels deemed necessary to protect the public health, and emissions would be reduced to levels that would achieve the ambient standards. It was not until 1970 that this could be achieved scientifically, but the development of a model for linking emissions to ambient concentrations cleared the way for establishing the regulatory structure that forms the basis for the modern Clean Air Act. Thus, Congress established the Act with the belief that safe air quality levels could be established and that these levels would drive the emission standards with mathematical precision. Since the entire system would be mathematical in nature there was no room for exception.

It would be very easy to overlook the lessons that produced modern air pollution control. Clearly, the modern programs result from the recognition that ambient air pollution presents hazards to the public health, and that emissions must be limited to those that achieve ambient levels that are consistent with public health. From what I have observed in Egypt, this is a fundamental lesson has still not taken firm hold but must if progress is to be made.

Structure of U.S. Air Quality Regulation

The program for control of air pollutants in the U.S. originated in the 1960s under the Clean Air Act and took its modern form in the 1970 Clean Air Act Amendments. It originally consisted of a simple structure based on two fundamental distinctions:

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[20] Stradling, supra, at 51.

1. regarding *types of sources*, it distinguished stationary sources from mobile sources; and

2. regarding *types of pollutants*, it distinguished between ambient air pollutants and hazardous air pollutants.[21]

Within those fundamental categories further distinctions were made between state and federal responsibilities, between new sources and existing sources, and so on. It is to be noted that the 1970 Act did not create a program for hazardous substances for mobile sources. Since hazardous air pollutants from mobile sources were not contemplated under the 1970 Act, it is shown in the Table as an empty cell.

Based on these distinctions, air pollutants covered by the Clean Air Act can be organized into a conceptual matrix, shown in Table B.1. It is obvious from the matrix that the Act is an ambitious attempt to control a variety of air pollution problems with numerous programs.

Table 11 Conceptual Organization of the Clean Air Act as Amended in 1970

pollutant type[a]	stationary sources	mobile sources
conventional pollutants- primary and secondary ambient air pollutants (based on criteria pollutants identified by HEW) -toxic potency- harmful to human health after prolonged exposure, possible secondary impacts to the environment -sources- results from numerous or diverse sources whose emissions are widely dispersed; exposure measured in open air	states- attainment of NAAQS left to states, which must adopt SIPs to show plan for attainment; federal government enforces SIP process federal- new source performance standards	strictly federal (states preempted except California) -auto emission standards (tailpipe and evaporative) and automotive fuels -aircraft emission standards and fuels
hazardous air pollutants- -toxic potency- hazardous to human health in small quantities or brief exposure -sources- relatively few, risk is greatest at point of emission or in path of plume; maximum exposure traditionally measured at the fenceline of emission source	-national emission standards for hazardous air pollutants (NESHAPs)	[none]

[a] Copyright, 1997, A. Loeb.

The structure of the Act has become far more complex over time, mostly due to amendments to the Act in 1977 and 1990. First, regarding types of pollutants, new categories of pollutants were added (i.e., additional categories of conventional pollutants and global pollutants). As a result, the Act now distinguishes three major categories of pollutants: conventional pollutants (including ambient pollutants, acidification, and visibility), hazardous air pollutants, and global air pollutants (stratospheric ozone depletors and greenhouse gases,

[21] The separation of air quality standards into two classes, conventional air pollutants and hazardous air pollutants, derives from the historical experience in the U.S. of distinguishing between pollutants that cause damage from indirect exposure to a pollutant concentration in the open air and those that cause damage from indirect exposure to a pollutant concentrated at its source or in a plume of emissions. The distinction is not essential to air pollution control programs — indeed, it is not generally followed in other programs — but simply reflects the American experience in developing air pollution programs. It is worth noting that in making the distinction of the classes categorical the Act assumed that no pollutant was both emitted by numerous or diverse sources and highly toxic. Subsequent experience has proved this assumption to be invalid. See The Clean Air Act, § 112(b)(2) (1990).

"GHGs"). Second, programs to control these pollutants were variously added, amended, and replaced, but for the most part greatly expanded. With these changes, the structure of the Act can be described within a similar table:

Table 12 Conceptual Organization of the Clean Air Act as Amended in 1990

pollutant type[a]	stationary sources	mobile sources
conventional pollutants- primary and secondary pollutants 1- criteria pollutants- -toxic potency- harmful to human health after prolonged exposure, possible secondary impacts to the environment -sources- results from numerous or diverse sources whose emissions are widely dispersed; exposure measured in open air -includes CO, NO2, SO2, Pb, O3, PM10, and PM2.5	states- attainment of NAAQS left to states, which must adopt SIPs to show plan for attainment; federal government enforces SIP process federal- -new source performance standards -PSD, added 1977	principally federal (with exceptions for California and other states under conditions) -auto emission standards (tailpipe and evaporative) and automotive fuels -aircraft emission standards and fuels -standards for consumer products such as lawn mowers and chain saws
2- visibility and other air quality related values	prevention of deterioration of air quality in Class I areas	no provisions
3- acidification- secondary effects of two criteria pollutants	acid rain program (Title IV) -SO2- mandated reductions via market-based program -NOx- technology-based standards	-parallel provisions for sulfur reduction in fuels under Title II
hazardous air pollutants- -toxic potency- hazardous to human health in small quantities or brief exposure, listed in 112(b)(1) -sources- relatively few, risk is greatest at point of emission or in path of plume; maximum exposure traditionally measured at the fenceline of emission source	-national emission standards for hazardous air pollutants (NESHAPs) -MACT standards for HAPs -accidental release program for extremely hazardous substances -special program for municipal solid waste	-vehicle emission standards- provisions under § 202(l) -fuels standards- specifications of RFG designed to reduce toxics
global air pollutants- -impacts- harmful to global resource, the degradation of which human health and the environment -sources- results from numerous or diverse sources whose emissions are widely dispersed; exposure measured in open air	1-stratospheric ozone depletors- ban on production of ozone depleting substances; restrictions on use of existing supplies	
	2-GHGs- CO2 and equivalents [by treaty]	

[a] Copyright, 1997, A. Loeb.

One should note, however, that the Act still maintains the fundamental distinction between conventional air pollutants, for which the point of public exposure is their concentrations in the open air, and hazardous air pollutants, for which the point of public exposure is the concentration at the fenceline.

While this is a highly developed approach, with different programs tailored to fit different pollutants, its resource requirements are well beyond the means of many other countries. In light of this, this report will only closely examine three types of pollution control programs — ambient air quality standards, stationary source emission control standards, and mobile source emission control standards, which are the same three types of standards found in the Egyptian law.

Air Quality Standards

As noted above, the Clean Air Act prescribes three categories of air quality standards — for conventional pollutants, hazardous air pollutants, and global pollutants. Three programs that have relevance to Egyptian air quality are examined here.

National Ambient Air Quality Standards

The Clean Air Act prescribes very specific procedures for establishing and attaining the ambient standards.

Process for establishment and periodic review of ambient standards. Since 1963 the federal government has been tasked with producing studies of ambient air pollution levels for health effects. Currently these documents, known as "criteria documents," are produced by the research office at EPA. After 1970, in addition to the health-based primary standards, standards are also set for secondary standards.

Each standard represents three components:

- *level*- a quantity representing the concentration in parts per million ("ppm") in the ambient air.
- *averaging time*- a period of time in which the measurements are taken, set according to the temporal nature of the pollutant hazard, and for which the standard level is the average.[22]
- *form*- the number of exceedances, traditionally one per averaging period, that will be accepted as compliance with the standard.

EPA is required to reconsider the ambient standards in 5-year review cycle. The criteria document is reviewed by the Clean Air Science Advisory Committee ("CASAC") and others in a public forum and revised if necessary. A Staff Paper is prepared by the EPA air office based on the criteria document to determine what are the factors the Administrator should consider in setting the standard. The staff paper is open to CASAC and public comment.

After review there is closure on the Staff Paper, and it is presented to the Administrator with recommendations. The Administrator makes a decision to reaffirm or change the standard and formally proposes that decision. Public hearings are held and a final decision issued, along with the reference method and other implementation rules.

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[22] Different averaging times may be needed for a pollutant because the time pattern of concentrations can be a determining factor in whether the pollutant causes an adverse effect. For example, total dose of a pollutant over a relatively long period may be more important for one adverse effect, whereas dose rate over a relatively short period may be more important for another adverse effect of the same pollutant. In such a case two different averaging times may be needed.

Bruce C. Jordan, Harvey M. Richmond and Thomas McCurdy,"The Use of Scientific Information in Setting Ambient Air Standards," Env. Health Perspectives, vol. 52, pp. 233-240, 1983.

Once the EPA Administrator has issued a standard and reference method, it goes to states, which have the responsibility for making emission reductions from individual sources to meet the standard. Federal emission control requirements, which apply only in specific circumstances (see below), may also contribute to emission reductions. It is the responsibility of states to make sure that the emission reductions in total are sufficient to attain the ambient standards.

The national ambient air quality standards. The Clean Air Act of 1970 ordered EPA to issue ambient standards for the five pollutants — carbon monoxide ("CO"), sulfur dioxide ("SO_2"), hydrocarbons ("HC"), total suspended particulates ("TSP"), and photochemical oxidants — for which NAPCA had already written criteria documents. At the time these were issued EPA added one more pollutant, nitrogen dioxide ("NO_2"), making it six in total. Prior to 1990 EPA dropped HC,[23] added Pb,[24] and changed the indicator pollutants for two pollutants — photochemical oxidants was changed to O_3, and TSP was changed to particulates with an aerodynamic diameter of 10 microns or less ("PM_{10}"). After these changes the number of standards remained at six.

In 1997 EPA amended the standards for PM_{10} and ozone, and added a new particulate standard, $PM_{2.5}$, because of evidence that these finer particles cause the most significant health effects. Thus, the current primary and secondary ambient standards consist of seven standards, six gaseous pollutants (CO, O_3, SO_2, Pb, NO_2) and two particulates (PM_{10} and $PM_{2.5}$). These are set out in Table B.3.

However, on judicial review of EPA's 1997 action, the D.C. Circuit Court in Amer. Trucking Assns. v. EPA (No. 97-1440, opinion issued May 14, 1999), vacated the PM_{10} standard entirely and remanded the $PM_{2.5}$ standard to EPA for reconsideration. On rehearing, issued October 29, 1999, the court reaffirmed its prior PM findings. Thus, the future of the new standards remains uncertain at this time. While it is expected that EPA will continue to support the existence of standards for O_3, PM_{10} and $PM_{2.5}$, their standard level concentrations or averaging times may be changed somewhat in the near future.

Table 13 National Ambient Air Quality Standards as Amended in 1997

Pollutant	Primary Standards		Secondary Standards	
	Averaging Time	Standard Level Concentration[a]	Averaging Time	Standard Level Concentration[a]
PM_{10}	Annual Arithmetic Mean[b]	50 μg/m^3	Same as Primary	
	24-hour[b]	150 μg/m^3	Same as Primary	
$PM_{2.5}$	Annual Arithmetic Mean[b]	15 μg/m^3	Same as Primary	
	24-hour[b]	65 μg/m^3	Same as Primary	
SO_2	Annual Arithmetic Mean	(0.03 ppm) 80μg/m^3	3-hour[c]	1300 μg/m^3 (0.50 ppm)

[23] 48 Fed. Reg. 628 (1983). Although HC was dropped as an ambient pollutant, it continued as an auto tailpipe standard because of its role as a precursor to ozone.

[24] 43 Fed.Reg. 46246 (Oct. 5, 1978).

Pollutant	Primary Standards		Secondary Standards	
	Averaging Time	Standard Level Concentration[a]	Averaging Time	Standard Level Concentration[a]
	24-hour[c]	(0.14 ppm) 365 µg/m^3		
CO	8-hour[c]	9 ppm (10 mg/m^3)	None	
	1-hour[c]	35 ppm (40 mg/m^3)	None	
NO_2	Annual Arithmetic Mean	0.053 ppm (100 µg/m^3)	Same as Primary	
0_3	8-hour[d]	0.08 ppm (157 µg/m^3)	Same as Primary	
	1-hour[d]	0.12 ppm (235 µg/m^3)	Same as Primary	
Pb	Maximum Quarterly Average	1.5 µg/m^3	Same as Primary	

[a] Parenthetical value is an approximately equivalent concentration used by EPA.

b TSP was the original indicator pollutant for the particulate matter (PM) standards. The primary standards were 260 µg/m3 for 24-hour average and 75 µg/m3 for annual average, and the secondary standard was 150 µg/m3 for 24-hour average; the secondary standard was not to be exceeded more than once per year. This standard was replaced with the PM10 standard in 1987 (particles less than 10µm in diameter, which are inhalable) as the new indicator pollutant. The TSP standard is no longer in effect. In 1997 EPA added a PM2.5 standard because of evidence that those particles cause the most significant health effects. The annual standard for PM10 is attained when the 3-year average annual arithmetic mean concentration is less than or equal to 50 µg/m3; the 24-hour standard is attained when the expected number of days per calendar year above 150 µg/m3 is equal to or less than 1. The annual standard for PM2.5 is spatially averaged over designated monitors; for the 24-hour standard the form is the 98th percentile.

c Not to be exceeded more than once per year.

d The 8-hour standard is attained when the 3-year average of the fourth-highest daily maximum 8-hour concentrations is less than or equal to the standard. The 1-hour standard is attained when the maximum hourly average concentration is less than or equal to the standard, with one exceedance allowed per year.

e The Amer. Trucking opinion also remanded the new ozone standard for further consideration. On rehearing, the court provided that the ozone standard can be enforced "only in conformity with Subpart 2."

Source: U.S. EPA, "National Air Quality and Emission Trends Report"; 62 Fed.Reg. 38652-38896 (Jul. 18, 1997).

Implementation of the ambient standards. Under Section 110 of the Act, states are required to adopt "State Implementation Plans," which are in effect commitments by them to implement controls that will bring ambient air quality levels in the air quality control regions under their jurisdictions within the national ambient air quality standards.[25]

[25] The states were required to provide in their SIPs for attainment of NAAQS no later than 3 years from date of SIP approval by EPA. If the schedule were strictly kept, that would have been approximately June 1974, although most commentators will say that the requirement was for compliance in 1975. The 1977 Amendments extended the compliance deadlines to December 31, 1982 for NAAQS, but in the case of CO and photochemical oxidants where a state demonstrates that attainment is impossible despite its use of all reasonably available measures the deadline was extended to December 31, 1987. However, further postponements were made. The Steel Industry Compliance Extension Act of 1981 provided an extension of compliance dates for steel companies. In the Clean Air Act Amendments of 1990 Congress established many specific new provisions for attainment programs.

Visibility Standards

A second U.S. program for conventional pollutants that has implications for Egypt is the visibility program. The program for attainment of the ambient standards under the 1970 Act was designed to reduce emissions in areas where they were most concentrated, but it did not explicitly set out a program to deal with already-clean areas. If stringent regulations were applied to polluted areas, that would give industries the incentive to relocate plants to areas that were not already polluted. But that would result only in moving the pollution around, to the detriment of clean areas. To comply with a court order[26] EPA established for prevention of significant deterioration ("PSD") in 1974.[27] Congress formally adopted a PSD program in amendments to the Act in 1977, which was to be implemented as a permitting system. As part of the adopted two programs for visibility regulation.

1. *New sources and major modifications*. As part of the PSD program, visibility was identified as an "air quality related value" to be considered in the permitting of new sources and major modifications to existing emission sources.

2. *Existing sources*. The Amendments mandated a program to protect visibility in certain areas, affecting even existing pollution sources.

As noted, the visibility standards are implemented principally through the permit process. By contrast, the visibility provisions for existing sources, while important to critical scenic areas, are among the least-enforced provisions of the Act.

Hazardous Air Pollutants

The Act creates a distinct category of national standards for separate treatment. By contrast with the ambient standards, which are measured by their concentration in the open air, the point of exposure to hazardous air pollutants is assumed to be at the fenceline of a plant that contains the source, where the pollutants may be most concentrated. In this way the treatment of hazardous air pollutants reflects the traditional assumptions that (1) pollutants naturally disperse in the open air, and (2) that the cause of damage (and hence the basis for regulation) is the source-receptor relationship.

The hazardous air pollutants are given a distinct approach in their regulatory treatment. Since they are not measured in the ambient air, there is no standard for their concentration in the open air. Instead, they are controlled directly through emission standards. Since these pollutants are much more toxic than the criteria pollutants, and exposure is assumed to be in concentrated form rather than diluted by dispersion, the standards for these pollutants are much more stringent than those for the ambient pollutants.

Regulation of HAPs prior to 1990. Under Section 112 of the 1970 Act,[28] EPA was required to identify and list air toxics, and then apply standards to control them with an adequate

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[26] Sierra Club v. Ruckelshaus, 344 F.Supp. 253 (D.D.C. 1972), *aff'd per curiam without opinion* (D.C. Cir. 1972), *aff'd by an equally divided Court without opinion sub nom.* Fri v. Sierra Club, 412 U.S. 541 (1973). Visibility, particularly in Western national parks such as the Grand Canyon, was the primary concern of the Sierra Club. R. Melnick, Regulation and the Courts: The Case of the Clean Air Act (Brookings, 1983) 81. See T. Disselhorst, *Sierra Club v. Ruckelshaus: "On A Clear Day ..."*, 4 Ecol. L. Quart. 739 (1975).

[27] 39 Fed.Reg. 42,510 (1974), *codified at* 40 C.F.R. Part 51.

[28] 42 U.S.C. § 7412.

margin of safety. These were known as the National Emission Standards for Hazardous Air Pollutants ("NESHAPs").

Section 112 established a definition of HAPs and delegated to EPA the task of identifying and listing those pollutants which met the definition. Section 112(a)(1) defined HAPs as those substances which caused air pollution resulting in "an increase in mortality or ... serious irreversible, or incapacitating reversible, illness." By definition, no HAP could also be a pollutant for which an ambient standard had been established. Over time, EPA developed risk assessment methodologies to identify the substances that met that definition.

The program established under the 1970 Act is generally regarded as a failure. Section 112(b)(1)(B) required that standards for HAPs be set "at the level which ... provides an ample margin of safety to protect the public health from such hazardous air pollutant." Because of the margin of safety requirement, the only standards that could be set for substances that do not have identifiable health thresholds (i.e., levels below which no health detriments can be detected) was zero. And because the deadlines for issuing controls for a pollutant once EPA listed it were so stringent, EPA simply avoided listing pollutants.

As a result, during the twenty years before the enactment of the 1990 Amendments EPA listed only eight pollutants. Three of those (asbestos, beryllium, and mercury) were listed within 90 days of enactment of the 1970 Act to comply with its mandate that EPA immediately list HAPs for which it intended to apply standards.[29] The other five were listed sporadically thereafter. The last HAP listed for which emission controls were issued was in 1980. EPA promulgated standards for seven of the eight listed pollutants.[30] See Table B.4. At the time of enactment of the CAAA, proceedings to establish standards for the eighth listed HAP, coke oven emissions, were ongoing.

Under the savings provision of the 1990 CAAA, Section 112(q), these standards remain in force.

Table 14 Hazardous Air Pollutants and Source Categories Established by 15 November 1990

listed air toxics	citation (date) of listing[b]	source categories subject to controls (§ in 40 C.F.R. Part 61)
Asbestos	36 Fed.Reg. 5931 (Mar. 31, 1971)	asbestos mills (§ 61.142), inactive asbestos mill waste disposal sites and manufacturing and fabricating operations (§ 61.151), active waste disposal sites (§ 61.143), and operations that convert asbestos-containing waste material to asbestos-free material (§ 61.155)
Beryllium	36 Fed.Reg. 5931 (Mar. 31, 1971)	extraction or processing plants for ore or beryllium compounds, and for machine shops which work with beryllium (§ 61.30), and rocket motor test sites (§ 61.40)
Mercury	36 Fed.Reg. 5931 (Mar. 31, 1971)	sources which process mercury ore, use mercury chlor-alkali cells to produce chlorine gas and alkali metal hydroxide, and incinerate or dry wastewater treatment plant sludge (§ 61.50)

29 The Clean Air Act, § 112(b)(1)(A) (1970).
30 Provisions for air toxics are found generally under 40 C.F.R. Part 61.

listed air toxics	citation (date) of listing[b]	source categories subject to controls (§ in 40 C.F.R. Part 61)
Vinyl Chloride	40 Fed.Reg. 59532 (Dec. 24, 1975)	plants that produce ethylene dichloride, vinyl chloride, and/or polymers containing any fraction of polymerized vinyl chloride, but not equipment used in research if the equipment does not have a capacity greater than 50 gallons (§ 61.60); (see also § 61.240)
Benzene	42 Fed.Reg. 29332 (June 8, 1977)	various benzene equipment (fugitive emissions) (§ 61.110), coke by-product recovery plants (§ 61.130), benzene storage vessels (§ 61.270), benzene transfer facilities (§ 61.300), chemical plants, coke by-product plants, petroleum refineries, and hazardous waste treatment, storage and disposal facilities (§ 61.340) (proposed to be stayed, see 56 Fed.Reg. 64217 (Dec. 9, 1991); (see also § 61.240)
Radionuclides	44 Fed.Reg. 7738 (Dec. 27, 1979)	underground uranium mines (§ 61.20) and uranium mill tailings (§§ 61.250 and 61.220 (partly stayed, see 56 Fed.Reg. 67537)), DOE facilities (§§ 61.90 and 61.190), NRC-licensed facilities and non-DOE federal facilities (§ 61.100), elemental phosphorus plants (§ 61.120) (proposed to be amended, see 56 Fed.Reg. 46252 (Sep. 11, 1991)), and phosphogypsum plants (§ 61.200)
Arsenic	45 Fed.Reg. 37886 (June 5, 1980)	glass furnaces (§ 61.160), primary copper smelters (§ 61.170), and metallic arsenic and arsenic trioxide plants (§ 61.180)
Coke Oven Emissions	49 Fed.Reg. 36560 (Sep. 18, 1984)	rulemaking began in EPA Docket No. A-83-33; addressed specifically in CAAA; new proposed rule produced by reg-neg proceedings

a In addition to the eight substances listed here, EPA published notice of intent to list an additional twenty-five substances as air toxics. See 40 C.F.R. § 61.01(b).

b Citation of original listing only; additional citations are found in the relevant C.F.R. subparts.

<u>Regulation of HAPs under the 1990 Amendments</u>. Frustrated with the slow pace of EPA's risk-based listing process, Congress decided to take the listing function away from EPA. In the 1990 Clean Air Act Amendments Congress replaced the existing program under section 112 with a new program that established a list of pollutants and a rolling regulatory program to set emission limitations for them. Under Section 112(b)(1) (1990), the CAAA established a list of 189 hazardous air pollutants for EPA to control by regulation. Section 112(b)(2) allows EPA to add or delete compounds from the (b)(1) list. EPA granted a petition to delist the listed substance caprolactam, bringing the list to 188. Given the state of toxicity knowledge, the (b)(1) list represents the legislative judgment that the public should not have to wait for full risk assessments to be done on individual substances, and that erring on the side of over-control is warranted.

Section 112 employs a two-phase control strategy for sources of HAPs. During Phase I, under authority of Section 112(d), technology-based standards are to be set for specific source categories. These must apply the "maximum achievable control technology" ("MACT"). Existing sources must meet the standards within three years of their issuance. During Phase II, EPA must evaluate the residual risk remaining after the installation of MACT controls and report to Congress, which may determine whether additional controls are necessary.

Section 112 proceeds by a process of "rolling" issuance of the MACT standards: EPA is required to develop a list of source categories and rank the categories into four priority tiers. EPA will then proceed through the category list category-by-category, in order of priority rank, to set standards for each of the HAPs emitted by each category. Phase II follows this rolling schedule: within eight years of the promulgation of the original MACT standards (nine years for the first tier regulated), EPA must issue residual risk standards for each of the categories.

The current program for hazardous air pollutants is too complex to list in detail here. With regulations setting emission standards for several hundred source categories covering 188 pollutants, it is far beyond the resources of this project to analyze here. However, the substances listed as NESHAPs prior to 1990 are the same as some of those listed as ambient air pollutants in other programs, making a comparison possible.

Stationary Source Emission Standards

For regulatory treatment stationary sources are categorized into new sources and existing sources,

New Sources

The Clean Air Act requires that new sources and major modifications to existing sources install "best available technologies." By this term I refer collectively to the NSPS or the two technology standards under NSR, "best available control technology" ("BACT"), and "lowest achievable emission rate ("LAER"). Most new stationary sources are required to meet a BAT, placing much of the burden of improvement on new sources rather than on existing sources to achieve air quality improvements, except where existing sources make major modifications.

While these requirements establish a technology-forcing function upon plant/equipment retirement and renovation, it also grandfathers existing sources into their emission rates — essentially uncontrolled — so long as they do not take the actions that trigger a best available technology review. Thus, as time passes the technologies used and the corresponding emission rates fall into two classes — those that have undergone a best available technology review and those that remain grandfathered. Moreover, with time, as the state of the art advances the performance of the best technology will improve, so that the difference between emission characteristics of the grandfathered sources and the new sources will grow greater. This could result in very different projections of emissions.

Table 15 NSPS Issued for Select Source Categories

source category	pollutants and emission limitations (operating practices, certification, etc. omitted)	implied control technologies
municipal waste combustors, MWCs with unit capacity > 250 tons/day, constructed before 12/20/89	*PM*: NTE 34 milligrams per dry standard cubic meter (0.015 grains per dry standard cubic foot), corrected to 7% oxygen (dry basis) [approx. 97% removal]; 10% opacity standard	
	dioxin/furan: NTE 30 ng/dry standard cubic meter (12 grains per billion dry standard cubic feet, corrected to 7% oxygen (dry basis)	
	SO_2: NTE 20% of potential emissions rate (i.e., 80% reduction by wt. or vol.), or 30 ppm by vol. corrected to 7% oxygen (dry basis), whichever is less stringent	
	HCl: NTE 180 ppmv, corrected to 7% oxygen (dry basis)	
sulfuric acid production units	*SO_2*: NTE 2 kg SO_2/metric ton of acid produced (4 lb/ton), production expressed as 100% sulfuric acid	
	sulfuric acid mist: NOTE 0.075 kg/metric ton of acid producted	
	opacity: NTE 10%	
fossil-fuel fired steam generators (construction commenced after 8/17/71),	*PM*: NTE 43 ng/J heat input (0.10/mmBtu); not more than one 6-minute period of > 20% opacity	
	SO_2: -liquid fuel (or w/ wood)- NTE 340 ng/J heat input (.80 lb/mmBtu) -solid fuel (or w/ wood)- 520 ng/J heat input (1.2 lb/mmBtu)	
	No_x: -gaseous fuel- 86 ng/J heat input (0.20 lb/mmBtu) -liquid fuel (or w/ wood)- 129 ng/J heat input (0.30 lb/mmBtu) -solid fuel (or w/ wood)- 300 ng/J heat input (0.70 lb/mmBtu) -lignite fuel (or w/ wood)- 260 ng/J heat input (0.60 lb/mmBtu) ->25% lignite fuel (or w/ wood) mined in ND, SD or MT and burned in a cyclone fired unit- 340 ng/J heat input (0.80 lb/mmBtu)	

source category	pollutants and emission limitations (operating practices, certification, etc. omitted)	implied control technologies
electric utility steam generating units (construction commenced after 9/18/78),	*PM*: -all plants- NTE 13 ng/J heat input (.03 lb/mmBtu) -liquid fuel- NTE 30% of potential combustion concentration (70% reduction) -solid fuel- NTE 1% of potential combustion concentration; not more than one 6-minute period of > 20% opacity	standard was intended by EPA to be technology-forcing; utilities could only meet the SO_2 standard with FGD (scrubber) systems
	SO_2: -liquid or gaseous fuel- 340 ng/J heat input (0.80 lb/mmBtu) and 10% of potential combustion concentration, or 100% of potential combustion concentration when emissions < 86 ng/J (0.20 lb/mmBtu heat input); -solid and solid-derived fuel- 520 ng/J heat input (1.20 lb/mmBtu) and 10% of the potential combustion concentration (90% reduction); when emissions < 260 ng/J (0.60 lb/mmBtu) heat input, facilities may emit 30% of their potential combustion concentration (70% reduction). -solid solvent refined coal- NTE 520 ng/J heat input (1.20 lb/mmBtu) and 15% of potential concentration	
	NO_x: -gaseous fuel- from coal: 210 ng/J heat input (0.50 lb/mmBtu); all other fuels: 86 ng/J heat input (0.20 lb/mmBtu) -liquid fuel- from coal or shale: 210 ng/J heat input (0.50 lb/mmBtu); all others: 130 ng/J heat input (0.30 lb/mmBtu); all others: -solid fuel- bituminous, anthracite and fuel containing > 25% lignite (w/ conditions): 260 ng/J heat input (0.60 lb/mmBtu); subbituminous and coal-derived: 210 ng/J heat input (0.50 lb/mmBtu) ->25% lignite fuel (or w/ wood) mined in ND, SD or MT and burned in a slag tap furnace- 340 ng/J heat input (0.80 lb/mmBtu) -fuel containing >25% coal refuse- no standard	
industrial-commercial-institutional steam generating units, applies to units with capacities > 29 MW	*PM*: -coal- NTE 22 ng/J heat input (.053 lb/mmBtu) -wood, MSW, mixtures, or oil- NTE 43 ng/J heat input (0.10 lb/mmBtu); not more than one 6-minute period of > 20% opacity	

source category	**pollutants and emission limitations (operating practices, certification, etc. omitted)**	**implied control technologies**
	SO_2: NTE 10% of potential SO_2 emission rate (90% emission reduction) or a limitations expressed in the following formula: $E_s = (K_aH_a + K_bH_b)/(H_a + H_b)$, where`$E_s$ is the SO_2 emission limit, K_a is 520 ng/J, K_b is 340 ng/J, H_a is the heat input from combustion of coal in J, and H_b is the heat input from combustion of oil in J	
	NO_x: -natural gas and distillate oil- high heat release rate: 86 ng/J heat input (0.20 lb/mmBtu); low heat release rate: 43 ng/J heat input (0.10 lb/mmBtu) -residual oil- high heat release rate: 170 ng/J heat input (0.40 lb/mmBtu); low heat release rate: 130 ng/J heat input (0.30 lb/mmBtu) -coal- mass-feed stoker and coal-derived synthetic fuels: 210 ng/J heat input (0.50 lb/mmBtu); spreader stoker and fluidized bed and lignite: 260 ng/J heat input (0.60 lb/mmBtu); pulverized coal: 300 ng/J heat input (0.70 lb/mmBtu); lignite mined in ND, SD or MT and combusted in slag tap furnace: 340 ng/J heat input (0.80 lb/mmBtu) -duct burner in combined cycle system- natural gas and distillate: 86 ng/J heat input (0.20 lb/mmBtu); residual: 170 ng/J heat input (0.40 lb/mmBtu)	
small industrial-commercial-institutional steam generating units, applies to units with capacities from 2.9 MW to 29 MW	*SO_2*: -oil-fired units- NTE 215ng/J (0.5 lb/mmBtu) -coal-fired units- NTE 10% of potential SO_2 emissions (90% reduction) or 520 ng/J (1.2 lb./mmBtu) -coal refuse- NTE 20% of potential SO_2 emissions (80% reduction) or 520 ng/J (1.2 lb./mmBtu) -emerging technologies- NTE 50% of potential SO_2 emissions (50% reduction) or 260 ng/J (0.6 lb./mmBtu) -others- 520 ng/J (1.2 lb./mmBtu)	
	PM: for facilities with capacity > 8.7 MW -coal-fired (< 10% other fuels)- 22 ng/J (0.05 lb/mmBtu) -coal and other fuels- 43 ng/J (0.10 lb/mmBtu) -wood or wood and other fuels- for capacity > 8.7 MW, 43 ng/J (0.10 lb/mmBtu); for capacity < 8.7 MW, 130 ng/J (0.30 lb/mmBtu); not more than one 6-minute period of > 20% opacity	
nitric acid plants	*NO_2*: NTE 1.5 kg/metric ton of nitric acid produced	

source category	pollutants and emission limitations (operating practices, certification, etc. omitted)	implied control technologies
	opacity: NTE 10%	
petroleum refineries	*SO_2:* no refining facility (except when burning to produce sulfur or sulfuric acid) may burn fuel gas containing hydrogen sulfide in excess of 230 mg/dscm except as emergency -FCC unit catalyst regenerators- subject to any of three alternatives: (1) reduce SO_2, averaged over 7 days, or to 50 ppm by volume; (2) SO_2 emissions < 9.8 kn/1000 kg coke burn-off; (3) limit fresh feed to sulfur content of 0.3% by weight, averaged over 7 days. -Claus sulfur recovery plants- NTE 250 ppm by vol. if controlled by oxidation control system or other system followed by incineration; or 300 ppm by vol. of reduced sulfur compounds (hydrogen sulfide, carbonyl sulfide and carbon disulfide) and 10 ppm hydrogen sulfide if controlled by system not followed by incineration	
	PM: -FCC unit catalyst regenerators- NTE 1.0 kg/1000 kg of coke burnoff; not more than one 6-minute period of > 30% opacity per 24-hour period -FCC emissions that pass through incinerator or waste heat boiler in which auxiliary fuel is burned- NTE 43.0 g/MJ or 0.10/lb/mmBtu.	
	CO: -FCC unit catalyst regenerators- NTE 500 ppm by vol. (dry basis)	
volatile organic liquid storage vessels (including petroleum liquid storage vessels) (construction, reconstruction or modification commenced after 7/23/84)	*volatile organic liquids:* -vessels w/ > 151 m^3 capacity and true vapor pressure > 5.2 kPa but < 76.6 kPa or > 75 m^3 but < 151 m^3 containing VOL with true vapor pressure of 27.6 kPa or more but < 76.6 kPa- must be equipped with any one of the following: (1) fixed roof in combination with internal floating cover equipped with seal between tank wall and edge of the floating roof; (2) external floating roof with double seal system between tank wall and floating roof; (3) closed vent system and a 95% emission control device; any equivalent -vessels w/ > 75 m^3 containing a VOL w/ true vapor pressure of 76.6 kPa must use 95% percent efficiency control device or equivalent	
primary copper smelters	*PM:* dryers NTE 50 mg/dscm ro 0.022 grans per stry standard cubic foot	

source category	pollutants and emission limitations (operating practices, certification, etc. omitted)	implied control technologies
	SO_2: roasters, smelting furnaces and copper converters NTE 0.065% by vol. (w/ exceptions)	
	visible emissions: dryers and other facilities using sulfuric acid to comply may not emit gases > 20% capacity	
stationary gas turbines	*NO_x:* (1) for electric utility gas turbines with heat input > 107.2 gigajoules/hr (100mmBtu/hr)- NTE 0.0075 (14.4/Y) + F by vol. at 15 % oxygen and on dry basis, where Y = mfr's rated heat rate at mfr's rated load (kj/watt hour) or actual measured heat rate at actual peak load, and where F = NO_x emission allowance for fuel-bound nitrogen (defined by special rules for nitrogen content of fuel); (2) for stationary gas turbines with heat input at peak load $\geq$ 10.7 gigajoules/hr, built after Oct. 3, 1982, and stationary gas turbines with rated base load of 30 MW or less- NTE 0.150 (14.4/Y) + F	
	SO_2: emissions NTE 0.015 % by vol. at 15% oxygen and on dry basis; facilities may notburn any fuel containing fulfur > 0.8 % by wt.	
bulk gasoline terminals (with throughput of > 75,700 liters/day)	*total organic compounds:* each loading rack must be equipped with vapor collection system designed to collect TOC vapors displaced from takn truck vapor collection systems during loading; emissions from loading NTE 35 milligrams TOC/liter of gasoline loaded; emissions from unrefurbished vapor processing systems constructed before 12/17/80 NTE 80 mg TOC/liter of gasoline loaded; other equipment specifications.	
new residential wood heaters	*PM:* -burn rates < 2.82 kg/hr- NTE 3.55 times burn rate + 4.98 g/hr -burn rates > 2.82 kg/hr- NTE 15 g/hr	
equipment leaks of VOC from onshore natural gas processing plants	various equipment standards	
onshore natural gas processing: SO2 emissions	*SO_2:* -facilities w/ sulfur feed rates > 5.0 long tons/day- removal efficiency from 90-99.8 % -facilities w/ sulfur feed rates > 2. LT/d but $\leq$ 5.0 LT/d- initial reductions of 79% and 74% thereafter	

source category	pollutants and emission limitations (operating practices, certification, etc. omitted)	implied control technologies
VOC emissions from petroleum refinery wastewater systems	standards for individual equipment, including individual drains, oil-water separators, closed vent systems and control devices	

note- abbreviations used in table: "NTE" is "not to exceed; "ng" is nanogram; "J" is joule.

Existing Sources

The philosophy adopted by Congress was that decisions about the control of existing sources was best left to state and local authorities, who had the best information on these and were best equipped to make judgments on how the emission reduction burden should be distributed. In consequence, with very few exceptions, existing sources are regulated by the states. In order to approve a State Implementation Plan that is approved a state must assign standards to the various sources that are not assigned federal standards so that the ambient standards will be attained.

With fifty different state plans setting stationary source standards it is impossible to set out a general picture of the stationary source emission standards that apply to existing sources in the U.S. Thus, while the institutions are described here, no generalizations are made about the quantitative standards that exist.

Mobile Source Emission Standards

Auto emission standards for new vehicles have been on a downward trajectory in the U.S. since the mid-1960s. As new emission control technologies were added, it became possible to achieve greater control efficiencies.

Vehicle Emission Standards

Mobile sources typically have shorter useful lives than most stationary sources. The is accelerated by automakers' marketing strategies (often known as "planned obsolescence") that encourage motorists to turnover vehicles before the engineering useful life has been reached. With emission standards tagged to specific model years Congress could count on the relatively quick replacement of high polluting cars with low polluting cars, without having to force a consumer to give up a car he had already purchased or install add-on devices to it. As a result, emission controls for vehicles are all directed to new sources, implemented by a blanket prohibition on sale of new cars that are not certified to the federal standards.

Historical emission standards. Because the newest standards in the U.S. may be far ahead of the standards that have been adopted in Egypt, it is appropriate to include first a view of the historical standards in the U.S. It should be noted that in addition to the federal standards that apply in 49 states there are also separate standards for California.

The first national vehicle emission control standards in the U.S. were mandated by Congress in 1965.[31] Federal standards, were virtually identical to the standards already adopted by California for the 1966 model year, were promulgated in 1966,[32] which were applicable to

[31] Pub.L. 89-272, 79 Stat. 992 (Oct. 20, 1965). See 1965 USCCAN 3608 et seq. Sections 101-103 of the 1965 Act divided the Act into three Titles and created Title II to contain the mobile source provisions. It also required HEW to make biannual progress reports to Congress on various aspects of automotive air pollution control. In 1966, the Act was amended to authorize grants to state and local air pollution control agencies, and to extend such programs. Pub.L. 89-675, 80 Stat. 954 (Oct. 15, 1966).

[32] Proposed at 30 Fed.Reg. 17192 (Dec. 31, 1965), issued in final at 31 Fed.Reg. 5170 (Mar. 30, 1966). The regulations set emission standards for HC and CO for passenger cars and light duty vehicles, but not for NO_x. They also set out test procedures for measuring emissions and mileage accumulation, including specifications for the fuels to use under these procedures. HEW specified a lead additive (tetraethyl or tetramethyl) content in the test fuel of as high as 3.25 ML/gallon. See The New York Times, Mar. 30, 1966, at 20.

1968 and subsequent model year vehicles. From this beginning the standards have come steadily down. In 1970 Congress enacted new standards reducing emissions by an additional 90 percent, an amount that was believed necessary to reduce emission levels enough to achieve the ambient standards. These were superseded by new standards, enacted as part of the 1977 Amendments. The standards that were adopted then continued in application until superseded by those under the 1990 Amendments, which took effect in the 1994 model year. They are listed in Table B.6.

Table 16 Tailpipe Standards for Gasoline Powered Vehicles, 1977–93

year	HC	CO	NO_x
pre-1968 (uncontrolled)	15 [9.321]	90 [55.926]	6.2 [3.8527]
1970	4.1 [2.548]	34 [21.128]	---
1972	3.0 [1.864]	28 [17.399]	---
1973-4	3.0 [1.864]	15 [9.321]	3.1 [1.9263]
1975-6	1.5 [.9321]	15 [9.321]	3.1 [1.9263]
1977-79	1.5 [.9321]	15 [9.321]	2.0 [1.2428]
1980	1.5 [.9321]	7.0 [4.3498]	2.0 [1.2428]
1981 and after	1.5 [.9321]	7.0 [4.3498]	1.0 [.6214]

Source: The Clean Air Act § 202(b)(1)(A) and (B) (1977), 42 U.S.C. § 7521(b)(1)(A) and (B) (1977).

The standards represent only tailpipe emissions for light-duty vehicles (passenger cars). Separate standards for other classes of vehicles (e.g., heavy-duty vehicles and diesel vehicles) and for other types of emissions (e.g., evaporative emissions) are not shown. Standards are stated in grams per mile ("g/m") of pollutant emitted, and in grams per kilometer in brackets. Dates refer to model years, not calendar years. The standards listed are those listed by the statute. The federal standards remained unchanged from 1981 through 1989.

Standards under the 1990 Amendments. The 1990 Amendments added new provisions establishing lower emission standards. There have been three steps in bringing the standards lower.

Tier 1 standards. The standards for light-duty vehicles and light-duty trucks that became effective by operation of the statute, effective beginning in model phase year 1994 (the "tier 1 standards") are listed in Table B.7.

Table 17 Tailpipe Standards for Vehicles Beginning 1994 ("Tier 1")

vehicle type	fuel	Short Useful Life				Long Useful Life			
		NMHC	CO	NO_x	PM	NMHC	CO	NO_x	PM
		5 years/50,000 miles				10 years/100,000 miles			
LDV[b]	gas	0.25	3.4	0.4	0.08	0.31	4.2	0.6	0.10
	diesel	0.25	3.4	1.0	0.08	0.31	4.2	1.25	0.10

vehicle type	fuel	Short Useful Life				Long Useful Life			
		NMHC	CO	NO_x	PM	NMH C	CO	NO_x	PM
		5 years/50,000 miles				10 years/100,000 miles			
LDT1	gas	0.25[b]	3.4[b]	0.4[b]	0.08[c]	0.31[b]	4.2[b]	0.6[b]	0.10[c]
	diesel	0.25[b]	3.4[b]	1.0[b]	0.08[c]	0.31[b]	4.2[b]	1.25[b]	0.10[c]
LDT2	gas	0.32[b]	4.4[b]	0.7[b]	0.08[c]	0.40[b]	5.5[b]	0.97[b]	0.10[c]
	diesel	0.32[b]	4.4[b]	---	0.08[c]	0.40[b]	5.5[b]	0.97[b]	0.10[c]
		5 years/50,000 miles				11 years/120,000 miles			
HLDT1[d]	gas	0.32	4.4	0.7	---	0.46	6.4	0.98	0.10
	diesel	0.32	4.4	---	---	0.46	6.4	0.98	0.10
HLDT2[d]	gas	0.39	5.0	1.1	---	0.56	7.3	1.53	0.12
	diesel	0.39	5.0	---	---	0.56	7.3	1.53	0.12

Source: 1990 Amendments § 203(a), establishing new Clean Air Act § 202(g) - (h), 42 U.S.C. § 7521(g) - (h) and Tables G and H. Summarized in John-Mark Stensvaag, Clean Air Act 1990 Amendments, Law and Practice (Wiley, New York, 1991), at 8-12.

Definitions: LDV- Light-Duty Vehicle (passenger cars); LDT1- light-duty truck category 1 (Gross Vehicle Weight Rating ("GVWR") of 6,000 lb. or less, and Loaded Vehicle Weight ("LVW") of 0-3750 lb.); LDT2- light-duty truck category 2 (GVWR of 6,000 lb. or less, and LVW of 3,751-5,750 lb.); HLDT1- heavy light-duty truck category 1 (GVWR of over 6,000 lb., and Test Weight ("TW") of 3,751-5,750 lb.; HLDT2- heavy light-duty truck category 2 (GVWR of over 6,000 lb., and TW of more than 5,750 lb.

a The standards represent only tailpipe emissions for LDVs, LDTs, and HLDTs. Separate standards for other classes of vehicles (e.g., heavy-duty vehicles) and for other types of emissions (e.g., evaporative emissions) are not shown. Standards are stated in grams per mile ("g/m") of pollutant emitted. The standards listed are those listed by the statute.

b Phasing: 40% model year ("MY") 1994, 80% MY 1995, 100% thereafter.

c Phasing: 40% model year ("MY") 1994, 80% MY 1996, 100% thereafter.

d Phasing: 50% model year ("MY") 1996, 100% thereafter.

Table 18 Tailpipe Standards for Vehicles Beginning 1994 ("Tier 1")

vehicle type	fuel	Short Useful Life				Long Useful Life			
		NMHC	CO	NO_x	PM	NMHC	CO	NO_x	PM
		5 years/50,000 miles				10 years/100,000 miles			
LDV[b]	gas	0.25 [.15535]	3.4 [2.1128]	0.4 [.24856]	0.08 [.49712]	0.31 [.19263]	4.2 [2.6099]	0.6 [.37284]	0.10 [.06214]
	diesel	0.25 [.15535]	3.4 [2.1128]	1.0 [.6214]	0.08 [.49712]	0.31 [.19263]	4.2 [2.6099]	1.25 [.77675]	0.10 [.06214]
LDT1	gas	0.25 [.15535]	3.4 [2.1128]	0.4 [.24856]	0.08 [.49712]	0.31 [.19263]	4.2 [2.6099]	0.6 [.37284]	0.10 [.06214]
	diesel	0.25 [.15535]	3.4 [2.1128]	1.0 [.6214]	0.08 [.49712]	0.31 [.19263]	4.2 [2.6099]	1.25 [.77675]	0.10 [.06214]
LDT2	gas	0.32 [.19885]	4.4 [2.7342]	0.7 [.43498]	0.08 [.49712]	0.40 [.24856]	5.5 [.34177]	0.97 [.60276]	0.10 [.06214]

vehicle type	fuel	Short Useful Life				Long Useful Life			
		NMHC	CO	NO_x	PM	NMHC	CO	NO_x	PM
		5 years/50,000 miles				10 years/100,000 miles			
	diesel	0.32 [.19885]	4.4 [2.7342]	---	0.08 [.49712]	0.40 [.24856]	5.5 [.34177]	0.97 [.60276]	0.10 [.06214]
		5 years/50,000 miles				11 years/120,000 miles			
HLDT 1	gas	0.32 [.19885]	4.4 [2.7342]	0.7 [.43498]	---	0.46 [.28584]	6.4 [3.9769]	0.98 [.60897]	0.10 [.06214]
	diesel	0.32 [.19885]	4.4 [2.7342]	---	---	0.46 [.28584]	6.4 [3.9769]	0.98 [.60897]	0.10 [.06214]
HLDT 2	gas	0.39 [.24235]	5.0 [3.7284]	1.1 [.68354]	---	0.56 [.34798]	7.3 [4.5362]	1.53 [.95074]	0.12 [.07457]
	diesel	0.39 [.24235]	5.0 [3.7284]	---	---	0.56 [.34798]	7.3 [4.5362]	1.53 [.95074]	0.12 [.07457]

Source: 1990 Amendments § 203(a), establishing new Clean Air Act § 202(g) - (h), 42 U.S.C. § 7521(g) - (h) and Tables G and H. Summarized in John-Mark Stensvaag, Clean Air Act 1990 Amendments, Law and Practice (Wiley, New York, 1991), at 8-12. Standards are measured in g/m [g/km].

The NLEV standards. Provisions of the 1990 Amendments allow states to voluntarily adopt the vehicle emission standards issued by California. Several of the Northeastern states were very interested in adopting the California standards for vehicles sold there. The product of negotiations that took place with of NE states is the National Low Emission Vehicle ("NLEV") program. Because the states and the automakers agreed to it, what started out as a voluntary program has become a nation-wide requirement which EPA memorialized in a regulation. As a result, the current California standards (NO_x = 0.3 gpm) apply to 2001 model year vehicles and are enforceable as a federal regulation.

Tier 2 standards. On Feb. 10, 2000 the U.S. EPA issued two sets of rules together — the tier 2 auto emission standards and limitations on the sulfur content of gasoline (see below).[33] The were effective April 10, 2000. The tier 2 standards, which automakers will be required to phase in beginning in model year 2004, resulted from a mandated study to determine whether tightening of the motor vehicle emission standards was warranted.[34] The tier 2 standards are the first set of tailpipe standards that apply equally to all passenger cars, light trucks, and larger passenger vehicles operated on any fuel.

The new rule is one of the longest and most complicated ever published by EPA. Instead of a single standard, each automaker must meet a corporate sales-weighted average. The average

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[33] 65 Fed.Reg. 6698 (Feb. 10, 2000).

[34] Under Section 202(i) of the Act EPA was required to determine whether standards more stringent than Tier 1 standards are appropriate beginning between the 2004 and 2006 model years, considering (1) the availability of technology to meet more stringent standards, taking cost, lead time, safety, and energy impacts into consideration; and (2) the need for, and cost effectiveness of, such standards, including consideration of alternative methods of attaining or maintaining the national ambient air quality standards. After the study is completed EPA was required to determine by rulemaking whether: (1) there is a need for further emission reductions; (2) the technology for more stringent emission standards from the affected classes is available; and (3) such standards are needed and cost-effective, taking into account alternatives. If EPA answers "yes" to these questions, then the Agency must issue new, more stringent motor vehicle standards (the "Tier 2 standards"). EPA submitted its report to Congress on July 31, 1998, answering all three questions in the affirmative.

changes during the phase-in periods until ultimately there are ten different standards below and above the average. Indeed, EPA found the rule it had written so complex that it was unable to condense it to prepare a fact sheet for the public.[35] The only generalization is that the average emissions of the whole fleet will be .07 gpm of NOx. Under these circumstances, Table B.8 is presented as a suggestion of the range of standards that apply. No further analysis will be pursued.

Table 19 "Tier 2" Light-duty Full Useful Life Exhaust Emission Standards

Bin No.	NOx	NMOG	CO	HCHO	PM
8	0.20	0.125	4.2	0.018	0.02
7	0.15	0.090	4.2	0.018	0.02
6	0.10	0.090	4.2	0.018	0.01
5	0.07	0.090	4.2	0.018	0.01
4	0.04	0.070	2.1	0.011	0.01
3	0.03	0.055	2.1	0.011	0.01
2	0.02	0.010	2.1	0.004	0.01
1	0.00	0.000	0	0.000	0.00

Source: EPA, 65 Fed.Reg. 6698 et seq. (Feb. 10, 2000), Table IV.B.-2A.

The tier 2 standards will be phased in beginning in 2004 in order to comply with EPA's declining fleet average NOx standard. 100% of the passenger car and light light truck fleet operating on both diesel and gasoline will be required to comply on average by 2007; 100% of heavier trucks up to 10,000 lbs. will comply by 2009. The National Low Emission Vehicle standards will be phased in in a few northeast states starting in 1999; nationally they go into effect in 2001. California's TLEV, LEV, ULEV, LEV2, ULEV 2 and SULEV standards are phased in by each manufacturer in a manner sufficient to comply with the fleet average NMOG standard.

Fuel Standards

EPA is granted authority under Section 211(c) of the Clean Air Act to regulate fuel quality in order to prevent pollution from fuels and additives and to protect emission control devices on vehicles using them. In 1973 EPA issued two sets of regulations: (1) mandating the availability of unleaded gasoline for use in vehicle equipped with catalytic converters; and (2) reducing the average lead content of gasoline ("the lead phasedown"). Substitution of other octane additives for lead additive caused gasoline volatility to rise, creating additional hydrocarbon emissions that contributed to growth in urban ozone pollution.[36] In the late 1980s EPA issued a set of rules controlling gasoline volatility.

In the 1990 Amendments Congress banned leaded gasoline effective January 1, 1996. It also enacted two additional provisions. (1) To reduce emissions of ozone-forming VOCs and air toxics, section 211(k) requires the sale of reformulated gasoline ("RFG") in certain ozone

35 Tad Wysor of EPA, OTAQ, reported to me that EPA attempted to write a fact sheet but couldn't, finding it impossible to condense the material.

36 See Loeb, A.P., "The Adolescence of Emissions Trading: A Short History and Analysis of the Lead Phasedown Lead Credit Market," presented as faculty at U.S. AID Technical Leadership Training Workshop: Emissions Trading for Environmental Protection, Energy and Environment, Washington, D.C., May 19, 2000.

nonattainment areas. The first phase began January 1, 1995; the second phase began January 1, 2000. The provisions regarding VOCs apply during the high ozone season. The provisions regarding toxic air pollutants apply during the entire year. (2) To reduce CO emissions from vehicles in CO nonattainment areas it required the use of oxygenated fuels.

Most recently, EPA mandated significant reductions in the sulfur content of fuel, both to reduce sulfur emissions and to protect the significant investment to be made in achieving the tier 2 emission standards. EPA determined that while technologies existed to make significant tailpipe emission reductions, such could not be achieved by vehicles in use with the existing fuel quality. The controls reducing the sulfur content of gasoline will enable technologies installed by automakers to meet the standards in use. Like the rules issued in 1973 to make unleaded gasoline available to protect catalysts, the new sulfur rules rely on the fuel as an essential predicate for maintaining performance of emission controls.

It should be noted that while both the vehicle standards and the fuel standards are measured principally at the time of sale, rather than in use, the fuel standards are not emission standards per se. Instead, they are product quality standards, directing refiners to produce gasolines having certain characteristics that affect emissions.

Appendix C – European Union Standards

The EU has an elaborate set of policies and standards for air quality.

Ambient Air Quality Standards

The EU issued new ambient standards in April 1999 in Council Directive 1999/30/EC, Apr. 22, 1999. The object of this directive is to establish limit values and, as appropriate, alert thresholds, for concentrations of sulfur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter, and lead so as to prevent damage to human health and the environment. Alert thresholds are levels beyond which there is an acute risk to human health and at which immediate steps must be taken. These standards are the minimum limit values that member states must achieve; however, member states can establish their own more stringent limits.

Directive 96/62/EC requires that action plans be developed for zones within which concentrations of pollutants in ambient air exceed limit values, plus any applicable temporary margins of tolerance.

Table 20 Ambient Air Quality Standards of the EU

pollutant	averaging time	limit value	allowed exceedances	alert threshold
SO_2	1-hour	350 µg/m^3	24/yr	350 µg/m^3 for 3 hrs
	24-hour	125 µg/m^3	3/yr	
	Annual	20 µg/m^3	---	
NO_2	1-hour	200 µg/m^3	18/yr	400 µg/m^3 for 3 hrs
	annual	40 µg/m^3	---	
NO_X	annual	30 µg/m^3	---	
PM_{10}[b]	24-hour	50 µg/m^3	35/yr	
	annual	40 µg/m^3	---	
Pb	annual	2 µg/m^3	---	
O_3	[]	[proposed]		
benzene	[]	[proposed]		
arsenic	[]	[proposed]		
mercury	[]	[in research]		
cadmium	[]	[in research]		
nickel	[]	[in research]		
PAH[c]	[]	[in research]		

Source: Annexes to Council Directive 1999/30/EC, Apr. 22, 1999. These Annexes are not available on line. These were obtained by personal correspondence with Lynne Edwards at lynne.EDWARDS@cec.eu.int. Some details of European standards are provided in the World Bank Handbook, which lists the EU standards in comparison tables; however, the discussion of European standards in the Handbook is obsolete.

a Since the purpose of this study is to look prospectively at opportunities for reductions, the standards listed here are only those that have been established for future compliance. The various dates for compliance with standards for individual pollutants are set out in the Annexes to Council Directive 1999/30/EC but not listed here. Details regarding former standards, as well as currently-applicable standards or parts of standards that are scheduled for repeal, are set out in Article 9 of 1999/30/EC.

b The limit values presented here are from the Stage 1 PM10 program. A stage 2 program, with a 24 hour standard of 50 µg/m3 (not to be exceeded more than 7 times per calendar year) and an annual standard of 20 µg/m3 are currently under consideration.

c PAH is poly-aromatic hydrocarbons.

In addition to the ambient standards listed in Table C.2, which are either now in force or currently listed to be applicable at definite future dates, proposals have been made to Parliament and the Council for standards for three additional pollutants — carbon monoxide, benzene, and ozone. The Commission is also currently carrying out research to consider proposing standards for four additional pollutants — PAHs, mercury, nickel, cadmium, and arsenic.[37] These would be integrated into the program for ambient standards; by contrast to the U.S., in the EU rules there is no separate air toxics programme.

Stationary Source Emission Standards

Standards for stationary source emissions in the EU have proved to be unavailable, since the annexes containing the limit values for the various sources are not posted on the EU website. Because of budget constraints in the project, the stationary source emission guidelines developed by the World Bank are used here instead.

Mobile Source Emission Standards

As in the U.S. program, the EU program for mobil sources contains rules for both vehicle emissions and fuel quality.

Vehicle Emission Standards

Until the mid-1980s, vehicle emission standards in Europe were developed by the U.N. Economic Commission for Europe ("ECE") and adopted by individual countries. Because of the consensus-based approach to rule-making, which required unanimity among the various states, the European standards lagged behind the U.S. standards. For example, the ECE did not adopt emission standards requiring three-way catalytic converters until 1988 (ECE regulation 83), and then only for vehicles with engine displacement of 2.0 liters or more. With the shift recently in the EU to decision process that allow adoption of standards with less-than-complete unanimity, it has become possible to adopt more stringent emission standards, and they have now begun to catch up with U.S. standards.[38]

Table C.2 summarizes the EU standards that apply to passenger car emissions, measured as limit values in grams per kilometer ("g/km").[39]

Table 21 European Union Standards for Passenger Cars

pollutant	2000		2005	
	gasoline	diesel	gasoline	diesel
carbon monoxide	2.3	0.64	1.00	0.50
mass of hydrocarbons	0.20	---	0.10	---
mass of oxides of nitrogen	0.15	0.50	0.06	0.25
combined mass of hydrocarbons and oxides of nitrogen	--- (0.5 prior standard)	0.56	--- (0.5 prior standard)	0.30
mass of particulates	---	0.05	---	0.025

Source: Mike Walsh (1999); standards represent the final Conciliation values agreed on June 30, 1999.

[37] Personal correspondence Lynne Edwards, EC, to Alan P. Loeb, May 30, 2000.
[38] Asif Faiz, Christopher S. Weaver, and Michael P. Walsh, Air Pollution from Motor Vehicles, Standards and Technologies for Controlling Emissions (The World Bank, Washington, DC, 1996), at 8.
[39] Faiz, et al., supra, at 8.

It should be noted for comparison purposes, that the EU standards do not assign automakers with the responsibility for emission performance of their vehicles once they enter service. That is, they have no emission warranty. Moreover, surveillance testing, recalls, and other features of the U.S. regulatory program do not exist in the EU program. Given the deterioration in performance of emission control devices, in-use emissions of vehicles certified to EU standards are likely to be significantly higher than the standards over their lifetimes.[40]

Fuel Standards

Initially, European nations varied greatly in their adoption of the U.S. model. West Germany unilaterally adopted a maximum lead content of 0.15 grams of lead per liter of gasoline (gpl) in 1975 for regular grade gasoline. The European Community ("EC") followed with a directive in 1978 requiring member countries to set maximum lead content standards between 0.15 and 0.4 gpl.[41] However, this did not occur with universal agreement. Major opposition came from the United Kingdom ("UK"), which argued that lead additives were important for energy conservation.[42]

Once the U.S. took action to strengthen its lead phasedown regulations in 1982 and 1985, the EC followed suit. The UK reversed its position in 1983 and actually took a leadership role in making lead reductions. The EC issued a second directive in 1985 which formally asked that member states reduce the lead content of leaded to 0.15 gpl "as soon as they consider it appropriate."[43b]

In the parallel to lead content rules, European countries adopted requirements for the availability of unleaded gasoline to supply new catalytic converters-equipped vehicles. The 1985 EC directive required the availability of unleaded gasoline by October 1, 1989. The EC set the maximum lead content standard for unleaded at 0.013 gpl. However, only unleaded premium (minimum 95 RON/85 MON) was required; member states were permitted, but not required, to require the availability of unleaded regular in addition.[44c]

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[40] Faiz, et al., supra, at 8.

[41] Council Directive 78/611/EEC, June 29, 1978. EC directives for gasoline exclude French overseas departments.

[42] Walsh, "Other Nations Phasing down Lead in Gas," EPA Journal, May 1985.

[43] "Directive on the Lead Content of Petrol," 85/210/EEC, 3 April 1985, as amended by 85/580/EEC, 31 December 1985, and 87/416/EEC, 21 July 1987.

[44] *Automotive Engineering*, Jan. 1987, p.49.

Appendix D – Standards Issued by International Organizations

This section evaluates the air quality standards worldwide that will affect the proposed project. It identifies standards and the associated policies and other factors that will be important for establishing new air quality standards in Egypt.

The approach here is to identify the actions, activities, roles and responsibilities of counterparts that need to be in place. Its purpose is to introduce key issues and principal assumptions. It also identifies the principal risks associated with the project and assesses the institutional approaches to their mitigation.

There is also a process of formation of international norms and expectations. The community of nations is a social community, which functions, as any other community by establishing

World Health Organization

The most influential body in development of air quality regulation is the World Health Organization ("WHO"), which produced its first air quality guidelines in 1987. These are now embodied in a substantial document, "WHO Guidelines for Air Quality," last revised in 1999. The document contains an extensive discussion of air pollution generally, evaluation of the health effects of specific pollutants, and methodologies for pollution control and program management. Governments and financial institutions turn to them for an authoritative source of information.

Most important among the issues discussed in the Guidelines are the WHO *guidelines for air quality*. While these are not intended as standards per se, they present the levels of air pollution below which lifetime exposure presents no significant health risk. As such, they provide the foundation upon which standards can be adopted. As a statement of the United Nations, these have become the universal source of ambient standards. In addition, the WHO Guidelines also provide guidance material for setting emission standards.

The WHO Guidelines present much valuable information that can be useful for developing the Egyptian program. For present purposes, we have focused on the WHO guidelines for air quality, presented in Table D.1.

Table 22 WHO Ambient Air Quality Guidelines

pollutant	averaging time	concentration
SO_2	Annual	50 µg/m^3
	24-hour	125 µg/m^3
	10-minute	500 µg/m^3
CO	8-hour	10 mg/m^3
	1-hour	30 mg/m^3
	30-minute	60 mg/m^3
	15-minute	100 mg/m^3
NO_2	annual	40 µg/m^3
	1-hour	200 µg/m^3
0_3	8-hour	120 µg/m^3

pollutant	averaging time	concentration
Pb	annual	0.5 μg/m^3

Source: "WHO guideline values for the 'classical' air pollutants," reprinted as Table 3.1 in Guidelines for Air Quality, WHO, Geneva, 1999.

In addition to the classical air pollutants, WHO also lists guidelines for "other air pollutants," categorized by non-carcinogenic (Table 3.2, 39 substances) and carcinogenic (Table 3.3, 16 substances) endpoints. Several of these other pollutants are important for this assessment, being also either proposed for listing or under research for listing as ambient pollutants by the EU. These are listed in table D.2.

Table 23 WHO Other Pollutants Proposed for Standards by EU

pollutant	average ambient air concentration	
	WHO	EU
benzene	5.0-20.0 μg/m^3 [Table 3.3]	[proposed]
arsenic	(1-30)*10^{-3} μg/m^3 [Table 3.3]	[proposed]
cadmium	(0.1-20)*10^{-3} μg/m^3 [Table 3.2]	[in research]
nickel	1-180 μg/m^3 [Table 3.3]	[in research]
PAH	(1-10)*10^{-3} μg/m^3 [Table 3.3]	[in research]

Financial Institutions

Financial institutions, especially multilateral lending institutions, are uniquely positioned to determine the environmental impacts of projects they finance, and in recent years they have responded to pressure by developing policies that require project developers to meet the more stringent emission levels that would apply in developed countries. Since they govern projects wherever located, these have become the international standard for emission control. Following this lead, some private lenders have taken these as a world norm to be enforced as a condition of loan approval.[45]

Where countries have environmental systems that do not control emissions to the world standard, or where regulations are not sufficiently enforced, the regulations of the financial institutions act as the principal agency of emission control. However, since by definition only new sources or significant modifications are financed, the influence of these international organizations is limited to constraining some additions to the emissions inventory. Existing sources are not affected directly by such institutions.

There are three types of financial institutions that have a role in development:

[45] See Andrew Giaccia and Erin Buckley Bradley, "World Bank Standards," *Independent Energy*, October, 1995, at 62.

1. Multilateral Development Banks. There are a variety of multilateral development banks, whose objective is to alleviate poverty and improve the quality of life through financing projects. They use loan guarantees to finance projects private institutions will not support. These are of two kinds, either globally focused or regionally focused. The principal global multilateral is the World Bank Group, including the International Finance Corporation and the Multilateral Investment Guarantee Agency. The regionals include the Asian Development Bank, the Inter-American Development Bank, the European Bank for Reconstruction and Development, and the African Development Bank.

2. Export Credit Agencies. These are bilateral public institutions set up by national governments to support exports and investment by companies in other countries, foreign operations of domestic companies; their objective is to support the competitiveness and investment of their constituents, not to alleviate poverty but to support economic growth; these do not take the place of commercial banks, they provide support beyond what commercial banks provide by providing insurance and loan guarantees that insure risks that commercial banks are unwilling to accept.

3. Commercial Banks- These organizations have as their objective to profit by support of sound projects whose risks are minimized.

Because these institutions all apply their environmental responsibilities currently, usually a combination of local, national, and financing organization standards apply. When the standards are not all equal, which is often the case, the most stringent standard applies.

A number of environmental policies, procedures, and/or standards have thus been set by the various financial institutions, which apply to individual project financings. As a developing country, Egypt sees the application of these policies when they are applied as a condition to economic development projects.

More importantly, these various practices taken collectively create norms that industries are expected to follow. Since all financed projects ultimately affect competitive conditions, what standards are applied in one financing have economic consequences to the others.

And there is a third reason to consider these as well. Since financial standards are already in the economy, they provide in essence what translates into a new source performance standard. The existence of this mechanism introduces equitable questions as companies compete and have to consider the equitable question of how to allocate the burdens fairly under such conditions.

The World Bank Group

The World Bank Group is a second essential source of universal standards. As mentioned above, the World Bank Group has three components, each of which has a somewhat different approach related to its functional role.

The World Bank Handbook. The World Bank published a comprehensive study of pollution control strategies and standards in its Pollution Prevention and Abatement Handbook ("the Handbook"), which first appeared in 1995. While it contains both water and air quality standards, its emphasis if overwhelmingly on air. In addition to providing a comprehensive survey of environmental methods and management practices, Part three of this volume contains discussions on three subjects relating to emission control:

1. *Pollutants*, a discussion of the substances PM, arsenic, cadmium, lead, mercury, NO_x, ozone, and SO_x;

2. *Pollutant Control Technologies*, a review of generic technologies for controlling PM, gasoline lead, NO_x, and SO_x; and

3. *Industry Sector Guidelines*, a set of performance standards for control of emissions at specific categories of stationary sources; since these are enforced as a condition of financing a project, they are in effect sector-specific emission standards applied in a preconstruction review process.

Since the World Bank is involved in financing development, not in controlling emissions, it does not have any say in emissions that do not result from new or expanded plant. In consequence, the World Bank has not developed standards or any guidance at all regarding mobile source emissions.

The World Bank Handbook is the most commonly used reference for setting standards in project finance. It is applied to projects even when its standards are more stringent than the local standards. But it should be borne in mind that the World Bank Guidelines are *emission* standards, and so there is no guarantee that their application results in attainment of the ambient standards.

Table 24 World Bank Air Emission Guidelines: Parameters and Maximum Values

source category	pollutants and emission limitations stated in milligrams per normal cubic meter (mg/Nm^3) unless otherwise specified				
	PM	SO_x	NO_x	metals	other pollutants
aluminum manufacturing	30	---	---	---	*total fluorine*: 2 *HF*: 1 *VOC*: 20
base metal and iron ore mining	---	---	---	---	---
breweries	---	---	---	---	---
cement manufacturing	50	400	600	---	---
chlor-alkali industry	---	---	---	---	*Cl*: 3
coal mining and production	50				*SO_2*:
coke manufacturing	50	---	---	---	*benzene*: 5 (leaks) *VOC*: 20 *sulfur*: recovery at least 97% (preferably over 99%)
copper smelting	smelters: 20 other sources: 50			*As*: 0.5 *Cd*: 0.05 *Cu*: 1 *Pb*: P.2 *Hg*: 0.05	---
dairy industry					*odor:* acceptable to neighbors
dye manufacturing					*Cl*: 10 *VOC*: 20
electronics manufacturing					*VOC*: 20 *phosphine*: 1 *arsine*: 1 *HF*: 5 *HCl*: 10
electroplating industry					*VOC*: 90% recovery
foundries	20 where toxic metals are present, 50 in other cases				
fruit and vegetable processing	---	---	---	---	---

source category	pollutants and emission limitations stated in milligrams per normal cubic meter (mg/Nm^3) unless otherwise specified				
	PM	SO_x	NO_x	metals	other pollutants
general environmental guidelines	*PM*: 50 for ≥50 MWe; 100< 50 MWe	*SO_2*: 2,000	coal: 750 (260 ng/J or 365 ppm) oil: 460 (130 ng/J or 225 ppm) gas: 320 (86 ng/J or 155 ppm)		*dioxin* (2,3,7,8-TCSS equivalent): max 1 ng/Nm^3
glass manufacturing	-50 -20 where toxic metals are present	*SO_x*: -gas fired: 700 -oil-fired: 1,800	1,000 (up to 2,000 depending on technology and if justified in the EA	*Pb + Cd*, total: 5 *other heavy metals*, total: 5 *As*: 1	*F*: 5 *HCl*: 50
industrial estates	-large facilities (energy consumption > 10 GJ/hour): 50 -small facilities (energy consumption ≤ 10 GJ/hour): 150	*SO_x*: 2,000	-solid fuels: 750 (260 ng/J or 365 ppm) -liquid fuels: 460 (130 ng/J or 225 ppm) gas: 320 (86 ng/J or 155 ppm)		*H_2S*: 15
iron and steel manufacturing	50	500 (sintering)	750 (260 ng/J or 365 ppm)		*F:* 5
lead and zinc smelting	20	*SO_2*: 400		*As*: 0.1 *Cd*: 0.05 *Cu*: 0.5 *Hg*: 0.05 *Pb*: 0.5 *Zn*: 1	*F*: 5 *HCl*: 50
meat processing and rendering	150 for smokehouses with C content < 50				odor minimize impact on residents
mini steel mills	-50 -20 where toxic metals are present	2,000	750		
mixed fertilizer plants	50		-nitrophosphate units: 500 -mixed acid units: 70		*NH_3*: 50 *F*: 5
nitrogenous fertilizer plants	50		300		*NH_3*: 50 *urea*: 50

source category	pollutants and emission limitations stated in milligrams per normal cubic meter (mg/Nm^3) unless otherwise specified				
	PM	**SO_x**	**NO_x**	**metals**	**other pollutants**
oil and gas development (onshore)		1,000	oil: 460 (130 ng/J or 225 ppm) gas: 320 (86 ng/J or 155 ppm)		*VOC:* 20 H_2S: 30 *odor*: not offensive at recptor end (H_2S at property line < 5 $\mu g/m^3$)
pesticides formulation	-20 -5 where very toxic compounds are present				*VOC*: 20 *Cl:* 5
pesticides manufacturing	-20 -5 where very toxic compounds are present				*VOC*: 20 *Cl:* 5
petrochemicals manufacturing	20	500	300		*HCl*: 10 *benzene*: -emissions: 5 -plant fence: 0.1 ppb *1,2 dicholoroethane*: -emissions: 5 -plan fence: 1.0 ppb *vinyl chloride*: -emissions: 5 -plant fence: 0.4 ppb NH_3: 15
petroleum refining	50	sulfur recovery units- 150 -combustion units- 500	460 (130 ng/J or 225 ppm)		H_2S: 15 *Ni + V*: 2
pharmaceutical manufacturing		20			*active ingredients* (each): 0.15 *Class A compounds* (total): 20 *Class B compounds* (total): 80 *benzene*: 5 *vinyl chloride*: 5 *dichloroethane*: 5
phosphate fertilizer plants	50	sulfuric acid plant: SO_2: 2 kg/t acid SO_3: 0.15 kg/t acid			*F*: 5

	pollutants and emission limitations stated in milligrams per normal cubic meter (mg/Nm^3) unless otherwise specified				
source category	**PM**	**SO_x**	**NO_x**	**metals**	**other pollutants**
printing industry					*VOC*: 20 *Cl*: 10
pulp and paper mills	recovery furnace: 100	*total S*: -sulfite mills- 1.5 kg/t air-dried pulp -Kraft and other- 1.0 kg/t air-dried pulp	2 kg/t air-dried pulp		*H_2S:* 15 (lime kilns)
sugar manufacturing	-100 -mills < 8.7 MW heat input to boiler: $150mg/Nm_3$		-liquid fuels: 460 (130 ng/J or 225 ppm) -solid fuels: 750 (260 ng/J or 365 ppm)		*odor:* acceptable to residents
tanning and leather finishing					*odor:* acceptable to residents
textiles industry					*VOC:* 20
thermal power, new plants	50 mg/Nm_3	-total SO_2: 0.2 metric ton/day MWe on first 500 MWe, 0.1 tpd over 500 MWe -flue gases: 2,000 mg/Nm_3 (500 tpd total)	thermal plants: -coal: 750 (260 ng/J or 365 ppm) -oil: 460 (130 ng/J or 225 ppm) gas: 320 (86 ng/J or 155 ppm) combustion turbine plants: -gas: 125 diesel (No. 2): 165 fuel oil (No. 6 and other: 300 coal < 10% volatile matter: 1,500 mg/Nm_3		
thermal power, rehabilitation of existing plants	-100; -rare cases: 150 mg/Nm_3				*CO:*
vegetable oil processing	50				*odor*: acceptable to neighbors
wood preserving industry					*VOC:* 20

note- abbreviations used in table: "NTE" is "not to exceed; all values stated in mg/Nm^3, unless otherwise specified; "ng" is nanogram; "J" is joule.
Source: Table 1, World Bank Handbook, at 194-95.

International Finance Corporation. A second institution within the World Bank Group is the International Finance Corporation ("IFC"), which is the private sector finance arm of the World Bank. IFC provides funding and advice to private-sector ventures and projects in developing countries in partnership with private developers. It is the largest multilateral source of loan and equity financing for private-sector projects in the developing world. The IFC generally follows the World Bank Handbook for its standards. However, in addition, it has also established a Procedure for Environmental and Social Review of Projects.

Multilateral Investment Guarantee Agency. The Multilateral Investment Guarantee Agency ("MIGA") was established in 1988 to offer guarantees to encourage the flow of foreign direct investment to its developing member countries for economic development. MIGA applies the World Bank Pollution Prevention and Abatement Handbook in its operations. MIGA has also adopted its own environmental policies, including procedures for consideration of project impacts, which are set out in its "Environmental and Social Review Procedures."[46] In addition it has additional policies set out in its "Draft Environmental Assessment and Disclosure Policies and Environmental Review Procedures."[47]

Regional Development Banks

The world network of regional development banks have important influence on applying emission control requirements on new projects they finance or develop. The following quick survey indicates the practices they use.

African Development Bank. The African Development Bank ("AfDB") provides assistance to private enterprises and financial institutions through term loans, equity and quasi-equity guarantees, and underwriting and advisory services. The AfDB requires environmental impact statements for all projects. Its environmental policies were stated in a series of policy statements that list principles of responsible environmental management. It provides a number of methods and measures for improving environmental performance of industry projects.

The African Development Bank is listed here first because it is the first line of approach to finding practices and techniques that would be applicable in Egypt. However, research was not done to determine the level of experience or expertise in application of air quality management tools and techniques, and other like organizations are listed below as possible additional sources of practices and techniques.

Asian Development Bank. The Asian Development Bank ("ADB") provides financial and technical assistance by extending loans and equity investments for the development of its developing member countries, provides technical assistance, and promotes public and private investment. The ADB reviews the environmental impacts of its projects and policies, encourages developing environmental programs by developing countries, and trains staff on environmental aspects of economic development. Its environmental guidelines are not available on line but are available by request.

European Bank for Reconstruction and Development. The European Bank for Reconstruction and Development ("EBRD") offers loans, equity and quasi-equity

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[46] See www.miga.org/disclose/soc_rev.htm.
[47] See www.miga.org/disclose/preface.htm.

investments, guarantees and advisory services to support projects in the twenty-six countries in central and eastern Europe in which it operates. EBRD projects are required to meet national and EU environmental standards. Environmental assessments must be carried out, and project sponsors must develop an environmental action plan. Environmental monitoring is required over the life of the loan.

Inter-American Development Bank. The Inter-American Development Bank ("IDB") is composed of 46 member countries, 26 of which are countries in Latin America or the Caribbean and have borrowing status. In analysis or proposed projects, the IDB reviews environmental impacts and incorporates factors to avoid adverse impacts.

Trade Assistance Organizations

National organizations provide trade assistance such as loan guarantees and direct loans. For example, in the U.S. the Overseas Private Investment Corporation ("OPIC") provides loan guarantees for U.S. small businesses and cooperatives. OPIC practices draw from four sets of environmental guidelines to evaluate the environmental and social impacts of projects: (1) Environmental Handbook, revised April 1999; (2) the World Bank Handbook; (3) the IFC environmental health and safety guidelines, to address issues not covered by world bank handbook; and (4) the World Bank Operational Directives.

World Trade Organization

The World Trade Organization ("WTO") is not a source of project finance. However, it has a substantial role in international environmental policy by seeking to minimize disparity in trade rules that can lead to trade discrimination. Developing countries are under some pressure in the international community to reconcile their environmental practices and standards to meet world norms.

International Organization for Standardization

The International Organization for Standardization ("ISO") is a federation of national standards bodies with member organizations from 111 countries. It has developed a series of specification standards for environmental management systems, which are known collectively as ISO 14000. The series contains six guidance standards:

- Environmental Management Systems
- Environmental Auditing
- Environmental Labeling
- Environmental Performance Evaluation
- Life-cycle Assessment
- Terms and Definitions

Of greatest interest is the guidance for Environmental Management Systems, ISO 140001. Organizations from 42 countries participated in the drafting procedure. Under ISO 14001 companies can voluntarily become certified; certification requires third-party auditing. There is a widespread movement of multinational companies to become certified in order to show good corporate citizenship. Certification is the formal recognition that a company or organization is operating an EMS that meets established standards. Unfortunately, ISO 14000 focuses on compliance with national regulation rather than with environmental performance. Given the differences in regulatory standards among countries, ISO 14000 does not provide a guarantee comparable performance.

On the other hand, the ISO 14000 series does provide a rich source of internationally-accepted methodologies for monitoring and modeling emissions. These could be quite useful in establishing new testing protocols in Egypt.

Appendix E – Meetings and Interviews

I departed for Cairo in the evening of Tuesday, May 2, and arrived in Cairo in the early hours of Thursday, May 4. I departed early on May 16. In my second week I interviewed the following individuals:

- Dr. Ahmed Gamal Abdel-Rehiem, Environmental Quality Sector, EEAA,
- Abdelhavez H. Adelhafez and Prof. Fawzy M. El-Mahallawy, faculty of engineering, cairo University,
- Dr. Ahmed Hamza, Sr. Technical Advisor, Ministry of State for Environmental Affairs, Env. Compliance Unit, Industrial sources, EEAA,
- Ahmed Ismael, consultant for EEAA environmental inspection,
- Dahlia Lotayef, Planning, Follow-up and Technical Cooperation Dept., EEAA,
- Dr. Nefisa S. Abo El-Seoud, EEAA,
- Nader Shehata Doas, GC environmental lab manager, EEAA, and
- Esko Meloni, Egyptian Pollution Abatement Project (EPAP).

In addition, I have also interviewed:

- David Fratt, Chemonics, CAIP,
- Yasser Sherif, and
- Lee Pasarew, U.S. EPA.

In addition to these interviews my counterpart Dr. Nasralla has conducted additional interviews.

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a. See Energy Conservation and Environment Project, Re-Design Report, May 13, 1993, Prepared for AID by Datex, Inc., at IV-7 to IV-9.

b.

c.