Cairo Air Improvement Project

Lead Pollution Abatement Component

Lead Smelters and Lead Foundries in Egypt

Chemonics International, Inc.
USAID/Egypt, Office of Environment
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Acronyms and Abbreviations

C	Centigrade
CAIP	Cairo Air Improvement Project
EEAA	Egyptian Environmental Affairs Agency
GOE	Government of Egypt
kg/hr	kilograms per hour
l	liters
LEAP	Lead Exposure Action Plan
LPA	Lead Pollution Abatement (component of CAIP)
LSAP	Lead Smelter Action Plan
m, m^2, m^3	meter, square meter, cubic meter
mg	milligram
mg/dscm	milligram per dry standard cubic meter
mm	millimeter
MT/Y	metric tons per year
No.	number
Pb	lead
Pb_3O_4	red lead or minium (lead tetraoxide)
PbO	lead oxide
T/d	tons per day
TCLP	Toxicity Characteristic Leaching Procedure
TCOE	Technical Cooperation Office for the Environment (of the EEAA)
USAID	United States Agency for International Development
µg	micrograms
£E	Egyptian pound (currency)

Executive Summary

The main goal of the Lead Pollution Abatement component (LPA) of the Cairo Air Improvement Project (CAIP) is to assist the Egyptian Environmental Affairs Agency (EEAA) to implement the Lead Smelter Action Plan (LSAP). One of the main objectives of the LSAP is to support the Government of Egypt (GOE) in the relocation of lead smelters to industrial sites, since they emit harmful lead particulates to the workplace and to the surrounding community. It is expected that the LPA will provide technical assistance to lead smelter owners so that the new smelters are equipped with state-of-the-art equipment and air pollution control systems.

Discussions held among experts and smelter owners concluded that the only way to reduce emissions from the existing smelters is to relocate them to new industrial zones, and to use modern emission control equipment, as well as modern equipment for production. All smelter owners are willing to consolidate operations and relocate their plants outside residential areas. Most owners—especially those who own small- and medium-sized smelters—are seeking technical and financial support to conclude their relocation. Lead foundries, which confine their hazardous emissions to the workplace, present a separate problem, as discussed in this report.

In order to facilitate discussions and planning, CAIP's LPA team undertook a survey to produce comprehensive baseline data about lead smelters and foundries—both licensed and unlicensed—throughout Egypt. The survey covered:

- Geographical distribution of smelters and foundries
- Annual production figures
- Smelter, foundry, and emission control equipment in use
- Fuel used
- Solid wastes produced
- Smelter work force
- Sites available for remediation
- Proposed sites for relocation of smelters and foundries

The survey allowed the LPA team to draw conclusions regarding the total number of licensed and unlicensed lead smelters and foundries in Egypt; their annual production, fuel use, and workforce; and their present status with regards to the Environmental Law (Law No. 4, Year 1994).

Introduction

Airborne lead pollution poses serious health risks for Cairo, one of the world's megacities. Data reported in 1992 showed that general lead levels in Cairo are higher than in nine other major cities in developing countries.[1] A 1996 study showed ambient airborne lead levels as high as 17 $\mu g/m^3$ in the industrialized area of Shoubra el-Kheima.[2] The maximum lead level measured at traffic sites during the same study, which was conducted prior to the introduction of unleaded gasoline in Greater Cairo, was 3.4 $\mu g/m^3$. The lead levels at all industrial and most traffic sites exceeded the standards set by the Environmental Law (Law No. 4, Year 1994) and the World Health Organization standards of 1$\mu g /m^3$. At that time it was believed that the predominate source of lead pollution in Cairo's air was leaded gasoline, with lead smelting the second most significant source.

The Government of Egypt (GOE) is working vigorously to eliminate the problem of airborne lead pollution in Egypt. In January 1996, it removed lead from gasoline sold in the Greater Cairo Area. This reduced general lead levels in ambient air. The complete phase-out of leaded gasoline in Egypt in 2000 will further reduce ambient lead levels.

The GOE, through the Egyptian Environmental Affairs Agency (EEAA), also developed a Lead Exposure Action Plan (LEAP). The plan addresses all sources of and actions associated with the airborne lead pollution problem. A major component of LEAP is the Lead Smelter Action Plan (LSAP). The Cairo Air Improvement Project (CAIP) is playing a major role in assisting EEAA to implement the LSAP.

The main objectives of the LSAP are to upgrade the operation of large smelters, to provide technical assistance to small and medium smelters, and to establish and enforce a comprehensive nationwide, long-term solution to the lead pollution problem.

In July 1997, several steps were identified to be taken within 5–7 years in order to complete the three major objectives of the LSAP. Some of these are related directly to the relocation of secondary lead smelters to appropriate long-term smelter sites.

It was necessary to identify all lead smelters in Egypt in order to facilitate their relocation to new industrial sites, and to identify old sites that will be subject to remediation.

In a baseline study of private sector lead smelters completed by the EEAA's Technical Cooperation Office for the Environment (TCOE), it was reported that most lead

[1] *Environmental Data Report, 3rd edition*, United Nations Environmental Program, 1991–92.
[2] Environmental Studies Department, Institute of Graduate Studies and Research, University of Alexandria, "A Comparative Study on the Contribution of Lead Emissions from Motor Vehicle to Atmospheric Pollution: A Consultancy Study for the Ministry of Petroleum," Alexandria, 1996.

smelting activities in Egypt take place in the Greater Cairo Area.[3] This appeared to be true for two reasons:

- Cairo is the major source of raw material (used batteries), because the region is home to about 50 percent of the vehicles in Egypt.
- Most battery manufacturers are located in Cairo, and most construction activity takes place in the capital.

This study also reported that the existence of an informal (unlicensed) lead smelting industry was doubtful. If such an industry existed, its size was small compared with the formal (licensed) lead smelting industry.

Since the implementation of the Environmental Law in March 1998, the lead smelters in Egypt have received warnings from governorate officials threatening to shut them down. Some licensed lead smelters have relocated to remote areas (mainly in Giza Governorate) where they are now operating unlicensed smelters.

The purpose of this report was to identify all lead smelters in Egypt, sites for remediation, and new sites for smelter relocation.

Characteristics of Cairo Smelters

Previous studies surveyed smelters only in the Greater Cairo Area, itemizing product lines, and quantifying production levels. The baseline study of private sector lead smelters by the EEAA's TCOE quantified lead product production. Another study, performed for Datex, Inc., and prepared in support of the development of CAIP, surveyed all lead smelters in Cairo, including the General Metals public sector smelter.[4] It was reported in the second study that about 20 percent of the country's total lead output was produced by General Metals, while a large private smelter company owned by the Awadallah family produced 75 percent of the total. The remaining 5 percent was produced by between 12–22 small lead smelters. Total production of lead ingots reported in Annex B to the CAIP project paper was 167.5 tons/day (t/d), while the baseline study estimated it to be 105.3 t/d. The discrepancy between the documents is probably due to two reasons:

- The reluctance of lead smelters owners to provide accurate information.
- The supply of available raw materials—used batteries—which varies from one season to another in an unstable market.

Table 1 shows the locations and sizes of private lead smelters surveyed in the technical analysis report of the CAIP project paper.

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[3] Technical Cooperation Office for the Environment, "Lead Smelting in Egypt: Baseline Study (Private Lead Smelters in Greater Cairo)," Egyptian Environmental Affairs Agency, Cairo, 1996.
[4] Wilson, Robert M. and Nahed El–Mahllawy, Ph.D., "Technical Analysis: Lead Smelter Component for the Cairo Air Improvement Project Paper," for Datex, Inc. under contract to USAID–Egypt Environment Office, Cairo, 1995.

Table 1
Private Lead Smelters in the Greater Cairo Area (as reported in EEAA/TCOE baseline study)

Survey Serial No.	Name of Facility	Area (m^2)	Location	Production (t/d)
1	Sayed Awadallah (1)	2,300	Hadayek el-Koba	
2	Sayed Awadallah (1)	3,000	Shoubra el-Kheima	125
3	Sayed Awadallah (1)	1,600	Shoubra el-Kheima	
4	Sayed Awadallah (1)	500	Shoubra el-Kheima	
5	El-Fabrika el-Maserya	1,000	El-Zawya el-Hamra	28
6	Warshet Ma'aden el-Mahi (2)	100	Bab el-Shereya	1
7	El-Mo'assasa el-Masreya	1,000	El-Zawya el-Hamra	1
8	El-Sherka el-Markazeya (Centrimetal)	5,000	El-Gamaleya	
9	Sherkat Rossas el-Mahi (2)	3,000	Shoubra el-Kheima	2
10	El-Amal	400	Shoubra el-Kheima	4.5
11	El-Sherka el-Ahleya	1,000	Hadayek el-Koba	6
			Total	**167.5**

(1) Same owners, Sayed Awadallah and Sons
(2) Same owners, El-Mahy family

According to previous studies, and as reported in the LSAP, the secondary lead smelting industry is dominated by one private sector company, which has three operating lead smelters, all located in Shoubra el-Kheima. The Awadallah family owns this company. These smelters produce mainly lead ingots and lead pipes. Other smelters in the Cairo Governorate are reported to have discontinued operations due to pressure from the Cairo City Administration.

Table 2 shows the data on private sector and governmental lead producers as reported in Annex B of the technical analysis of the CAIP document paper. It is shown that Awadallah's production of lead ingots was 20,904 tons/year, the other private lead smelters produce 2,028 tons/year, and the public sector smelter (General Metals) produces 8,000 tons/year. General Metals also produces 3,400 tons/year of lead oxides.

Table 2
Lead Producers, their Locations, Production Rates, Furnaces, and Fuels (as reported in Annex B of the CAIP project paper)

No.	Owner	Location	Production		Furnaces		Fuel			Comments
			Type	Amount	Type	No.	Type	Rate	Cost	
1	Ahmed Ali	El-Zawya el-Hamra	Pipes	28t/d	Crucible	2	Solar	20 L/day	0.4 £E/l	Melting and refining is transferred to 6th October factory
2	Sayed Awadallah	Port Said St.	Pipes and Siphons	35 t/d	Crucible	4	Solar	320 L/d		
3	Sayed Awadallah	10th of Ramadan	Ingots	4 t/d	Rotary	2	Mazot	2 t/d	145 £E/t	Only runs one trial shift
4	Sayed Awadallah	Shoubra el-Kheima	Ingots, Alloys Pipes Pb for welding	15 t/d 24 t/d 3 t/d	Rotary Refining Alloying Crucible	2 5 2 2	Mazot	11 t/d	140 £E/t	Production is taken from rotary to other furnaces
5	Sayed Awadallah	Shoubra el-Kheima	Ingots	24 t/d	Rotary	2	Mazot	2 t/d	140 £E/t	
6	Sayed Awadallah	Shoubra el-Kheima	Ingots, Alloys plates, Pipes	24 t/d	Rotary Refining Crucible	2 4 3	Mazot	9 t/d	140 £E/t	
7	Omar El Mahi	Bab el-Shareya	Pipes	1 t/d	Crucible	1	Butagaz	2 Bottle/d	17 £E/d	Now closed. Full capacity was 50–60 t/d

No.	Owner	Location	Production		Furnaces		Fuel			Comments
			Type	Amount	Type	No.	Type	Rate	Cost	
8	El-Mahi	Port Said St.	Pipes & Siphons	1 t/d	Rotary Crucible	1 2	Mazot	250 L/d		Now closed. Full capacity was 5t/d
9	Adel Abdel Azim	El-Gamaleya			Rotary ½ Rotary Refining	2 2 1				Now closed.
10	Mohamed Abdel Karim	Shoubra el-Kheima	Ingots	2 t/d	Rotary Refining of slag Refining Pb Crucible	1 1 2 2	Mazot Kerosene	1.4 t/d 120 L/d		
11	El-Amal (Seoudi)	Shoubra el-Kheima	Ingots	4.5 t/d	Rotary	1	Mazot	2 t/d	137 £E/t	
12	Nabih Abdel Hamid	Port Said	Pipes Sheets	6 t/d 20 t/d	Rotary Crucible	5 2	Kerosene			Now closed
13	General Metals Co. (Governmental)	Tebbin Helwan	Ingots, pipes, sheets Oxides	8000 t/y PbO: 2400 t/y Pb_3O_4 1000 t/y	Rotary Refining	3 4				For battery manufacture For paint manufacture

As indicated in Table 2, there were 16 rotary and 2 semi-rotary furnaces in Greater Cairo private smelters. General Metals, the public sector company, has three rotary furnaces. Four private smelters and General Metals did lead refining, and one of the Awadallah smelters performed alloying. All lead smelters used *mazot* (an inexpensive, heavy oil) as fuel for the smelting process, while for refining and lead forming they used gas and *solar* (an oil-based fuel that produces fewer pollutants than mazot).

As reported in the baseline study prepared by EEAA/TCOE, none of the lead smelters in the Greater Cairo Area conform to the requirements of the Environmental Law. The concentrations of particulate matter and lead in their exhaust gases are several times greater than the law's stack emission standards of 100 and 20 mg/m^3, respectively. Moreover, pollution levels inside the workplace are much higher than the Egyptian standards. The report concluded that no adequate emission control equipment is installed in any lead smelter in the Greater Cairo Area.

Field Study

For this study, CAIP conducted a comprehensive survey of all lead smelters in Egypt. The Ministry of Local Administration provided a list indicating the number of lead smelters in each governorate, shown in Table 3.

Visits were made to each governorate to identify the smelters. It was found that in some governorates (Behira, Menofia, and Suez) governorate officials did not distinguish between lead smelters and other foundries. Based on this survey, lead smelters exist in the following governorates:

- Cairo
- Qaliobiya
- Giza
- Sharkiya
- Dakahliya
- Alexandria
- El-Minya

Information about the locations of licensed and unlicensed lead smelters was obtained from the governorate and from lead smelter owners and operators. There are a limited number of families working in this business, and they know one other.

A questionnaire was used to collect detailed information about each lead smelter during the field visits. The questionnaire asked for the following information:

- General information including address, telephone number, and contact person
- Technical details including production rate, raw material, fuel consumption, type of equipment, solid waste disposal, and information on emission control equipment
- Production processes
- Waste generated
- Layout of the smelter.

Table 3

Number and Type of Lead Smelters, by Governorate (as provided by the Local Administration Authorities)

Governorate	Smelters							Totals
	Lead	**Aluminum**	**Iron**	**Copper**	**Steel**	**Manganese**	**Other**	
Cairo	3	128	55	148			45	379
Giza								0
Qaliobiya	5	7	90	6			41	149
Alexandria	2	20	112	40	1		4	179
El-Behira	14	2	8	1				25
Matrouh		0						
El-Menofia	1	5	6	3				15
Gharbiya		5	14					19
Kafr el-Sheikh			4					4
Damiat			2					2
Dakahliya	3	23	14					40
North Sinai		0						
South Sinai						1		1
Port Said		0						
Ismailia		1	2				1	4
Suez	3	4	5	3				15
Sharkiya	5	4	10	3				22
Beni Suef								
El-Minya								
El-Fayoum								
Assiut				1	1		10	12
New Wadi		0						
Sohag			3					3
Qena		4	5	4				13
Aswan							1	1
Red Sea		0						
Luxor		0						
Total	**36**	**203**	**330**	**209**	**2**	**1**	**102**	**883**

Characteristics of the Lead Industry in Egypt

The establishments that produce lead fall into two main categories:

Secondary lead smelters, which extract lead from used batteries. The smelting process takes place in rotary furnaces that are locally manufactured. A rotary furnace consists of a refractory-lined steel drum mounted on rollers and rotated by an electric motor. Some smelters separate the battery plates from the plastic casing before charging the furnace while others feed the furnace with whole batteries. Smelting is performed at 1450°C, and takes 4 hours.

In both cases, the gases contain high concentrations of lead particles if no emission control equipment is used. Lead smelters are the main source of lead emitted to the atmosphere. The lead ingots produced at this stage are semi-soft lead.

Lead fabrication foundries, which re-melt lead ingots. This process occurs in special steel kettles at a temperature of 450°C, through external heating from underneath. Lead pipes are the only commodities produced by most lead foundries. To make these, the liquid metal is allowed to flow from the kettle to an extrusion container and then extruded in pipes of different diameter.

The concentration of lead in the flue gases is within the limit of the Environmental Law, while the concentration of lead in the air of the workplace is high.

Therefore, it is concluded that the flue gases emitted to the air from secondary lead smelters have high concentrations of lead, while those emitted from lead foundries are in compliance with the standards set by the Environmental Law. The environmental hazards of the lead foundries are confined to the workplace, and the fugitive gases emitted take a toll on the workers' health.

Secondary lead smelters need relatively larger spaces than lead fabrication foundries, which can operate in small workshops. This makes it less difficult to identify secondary lead smelters and more difficult to identify lead fabrication foundries. In preparing this report, CAIP found five licensed lead fabrication foundries, but there may be others that were not identified.

Tables 4 and 5 show the details of lead smelters and lead fabrication foundries in all governorates. Preliminary findings include:

Distribution

Twenty-seven lead smelters and five lead fabrication foundries were identified, all owned by the private sector except for one public sector smelter. Figure 1 shows that 84 percent of the existing establishments are secondary lead smelters. Fifteen percent of those manufacture lead products. The remaining 16 percent are lead fabrication foundries.

The smelters are located in seven governorates. The smelting industry still is centered in the Greater Cairo Area. However, a few smelters were identified in Sharkiya, Alexandria, Dakahliya, and El-Minya.

Table 4
Secondary Lead Smelters

Cairo Governorate							
Serial No.	Company Name	Address	Contact Person	Rate t/d	Area m^2	Type of Product	Remarks
1	Awadallah for Smelting, Refining, and Manufacturing Lead Pipe	696 Port Said St. Hadayek el-Koba Cairo	Bahgat Abdel Fatteh	—	1,000	—	Shut down
2	Ibrahim Nabih Abdel Hamid Lead Smelter	El-Bassateen The Industrial Zone 10 Wafaa el-Deen	Ibrahim Nabih Abdel Hamid	6.92	1,100	Lead ingots, Pipes	Unlicensed
3	Nagy Nabih Abdel Hamid	Shak el-Taban Tora Autostrad, Cairo	Nagy Nabih Abdel Hamid	4.6	600	Lead ingots, Pipes	Licensed
4	Alam Masr for Castings	El-Herafeyeen Town Block M No. 21	Ateya Kamel	—	100	—	Now an iron foundry
5	General Metals	El Tebbin Helwan	Fawzy Hassan	12.51 7.7 1.4	2,489	Lead ingots Lead alloys Lead products	

Table 4 (Continued)
Secondary Lead Smelters

Qalioubiya Governorate							
Serial No.	Company Name	Address	Contact Person	Rate t/d	Area m^2	Type of Product	Remarks
6	El-Masreya Co. for Smelting, Refining, and Manufacturing Lead Pipes (Awadallah)	El Magray St. from Ismailia Canal Rd. Shoubra el-Kheima Qalioubiya	Abdel Nabi Sayed Awadallah	42.3	1,760	15 MT/d of lead pipes are produced from lead ingots	Licensed
7	El-Masreya Co. for Smelting, Refining, and Manufacturing Lead Pipes (Awadallah)	El-Rashah St. Shoubra el-Kheima Qalioubiya	Said Nagy	42.3	3,727	10 t/d of lead pipes and other products	Licensed
8	El-Masreya Co. for Smelting, Refining, and Manufacturing Lead Pipes (Awadallah)	Ismailia Rd. Hod el-Khors and El-Agam Shoubra el-Kheima Qalioubiya	Edward Shaker	32	1,700	Lead ingots	Closed
9	El-Mahi Co. for Lead	101 Ismailia Rd. Shoubra el-Kheima Qalioubiya	Mohamed El Mahi	13.8	1,800	Lead ingot, lead pipes	Licensed
10	Al-Amal Co.	Ismailia Rd. Shoubra el-Kheima Qalioubiya	Emad Ismail Saoudi	6.9	350	Lead ingots	Licensed

Table 4 (Continued)

Secondary Lead Smelters

Alexandria Governorate							
Serial No.	Company Name	Address	Contact Person	Rate t/d	Area m^2	Type of Product	Remarks
11	Atom for Batteries	Borg el-Arab City Second Industrial Zone Alexandria	Mohamed Mostafa Hassan	13.8	2,225	Lead ingots	Licensed

Giza Governorate							
Serial No.	Company Name	Address	Contact Person	Rate t/d	Area m^2	Type of Product	Remarks
12	Aly Mohamed Hussein El Mahy	Arab Abou Saed Giza	El Mahy	1.9	2,000	Lead ingots	Unlicensed
13	Mohamed Abou Skera and Nabil El Mahy	Arab Abou Saed Giza	Nabil El Mahy	2.8	2,275	Lead ingots	Unlicensed
14	Mahmoud Abdel Kader and Shams	Arab Abou Saed Giza	Mahmoud Abdel Kader	2.05	3,150	Lead ingots	Unlicensed
15	Sayed Awadallah	Arab Abou Saed Giza	Sayed Awadallah	32.3	10,500	Lead ingots	Unlicensed

Table 4 (Continued)
Secondary Lead Smelters

Giza Governorate (Continued)							
Serial No.	Company Name	Address	Contact Person	Rate t/d	Area m^2	Type of Product	Remarks
16	Sayed Awadallah	Arab Abou Saed Giza	Sayed Awadallah	—	6,300	—	Under construction and unlicensed
17	Mosad El Sayed Ahmed Abo Skera and Saad Termaz	Arab Abou Saed Giza	Mosad Abo Skera	1.9	2,600	Lead ingots	Unlicensed
18	Samir Abou Skera	Arab Abou Saed Giza	Samir Abou Skera	2.31	2,800	Lead ingots	Unlicensed
19	Nabih Abdel Hamid	Arab Abou Saed Giza	Nabih Abdel Hamid	5.4	2,100	Lead ingots	Unlicensed
20	Arafa Bekhit and Nabil el Mahy	Arab Abou Saed Giza	Arafa Bekhit	2.4	2,475	Lead ingots	Unlicensed
21	Abdel Hamid Abdel Kader Osman	Arab Abou Saed Giza	Abdel Hamid Abdel Kader Osman	13.85	3,720	Lead ingots	Unlicensed
22	Adel Abdel Hamid Saudi	Arab Abou Saed Giza	Adel Saudi	3.46	1,974	Lead ingots	Unlicensed

23	Abdel Kader Abdel Hamid Osman	Arab Abou Saed Giza	Abdel Kader Osman	3.85	1,364	Lead ingots	Unlicensed

Table 4 (Continued)

Secondary Lead Smelters

El-Sharkiya Governorate							
Serial No.	Company Name	Address	Contact Person	Rate t/d	Area m^2	Type of Product	Remarks
24	El-Masreya Co. for Smelting , Refining, and Lead Pipe Manufacturing (Awadallah)	10th of Ramadan 3rd Industrial Zone A1	Mostafa Sayed Awadallah	14	11,792	Lead ingots	Licensed

Dakahliya Governorate							
Serial No.	Company Name	Address	Contact Person	Rate T/d	Area m^2	Type of Product	Remarks
25	Abdel Hamid Abdel Kader Osman	Meet Ghamr Dondat Agriculture Rd.		—	970	—	Closed down
26	Nabil Abdel Karim El Mahy	Meet Ghamr Dondat Agriculture Rd.	Nabil Abdel Karim El Mahy	—	800	—	Closed down

Table 4 (Continued)
Secondary Lead Smelters

El-Minya Governorate							
Serial No.	Company Name	Address	Contact Person	Rate t/d	Area m^2	Type of Product	Remarks
27	El-Kods Co. for Casting	The Industrial Zone No.4 El-Minya	Ahmed Khalifa	4.6 1.2	3,000	Lead ingots Lead pipes	Licensed

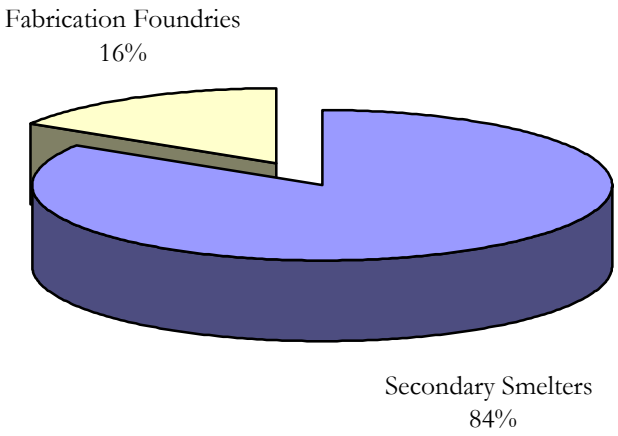
Table 5
Lead Fabrication Foundries

Cairo Governorate							
Serial No.	Company Name	Address	Contact Person	Rate t/d	Area m^2	Type of Product	Remarks
1	El-Ahleya Co. for Trading Metals and Lead Smelting	849 Port Said St. Hadayek el-Koba Cairo	Mansour Nabih Abdel Hamid	9.23	2,000	Lead pipes	Licensed
2	El-Fabrika el-Masreya for Lead	105 Kassarat el-Baladeya El-Zawia el-Hamra Cairo	Ahmed Aly	2.77	600	Lead pipes	Licensed
3	El Mahi Co. for Lead Products	85 Mahmasha El Bahary St., Ezbet Belal – El-Shorabiah, Cairo	Ali El Mahi	1.85	100	Lead pipes	Licensed
4	Abdallah El Farouk Aly Hussein Lead Foundry	Port Said St. – Region 16 - Ghamra Industry Zone, Cairo	Mohamed Abdallah El Farouk	2.3	1,000	Lead pipes	Licensed

Table 5 (Continued)
Lead Fabrication Foundries

Alexandria Governorate							
Serial No.	Company Name	Address	Contact Person	Rate t/d	Area m^2	Type of Product	Remarks
5	Atom for Batteries	Abdel Rahman el-Rafaei St. Bakous Alexandria	Hassan Mostafa Hassan	9.2	1,000	Lead pipes Lead sheets Battery plates Lead oxide	Licensed

Figure 1



Lead Fabrication Foundries vs. Secondary Smelters

The distribution of lead smelters in the Greater Cairo Area has changed considerably since enforcement of the Environmental Law began in March 1998. Twelve new unlicensed smelters were identified in a remote area in Giza Governorate, Arab Abo Saed. This could be attributed to:

- The considerable pressure exerted by the local authorities on the smelter owners to comply with Law No. 4 standards. Some smelters were closed and their owners relocated to remote areas in order to sustain their activities.
- Upgrading of the existing facilities proved to be infeasible, especially for smelters with relatively small areas.
- Delays in allocating new sites for relocation.

Figure 2 shows the location of lead smelters and lead foundries on a map of Egypt, while Figure 3 shows in detail the distribution of lead smelters and foundries in the Greater Cairo Area.

Analysis of Data

This study provided information concerning lead smelters and fabrication foundries, including geographical distribution, production, equipment, fuels used, emission control

Figure 2

Locations of Lead Smelters and Foundries in Egypt

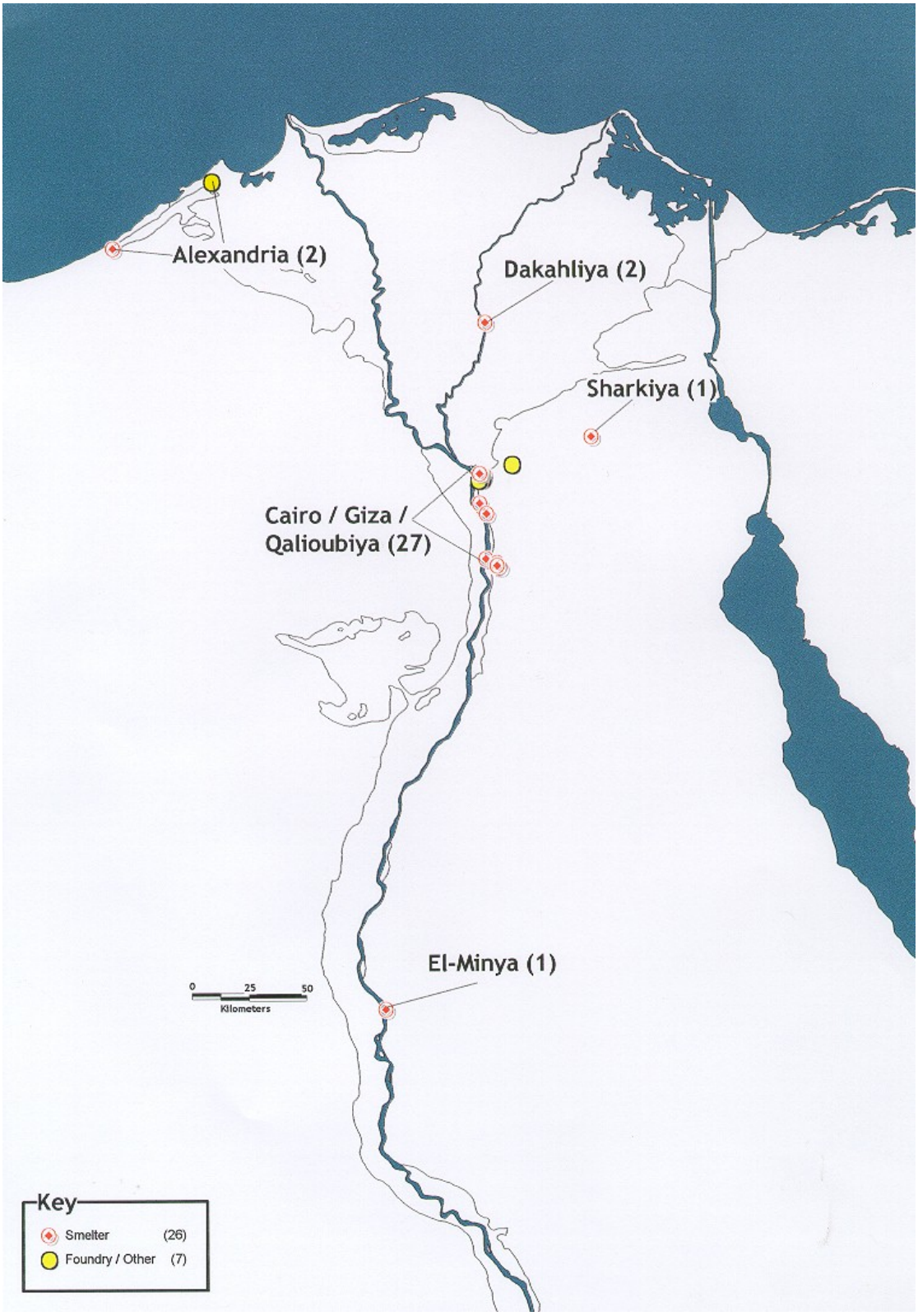
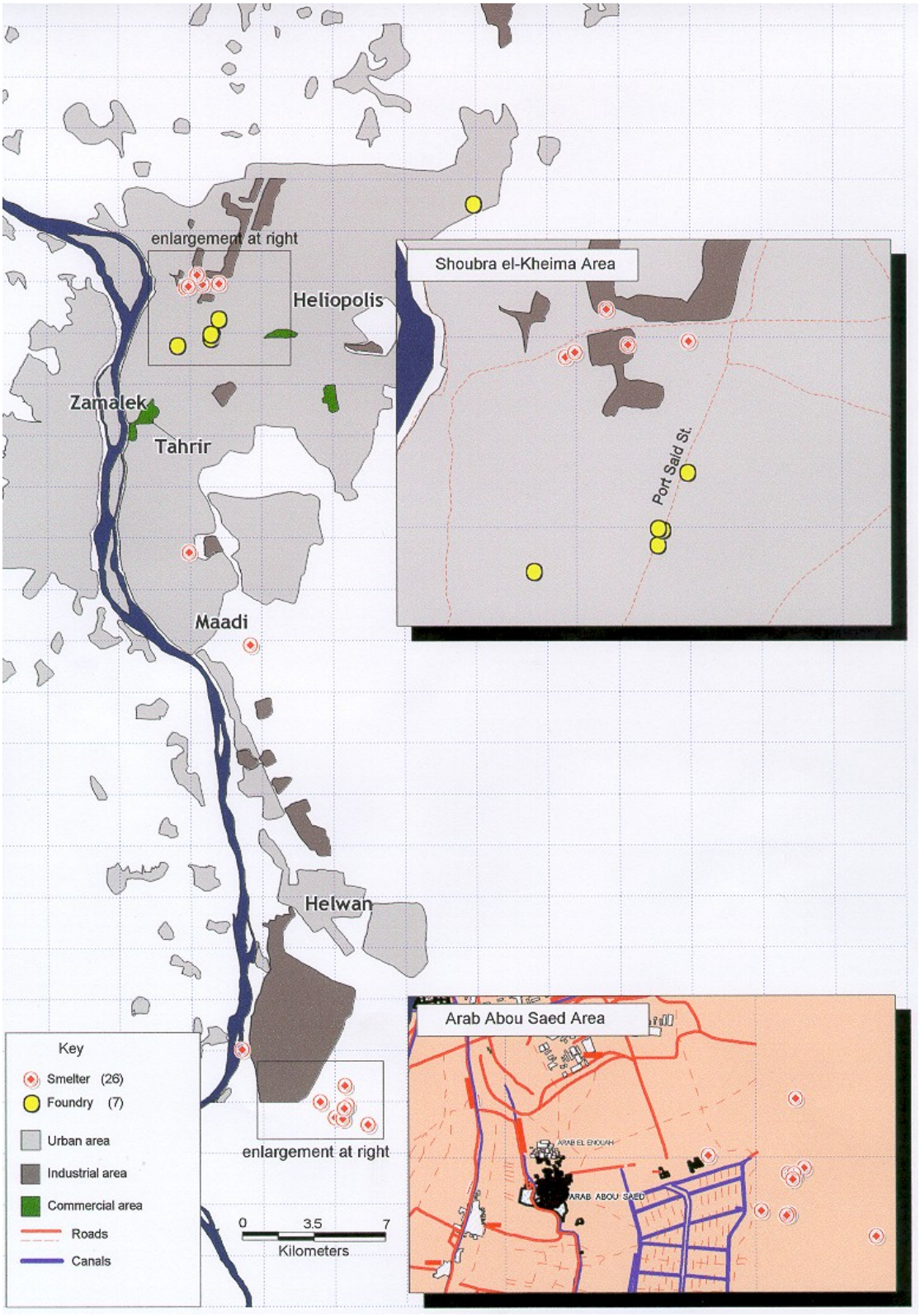


Figure 3

Lead Smelters and Foundries in the Greater Cairo Area



equipment, legal status, production rates, facility areas, solid wastes produced, work force, sites identified for remediation, and possible sites for relocating smelters and foundries.

Geographical Distribution of Lead Smelters

Lead smelters were found to be in seven governorates in Egypt: Cairo, Qalioubiya, Giza, Alexandria, Dakahliya, Minya and Sharkiya. The total number of smelters and foundries is 32, 27 smelters and 5 fabrication foundries.

Figure 4 graphically illustrates the number of lead smelters and fabrication foundries in each of the seven governorates. It is clear that the lead industry is centralized in the Greater Cairo Area, where 26 establishments exist. In Figure 5, lead fabrication foundries in Cairo and Alexandria governorates have been included to show the total number of lead smelters and lead foundries in each governorate.

Forty-eight percent of secondary lead smelters are licensed, as shown in Figure 6, while all fabrication foundries that were surveyed in this study are licensed. Figure 7 shows that the unlicensed lead smelters are located in the Cairo and Giza governorates. In Cairo they are located in the remote Basateen area, in the vicinity of the marble factories, while in Giza they are located in Arab Abo Saed, in the vicinity of the brick factories. Since the Environmental Law began to be enforced in March 1998, some of the secondary lead smelters have relocated to these remote areas, and now 41 percent of all smelters are located in these remote areas.

Figure 4
Distribution of Secondary Lead Smelters in Egypt

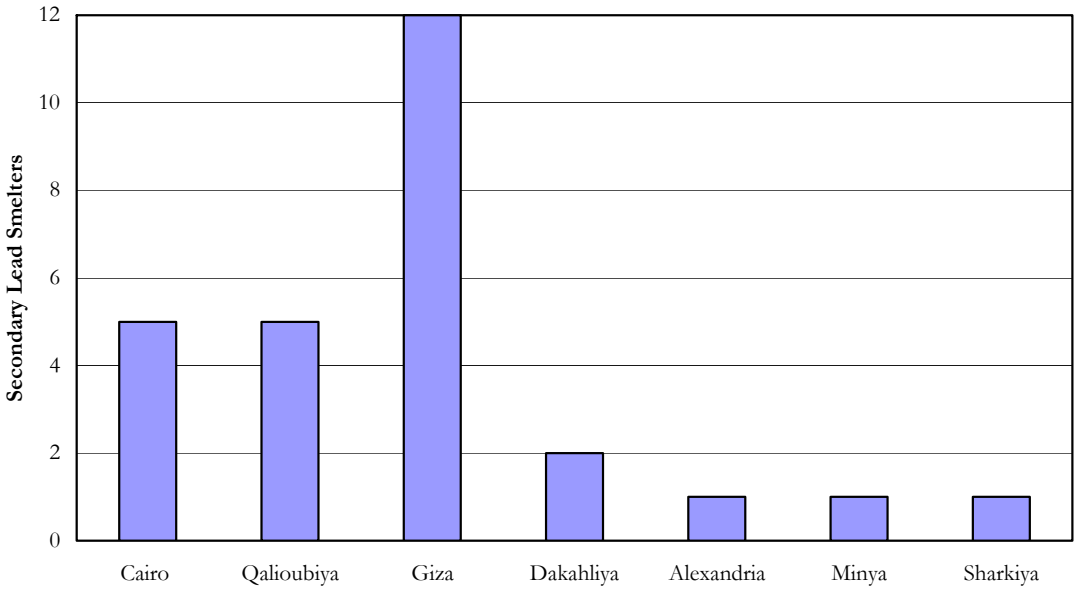
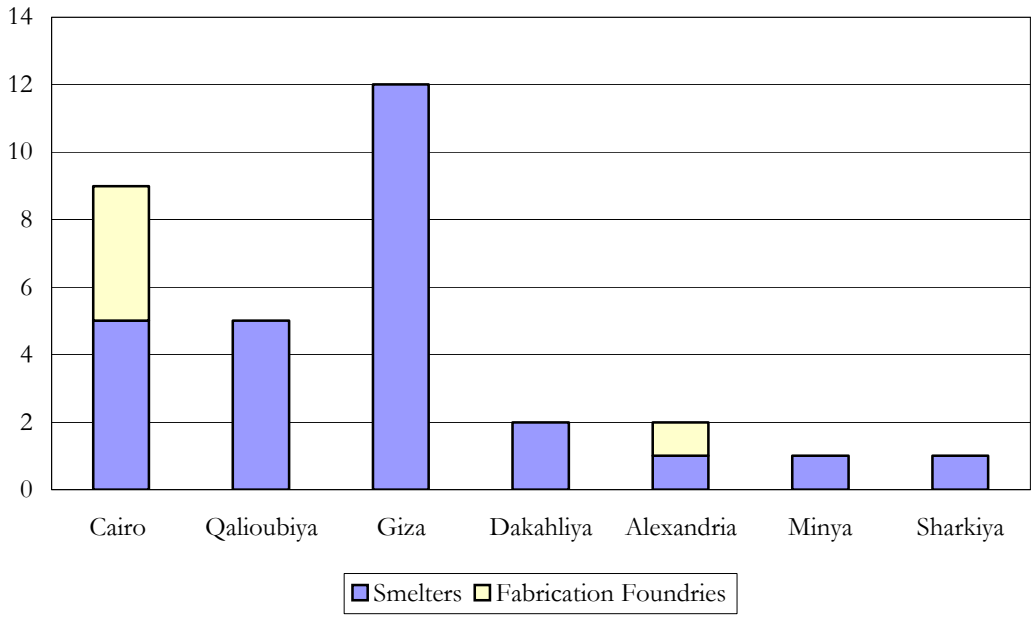


Figure 5
Distribution of Lead Fabrication Foundries and Secondary Smelters in Egypt



Sixteen percent of all lead smelters in Egypt are located in industrial areas, 31 percent in residential areas, 6 percent in agriculture areas, and 6 percent in commercial areas (see Figure 8). This indicates that a large number of small- and medium-sized smelters are operating in remote areas.

Sixty-six percent of the lead fabrication foundries operate in residential areas; 17 percent are in commercial areas; and 17 percent are located in industrial areas (see Figure 9). Figure 10 illustrates the kind of areas the lead smelters and foundries inhabit in each governorate. There were only five smelters located in industrial areas such as 10th of Ramadan City in Sharkiya, Borg el-Arab in Alexandria, New Industrial Minya in El-Minya, and Basateen, in Cairo. Two lead smelters are located in agricultural areas in Dakahliya, and 13 lead smelters are located in remote areas.

Figure 6
Licensed vs. Unlicensed Lead Smelters

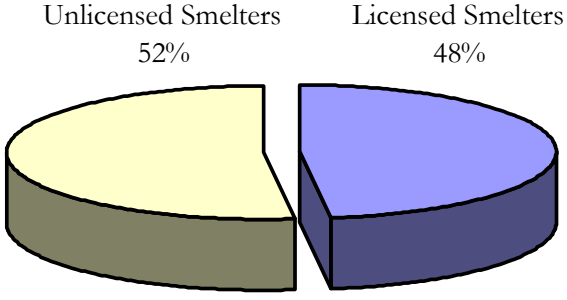
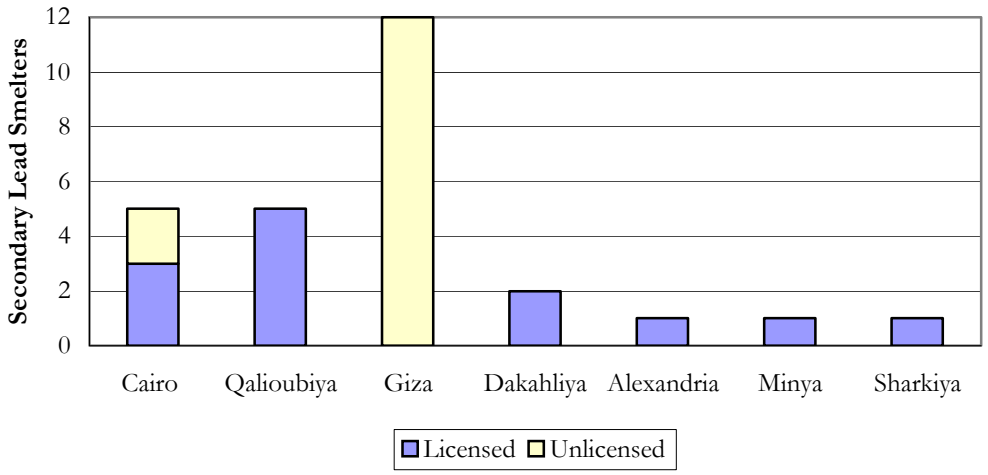


Figure 7
Licensed and Unlicensed Lead Smelters by Governorate



Lead Smelter Production

Private sector smelters of all sizes dominate lead production. Total daily production of lead ingots is 231.8 MT, resulting in annual production of 60,270 MT, assuming 260 working days.

Total annual production of the private large smelters, Awadallah, is 35,400 MT, which represents 56.6 percent of Egypt's total production. General Metals, the single public sector smelter, reduced its annual production from 8,000 to 3,250 MT, which represents only 5.4 percent, while small and medium (privately owned) smelters produce

Figure 8
Surroundings of Lead Smelters

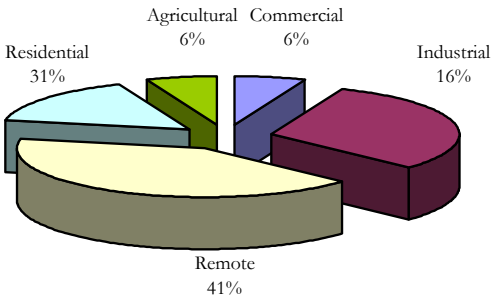


Figure 9
Surroundings of Lead Foundries

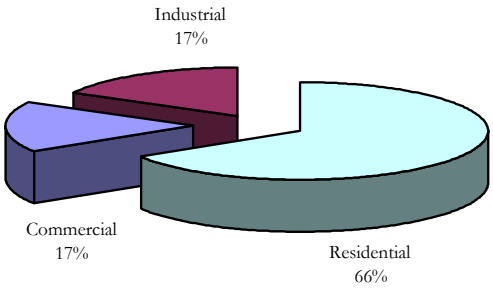
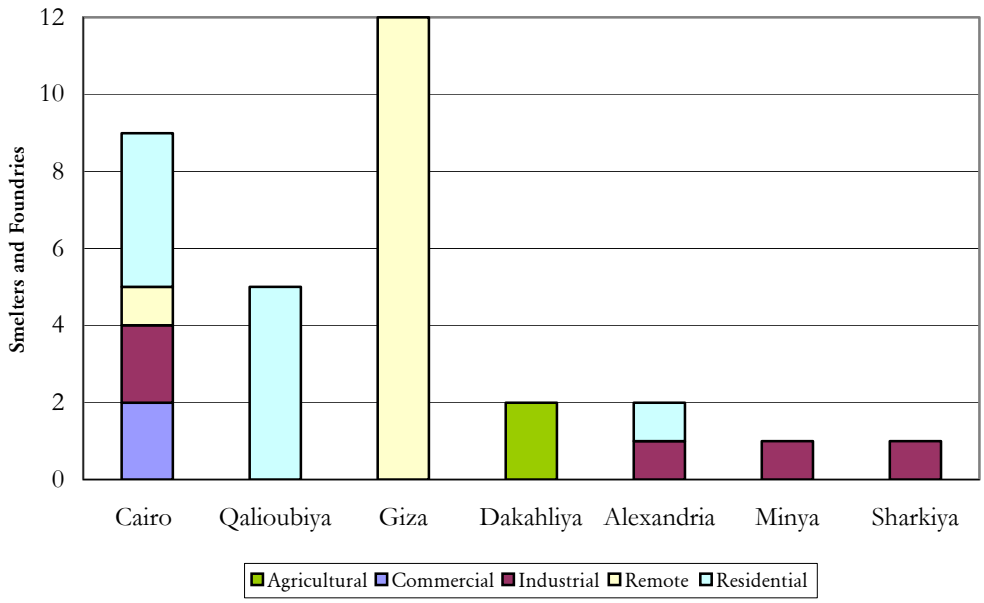


Figure 10
Surroundings of Lead Smelters and Foundries in Each Governorate



22,900 MT/Y, which is 38 percent of total production. This breakdown is shown graphically in Figure 11. The production rate of the small and medium smelters appears to have increased considerably due to their new unlicensed plants operating in Giza. The production of lead ingots occurs mainly in the Greater Cairo Area, which produces 52,402 MT/Y of ingots: 27,378 MT in Qalioubiya, 18,777 in Giza, and 6,247 in Cairo, as shown in Figure 12.

Small and medium lead smelters produce between 1,000 and 4,000 tons annually. Fewer than 32 percent of lead smelters—the "small smelters"—have an annual production rate of 1,000 tons or less. Fifty percent—"medium smelters"—have annual production

Figure 11
Lead Production by Sector

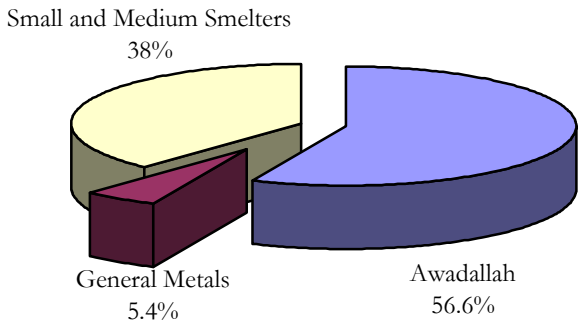
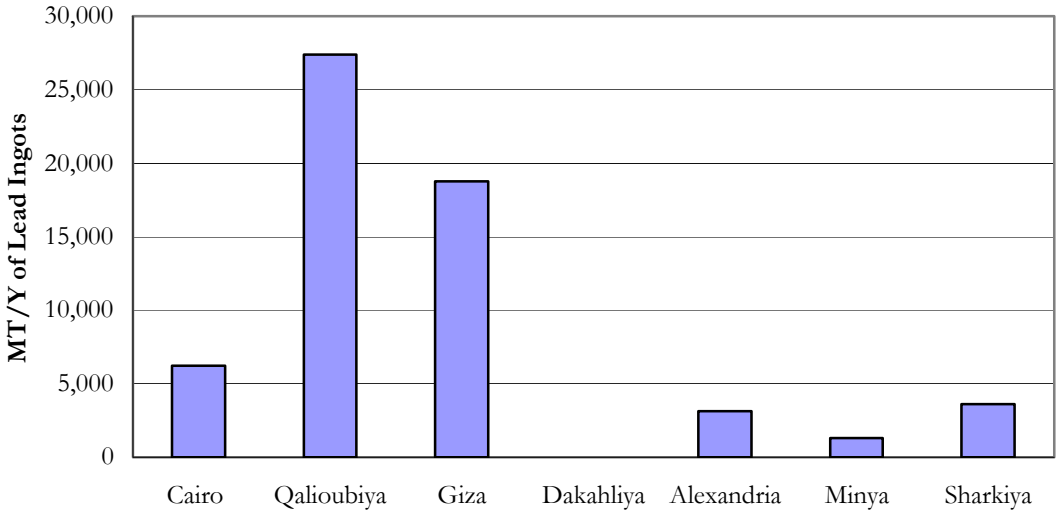
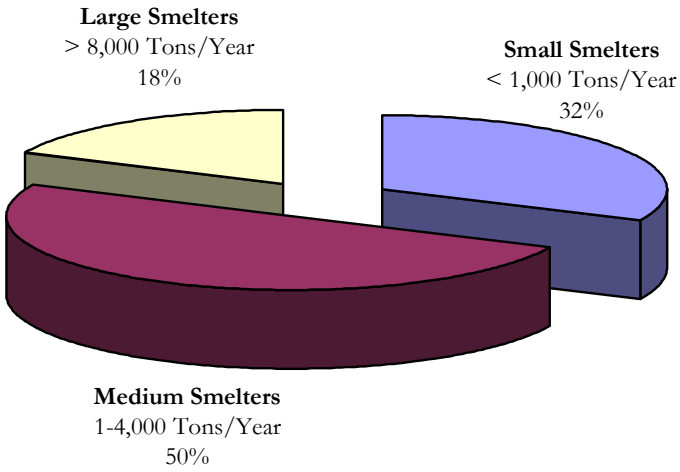


Figure 12
Lead Ingot Production by Governorate



outputs of 1,000–4,000 tons annually. The remaining 18 percent—large smelters—have annual production rates of more than 8,000 tons. This breakdown is shown in Figure 13. One-third of the total lead ingots produced are used by the lead fabricating foundries for the manufacture of lead pipes and products, which yield a total of 20,360 MT/Y of lead products. The remainder of the ingots are used in the manufacture of batteries, electric wires, lead crystal, lead oxides, hydraulic hoses, and glazed ceramics.

Figure 13
Smelter Production Rates



Facility Physical Size

The area of the smelters and foundries varies from less than 500 m^2 to more than 10,000 m^2. Figure 14 shows that 51 percent the lead smelters and foundries have a facility area of 2,000 m^2 or less. This is considered small, and it is not feasible to install emission control equipment. Figure 15 shows that most of the facilities now located in Giza have large areas. This may be because the area is remote and the smelter owners acquire the land free of charge. The facility area of smelters located in industrial zone such as Sharkiya and Alexandria are also large, and allow for the installation of emission control equipment.

Production Equipment

All private smelters use the same technology in their operations.

Figure 16 illustrates the sequence of operation starting from drained batteries through production of lead ingots. The technology used is primitive. Battery breaking is usually done manually, in open areas, without any pollution control equipment. Extraction of lead from batteries is done in rotary furnaces. There are 35 rotary furnace used in the smelting industry in Egypt with an average charging capacity of 4-5 tons. Charging is done manually in batches using shovels. It is a common practice in rotary furnace charges to include fluxing agents, such as limestone, coke, and iron chips. Limestone is used to decrease the concentration of sulfur dioxide in the flue gases. The maximum limit for the sulfur dioxide in the emissions from industrial establishments is 3,000 mg/m^3, as stated in the environmental law, which indicates that there is no need to add limestone to the charge of lead smelters, which might cause rapid corrosion of the firebrick lining the furnace. It has been reported that all smelters in Egypt add iron chips in excessive amounts. The rate is about 10 percent by weight of the battery charge. The excessive amount usually added causes an increase in the slag formed during the smelting process.

Figure 14
Facility Area for Lead Smelters and Foundries

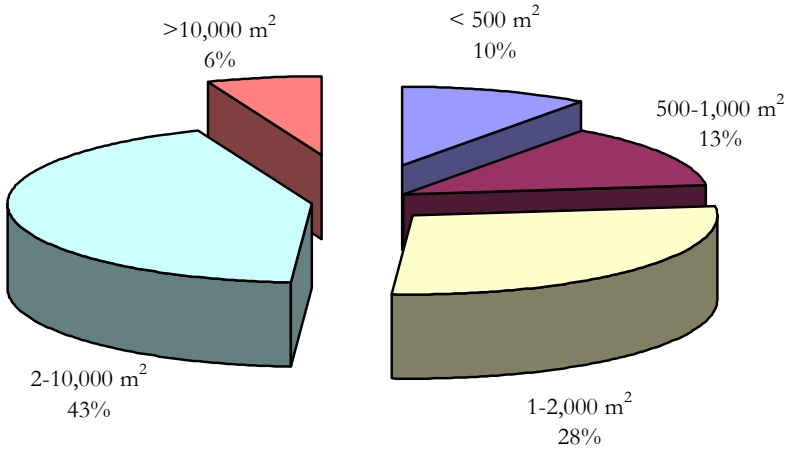
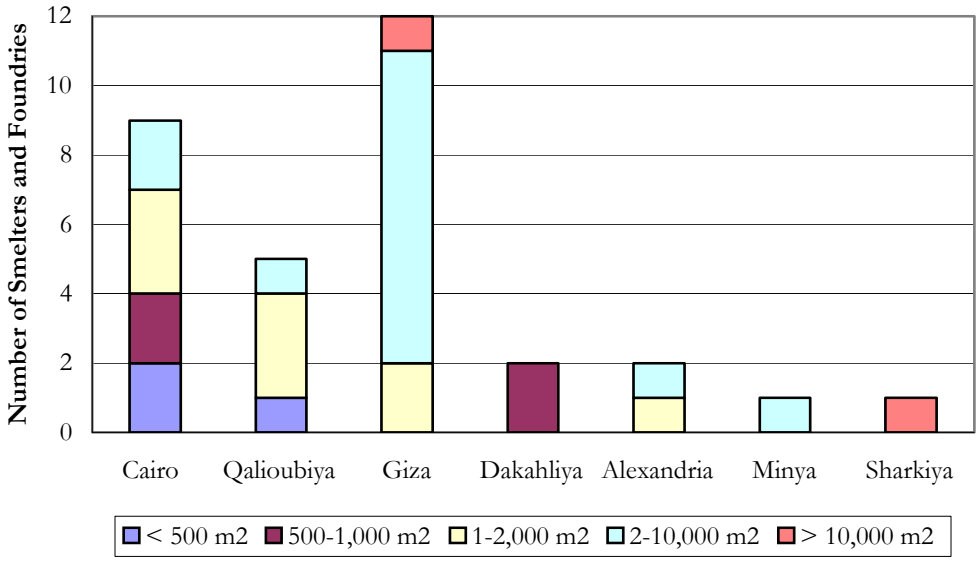


Figure 15
Facility Area for Lead Smelters and Foundries by Governorate



The commonly used rotary furnace shown in Figure 17 in the Egyptian lead industry is manufactured locally. The furnace configuration is out of proportion, with a length to diameter ratio about 2.9. Most of the rotary furnaces in operation are charged from one end, with gases discharged from the opposite end. However, the rotary furnaces at General Metals are top charged. This type of furnace contributes to pollution due to the excess lead concentration in the exhaust gases originated from the contact between the burner flame and the charge, which allows the conduct of a considerable amount of lead dust by the furnace gases.

Figure 16
Process Flow Diagram for Secondary Lead Smelting

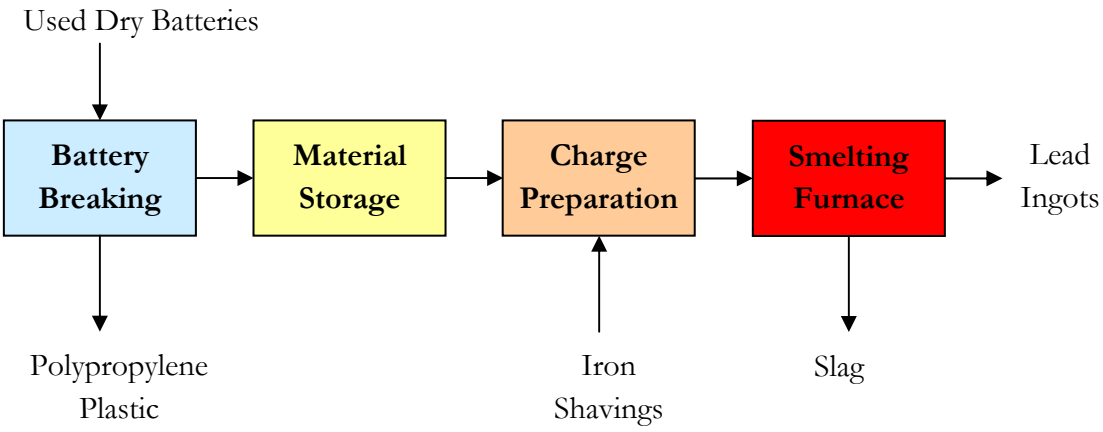
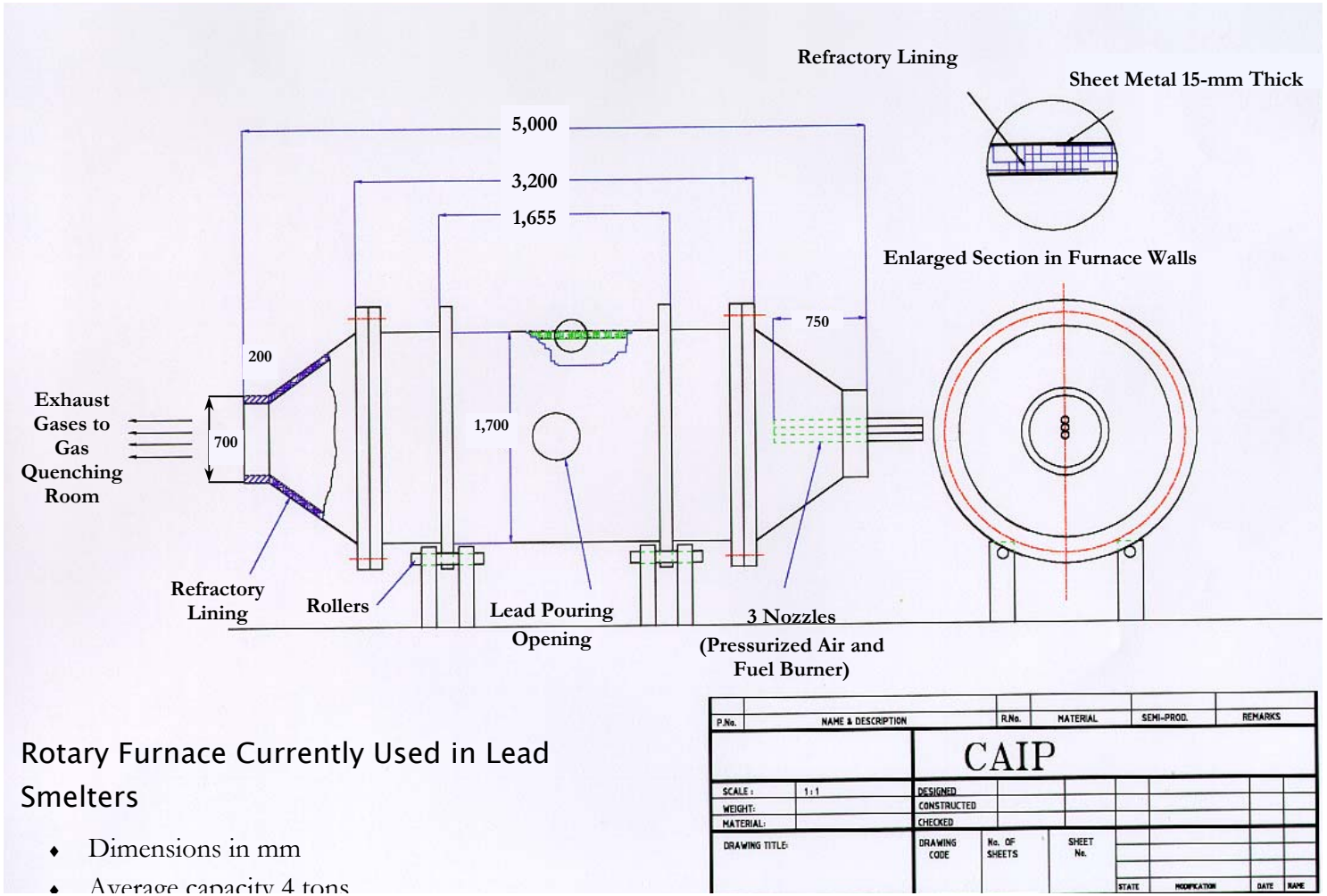


Figure 17

Commonly Used Rotary Furnace



The furnaces are equipped with locally made burners, which have no fuel control devices. Mazot was commonly used in smelters, but since the implementation of Law 4, some lead smelters have converted the fuel to solar. Article 42 of the Executive Regulations of Law 4 prohibits the use of mazot and other heavy oil products as fuel in residential areas, leading many lead smelter owners to use solar instead of a heavy oil.

The crude lead produced by the rotary furnaces is further processed in refining furnaces. There are 18 refining furnaces and 37 kettles in use in the Egyptian lead smelting industry. A typical locally manufactured kettle is shown in Figure 18. The lead ingots and lead scrap are heated to a temperature of 450ºC to melt the lead.

Refinery furnaces and kettles are made of a steel casing and may be lined with refractory bricks. They may be either cylindrical or parallelepiped. The burner is directed to the refinery furnace/kettle from underneath. All equipment is locally manufactured. Other equipment used in the production of lead pipes in some smelters and in lead fabrication foundries is mainly pipe extrusion machines. Other machines are used for lead sheet rolling, while lead oxide is produced in special mills.

Fuels Used

All lead smelters used mazot for smelting and solar or gas for refining. Since the implementation of the Environmental Law, some of the lead smelters owners converted from mazot to solar. They are using unconventional burners with no air to fuel ratio controls, which results in low combustion efficiency and higher consumption of fuel than with conventional burners. Forty-five and-a-half percent of lead smelters use solar, and 54.5 percent use mazot, as shown in Figure 19. Almost all lead smelters that use mazot as their main fuel consume a small amount of solar to start the burner. This amounts to about 6 percent of the mazot consumed. All lead fabrication foundries use solar. Conversion form mazot to solar has not decreased the level of pollutants emitted from lead smelters; it has only increased the quantity of solar imported to Egypt. The total annual fuel consumption of lead smelters is estimated to be 10,714 MT/Y of solar and 4,196 MT/Y of mazot.

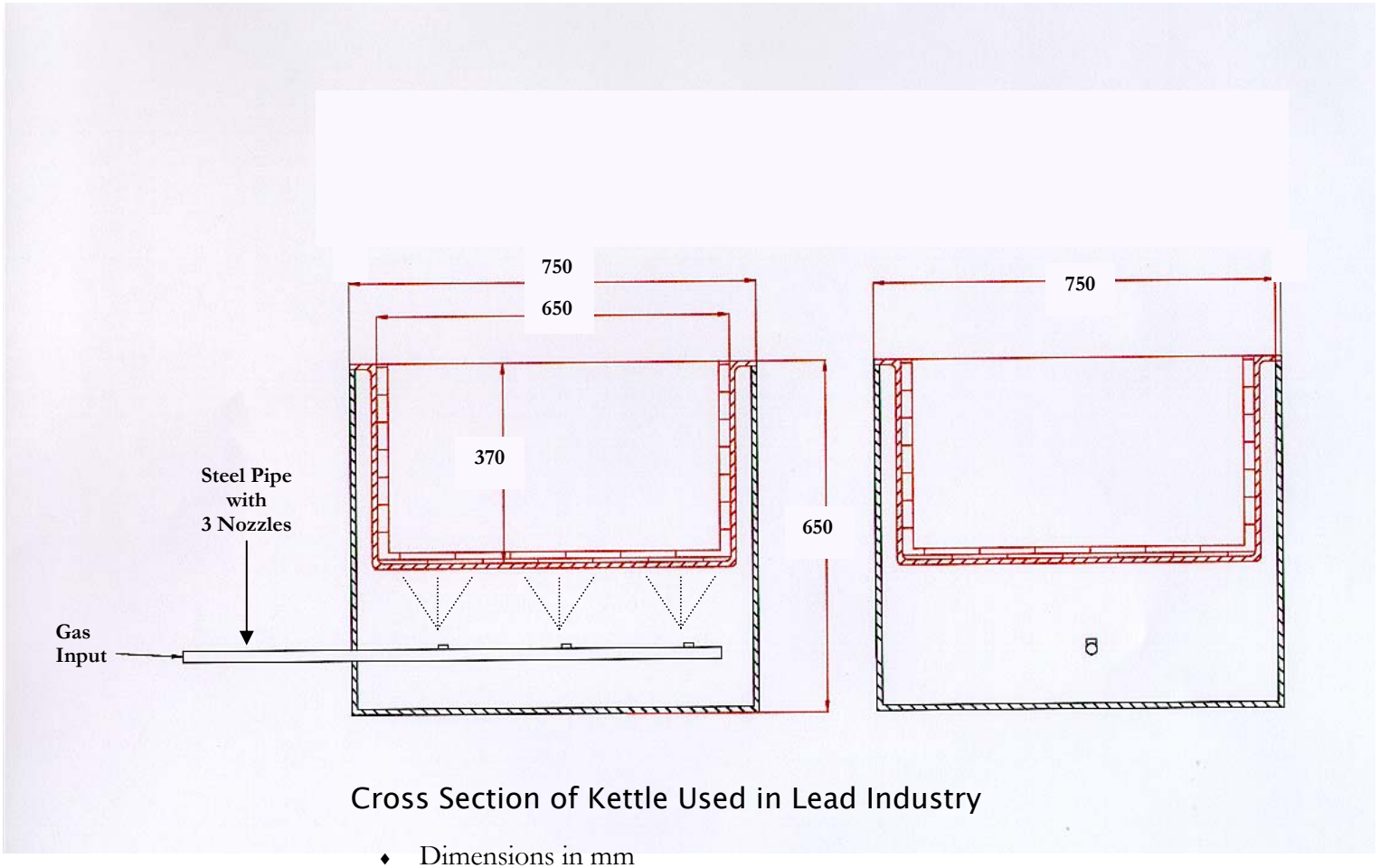
Emission Control Equipment

Exhaust gases emitted from lead smelters have high concentrations of particulate matter and lead. CAIP measurements indicated that the lead concentrations in the flue gases range between 8,413–905.7 mg/dscm, depending on whether the smelter uses whole batteries or plates as raw material. No emission control devices are used in most of the smelters.

- Awadallah installed wet scrubbers in his plants in Shoubra el-Kheima. CAIP's measurements show that the efficiency of this system is about 20 percent, as shown in Table 6. The system was recently upgraded to a three-stage system, consisting of a cyclone, a wet scrubber, and a dust collector. Measurements to gauge the efficiency of this new system are yet to be made.

Figure 18

Commonly Used Kettle



Cross Section of Kettle Used in Lead Industry

- Dimensions in mm

- Saudi installed a system consisting of a cyclone and a wet scrubber at his plant, El-Amal, in Shoubra el-Kheima. The efficiency of the system is 20 percent, as measured by CAIP. The results of these measurements are shown in Table 7.
- Awadallah installed a complete emission control system in the 10th of Ramadan plant, consisting of baghouse and all necessary accessories including hoods, fans and air ducts. The efficiency of the system is expected to be high, but that is yet to be proved.

Table 6
Emission Test Results for Awadallah's Shoubra el-Kheima Smelter

Run Number		Test 1	Test 2	Test 3	Averages
Particulate Matter	- Quantity collected (mg) - Concentration (mg/dscm) - Emission rate, kg/hr	589.1 607.9 4.01	804.2 1195.4 8.85	405.2 1832.7 13.67	 1212.0 8.85
Lead	- Quantity collected (mg) - Concentration (mg/dscm) - Emission rate, kg/hr	495.5 511.3 3.38	583.8 867.8 6.43	295.8 1337.9 9.98	 905.7 6.59

Figure 19
Type of Fuel Used in Lead Smelters

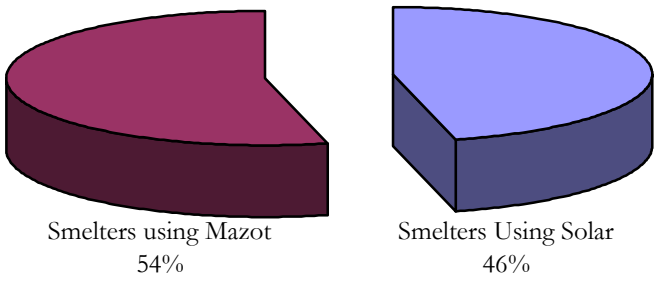


Table 7
Emission Test Results for Saudi's Shoubra el-Kheima Smelter

Sample No.[a]	PM Emissions		Pb Emissions		Percent Pb in Sample
	mg/dscm	kg/hr	mg/dscm	kg/hr	
Test-090198-1-IN	18127	81	13949	62	76.9
Test-090198-1-OUT	14214	56	11188	44	78.7
Test-090198-2-IN	8154	23	6767	19	83.0
Test-090198-2-OUT	8002	22	5637	16	70.4
Inlet Average	13141	52	10358	41	
Outlet Average	11108	39	8413	30	

[a] In-sampling performed at control device inlet; out-sampling performed at control device outlet.

Solid Wastes

The solid wastes produced by the smelters are mainly slag—3,874 MT/Y—and the plastic cases from the used batteries. Each smelter owner transports slag to the nearest dump as there are as yet no industrial landfills available in Egypt.

The slag produced contains a variable percentage of lead depending on whether whole batteries or lead plates are used as input raw material in the smelting process. This percentage varies from 2 to more than 6 percent. A waste determination of slag produced by Awadallah's lead smelting operations was performed using the United States Environmental Protection Agency's test method, Toxicity Characteristic Leaching Procedure (TCLP). The analysis showed that samples of slag taken from three of Awadallah's smelters were not hazardous or toxic waste. Therefore, the slag can be disposed in a solid waste landfill without pretreatment. In the absences of landfill, the slag can be stored at the smelter site in a secure location.

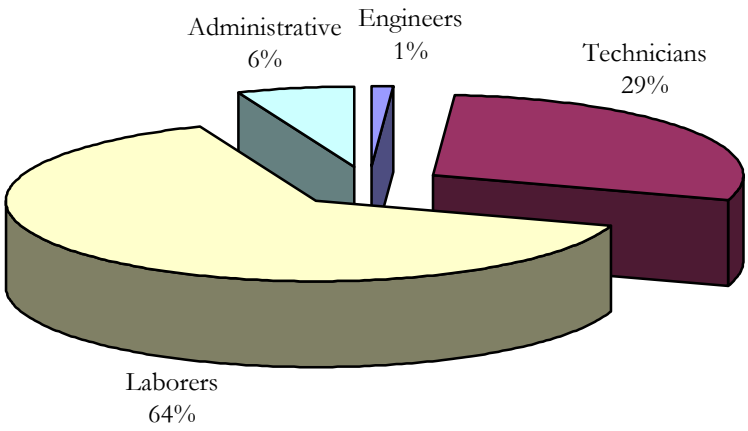
If a relatively lead-rich slag is produced, however, it should be reintroduced into the smelting operation.

Smelter Work Force

Families dominate the lead smelting industry in Egypt, with family members running the business. The industry workforce in smelters and lead fabrication foundries is about 800 workers. Most of the workers are laborers, representing 64 percent of the total, as shown in Figure 20. This workforce is subjected to high health risks since the workers are present in the smelting areas for long periods of time and do not use any measures to

lower the risks to their health. Twenty-nine percent of the workforce are technicians, who gain their knowledge through practical experience. The number of engineers is

Figure 20



Smelter Workforce

currently limited, but it is expected that more engineers will be needed to maintain and operate emission control equipment.

Impact of Law No. 4 Enforcement on the Lead Industry

Since enforcement of the Egyptian Environmental Law began in March 1998, governorate officials have threatened many lead smelters with closure. A number of smelter owners closed their old smelters and relocated to the remote area of Giza called Arab Abo Saed.

Fewer lead smelters are now operating in residential areas of Cairo and Qalioubiya Governorates, and this resulted in less lead in the ambient air. New smelters have been opened in a sparsely populated region of Giza Governorate, and most are operating without licenses. Currently, about 48 percent of lead smelters in Egypt are unlicensed, and the are producing approximately 30 percent of total lead ingots.

With enforcement of Law No. 4, Awadallah's 10th of Ramadan facility was also forced to comply with the law's regulations. They installed a German-made baghouse to bring the plant into compliance with the law.

Many smelter owners converted from mazot to solar as fuel for their furnaces, to comply with the law's regulations banning the burning of heavy oils in residential areas. While this may decrease the sulfur dioxide emitted, it does not affect the quantity of lead particulates.

It can be concluded that enforcement of Law No. 4 has compelled lead smelters to relocate to remote areas outside of residential areas, thereby reducing the hazards of their emissions on human health.

Sites for Remediation

Currently there are attempts to relocate four of Awadallah's smelters and two other small and medium smelters that belong to Saudi and El Mahi and are located in Shoubra el-Kheima. If these attempts are successful, there will be five private smelter sites available for remediation in Qalioubiya and one in Cairo Governorate. In addition to these, there are two other smelters in Dakahliya Governorate that were shut down by the Local Authorities.

General Metals is also a potential site for remediation; however, it is currently mired in issues related to policy and finance. Figure 21 shows the location of sites that are available now for remedial action.

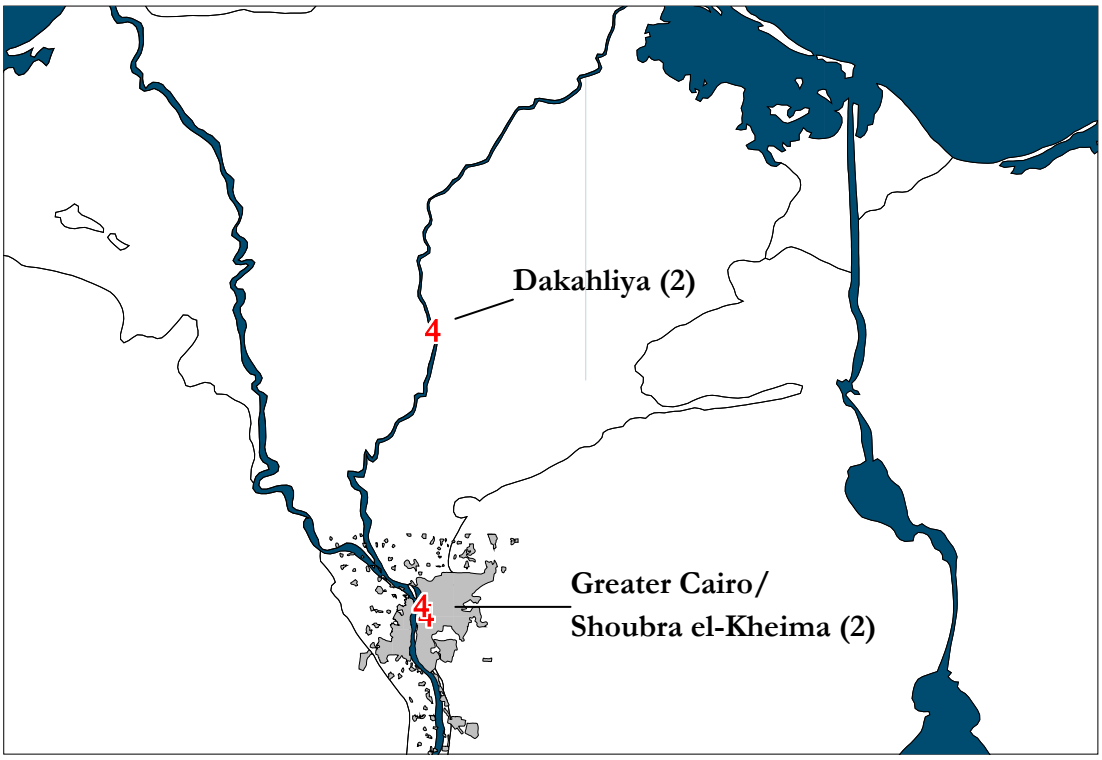
Relocation

Many lead smelters are now located in residential areas and their facilities are relatively small, making it is impossible to install emission control equipment. The only way to reduce lead in the atmosphere is to relocate lead such smelters and foundries to industrial zones and to use up-to-date technologies to ensure that these establishments comply with the Environmental Law.

Two sites have been identified for the relocation of lead smelters and foundries. One is in Katameya in Cairo Governorate, where 250 feddans have been allocated for foundries.

Figure 21

Sites Available Now for Remedial Action



It is the responsibility of Cairo Governorate to supply this site with necessary infrastructure, but this has not yet been done. It is important that an environmental assessment be made for the industrial site to identify the maximum number of foundries that can be allocated in this area and to identify the limit of the buffer zone.

The second site identified is in Qalioubiya Governorate. This is where the Awadallah, El-Mahi, and Saudi smelters will be relocated. The two sites are shown in Figure 22. Many issues are still to be resolved for this new site, such as the connection of electricity, water, and sewerage, location of a waste landfill, and the environmental assessment for the industrial site.

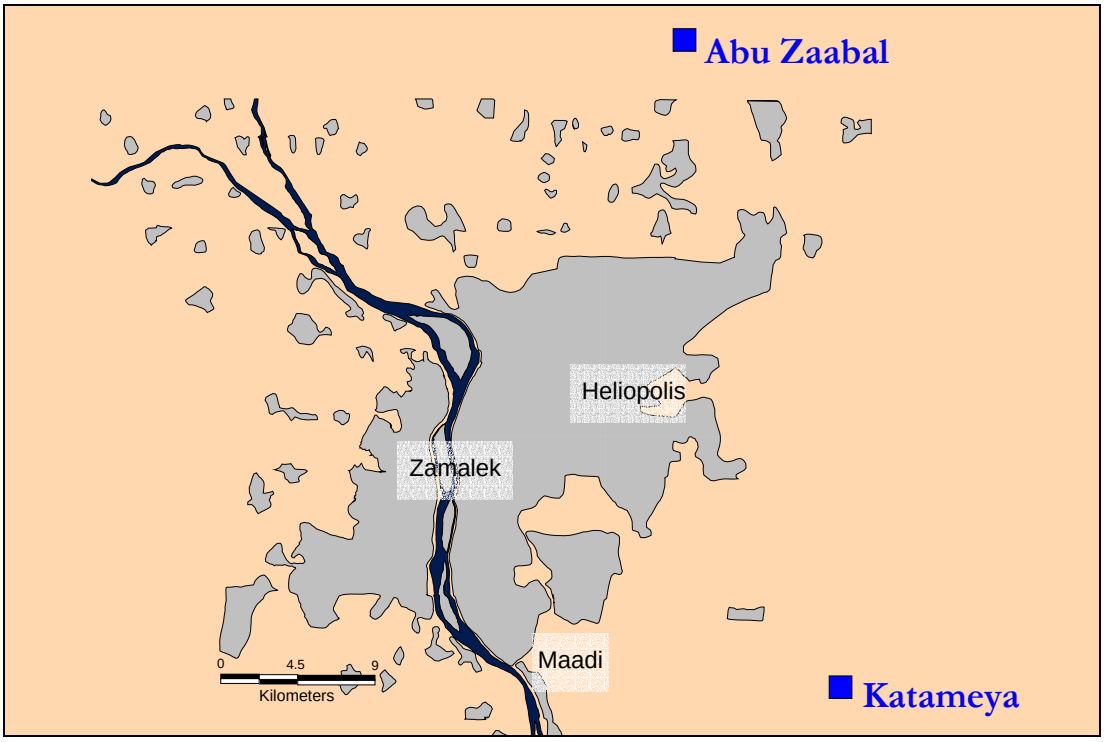
Conclusions

The comprehensive study conducted to identify smelters in Egypt, revealed:

1. There are 27 lead smelters and 5 lead fabrication foundries located in seven governorates in Egypt. These governorates are Cairo, Qalioubiya, Giza, Alexandria, Sharkiya, Dakahliya and El-Minya. The authorities have shut down three of these smelters and an owner closed one because of pressures exerted by the local authorities.

2. Forty-eight percent of lead smelters are unlicensed, and they produce almost 30 percent of the total lead ingots in Egypt; all lead-fabricating foundries are licensed.

Figure 22
Sites for New Foundries in Cairo and Qalioubiya Governorates



3. Forty-one percent of lead smelters are located in remote areas, 31 percent in residential areas, 6 percent in agricultural areas, 6 percent in commercial areas, and 16 percent in industrial zones.

4. The annual production of the lead smelters is 60,720 MT of lead ingots and 20,360 MT of lead pipes and other products are produced in the lead fabricating foundries. The remainder of the lead ingots are used in other industries.

5. The private sector still dominates this industry, and it produces 94.6 percent of the lead ingots.

6. Eighty-seven percent of the lead ingots are produced in the Greater Cairo Area.

7. The enforcement of the Environmental Law (Law No. 4, Year 1994) in March 1998 greatly affected the geographical distribution of the smelters, especially in the Greater Cairo Area. Twelve new unlicensed smelters have been identified in a remote area of Giza Governorate, Arab Abo Saed. This is attributed to the pressure exerted by the Local Authorities for smelter owners to comply with the Environmental Law.

8. Relocation of lead smelters to Arab Abo Saed, which is south of the Greater Cairo Area, and suspension of operation of old smelters in Qalioubiya, have resulted in a reduction in the concentration of lead in the ambient air, thereby reducing the hazardous effects on human health of lead particulate emissions.

9. The technology used in this industry is old, depending mainly on locally manufactured equipment. No upgrades were reported in the existing smelters, except for the Awadallah facility in 10th of Ramadan City.

10. There will be eight private smelter and one public sector smelter sites available for remedial action after they have relocated to new sites. In addition, there are presently four sites available to begin remedial action immediately, because the smelters are closed. Two of these belong to Awadallah (one each in Cairo and Qalioubiya); the other two are in Dakahliya.

11. Two sites have been identified for smelter relocation. One is in Abu Zaabal, Qalioubiya Governorate, where one big and two small smelters will be established. The other is in Katameya, Cairo Governorate, where 250 feddans have been allocated for foundries and smelters. These new industrial sites need utility connections to speed up the relocation process.

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