PHASE-OUT OF LEADED GASOLINE
SYNTHESIS REPORT

CHAIR:
MINISTRY OF ENVIRONMENT AND WATERS
REPUBLIC OF BULGARIA

SECRETARIAT:
THE REGIONAL ENVIRONMENTAL CENTER
FOR CENTRAL AND EASTERN EUROPE
Phase-out of Leaded Gasoline
SYNTHESIS REPORT

Szentendre
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I trust this Report will provide invaluable information in all follow-up work to the Sofia Initiative on Local Air Quality.

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Director General, National Centre of Environment and Sustainable Development,
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This Report presents a summary of the results of the SILAQ Working Group for the Phase-out of Lead in Gasoline. Its primary purpose is to provide an up-to-date overview of the progress achieved so far in the implementation of lead phase-out strategies in the SILAQ countries: Bulgaria, the Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia.

Each country has a definite phase-out schedule, but the approaches used vary from one country to another. Therefore, an exchange of experiences and lessons learned is beneficial to all participating parties. Moreover, lessons learned can also be used by other CEE and NIS countries participating in the pan-European Task Force on the Phase-out of Lead which do not yet have any specific phase-out plans in place.

The Report is divided into six sections. Section 1 presents the background to the SILAQ Initiative on the Phase-out of Leaded Gasoline. Section 2 focuses on the rationale for the phase-out of lead in gasoline, including an overview of lead emissions in the SILAQ countries and the health consequences of exposure to lead.

Current conditions influencing the phase-out of lead in the SILAQ countries are discussed in Section 3. The section includes an overview of the existing regulatory framework regarding vehicle-related air pollution; the structure of the vehicle fleets; and the situation in the refinery sector. Information is also provided on the use of gasoline and the gasoline distribution system in the SILAQ countries.

Section 4 reviews the various technical and economic considerations for the phase-out of leaded gasoline, including technological options for the petroleum refinery sector, considerations for the vehicle fleet, and other economic aspects.

Policy measures and instruments applicable are discussed in Section 5, which outlines possible approaches to the phase-out of lead, and examines specific policy measures and the instruments available. Details of current phase out strategies used by the SILAQ countries are presented, as well as some examples of the successful implementation of lead phase-out in other countries.

Section 6 concludes the report with an overview of key findings regarding plans and the implementation of the phase-out of lead in gasoline. Discussed are also key issues still needing to be addressed, possible follow-up actions to the SILAQ Initiative, and future assistance needs.
Background

This Report presents a summary of the results of the Sofia Initiative on Local Air Quality (SILAQ) Working Group for the phase-out of lead in gasoline. The Working Group is chaired by Bulgaria and includes representatives from the Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia.

The SILAQ Initiative focuses on the improvement of local air quality, with two areas of emphasis: (1) promotion of unleaded gasoline and (2) reduction of sulfur and particulate emissions.

This Report, prepared by the Regional Environmental Center for Central and Eastern Europe (REC), in cooperation with the Bulgarian Ministry of Environment and Waters, provides an up-to-date overview of the progress achieved in phasing out lead from gasoline in the SILAQ countries.

Health Effects of Lead Emissions

Lead is a hazardous, heavy metal that has a damaging impact on human health. It is regarded to be one of the most serious health problems facing populations, particularly children. Common symptoms include IQ loss, reading and learning difficulties, hearing loss, difficulties in concentration, adverse effects on kidney function, blood chemistry, and the cardiovascular system as well as adverse reproductive effects for women. The negative impacts of lead pollution on human health are well documented. The key indicator of lead exposure is the Blood Lead Level (BLL). In the SILAQ countries, the highest BLLs have been measured in Romania, where they were found to be some 2-5 times higher than those of Bulgaria and Slovakia.

Exposure is primarily caused by airborne lead. In congested urban areas, exhaust fumes from vehicles using leaded gasoline typically account for some 90 percent of airborne lead pollution. Lead emissions in the SILAQ countries have been declining since 1990, both in terms of total and vehicle-related emissions. Vehicles account for a major percentage of lead emissions, although there are significant country variations. Slovakia has the lowest total lead and vehicle-based emissions, along with the lowest per capita levels, owing to the rapid phase-out of leaded gasoline completed in 1995. Slovenia has the highest per capita emissions. It is unclear, however, as to whether this trend in the SILAQ countries is due to the increasing use of unleaded gasoline, or because of the decline in emissions from stationary sources.

The health benefits from reducing human exposure to lead can be grouped into three categories: (i) a positive impact on neurological development and intelligence; (ii) avoidance of costs in the special education of children with learning disabilities resulting from lead pollution; (iii) reduction in the number of lives lost prematurely due to cardiovascular problems caused by lead. Significant health benefits may be anticipated particularly in congested urban areas with high population densities. When comparing estimates, the benefits of lead removal may exceed the costs by 3-6 times. Based on US experiences, even higher cost/benefit ratios may be obtained when considering the reduced vehicle maintenance costs.

Regulatory Instruments

Strong political commitment is required to introduce and enforce the necessary measures for reducing human exposure to lead. Among these commitments is the harmonization of the regulatory framework in the SILAQ countries with that of the European Union (EU).

In all the SILAQ countries, the EU lead limit of 0.15 g/l in leaded gasoline and 0.013 g/l for unleaded has either already been adopted, or will be applied in the near future (and no later than the year 2000). With the exception of Romania, where the maximum lead content stands currently at 0.32 g/l, the actual average lead content in leaded gasoline sold
in the SILAQ countries is approximately 0.15 g/l. Some countries have also introduced regulations for other components.

The mandatory use of catalytic converters on new cars is an effective instrument for controlling vehicle-related air pollution. Catalytic converters in Slovakia have been required for both imported and domestically produced cars since 1993. Similar requirements have been introduced in Slovenia (1994), in Poland (1995) and in Hungary (1996), and are forthcoming in Bulgaria (1998), and in Romania (1998 for imported cars, and 2000 for those produced domestically).

Most SILAQ countries require the periodic technical testing of vehicles, which should also include the measurement of exhaust emission levels. Some SILAQ countries have introduced roadside spot-checks for vehicle emission levels using portable equipment.

**The Unleaded Gasoline Market**

The consumption of unleaded gasoline varies substantially in the surveyed countries, ranging from only 5-7 percent in Bulgaria and Romania to 100 percent in Slovakia, where leaded gasoline has been completely phased out. Relatively high shares for the use of unleaded gasoline (above 50 percent) are reported for the Czech Republic, Hungary and Slovenia. For unleaded gasoline, RON 95 grade is the norm, followed by RON 98. By the end of 1996, all gasoline stations in Hungary, Slovakia and Slovenia sold unleaded gasoline. In Bulgaria, the Czech Republic, and Poland, most stations offered unleaded gasoline, while in Romania only about a third sold unleaded gasoline. Overall, the distribution system is clearly not a significant obstacle to the phase-out of leaded gasoline.

Hungary and Slovakia are well-positioned to produce sufficient quantities of unleaded gasoline to meet domestic demand. Bulgaria, through domestic production, is able to cover about 45 percent of the market need for unleaded gasoline, while Romania could produce enough unleaded gasoline to satisfy domestic demand completely. In Poland, one third of its unleaded gasoline is imported, while Slovenia imports 90 percent of that used. Poland is planning also to increase production, but it is unlikely to meet the demand based on domestic production alone. Interestingly, the production of unleaded gasoline has been increasing in most countries at a rate much faster than its domestic consumption.

**Vehicle Fleet Considerations**

There are over 21.6 million cars in the seven SILAQ countries. On average, 94 percent of those are passenger cars and light duty vehicles. The share of diesel-driven passenger cars is small — between 6 and 12 percent. Poland and the Czech Republic have the highest total number of vehicles, followed by Bulgaria, Hungary and Romania. Slovenia has the lowest total number of vehicles, but the highest number per capita. The number of vehicles in the SILAQ countries has been increasing, with growth in Romania and Poland most rapid.

On average, passenger cars are considerably older (approximately 11.2 years) in the SILAQ countries, compared with their West European counterparts (6-8 years). Bulgaria, the Czech Republic and Slovakia have the oldest passenger car fleets. Domestically manufactured cars or those from the other former Eastern bloc countries are the prevailing makes of cars. The share of cars made in Western Europe and Far East countries is still low, at fewer than 30 percent. The share of passenger cars equipped with catalytic converters is even lower in all the SILAQ countries, and does not exceed 15 percent.

A large percentage (40 to 60 percent) of car fleets in the SILAQ countries are made up of older cars equipped with engines containing soft exhaust valve seats, which are believed to require leaded gasoline for its lubricant properties. The structure of the vehicle fleet is often cited as a major obstacle to lead phase-out. However, research shows that the amount of lead required for lubrication is much lower than the currently applied standards of 0.15 g/l, and that 0.05 g/l is sufficient to provide the required effect. Secondly, lubrication can be provided by commercially available potassium and sodium-based lubricant additives. There is also evidence that suggests many cars previously thought to need leaded gasoline can operate using unleaded gasoline. The cost of replacing lead as a lubricating additive has been estimated at approximately USD 0.003 per liter of gasoline.
Refinery Sector Considerations

Aside from providing lubrication, lead additives are a cheap means for increasing the gasoline’s octane number. From a technological point of view, there are no obstacles to the phase-out of lead from gasoline, however, the removal of lead will lead to increased production costs as the refinery will need to compensate for the resulting octane loss. For the purpose of this Report, three types of refineries were distinguished: simple refineries, undertaking crude oil distillation, treatment and blending (Type 1); refineries undertaking crude oil distillation, treatment, upgrading and blending (Type 2); and complex refineries, undertaking crude oil distillation, treatment, upgrading, conversion, blending and catalytic reforming (Type 3).

Slovakia and Slovenia have one refinery each. Bulgaria and Hungary have two, while the Czech Republic has four refineries. Poland and Romania operate a larger number of refineries: seven and five, respectively. The prevailing type of refinery is Type 2, followed by Type 3. Crude distillation and conversion processes are the norm, with the upgrading and the use of organic and lubricating additives practiced in some refineries.

The SILAQ countries generally do not use their refineries to full capacity. Poland and Slovakia present the highest usage, at 89 percent and 80 percent, respectively. Romania and Bulgaria utilize their refineries to 69 percent and 65 percent, respectively. Only 55 percent of the refinery capacity is utilized in Slovenia. Ownership of the refineries is mixed: they are fully privatized in Hungary, while in Poland, all refineries are owned by the state. In Slovakia, the sole refinery is in private hands. In Romania and Slovenia, ownership is shared by the state with private interests. In Bulgaria, two out of the three refineries are privately owned.

A significant obstacle to the phase-out of lead is the need for investment in modernizing existing gasoline production units. Worldwide experience and estimates indicate that annual investment expenditures and added operating costs associated with the removal of lead from gasoline are typically in the range of USD 0.01-0.02 per liter of gasoline. Preliminary estimates as to the cost of removing lead from gasoline in Romania did not exceed the range of USD 0.005-0.02 per liter, including both operation and capital recovery costs.

Policy Approaches

Most authorities note that the need for significant investments in modernizing existing production units is the major obstacle to lead phase-out, and all other problems encountered tend to be related to public support and policies used by governments. Therefore, while lead phase-out is a highly cost-effective measure, a strong commitment to the appropriate policy intervention is required.

The core aspects that need to be addressed include: regulations and enforcement; incentives; a broad consensus among the affected stakeholders; and public understanding and acceptance. Three general approaches may be considered, including:

- the technology-based approach, which relies on a change in gasoline demand due to changing car technology (e.g. requirements for catalytic converters);
- the incentive policy approach, which uses price incentives and other policy measures to promote the use of unleaded gasoline in both cars with and without catalytic converters;
- the rapid phase-out policy, which encourages the use of unleaded gasoline (or prohibits the use of leaded gasoline altogether) before catalytic converters become universally used by the entire car fleet.

The key measures adopted by those countries which have already phased out leaded gasoline, tended to include the maximum permissible lead content in gasoline of 0.15 g/l, the use of tax incentives to promote market demand for unleaded gasoline, and the introduction of stricter air emission standards for new cars, which could only be met through the use of catalytic converters.

Considering the current conditions in most SILAQ countries, the technology-based approach alone would require a lengthy transition period because of the large numbers of old cars within the vehicle fleet. It appears that combining the incentive and rapid phase-out approaches, a more suitable way of dealing with vehicle-related lead exposure problems in the SILAQ countries can be found. Bulgaria, Hungary, Poland and Slovenia have
followed the incentive approach, combined with regulations to reduce the lead content of gasoline, and support the use and import of cars with catalytic converters. Tax incentives have been applied in all the SILAQ countries, but with the exception of Slovakia and Slovenia, the difference in the consumer price of gasoline is relatively small.

The phase-out strategy should also include a realistic schedule with clearly defined and well-communicated objectives and time-lines. The timely introduction and enforcement of corresponding regulations would accelerate the lead phase-out process. Such an approach would provide a sufficient adjustment period for the refineries and reduce the adjustment costs.

Conclusions

All the SILAQ countries intend to phase out leaded gasoline by the year 2003 at the latest. The phase-out of lead is technically and economically feasible. The key issues needing to be addressed include the:

- Ability of domestic refineries to supply unleaded gasoline;
- Use of unleaded gasoline by local vehicles;
- Awareness of the public as to the applicability of unleaded gasoline.

The lack of finance constitutes a significant barrier in the SILAQ countries, particularly in Bulgaria and Romania, and to some extent in Poland. Modernization of existing refineries in order to produce unleaded gasoline is technically feasible, especially since most refineries are of the more advanced type, but the process requires significant investments. If a proper combination of tax incentives and stricter regulations can be introduced, refineries will have to look more actively for the necessary funding.

The problems related to the high share of vehicles with soft exhaust valve seat engines, believed to require lubrication provided by lead, can be solved by the application of commercially available alternative non-lead lubricants. For instance, Slovakia completely phased out lead in 1995 despite the fact that more than half of the car fleet carried engines with soft exhaust valve seats. Slovakia’s experience shows there are available technological options, policy measures and alternatives in the phase-out of leaded gasoline that may be applicable to the other SILAQ countries where high vehicle age is a problem.

Awareness raising measures will have to be widely used to overcome the lack of information among the public as to a vehicle’s ability to use unleaded gasoline. This is particularly important for that segment of the vehicle fleet which can use both leaded and unleaded gasoline. Mass media information campaigns and brochures available at gasoline stations and vehicle technical control centers are possible means to increase awareness of the rationale and benefits from the phase-out of lead in gasoline.

Recommendations

Further steps will have to be taken by the SILAQ countries to address the following areas:

(i) Public information and outreach campaigns regarding the applicability of unleaded gasoline in older types of cars;
(ii) Awareness raising with regard to the health benefits of lead phase-out;
(iii) Exchange of experiences with other countries also phasing out leaded gasoline;
(iv) Needs assessment for the development and use of non-lead lubricating additives;
(v) Research into the feasibility of using unleaded gasoline in cars with soft exhaust valve seats;
(vi) Ensuring access to the necessary financial support for refinery modernization;
(vii) Technological development of refineries;
(viii) Introduction and enforcement of vehicle emissions and gasoline standards;
(ix) Introduction and modernization of the control system for periodic technical inspection of vehicles;
(x) Implementation of the requirement for the fitting of cars with catalytic converters and other pollution control devices;
(xi) Development of the production and distribution systems to improve the supply of unleaded gasoline and lubricating additives;
(xii) Implementation of policy incentives (e.g., taxes, pricing) to increase the market share of unleaded gasoline and speed up the complete phase-out of leaded gasoline;
(xiii) Requirements for lead phase-out in negotiations leading to the privatization of refineries.

To implement some of these actions, external assistance must be sought.

**Follow-up to the SILAQ Initiative**

Most of the Central and Eastern European (CEE) countries and the Newly Independent States (NIS) face similar problems and obstacles in phasing out lead. Clearly there is a demonstrated need across the region for learning from each other’s experiences. A multi-country follow-up project to the SILAQ Initiative would enable participating countries to: carry out joint activities; facilitate the shortening of the transition period; support the implementation of investment projects; share experiences and information which can help to reduce implementation costs; initiate programs that address the main obstacles to lead phase-out; provide technical assistance to countries which are less advanced in the lead phase-out process; facilitate feasibility studies for investment projects; and organize workshops related to the problems associated with lead phase-out and possible ways to facilitate this process.

Under the aegis of the SILAQ Working Group, and with the coordination provided by the Regional Environmental Center, small joint-expert teams could be established to facilitate the exchange of experiences and to help accelerate the lead phase-out process. Exchanges of experience could focus on successful programs and case studies, and would address the major constraints to the implementation of lead phase-out activities. The SILAQ countries might also initiate country studies on how best to address technical problems resulting from the characteristics of vehicle fleets. Work could also focus on the implementation of effective emission control systems and the periodic technical inspection of vehicles.

Such joint activities would help facilitate Task Force initiatives realize the pan-European strategy for the phase-out of leaded gasoline. The follow-up to the Sofia Initiative for Local Air Quality, organized as a multi-country regional cooperation project open to new participants would not only accelerate the phase-out of lead, but also contribute to the European integration process.
1. Introduction

1.1 PROJECT BACKGROUND

The Sofia Initiatives were adopted during the Third “Environment for Europe” Ministeri-
al Conference in Sofia, Bulgaria in October 1995. The aim of the four adopted Initiatives (Local Air Quality, Environmental Impact Assessment, Use of Economic Instruments, and Biodiversity), was to accelerate the implementation of the Environmental Action Pro-
grame (EAP) for Central and Eastern Europe (CEE), through policy, regulation and invest-
ment measures. The Sofia Initiative on Local Air Quality is one of those Initiatives, dedicat-
ed to the general improvement of local air quality in Central and Eastern Europe with the
following two areas of emphasis: (1) the promotion of unleaded gasoline throughout the
region, and (2) the significant reduction of sulfur and particulate emissions.

SILAQ Objectives

To exchange information on local air pollution control strategies and their imple-
mentation;

To harmonise policies, standards and regulations among the participating countries
(with regard to international practices and approximation to EU norms);

To develop and implement national or municipal strategies for the least-cost reduction of
airborne lead, particulate and sulfur, as well as public information and participation.

SILAQ Working Group

The Initiative was open to all participants in the Environment for Europe process, who
wished to contribute to the adoption and implementation of the Environmental Action
Programme’s objectives and outcomes. Bulgaria, Hungary, Poland, Romania, Slovakia and
Slovenia supported the local air quality initiative prior to the Sofia conference, and since
then, two more countries, the Czech Republic and Croatia, have joined the core Working
Group of governmental officials.

Participation in the Initiative has been open-ended — both CEE and Western partici-
pants were welcome to join all or some of the activities in accordance with their interests
and at any point in time. Reporting commitments were voluntary; however, participants
were expected to carry out their commitments once made. In line with the decisions of the
Sofia conference to encourage the gradual shift of activities toward the CEE countries, core
meetings related to the Initiative took place in this region.

The work program under the Sofia Initiative on Local Air Quality focuses mainly on:

- Data collection, in order to obtain a comprehensive overview of the situation in the
participating CEE countries with respect to the phase-out of leaded gasoline and the
reduction of sulfur and particulate emissions;
- Exchange of experiences in the two main areas above, through regional workshops for
experts from both CEE and Western countries;
- Preparation of a synthesis paper, which would provide a comparison among the part-
ticipating CEE countries, including their current circumstances with regard to air pollu-
tion, approaches to reducing air pollution, policies adopted, and experiences with
regard to the implementation of those policies;
- Development of a database containing pertinent data regarding the available technolo-
gy options and suitable alternatives;
- Support to the participating CEE countries through the preparation of country analyses
and the development of possible scenarios, specific projects and project proposals,
and legislative, economic and investment measures for implementation.
INTRODUCTION

Role of the REC

On March 18, 1996, a Working Group consisting of members from Bulgaria, Hungary, Poland, Romania, Slovakia and Slovenia was established, with Bulgaria appointed as chair. In his capacity, the elected Chairman reviewed the available options for appointing a Secretariat and a means for securing international technical and policy expertise. The Regional Environmental Center for Central and Eastern Europe was requested to provide these services. A Memorandum of Understanding between the Ministry of Environment in Bulgaria and the Regional Environmental Center was signed on September 27, 1996. To support the work of the Secretariat, the US Environmental Protection Agency (EPA) approved a financial assistance package of USD 150,000 to the Regional Environmental Center.

In accordance with the draft SILAQ program outline, a meeting of the Working Group took place on February 12-13, 1997 in Szentendre, Hungary. The meeting was attended by representatives of Bulgaria, Hungary, Poland, Slovakia and Slovenia. Western governments and international institutions were represented by Denmark, Germany, the US EPA, and the World Bank. A work plan for 1997-1998 was developed and approved by the Working Group and endorsed by the participating representatives of Western governments and international institutions. It was recommended that the implementation of the Work Plan begin immediately.

It should be noted that a number of key recommendations from the Environment Programme for Europe (EPE) were inserted as an annex to the Sofia Ministerial Declaration during its completion. One of these recommendations was to reduce the lead content of gasoline with the long-term aim of completely phasing out lead in gasoline across Europe.

UN ECE Task Force

Based on the Sofia Ministerial Declaration, an open-ended pan-European Task Force was established during the meeting of UN ECE Committee on Environmental Policy (CEP) held on May 20-23, 1996, to consider a strategy for the phase-out of lead in gasoline in Europe. The Task Force has since held four meetings and has implemented several initiatives investigating the conditions for the phase-out of lead in gasoline.

The Task Force’s key initiatives included:

- General considerations for a strategy to phase out leaded gasoline in Europe;
- Country Assessments for 34 European countries;
- A country programme under preparation in Ukraine;
- A National Commitment Building Programme covering Azerbaijan, Kazakhstan and Uzbekistan currently under implementation;
- A guide book on the processes involved in phasing out lead in gasoline, and;
- A regional car park study.

The conclusions of the Task Force were based on the findings of the above initiatives, supplemented with existing relevant material compiled and processed by the Task Force.

SILAQ and the UN ECE Task Force

With respect to the work done under the UN ECE Task Force to phase-out lead in gasoline, it is important to emphasize that the Sofia Initiative on Local Air Quality is not a stand-alone Initiative. All SILAQ activities concerning the phase-out of lead have been closely coordinated with the UN ECE Task Force. The Chairman of the SILAQ Working Group has also co-chaired the meetings of the Task Force. The Danish Environmental Protection Agency, the leading government within the Task Force, has been instrumental in providing the SILAQ Working Group with experts and up-to-date research data, and in turn, the results of the SILAQ Initiative have been made available to the Task Force members through several reports and presentations. From this and other points of view, SILAQ is a complementary activity to those of the Task Force.

Bourgas Workshop

A SILAQ workshop on the phase-out of lead in gasoline was held on June 24-26, 1997, in Bourgas, Bulgaria, with participants from five Working Group member countries (Bulgaria, Hungary, Romania, Slovakia and Slovenia), and three other countries from the region (Albania, the Czech Republic, and the Russian Federation). Facilitators from Western countries included representatives from Denmark, Norway, and the US.

The workshop covered the following topics:

- Health consequences of air lead emissions;
- The pan-European process for the phase-out of leaded gasoline and co-operation with the UN ECE Task Force;
- The regional car-park study;
The technological, administrative and economic aspects of phasing out lead in gasoline — with case studies from Norway, Slovakia and the US;

The phase-out of lead in CEE — Country Status Reports of the Sofia Initiative Working Group members;

The preparation of draft phase-out schedules for Bulgaria, Romania and Slovenia;

Experience sharing with other countries of the region, including Albania, the Czech Republic and the Russian Federation;

A visit to “Neftochim”, the largest Bulgarian refinery.

In order to obtain a comprehensive overview of the current situation within the Working Group member countries, a questionnaire (in the form of a “Data Sheet”) was prepared in order to examine the status of the phase-out of lead in gasoline. The questionnaire was completed by the participating countries (Bulgaria, the Czech Republic, Hungary, Poland, Romania, Slovakia, and Slovenia), and the conclusions presented as a contribution to the pan-European study on the phase-out of lead in gasoline. The results of these questionnaires were compiled by Working Group members into Country Status Reports for Bulgaria, Hungary, Romania, Slovakia and Slovenia.

Concluding Synthesis Report

The combined results of the questionnaires and Country Status Reports, as well as all additional information available, are presented in this Synthesis Report. The major SILAQ input to the next Ministerial Conference to be held in Aarhus, Denmark, in June 1998 will be based on this Report (one of the many Official Documents to the Conference) and on the separate study for SOx and particulate emissions. Both these Synthesis Reports will:

- Present an interpretation of the available data and assess the current situation with regard to lead phase-out and air pollution in the participating countries;
- Provide a comparison among the participating countries;
- Present relevant case-studies and identify successful programmes, as well as examine the problems encountered by participating and other CEE countries;
- Outline a list of priority projects for each participating country, and for the region as a whole. This list is to be submitted for approval by the international organisations and other relevant participants present at Aarhus, and proposed as a framework for further collaborative actions.

In addition, an easily accessible database of available technology options and alternatives containing pertinent data is to be developed prior to the Aarhus conference.

Besides the Synthesis Reports, a number of background SILAQ documents will also be presented, including data sheets, Country Status Reports, and the minutes of the Working Group member meetings and regional workshops.

2. Rationale for the Phase-out of Lead in Gasoline

Lead is a hazardous, heavy metal that has a damaging impact on human health. Evidence from many countries suggests that human exposure to lead is one of the most serious health problems facing populations, especially children.

Health Impacts

Lead and lead compounds can adversely affect human health through either direct inhalation or ingestion of lead-contaminated soil, dust, or paint. Elevated lead levels can adversely affect mental development and performance, kidney function, and blood chemistry. This is particularly a risk for young children, due to the increased sensitivity of young tissues and organs to lead as well as to their greater chance of ingesting lead with soil and dust. Lead-related pollution also causes cardiovascular problems in adults even with low levels of exposure, as well as adverse reproductive effects for women.

Pollution Sources

The exposure is primarily caused by airborne lead, and lead in dust and soil. In congested urban areas, in countries where only limited or no initiatives to reduce lead emissions have been taken, exhaust fumes from vehicles using leaded gasoline typically account for some 90 percent of airborne lead pollution.

Other sources of lead emissions include industrial processes such as metal smelting, production and destruction of lead batteries, and combustion processes in coal-fired power plants, waste incinerators, and domestic heating sources.
Both the negative impact of lead pollution on human health, as well as the health and environmental benefits of the phase-out of leaded gasoline are well documented through research carried out in those countries which have already completed the phase-out process.

2.1 TOTAL LEAD EMISSIONS AND THE SHARE OF LEAD EMISSIONS FROM THE USE OF GASOLINE

Vehicle-related Lead

Data on the environmental stress caused by lead, as measured by the level of emissions from vehicles for the years 1990-1996, are given in Box 1. The declining trend in vehicle-related lead emissions is common in all the SILAQ countries but the levels of reduction vary.

Table 1 summarizes the total and vehicle-based lead emission levels, per capita lead emission levels, and the use of unleaded gasoline. This table illustrates that vehicles account for a major percentage of lead emissions, although the magnitude of total emissions and the share from vehicles varies substantially from one country to another.

Total lead emissions and vehicle-based emissions are declining in all of the surveyed countries. Between 1990 and 1995, the total lead emissions in Slovakia were reduced by 55 percent, and by 77 percent for vehicle-based emissions. It is worth noting that since 1995, only unleaded gasoline has been sold in the Slovak market. In Bulgaria, total and vehicle-based emissions in the same period were reduced by 36 percent and 23 percent, respectively, although the market share of unleaded gasoline is still only 7 percent. In the Czech Republic, total lead emissions decreased by 18 percent between 1993 and 1995, but for the same period, vehicle-based emissions have remained almost unchanged (although a decrease of 18 percent was registered in 1994). In Slovenia, the reduction of vehicle-based emissions during the period 1990-1995 has been significant (58 percent), but at 92g of lead per capita, the level of emissions still remains the highest among the surveyed countries.

As can be seen in Table 1, the trends in the use of unleaded gasoline in the SILAQ countries show the differences in the effectiveness of policy measures. Slovakia is clearly a leader in the fast phase-out of leaded gasoline, with the complete phase-out achieved by 1995. It is worth noting that Slovakia has the lowest total lead and vehicle-based emissions along with the lowest per capita levels. Considering the data presented in Table 1, it is clear that the increased use of unleaded gasoline in Slovakia has led to a significant decrease in the share of vehicle-based lead emissions and very low levels of lead pollution per capita.
However, Hungary and Slovenia are also increasing their share of unleaded gasoline in the market, exceeding 55 percent in both countries in 1996. The lowest consumption of unleaded gasoline is in Romania. In Bulgaria, in contrast, the share of vehicle-based lead emissions has actually increased, from 46 percent in 1990 to 56 percent in 1995. This is due to the greater reduction of lead emissions from other sources, and because the market share of unleaded gasoline has remained at a very low level, at 7 percent.

In the Czech Republic, the share of vehicle-based emissions decreased from 67 percent in 1993 to 45 percent in 1994, but an upward change toward 80 percent has been reported for 1995. These values are estimated on the basis of total gasoline consumption, which has fluctuated significantly in the same period, with a strong decline in 1994.

In both Bulgaria and Romania, the share of unleaded gasoline in the market is low. Even though the levels of per capita emissions from vehicles are fairly low in Bulgaria, it is obvious that any significant reduction of vehicle-based emission in both countries has been mainly due to the lower levels of fuel consumption during the economic transition period. Interestingly, among the surveyed countries, only Romania’s market share of unleaded gasoline decreased, from 13 percent in 1995 to 5 percent in 1996. This is due to the lack of efficient policy measures and commercial interests in exporting unleaded gasoline, rather than increasing availability domestically.

### 2.2 ASSESSMENT OF HEALTH CONSEQUENCES FROM LEAD AIR POLLUTION

#### Health Impacts

Exposure to lead-related pollution can adversely affect mental development and performance, kidney function, and blood chemistry. This is particularly a risk for young children, due to the increased sensitivity of young tissues and organs. Common symptoms observed in children include IQ loss, reading and learning difficulties, hearing loss, hyperactivity, and difficulties in concentration.

Lead-related pollution also causes cardiovascular problems in adults, even with low levels of exposure. Adverse reproductive effects in women have also been observed. Finally, fetal exposure can result in reduced birth weight, infant mortality, and fetal deaths.

The health impacts of airborne lead pollution are highly dependent on the levels and distribution patterns of the pollution, as well as on the features of the population exposed (e.g., age and health conditions). The influence of other local characteristics, such as building height, distance from intensive road traffic, and the existence of stationary lead sources should also be considered.

#### Blood Lead Levels (BLL)

The key indicator of exposure is the Blood Lead Level (BLL). Although the US Center for Disease Control and Prevention (CDC) revised its intervention threshold for the blood lead level from 25 μg/dl to 10 μg/dl (Center for Disease Control and Prevention, 1991), recent studies have indicated that, depending on the individual sensitivity to lead-induced neuro-
toxicity and individual susceptibility, even a Blood Lead Level below 10 μg/dl can lead to negative neuro-motoric and neurobehavioral effects in older children (Grandjean, 1993).

Recent research in Slovakia (E. Sovcikova, 1996) has revealed subtle changes in the neuromotor and cognitive performance of older children with a BLL lower than 10 μg/dl. Significantly worse performance was found in fundamental functions (such as lower psychological activity and slowed reaction time), and in the overall levels of intelligence.

Data on the concentration of lead in ambient air, and on the blood lead levels as an indicator of the health impact from lead air pollution are presented in Tables 2 and 3, respectively. The tables provide comprehensive data for different groups of people.

### Table 2: Concentrations of Lead in Ambient Air

<table>
<thead>
<tr>
<th>Country</th>
<th>City or area</th>
<th>Lead concentrations in ambient air (μg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td>Sofia</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>Pernik</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Plovdiv</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>Kardjali</td>
<td>1.2</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>Prague</td>
<td>0.055</td>
</tr>
<tr>
<td></td>
<td>Pribram</td>
<td>0.078</td>
</tr>
<tr>
<td></td>
<td>Ústí n. Labem</td>
<td>0.058</td>
</tr>
<tr>
<td></td>
<td>Brno</td>
<td>0.069</td>
</tr>
<tr>
<td></td>
<td>Ostrava</td>
<td>0.050</td>
</tr>
<tr>
<td>Hungary</td>
<td>Budapest</td>
<td>0.20</td>
</tr>
<tr>
<td></td>
<td>Pecs</td>
<td>0.42</td>
</tr>
<tr>
<td></td>
<td>Miskolc</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>Debrecen</td>
<td>0.56</td>
</tr>
<tr>
<td>Poland</td>
<td>Katowice</td>
<td>0.730</td>
</tr>
<tr>
<td></td>
<td>Chorzow</td>
<td>2.690</td>
</tr>
<tr>
<td></td>
<td>Pszczyna</td>
<td>0.640</td>
</tr>
<tr>
<td></td>
<td>Lodz</td>
<td>0.162</td>
</tr>
<tr>
<td>Romania</td>
<td>Copşa Mica</td>
<td>30.30</td>
</tr>
<tr>
<td></td>
<td>Bucuresti</td>
<td>60.58</td>
</tr>
<tr>
<td></td>
<td>Bala Mare</td>
<td>5.45</td>
</tr>
<tr>
<td></td>
<td>Medias</td>
<td>10.15</td>
</tr>
<tr>
<td></td>
<td>Zlatna</td>
<td>22.72</td>
</tr>
<tr>
<td>Slovakia</td>
<td>Bratislava</td>
<td>0.114</td>
</tr>
<tr>
<td></td>
<td>B. Bystrica</td>
<td>0.111</td>
</tr>
<tr>
<td></td>
<td>Ruzomberok</td>
<td>0.142</td>
</tr>
<tr>
<td></td>
<td>Richnava</td>
<td>0.505</td>
</tr>
<tr>
<td>Slovenia</td>
<td>Trebicjë</td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td>Zagorge</td>
<td>1.50</td>
</tr>
<tr>
<td></td>
<td>Hrastnik</td>
<td>0.25</td>
</tr>
</tbody>
</table>

**NOTE:** Italicized text denotes short term max. concentration (μg/m³)

1 Source: National Institute of Public Health, annual geometric means, 1996
2 Data from the State Health Inspectorate (max. average daily concentration)

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### Declining Lead Concentrations

The data in Table 2 clearly shows a decline in the concentrations of lead in ambient air in the SILAQ countries, with the exception of certain areas in Poland (Pszczyna and Lodz) and in Romania (Baia Mare and Medias). The apparent increase in these cities may be caused by stationary sources. At any rate, it is interesting to note that for both Poland and Romania, the total lead emission levels are significantly higher (even up to one order of
magnitude), than those for Hungary and Slovenia (although it is unclear whether the difference may have been caused by different measurement techniques for short term maximum concentrations). Comparison of figures for Bulgaria and Slovakia (which provided data concerning annual mean values rather than short term maximum concentrations) shows that progress in the phase-out of leaded gasoline in Slovakia has resulted in a remarkable decline in airborne lead. In Bulgaria, the average decrease between 1990 and 1995 has been about 30 percent, while in Slovakia it has ranged between 50 percent and 88 percent.

In the Czech Republic, a trend in the decline of the ambient air lead concentrations during the period 1993-1995 has been reported in three of the surveyed industrial centers with heavy traffic, namely in Prague, Pribram and Usti n. Labem.

It is worth noting that airborne lead concentration limits for ambient air are 1 µg/m$^3$ in Bulgaria, 0.3 µg/m$^3$ in Hungary and 0.5 µg/m$^3$ in Poland.

Table 3 reports on the results of investigations of blood lead levels, chiefly in children.

<table>
<thead>
<tr>
<th>Country</th>
<th>City or area</th>
<th>Year</th>
<th>BLL – mean value (range) [µg/dl]</th>
<th>Groups under examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td>Momchilgrad</td>
<td>1991</td>
<td>11.4 [10.8-11.8]</td>
<td>children, 5-7 years old</td>
</tr>
<tr>
<td></td>
<td>Momchilgrad</td>
<td>1991</td>
<td>11.6 [11.0-12.2]</td>
<td>teenagers, 12-14 years old</td>
</tr>
<tr>
<td></td>
<td>Kurtovo Konare</td>
<td>1991</td>
<td>17.0 [16.5-17.5]</td>
<td>children and teenagers</td>
</tr>
<tr>
<td></td>
<td>Haskovo</td>
<td>1995</td>
<td>10.1 [9.7-10.5]</td>
<td>children, 5-7 years old</td>
</tr>
<tr>
<td></td>
<td>Haskovo</td>
<td>1995</td>
<td>11.4 [11.0-12.0]</td>
<td>teenagers, 11-12 years old</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10.2; 4.95; 4.67</td>
<td>children, 4-7 years old</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12.50; 5.57; 4.51</td>
<td>children, 8-11 years old</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7.21; 4.84; 4.69</td>
<td>teenagers, 12-14 years old</td>
</tr>
<tr>
<td></td>
<td>local</td>
<td>1994</td>
<td>7.4 [7.0-7.9]</td>
<td>children</td>
</tr>
<tr>
<td></td>
<td>Pribram</td>
<td>1996</td>
<td>6.5 [6.2-6.9]</td>
<td>children</td>
</tr>
<tr>
<td></td>
<td>industrial lead</td>
<td></td>
<td>2.38-4.83 [2.2-4.6]</td>
<td>females</td>
</tr>
<tr>
<td></td>
<td>emitters</td>
<td></td>
<td>2.39-6.3 [2.2-6.5]</td>
<td>children</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4.94-10.50 [4.5-10.0]</td>
<td>females</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7.37-11.40 [7.0-11.0]</td>
<td>children</td>
</tr>
<tr>
<td>Romania</td>
<td>North Railway Station</td>
<td>1983-1985</td>
<td>17.1 [16.5-17.5]</td>
<td>children</td>
</tr>
<tr>
<td>(six areas of)</td>
<td>Bucharest(1)</td>
<td>1983-1985</td>
<td>18.40 [17.5-19.0]</td>
<td>children</td>
</tr>
<tr>
<td></td>
<td>Militari</td>
<td>1983-1985</td>
<td>17.84 [17.0-18.0]</td>
<td>children</td>
</tr>
<tr>
<td>Slovakia</td>
<td>Bratislava</td>
<td>1993</td>
<td>5.65 [5.5-5.8]</td>
<td>children</td>
</tr>
<tr>
<td></td>
<td>Middle Slovakia</td>
<td>1995</td>
<td>4.5 [4.0-5.0]</td>
<td>children</td>
</tr>
<tr>
<td></td>
<td>North Slovakia</td>
<td>1996</td>
<td>3.04 [2.8-3.2]</td>
<td>children</td>
</tr>
</tbody>
</table>

1 Geometric mean values [µg/dl] for subjects living at distances from the lead smelter of less than 3 km, 3-5 km, and over 5 km

Source: Final Report of the National Integrated Program on Environment and Health Project, 1999
but also for adults. In Poland, for instance, three groups are distinguished: “males”, “females” and “children”. For Bulgaria, sex is not distinguished, but rather data is provided for the categories of “children” and “teenagers” as well as “adults.”

Trends in BLL

Based on the data in Table 3, no firm conclusions can be drawn concerning the BLL trends during a certain period of time for a given area. The only exception is Budapest, where a remarkable decrease of 45 percent in BLL is shown between 1992 and 1996. However, since there is no data available for 1992 levels of airborne lead, this cannot be directly related to airborne lead pollution.

The data for Bulgaria shows that the BLLs for both “children” and “teenagers” are almost the same, and range around 11 µg/dl. The highest BLLs have been measured in Romania (17-22 µg/dl). These are 2-5 times higher than those in Bulgaria and Slovakia, respectively, although it should be pointed out that the data for Romania is dated (1983-1985). When comparing BLL data for Bulgaria, Hungary, Poland and Slovakia, it appears that the phase-out of leaded gasoline in Slovakia has had a significant effect on health, since the lowest BLLs are measured there.

A recent study carried out in the Czech Republic within the framework of the National Integrated Program on Environment and Health (NIPEH) determined that BLLs are within the range of 6-25 µg/dl for adults and less than 10 µg/dl for children. Levels of 20-30 µg/dl were commonly found in workers in certain industrial sectors. Data on BLLs for children living in the vicinity of a lead smelter in Pribram are presented in Table 3. As a result of lead exposure, significant changes in psychomotorical development of children were observed.

2.3 HEALTH AND ENVIRONMENTAL BENEFITS FROM THE PHASE-OUT OF LEADED GASOLINE

The precise assessment of the health benefits of the phase-out of leaded gasoline is difficult to make, as there are a variety of factors to consider. Exact information is not available regarding the total number of people currently affected by lead pollution, or for the people who would benefit from the phase-out of lead in gasoline. Even “rough” figures are difficult to estimate since there are many factors influencing exposure.

To illustrate, Table 4 presents a summary of results from a study on the impact of lead phase-out in the US during the period between 1970 and 1990. The table shows the differences in health effects when comparing scenarios with and without lead phase-out, and the substantial benefits that were achieved from the phase-out of lead in the US. Estimated for a total US population of 202 million in 1970, growing to 247 million by 1990, it is interesting to compare the health effects with the population of the SILAQ countries. In 1997, the combined population of all the SILAQ countries amounted to approximately 98 million. Even if the figures in Table 4 are conservatively reduced by two thirds (roughly in proportion with the SILAQ countries’ population) the health benefits from the phase-out of lead are still very significant.

An example of a systematic study is presented in the Data Sheet and Country Assessment provided by the Czech Republic. The study examined the influence of road traffic on blood lead levels in Prague. Surprisingly, the results show neither elevated blood lead levels nor health impairments.

The only available set of data showing a clear link between the decline in blood lead levels and the decline of vehicle-based lead emissions can be found in the Data Sheet for Hungary, where sufficient data over a number of years has been provided.

In Hungary, the phase-out of leaded gasoline has led to a noticeable reduction of airborne lead concentrations – in all surveyed Hungarian cities the lead concentration was below 0.3 µg/m³. Significantly, an average decrease in BLL of 70 percent has been observed for the period 1985-1995, as the lead contents in gasoline was reduced from 0.7 g/l to 0.15 g/l during the same period.

Similar health and environmental benefits from the phase-out of leaded gasoline can be expected in other countries, and BLL should decline in the coming years due to the programs being implemented to increase the use of unleaded gasoline. In all the SILAQ countries, the EU limit of 0.15 g/l lead in gasoline has either already been adopted or will be applied in the near future (and before the year 2000). Particularly in congested urban areas with high population densities, i.e. the capital cities such as Bucharest, Budapest, Sofia, Warsaw, etc., significant health benefits may be anticipated, but this can only be confirmed with regular case studies during the coming years.
The data above shows the benefits of the phase-out policy with regard to the environment, but without further in-depth surveys, one cannot yet conclusively show the link between the policy and the related health benefits. While there are indications that at least part of the reduction in BLL has been achieved by reducing emissions from transportation sources, more research will have to be performed, especially over a longer time span.

Hence, systematic investigation is necessary to obtain detailed information concerning the influence of road traffic on lead concentrations in air and the BLLs over a period of time. This information should be related to the progress of the phase-out process to differentiate the impacts of mobile and stationary sources of lead emissions. It is obvious that selected residential areas should be the subject of specific case studies.

In concluding, although the relationship between the phase-out of leaded gasoline and the environmental benefits is quite clear, it is very difficult to quantify. As shown in Table 1, most countries with a significant increase in the share of unleaded gasoline in the market have experienced a marked decline in vehicle-based lead emissions as well as in total lead emissions (although the latter was often also influenced by a reduction of lead emissions from stationary sources). Also, there is a downward trend in airborne lead concentration levels in those countries. Slovakia is a prime example, clearly demonstrating environmental benefits from the lead phase-out—the reduction in ambient air lead concentrations in the period 1990-1995 has averaged between 50 percent and 88 percent.

### 3. Current Conditions Influencing the Phase-out of Lead in the SILAQ Countries

#### 3.1 Existing Regulatory Framework Regarding Vehicle-Related Air Pollution

New environmental legislation has been, or is in the process of being introduced in all the SILAQ countries, with standards increasingly being harmonized with those of the EU. Each of the SILAQ countries has its own program for EU approximation and for the implementation of new legislation, thus bringing further air pollutants under control.

**Regulatory Issues**

The key issues from the regulatory framework point of view include: standards for lead content in gasoline; requirements for the technical testing of vehicles and the mandatory use of catalytic converters; and the air quality monitoring network.
3.1.1 In-country Standards for Lead Content in Gasoline

**EU Harmonization**

Gasoline quality standards in the EU are regulated by Directive 85/210/EEC. Currently, only the lead and benzene content of gasoline are regulated by the Directive, although a revision is expected in the year 2000, to regulate other components (e.g., benzene and aromatics), and perhaps to introduce a total ban on the production of leaded gasoline.

**European Norms**

A Technical Norm (EN 228) for unleaded gasoline with an octane number of 95 has been introduced by the European Committee for Standardization (CEN), and is used by some EU countries as a basis for national standards.

All SILAQ countries are involved in harmonizing their domestic legislation in the field of gasoline quality with those regulations in force in the EU. In addition to decreasing the maximum lead content of gasoline, there are an increasing number of other hazardous components in gasoline that are controlled.

Data on the quality standards applied (as of 1996) to leaded and unleaded gasoline in the SILAQ countries are presented in Tables 6 and 7, respectively. The data also shows which types of gasoline (as determined by the Research Octane Number) are in use in each country. For comparison, Tables 6 and 7 also present EU requirements regarding fuel quality.

**SILAQ Country Standards**

Bulgaria reports that since 1990, the average actual lead content in its leaded gasoline (0.13 g/l) is lower than the maximum permissible value specified in the country’s regulations. In the Czech Republic, the quality standards for both leaded and unleaded gasoline have not changed during the period from 1990-1995. In Hungary, the actual lead content is closer to 0.12-0.13 g/l in leaded gasoline, and 0.005-0.0095 g/l in unleaded. An increase in the actual lead content in leaded gasoline from 0.075 g/l in 1993 to 0.13 g/l in 1996 was reported by Poland. Romania has the highest lead levels, exceeding the EU limit of 0.15 g/l for leaded gasoline. However, the maximum lead content was reduced from 0.4 g/l to 0.52 g/l in 1996.

In Slovakia, a new Decree of the Ministry of Environment, No. 268 on Fuel Quality was adopted in 1997. The standards came into force on January 1, 1998, and set the following obligatory requirements:

- benzene (max. concentration) 3% vol.
- sulfur (max. concentration) 0.05%
- lead (max. concentration) 0.005 g/l

Fuel quality has to be proved through a certification procedure, and at present, only unleaded gasoline is in use. In Slovenia, the lead content in leaded gasoline was decreased from 0.6 g/l to 0.15 g/l in 1995 following the introduction of new quality standards.

**Phase-out Process**

The implementation of EU guidelines and the adoption of new quality standards for the lead content in gasoline will continue up to the year 2000 in Hungary, Slovenia and Slovakia. The phase-out of leaded gasoline in Slovenia is dependent on imports of unleaded gasoline and the appropriate additives. Bulgarian, Romanian and Polish authorities ascertain that a major constraint to the acceleration of the phase-out of lead in gasoline is the poor octane production capacity of their refineries, and the need for significant investments in modernizing existing production units. At the same time, especially in Bulgaria and Romania, a more effective policy needs to be introduced to encourage the consumption of unleaded gasoline, because production capacity currently exceeds domestic market demand. In fact, production capacity for unleaded gasoline in Romania could even meet total consumption demands.

3.1.2 Use of Catalytic Converters

**Vehicle Fleet Turnover**

The introduction of requirements for the mandatory use of catalytic converters on new cars is one of the most effective instruments for controlling vehicle-related air pollution. However, two facts should be pointed out in this context.

First, the effectiveness of this measure depends on the vehicle fleet turnover rate, that is how quickly new cars replace old ones. The effectiveness is lower in countries with old vehicle fleets and low turnover rates. This is the case in most SILAQ countries, which indicates that the fitting of converters alone will not be sufficient to bring about a quick reduction in levels of vehicle-related air pollution.

Second, the primary purpose of the catalytic converter is not to limit the level of lead emissions (this can only be achieved through reducing the lead content of gasoline) but,
rather, to control emissions of other air pollutants, such as nitrogen oxides, carbon monoxide, and hydrocarbons. The installation of the catalytic converter can reduce those emissions by as much as 70 percent to 80 percent. Engines equipped with catalytic converters cannot, however, use leaded gasoline, as the lead compounds can cause almost immediate damage to the converter.

Notwithstanding the comments above, the requirement for the use of catalytic converters in SILAQ Countries is an important factor in any lead phase-out strategy. All of the SILAQ countries, with the exception of Bulgaria, include measures for the adoption of catalytic converters as part of their government plans for the phase-out of leaded gasoline. However, requirements for the use of catalytic converters differ among these countries.

Converters have been required on all new and imported cars in the Czech Republic...
(since 1995), Hungary (since 1996), Poland (since 1995), Slovakia (since 1993) and Slovenia (since 1994). In addition, the Czech Republic passed a requirement for the fitting of catalytic converters complying specifically with EU regulation 93/59 (S2) on all new imported cars from January 1, 1997.

In Bulgaria, only imported cars fueled by unleaded gasoline must have catalytic converters. Two stages are planned in Romania: in 1998, catalytic converters will be mandatory for imported cars, while between 1999 and 2000 will be required for domestically-produced cars.

Table 8 presents data on the use of catalytic converters among passenger cars. It is clear that the number of passenger cars with catalytic converters varies quite considerably among the SILAQ countries.

These figures are largely the result of a large share of aged cars and the smaller share of new and imported cars equipped with catalytic converters. Economic growth will likely allow an increase in the number of new cars on the road and the number of passenger cars equipped with catalytic converters.

In this context, it is important to point out that vehicles with catalytic converters can only use unleaded gasoline (lead will cause almost irreversible damage to the catalyst or even mechanical destruction of the catalytic unit). Therefore, an adequate supply of and access to unleaded gasoline is imperative, possibly accompanied by measures preventing accidental misfuelling.

3.1.3 Requirements for the Technical Testing of Vehicles

The importance of the technical testing of vehicles lies in the fact that it involves the gasoline “end-user”. Individual car owners tend to be much more difficult to influence and control than the limited number of refineries and gasoline distributors.

Emission Testing

In the early eighties, the periodic technical testing focused primarily on the “roadworthiness” of a vehicle, that is the state and functioning of its components influencing road safety (e.g., brakes, steering system, lights adjustment, etc.). In most EU countries, strict air emission standards have since been imposed on cars, and the measurement of exhaust emission levels has become an integral part of the technical testing process. Cars failing to meet the required standards are not allowed on the road until they comply with the applicable limits.

While issues concerning the framework for the periodic technical inspection of vehicles were not explored in the country Data Sheet surveys, it is important to note that the technical testing of vehicles is an issue of importance, not only for the transition phase-out period, but is also obligatory in harmonizing with EU standards for vehicle emission control.

In Hungary, the periodic technical inspection of vehicles has been enforced since 1991, and includes the control of vehicle emissions. Most other SILAQ countries have similar systems in place, although with varying emphasis on controlling exhaust emissions and with varying degrees of success.

Programs for the periodic technical inspection of vehicles together with cost analyses, financing, and organizational proposals should be further developed by all the SILAQ countries.

Table 8: Passenger Cars Fitted with Catalytic Converters (in 000s)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Czech Republic</td>
<td>5</td>
<td>5.2</td>
<td>7.5</td>
<td>11.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td>134</td>
<td>171</td>
<td>210</td>
<td>295</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td>70</td>
<td>205</td>
<td>600</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Romania</td>
<td>1</td>
<td>2.8</td>
<td>4.7</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Slovakia</td>
<td>5.88</td>
<td>6.15</td>
<td>6.45</td>
<td>8.06</td>
<td>38.02</td>
<td>85.4</td>
<td>175.0</td>
</tr>
<tr>
<td>Slovenia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1 Denotes the introduction of requirements for the use of catalytic converters.
2 Percentage figure of the total numbers of cars.
3.1.4 Existing Monitoring Frameworks for the Control of Air Pollution from Mobile Sources

Roadside Testing

The monitoring systems for air pollution control, and the related regulations and standards play an important role in air quality management. Most monitoring activities with regard to mobile pollution sources focus on ambient air quality. However, some SILAQ countries have introduced, albeit on a limited scale, spot-checking of vehicle emission levels using portable equipment.

Monitoring Networks

In Bulgaria, there are more than 20 stations measuring air pollution from mobile sources in residential districts. The stations are part of the National Automated System for Environmental Monitoring (NASEM), and are situated in residential areas with heavy industry, in towns with lead production facilities, and within two of the largest cities in Bulgaria. Since 1991, the monitoring data indicate decreasing lead emissions in regions with industrial pollution and a slight decrease in the level of pollution from mobile sources. In the Czech Republic, a National Monitoring Network of the Health Service monitors air quality, including the concentration of lead in air. Measuring points are placed in the capitals of all districts. In Slovakia, air quality is monitored by seven regional (background) and 35 local monitoring stations.

Overall, the Country Status Reports and Data Sheets provided limited information regarding the existing framework for controlling air pollution from mobile sources. For more detailed analysis, additional information is needed.

Future follow-up studies might correlate exposure data with the health status of the residents of regions, cities, and districts heavily affected by airborne lead pollution.

3.2 VEHICLE FLEET STRUCTURE

The structure of the vehicle fleet is an important factor when implementing any lead phase-out strategy. The key issues to consider are the types of engine (i.e., which gasoline type can be used), and the age and turnover rate of the vehicle fleet (i.e., how quickly old cars are being replaced by newer models).

Table 9 shows the total number of vehicles and the structure of the vehicle fleet in the SILAQ countries.

Types and Numbers

Overall, there are over 21.6 million cars in the seven SILAQ countries. On average, 94 percent of those are passenger cars and light duty vehicles, while 6 percent is made up of trucks, buses and heavy duty vehicles.

Use of Diesel Engines

The percentage of passenger cars and light-duty vehicles equipped with gasoline engines is similar in all the surveyed countries, and ranges from 78 percent in Romania to 94 percent in the Czech Republic. In addition, Bulgaria and Romania use a number of heavy duty vehicles and buses equipped with gasoline engines (2 percent and 5 percent of the total, respectively), which constitute some 40-50 percent of the total number of heavy-duty vehicles and buses. In all the SILAQ countries, the share of diesel-driven passenger cars is small – between 6 percent and 12 percent of the total number of vehicles. This implies that the phase-out of leaded gasoline will impact a large percentage of the respective vehicle fleets.

Table 10 provides more details on vehicle fleets of the SILAQ countries. Also, it presents somewhat more up-to-date information regarding the total number of vehicles in comparison with Table 9.

Poland and the Czech Republic have the highest total number of vehicles, while Bulgaria, Hungary and Romania follow, with similar values for the total number of vehicles. Although Slovenia has the lowest total number of vehicles, it also has the highest number per 1,000 inhabitants, a figure comparable with countries like Denmark and Finland.

The number of cars per capita is also high in the Czech Republic. The per capita figure for Bulgaria, Hungary, Poland and Slovakia is fairly similar, ranging from 244 to 281 cars per 1,000 inhabitants. Romania has about the same overall number of vehicles as Bulgaria and Hungary, but just half the number of vehicles per 1,000 inhabitants.

Vehicle Age

On average, passenger cars are considerably older in the SILAQ countries (approximately 11.2 years) compared with their West European counterparts (6-8 years, COWI). The only exception is Slovenia, with an average car age of 6.5 years. Bulgaria, the Czech Republic and Slovakia have the oldest passenger car fleets. The turnover rate in Slovakia, Romania and Slovenia is close to that reported for Denmark, Switzerland and the UK (COWI). However, the share of passenger cars equipped with catalytic converters is fairly
low in all SILAQ countries, and does not exceed 15 percent. In comparison, 24 percent of the vehicles in Finland have catalytic converters.

### Vehicle Growth

Table 11 shows the growth of vehicle fleets over the past six years in the SILAQ countries. The data indicates a steady growth in the number of vehicles in the surveyed countries, with growth in Romania and Poland most rapid. It is noteworthy that the turnover rates, as a rule, are slightly higher than the growth rates in the total number of vehicles. This may mean some reduction in the negative environmental impact of vehicles, especially in countries where new cars are produced domestically (e.g., Poland and Romania) and/or where customers are encouraged to buy new cars instead of used Western vehicles.

Table 12 shows that domestically manufactured cars (in the Czech Republic, Poland, Romania, Slovakia and Slovenia), or those from the former Soviet Union and other East European countries (in Bulgaria and Hungary) are the prevailing makes of cars in the

### TABLE 9: Vehicle Fleet Structure

<table>
<thead>
<tr>
<th>Country</th>
<th>Total number of vehicles (000s)</th>
<th>Passenger cars and light duty vehicles (in 000s and as a percentage of total vehicle fleet)</th>
<th>Heavy duty vehicles and buses (in 000s and as a percentage of total vehicle fleet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Gasoline engines</td>
<td>Diesel engines</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulgaria¹</td>
<td>2,051.2</td>
<td>1,808.5</td>
<td>37.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>89%</td>
<td>57.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Czech Republic²</td>
<td>3,358</td>
<td>3,154</td>
<td>94%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2,044</td>
<td>6%</td>
</tr>
<tr>
<td>Hungary³</td>
<td>2,534.2</td>
<td>2,174</td>
<td>11.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>269</td>
<td>79.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poland¹</td>
<td>9,400</td>
<td>8,100</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td></td>
<td>700</td>
<td>540</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Romania¹</td>
<td>2,350.2</td>
<td>1,850.1</td>
<td>116.6</td>
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<tr>
<td></td>
<td></td>
<td>189.9</td>
<td>213.6</td>
</tr>
<tr>
<td></td>
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<td></td>
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<tr>
<td>Slovakia¹</td>
<td>1,176</td>
<td>1,006.6</td>
<td>3.8</td>
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<tr>
<td></td>
<td></td>
<td>26.1</td>
<td>159.5</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Slovenia¹</td>
<td>783</td>
<td>680</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>97</td>
<td>6</td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Total</td>
<td>21,632.6</td>
<td>18,753.2</td>
<td>230</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1,013.6</td>
<td>1,035.8</td>
</tr>
</tbody>
</table>

¹ Data for 1996; ² Data for 1995; ³ Data for 1994; ⁴ According to the Czech Country Report, no consistent data is available on gasoline and diesel engine distribution in all categories used. In heavy duty vehicles and buses, diesel-engines strongly prevail (nearly 100%).
CURRENT CONDITIONS INFLUENCING THE PHASE-OUT OF LEAD IN THE SILAQ COUNTRIES

surveyed countries. Most of these are based on older technologies and therefore can not meet today's emission standards. That share of the vehicle fleet made in Western Europe and Far East countries is still low, below 30 percent. The highest level, at 29 percent, is reported for Slovakia.

As seen from Table 12, a large percentage of car fleets in the SILAQ countries consist of older cars equipped with engines carrying soft exhaust valve seats, which are generally believed to require the lubricant effect provided by lead in gasoline. It is estimated that some 40 percent to 60 percent of vehicle fleets in the SILAQ countries consists of cars with soft exhaust valve seats (as opposed to an estimated 20 percent in the EU). Such an issue is often cited as a major obstacle to the phase-out of lead in gasoline.

Use of Lubricants

However, two observations regarding the lubrication requirements of soft-valved engines should be made. First, various research studies show that the amount of lead in gasoline required to provide the required lubrication is much lower than the currently applied standards of 0.15 g/l. It has been shown that the lead content of 0.05 g/l is sufficient to provide the required effect. Secondly, it is important to note that the required lubrication can be provided by additives which are not based on lead. Indeed, potassium and sodium-based lubricant additives are commonly used in a number of countries, and the cost of replacing lead as a lubricating additive has been estimated at approximately USD 0.003 per liter of gasoline.

Therefore, the high share of cars equipped with older engines carrying soft exhaust valve seats does need not be an insurmountable obstacle to the effective phase-out of lead. This has been made evident by Slovakia, completely phasing out lead in 1995, despite the fact that more than half of the car fleet was equipped with engines containing soft exhaust valve seats.

In fact, it can be concluded that the higher the share of older cars and the lower the turnover rate of vehicle fleet, the more cost-effective it is to develop and introduce non-lead based lubricant additive.
3.2.1 Considerations for the Lead Phase-out Policy

The large share of old cars with soft valve seats and the small share of new and import-ed cars equipped with catalytic converters has hindered the rate at which the car fleet can move towards the use of unleaded gasoline. However, economic stabilization in the SILAQ countries and an increase in the share of new cars on the road will see a growth in the number of passenger cars equipped with catalytic converters. During the transition period, the existence of cars with soft valve seats and pricing policies seem to be the most important areas needing to be addressed in increasing the consumption of unleaded gaso-

**TABLE 12: Breakdown of the Vehicle Fleet by Make**

<table>
<thead>
<tr>
<th>Country</th>
<th>Most popular car makes</th>
<th>Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria²</td>
<td>LADA</td>
<td>44.6</td>
</tr>
<tr>
<td></td>
<td>MOSKVICH</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>FIAT</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>TRABANT</td>
<td>5.5</td>
</tr>
<tr>
<td></td>
<td>WARTBURG</td>
<td>4.9</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>SKODA</td>
<td>59</td>
</tr>
<tr>
<td></td>
<td>VAZ</td>
<td>7.8</td>
</tr>
<tr>
<td></td>
<td>FIAT</td>
<td>5.3</td>
</tr>
<tr>
<td></td>
<td>FORD</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>VW</td>
<td>2.1</td>
</tr>
<tr>
<td></td>
<td>OPEL</td>
<td>2.0</td>
</tr>
<tr>
<td>Hungary¹</td>
<td>LADA</td>
<td>20.1</td>
</tr>
<tr>
<td></td>
<td>TRABANT</td>
<td>15.9</td>
</tr>
<tr>
<td></td>
<td>WARTBURG</td>
<td>8.8</td>
</tr>
<tr>
<td></td>
<td>SKODA</td>
<td>8.3</td>
</tr>
<tr>
<td></td>
<td>OPEL</td>
<td>6.1</td>
</tr>
<tr>
<td>Poland¹</td>
<td>FIAT 126P</td>
<td>31.6</td>
</tr>
<tr>
<td></td>
<td>FIAT 125</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>POLONEZ</td>
<td>9.4</td>
</tr>
<tr>
<td></td>
<td>VOLKSWAGEN</td>
<td>4.1</td>
</tr>
<tr>
<td></td>
<td>SKODA</td>
<td>3.8</td>
</tr>
<tr>
<td>Romania¹</td>
<td>DACIA</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>OLTCEIT</td>
<td>5.4</td>
</tr>
<tr>
<td></td>
<td>ARQ</td>
<td>3.3</td>
</tr>
<tr>
<td></td>
<td>VOLKSWAGEN</td>
<td>2.6</td>
</tr>
<tr>
<td>Slovakia¹</td>
<td>SKODA 100, 105, 120, 130</td>
<td>37.9</td>
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<tr>
<td></td>
<td>SKODA FAVORIT and FELICIA</td>
<td>16.4</td>
</tr>
<tr>
<td></td>
<td>LADA, MOSKVICH, VOLGA</td>
<td>12.1</td>
</tr>
<tr>
<td></td>
<td>WARTBURG</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>VEHICLES FROM WESTERN COUNTRIES</td>
<td>29</td>
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<tr>
<td>Slovenia¹</td>
<td>ZASTAVA</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>RENAULT</td>
<td>10.1</td>
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<tr>
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<td>IMV (RENAULT)</td>
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</tr>
<tr>
<td></td>
<td>UNIS (VOLKSWAGEN)</td>
<td>6.4</td>
</tr>
<tr>
<td></td>
<td>OPEL</td>
<td>5.6</td>
</tr>
</tbody>
</table>

¹ Data for 1995; ² Data for 1995; ³ Data for 1996
CURRENT CONDITIONS INFLUENCING THE PHASE-OUT OF LEAD IN THE SILAQ COUNTRIES

Expected Trends
The volume and structure of the vehicle fleet in the SILAQ countries is expected to be characterized by the following trends in the coming years:

- A slight increase in the number of new cars and the simultaneous introduction of mandatory catalytic converters. As experiences in Slovakia have shown, lubricating additives can be added to fuel thus making possible the use of unleaded gasoline in old cars with soft valve seats.
- The gradual elimination of older vehicles.
- Limitations on the import of cars which cannot use unleaded gasoline, resulting in the gradual phase-out of cars using only leaded gasoline.

The success of the pan-European strategy for the phase-out of leaded gasoline could give a new face to the European integration process and can serve as a good example of a new policy that works towards a sustainable environment for Europe.

Public Awareness
The information collected during the workshops and meetings of the SILAQ Working Group in the period between the Sofia and Aarhus Ministerial Conferences should be publicized. In CEE countries, it could help to raise public pressure and understanding to the need for accelerating the process of phasing out leaded gasoline. The lessons learned and the main findings from the last few years should serve as a catalyst for a range of new policy measures which should be taken in the very important coming three years.

3.3 THE REFINERY SECTOR

From a technological point of view, there are practically no obstacles to the phase-out of lead from gasoline. However, lead additives (i.e., tetra ethyl lead and tetra methyl lead) are a cheap and effective means of increasing the octane number of gasoline produced, possibly by as much as 10 to 15 units. Therefore, the removal of lead from gasoline will lead to increased production costs for the refinery.

Additionally, lead additives are generally believed to provide some engine lubrication, important for the older types of engines with soft exhaust valve seats. This issue is explored in more detail in section 4.2 on vehicle fleet composition.

Refinery modernization is a priority issue in the lead phase-out process and it is the

CASE STUDY: Technical Options for Lead Phase-out

From a refinery’s point of view, the crucial issue when removing lead from gasoline is how to compensate the resulting octane loss. This can be achieved through increasing the severity of the reformer unit, thus producing less gasoline but with a higher octane number. New production equipment, such as catalytic reformers or isomerization units can increase the octane production capacity, but the process leads to an increased benzene and aromatic content.

An alternative option is to increase the octane number by adding commercially available organic additives such as ethanol, ethyl tertiary butyl ether (ETBE) or methyl tertiary butyl ether (MTBE). The latter is the most commonly used additive. While additives are generally expensive, their use does not require capital investment.

Other options include purchasing high-octane reformate from other refineries, or the installation of the fluid catalytic cracking (FCC) unit which enables a refinery to use more advanced processes to increase the octane number of gasoline or even produce its own MTBE additive.

Thus, the more advanced the refinery, the more technical options there are available for increasing the octane number of the gasoline produced. While an advanced refinery is not a technical prerequisite for the production of unleaded gasoline, the output is improved and the costs of unleaded gasoline production reduced – within the more modern refineries.

single largest economic obstacle. Each refinery has its own production structure and the processes used differ among each of them. As a result, each refinery has to take into account its own cost structure and technical requirements when converting to the production of unleaded gasoline.

The important processes involved are crude oil distillation, fluid catalytic cracking (FCC), and ensuring the inclusion of oxygenates and other additives when upgrading quality to increase the octane level.

Cost-benefit analysis is needed for each refinery to select the best approach. Closer cooperation between the SILAQ countries and the involvement of Western partners may facilitate the process of refinery modernization and improve the production capacity of unleaded gasoline in the SILAQ countries.

3.3.1 Overview of the Refining Industry

Types of Refineries

Three types of refineries exist:

- **Type 1** – simple refineries, undertaking crude oil distillation, treatment and blending;
- **Type 2** – refineries undertaking crude oil distillation, treatment, upgrading, and blending;
- **Type 3** – complex refineries, undertaking crude oil distillation, treatment, upgrading, conversion, blending, and catalytic reforming.

Poland, Romania, and Slovenia classified refineries on the basis of the processes used. Table 13 summarizes the key characteristics of the industry for each of the SILAQ countries. Slovakia and Slovenia have one refinery each, but Slovakia’s is a complex type refinery (Type 3) while Slovenia’s is a simple refinery (Type 1). Bulgaria and Hungary have two refineries each, one of Type 2 and one of the more complex Type 3. The Czech Republic has four refineries, with two of them being small producers of lubricants and special products. Poland and Romania operate a larger number of refineries: seven and five, respectively. Most of the refineries in Poland are of Type 2 (five refineries out of the seven) while in Romania they are of the more complex Type 3.

Therefore, it can be concluded that the prevailing type of refinery is Type 2, followed by Type 3. This means that many of those more advanced refineries have a wide range of possible technological options to increase the octane number of gasoline produced. However, the various types also therefore require different forms of optimal readjustment for the production of unleaded gasoline, and different costs associated with this process. In Slovakia, for instance, where the ANABEX additive had to be developed to replace lead in gasoline, the necessary R&D investments were significant. In Slovenia, the main problem is the import of additives (VSPA or other suitable types).

In other cases, refinery modernization can be extremely complicated, and it seems that considerable levels of investment will be necessary not just for conversion but for the replacement of old equipment.

Production Capacity

Data on the production capacities of the refinery sector in the surveyed countries are shown in Table 13. The countries generally do not use their refineries to full capaci-
Poland and Slovakia present the highest usage, at 89 percent and 80 percent, respectively. Romania and Bulgaria utilize their refineries to 69 percent and 65 percent, respectively. Only 55 percent of the refinery capacity is utilized in Slovenia.

Table 14 shows the kinds of refinery processes employed in the SILAQ countries. Clearly, crude distillation and conversion processes are the norm, with the upgrading and the use of organic and lubricating additives practiced in some refineries. Additives tend to be produced in-country, but the capacity can not meet total demand. Only Slovakia produces a surplus; however, its capacity to export ANABEX has yet to be exploited by the other SILAQ countries.

### Key Technological Processes

<table>
<thead>
<tr>
<th>Refinery processes</th>
<th>Bulgaria</th>
<th>Hungary</th>
<th>Poland</th>
<th>Romania</th>
<th>Slovakia</th>
<th>Slovenia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude Distillation</td>
<td>2</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Direct blending into gasoline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct blending in larger proportions</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Upgrading by isomerization</td>
<td>1</td>
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<td></td>
<td></td>
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<tr>
<td>Conversion Process</td>
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<td>1</td>
<td>5</td>
<td>1</td>
<td>-</td>
</tr>
<tr>
<td>Fluid catalytic cracking (FCC)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Hydrocracking</td>
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<tr>
<td>Upgrading</td>
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<td>1</td>
<td>2</td>
<td>1</td>
<td>-</td>
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</tr>
<tr>
<td>Catalytic reforming</td>
<td>2</td>
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</tr>
<tr>
<td>Isomerization</td>
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</tr>
<tr>
<td>Alkylation and polymerization</td>
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<td>Use of Organic Additives</td>
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</tr>
<tr>
<td>MTBE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Use of Lubricating Additives</td>
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<td></td>
<td></td>
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<tr>
<td>Sodium</td>
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</tr>
</tbody>
</table>

### Ownership of Refineries (1996)

<table>
<thead>
<tr>
<th>Country</th>
<th>Ownership (numbers and percentages)</th>
<th>State</th>
<th>Private</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td>1 (75%)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td>2</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Poland</td>
<td>7</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Romania</td>
<td>5 (51% state and 49% private)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slovakia</td>
<td>-</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Slovenia</td>
<td>1 (49% state and 55% private)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Gasoline Quality (1996)

<table>
<thead>
<tr>
<th>Country</th>
<th>Leaded RON quality</th>
<th>Unleaded RON quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td>86, 95, 98</td>
<td>95</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>91, 96</td>
<td>95, 98</td>
</tr>
<tr>
<td>Hungary</td>
<td>92, 98</td>
<td>91, 95, 98</td>
</tr>
<tr>
<td>Poland</td>
<td>86, 94, 98</td>
<td>95, 98</td>
</tr>
<tr>
<td>Romania</td>
<td>95</td>
<td>90, 95</td>
</tr>
<tr>
<td>Slovakia</td>
<td>91</td>
<td>91, 95, 98</td>
</tr>
<tr>
<td>Slovenia</td>
<td>98</td>
<td>91, 95</td>
</tr>
</tbody>
</table>
Ownership and Privatization

The ownership and privatization of the refineries in the SILAQ countries vary. In Hungary, the refineries are owned by MOL, a private Hungarian Oil Gas Company. Fifty-one percent of MOL's shares are owned by the state. In Poland, all refineries are owned by the state. In Slovakia and Slovenia, the refineries are privately owned.

Gasoline Types

The gasoline quality in the SILAQ countries ranges from RON 86 to RON 98. For unleaded gasoline, RON 95 is the norm, followed by RON 98. Progress in the privatization process may heavily influence gasoline quality in the future. This process may bring about substantial restructuring within the refinery industry, and the inflow of capital may add more options to the range of gasoline quality produced.

3.3.2 Considerations for the Lead Phase-out Policy

Table 17 presents industry data and considerations related to the policy of lead phase-out. The table shows that Hungary and Slovakia are well-positioned to produce sufficient quantities of unleaded gasoline to meet domestic demand. The refineries in Bulgaria and Romania require some modernization in order to produce greater quantities of unleaded gasoline. An increase in isomerate application is planned in the near future in Poland.
3.4 USE OF GASOLINE

In calculating the consumption of both leaded and unleaded gasoline, an assumption was made that consumption can be calculated as production plus import minus export (although this method does not consider variations in supply stocks, which in some cases may be substantial). The consumption of unleaded gasoline, and trends in consumption growth over time, serve as an indication of the efficiency of policy measures. The ratio of consumed unleaded and leaded gasoline is also a suitable criterion for evaluation.

3.4.1 Gasoline Production and Consumption

Table 18 gives a comprehensive overview of the consumption of gasoline for the years 1991-1996.

The consumption of unleaded gasoline in Bulgaria has increased in recent years, but is still only 7 percent of the total amount consumed. The majority of domestically produced unleaded gasoline is exported. In Romania, the export of unleaded gasoline declined in 1996, somewhat raising levels of domestic consumption. The consumption of unleaded gasoline in Poland, Hungary, Slovakia and Slovenia has shown a gradual increase during the 1990's. However, only Slovakia has seen a radical decline in the consumption of leaded gasoline.

An examination of gasoline consumption data shows the need for considerable efforts and more efficient policy measures to be taken in order to ensure the attractiveness and increased use of unleaded gasoline. This is especially important considering that the production of unleaded gasoline (both in actual numbers and as a percentage of the overall domestic production) has been increasing in most countries at a much faster rate than its domestic consumption.

3.4.2 Gasoline Types and their Respective Share of the Market

The consumption of unleaded gasoline varies substantially in the surveyed countries, ranging from only 5-7 percent for Bulgaria and Romania, to 100 percent for Slovakia, as shown in Table 19.

Thus, Slovakia has completely phased out leaded gasoline. Relatively high shares of unleaded gasoline (above 50 percent), are reported for the Czech Republic, Hungary and Slovenia. In Bulgaria and Romania, the share of unleaded gasoline in terms of overall consumption is quite low, although it is interesting to note that in both countries, the share of unleaded gasoline in domestic production is significantly higher, as shown in Table 18.

Detailed data on the market shares of different gasoline types are provided for Hungary and Slovakia in Table 20. The two countries have the largest market shares of unleaded gasoline. An analysis of the data and the pricing policies of other SILAQ countries shows some of the barriers to the process of phasing out lead.

In July 1993, the “Slovnaft” joint-stock company, the sole refinery in Slovakia, ceased production of the leaded gasoline, SUPER 96. This was replaced by the unleaded gasoline UNISUPER 95. However, UNIGASOLINE 91 is most commonly used since it is the most widely produced and distributed (some 55 percent). In Hungary, the largest market share (some 43 percent) belongs to the unleaded gasoline ESZ 95. Bulgaria and Romania are also planning some changes in the availability of different types of gasoline on the market.

The analysis of the data and the pricing policies of other SILAQ countries shows some of the barriers to the process of phasing out lead. The analysis also reveals the approaches that could be taken into consideration for future activities, and highlights the experiences that might be exchanged.

Projections for gasoline supply in the SILAQ countries in the near future are not available, but on the basis of the known refinery capacities and the feasibility studies conducted for their reconstruction, some estimates can be made. Bulgaria’s National Action Plan shows demand for unleaded gasoline for the period 1997-2001 to increase sharply to 435,000 tons/year in 1999, and to rise by a further 35,000 to 40,000 tons/year until 2010. The actual scenario could be quite different, depending on the policies and measures taken, but the import of unleaded gasoline is not likely.

Slovenia has reported (see Table 18) that it imports a considerable amount of high grade gasoline. In 1996, all of the leaded gasoline imported was of the RON 98 standard, while 94 percent of the imported unleaded gasoline was RON 95. In Poland, 93 percent of its imported gasoline was the RON 95 standard. Romania does not import any gasoline because of its high domestic production capacity.
### TABLE 18: Gasoline Consumption (000s m³/year)

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bulgaria</strong></td>
<td>Leaded production</td>
<td>1,542</td>
<td>1,057</td>
<td>1,131</td>
<td>1,404</td>
<td>1,144</td>
<td>1,088</td>
<td>919</td>
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<td>import</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>0.64</td>
</tr>
<tr>
<td></td>
<td>export</td>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>consumption</td>
<td>1,306</td>
<td>665</td>
<td>786</td>
<td>919</td>
<td>1,146</td>
<td>1,029</td>
<td>889</td>
</tr>
<tr>
<td><strong>Unleaded</strong></td>
<td>production</td>
<td>4.43</td>
<td>8.46</td>
<td>0.96</td>
<td>348.8</td>
<td>304.7</td>
<td>368.6</td>
<td>322</td>
</tr>
<tr>
<td></td>
<td>import</td>
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<td>–</td>
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<td>–</td>
<td>–</td>
<td>–</td>
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</tr>
<tr>
<td></td>
<td>export</td>
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<td>–</td>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>consumption</td>
<td>4.43</td>
<td>8.46</td>
<td>4.1</td>
<td>19</td>
<td>54</td>
<td>78</td>
<td>54</td>
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<tr>
<td><strong>Share of unleaded gasoline in total production</strong></td>
<td>0%</td>
<td>1%</td>
<td>0%</td>
<td>20%</td>
<td>21%</td>
<td>25%</td>
<td>26%</td>
<td></td>
</tr>
<tr>
<td><strong>Hungary</strong></td>
<td>Leaded production</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>2,796</td>
<td>874</td>
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<tr>
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<td>import</td>
<td>–</td>
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<td>–</td>
<td>–</td>
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<tr>
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<td>export</td>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>consumption</td>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td><strong>Unleaded</strong></td>
<td>production</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>775</td>
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</tr>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
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<td>export</td>
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<td>–</td>
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</tr>
<tr>
<td></td>
<td>consumption</td>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td><strong>Share of unleaded gasoline in total production</strong></td>
<td>0%</td>
<td>47%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Poland</strong></td>
<td>Leaded production</td>
<td>–</td>
<td>2,796</td>
<td>3,855</td>
<td>4,574</td>
<td>4,223</td>
<td>4,125</td>
<td>3,537</td>
</tr>
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<td></td>
<td>import</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>430</td>
<td>37</td>
<td>1</td>
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<td>export</td>
<td>–</td>
<td>–</td>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>consumption</td>
<td>–</td>
<td>2,796</td>
<td>3,855</td>
<td>4,574</td>
<td>4,653</td>
<td>4,162</td>
<td>3,538</td>
</tr>
<tr>
<td><strong>Unleaded</strong></td>
<td>production</td>
<td>–</td>
<td>13</td>
<td>402</td>
<td>985</td>
<td>1,424</td>
<td>2,085</td>
<td>2,052</td>
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<td>–</td>
<td>240</td>
<td>195</td>
<td>1,238</td>
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<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>consumption</td>
<td>–</td>
<td>13</td>
<td>402</td>
<td>985</td>
<td>1,664</td>
<td>2,278</td>
<td>3,290</td>
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<tr>
<td><strong>Share of unleaded gasoline in total production</strong></td>
<td>0%</td>
<td>9%</td>
<td>18%</td>
<td>25%</td>
<td>34%</td>
<td>37%</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Romania</strong></td>
<td>Leaded production</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>1,239</td>
<td>1,557</td>
</tr>
<tr>
<td></td>
<td>import</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>export</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>consumption</td>
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<td>–</td>
<td>–</td>
<td>1,239</td>
<td>1,557</td>
</tr>
<tr>
<td><strong>Unleaded</strong></td>
<td>production</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>1,031</td>
<td>2,558.4</td>
<td>2,507</td>
<td>2,802.8</td>
</tr>
<tr>
<td></td>
<td>import</td>
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<td>–</td>
<td>–</td>
<td>1,031</td>
<td>2,558.4</td>
<td>2,319</td>
<td>2,007.8</td>
</tr>
<tr>
<td></td>
<td>export</td>
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<td>–</td>
<td>–</td>
<td>0</td>
<td>0</td>
<td>188</td>
<td>855.0</td>
</tr>
<tr>
<td></td>
<td>consumption</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>0</td>
<td>0</td>
<td>188</td>
<td>855.0</td>
</tr>
<tr>
<td><strong>Share of unleaded gasoline in total production</strong></td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>0%</td>
<td>67%</td>
<td>65%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.4.3 Domestic Capacity for Meeting Demand

Bulgaria and Romania can clearly increase consumption of unleaded gasoline by reducing its export. This could happen if the policy were to be adjusted to meet market needs. Bulgaria, through domestic production, is able to cover about 45 percent of the market needs for unleaded gasoline, while Romania could produce enough unleaded gasoline to satisfy domestic demand completely. Hungary notes in its Country Status Report that it is ready to fully meet market demand through domestic production. In Poland, one third of its unleaded gasoline is imported, while Slovenia imports 90 percent of its unleaded gasoline. If a rapid phase-out approach would be taken, Bulgaria, Poland, and Slovenia would have to import substantial quantities of unleaded gasoline to satisfy domestic demand. This approach, however, is only likely to take place in Slovenia.

It is necessary to note that cars with soft valve seats are prevented from using unleaded gasoline, without the addition of a suitable substitute lubricant (e.g., based on potassium or sodium). Therefore, an analysis of the vehicle fleet is needed for a true assessment of the domestic demand for unleaded gasoline, and the need for developing the alternative additive. The number and average age of the vehicle fleet determines the possibility for a conversion to and consumption of different types of gasoline. This information is important both to consumers and to decisionmakers.

3.5 GASOLINE DISTRIBUTION SYSTEM

The availability of the necessary infrastructure for the distribution of unleaded gasoline is central to increasing consumption. The distribution system includes tanker trucks, gas station storage tanks, pump stations and pump nozzles.

In most cases, significant investment is not required to ensure the distribution of unleaded gasoline, and the distribution system is not seen as a serious obstacle to the phase-out of lead. Both tanker trucks and underground storage tanks can be used for unleaded gasoline after the substantial clean-up of any traces of leaded gasoline.

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Slovakia</td>
<td>Leaded production</td>
<td>646</td>
<td>715</td>
<td>771</td>
<td>616</td>
<td>218</td>
<td>49</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>import</td>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>export</td>
<td>57</td>
<td>160</td>
<td>170</td>
<td>260</td>
<td>91</td>
<td>49</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>consumption</td>
<td>589</td>
<td>555</td>
<td>601</td>
<td>356</td>
<td>127</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td>Unleaded production</td>
<td>18</td>
<td>27</td>
<td>48</td>
<td>316</td>
<td>688</td>
<td>1,024</td>
<td>1,089</td>
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<td>–</td>
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<td>6</td>
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<td>48</td>
<td>152</td>
<td>261</td>
<td>427</td>
</tr>
<tr>
<td></td>
<td>consumption</td>
<td>16</td>
<td>21</td>
<td>38</td>
<td>268</td>
<td>536</td>
<td>763</td>
<td>662</td>
</tr>
<tr>
<td></td>
<td>Share of unleaded gasoline in total production</td>
<td>9%</td>
<td>4%</td>
<td>6%</td>
<td>34%</td>
<td>76%</td>
<td>95%</td>
<td>96%</td>
</tr>
<tr>
<td>Slovenia</td>
<td>Leaded production</td>
<td>110.2</td>
<td>141.4</td>
<td>111.9</td>
<td>94.6</td>
<td>22.6</td>
<td>48.6</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>import</td>
<td>677.5</td>
<td>514.2</td>
<td>538.9</td>
<td>568.2</td>
<td>633</td>
<td>561.7</td>
<td>538.5</td>
</tr>
<tr>
<td></td>
<td>export</td>
<td>58.1</td>
<td>29.3</td>
<td>–</td>
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<td>–</td>
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<td>–</td>
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<tr>
<td></td>
<td>consumption</td>
<td>729.6</td>
<td>626.3</td>
<td>650.8</td>
<td>662.8</td>
<td>655.6</td>
<td>610.3</td>
<td>576.5</td>
</tr>
<tr>
<td></td>
<td>Unleaded production</td>
<td>11.3</td>
<td>68.4</td>
<td>89.8</td>
<td>76.1</td>
<td>111.2</td>
<td>67.3</td>
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</tr>
<tr>
<td></td>
<td>import</td>
<td>24.4</td>
<td>51.3</td>
<td>90.7</td>
<td>178.4</td>
<td>297.1</td>
<td>384.4</td>
<td>604.8</td>
</tr>
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<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>consumption</td>
<td>24.4</td>
<td>62.6</td>
<td>159.1</td>
<td>268.2</td>
<td>373.2</td>
<td>495.6</td>
<td>672.1</td>
</tr>
<tr>
<td></td>
<td>Share of unleaded gasoline in total production</td>
<td>0%</td>
<td>7%</td>
<td>38%</td>
<td>49%</td>
<td>77%</td>
<td>70%</td>
<td>64%</td>
</tr>
</tbody>
</table>

* Figures are in tons/year
If unleaded gasoline replaces older leaded gasoline grades (that is, if there is no change in the total number of gasoline types sold at a particular station), the additional distribution costs are small, and consist mainly of the cost of tank cleaning, and relabelling of pump stations and nozzles. If the phase-out of lead would result in more gasoline grades being sold, the added costs include additional storage tanks and fuel pumps.

It is important to note that measures should be taken to ensure that vehicles equipped with catalytic converters are not accidentally filled with leaded fuel (which would result in the destruction of the converter). Finally, information should be made available at gas stations regarding the applicability of unleaded gasoline.

The necessary modifications to the distribution network have been taking place during recent years. Table 21 provides details on the existing gasoline distribution system in the SILAQ countries.

### Table 19: Consumption of Unleaded Gasoline (as a percentage of the total gasoline consumption)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td>&lt;1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>35</td>
<td>–</td>
<td>55</td>
</tr>
<tr>
<td>Hungary</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>50</td>
<td>64</td>
</tr>
<tr>
<td>Poland</td>
<td>–</td>
<td>&lt;1</td>
<td>9</td>
<td>18</td>
<td>25</td>
<td>34</td>
<td>37</td>
</tr>
<tr>
<td>Romania</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>Slovakia</td>
<td>3</td>
<td>4</td>
<td>6</td>
<td>43</td>
<td>81</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Slovenia</td>
<td>3</td>
<td>9</td>
<td>20</td>
<td>29</td>
<td>36</td>
<td>45</td>
<td>54</td>
</tr>
<tr>
<td>EU average*</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>56</td>
<td>62</td>
<td>65</td>
<td>n.a.</td>
</tr>
</tbody>
</table>

* It is expected that by the year 2000, unleaded gasoline will make up 98 percent of the total consumption in the EU.

### Table 20: Market Shares of Different Gasoline Types

<table>
<thead>
<tr>
<th>Country</th>
<th>Ledged</th>
<th>Unleaded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type</td>
<td>Share (%)</td>
</tr>
<tr>
<td></td>
<td>AB 92</td>
<td>9.4</td>
</tr>
<tr>
<td></td>
<td>AB 98</td>
<td>26.8</td>
</tr>
<tr>
<td></td>
<td>ESZ 98</td>
<td>2.5</td>
</tr>
<tr>
<td>Slovakia*</td>
<td>Unigasoline 91</td>
<td>55</td>
</tr>
<tr>
<td></td>
<td>Unisuper 95</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Natural 95</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Super Plus 98</td>
<td>7</td>
</tr>
</tbody>
</table>

* Taken from the Slovak Country Status Report
4. Technical and Economic Considerations for the Phase-out of Leaded Gasoline

The phase-out of leaded gasoline is technically and economically feasible. Most refineries in the SILAQ countries could easily, at least from a technical point of view, switch to producing unleaded gasoline. It is obvious that a significant problem in the phase-out of lead from gasoline in the SILAQ countries is the need for investment in modernizing existing gasoline production units. Another issue to consider is the high share of vehicles with soft exhaust valve seats, which may require lead in gasoline for lubrication. However, this can also be achieved by adding alternative lubricants which do not contain lead. All other problems encountered tend to be related to public support and policies adopted by governments.

This section reviews in more detail considerations for the refinery sector and the vehicle fleet.

4.1 Technical Options for the Petroleum Refinery Sector

Substituting Lead

Depending on refinery type, there are different technological options and alternatives to producing lead-free gasoline. The phase-out of lead from gasoline requires the replacement of tetra(m)ethyl lead component which is used to increase the octane number and to provide lubrication. The octane number can be compensated by:

- Increasing the proportion of high-octane blendstocks in the gasoline pool;
- Increasing the octane levels of at least some blendstocks.

The technical options available for the replacement of the lead-related octane include:

- Increasing the octane number of the reformate by increasing reformer severity (within the limits of sustainable operations). The achievement of the necessary increase in reformer severity may require reconfiguration and modernization of the reformer unit;

---

**TABLE 21: Infrastructure for Gasoline Distribution**

<table>
<thead>
<tr>
<th>Country</th>
<th>Gasoline tankers</th>
<th>Gas stations (total number)</th>
<th>Fuel pumps (average number of pumps per station)</th>
<th>Differentiation in filling nozzles between leaded and unleaded gasoline (yes/no)</th>
<th>Percentage of stations offering unleaded gasoline</th>
<th>Number of stations with vapor recovery installations</th>
<th>Ownership of gas stations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td>n.a.</td>
<td>1,170</td>
<td>4.5</td>
<td>yes</td>
<td>95%</td>
<td>13</td>
<td>State</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>2,317</td>
<td>1,346</td>
<td>4-5</td>
<td>yes</td>
<td>50%</td>
<td>approx 50%</td>
<td>n.a.</td>
</tr>
<tr>
<td>Hungary</td>
<td>n.a.</td>
<td>n.a.</td>
<td>5,150</td>
<td>yes</td>
<td>50%</td>
<td>50%</td>
<td>1,420</td>
</tr>
<tr>
<td>Poland</td>
<td>n.a.</td>
<td>5,150</td>
<td>5.7</td>
<td>yes</td>
<td>35%</td>
<td>570</td>
<td>1,420</td>
</tr>
<tr>
<td>Romania</td>
<td>1,120</td>
<td>1,186</td>
<td>4</td>
<td>yes</td>
<td>100%</td>
<td>55</td>
<td>576</td>
</tr>
<tr>
<td>Slovakia</td>
<td>245</td>
<td>1,186</td>
<td>10-9</td>
<td>yes</td>
<td>100%</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td>Slovenia</td>
<td>n.a.</td>
<td>245</td>
<td>4-7</td>
<td>yes</td>
<td>100%</td>
<td>72</td>
<td>576</td>
</tr>
</tbody>
</table>

1 Data for 1995.
Increasing the production of high octane blendstocks (reformate, FCC gasoline, alkylate, isomerate or oxygenate) in the refinery by increasing utilization and, if necessary, expanding or modernizing existing process units. Note that alkylate and oxygenate can be produced only in conversion refineries, and increasing their production in existing units calls for increasing the output of the refinery’s FCC unit.

- Blending additives such as MTBE into the gasoline pool;
- Reducing the volume of light naphtha in the gasoline pool, by
  1. Increasing the volume of light naphtha upgraded to isomerate;
  2. Increasing the volume of light naphtha sold to the petrochemical sector.

**Constraints to Accelerating Lead Phase-out**

Bulgarian, Romanian and Polish authorities note that a major constraint to accelerating the phase-out of lead in gasoline is the poor octane pool of the refineries and the need for significant investments in modernizing existing production units. Moreover, in most SILAQ countries, there are some refineries which are in a poor state of repair as a result of the economic recession.

The need for investment related to the phase-out of lead from gasoline has been estimated at between one and five USD per 100 liters of gasoline produced (this includes investment costs and increased operation costs). While this is not prohibitive, it may appear high, particularly for older and simpler refineries which will require more fundamental modernization to produce unleaded gasoline at a profit. However, as a result of such modernization, operational costs may be substantially lower due to efficiency gains.

**Further Studies**

To ascertain the most effective and economical approach, feasibility studies should be conducted for each refinery. Many feasibility studies, supported by the World Bank and other parties, have already been performed in all SILAQ countries. However, their implementation requires considerable investment in most cases, and the availability of financing is of crucial importance for the lead phase-out process. Accelerating the privatization process, combined with the strong support of external partners can help advance the implementation of such projects.

### 4.2 CONSIDERATIONS FOR THE VEHICLE FLEET

**Lubrication**

In addition to increasing the octane number, tetra ethyl lead also provides a degree of engine lubrication since lead prevents the wear of engine valve seats in vehicles manufactured with older soft-valve technology. This is an important factor in those SILAQ countries where the percentage of vehicles with soft-valve technology is high and turnover rate is low.

However, tests carried out in both the US and Europe have found that the level of lead in gasoline required for the protection of soft engine valves can be as low as 0.02-0.05 g/l. These levels are several times lower than that which is currently applied in leaded gasoline, and much lower than the permissible level under EU regulations (0.15 g/l).

Furthermore, data from COWI and the results from tests carried out in Bulgaria (for Lada, Volga, and Moskvich vehicles) report the effects of unleaded gasoline on soft engine valve seats to be insignificant...
improved fuel economy (as a result of engine tune-ups) and less frequent oil changes.

Slovakia’s experience shows there are available technological options, policy measures and alternatives in the phase-out of leaded gasoline that may be applicable in the other SILAQ countries where high vehicle age is a problem.

Future Targets

The efficiency of different gasoline lubricant additives requires further study, and any results obtained should be well-communicated to the public. Cost estimations should be examined along with emission data from cars, and the detrimental environmental effects. Fuel consumption and engine behavior should also be investigated. Studies are also need-ed with regard to the different catalytic converters available. Local action plans and administrative, economic and control regulations could accelerate this process.

4.3 ECONOMIC CONSIDERATIONS

Cost Factors

The costs of lead phase-out at the refinery level are determined by the relationship between the general technical and economic characteristics of the petroleum refining process, and refinery-specific conditions, such as the processing capabilities, refinery configurations, the existence of excess capacity, crude oil availability, and product range. Thus, a strategy to phase-out lead affects the relative competitiveness of refineries, which may well become an important socio-economic issue as well.

World-wide experience and estimates indicate that annual investment expenditures and added operating costs associated with the removal of lead from gasoline are typically in the range of USD 0.01-0.02 per liter of gasoline.

Preliminary estimates of the cost of removing lead from gasoline in Romania did not exceed the range of USD 0.005-0.02 per liter, including both operation and capital recovery costs.

Country Studies

A World Bank feasibility study on the phase-out of lead in Bulgaria concluded that the optimization of operations is needed, and that a USD 1.4 million investment to modernize Neftochim refinery’s fluid catalytic cracking (FCC) unit could enable the refinery to increase the share of unleaded gasoline manufactured from the current 25 percent to between 35 percent and 38 percent of total production. It should also be noted that the total necessary investments for the modernization of the refineries’ units are significant, amounting to some USD 70 million for Neftochim, and USD 30 million for Plama.

Social Benefits

The social benefits from reducing human exposure to lead can be grouped into three categories: (i) a positive impact on neurological development and intelligence; (ii) avoidance of costs in the special education of children with learning disabilities resulting from lead pollution; (iii) reduction in the number of lives lost prematurely due to cardiovascular problems caused by lead. Research and statistical relationships between IQ gradients and wages indicate the direct relationship between intellectual performance and earnings. In the Russian Federation, for example, the annual benefits from a 1 mg/dl BLL decrease in

<table>
<thead>
<tr>
<th>RON categorization</th>
<th>Number of cars</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE 1</td>
<td>419,400 (49%)</td>
<td>BA-91: Leaded gasoline with an Octane number of 91, including lead as the lubricating additive, with the lead content of 0.13 g/l (produced until 1994)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BA-91 UNI: Lead-free gasoline with an Octane number of 91, including lubricating additive ANABEX, with the lead content of 0.005 g/l (produced since 1992)</td>
</tr>
<tr>
<td>TYPE 2</td>
<td>392,700 (46%)</td>
<td>BA-96: Lead gasoline with an Octane number of 96, including lead as the lubricating additive, with the lead content of 0.138 g/l (produced until 1993)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BA 95 UNI: Lead-free gasoline with an Octane number of 95, including lubricating additive ANABEX, with the lead content of 0.004 g/l (produced since 1993)</td>
</tr>
<tr>
<td>TYPE 3</td>
<td>46,500 (5%)</td>
<td>BA 98: Leaded gasoline with an Octane number of 98, with lead as the lubricating additive, the lead content of 0.14 g/l (imported since 1994)</td>
</tr>
</tbody>
</table>
the exposed population were estimated at USD 15 per person.

Cost/Benefit Ratio

In comparing this estimate with the previously mentioned mid-points of cost range calculations, the benefits of lead removal may exceed the costs by 3 to 6 times. Cost/benefit ratios depend mainly on the refinery’s adjustment to the changes in market conditions. The experience of the US confirms that even higher cost/benefit ratios may be obtained by considering the advantages of reduced vehicle maintenance costs.

5. Policy Measures and Instruments

While the phase-out of lead in gasoline is technically and economically feasible, any phase-out policy should address in detail two key factors: the policy measures applied, and the appropriate time schedule. Additionally, regulatory changes (e.g., stricter standards for the emissions of benzene, aromatics, and sulfur) should also be taken into account.

The analysis of existing phase-out strategies and their implementation shows that the SILAQ countries have considered and adopted quite different approaches to the lead phase-out process.

Instruments in Use

Most of the countries involved have introduced a requirement for the fitting of catalytic converters. Hungary has even offered financial support for the equipping of cars with catalytic converters, while the tax charged on vehicles is 50 percent lower for cars with catalytic converters. Bulgaria has introduced an environmental tax (5 percent of the gasoline price) and Poland has applied a local tax that varies according to engine capacity.

Tax incentives have been applied in all the SILAQ countries, but with the exception of Slovakia and Slovenia, the differences in consumer prices of gasoline are relatively small.

Western Experience

The special attention given to gasoline additives in Slovakia and Slovenia is a key issue in the success of their lead phase-out programs. The elimination of the problems caused by an aging car fleet through the use of lubricating additives in unleaded gasoline is a potential solution to the problem. Nevertheless, a lack of information in the SILAQ countries still prevails.

The experience of other countries, such as Finland, shows that the use of unleaded gasoline for both types of cars (i.e., those with engines designed for unleaded gasoline, and those for leaded) is the key issue to the rapid phase-out of lead from gasoline. Additionally, the introduction of catalytic converters and additives were also crucial measures.

5.1 POLICY APPROACHES TO THE PHASE-OUT OF LEAD

Policy Approaches

Three general approaches, based on world-wide experiences in the phase-out of leaded gasoline, may be considered. These include:

- Technology-based approaches;
- Incentive-based policy approaches;
- Rapid phase-out policies.

The technology-based approach relies on a change in gasoline demand due to changing car technology (e.g., the use of catalytic converters). This option may be feasible in countries where:

(I) there are significant pollution problems which could be resolved by the wide use of catalytic converters;

(II) the penetration of new car technology is high (e.g., countries with high vehicle turnover rates);

(III) gasoline supply can be easily adjusted to shifting demand. For example, the early lead phase-out policy in the US was primarily based on this approach.

The incentive policy approach uses price incentives and other policy measures to promote the use of unleaded gasoline in cars both with and without catalytic converters. Such an approach might promote alternating fueling practices such as: (i) using leaded gasoline occasionally, i.e., relying on the “lead memory” of the engine; or (ii) using lubricant additives for cars with soft valve seats which require a level of lubrication that was previously provided by lead.
This approach may be combined with the gradual reduction of the lead content in gasoline and the promotion of catalytic converter use.

Finally, the rapid phase-out policy encourages the use of unleaded gasoline (or prohibits the use of leaded gasoline altogether) before catalytic converters become universally applicable for the entire car vehicle fleet. This approach compels countries to shorten the transition period from the use of leaded fuel to an entirely unleaded gasoline market.

Slovak Experiences

Slovakia’s positive experience could be drawn on more effectively where the slowly changing car fleets contain a substantial proportion of vehicles with soft valve seats, and domestic gasoline suppliers may need some time to adjust their capacity to the production of unleaded gasoline. Most West European countries, e.g., Great Britain and France have tended to follow this approach.

In the countries where the vehicle fleet includes a significant share of vehicles with soft valve seats, special gasoline brands may be designed for these cars or suitable additives introduced on the market. Such gasoline brands should contain a lubricant additive. This approach has been typically followed in countries importing all or most of their gasoline, or those with relatively homogeneous refining sectors capable of producing exclusively unleaded gasoline. Besides the health benefits, this approach also reduces costs by eliminating the need for a dual distribution system. It also eliminates the risks of misfuelling and potential damage to the catalytic converter.

Soft-valve Seats

In the countries where the vehicle fleet includes a significant share of vehicles with soft valve seats, special gasoline brands may be designed for these cars or suitable additives introduced on the market. Such gasoline brands should contain a lubricant additive. This approach has been typically followed in countries importing all or most of their gasoline, or those with relatively homogeneous refining sectors capable of producing exclusively unleaded gasoline. Besides the health benefits, this approach also reduces costs by eliminating the need for a dual distribution system. It also eliminates the risks of misfuelling and potential damage to the catalytic converter.

Technology

Combining an incentive policy with regulations that ensure the reduction of the lead content in gasoline, and which support the use and import of cars with improved pollution characteristics. These programs include limitations on the import of cars not able to use unleaded gasoline (Bulgaria), requirements for catalytic converters on all new cars (Hungary and Poland), or mandatory catalytic converters for imported cars and domestically produced cars (Romania).

The success of Slovakia’s incentive policy which was later combined with the rapid phase-out approach to influence consumer behavior and to smooth the transition could be widely used for information campaigns in other SILAQ countries. In particular, it could help to overcome the problem of old vehicle fleets and the respective low turnover rates.

Any phase-out strategy should include realistic schedules with clearly defined and communicated objectives and time-lines. These must be accompanied by the timely introduction and enforcement of corresponding regulations, announced well in advance. A gradual approach would provide sufficient adjustment time for the refineries, reduce the adjustment costs, and ensure that steps are taken to comply with the upcoming requirements. Importantly, during the transition period, awareness-raising measures can be taken to influence consumer behavior.

Combined

with Policy

5.2 POLICY MEASURES AND INSTRUMENTS FOR THE PHASE-OUT OF LEAD

Policy Elements

Although lead phase-out is expected to be a highly cost-effective measure (particularly in terms of the impact on health), strong commitment and the appropriate policy intervention is required. The core of such policy intervention includes the following four aspects (Lovei, 1997):

- Regulation and enforcement;
- Incentives;
- A broad consensus among the affected stakeholders;
- Public understanding and acceptance.

It is not only the technical capacity of refineries that restricts the use of unleaded gasoline within the domestic market. The lack of regulations and incentives also serves as a barrier. For example, Bulgaria and Romania export significant amounts of domestically produced unleaded gasoline; however, if the policy measures were effective, the domestic consumption of unleaded gasoline could be significantly increased.
Regulations

World-wide experience shows that strong political commitment at the highest government level is necessary to introduce and enforce regulations aimed at alleviating human exposure to lead. Such regulations fall into two major categories: (i) environmental regulations that limit the maximum permissible concentrations of lead and other pollutants in the air, and (ii) regulations ensuring compliance with environmental objectives. The latter category includes for example, the reduction of the maximum permissible lead content in gasoline; setting specific deadlines for the complete ban of leaded gasoline sales; other fuel specifications to ensure that lead in gasoline is not replaced by substances harmful to health; and regulations concerning the pollution characteristics of vehicles.

As for the latter, it is important to stress that there should be a distinction in the policy between the phase-out of lead from gasoline as an objective in itself, and the requirement for the use of catalytic converters which primarily aims at reducing other pollutants such as nitrogen oxides, carbon monoxide, and hydrocarbons. The phase-out of lead can be achieved without the introduction of the catalytic converter.

5.2.1 Emission Standards

Use of Catalytic Converters

Central and East European countries (including all the SILAQ countries) seeking membership to the EU have started to harmonize their emission standards with those of the EU. These standards can be satisfied through the use of catalytic converters. Catalytic converters in Slovakia have been required for both imported and domestically produced cars since 1993. Similar requirements have been introduced in Slovenia (1994), in Poland (1995) and in Hungary (1996) and are forthcoming in Bulgaria (1998) and in Romania (1998 for imported cars, and 2000 for those produced domestically).

Country Study

In Slovakia, legislation was introduced to set standards for the technical condition of vehicles on the roads. At present, all gasoline-engined vehicles must fulfill the following conditions:

- New vehicles must be capable of the permanent use of unleaded gasoline without additives for lubricating the valve seats;
- New vehicles must be fitted with functional controlled three-way catalytic converters;
- Imported vehicles must have been produced in 1985 or later.

Vehicles that do not fulfill the above conditions cannot be registered. All gasoline vehicles in operation are subjected to regular pollution inspection in authorized pollution test centers. Table 23 shows Slovakia’s emission standards for gasoline vehicles.

### TABLE 23: Emission Standards for Gasoline Vehicles in Slovakia*

<table>
<thead>
<tr>
<th>Year of vehicle production</th>
<th>Standard for CO (%)</th>
<th>Standard for HC (ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>before Dec. 31, 1972</td>
<td>6.0</td>
<td>2,000</td>
</tr>
<tr>
<td>Jan. 1, 1973 - Dec. 31, 1985</td>
<td>4.5</td>
<td>1,200</td>
</tr>
<tr>
<td>after Jan. 1, 1986</td>
<td>3.5</td>
<td>800</td>
</tr>
</tbody>
</table>

*For vehicles without catalytic converters; CO = carbon monoxide; HC = hydrocarbons.

Emission Standards

Hungary, Poland, Slovakia and Slovenia also report the adoption of stricter emission standards that require the installation of catalytic converters on new cars. Bulgaria and Romania have yet to introduce such regulations. Bulgaria is currently preparing new emission standards which will include limits on hydrocarbons and NOx emissions, and which will be in line with EU standards.

Although the new regulations introduce stricter exhaust emissions requirements, they correspond only to the first US standard enforced in 1966/1967. Therefore, SILAQ countries should prepare for the adoption of EU standards, i.e., by using more rigorous testing procedures including test cycles and by limiting permissible concentrations.

In all SILAQ countries the harmonization of regulations with those of the EU is a high priority, and most countries have already adopted EU gasoline specifications. Accelerating the phase-out of lead as part of the harmonization process would facilitate the acceptance of these countries as a part of the European Union. Since 1985, Directive 85/210/EEC allows for exceptions in the adjustment period during which for example, 0.4 g/l limit is permitted (e.g., in Romania 0.52 g/l has been adopted). The EU also requires the sale of only one grade of leaded gasoline, with an octane number rating of at least 95. A recent
European Commission proposal recommended that a Directive requiring the total lead phase-out be adopted by the year 2000.

Environmental regulations related to lead have been introduced in all the SILAQ countries. The reduction of the maximum permitted lead content in gasoline to levels of 0.15 g/l (EU standard) or less was the first step. As shown earlier in Tables 6 and 7, all the SILAQ countries, with the exception of Romania, have already adopted the 0.15 g/l limit for leaded gasoline. The maximum permissible lead content regulation was combined with other gasoline quality specifications, such as the octane rating, volatility, aromatic content, benzene and oxygenates.

5.2.2 Enforcement of Regulations

Regulations can only be effective if proper enforcement is available to ensure compliance. Governments should ensure that: (i) refiners and importers comply with specifications; and (ii) distributors and retailers do not mismanage the various gasoline brands.

While the control and enforcement of gasoline specifications may be considered relatively simple with regard to production and at the wholesale level, it may require more significant administrative effort at the distribution and retail levels, especially if there is no punishment for gasoline taxation abuse. All countries use different pump nozzle sizes which helps to maintain the correct use of leaded and unleaded gasoline.

Additionally, vigorous enforcement of vehicle air emission standards will be necessary to ensure that new regulations are complied with. This can be best achieved in practice by including emission measurements in the mandatory periodic technical testing of vehicles.

### Table 24: Applicable Taxes and Tax Differentiation (1996)

<table>
<thead>
<tr>
<th>Taxes</th>
<th>Bulgaria</th>
<th>Czech Republic</th>
<th>Hungary</th>
<th>Poland</th>
<th>Romania</th>
<th>Slovakia</th>
<th>Slovenia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tax differentiation for leaded gasoline; leded gasoline; prices and different RON quality</td>
<td>Taxes</td>
<td>110/100</td>
<td>0%</td>
<td>0%</td>
<td>RON 95</td>
<td>Only unleaded gasoline is produced</td>
<td>n/a</td>
</tr>
<tr>
<td>Prices</td>
<td>100/100</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Taxation on crude oil</td>
<td>-</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>none</td>
</tr>
<tr>
<td>Excise duty on gasoline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leded: 70% for low octane</td>
<td>Leaded:</td>
<td>none</td>
<td>43.4%</td>
<td>10%</td>
<td>-</td>
<td>Leded: 15%</td>
<td>RON 86</td>
</tr>
<tr>
<td>110% for RON 86</td>
<td>876 zł</td>
<td>Leaded containing ethyl alcohol - 2l 743</td>
<td>129.2%</td>
<td>RON 98</td>
<td>SIT 44.7</td>
<td>117%</td>
<td></td>
</tr>
<tr>
<td>Unleaded: 60% for low octane</td>
<td>Unleaded:</td>
<td>none</td>
<td>43.4%</td>
<td>13.5%</td>
<td>-</td>
<td>Unleaded: RON 91</td>
<td>SIT 32.6</td>
</tr>
<tr>
<td>100% for RON 91</td>
<td>791 zł</td>
<td>Unleaded:</td>
<td>85.7%</td>
<td>RON 95</td>
<td>SIT 36.5</td>
<td>91.8%</td>
<td></td>
</tr>
<tr>
<td>Higher octane</td>
<td>for RON 95</td>
<td>SIT 36.5</td>
<td>91.8%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VAT</td>
<td>22%</td>
<td>22%</td>
<td>25%</td>
<td>22%</td>
<td>18%</td>
<td>-</td>
<td>Not yet adopted</td>
</tr>
<tr>
<td>Road tax</td>
<td>15% (added to gasoline price)</td>
<td>All cars for business purposes</td>
<td>16%</td>
<td>none</td>
<td>25%</td>
<td>-</td>
<td>Road tax depends on lorry capacity</td>
</tr>
<tr>
<td>Other kinds of transport taxation</td>
<td>environmental tax of 5% (added to the gasoline price)</td>
<td>Highway tax for passenger cars and trucks</td>
<td>1.7%</td>
<td>taxation depending on the engine capacity, and a local tax</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*zł=Polish zloty*
5.2.3 Economic Incentives

Economic incentives influence supply and demand by changing the price structure for the alternative products. For instance, preferential tax rates can be applied to unleaded gasoline, thus causing refineries (or importers, for that matter) to adapt production to meet the change in demand.

Differentiate taxes can also alter the "pump" price of leaded and unleaded gasoline grades which will allow, for comparable octane numbers, lower prices for unleaded gasoline in comparison with leaded gasoline prices. This creates an incentive for the buyer to choose unleaded gasoline (provided the use of unleaded gasoline is technically feasible with a particular brand of car). Overall, the trend seems to be that the closer the country is to complete phase-out, the wider the price gap between leaded and unleaded gasoline carrying the same octane number.

Incentive policies could play a key role in smoothing the transition period during the phase-out of lead by influencing gasoline supply and demand. Table 24 shows data on the applicable taxes and the tax differentiation applied in 1996 in the SILAQ countries, while Table 25 provides further data on prices and price advantages of leaded and unleaded fuel.

Country Studies

In Bulgaria, gasoline prices are regulated by price formulas which reflect international world market prices. The excise duty on unleaded gasoline is 10 percent lower than that for the same grade of leaded gasoline. However, one of the reasons why the market share of unleaded gasoline is so low in Bulgaria is a result of the current tax system, where the pump price of unleaded gasoline at some stations is about 15 percent higher than that of the leaded equivalent.

Until July 1996, when sales of REGULAR leaded gasoline were discontinued in Hungary, the differentiation in excise taxes for REGULAR leaded (RON 92) and unleaded (RON 91) gasoline resulted in an approximate difference of 5 percent in the retail prices of the two gasoline brands. In Poland, the retail price difference between PREMIUM leaded (RON 94) and unleaded (RON 95) gasoline was close to 4 percent in 1995, and to 2.5 percent in 1996.

<table>
<thead>
<tr>
<th>Country</th>
<th>Leaded</th>
<th>Unleaded</th>
<th>Price advantage of unleaded</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Brand</td>
<td>Price (USD/liter)</td>
<td>Brand</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>Eurosuper 98</td>
<td>0.65</td>
<td>Euro 95H</td>
</tr>
<tr>
<td></td>
<td>LEADED 93 (limited availability)</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td></td>
<td>LEADED 91</td>
<td>0.46</td>
<td></td>
</tr>
<tr>
<td>Czech Republic</td>
<td>SPECIAL 96</td>
<td>0.73</td>
<td>NATURAL 95</td>
</tr>
<tr>
<td></td>
<td>SPECIAL 91</td>
<td>0.68</td>
<td>NATURAL PLUS 98</td>
</tr>
<tr>
<td>Hungary</td>
<td>EURO/SUPER 98</td>
<td>0.79</td>
<td>SUPERPLUS 98</td>
</tr>
<tr>
<td></td>
<td>EURO 95</td>
<td>0.74</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EURO 91</td>
<td>0.72</td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td>Leaded 98</td>
<td>0.57</td>
<td>Unleaded 98</td>
</tr>
<tr>
<td></td>
<td>Leaded 95 (limited availability)</td>
<td>0.55</td>
<td>Unleaded 95</td>
</tr>
<tr>
<td></td>
<td>Leaded 94</td>
<td>0.55</td>
<td></td>
</tr>
<tr>
<td>Romania</td>
<td>Premium Super Plus 98</td>
<td>0.54</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Premium 95</td>
<td>0.52</td>
<td>Fara Plomb 95</td>
</tr>
<tr>
<td>Slovakia</td>
<td>UNI 91</td>
<td>0.62</td>
<td>98 Super Plus</td>
</tr>
<tr>
<td></td>
<td>95 Super</td>
<td>0.65</td>
<td>95 Super Natural</td>
</tr>
<tr>
<td>Slovenia</td>
<td>Eurosuper 98</td>
<td>0.71</td>
<td>RON 98</td>
</tr>
<tr>
<td></td>
<td>RON 95</td>
<td>0.62</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RON 91</td>
<td>0.60</td>
<td></td>
</tr>
</tbody>
</table>

Note: Average prices in capital cities, as of mid-May 1998.
In Slovakia, where a complete and relatively smooth transition to unleaded gasoline took place during the course of just 18 months, the retail price difference between leaded and unleaded gasoline was some 13 percent. Retail price differentiation favoring unleaded gasoline not only creates economic incentives for its use, but also helps to prevent the use of leaded gasoline in vehicles equipped with catalytic converters.

In the longer term, the improved availability and lower prices of unleaded gasoline will lead to a growth in demand for cars using unleaded gasoline, while stricter emission control requirements will increase demand for vehicles equipped with catalytic control devices.

Long-term Prospects

‘Lead-credit’ Trading

Interestingly, other market-based incentive mechanisms could also be considered in countries with large gasoline markets and several refineries (e.g., Poland and Romania). For example, under a lead credit trading system (employed in the US between 1983 and 1987) refineries producing gasoline with a lead content lower than the standard requirement obtained “lead credits.” These credits, in turn, could be sold to refineries which were unable to meet the standard, or whose costs in doing so were relatively high. Whether such a system could be successful in SILAQ countries is open to question. Drawing conclusions on the matter requires an in-depth study of the regulatory and legal institutions in the respective countries.

5.2.4 Public Awareness Raising

Raising public awareness and understanding forms part of a broad, consensus-building effort. For instance, a recent sociological study in Hungary showed that many people were unaware as to the severity of health hazards resulting from lead. More importantly, the lack of information and misconceptions concerning the use of unleaded gasoline in older passenger cars presents one of the largest obstacles to changing consumer behavior.

Information Campaigns

Despite a degree of success achieved in the SILAQ countries in terms of public awareness raising, greater efforts need to be concentrated on informing the public of the health and environmental risks posed by lead. Taking advantage of the mass media, an education campaign directed toward the general public can inform individuals about the respective health hazards.

Additionally, it is crucial to educate consumers with regard to the feasibility of using unleaded gasoline. In Denmark, for instance, awareness building was effectively used to reduce consumer reluctance towards unleaded gasoline that was caused by uncertainties regarding its possible negative effects on cars.

Significant effort is also needed to reach those consumers whose cars can use both leaded and unleaded types of fuel. At the very least, there should be clear information at all gas stations with respect to the applicability of unleaded gasoline for a particular brand of car and/or engine.

5.3 ENABLING FACTORS

Cross-sectoral Cooperation

Policies aimed at reducing human exposure to lead can be implemented only with the support and participation of government agencies, industries, and public organizations. The cooperation of government agencies responsible for environmental protection and public health, and the involvement of industry is necessary in setting targets and determining a feasible schedule for any lead phase-out program. Control measures and inspection controls are also preconditions for ensuring the effectiveness of the actions undertaken.

Case Studies

To facilitate the implementation of lead phase-out, Bulgaria, for example, established an inter-governmental coordination committee, which involved the participation of government agencies, industries, and other affected parties. Romania set up an inter-agency board that was to be responsible for preparing the lead phase-out action plan. The preparation of this plan forms a part of the World Bank’s “Road Project”. Cooperation among gasoline producers, distributors and retailers is essential in ensuring the supply and distribution of unleaded gasoline. In Slovenia, for instance, an agreement was reached between the government, gasoline suppliers and distributors, which is of crucial importance in ensuring the supply of sufficient quantities of unleaded gasoline to the market.

Control measures and inspections of the production, market and distribution systems for gasoline are important factors during the lead phase-out process, and their implementation should become obligatory. The effectiveness of the lead phase-out process is dependent on these factors.
5.4 CURRENT STRATEGIES FOR THE PHASE-OUT OF LEAD IN THE SILAQ COUNTRIES

**Western Experience**

Several West European countries (i.e., Austria, Denmark, Finland, Sweden and Switzerland) have already phased out leaded gasoline. Key measures adopted included the maximum permissible lead content in gasoline of 0.15 g/l, the use of tax incentives to promote market demand for unleaded gasoline, and the introduction of strict air emission standards for new cars which can only be met through the use of catalytic converters.

The current situation in this respect in the SILAQ countries is somewhat similar. All the SILAQ countries have plans to phase out lead in gasoline by the year 2003 at the latest. The examination of the existing phase-out plans in the SILAQ countries shows that the three general policy approaches explored in the previous sections are used:

- A technology-based approach that relies on shifting the demand away from leaded gasoline by modernizing car technology (through the use of catalytic converters), and enforcing the mandatory use of catalytic control devices on vehicles.
- An incentive policy approach that uses price incentives and other policy measures to promote the use of unleaded gasoline in cars with or without catalytic converters.
- A rapid phase-out approach that discourages or bans the use of leaded gasoline even before catalytic converters become universally used by the entire vehicle fleet.

In general, it appears that the last two approaches offer a more suitable way of dealing with vehicle-related lead exposure problems in the SILAQ countries. Bulgaria, Hungary, Poland and Slovenia have followed the incentive approach, combined with regulations reducing the lead content of gasoline, and supporting the use and import of cars with catalytic converters.

**Introduction of Unleaded Gasoline**

By the early 1990’s, Bulgaria, Hungary, Poland and Slovakia had all introduced unleaded gasoline to the market. These countries had also gradually started to decrease the production of gasoline with high lead content, from levels that often exceeded 0.7 g/l in the early 1980’s, to the current European Union standard of 0.15 g/l. These measures, taken under the auspices of government policy, led to significant reductions in vehicle-based lead emissions, general improvements in ambient air quality, and decreasing levels of human exposure. In 1996, Romania adopted a national programme for the gradual reduction of lead in gasoline, while in Slovakia, the maximum lead content of gasoline was reduced to 0.005 g/l as of September 2, 1997, thus practically banning leaded gasoline from the Slovak market.

Interestingly, when no standard was applied in Slovenia to regulate the quality of oil derivatives while the country was in transition, Slovenian oil companies used the given EU standards instead. For domestic producers, a lead standard of 0.40 g/l was applied until December 31, 1995.

The following section reviews in more detail the approaches used in each country.

**Bulgaria**

Bulgaria produces unleaded and leaded gasoline, although the share of unleaded gasoline in the market is small. The current maximum lead content is 0.15 g/l. Tax differentiation is applied but on a limited scale.

The country is in the final stages of developing a National Action Plan. The Plan is based on the gradual phase-out scenario, and includes the following incentives and timelines:

- The introduction of economic incentives for consumers (and producers) related to the use of unleaded gasoline. This includes the introduction of a new regime of excise duties ensuring that the duty which is paid for unleaded gasoline is 20 percent lower than that paid for leaded grades with similar octane. (1998-1999)
- Restrictions on the import of cars which can not use unleaded gasoline, aiming toward their gradual phase-out (1998).
- Prohibition of the import and production of leaded gasoline (2003).

Table 26 provides more detailed information on the National Action Plan presented in Bulgaria’s Country Status Report and its respective targets.
Czech Republic

A three-year modernization plan was elaborated at the end of 1996, and the strategy for the phase-out of lead in gasoline is expected to be approved shortly. However, a major obstacle to completing the phase-out of leaded gasoline is the need for information and the improved availability of alternative valve lubricants. Limited amounts of the ANABEX additive (imported from Slovakia) are available. However, according to the Automotive Industry Association, in 1995 there were some 800,000 cars (about 25 percent of all cars) requiring lubricating additives due to their soft valve seats. Nearly all of them currently use leaded gasoline.

A ban on leaded gasoline requires the sufficient supply of unleaded gasoline with the appropriate octane number and substitute lubricating additives. However, the country is dependent on the import of high-grade unleaded gasoline as the present condition of its domestic refineries does not allow for its production. Therefore, cooperation between the government and gasoline distributors is necessary to prevent or to diminish the eventual rise of gasoline prices.

Hungary

Hungary plans to phase out the production of leaded gasoline by the year 2000, despite the lack of a formally approved government program to pursue this objective. Some important steps envisaged in the process include:

- The introduction of legal requirements for catalytic converters on all new cars in effect since 1996;
- Granting of financial support for the equipping cars with catalytic converters. A 50 percent reduction in road tax will be applied to cars fitted with catalytic converters (the tax is currently HUF 400-800, or USD 2-4 per 100 kg weight);
- Information campaigns and awareness raising measures, existent since 1992.

<table>
<thead>
<tr>
<th>Approaches</th>
<th>Targets</th>
<th>Time limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology based approaches</td>
<td>1. Modernization of existing refineries to increase production of unleaded gasoline in order to meet future demands.</td>
<td>1998-2000</td>
</tr>
<tr>
<td></td>
<td>2. There is currently no requirement for the fitting of catalytic converters on new cars.</td>
<td></td>
</tr>
<tr>
<td>Incentive approaches</td>
<td>Introduction of a system for accelerating the phase-out policy, to include economic incentives, customs duties, taxes and fines both for producers and consumers.</td>
<td>1998-1999</td>
</tr>
<tr>
<td>Rapid phase-out policy</td>
<td>Prohibition of the import and production of leaded gasoline.</td>
<td>2005</td>
</tr>
</tbody>
</table>

Discussion:

- The level of investments necessary for the modernization of refineries are significant: around USD 60-70 million for “Neftochim,” and some USD 30-40 million for “Plama.” Cooperation with international financial institutions and companies is needed in order to obtain the necessary credits for the completion of this objective.
- In order to stimulate the production and consumption of unleaded gasoline, the excise tax for unleaded grades should be at least 20 percent less than that for leaded grades. The existing 10 percent difference barely offsets the higher costs of producing unleaded gasoline.

- Car importers must certify that engines are fit for the use of unleaded gasoline. Special legislation needs to be enacted to ensure this. A specific call for an increase in the installation and use of catalytic converters should be included in the National Action Plan.
Domestic leaded gasoline production has been declining and is expected to cease by the year 2000.

**Poland**

Government plans intend to gradually phase out leaded gasoline before the year 2000. Specifically, this has so far resulted in:

- A reduction in the gasoline lead content from 0.3 g/l to 0.15 g/l (1992);
- Tax differentiation between unleaded and leaded gasoline (effective since 1992);
- Legal requirements for the installation of catalytic converters on all new cars (effective since 1995);
- Information campaigns on:
  - Those types of vehicles suited to the use of unleaded gasoline (1992);
  - The use of mixed (leaded/unleaded) fuels (1993);

**Lead Phase-out in Poland**

Poland aims to increase its production of unleaded gasoline in order to meet future gasoline demands. The poor octane pool of Polish refineries is considered by the Polish authorities to be a major constraint for accelerating the phase-out of lead in gasoline. Additionally, the relatively old car fleet is also considered to be a significant constraint to the phase-out of lead. Catalytic converters have been required on new cars since the beginning of 1995; however, only 6.4 percent of passenger cars had been fitted with the device by 1996. Additional incentives encouraging consumers to use mixed fuels and new gasoline with lubricating additives (domestically produced or imported) would help Poland accelerate the phase-out process.

**Romania**

Romania has developed its own action plan, which includes an agreement reached among a wide number of government and public institutions, gasoline manufacturers and car producers. The country plans to gradually phase out lead in gasoline between 1997 and 2003. Specifically, this includes:

- The production and distribution of gasoline with a reduced lead content of 0.52 g/l (1997-1998);
- Vehicle research regarding the use of gasoline with a lead content of 0.15 g/l (to be financed by an external source) (1997-1999);
- The reduction of lead content from 0.52 g/l to 0.15 g/l by modifying technology in the refinery sector (1999-2001);
- The introduction of mandatory catalytic converters for imported cars (1998);
- The introduction of mandatory catalytic converters for domestically produced cars (1999-2000);
- The total phase-out of lead from gasoline (2001-2003).

The following two scenarios were discussed within Romania’s action plan:

(I) Slow transition, which proposes the production of gasoline with the lead content lowered from 0.5 g/l to 0.32 g/l, from the beginning of 1998. This would reduce lead emissions by 78 percent by the year 2000, compared with 1995 levels.

(II) Fast transition, which proposes the immediate production of gasoline with a lead content of 0.15 g/l.

The first scenario was eventually adopted by the Action Plan.

Additionally, Romania aims to start manufacturing engines with catalytic converters by the turn of the century, and by the year 2001, to complete research on the engine performance of existing cars fueled with 0.15 g/l lead gasoline. Research into the production and commercialization of such gasoline will also be finished by this time and will be based on the use of external financing and technical assistance from the European Bank for Reconstruction and Development.

The mandatory use of catalytic converters on imported and domestically produced cars is planned for 1998 and 2000, respectively. Furthermore, the targets of the Romanian
Action Plan include the development of economic and fiscal incentives together with improved refining technologies, and the increased distribution of unleaded gasoline.

**Slovakia**

Slovakia achieved a rapid, complete and relatively smooth transition from leaded to unleaded gasoline within 18 months. It is currently the only country in Central and Eastern Europe to have chosen the rapid phase-out approach.

The key milestones in the Slovakian phase-out included:
- Catalytic converters required on all new cars (introduced in 1993);
- Information campaigns launched (between 1990 and 1996);
- The maximum lead content allowed in gasoline reduced to 0.005 g/l (adopted on September 2, 1997).

The last measure practically bans leaded gasoline from the Slovak market.

To influence consumer behavior and to facilitate the transition, the rapid phase-out approach was preceded and combined with an incentive policy approach, while different measures, such as tax differentiation schemes, to accelerate the switch to unleaded gasoline were applied.

**Success Story**

It is remarkable that even in spite of the success of the combination of the incentive policy approach and the rapid phase-out approach, which has resulted in the total phase-out of leaded gasoline in less than two years, and a significant decrease in the levels of lead emissions, none of the other SILAQ countries have adopted similar approaches.

However, even though the characteristics of Slovakia’s car fleet were not favorable to the rapid phase-out, a number of other factors helped the country in this process. First of all, a single refinery existed in the country, with a monopoly on gasoline production and sales. The refinery was modern and could easily adjust its production to provide high octane gasoline. The use of a lubricating additive provided the necessary lubrication to the high share of cars with soft exhaust valve seats.

**Slovenia**

The Slovenian government plans the complete phase-out of leaded gasoline by the end of the year 2000. Its achievements so far have included:
- Tax differentiation between unleaded and leaded gasoline (introduced in 1991);
- The mandatory installation of catalytic converters on all new cars (1994);
- The adoption of the EU of 0.15 g/l standard for the lead content in gasoline (1994).

**Incentive Policies**

Slovenia does not have enough blending facilities for producing unleaded gasoline with the VSPA additive, and therefore will have to import unleaded gasoline which already contains the additive. The government will have to implement a well-balanced incentive policy, and discussion between the government and the dealers is to take place shortly. An estimation of the number of cars with soft valve seats still needs to be carried out.

### 5.5 EXAMPLES OF SUCCESSFUL LEAD PHASE-OUT STRATEGIES

Several factors affect the implementation of any strategy for the phase-out of lead from gasoline.

**Factors of Success**

Oil refineries in different countries enjoy a unique starting point with regard to the various possibilities and options they have to reduce or phase out lead from gasoline. Vehicle fleets, characterized by different average ages and turnover rates, consist of a variety of vehicles equipped with engines that may or may not use unleaded gasoline. The availability of a substitute lubricant (non-lead based) is an important factor, and the overall economic situation, the availability of financing, and public awareness and pressure will determine the specific policy approach applied in each country.

The transition period of pioneer countries like the US and Japan was much longer due to the long term research studies carried out on the risks to human health and the environment, and so the countries of Central and Eastern Europe can effectively speed this process based on the results already experienced elsewhere.

Following, three specific case studies (from Denmark, Slovakia, and Sweden) on the successful phase-out of lead are presented.
6. Conclusions and Recommendations

Phase-out by 2003?

All the SILAQ countries intend to phase out leaded gasoline by the year 2003. The countries either have specific phase-out plans already in place, or are in the process of drafting national strategies in this field appropriate to their current conditions. An overview of the situation presented in this report shows that even though in some cases it may be difficult to meet the planned deadline, the phase-out is technically and economically feasible.

**CASE STUDIES: Sweden and Finland**

Sweden has been selling only unleaded gasoline since 1994. The phase-out was achieved as a result of a combination of various policy measures.

The lead phase-out process started with the gradual reduction in the maximum permitted content of lead in gasoline, which was reduced from the initial 1.2 g/l in the 1970’s to the current 0.15 g/l.

Tax incentives were introduced in the mid-eighties, and tax differentials were gradually increased to compensate for the necessary investment costs and higher operating costs.

The requirement for the installation of catalytic converters on all new cars was introduced in 1989. However, to ensure the proper operation of older types of engines, a lead-free gasoline with a sodium-based lubricating additive was introduced into the market in 1992. Interestingly, the refinery which developed the additive based on its own initiative gained a significant competitive advantage over its competitors.

Economic incentives were used effectively in Sweden because of the existence of several refineries and a strong competitive environment, as well as the high turnover of vehicles.

The phase-out of leaded gasoline in Finland was achieved through a tax differentiation scheme and the use of unleaded gasoline by cars that normally have used leaded gasoline. The latter was possible through the introduction of lubricating additives. Finland also introduced strict requirements for catalytic converters which created a strong need for the removal of lead from gasoline. Other Nordic countries, Germany and Austria have adopted similar approaches.

The experiences of these countries show that the introduction of lubricating additives and the use of unleaded gasoline in different types of cars are the key requirements for the successful rapid phase-out of lead from gasoline.

**CASE STUDY: Denmark**

Denmark was one of the first West European countries to have phased out lead completely. At the beginning of the process, it operated three refineries. However, one was closed while the remaining two, somewhat different in size with production at 95 and 65 thousand barrels/day, were considered small by West European standards. The refineries were relatively simple, with no FCC facilities, and underwent similar modifications.

The Danish refineries suffered only minor problems when the lead reduction process began in Denmark in 1982, since all fuel qualities could be blended from the RON98 reformate produced. The refineries increased reformer severity resulting in a RON100 reformate when the unleaded RON98 gasoline was introduced in 1989. However, this had the adverse effect of lowering output, increasing the wear on the catalyst reformer, and reducing intervals between overhauls.

Initially, in order to ensure the availability of RON98 unleaded gasoline for the fraction of the vehicle fleet that needed it, MTBE was purchased and added (Danish refineries cannot produce MTBE themselves), since increasing reformer severity was not enough to produce RON 98. To comply with future benzene legislation, and to ensure greater flexibility in production, Danish refineries acquired isomerization units enabling the production of high octane gasoline with a low benzene content. This action now also prepares the refineries for new European Union legislation to be introduced in the year 2000.

The phase-out of lead had little effect on the distribution costs. Storage tanks and pumps formerly used for leaded gasoline were converted for use with low-lead or unleaded gasoline. Alternative pump nozzles were installed for unleaded gasoline.

Since 1994, only unleaded gasoline has been used in Denmark, with only one quality of fuel produced at the refineries. The same gasoline is offered to cars with soft valve seats. However, a potassium-based anti-valve seat recession additive is added while filling gasoline tankers at the refineries. The Danish oil companies report no complaints from customers relating to valve seat recession since introducing unleaded fuel in Denmark.

Source: COWI
6.1 KEY ISSUES NEEDING TO BE ADDRESSED

The key factors noted by the SILAQ countries needing to be addressed when drafting a successful phase-out strategy included the:

- Ability of domestic refineries to supply unleaded gasoline;
- Feasibility of using unleaded gasoline by local vehicles, and;
- Awareness of the public as to the applicability of unleaded gasoline.

Financing Conversion

The information collected on the major constraints to lead phase-out show that the lack of finance constitutes a significant barrier in the SILAQ countries, particularly in Bulgaria and Romania, and to some extent in Poland. Modernization of existing refineries in order to switch to the production of unleaded gasoline is technically and economically feasible, especially since most refineries are the more complex Type 2 and Type 3, but the process requires significant investment.

However, accessing funds is not an overwhelming obstacle. For instance, in March 1998, the European Investment Bank extended a loan of ECU 125 Million to the Hungarian main oil refinery, owned by MOL Rt. The loan, with a 15-year maturity period, will cover approximately half of the required investment costs of the necessary technical upgrades. With a proper mix of tax incentives and stricter regulations, refineries will have to look more actively for the necessary funding. To this end, it will be necessary to improve the ability of refineries to attract investors.

Vehicle Fleets

Another obstacle to the phase-out of lead in gasoline is the structure of vehicle fleets, which in the SILAQ countries are characterized by a fairly high average age, low turnover rates, and a relatively high share of vehicles with soft exhaust valve seat engines, which are generally believed to require lead lubrication.

As for the latter concern, commercially available alternative lubricants not based on lead already exist. Some countries have already introduced gasoline with potassium or sodium-based lubricants (e.g., Slovakia’s phase-out, or Aral in Hungary), and experiences with these have been successful. Moreover, there is evidence that many cars previously thought to need leaded gasoline can operate using unleaded gasoline.

Increasing Use of Catalytic Converters

Another rationale to phasing out lead from gasoline is the introduction of the requirement for the mandatory fitting of catalytic converters (which can only be installed for engines using unleaded gasoline). A review of existing studies and the available information on the lead phase-out process in the EU and other West European countries shows that requirements for catalytic converters (implemented on a EU-wide level in 1993) help to gradually increase the market share of unleaded gasoline, although this development was further supported by the use of appropriate tax incentives. However, for the SILAQ countries, with low

CASE STUDY: Slovakia

The success of the Slovak Republic in the fast phase-out of lead from gasoline was facilitated by a number of related policy initiatives introduced at an early stage. The process of lead content reduction in gasoline produced at the Slovnaft Refinery occurred in three stages:

(I) The period to 1988: production of unleaded gasoline began with technological improvement and a resulting reduction in lead content from 0.25 g/l in 1986 to 0.15 g/l in 1989;

(II) 1989-1991: further development oriented to more complex crude oil processing with the aim of maximizing output and increasing the production of unleaded gasoline;

(III) The period following 1992: the creation of conditions that saw the exclusive production of unleaded gasoline in 1992, and the installation of a unit for the isomerization of light naphtha (C5-G6 hydrocarbons). The octane number was raised from RON 70 to RON 84, without any increase in the aromatic content in gasoline.

At the beginning of the lead phase-out process, the main factor preventing the increased consumption of unleaded gasoline was the state of the car vehicle fleet in the Slovak Republic. The only possible solution was the application of an adequate additive, and as a result, the additive ANABEX® 99 was developed by Slovnaft VUBUP. The availability of this additive transformed the UNI series of unleaded gasoline into a universal gasoline for the whole car fleet. Simultaneously, conditions established in Slovakia (from the beginning of 1995) permitted the distribution of unleaded gasoline only. The relatively smooth and complete transition process to unleaded gasoline was accomplished thanks to the use of a universal gasoline type suitable for a mixed car fleet. The success of this strategy was essentially a result of the combination of an incentive policy and a far-reaching information campaign.
vehicle turnover rates, the impact of the requirement for converters alone is not sufficient to significantly increase the market share of unleaded gasoline, and the process needs to be driven by other policy components. Among other things, an appropriate tax differentiation system will have to be introduced to ensure that the higher manufacturing cost for unleaded gasoline is not reflected by the higher pump price of unleaded gasoline at the gas station.

Awareness raising measures will have to be widely used to overcome the lack of information among the public as to a vehicle’s ability to use unleaded gasoline. This is particularly important for that segment of the vehicle fleet which can use both leaded and unleaded gasoline. Mass media information campaigns and brochures available at gasoline stations and vehicle technical control centers are possible means to raise awareness to the rationale and benefits from the phase-out of lead in gasoline.

**Further Studies**

Based on the findings presented in this Report, further steps will have to be taken in the SILAQ countries in the following areas:

(i) Public information and outreach campaigns concerning the use of unleaded gasoline in older types of cars;
(ii) Awareness raising regarding the health benefits of lead phase-out;
(iii) Exchanges of experience with other countries phasing out leaded gasoline;
(iv) Needs assessments for the development and use of non-lead lubricating additives;
(v) Research into the feasibility of the use of unleaded gasoline in cars with soft exhaust valve seats;
(vi) Ensuring access to the necessary financing schemes and sources for refinery modernization;
(vii) Technological development of refineries;
(viii) Introduction and enforcement of vehicle emissions and gasoline standards;
(ix) Introduction and modernization of the control system for the periodic technical inspection of vehicles;
(x) Implementation of the requirement for the fitting of cars with catalytic converters and other pollution-control devices;
(xi) Development of production and distribution systems for improving the supply of unleaded gasoline and accelerate complete phase-out of leaded gasoline;
(xii) A requirement for the phase-out of lead in negotiations during the privatization of refineries.

To implement some of these actions, the assistance of government and public organizations from within the EU and other industrialized countries, such as the US or Japan, will be sought.

**Experience Sharing**

As most of the CEE and NIS countries face similar problems and obstacles in phasing out lead, there is a demonstrated need across the region for sharing and learning from each other’s experiences. A multi-country follow up project to the SILAQ Initiative would enable participating countries to:

- Carry out joint activities, facilitating and shortening the transition period;
- Support the implementation of investment projects;
- Share experiences and information which can help to reduce implementation costs;
- Initiate programs that address the main obstacles to the lead phase-out process;
- Provide technical assistance to countries less advanced in the lead phase-out process;
- Facilitate feasibility studies for investment projects;
- Organize workshops related to the problems associated with lead phase-out and possible ways of facilitating the process.

**6.2 FOLLOW-UP TO THE SILAQ INITIATIVE: FUTURE ASSISTANCE NEEDS**

A determined effort to succeed in the phase-out of lead has been demonstrated by the SILAQ countries and their supporters over the last three years. Yet for some countries the process will last until between 2003 and 2005. Therefore it is obvious that for some countries the largest tasks still lie ahead.

As most of the CEE and NIS countries face similar problems and obstacles in phasing out lead, there is a demonstrated need across the region for sharing and learning from each other’s experiences. A multi-country follow up project to the SILAQ Initiative would enable participating countries to:
Further Support

To maintain the momentum gained during the last three years of the SILAQ Initiative, a continuation of external support is essential. The continued assistance is of principal importance to those CEE countries where economic transition is still slow and hard, and where the implementation processes will face problems. To this end, the US Environmental Protection Agency, the Danish Environmental Protection Agency, the World Bank and the Regional Environmental Center as well as the European Commission and the European Bank for Reconstruction and Development will be invited to continue their support.

Under the aegis of the SILAQ Working Group, and with the work coordination provided by the Regional Environmental Center, small joint-expert teams could be established to facilitate the exchange of experiences and the creation of synergies among participating parties, and through this, to help accelerate the lead phase-out process.

Exchanges of experience could focus on successful programs and case studies, and would address the major constraints to the implementation of lead phase-out activities. For example, the experiences of Slovakia in the rapid and relatively smooth phase-out of leaded gasoline, or the experience of Hungary where production of leaded gasoline will be completely phased out by the year 2000, could provide useful lessons for countries less advanced in their efforts.

Technical Inspections

The SILAQ countries might also initiate country studies on how best to address technical problems resulting from the characteristics of vehicle fleets. Work could also focus on the implementation of effective emission control systems and the periodic technical inspection of vehicles. In this context, the experience of the countries successful in the phase-out, as well as input from such institutions as the US Environmental Protection Agency, the World Bank, and the European Bank for Reconstruction and Development would be of great value and importance.

Long-term Goals

Such joint activities would hopefully facilitate Task Force initiatives to realize the pan-European strategy for the phase-out of leaded gasoline, as recommended in the Pan-European Strategy to Phase-out Lead in Gasoline. The data collected to date by the SILAQ Working Group serves as a particularly good basis for the transfer of experience to those CEE and NIS countries where less progress has been made in introducing lead phase-out policies.

The follow up to Sofia Initiatives for Local Air Quality, organized as a multi-country regional cooperation project, and opened up to new participants, would not only accelerate the phase-out of lead but also contribute to the European integration process.

7. References

The Regional Environmental Center for Central and Eastern Europe (REC) is a non-partisan, non-advocacy, not-for-profit organisation with a mission to assist in solving environmental problems in Central and Eastern Europe (CEE). The Center fulfils this mission by encouraging cooperation among nongovernmental organizations, governments, businesses and other environmental stakeholders, by supporting the free exchange of information and by promoting public participation in environmental decisionmaking.

The REC was established in 1990 by the United States, the European Commission and Hungary. Today, the REC is legally based on a Charter signed by the governments of twenty-six countries and the European Commission, and on an International Agreement with the Government of Hungary. The REC has its headquarters in Szentendre, Hungary and local offices in each of its 15 beneficiary CEE countries which are: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, FYR Macedonia, Poland, Romania, Slovakia, Slovenia and Yugoslavia.

Recent donors are the European Commission and the governments of the United States, Japan, Austria, Canada, Czech Republic, Croatia, Denmark, Finland, France, Germany, Hungary, the Netherlands, Norway, Slovakia, Switzerland and the United Kingdom, as well as other intergovernmental and private institutions.

Phase-out of Leaded Gasoline