The World Bank
Clean Air Initiative in
Sub-Saharan African Cities

CLEAN AIR INITIATIVE in Sub-Saharan African Cities

National Conference on the

PHASE-OUT of LEADED GASOLINE in NIGERIA

Working Paper Number 6

PROCEEDINGS

Abuja, Nigeria
November 15 – 16, 2001

The Committee on the Phase-out
of Leaded Gasoline in Nigeria

CLEAN AIR INITIATIVE • in Sub-Saharan African Cities •

PROGRAM COORDINATION FOR THE PHASE-OUT OF LEADED GASOLINE IN NIGERIA:

Engr. Aminu Jalal, Chairman

The Committee on the Phase-out of Leaded Gasoline in Nigeria

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THE COMMITTEE ON THE PHASE-OUT OF LEADED GASOLINE IN NIGERIA GRATEFULLY ACKNOWLEDGES:

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Nigerian Federal Ministry of Science & Technology

Nigerian Federal Ministry of Transport

Friends of the Environment

FOREWORD

On June 26-28, 2001 a regional conference was held in Dakar, Senegal, on the subject of phasing-out leaded gasoline in sub-Saharan Africa. This conference, organized by the World Bank in the framework of the Clean Air Initiative in sub-Saharan Africa, was attended by delegates from 25 countries. One of the major output of the Dakar conference was a unanimous agreement to eliminate lead from gasoline as soon as possible, and at the latest by 2005.

Five sub-regional Actions Plans, framing national clean air implementation programs, were drafted by groups of countries. The sub-regional group led by Nigeria was the first to start the implementation process, on the basis of the features of the oil industry prevalent in that country.

This Working Paper gives the proceedings of a national conference organized by the Nigerian Authorities in Abuja on November 15-16, 2001. The main results of the conference was the adoption of a two-step approach :

- Reduction to 0.15 g Pb/l by the end of 2002, a project currently undertaken by the Nigerian National Petroleum Corporation (NNPC);

- Total phase-out of leaded gasoline by year 2004.

Michele E. de Nevers
Manager
Environment & Natural Resources Division
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Sector Manager
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This Working Paper is the first of a series on the follow up and monitoring of the elimination of leaded gasoline in sub-Saharan Africa. Each sub-regional group will have its own agenda and milestones but Nigeria plays a prominent role in African oil industry. Its stated policy and program to phase-out leaded gasoline is most relevant to other countries of the continent and should contribute to improving air quality in the urban areas of sub-Saharan Africa.

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1.0 EXECUTIVE SUMMARY

Leaded gasoline is the greatest single source of human exposure to lead. Children are particularly vulnerable to lead poisoning. The elimination of leaded gasoline has been identified as a priority, not only because of its harmful lead content but also because of the triggering effect that this elimination would have on pollution. The use of unleaded gasoline is a prerequisite to introducing automobile catalytic converters which, in turn, can help reduce pollutants by as much as 90 percent.

The National Conference on the Phase-Out of Leaded Gasoline in Nigeria held at the Nicon Hilton Hotel in Abuja, on the 15th and 16th of November 2001, was attended by 130 delegates from the government, the private sector, NGO s, international organisations, transport fleet owners, Universities, and the public.

THE CONFERENCE WAS ORGANISED BY A COMMITTEE WITH MEMBERS FROM THE GOVERNMENT, UNIVERSITIES AND NGOS. THE OBJECTIVES OF THE CONFERENCE WERE:

- To enlighten all the stakeholders on the toxic effects of lead in gasoline.
- To obtain information on all aspects of lead in gasoline and its elimination.
- To work out an action plan for the phase-out of lead in gasoline in Nigeria.

The information contained in the following papers presented at this conference and the outcome of the discussions that followed was summarized in the below Findings. These were subsequently used to formulate the Abuja Action Plan for phasing-out leaded gasoline in Nigeria.

FINDINGS

- Although there are no national surveys of blood lead levels in the general Nigerian population, isolated studies indicate these levels are very high compared with current acceptable limits. These levels have consistently been associated with various pathological conditions such as anaemia, neurobehavioral deficits, renal impairment, reproductive abnormalities and suppressed body defence system.

- Children are particularly vulnerable to lead poisoning. Lead causes devastating and irreversible neurological damage to children, leading to learning disabilities, lower levels of intelligence, behavioural problems, growth impairment, permanent visual and hearing impairment and other damage to the brain and nervous system. Exposure to high doses of lead can lead to coma, convulsions and death.

- The major source of human lead accumulation in developing countries was found to be airborne lead, 90% of which came from leaded gasoline.

- It is considered imperative to reduce and eliminate lead pollution, and any financial support to remove hazardous effect should be considered an investment.

- The financial cost of lead phase-out is insignificant compared to economic losses estimated by the World Bank at between 0.05 to 2.5% of the GDP of the affected countries, and the burden on health facilities is inestimable.

- Lead phase-out in Nigerian gasoline is realisable using a two stage approach:

  ➔ Reduction to 0.15 g Pb/l by the end of 2002. This project is already being undertaken by the Nigerian National Petroleum Corporation (NNPC). Currently NNPC produces gasoline at 0.20 g Pb/l at Kaduna and Warri refineries and unleaded gasoline at Port Harcourt Refineries.

  ➔ Total elimination of lead in gasoline by year 2004. Production of unleaded fuel in Kaduna and Warri refineries would cost US $500 million. The work would involve:

    1. The installation of Isomerization plants in the two refineries to upgrade RON of light Naphta;
    2. Upgrading the Reforming units to Continuous Catalyst Regeneration Unit (CCR);
    3. Upgrading and upsizing the Fluid Catalytic Cracking Unit (FCCU) in the two refineries; and
    4. Installation of Resid Fluid Catalytic Cracking Unit (RFCCU) in at least one refinery.

This project would take 2 to 3 years, so that by the year 2004 the gasoline supply to all parts of the country could be lead free.

- Some older vehicles, when operated under extreme conditions (150 Km/h on a freeway for more than four hours) may experience burning of the exhaust valves, called valve seat recession (VSR). Newer vehicles have hardened valve seats and are not affected. Peugeot vehicles affected are those made before 1986. American and Japanese vehicle manufacturers have introduced reinforced valve seats as far back as 1975 and 1981 respectively. Considering also that the eastern part of the country already uses unleaded fuel without problems reported, even though no additives have been added to the fuel to counter VSR, it is recommended that no additive should be added to unleaded fuel to counter VSR.

- The current distribution system is used to distribute both leaded and imported unleaded fuel.

2.0 ACTION PLAN

Presented at the Closing Ceremony by
Mr. Alh A. M. O. Muse
General Manager
Group Executive Director's (Refinery and Petrochemicals) Office
Nigerian National Petroleum Corporation

THE KEY RESULT OF THE CONFERENCE ON THE PHASE-OUT OF LEADED GASOLINE IN NIGERIA WAS THE FORMULATION OF AN ACTION PLAN AS FURTHER DESCRIBED, LEADING TO:

- The reduction of the lead content in gasoline to 0.15 g Pb/l, by the end of the year 2002.
- The total phase-out of leaded gasoline in Nigeria by the year 2004.

THE DETAILS OF THIS ACTION PLAN ARE AS FOLLOWS:

- The on-going deregulation and privatisation effort of the government should be a driving force towards adoption of worldwide standard in product specification. The Standards Organisation of Nigeria and NNPC should change the current lead in gasoline standard of 0.45 gm Pb/l to 0.15 gm Pb/l in 2002 and Lead free from year 2003 onwards.
- There is the need to develop public enlightenment campaign and capacity building on improved air quality with active collaboration of WHO, USEPA, UNEPA, relevant NGO s, private sector concerns and Government outfits. A publicity sub-committee to design and implement a publicity campaign should be formed by the Ministries of Environment and Health and NAC.
- The political will of the newly inaugurated African Union should be solicited with a view to endorsing lead phase out and the harmonisation of standards and technical specification of gasoline in Africa. The Federal Ministries of Foreign Affairs and Integration and Cooperation in Africa should take this up.
- The Department of Petroleum Resources and NNPC should ensure that all new refineries must be configured to produce only unleaded gasoline.
- NNPC should ensure that all gasoline imported into the country would continue to be lead free.
- Efforts should be made by NNPC to maintain the current gasoline lead content of 0.2 g Pb/l, 0.15 g Pb/l by end of the year 2002 and zero level in the year 2004.

- NNPC should be assisted and encouraged to upgrade the existing refineries to enable production of unleaded gasoline at an estimated cost of about $500 million. The Federal Government should accept these modifications and upgrading into the rolling plan of NNPC priority projects.

- NNPC should consider maintaining the existing single distribution system with the allowance of a few months made to flush out lead when the fuel supply becomes unleaded.

- The National Universities Commission, the Federal Ministry of Science and Technology should boost the R&D efforts of the Universities and other related institutions in Nigeria with a view to proffering solutions to reducing associated sources of air pollutants like CO, CO2, NOX, SOX, Aldehydes and Arsenic.

- The Federal Ministry of Environment, the Standards Organisation of Nigeria and other affected agencies should formulate vehicle exhaust emission standards and a programme for its implementation, with a definite target for the installation of catalytic converter on the exhaust of all vehicles.

- The Federal and states Ministries of Health should conduct a national survey of blood lead levels preferably combined with nutritional assessment. This will allow a baseline to be established to which subsequent monitoring studies can be compared.

- The Federal Ministries of Environment and Health should address other sources of lead intake by the general population such as lead in auto and home paints, water supplies and food containers, with a view to reducing the quantities involved.

3.0 AGENDA

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Thursday, November 15, 2001

Time	Topic/Sub-Topics	Speakers
10.00-10.30	**1. Opening Ceremony** • Chairman's opening remarks by **Engr J. J. Enemari,** Federal Ministry of Environment • Address by **Mr Kerry Wark**, Exxon Mobil Regional Director, Fuels Marketing, Africa and Middle East • Address by **Mr Richard Hawkins**, Regional Environmental Officer for West and Central Africa, USA Department of State • Keynote Address by **Engr S. Kupolukum**, the Special Assistant to the President on Petroleum • Opening Address by the Special Guest of Honour, **Chief Kolawole Jamodu**, the Honourable Minister of Industry	
10.30-11.00	*Coffee Break*	
11.00-11.05	**2. Introduction of the Chairman of Session I** • **Engr Mansur Ahmed**, Executive Director, Refinery and Petrochemicals, NNPC	
11.05-11.15	**3. Conference Framework** • Conference objectives and expected output	Engr Aminu Jalal (National Automotive Council)
11.15-12.00	**4. Leaded Gasoline and Human Health** • Sources of environmental lead levels in Nigeria • High blood lead levels in the general Nigerian population: causes and implications	Engr (Mrs) J. Maduka (Friends of the Environment) Dr John I. Anetor (University of Ibadan)
12.00-12.45	**5. Discussion on Papers Presented in Session I**	
12.45-13.45	*Lunch*	
13.45-13.50	**6. Introduction of the Chairman of Session II** • **Mr John Pototsky**, Chairman/Managing Director, Mobil Oil Nigeria Plc.	
13.50-14.35	**7. Lead Phase-Out in Gasoline and Fuel Distribution Systems** • Phase-out of leaded gasoline in other countries • Feasibility of using current fuel distribution system with a transition time to allow the lead to be flushed out	World Bank (Presented by Engr Aminu Jalal, NAC) Mr Henry Ikem Obih (ExxonMobil)
14.35-15.05	**8. Discussion on Papers Presented in Session II**	

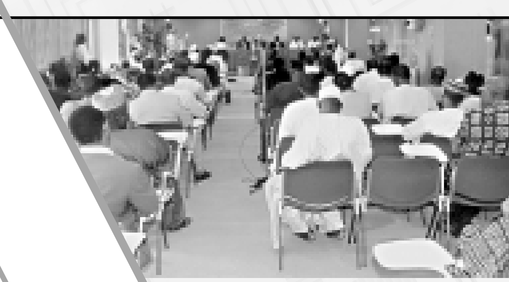
Thursday, November 15, 2001 (continued)

15.05-15.10	**9. Introduction of the Chairman of the Session III** • **Mr Matthew Adegbite,** Manager, Business Planning and Analysis (Fuels), Mobil Oil Nigeria plc.	
15.10-15.40	**10. Leaded Gasoline and Vehicles** • Effects of unleaded gasoline in vehicles • Vehicle emissions	Mr Daniel Wintenberger, (Peugeot Automobile Nigeria Ltd.) Engr J. J. Enemari (Federal Ministry of Environment)
15.40-16.10	**11. Discussion on Papers Presented in Session III**	
16.10-16.20	**12. Report of the Day's Conclusions**	Rapporteurs

Friday, November 16, 2001

9.00-9.05	**13. Introduction of the Chairman of Session IV** • **Mr Richard Hawkins,** Regional Environmental Officer for West and Central Africa, USA Department of State	
9.05-10.00	**14. Lead Phase-out in Gasoline in Nigeria** • Modification of Nigerian refineries to produce gasoline with 0.2gmPb/l and later unleaded fuel	Engr Gius Obaseki, (Nigerian National Petroleum Corporation)
10.00-10.45	**15. Discussion on Papers Presented in Session IV**	
10.45-11.15	*Coffee Break*	
11.15-11.45	**16. Closing Ceremony** • Chaired by **Dr Ojo Maduekwe**, Honourable Minister of Transport • Nigerian Action Plan for Lead Phase-Out in Gasoline	Rapporteur-General: Alh A.M. O Muse (Nigerian National Petroleum Corporation)
11.45-12.30	*Lunch*	

4.0 PRESENTATIONS



4.1 OPENING ADDRESS

Chief Kolawole Jamodu
Honourable Minister of Industry

It gives me great pleasure to address you this morning at this important conference on the Phase-out of Leaded Gasoline in Nigeria. This invitation could not have come at a better time considering the fact that the Petroleum Industry in Nigeria has undergone significant changes since oil was discovered in commercial quantity more than four decades ago. The sector has become the mainstay of the Nigerian economy, and thus determining the collectable revenues of Government and the general economic development of the country.

We are all aware that for the sustainability of the sub-sector, it has been the policy of Government to put in place adequate facilities particularly in the downstream sector of refining, distribution and marketing of petroleum products. Information available to us confirms that Nigeria s refineries with total production of 445,000 barrels per day to meet domestic consumption estimated at 400,000b/d leaves a spare capacity of 45,000 for exports. In this circumstance, Government has no alternative but to adopt importation of refined petroleum products to bridge only the shortfall in internal refining capacity of our refineries because they are operating at below installed capacities. Incidentally, the locally produced gasoline, has lead additives which is a neurotoxin added to gasoline to improve its anti-knock characteristic.

In recent years, studies have shown the harmful effects of lead in gasoline and the need for its phase -out and ultimately its total elimination.

One major effect of lead pollutants in the atmosphere is its negative impact on our learning capacities and generally on the good health of the society. In fact, it has been demonstrated that lead lowers Intelligent Quotients (IQs), hearing and growth facilities particularly in children, increases blood pressure, and induces hypertension and cancer in adults. In addition, lead released through industrial processes, wastewater discharge, paints and exhaust form vehicles have negatively impact on the ecosystem causing serious damage to the environment. The clarion call for the elimination of lead from petroleum products in Nigeria is therefore hinged mostly on the health hazards induced by leaded gasoline present in the environment.

The harmful effects of leaded gasoline on human health on children and adults alike was a major item of discussion at the 13th meeting of the National Council on Industry (NCI) held at Makurdi from 26th to 27th July 2001. In the communiqu of that meeting, the National Council on Industry (NCI) noted the danger inherent in leaded gasoline and its hazardous effects on human health and recommended that the attention of the Federal Ministries of Petroleum Resources, Health and Environment as well as the Nigerian National Petroleum Corporation, should be drawn to it with a view to raising a memo to the Federal Executive Council on the matter . I believe that this Conference therefore will provide a good opportunity for further discussions on and the need for the implementation of the NCI decision in this regard.

The Regional Conference on the Phase-out of leaded gasoline in sub-Saharan Africa organized by the World Bank Clean-Air-Initiative recommended to governments, among other things, the reduction of lead content in gasoline from its current level of 0.6gm/ltr to 0.2gm/ltr by 2002 and the elimination of lead in gasoline in the foreseeable future. The reduction of lead content in gasoline requires pragmatic and systematic planning involving major stakeholders and key agencies of government as it involves re-engineering of our downstream industries. I therefore plead with all government agencies, major stakeholders and relevant organizations to join efforts to accelerate the formulation and implementation of programmes to completely phase out laded gasoline in Nigeria in the very near future. In addition, the country should encourage oil supply chain operators to improve their production, storage and distribution facilities in accordance with target lead phase-out time frame.

Further, the World Bank and other international donor agencies should be requested to give high priority to lead phase-out in economic policy dialogue and also, support required technical assistance programmes and direct financing of viable investment in that direction. The OAU and other regional organizations such as ECOWAS, USAID, and UNEP should practically endorse phasing out of leaded gasoline and make meaningful contributions to the harmonization of standards and technical specification for the production of lead-free gasoline.

The phasing out of lead content in gasoline of course, has its attendant costs in view of the re-engineering of existing facilities, in particular, the refineries to meet desired standards and technical specifications. However, the aggregate cost of conversion of existing refineries to produce lead-free gasoline is quite insignificant to the enormous penalty of lead induced health

There is also the need to join issues on evolving other substitute or alternative sources of energy such as natural gas, and liquefied petroleum gas (LPG) in view of the increasing concern for the environment and also with regards to its relative cleanliness, cheapness and abundance in Nigeria.

In conclusion, Distinguished Ladies and Gentlemen, I have shown that a lot is already in place in terms of the political will required for the phase-out of leaded gasoline in Nigeria. What is now required is the detailed approach which I believe will evolve from this Conference. Let us therefore give a strong and an unqualified support to the organizers and sponsors of this Conference. While I wish you fruitful deliberations, I now declare the Conference open.

God bless you.

4.2 KEYNOTE ADDRESS

Engr S. Kupolukum
Special Assistant to the President on Petroleum

It is my great pleasure to address this conference on phasing-out leaded gasoline in Nigeria.

There are several pathways by which lead is ingested by the population. But the major pathway is airborne lead, which is mostly produced by vehicles using leaded gasoline. Although the vehicle population in Nigeria is not large, about one million, it is concentrated in the major urban areas. The Harmful effects of lead on the population in our urban areas may therefore be considerable and would get worse with increased urbanization unless urgent steps are taken to eliminate lead in our gasoline supply.

The Nigerian National Petroleum Corporation (NNPC) is already aware of this problem and has started to eliminate lead in our gasoline. The two refineries in Port-Harcourt have been modified to produce only unleaded gasoline. The distribution system associated with them is also lead-free. In other words, the eastern part of the country is already lead-free.

The two other refineries in Kaduna and Warri already have the capability to produce unleaded gasoline, but would need modifications to be produce 100% unleaded gasoline. During this conference, officials of the NNPC would present to you the technical and financial requirement needed to modify these two refineries. The Pipelines and Products Marketing Company (PPMC) would also present the financial and other implications in the importation of unleaded gasoline. These submissions would assist you to formulate your action plan to leiminate lead in our gasoline supply.

This action plan, we hope and believe, would be approved by government. The NNPC on its part would do its best to ensure lead is taken out of our gasoline supply, thereby eliminating its adverse health impact on our population.

I would like to use this opportunity to express our thanks to the World Bank for its role in drawing our attention on the harmful effect of leaded gasoline and the need for its elimination and the sponsors of this conference, especially the Nigerian National Petroleum Corporation, ExxonMobil, the United States National Safety Council and Environmental Protection Agency.

Finally, I wish to thank the planning Committee of this Conference for their efforts and commitment.

I wish you fruitful deliberations and God's blessing.

4.3 ADDRESS

Kerry Wark
ExxonMobil Regional Director
Fuels Marketing, Africa and Middle East

I appreciate the opportunity to address this conference on the Phase-out of Leaded Gasoline in Nigeria and Neighbouring countries. It is a pleasure to share this opening session with the Honourable Ministers of Environment, Industry, and Presidential Advisor on Petroleum and Energy.

I represent the International Petroleum Industry Environmental Conservation Association, or IPIECA, and my company, ExxonMobil Corporation. My message is simple — we stand ready to do our part in the effort to phase-out Leaded Gasoline from our fuels distribution chains.

Let me start with defining both organisations, then I will explain why this issue is important to us, and finally, discuss the specific role the oil industry can play to facilitate the phase-out of leaded gasoline in your respective countries. First, who is IPIECA? IPIECA is comprised of many private and state owned oil companies, as well as various national, regional and international trade associations. IPIECA holds formal United Nations consultative status as a Non-Governmental Organisation. Its prime aim is to help members address long-term global environmental challenges, facilitating discussion/information exchange.

ExxonMobil is better known in this part of Africa as Mobil. We hold significant investments in Africa, and share the desire of your governments to see your economies grow and its people prosper. With a workforce in excess of 4,000 employees, we market fuels and lubes in about 40 African countries, including Nigeria, Togo, Benin, Chad and Niger, and carry out Oil & Gas production activities in a number of these countries. We are also partners in 4 refineries in the Region (memo: Gabon 11.7%; Senegal 11.8%; Cameroon 8%; and Cote d Ivoire 8%).

So, why is this issue important to us?

In 1999 two oil companies, Exxon and Mobil decided to merge to form ExxonMobil, my company. Each of those companies had been working the Lead Phase-out issue for years in various parts of the world. A key step in the early part of the merger planning process was to define the values we would share as a combined company and adopt a firm set of Standards of Business Conduct governing all aspects of our operations.

When we looked at our combined operations in relation to these standards, we identified leaded gasoline as a product that was inconsistent with our values. As a result, we redoubled our Leaded Gasoline Phase-out efforts through IPIECA and joined in partnership with the World Bank who had a similar effort underway.

The Petroleum industry position on this issue is represented in the following statement adopted by all IPIECA members: IPIECA members encourage governments in countries still using leaded gasoline to develop lead phase-out action plans and finally mandate the elimination of lead as an additive. We recognize that affordable energy supplies are just one of many other issues critical to the health and public welfare of people, particularly in countries of the developing world. We understand that each country must set their own priorities and timetables on these issues. Therefore, we intend to approach lead phase-out constructively by working with governments, car manufacturers and others to address the economic, political, and supply barriers to quick action .

"Why don't we want to sell Leaded Gasoline?"

Two reasons: First, using leaded gasoline perpetuates air pollution form motor vehicles because it harms catalytic converters and prevents their broader use. Modern vehicles fitted with catalytic converters are 98% less polluting than they were 35 years ago. These benefits could be available to Africa over time by bringing both new and previously owned catalyst equipped vehicles into the vehicle fleet — but not until lead is removed from gasoline.

Second, numerous scientific studies show that exposure to lead presents health concerns, particularly in children.

For these two reasons, we are focusing our energies on encouraging countries still using Leaded Gasoline to phase it out in the shortest possible time.

Since IPIECA began actively working this issue, momentum has been building around the world to phase-out Leaded Gasoline. This year, several countries in Africa and the Middle East set timelines for the elimination of Lead in Gasoline — Saudi Arabia, Kuwait, Oman and Mauritius--have decided to phase-out Leaded Gasoline in their domestic markets. We are excited to see this momentum building and want to help it along.

The oil industry can play a key role in facilitating lead phase-out in your respective countries.

First, I believe this process can proceed most effectively if there is a partnership between government, industry, and the development banks. One company cannot do this alone, and even all the IPIECA members working together cannot do this alone. There are many other local and state owned companies involved in the refining, importing, and marketing of Leaded Gasoline in Africa that must also be part of the solution.

We all recognize, each government will set standards for lead in Gasoline in its markets, and enforce those standards. Government officials in each country are responsible to make the difficult decision on how to prioritise the lead phase-out problem versus other problems, to allocate available resources, and to set time frames for implementing solutions.

The first Sub-Saharan Conference on Leaded Gasoline Phase-out was held in Dakar, Senegal in June this year. The conference was a success and set the pace for concerted effort by all governments to achieve the objective of Leaded Gasoline Phase-out by 2005. Many countries have committed to this timetable and Mauritius has gone a step further by revising its timetable to August 2002. This conference is a follow-up to the Dakar Conference and the various action plans adopted in Dakar. I have no doubt; this event will mark the beginning of the process to eliminate lead from Gasoline in Nigeria.

Industry can play a key role in this process and we would like to be partners in this effort. We can offer advice on HOW best to achieve the lead phase-out goals set by your governments. We can lay out range of refining and supply options, provide cost data, show the impact of using various fuels on the vehicle population, and show the impact of fuel changes on local air quality. Such advice from our industry can help streamline the phase-out process, minimize supply disruptions to the marketplace, minimize costs to citizens, and improve air quality.

Before I close, I want to convey my apologies that I will not be able to stay for the entire duration of this conference due to other engagements. However, several of my ExxonMobil colleagues will continue to participate including John Pototsky, and Henry Obih who will speak this afternoon on Fuel Distribution and Logistics.

We also have an important opportunity here at this conference that is worth seizing. We have the oil industry, Car Manufacturers, Research Institutes and the NGO community poised to work with Government Ministers and officials to develop action plans to phase-out leaded gasoline in this part of Africa.

This is an opportunity to take an important step towards improving the quality of air and life of the citizens of your countries. I encourage you to take advantage of this opportunity and begin laying the groundwork that will result in cleaner air, lower health care costs, and most important, healthier and more productive citizens. The international petroleum industry stands ready to do its part to help make this happen.

In closing I would like to commend the Conference organizers for making this happen. On behalf of my IPIECA colleagues, I want to say that we are looking forward to working with all of you in the months ahead to move this initiative along.

Thank you.

4.4 ADDRESS

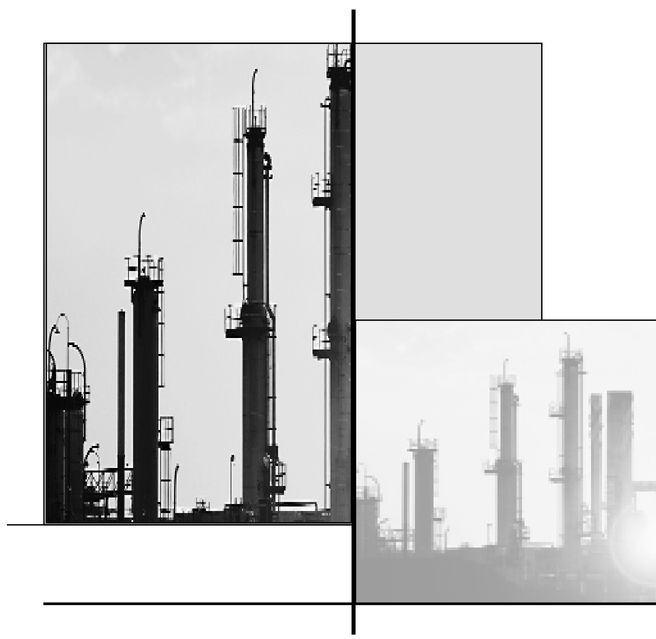
Richard S. D. Hawkins
Regional Environmental Officer for West and Central Africa,
United States Department of State:

Lead Poisoning-A Major Threat Domestically And Internationally

Thank you for this opportunity to discuss the issue of lead. Events like this provide a valuable forum for exchanging views and sharing information and experiences regarding important environmental threats such as lead and to unify our actions to combat such threats. In 1994, at the U.S. Environmental Protection Agency s (USEPA) initiative, the Commission on Sustainable Development identified lead in gasoline as a major area for concern. At that time, USEPA, The World Bank and other international entities called for a global phase out of lead in gasoline. Since then, the elimination of lead in the domestic and international environment has been a priority for many of us.

The call for protecting the world s children from the risk of lead poisoning has been very effective. The number of resolutions from international for a calling for phase out of leaded gasoline since 1994 has been impressive. From the Summit of the Americas to the OECD, from Habitat II to APEC and the World Bank, the role of lead and its negative impacts on human, particularly children s health has been recognised. It is USEPA s experience, however, that these high level resolutions have not halted the use of lead additives in many parts of the world and millions of children are still facing a lifetime of disabilities caused by early exposure to lead. Despite their greater awareness of the significant public health risk posed by leaded gasoline, many countries lack the institutional, technical and programmatic capacity to address this problem. So the battle goes on.

The World Bank reports that in some developing countries, all urban children under 2 years of age, and more than 80 percent of those between the ages of 3 and 5, are suspected to have blood lead levels exceeding WHO health standards. It is estimated that between 15 and 18 million children in these countries may suffer permanent brain damaged due to lead poisoning.



Children are particularly vulnerable to lead poisoning. Their exposure to lead is greater, considering their body size. If lead is volatilised, children breathe it in -- and they breathe more air for their body size than do adults. If lead is in the drinking water or food, children ingest it — and they drink and eat more than adults for their body size. Children s behaviour causes them to be exposed in ways that adults are not exposed. They put their hands, toys and other things in their mouths often after crawling on the ground and playing in the dirt, and so, if those things are contaminated with lead, a child s chances of exposure are magnified.

Not only are children at greater risk to exposure, they are also affected more severely by lead than are adults due to the unique susceptibility of their immature developing organs to damage. Science has shown us that children absorb lead at a much greater rate than adults and that, even at very low levels of lead exposure, unborn and young children can suffer metabolic and developmental effects. Lead causes devastating and irreversible neurological damage to children, leading to learning disabilities, lower levels of intelligence, behavioural problems growth impairment, permanent visual and hearing impairment and other damage to the brain and nervous system. Exposures at high doses of lead can lead to coma, convulsions and death.

The United State has been successful in reducing lead from gasoline for the last 20 years. The U.S experience shows that lead risk reduction measures can dramatically lower children s blood lead levels --- from 1976 to 1993, the percentage of U.S. children ages 1 to 5 with blood lead levels higher than acceptable levels decreased from 88 percent to about 4 percent. This decline in blood lead levels correlated with the decline in the use of leaded gasoline over the same period. But even in the U.S we have not completely eradicated this terrible disease. In addition, the U.S. experience shows that the health benefits and vehicle maintenance benefits from eliminating lead in gasoline significantly outweigh the costs of the required technical modifications.

Eliminating lead in gasoline has other very important benefits. Because even a minute amount of lead will destroy a catalytic converter, lead must be eliminated before emissions control measures can be effective. Thus, phasing out lead is the first step in any comprehensive vehicle emissions control program, so important to public health. It will also facilitate the evolution of vehicle fleets to more advanced automobiles.

While the U.S Centre for Disease Control reports that lead poisoning in children in our country continues a steady decline, there are still more than a million kids less than six years of age (mostly poor, urban children) who suffer from this awful condition. Thus, USEPA continues to work toward reducing lead exposure from paint, food containers, drinking water systems, and other sources.

We congratulate the World Bank and IPIECA (International Petroleum Industry Environmental Conservation Association) for their sponsorship on the Dakar Conference on the Phasing Out Lead in Gasoline in Sub-Saharan Africa, and we feel that today's meeting is a critical step in realizing the goals of the Declaration of Dakar.

Recently, USEPA developed a Decision-Makers Guide to Phasing Lead Out of Gasoline . This guidebook provides a step-by-step approach for transitional and developing countries to generate and implement national action plans for the phase out of lead in gasoline. The target audience for this document includes national and local government officials, industry leaders and representatives from environmental NGOs. Participants at the Dakar Conference received this guide, and it can be obtained directly from the USEPA.

The US applauds the Nigerian Government today in their efforts to bring to an end the ravages of this dreadful disease that is lead poisoning. We urge all government agencies represented here to support the important decision to take the lead out of gasoline. We urge all participants to redouble their efforts to reach this important objective within an agreed timeframe. Those most vulnerable among us, our children, must be safe from the risk posed by lead.

4.5 CONFERENCE OBJECTIVES

Engr Aminu Jalal
Director of Policy and Planning
National Automotive Council

INTRODUCTION

Air pollution is largely caused by industry, transport equipment and wood fires (used mostly for cooking in rural areas). In Nigeria, transport equipment is responsible for much of the urban air pollution due to the low level of industrialisation. These pollutants are mostly carbon monoxide (CO), carbon dioxide (CO2), lead (Pb), nitrogen dioxide (NO2), hydrocarbons (HC), sulphur dioxide (SO2), and particulate matter (PM). Though total vehicle per capital is low, available vehicles tend to be concentrated in our urban areas. Of the approximately 1 million vehicles plying our roads, 40% are concentrated in Lagos and environs. Various studies have shown that urban air pollution caused by vehicles is already affecting the health of our urban residents.

The best method of reducing pollutants from vehicle exhaust is by the use of catalytic converters. But lead destroys catalytic converters and therefore need to be eliminated from gasoline for catalytic converters to work. Lead itself is toxic to humans, which ought to be eliminated from gasoline as such. The major source of human lead accumulation in developing countries was found to be airborne lead, 90% of which came from leaded gasoline.

The problems associated with leaded gasoline is the reason many countries reduced the amount of lead in their gasoline from the 1970s onwards and eliminated it in the 1980s. North America, Europe and Japan now use unleaded fuel. Many countries in Asia, Latin America etc. are gradually phasing out lead in petrol. Sub-Saharan Africa is the major exception. Currently, 62 countries that consume 80% of the global gasoline output use unleaded fuel.

CLEAN AIR INITIATIVE IN SUB-SAHARAN AFRICAN CITIES

The World Bank therefore launched the clean Air Initiative in Sub-Saharan African Cities in 1998. The Clean Air Initiative aims to address the problems of air pollution, particularly from vehicles still using leaded gasoline by:

Raising awareness among decision makers and public authorities of the effects of air pollution on health, the environment and productivity.

Identifying corrective measures for fuel, emissions and traffic to reduce air pollution.

Designing, implementing and monitoring action plans to reduce air pollution at the sub-regional and regional levels.

The Initiative formally launched the lead phase-out programme in the Sub-Saharan Africa with a conference held at Dakar, Senegal, during June 26-28, 2001. The objectives of the conference were to:

Raise awareness about the health impacts of leaded gasoline and build consensus among the main stakeholders on the technical, regulatory, institutional, economic issues and the priorities for implementing lead phase-out programmes.

Develop action plans to phase-out leaded gasoline with a timetable and monitoring indicators.

The key result of the conference was the formulation of a Declaration, agreed to by all parties, which states that leaded gasoline will be completely phased-out in all Sub-Saharan countries as soon as possible, and by 2005 at the latest.

THE CONFERENCE ON THE PHASE-OUT OF LEADED GASOLINE IN NIGERIA.

As a result of the above, a committee was formed to plan for a conference on the phase-out of leaded gasoline in Nigeria. The Federal Ministries of Environment, Transport, Science and Technology and Health, the Nigerian National Petroleum Corporation and the National Automotive Council formed the committee. The committee also includes a Non-Governmental Organisation, the Friends of the Environment. This committee planned the conference with the following objectives to:

Enlighten all the stakeholders on the toxic effects of lead in gasoline.

Obtain information on all aspects of lead in gasoline and its elimination.

Work out an action plan for the phase-out of lead in gasoline in Nigeria.

The papers to be presented, the discussions that will follow and both the pre- and post conference publicity, would it is hoped, achieve the objectives above. The action plan for the phase-out of leaded gasoline that would be developed here would be presented to government for its consideration, approval and implementation.

I wish to thank all the participants present here for the interest they show in this subject matter and wish us all a very fruitful conference.

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SOURCES OF ENVIRONMENTAL LEAD LEVELS IN NIGERIA

Engr. J.O. Maduka
Chairperson, Friends of the Environment (FOTE)

1. INTRODUCTION

Undoubtedly, our world is facing an extremely serious situation with respect to the global environment. The 1990s were described as the critical decade for ensuring planetary survival; with the way things are going, I believe this still very much applies to our situation in this new millennium. Global concern over phasing out of LEAD in gasoline is growing daily due to their health implications and it is indeed heartwarming that multilateral institutions like the World Bank is championing this noble cause in Sub Saharan Africa.

This conference is a major milestone on our journey to the Phasing out of LEADED Gasoline in Nigeria.

2. SOURCES AND PATHWAYS OF LEAD IN OUR ENVIRONMENT

LEAD is a useful and widely used material. Nigerians are exposed to lead from sources such as older paint, industrial emissions, petrol and lower level sources including fertilizers and building materials. See Figure I (The outer shaded area). While the Pathways (outer white ring) (Figure I) such as dust, soil and air act as media for the transfer of LEAD from these sources into living environments, where they are primarily inhaled, ingested and, in some cases, absorbed through the skin. Multiple sources of LEAD contribute varying amounts of LEAD to the environment, while some sources contribute more LEAD than others (especially older paint), combined, multiple low-level inputs can result in a significant aggregate exposure and a range of health effects.

3. PATHWAYS OF EXPOSURE TO LEAD

Food

Food is a principal source of LEAD intakes. LEAD in food is derivable mainly in form of soil, sea food especially fishes from contaminated water, dried deposition onto plant foliage and vegetables, rainfall, irrigation water and food processing and packaging. While some crops can take up LEAD, the roots usually contain more LEAD than the stems, leaves and fruits. However, surface contamination by LEAD in soil is considered a greater problem. Crops close to heavily trafficked roads or industrial sources can accumulate atmospheric LEAD deposits on stems and foliage. Crops grown in backyards gardens near former LEAD industries or previously demolished LEAD painted buildings can also contain high levels.

LEAD is present in some food preparation and serving utensils such as cooking pots, pewter vessels, chinawares and others, from which it can leach over a period of time. This is particularly true of older ceramics and pottery from countries like Mexico, Central America, Portugal, and China.

Leaching of LEAD is a particular problem when the utensil is used for serving or storing acidic foods or beverages. Some of these utensils, such as LEAD crystal decanters or wine glasses have been found to contain up to 36% lead which has leached out when tested. Though unlikely sources of exposures for small children, they may present a special hazard for women of childbearing age and other adults.

The issue of imported canned food into the country is also of great concern as most of these products could still be using the LEAD based can soldering technologies, instead of welded can technology for sealing food containers. Since some of these imported cans are LEAD soldered, it is important that if storing acidic foods (such as tomatoes or pineapple), once opened, they should not be left stored in these cans as this may further increase LEAD leaching from the seams.

Soil

In Nature, the amount of LEAD in the earth s crust varies from 8ppm in basic rocks to 20ppm in acidic rocks with an average estimated to be about 16ppm. The water that flows through them is contaminated with LEAD. The yearly contribution of LEAD to man through air is 15mg, water 5mg, and 100mg from food. As far as Nigeria is concerned I have not seen any published data on the relative abundance of LEAD in these media. Apart from several unique geological areas where natural LEAD levels in soil may be elevated, the natural background level of LEAD in the country is comparable to worldwide background levels of 10 to 70 mg/kg. Although there are variations from the values obtained from different parts of the countries, soil may become contaminated through historical industries, historical or contemporary uses of LEAD or current unsafe LEAD management practices. Since LEAD does not dissipate, biodegrade or decay, LEAD pollution deposited into soil and dust remains a potential source of LEAD exposure.

There is an urgent need therefore for the Federal Ministry of Environment to work with non-governmental organisations and scientists in the country, to come up with guidelines on LEAD standards for our residential sites, parks, recreational open space and playing fields, including secondary schools and for commercial and industrial sites, as its obtainable in other countries of the world.

Water

The major source of LEAD in domestic drinking water is the corrosion of LEADED plumbing materials in the water supply and household distribution systems. In Nigeria, leaded pipelines for distribution of drinking water is still a very common site. This serves as a major source of contamination, although, there are several factors affect the extent of LEAD contamination from a particular water delivery system. They include:

- Corrosiveness of the water (pH, alkalinity and mineral content),
- Age of LEAD-soldered joints and other lead components (the newer ones pose a higher risk),
- Quantity and surface areas of LEAD materials
- Standing time and temperature of water in contact with LEADED surfaces.

It is important to note that the First draw water taken from the pipes, particularly hot water, after standing unused (e.g. first thing in morning) may pose a hazard in homes with LEAD piping or solder, brass fixtures or fittings, PVC piping or where home-repair with LEAD solder occurred.

Researchers have estimated that an average of 0.53 gm LEAD (about 20% the total in gasoline) was put into water by a gallon of gasoline burnt by a motorboat. LEAD up to the concentration of 100 ug/litre has been detected in run-off waters, and certain other river waters. Small amounts of LEAD in water are contributed by the painting of water storage tanks because the paints usually contain LEAD-chromate.

Dust

LEAD dust is perhaps the least understood and most insidious factor in young children s total LEAD exposures. As interior or exterior LEAD paint ages, it chalks into a fine dust of very small particles. Households contain this fine dust as well as LEAD particles from previous renovation activities, petrol and industrial emissions accumulated in soil and street dust tracked in by residents and pets. Ceilings, wall voids and floor spaces as well as other housing cavities may contain LEAD dust. LEAD-bearing household dust can contaminate soft furnishings (e.g. carpets, lounges, curtains), particularly if not removed or well covered with plastic and taped up during renovation activities.

4. INDUSTRIAL SOURCES OF LEAD

Because LEAD is cheap and useful and has unique chemical properties, it is found in many common consumer products and many places in the environment. LEAD from these many different sources can enter and contaminate your home and surroundings. There are a number of potential sources of LEAD in Nigeria — here are just a few:

Lead Industries, Mining and Smelting

These activities lead to the production of air and dust emissions and other forms of LEAD pollution include scrap metal recovery operations, battery manufacture and recycling, incineration (including cremation), metal foundries and fabrication, electrical appliance, plastics and cable manufacture, metal plating, and pigment and dye manufacture.

Petrol: Lead in Gasoline

One of the most common sights in our big cities in Nigeria are highways congested with vehicles and motorcycles on a sunny afternoon, with smoke billowing from most of the ill-tuned and/or mechanically defective vehicles. Another sight is a typical service station or mechanic workshop with attendants and workers in overalls reeking of petrol, diesel and engine oil, sucking petrol with their mouths to service carburetors, etc. Worse still is the sight of women burning cowhide with engine oil to be sold for human consumption. Whilst the aforementioned examples demonstrate those who work directly with petrol, diesel oil and engine oil, there are many passive sufferers of LEAD Poisoning who breathe in exhaust smoke, either in the traffic or those who live near highways.

It is common knowledge that Nigeria refineries used to produce mostly LEADED fuels and about 70 80% of this is emitted as fine LEAD particles. Although, the Kaduna and Warri refineries now produce gasoline with LEAD levels of only 0.2gm Pb/l and 0.15 gm Pb/l respectively. This is of course in line with the Nigerian National Petroleum Corporation (NNPC) s plans to phase out LEAD completely by December 2002 and I believe we shall hear more about this before the end of this conference. The technology is currently available if the refineries are prepared to modify their production systems.

Catalytic converters can only work with LEAD free gasoline. As some of us are aware, newer models of vehicles being imported into Nigeria are already fitted with catalytic converters, but currently they serve no purpose as they are ruined as soon as LEADED gasoline is used in them.

The organic LEAD additives, tetraethyl and tetramethyl LEAD, were first introduced into petrol in the 1920s to enhance the octane value of gasoline which prevents knocking and lubricate engine valves. Since then, tetramethyl and mixed lead alkyls have also been added to fuels. The increasing number of cars and rising petrol consumption resulted in wide dissemination of LEAD in the environment since first introduced into petrol.

Of the 300 milligrams emitted to the air, 140 milligrams are emitted to the atmosphere as LEAD aerosol (very small particles with the potential for long-range transport and pollution, while 160 milligrams are emitted to the roadway as large particles resulting in localised pollution. The 10% of the LEAD remaining in lubricating oils and additional 15% on engine and exhaust parts can result in further LEAD emissions if burned for heat or cut apart during scrap metal recovery.

Inhalation of LEAD from LEADED petrol emissions is the main route of LEAD exposure for the general population and provides a generalised low dose to everyone. LEAD is not added to diesel fuel or jet fuel, but it is used in small propeller aircraft fuel.

Paint

Due to LEAD s unique properties, it has been used as a pigment and drying agent in primers, paints and enamels, inks, oils, resins and other surface coatings for centuries. To a great extent, there is no authoritative source regarding the extent of LEAD paint across the whole of the country. LEAD carbonate or white LEAD is especially used in white paints.

Piping, Fixture and Solder

The major source of LEAD in domestic drinking water is the corrosion of LEADED plumbing materials in the water supply and household distribution systems. Do-it-yourself (DIY) home repairers may still use LEAD solders, though current-joining materials used by professional plumbers contain no more than 0.1% LEAD. Water from LEAD-soldered water tanks or roof run-off systems painted with LEAD may also pose health risks though the extent of these systems in NSW is unclear.

Hobbies and Recreational Activities, which use Lead

People engaged in hobbies, which use LEAD, can accidentally expose themselves and others to hazards, particularly if done in the home. Fumes, dust or pieces of LEAD can contaminate the work area, home and immediate environment.

Hobbies that can expose the user or others to LEAD

LEAD HOBBIES	HAZARD
Antique furniture refinishing	Stripping old LEAD paint
Art conservation or restoration	Old LEAD paint
Automotive body or radiator repair and maintenance	Stripping old LEAD paint, using modern automotive LEAD paints, soldering, welding fumes, using LEADED petrol
Boat building, repair and maintenance	LEAD paint, soldering, fumes
Casting LEAD fishing sinkers, lead shot or LEAD or pewter toys	Fumes from melting LEAD ready to cast, handling LEAD)
Ceramics or pottery	Using LEAD paint and glazes
Electronics	Soldering fumes
Enamelling	Using LEAD paints and glazes
Glass blowing	Using LEAD glass paints
Home renovation	Disturbing old LEAD paint and LEAD contaminated dust, handling LEAD building materials)
Jewellery	Soldering and handling LEAD)
LEAD lighting	Soldering and handling LEAD, using LEAD glass paints)
Model making	Fumes from melting LEAD ready to cast, handling LEAD
Print making	Using LEAD inks
Shooting at indoor firing ranges	Combustion of firing, dust created by impact of bullets
Welding	Fumes when preparing/welding LEAD painted surfaces

FIGURE 2:
Hobbies that can expose the user or others to lead

5. CONCLUSION

It is a good thing that Nigeria is now beginning to appreciate the fact that Sustainable Industrial Development, like Sustainable economic progress, must be inseparably linked to a healthy environment. The full economic costs imposed upon the nation by illness, disability and premature deaths all of which may derive from detrimental effects of excessive presence of LEAD in the environment would be minimized through the improvement of our living environment.

There is no doubt that the relationship between wholesome environments, good health and economic growth can only be better appreciated if we view health as a prerequisite of balanced socio-economic development.

The continued use of LEAD and LEAD compounds in water pipes, paints, insecticides and herbicides etc. have devastating effects on human health, especially children. Therefore, there is need for LEAD to be completely phased out in Nigeria gasoline, Paint Industries, pipes for domestic water and solders used for water system delivery, insecticides and herbicides; irrespective of the cost since the disadvantages far outweigh the advantages.

Distinguished Ladies and Gentlemen, I thank you for listening and God bless.

FIGURE 1:

Lead sources and pollution pathways

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HIGH BLOOD LEVELS IN THE GENERAL NIGERIAN POPULATION: CAUSES AND IMPLICATIONS

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SUMMARY

Lead (Pb) is a highly toxic chemical with no known physiological benefits. There are no national surveys of blood lead levels in the general Nigerian population, Isolated studies on assessment of occupational exposure in which unexposed individuals were used as controls have largely been extrapolated to reflect levels in the general population. The data from such studies indicate that levels in the general Nigerian population are at least two to three fold levels found in countries that have either significantly reduced or totally eliminated lead in gasoline. Advances in science and medicine indicate that lead levels hitherto considered innocuous are associated with significant adverse health outcomes. Thus levels in the general Nigerian population compared with current levels in such countries are quite high, and given that the ideal blood lead level is zero as well as the wide spread deficiency of Micronutrients in this environment, which potentate the deleterious effects of such lead levels. The potential adverse health effects of these elevated BLLs are enormous.

It is therefore, high time the admonition of renowned environmentalists is heeded, that the lead content of Nigeria s gasoline be considerably reduced or eliminated completely with a pay off of a healthier environment reflected by low blood lead levels.

INTRODUCTION

Lead (Pb) is a non-essential trace element for man with a toxic potential for biological systems. Rieke (1969) described lead as a protoplasmic poison harmful to a variety of organs and tissues including smooth muscles and the red blood cell membrane. Damastra (1977) has described some of the currently well recognized pathological effects of lead on many physiological systems including those of the kidneys, nervous, haemopoietic (blood forming system), the immune (body defense system), reproductive and the endocrine systems.

Lead is widely used in many industrial and domestic activities. More has been written about the causation and symptommatology of poisoning by Pb than by any other toxic agent (Orfilia, 1817, Johnston, 1964). Despite the serious adverse health effects of Pb (Table 1) the excellent physico-chemical properties of Pb have endeared this invaluable industrial metal to many occupations (Landrigan 1987, Gots, 1993). Industrially, the most important lead compounds are lead oxide the basis of most paints and pigments and tetraethyl lead (TEL) (Zielhuis 1983, WHO, 1986). Tetraethyl lead is an anti-nock additive to gasoline, the environmental pollution and attendant health effects associated with it has been described as the mistake of the twentieth century (Shy, 1990)

History of Lead Toxicity

Since the age of metals began when man first learned to extract them from ores and work them, exposures to lead have vastly increased. Man was exposed to lead in Asia Minor 4500 years ago as a by-product of silver smelting. Because lead is an insidious and slow acting poison, man continued to use lead without suspecting toxicity. Only since about two centuries ago has he become aware of some of the extreme toxicological effects of lead and learned or is learning to avoid them.

The highest known exposures of human beings to lead before the age of petrol, probably occurred in ancient Rome. Lead amphorae stored syrups and Wines, lead pipes carried water to the house of the rich (When water was soft, it dissolved lead) lead cosmetics were used by the ladies. There is little doubt that lead poisoning was endemic among those who could afford such luxuries. Infact, Gilfillan (1965) believes that lead poisoning resulting in still birth, spontaneous abortions and sterility, was responsible for the low birth rate of the upper classes of the Roman empire which led to the ultimate fall of Rome. It is speculated currently that the accumulating evidence of a major decrease in sperm count in industrialized countries during the past 50 years is not unconnected with environmental factors of which Pb is a prime suspect (Carlsen et al 1992). There was little lead found in the bones of third century Monks but large amounts occurred in those of the eleventh to the nineteenth century. It is indisputable that even more will be found in the bones of our own generation. Indeed it has been pointed out that Africa s contribution to global lead pollution has increased from just 5% in 1980s to 20% as at 1996 (Nriagu 1989, Anony, 1996). There is no gain saying that Nigeria will contribute a disproportionate fraction to this increase for reasons that are clear, one being as a major global petrochemical producing nation.

Lead in Gasoline

Lead from gasoline combustion has been greatly reduced in the United States, with the introduction of unleaded gasoline (Savory & Wills 1992 Brody et al 1994, Pirkle et al 1994,). This has been accompanied by very Low blood lead levels (BLL) in the general American (non-occupationally exposed) population (Muldoon et al 1994, Brody et al 1994, Pirkle et al, 1994). The lead content of Nigeria s gasoline (petrol) is in contrast to current levels in most developed countries very high (Arah 1985, Osibanjo and Ajayi 1989).

Exposure in the General Population

The exposure of the general population to Pb occurs mainly through inhaled air and dust and also through water and food intake (Howanitz & Howanitz 1984) Emission from automobiles can account for as much as 50 fold increase in lead content in surface soil close to highly traveled roads (smith 1976, savory, 1989, savory and wills, 1992). This paper discusses the causes and implications of high blood lead levels in the general Nigerian population.

Environmental and Community Effects of Lead

Heavy metals including Pb contribute to the pollution of the environment and can harm human health. Brodie (1970) was one of the first environmentalists to warn about the danger of environmental pollutants. Schroeder (1976) described lead as one of the most abundant pollutant of the human environment and contaminant of the human body. Last (1987) has extended this by noting that there is a growing concern about the ill effects of environmental pollution, not only on human health but also on all living things. Lead also affects the food chain by being absorbed into crops which are ultimately consumed by humans (last 1987).

The neurotoxic effects of lead on the developing nervous system is well recognized. The most important of the neurological (brain) disorders associated with toxicity are mental retardation and learning and behavioral abnormalities (Solleretal 1977 Agency for Toxic Substances and Disease Registry (ATSDR 1988).

Although lead is emitted from a wide variety of natural and anthropogenic sources the dominant potential source in most African countries including Nigeria is automobile emissions (Nriagu et al, 1996). Although a substantive data base exists on lead as a toxic air borne pollutant few measurements have been undertaken in Nigeria owing to paucity of facilities. These few studies have however revealed disturbing blood lead levels in the general population (Anetor et al 1999, Anetor and Adeniyi 1999) Scientific and medical evidence accumulated during the past several decades (ATSDR, 1988, Needleman, 1992) suggest that environmental lead pollution from highly leaded gasoline sold on the African continent should elicit adverse health out comes particularly in children in Nigeria, one of the most rapidly industrializing countries in Africa.

Subclinical Toxicity

Current state of knowledge has revealed that at hitherto acceptable blood lead levels of 60 to 80ug (Goyer 1990 Graziano, 1994) harmful effects to health occur that are not evident during standard clinical examination (subclinical toxicity; metabolic plumbism). The underling premise is that there exists a range of toxic effects in which clinically apparent effects have their asymptomatic subclinical counterparts. These subclinical counterparts have come recently to be termed biological markers of toxicity (Goldstein et al, 1987). Thus clinically obvious manifestations of lead poisoning such as anaemia wrist drop, kidney failure are at the upper end of the range of toxic effects, while such covert effects as slowed nerve conduction, impaired early biochemical processes of blood formation and altered excretion of uric acid (the causative agent of gout) are their subclinical correlates (Mahaffey, 1985). It is important to note that these subclinical changes represent truly harmful out comes and are not merely homeostatic or physiological adjustments (Landrigan, 1989, 1991)

Blood Lead Levels

Human and animal exposure to lead from various sources can result in serious pathological consequences (Table 2) if the body content reaches a critical level, now thought to be determined by nutritional and metabolic factors (Granic et al 1978 Goyer, 1993, 1995, Anetor, and Adeniyi 2000 Anetor et al 2000). In humans, blood is the most common tissues sampled for lead analysis, and the medical literature relates the clinical features of lead toxicity to these blood lead levels. In many countries the blood lead level is taken as the main biological indicator of exposure irrespective of its limitation of possibly reflecting short term exposure (Kehoe, 1971 zielhuis, 1983; Delves, 1985, Wittmers etal, 1988). One of the advantages is that BLL increases uniformly over the whole range of slight (non-occupational)to intensive (occupational) exposure in contrast to various response parameters. (haem precursors and other biological markers) (Kehoe 1971; Zielhuis, 1983, Delves, 1985). Lead in blood is in dynamic equilibrium, which implies that with constant exposure it is relatively stable (Delves et al, 1984)

Good correlations have been observed in exposed children during 3-to-5- year gap between blood samples (Winneke et al, 1989). The concentration of lead in the blood has generally been regarded as the most important measure of hazard and for the prevention of lead toxicity in lead exposure (Kehoe, 1971).

Acceptable Blood Lead Levels

Between 1937 and 1941 Kehoe et al (1943) conducted a classical series of lead balance studies in normal human volunteers. From these studies it was believed that blood lead levels of 80ug/dl were inconsequential. Given our present knowledge of lead toxicity, one is shocked when reading the work of Kehoe et al (1943) documenting increases in blood and urine concentrations with PbB averaging 60ug/dl for years in some individuals. Those experiments however, provided the first crude descriptions of dose response relationships between exposure and BLL as well as bioavailability and kinetic behaviour of Pb in humans. There has been a shift toward blood lead level as the biomarkers of choice because all the major studies of pathologcal outcomes pregnancy disorders, cognitive function in children or kidney function in adults have included blood lead and all have reported adverse associations with blood lead level (Wassermann et al, 1992, Staessen et al, 1992 Grazino et al, 1994)

Progress in basic and clinical research has resulted in a better understanding of the cellular toxicity of lead. The new awareness has prompted the lowering of acceptable exposure as indicated by blood lead levels (Goyer 1990a). The current world Health organization (WHO) recommendation for acceptable blood Pb is that no more than 2% of the population should have blood lead above 20ug/dl (Wixson and Davies, 1994).

The continuous decline in blood lead level in countries that have either eliminated Pb in gasoline or reduced it considerably confirms the observation of Landrigan (1987) that the ideal whole blood level of Pb is zero. Shy (1990) and Harvey (1994) have also observed that Pb has no threshold limit.

Blood Lead Levels in the General Nigerian Population from Local Studies

There are no national surveys of blood lead levels in the general Nigerian population comparable to the second national health and nutrition examination survey (NHANES II) in the united states of American (Annest et al, 1983) and many other national surveys such as the one in Sweden (Ellinder et al 1984).

The blood lead levels in control subjects in studies designed purposely to evaluate lead toxicity in occupationally exposed individuals have largely been extrapolated to reflect levels in the general Nigerian population.

Various investigators had examined the problem of lead toxicity in Nigeria. (Sofoluwe et al, 1971; Asogwah; 1979; Ayoola 1979, Anetor et al 1999 Adeniyi and Anetor 1999). Due to lack of costly equipment needed for lead studies (Sofoluwe, 1971) Measured amino laevulinic acid in urine (an intermediate product in haem (blood formation) synthesis which accumulates due to inhibition of the biochemical pathway by lead). However, relying on facilities from outside the country Asogwah (1979) and Ayoola (1979) established lead levels in exposed and unexposed subjects. Asogwah studied 43 battery workers and 50 controls (unexposed subjects. He simply reported that 49 of his unexposed subjects had BLL below 40 ug/dl the upper limit of acceptable level in lead workers. He also observed that one of the unexposed population had a value between 40 and 50ug/dl. Ayoola (1979) drew attention to the difficulty of the diagnosis of lead toxicity and cautioned that with the rapid industrialization of Nigeria, doctors and other health professionals should be aware of the possible increase in the incidence of plumbism. Ayoola (1979) also noted the long term consequences even after cessation of exposure to lead.

In a series of studies conducted by Anetor and Adeniyi, 1999, Adeniyi and Anetor (1999) Anetor, Akinpelu and Adeniyi 2000 (Tables 3a & 3b) the Mean BLL in control subjects gives cause for concern. Recent reports (Landrigan 1987, shy 1990, Goyer 1993, Muldoon et al 1994, Harvey, 1994 Goyer 1993 and Kim et al, 1995) indicate that lead has no threshold value below which there is no adverse effect (harm). The ideal blood lead level is now considered to be zero (Landrigan, 1987). The mean levels of PbB was about two to three fold current levels in unexposed populations else where (Leung et al 1993, Brody et al 1994, Pirkle et al, 1994, Kim et al, 1995). Indeed these mean levels fall within the level currently considered to indicate Moderate Pb toxicity, 25 to 55ug/dl (Harvey, 1994). The lead levels in the studies however, compare favourably with the levels obtained prior to the reduction or elimination of Pb in gasoline in developed countries. The Centre for Disease Control (1978) gave criteria in which it defined blood Pb level of 30ug/dl in a child as the upper safe limit above which a child might be treated for undue exposure. Gregory and Mohan (1977) had earlier stated that for the normal child in the United States average Blood lead was above 27ug/dl. Zielhuis (1983) gave a reference range of 25-30 ug/dl.

In Europe, the European Economic Community (EEC) (now EU) set reference level in 1977 which stated that no more than 2% of any group should have a blood lead level greater than 35 ug/dl, no more than 5% should have a blood lead higher than 20 ug/dl (Smith, 1985). This implies a reference range of 20-35 ug/dl in the European Union (EU). Thus a BLL of between 27 and 30 ug/dl found in these studies at this time (mid 1970s to mid 1980s) Would have been considered within acceptable limit. Furthermore, in 1985, the U.S Department of Health and Human services defined lead toxicity and the level at which treatment should start at a blood lead level of 25ug/dl or greater. The foregoing indicates that about two decades ago the mean BLL in these studies could have been considered normal or marginally elevated and thus raises no concern.

While many factors may be responsible for the relatively high blood lead level in these studies such as high lead content in petrol, cigarette smoking, use of alcoholic beverages distilled in lead containing stills (Savory, 1989 Muldoon et al, 1994, Schwartz 1995) salt contaminated with Pb the contribution by a highly polluted environment due to the high lead content of Nigeria s gasoline is most probably more culpable.

In countries where petroleum that contains high Pb levels is still used atmospheric lead pollution from vehicular exhaust aerosols is a major source of lead pollution (U.S.EPA, 1977), Harrison and Laxen 1981, Ferguson, 1986). Additionally BLL has been reported to fall in the general population with decreasing Pb content of petrol (Pirkle et al, 1994, Brody et al, 1994, Gulson et al, 1995). Grobler et al (1992) reported a stepwise decrease in BLL with decrease in the Pb content of petrol in athletes. These investigators found that the reduction of petrol Pb level in South Africa from 0.8g/l to 0.4g/l was accompanied by a drop of BLL from 52 ug/dl to 13ug/dl. In Athens, a reduction of gasoline Pb from 0.4g/l to 0.22g/l was associated with a 24% reduction in blood lead levels of its inhabitants (Chartsias et al 1986). Thus the observation of shy (1990) that it was wrong to have added Pb to petrol appears apt.

It is thus conceivable that the lead content of Nigerian s petrol which is high (Arah 1985, Osibanjo and Ajayi, 1989) May largely be responsible for the high , BLL in the control subjects in these studies, reflecting the level in the general population. These studies support the observation of Okoye (1994) that there is serious lead contamination in Nigeria. According to Okoye (1994), this is no surprise in view of the high lead content of local automobile fuels. Thus lead in petrol is most probably responsible for the high BLL in the general Nigerian population. This state of affairs is undesirable especially given that current opinion has moved towards drastic reduction or total elimination of tetraethyl lead additives in automobile fuel.

Leaded Petrol and Environmental Health

The use of lead had been increasing particularly for the manufacture of leadalkyl for anti-nock agents in petrol until the weight of scientific and clinical evidence indicated the undisputed deleterious effects of widespread environmental Pb pollution from automobile emission. Concern has been expressed about the adverse effects of this on the general population (Waldron and Stofen, 1974 shy 1990, Savory and Wills 1992). The fall in BLL in countries that have either reduced or eliminated Pb in petrol is a proof of this.

Tetraethyl lead was introduced as an anti-nock in petrol in February 1923 in Daytona, Ohio in the United States (Kehoe et al 1923). It was later introduced in Britain during the 1930s, but TEL was not manufactured there until 1940 (Cassells and Dodds, 1946). It is note worthy that the quantity of lead in petrol in the United States and Great Britain in the early 1960s that raised much concern were 0.54g/l and 0.4g/l respectively (United States pubic Health service publication, 1965, Institute of petroleum, 1971) It is interesting to note that these levels are even lower than what currently obtains in Nigeria put as between 0.64 and o.70g/l about four decades later, (Arah 1985, Osibanjo and Ajayi 1989). Though Coal burning also contributes to atmospheric lead (Waldron and Stofen, 1974) present day environmental lead contamination appears to come principally from petrol (Waldron and Stofen, 1974, Nriagu et al, 1996). Lead poisoning is assuming what Hammrond, (1969) has called a new dimension, as earlier views have been re-examined and it is felt by an overwhelming majority that the current levels of Pb in the environment in the rapidly industrializing countries constitute a chronic danger to health (Anetor and Adeniyi, 2000). This may no w be only true of developing countries like Nigeria as most advanced countries have taken steps to reduce the lead content of petrol (Savory, 1989, Vahter and Slorach, 1990, Savory and wills 1992, Graziano 1994, Body et al, 1994, Pirkle et al, 1994).

One example of such countries is Sweden. In this country legislative Measures taken in 1987 lowered the maximum permissible level of the lead in petrol from 0.4 to 0.15g/l and in 1987 unleaded petrol was introduced. About eleven years ago only 30% of the petrol used in Sweden was leaded. (Vahter and Slorach,1990). This has largely been given as the reason for decrease in the exposure of the general population to lead. National survey of lead level in Stockwolm is currently 4.2ug/dl (Elinder et al, 1984) No similar survey has been conducted in Nigeria, isolated studies estimates this conservatively as about 28ug/dl (Anetor and Adeniyi, 1999, Adeniyi and Anetor, 1999, Anetor Akinpelu and Adeniyi 2000).

Schroeder, a renowned environmentalist over two and a half decades ago expressed concern about continuing lead accumulation (schroeder 1976). The environmentalist believes that a collective action (such as we are about to embark upon hopefully) is required to solve the problem. The solution according to Schroeder lies in the removal or severe restriction of lead additives to petrol. According to this investigator the adverse health effects of lead outweigh the benefits of Pb in petrol. It is probably a high time Schroder s appeal to eliminate or reduce the Pb content of gasoline is heeded in Nigeria. This is the current practice in advanced countries with the pay off of a more healthy environment as reflected by low blood lead levels in the general (occupationally unexposed) population.

Health Implications of Elevated Blood Lead Levels

There are no signs and symptoms characteristic of lead poisoning and this can cause difficulties in diagnosis particularly in children (Table 2). The absence of specificity of symptoms of lead poisoning has resulted in a patient being admitted in a surgical ward (Waldron and Stofen, 1974). Gots (1993) has described lead as a silent hazard and powerful neurotoxin with non-specific symptoms. Jeyaratnam et al (1985) from evidence from individuals exposed to lead questioned the then prevailing view that lack of clinical evidence of lead toxicity necessarily indicates that the individual is free of the ill effects of lead — Metabolic poisoning the fore runner of clinical poisoning may exist.

Though until mid 1960s whole blood lead levels as high as 30ug/dl were considered acceptable (current acceptable level being between 5 and 10ug/dl or less) disturbances in biochemical functions are demonstrable at concentrations well below this figure (Landrigan, 1987), for instance inhibition of d-amino laevulinic acid dehydratase (ALA-D),an enzyme important in the synthesis of haem, occurs at BLL below 10 ug/dl (Hernberg, 1980). Similarly, the enzyme ferrochelatase, which converts protoporphyrin to haem is inhibited at blood lead concentration of approximately 15ug/dl. One clear implication of these observations is that in the presence of deficiency of other nutritional factors anaemia of uncertain causes may be common. Additionally, depression of Circulating levels of 1,25 — dihydroxy vitamin D (the active form of vitamin D) is seen well below 25ug/dl (Rosen et al, 1980; Anetor et al, 1999). This also implies that rickets (in children) and Osteomalaria (in adults) or other metabolic bone disease will be prevalent. Neurophysiologic dysfunction, characterized by reduction in intelligence and behavioral disorders have been shown in children with elevated blood lead levels (Needleman et al 1979). Suggestive biochemical indices have also been reported in this environment (Anetor et al 2001). Clinical and experimental studies conducted about twenty years ago suggest that neurophysiologic damage may be produced in young populations with BLL below 35ug/dl (Rutter, 1983).

Some more disturbing findings in this environment with far reaching implications are the possible association of elevated blood lead level and immunosuppression (Anetor and Adeniyi, 1998) this implies reduced host resistance to infectious agents, a condition which may be comparable to the current pandemic, AIDs or Susceptibility to the latter and other opportunistic infections. Furthermore, deficiencies and disturbances in immune function (body defense system) may in addition to increasing the risk of contracting allergies and infectious diseases (endemic in this community) may also predispose to automimmune disease, athritis and cancer (Tolonen, 1990). High blood lead levels have been associated with reduced sperm count and decline in fertility rates. High blood pressure has recently been associated with blood lead level as low as 7ug/dl (Newschaffer 1998). Elevated blood lead levels may also lead to oxidant stress, which is an important factor in the causation and complication of many pathological states (Tolonen, 1990, Anetor and Adeniyi, 2000).

Disturbing reports indicating severe decline in nutritional status (Olusi and Jess- op, 1977, Atinmo and Mbofung, 1980, Atinmo, 1983, Chinock 1994, Rolfe 1994) particularly as regards Micronutrients, suggest that these elevated blood lead levels may be more deleterious than similar levels in developed countries. This is because micronutrients like copper, iron, zinc, selenium and vitamins may be protective against the harmful effects of lead (Goyer, 1993, 1995, Anetor et al, 2000)

Action on Blood Lead Levels by Regulatory Bodies Internationally

In 1980, the world organization (WHO) gave a blood lead level of 40ug/dl in the general population and 30ug/dl in women of child-bearing age. As research findings unfolded subsequent WHO standards have been based on keeping levels in the vast majority of the population below 20ug/dl (Goyer 1991). Various countries through their regulatory bodies have issued official limits on BLL in the general population (as opposed to occupationally exposed subjects). In Australia, Medical authorities set a national goal for all unexposed Australians of BLL below 10ug/dl (Australian EPA, 1996). Health authorities in Canada have recommended 10ug/dl, while Germany has set a guideline of 15ug/dl for adults and 10ug/dl for children and women of child bearing age. In Switzerland official reports have clearly indicated that BLL as low as 10-15 ug/dl may be detrimental to the foetus and that prolonged exposure to 10ug/dl BLL is harmful to children. In the United states of America the CDC has specified a level of

10ug/dl as an action level for blood lead in children, pointing out that this may be associated with about two and a half (2_) decrease in intelligent quotient (I.Q). Generally, these standards have been promulgated fairly recently, reflecting increasing concern over exposures to lead that were once considered innocuous or safe. Thus the conservative estimate of BLL in the general Nigerian population of about 28ug/dl (range 27-30 ug/dl) must be considered high indeed (Table 4) and action is long overdue to take steps aimed at reducing current levels. It is interesting to end by saying that as low as blood lead levels currently are in the United States, (<10 ug/dl). in 1997 the government through its Environmental Protection Agency (EPA) set up a programme to strength children s environmental Health protection (Brown, 1997)

CONCLUSION

Though the blood lead levels found in the general Nigerian population fall within the limit previously considered to be acceptable over two decades ago before the reduction or elimination of lead in gasoline in the developed countries, they are very high compared to current acceptable levels. These levels have consistently been associated with various pathological conditions such as anaemia, neurobehavioural deficits, renal impairment, reproductive abnormalities and suppressed body defence system.

These adverse effects may indeed be more deleterious in this environment owing to wide spread micronutrient deficiency which potentiate the harmful effects of lead.

RECOMMENDATIONS

- There is need for a national survey of blood lead level preferably combined with nutritional assessment. This will allow a baseline to be established to which subsequent monitoring studies can be compared.
- There is the need to establish an agency to study various aspects of the toxic effects of lead and other related toxins comparable to the Agency for Toxic Substances and Disease Registry (ATSDR) in the United States.
- There should be at least a stepwise reduction of the lead content of Nigeria s gasoline with a view to completely eliminating it within a time frame of not more than five years.
- Provision of facilities and strengthening of laboratories in at least some designated Universities / Research Institutes to study the silent epidemic of lead is desirable.
- Establishment of a standing committee to disseminate information (public enlightenment programmes) about the adverse health effects of lead.
- Other sources of lead to the general population such as lead in auto and home paints should be addressed.

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TABLE 1: Organ Systems Affected by Lead

Nervous system	Alters neurotransmitter levels
Renal system	Causing tubular damage
Biochemistry	Impairs Vitamin D metabolism Impairing osseous system
Reproductive system	Irregular female cycle & decreased Sexual hormone levels
Immune system (Lymphocytes)	Impairs defence cells function and impaired antibody formation
Gastro intestinal system	Causes colic (cramping)
Male reproductive system	Impairs quantity and quality of semen
Prenatal postnatal life	Decreases gestation duration and decreased growth rate in children.

TABLE 2: Some non-typical signs and symptoms of lead toxicity

Fatigue	Joint pain (athralgia)
Irritability	Muscle pain (Myalgia)
Poor concentration	Raised blood potassium (Hyperkalemia)
Wrist or foot drop	Nausea and vomiting
Vague abdominal pain	Anorexia
Ginginval leadline (Burton's line)	Sleep disturbance (insomnia)
Microcytic hypochromic anaemia	Memory loss
Gout (Hyperuricaemia)	Mental retardation / dysfunction
Interstitial nephritis	Personality change
Anaemia	Metallic taste
Dulling sensation	Immunosuppression
More rapid aging	Sterility / Reproductive dysfunction
Weight loss	ETC
Dizziness	

TABLE 3A: Blood lead levels in unexposed subjects

(Source: Adeniyi and Anetor, 1999) modified

Subjects/location	Number of subjects	Blood lead level (ug /dl)
Group I Ibadan metropolis	51	30.1 ± 1.47 (10 – 58)
Group II Iseyin, Shaki ogbomosho and sokoto	880	28.8 ± 1.22 (15 – 63)

Values are mean ± sem.

TABLE 3B: Blood lead levels in unexposed subjects

(Source: Anetor, Akimpelu, Adeniyi 2000)

Subjects / location	Number of subjects	Blood lead level ug/dl
Out skirts of Ibadan	40	27.7 ± 6.6

Values are mean ± SD.

TABLE 4: Fairly recent blood lead level in some countries and organizations reacting to current scientific evidence

Country / Organization	Population	BLL in ug/dl
WHO (1980)	General population	20
Germany	General population children and women of child bearing age	15 10
Switzerland	Fetus Children	10-15** 10
Australia/Canada	General population	10
United states /CDC	Children	10*
Nigeria	General Population	No reaction

** Levels considered to be potentially detrimental

* Action level (i.e requiring intervention) ug/dl = Blood lead levels in Microgram per decililtre.

4.8 CASE STUDIES

Michel Muylle
Senior Gas Specialist, World Bank

Eleodoro Mayorga-Alba
Lead Petroleum Economist, World Bank

Presented by
Engr Aminu Jalal
National Automotive Council

Clean Air Initiative

A Road Map to Lead Phase Out
A Few Case Studies

-1-

Content

- Methodology
- A Few Case Studies
- Refining
- Lessons Learned
- Role of the World Bank Group

-2-

The Perfect Road Map

Analysis
- Health impact
- Vehicle fleet
- Oil industry (supply and distribution)
- Cost implications

Consensus building
- Octane pool and other fuel quality requirements
- Fuel price policy (incl. kero and diesel)
- Quality control mechanisms (fuels, vehicles, contamination)

Communication
- Stakeholders awareness (oil companies, transport, health, …
- Public outreach and education

Implementation …

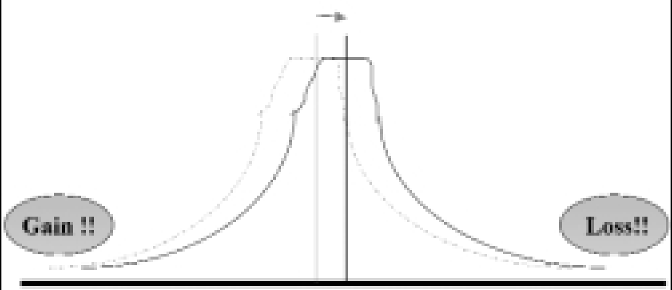
-3-

Impact on health

- Air quality deterioration results in important economical losses in developing countries (estimated at 0.5 to 2.5% of the GDP).
- Vehicle emissions are major contributors in atmospheric pollution
- In large cities of developing countries two pollutants merit particular attention:
  - Lead: known to negatively impact health, even in small doses.
  - Particles: smaller than several microns (PM10 - PM2.5) **they are a main cause of respiratory illnesses.**

-4-

Lead contamination impact the IQ of the population



Distribution of QI and lead in blood

-5-

Importance of Catalytic Converters

Gas emissions from vehicles

"well tuned vehicles"	without c.c.	With c.c.
CO (gm/km)	42.67	6.86
VOCs (gm/km)	5.62	0.67
CH_4 (gm/km)	0.19	0.04
NO_x (gm/km)	2.70	0.52

Lead precludes the use of CC necessary to reduce gas vehicle emissions

-6-

Old engines and unleaded gas

- *1970 -USA*, approx.one third of all cars had old valve seats. EPA and other studies have determined that:
  - Damage would only occur in extreme driving conditions (..100 Km/hr for more than 5 hr.).
  - The problem would be solved if 0.02 gmPb/lt.were added.
- *1992 – in Slovakia*, only 6% of gas was unleaded; in 1995, all gas was unleaded.
  - 70% of cars had old valve seats so an additive had to be used (NABEX-99) to replace lead as a lubricant.
  - The cost of the general plan was estimated at $0.07/gal of gas.
- *In Colombia, Honduras, Bolivia, Guatemala* ... countries with similar vehicle fleets to those in Sub-Saharan Africa where nothing was added and no problems were ever reported.

-7-

The Cost of Lead Phase-Out.

- Depending on a country's fuel supply:
  - *Importers could benefit from lower international prices*
  - *Producers have to adapt the refineries*
- Octane supplies replacing TEL have different costs and different consequences on technical specifications of the resulting gasoline.

Direct gasoline = 60-73 RON
C4 = 93 RON
Isomerate = 82-92 RON
FCC naphta = 90-93 RON
Reformate = 90-103 RON
Alkylate = 90-97 RON
MTBE = 118 RON

- For the same octane index, one liter of unleaded gas costs approx. US$ 0.01 à 0.02 more than leaded gas.

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Import Countries

- **Few if any constraints to phase out lead**
- **Economic cost is small and relatively simple to assess**
- **Timing / Phasing within own control**

Critical issues are

- **regional supply options**
- **import terminal and distribution flexibility**
- **landlocked countries supply options**
- **limited competition / entrenched positions**
- **vehicle fleet (current and future)**
- **public outreach / education**
- **commitment to environment & health**

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Refining Countries

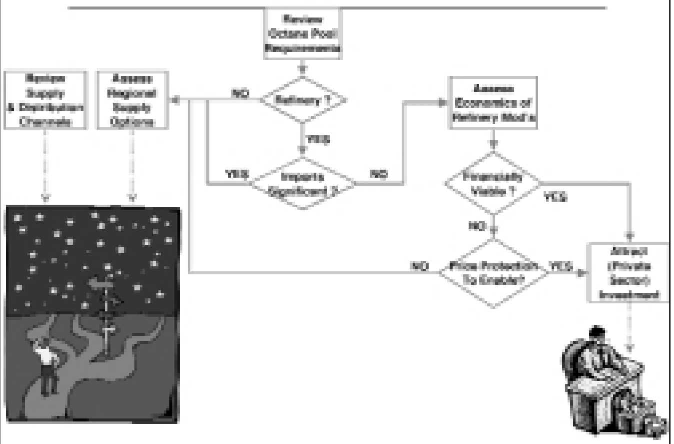
- **Refineries impose constraints on lead phase out**
- **Economic cost complex to assess**
- **Timing constrained by investment schedule**
- **Political / Strategic role of refining asset overstated**

Critical issues are

- **small scale and configuration of the refinery**
- **product yields and qualities (a.o. sulphur)**
- **ownership and control of the refinery**
- **regulatory regime**
- **investment climate, availability of finance**
- **demand growth and need for imports are enablers**

-10-

Decision Tree



-11-

Case Studies

A Recap with a few lessons learned

12

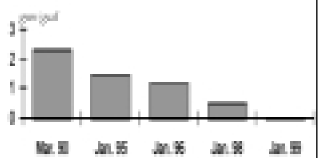
Rep. Dominicana - Lead Phase Out

Unleaded is a Consumer Product:

- 1991 : Shell introduces Premium unleaded in Dom Rep
- Unleaded priced 20% above leaded gasoline
- Market share of 10% unleaded in little over one year
- Main consumer class : motorcycles !!

Enabling

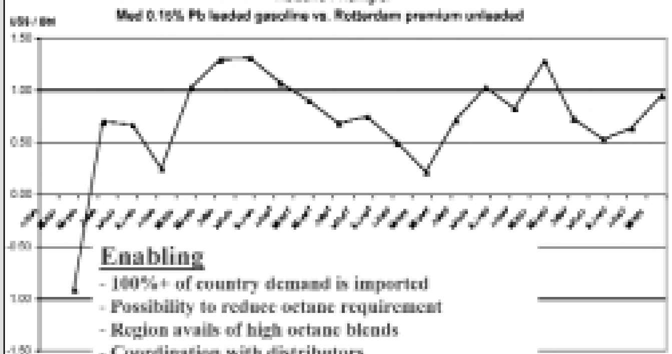
- 50%+ of country demand is imported
- Single import facility allows for economies of scale
- Regulation allows 3rd party imports
- Region avails of high octane blends
- Reduce octane pool to match refinery configuration



-13-

Haiti - Lead Phase Out

Unleaded can be Cheaper !



Enabling

- 100%+ of country demand is imported
- Possibility to reduce octane requirement
- Region avails of high octane blends
- Coordination with distributors

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El Salvador – Lead Phase Out

Urbanization : respiratory diseases public health enemy No 1!

Lead eliminated in less than one year !

- Avoided investments in dual fuel supply systems
- Limited period of possible cross contamination
- Complemented with efforts on regional harmonization and vehicle emission standards

Enabling

- Prices deregulated
- Downstream sector in private sector
- Product imports

Cost of lead phase out : $ 0.01 / liter

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Chile – Lead Phase Out

Pollution in Santiago de Chile

Comprehensive emissions reduction strategy !

- Transport responsible for 1/3 of PM emissions
- Catalytic converters most effective solution

⇨ NEED FOR LEAD PHASE OUT

Enabling

- Thorough analysis of pollution was possible
- Participatory and comprehensive approach
- Refineries world scale

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Jamaica - Lead Phase Out Plan

Commitment from heads of state at Summit of the Americas

Change the octane grades !

- Increasing proportion of Japanese vehicles
- No benefit from higher octane gasoline
- Adjust taxes on premium leaded gasoline

Enabling

- Car population enabled lower octane
- Overall reduction of octane pool avoids investments
- Attention to the fiscal regime

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Worldwide

- 62 countries accounting for more than 80% of worldwide consumption use unleaded gas.
- By 2005, practically all of the countries in American, Middle East and Asia will be "lead-free".

Sub-Saharan Africa must follow

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Refining Issues

Is it time to face reality ?

- No appetite to invest because of regulated prices
- Inability of public sector to sustain participation
- Uncertain political stability
- Limited sources of finance
- Regional supply options offer opportunities

Attract private operators / investors

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Nigeria

- Nigeria has complex refineries that can produce unleaded gasoline without major investments.
- Refineries need to improve operational procedures and rates to become profitable.
- Finding private operators is an option to be pursued more aggressively.
- Deregulation of prices is politically difficult
- Price subsidies need be better targeted

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A Few Lessons Learned

Aggressive Time Schedules Possible

- One – two year horizon.
- The Dakar resolution provides time until 2005

Question the octane requirements

- Too many, too few …
- Fit for purpose (vehicle fleet, driving conditions)
- Reduce octane pool to avoid or delay investments

Let the Market Play

- Early introduction of unleaded as pure market play
- Leverage third party investments (e.g. in refining, distribution)

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A Few Lessons Learned (cont'd)

Time it Right

- Regional supply options
- Combine investments in quality with refining capacity

It's not only about lead or octane

- Comprehensive view on pollution from transport
- Fuel pricing policy (incl. kero and diesel)
- RVP, T50, Sulphur, Aromatics, …
- Comprehensive supply & demand analysis for all fuels

Find a Champion!

- Oil Companies have the greatest leverage
- Large or densely populated cities most to benefit

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The World Bank offers assistance

- **Multi-sectoral and regional organizations**
  - Transport
  - Environment
  - Oil & Gas
- **Policy support and capacity building**
  - Product quality
  - Pricing regimes and fuel taxation
- **Risk management**
  - Limited recourse financing
  - Equity
  - Partial Risk Guarantees

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Clean Air Initiative

A Road Map to Lead Phase Out

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4.9 FUEL DISTRIBUTION AND LOGISTICS

Henry Obih
Analyst Business Planning and Analysis,
ExxonMobil Chemical Middle East & Africa

Fuel Distribution and Logistics

Sub-Regional Conference on the Phase-out of Leaded Gasoline in Nigeria & Neighbouring Countries

Abuja, Nigeria

November 15 - 16, 2001

Henry Obih

ExxonMobil

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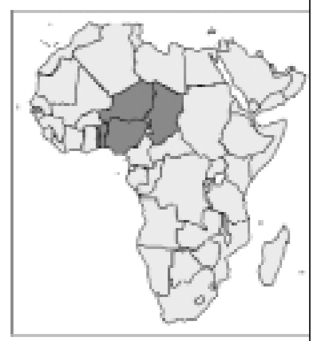
OBJECTIVE

To define a cost-effective Distribution/Logistics chain for the transitioning from Leaded to Unleaded Gasoline in Nigeria and Neighbouring countries (Chad, Niger, Benin and Togo)

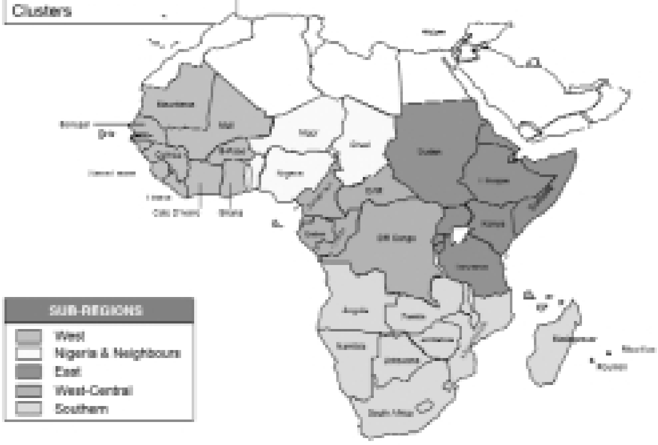
SCOPE

- Sub-Regions / Key Refining centres
- Supply and Demand patterns
- Market characteristics
  - Gasoline grade availability
  - Lead Specification levels
  - Service Station distribution
  - Vehicle population
  - Road transportation
- Fuels Distribution facilities
- Options for meeting Gasoline requirements
- Timing and Costs



-2-

SSA SUB-REGIONS - Clusters



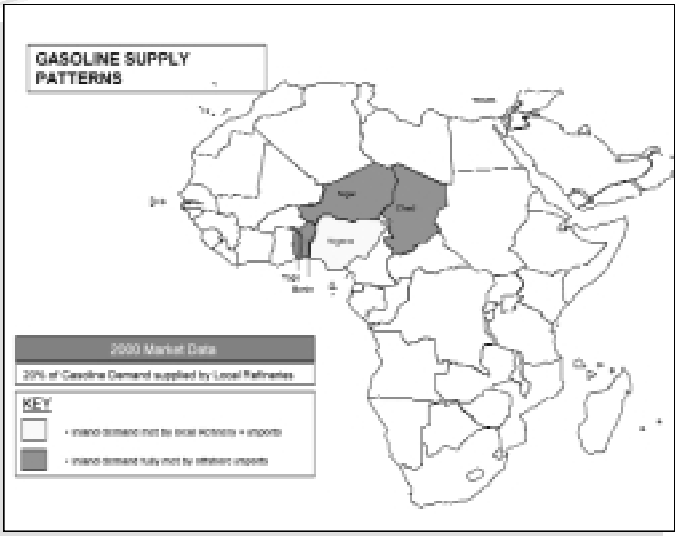
-3-

KEY REFINING CENTRES: Sub-Regional Coverage

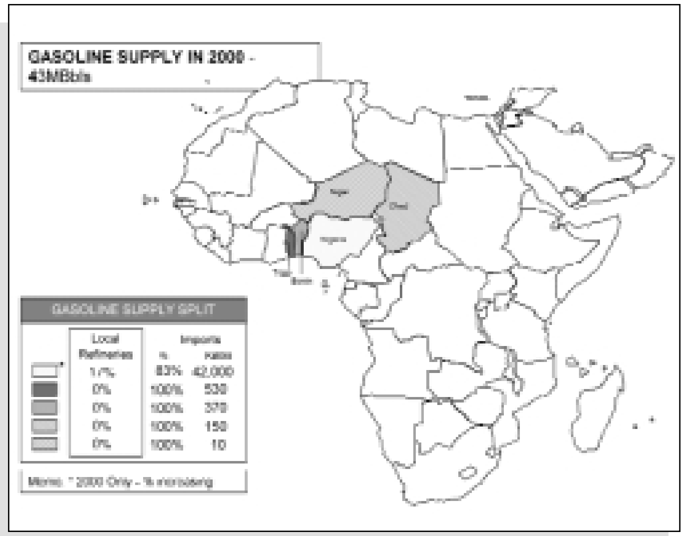
SUB-REGIONS	COUNTRIES	KEY REFINING CENTRES
West Africa	Burkina Faso, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Mauritania, Senegal, Sierra Leone	Cote d'Ivoire, Ghana, Senegal
Nigeria and Neighbouring Countries	Benin, Chad, Niger, Nigeria, Togo	Nigeria
West Central Africa	Cameroon, Congo (Brazzaville) Central African Republic, Democratic Republic of Congo, Equatorial Guinea, Gabon, Sao Tome and Principe	Cameroon, DR Congo, Gabon
Southern Africa	Angola, Botswana, Comoros, Lesotho, Madagascar, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Zambia, Zimbabwe	Angola, South Africa
East Africa	Burundi, Eritrea, Ethiopia, Djibouti, Kenya, Malawi, Rwanda, Somalia, Sudan, Tanzania, Uganda	Kenya

Local Refineries in Sub-Saharan Africa provide 80% of Gasoline demand in sub-region and the demand balance is met through imports of finished Gasoline

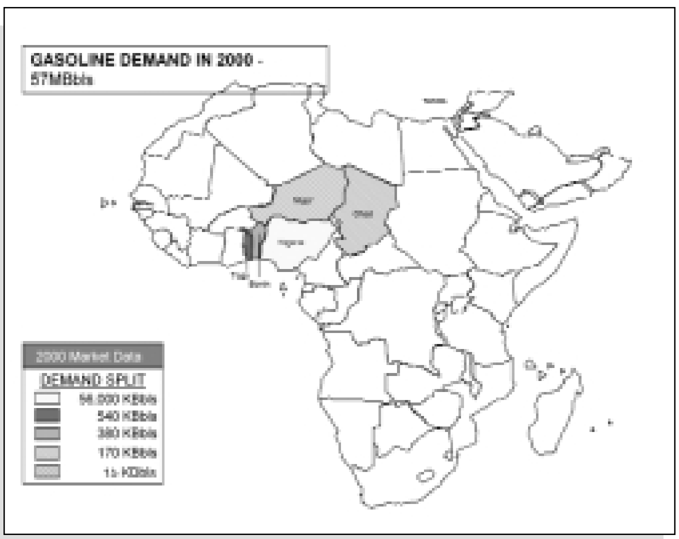
-4-


GASOLINE SUPPLY PATTERNS
2000 Market Data
KEY

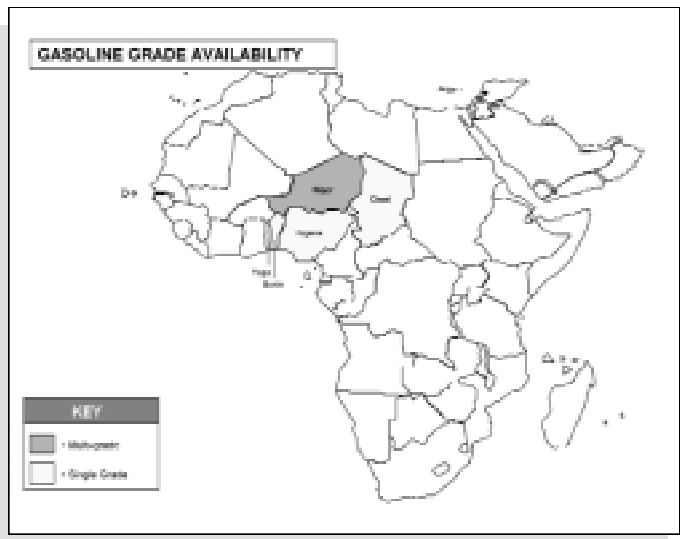
-5-


GASOLINE SUPPLY IN 2000 - 43MBbls
GASOLINE SUPPLY SPLIT
Local Refineries
Imports
%
17%
83%
42,000
0%
100%
530
0%
100%
370
0%
100%
150
0%
100%
10

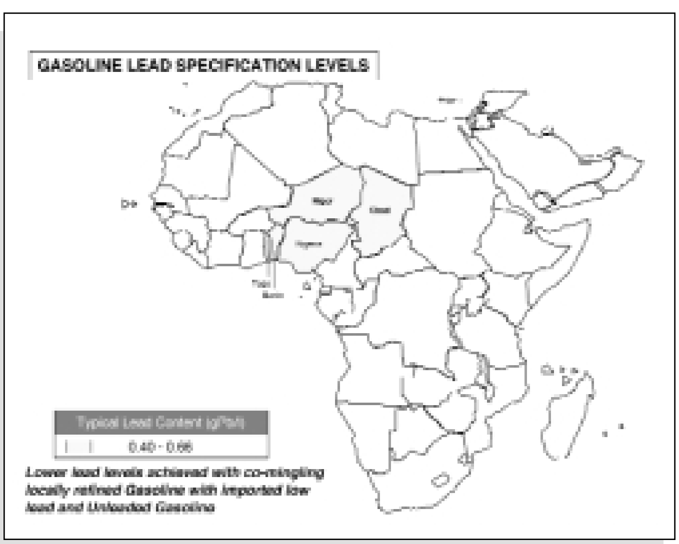
-6-


GASOLINE DEMAND IN 2000 - 57MBbls
2000 Market Data
DEMAND SPLIT
56,000 KBbls
540 KBbls
380 KBbls
170 KBbls

-7-


GASOLINE GRADE AVAILABILITY
KEY

-8-


GASOLINE LEAD SPECIFICATION LEVELS
Typical Lead Content (g/Pb/l)
0.40 - 0.66
Lower lead levels achieved with co-mingling locally refined Gasoline with imported low lead and Unleaded Gasoline

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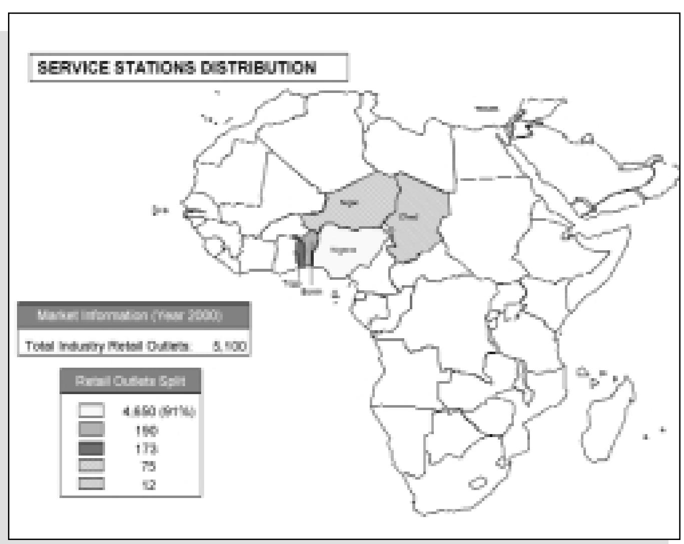
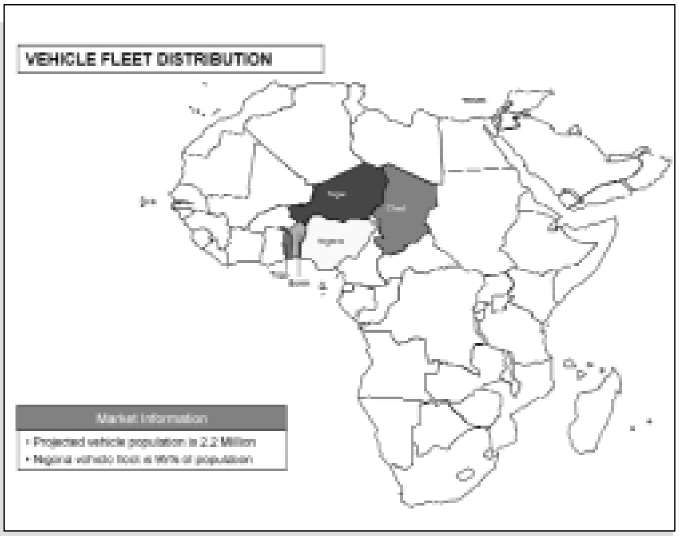

SERVICE STATIONS DISTRIBUTION
Market Information (Year 2000)
Total Industry Retail Outlets: 5,100
Retail Outlets Split
4,650 (91%)
190
173
75
12

-10-



-11-

ROAD TRANSPORTATION

- Main transportation mode, accounts for 90% of passenger/freight movements
- Good network spanning over 150,000 Km linking major cities, and rural communities
- Road network valued largely managed by Governments
- 70% of network deteriorated due to lack of maintenance, most inaccessible during rains
- Gasoline engines represent 60% of vehicle fleet
- 25% of vehicle fleet are soft valve seat technology engines requiring valve seat lubrication
- Low turnover rates for replacement of older cars to newer models

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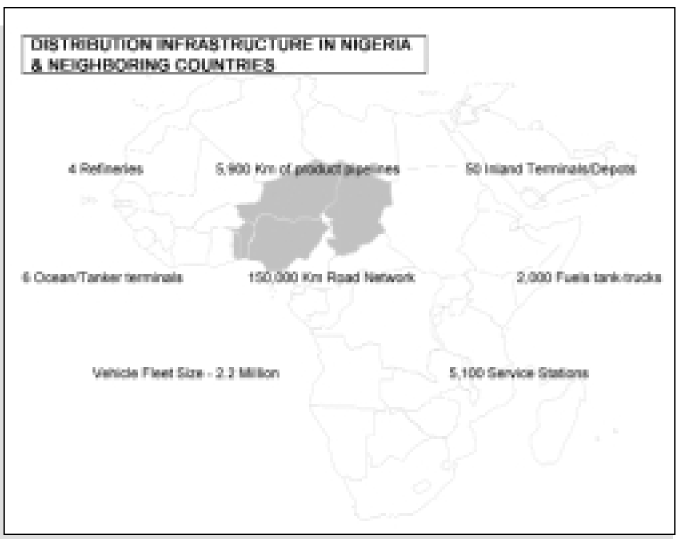
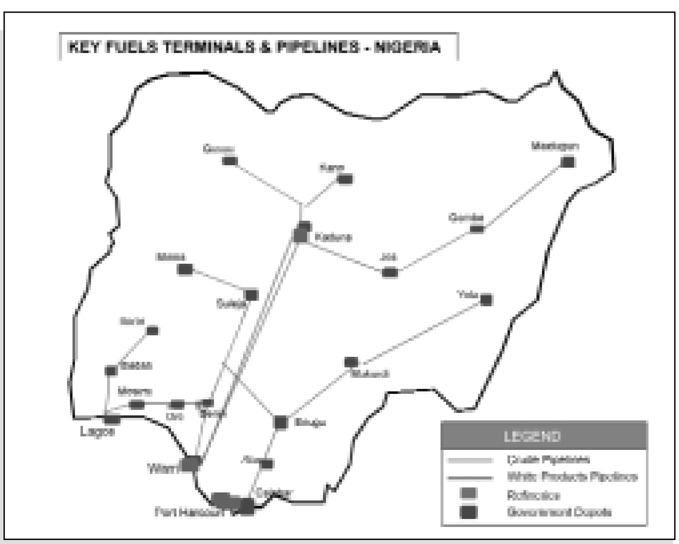


-13-

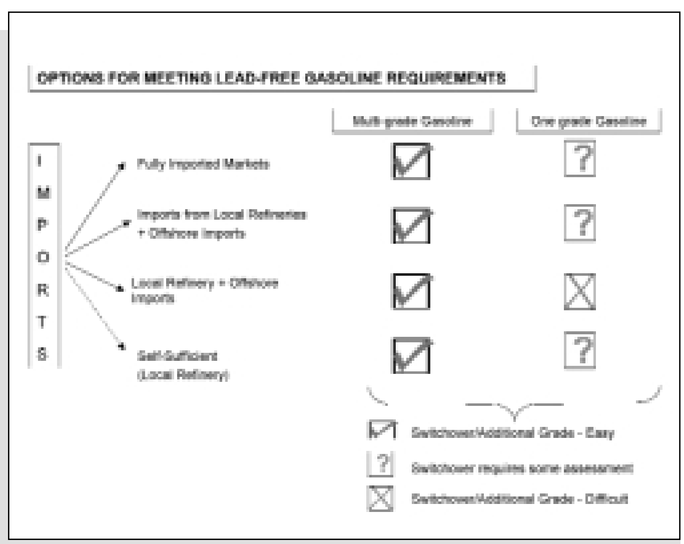
Downstream Petroleum Industry - Nigeria

- Government controlled/regulated market
- Four domestic refineries, with total capacity of 445 KBD
  - Phased refurbishing of refineries in progress
- Total annual Fuels demand, 100MB: Gasoline accounts for 50% of demand
- 5,500 Km of pipelines for product receipts/transportation
  - Mostly non-segregated systems, product cross contamination possible
- 21 Government owned Fuels depots and numerous Marketers terminals/depots
  - Storage capacity in excess of 7 million barrels
- Eight Major Marketers and significant presence of Independents

-14-



-15-



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ALTERNATIVE SUPPLY REQUIREMENTS

1. LOCAL REFINING AND SUPPLEMENTARY OFFSHORE IMPORTS

- Octane issues and Additivation dealt with in Refining presentation
- Imports can be Lead-free provided multi-grades of gasoline are in the market place
- Additionally, imports can be used to boost octane pool when refining octane capability is inadequate

2. IMPORTS FROM LOCAL REFINERIES AND OFFSHORE IMPORTS Chad, Niger

- Import requirements will be dependant on action taken at local Refineries
- Where logistics permit, some importation of Unleaded Gasoline may be possible

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ALTERNATIVE SUPPLY REQUIREMENTS - (Continued)

3. FULLY OFFSHORE IMPORT MARKETS - Togo, Benin

- Immediate conversion to Lead-free Gasoline possible
- Due to generally higher percentage of older vehicles, Anti-VSR additivation may be considered
- Multi-grade markets: Unleaded can be substituted for one of the grades
  - Low cost option but precautions necessary to minimize cross contamination
- Single grade markets: Major capital investments required to introduce additional grade
  - New dispensing pumps and nozzles to avoid cross contamination
    - Investments also required in storage tanks and pipelines (terminals/service stations)
    - Single octane rating will reduce infrastructure requirements

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SERVICE STATION INFRASTRUCTURE

2 SCENARIOS:

1. FULLY IMPORTED MARKETS

- No problems for either Single or Multi-grade markets - Flush out Leaded Gasoline grade(s) with Lead-free Gasoline

2. REFINERY DEPENDENT (1 Gasoline grade)

- Complicated and difficult
- Relies on Refinery conversion/upgrade or the costly option of adding a grade

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TIMING AND COSTS

SHORT TERM CHANGEOVER

- Countries fully serviced by offshore imports, can convert rapidly at low costs
- Careful planning required for Nigeria - Study and phased implementation
- Timing of change is affected by time for legislation, local oil industry planning and time to physically work old leaded fuels through the supply chain
- Additional cost of approximately $0.002/l may be incurred for Anti-VSR additivation

LONGER TERM

- Refinery production dependent

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RESEARCH FINDINGS

Recent studies on soft valve seats show that 0.02 - 0.05gPb/l of Gasoline is adequate for valve lubrication

Various research work estimate the cost of replacing lead as a lubricating additive in Gasoline at $0.002/l

Use of non-lead based additives in countries with high proportion of soft valve technology cars has been determined as the least expensive option for lead phase-out

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IDENTIFYING TECHNICAL OPTIONS - Summary Process Flow

- Evaluate the current Gasoline supply
- Assess the local refining industry
- Identify alternative sources of Gasoline octane value
- Evaluate Gasoline supply scenarios
- Analyze impact on the Gasoline distribution and marketing systems
- Assess the costs of alternative strategies to the fuel supply sector

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4.10 EFFECTS OF UNLEADED GASOLINE IN VEHICLES

Daniel Wintenberger
Assistant General Manager Engineering/Quality
Peugeot Automobile Nigeria Ltd.

1. EFFECT OF UNLEADED GASOLINE ON VEHICLES

1.1 Leaded Gasoline

It is a Fuel to which TEL (Tetra — ethyl lead) has been added.

Why TEL is added to Fuel ?

- For its anti — knock properties, to increase its octane ratio (RON) thus its performance.
- For an improved lubrication of the pistons
- For a good tightness between Valves and Seats. (The lead deposits a thin layer of lead oxides and sulfates on Valves heads and on Seats).

The content of TEL varied with time and from one country to another between 0.7g / L and 0.15g / L.

1.2 Unleaded Gasoline

In order to avoid poisoning of the environment with lead and to enable the use of catalytic converters in view of reduction of exhaust emission the addition of TEL is prohibited in most countries. (Such unleaded gasoline contains less than 0.01g/l of lead).

THE DELETION OF TEL POSES NOW 2 PROBLEMS :

1.2.1 HOW TO MAINTAIN THE RATIO (RON) OF THE FUEL :

If the suppression of leaded Fuel meant the availability on the market of a gasoline with only a lower octane ratio (for ex-below RON 88), that would necessitate the readjustment of the timing of all engines.

Furthermore, many engines that could not be sufficiently readjusted would be very quickly destroyed by the phenomenon called pinking or clinking , provoqued by the premature explosion of the air / fuel mix inside the cylinder, i.e. before the piston reaches its top dead center.

Indeed, it is essential to keep the highest possible ratio, because a higher ratio means a better performance of the engines, thus a lower fuel consumption.

(Consumption improves by 5% if the RON increases from 91 to 95). Then, a lower fuel consumption makes it easier to meet the target of exhaust emission control.

(In fact, in the case of NIGERIA , it should be wise to use the opportunity of introduction of unleaded fuel to raise the octane ratio of the gasoline to the international standard of RON 95).

This necessitates the use of various additives.

- Aromatics (Toluene — Xylene) 19 to 35%
- Benzene is toxic and prohibited
- Organometallics (MMT - FERROCENE) - Prohibited
- Oxygenated (Methanol — Ethanol — MTBE - ETBE ...) 10 to 12%

IMPORTANT NOTE:

Some countries have in the initial stage tolerated the use of FERROCENE or MMT (Methylcyclopentadienyl -Manganese -Tricarbonyle) produced by the company ETHYL .

These pro-octane additives MUST BE PROHIBITED as they induce :

- Environment poisoning by the Manganese which is as bad as lead
- Many damages to the engine and its ancillaries

(*Catalysator clogged — lambda probe destroyed, spark plugs sooted up*).

This would lead to a highly polluting engine, which is contradictory with the initial target of exhaust emission control.

In order to produce fuels with a good octane ratio (RON 95) without using MMT, it is necessary to improve the refineries quality standards (It would cost about 4% extra energy consumption to raise the ratio from 91 to 95) and to use other additives as listed above (reformat-oxygenated-alkylat etc).

1.2.2 HOW TO PRESERVE THE PERFORMANCE AND THE LIFE OF THE ENGINES

The absence of the protective layer of lead on the exhaust valves seats leaves them exposed to the combination of heat and valve head impact.

If the engine is of an old design, not suitable for unleaded fuel, the valve seats are progressively hammered down and even sink into the cylinder head. This affects particularly the exhaust valves and could lead to burning of the valves. This is called valves seat Recession

(The inlet valves are less affected since they are cooled by the air / fuel intake flow).

The only known way to preserve the engine is to substitute the lead by potassium which gives similar protection.

The tests conducted by various bodies have shown, however, that this phenomenon is significant only in case of utilization of the engine under heavy load (maximum speed during long time, e.g. driving at 150km/h on Freeway more than 4 hours). In case of town use the consequence on the valves seats are of little importance.

In any event, all the countries which have decided to change to unleaded gasoline have introduced during a few years on their market simultaneously :

- RON 95 unleaded gasoline to be used on the newest brands of vehicles
- RON 95 unleaded gasoline, with Potassium additive, to be used on the oldest brands of vehicles

2. VALVE SEATS RECESSION – VEHICLES AFFECTED

2.1 Valve Seat Recession

The valve seat recession phenomenon has been described in the previous chapter explaining the effects of the unleaded gasoline on engines.

All engines designed with valves seats made of reinforced steel or sintered steel will admit the unleaded gasoline. Those which are not could suffer that phenomenon.

2.2 Valve Seat Recession

As far as PEUGEOT vehicles are concerned we must consider 2 cases.

2.2.1 OLD GENERATION VEHICLES (404, 504 , 505 and J5 ranges)

All 404 vehicles would be affected therefore they should only run with either leaded fuel or unleaded fuel with potassium additive.

The 504, 505 and J5 vehicles produced before 1986 would equally be affected, whereas those produced since 1986 can function indifferently with leaded fuel RON 89 or unleaded fuel RON 91

2.2.2 NEW GENERATION VEHICLES (306 — 406 - Boxer)

They were designed to function with unleaded fuel, but can indifferently function with leaded and unleaded fuel. They reach better performance with RON 95 unleaded. Therefore the introduction of such gasoline would improve their life and performance, thus reduce the fuel consumption.

Concerning the vehicles of other makers we have no data but we can reasonably consider that the same dates apply — (some USA manufacturers introduced reinforced valve seats as far back as 1975 and some Japanese manufacturers did it from 1980 or 1981)

3. ADDITIVES TO COUNTER VALVE SEAT RECESSION

3.1 Tests

Many tests made both in USA and Europe since 1970 show contrasted results

- 1562 FORD vehicles tested during 31/2 years between 1970 and 1973 with unleaded fuel show that only 1.2 % met valve seat recession problems.
- Same finding in Europe with various vehicles in normal average road utilization.
- But ROVER engines tested on bench at maximum load showed 1mm seat recession after 70 hours.

3.2 Additives

The additives used to substitute lead and counter valves recession are:

- The pro - Octane additives (see 1.2 unleaded fuel)
- The lead substitutes (Potassium - Ferrocene - Sodium — metallic additives phosphorus additives — various salts).

Those additives could produce corrosive agents which will deteriorate the valves ,spark plugs, exhaust system.

- The potassium additive is a lamellar composite which like the TEL has good lubrication properties and also deposits a thin layer of particles or the valve head and valve seat.
- The potassium alkylate is the only additive used throughout Europe.
- The dosage in the fuel must be between 8 and 20 ppm (part per million or mg/kg).

3.3 Conclusion

The countries which have banned the leaded gasoline have adopted one of the two solutions :

- Producing and marketing throughout the country an unleaded fuel RON 95 or RON 98 with potassium additive.
- Producing only unleaded fuel but distributing, at each petrol station, cans of concentrated additive to be poured to the fuel tank by the car user himself. This solution is not reliable and difficult to put in use.

4. CONTROL OF VEHICLE EXHAUST EMISSION BY USE OF CATALYTIC CONVERTER

4.1 European Emissions Standards (in gramme per kilometer)

<table>
<tr><th>YEAR</th><th>1970</th><th>72</th><th>76</th><th>80</th><th>84</th><th>88</th><th>92</th><th>96</th><th>00</th><th>05</th></tr>
<tr><td>CO_2</td><td>N/A</td><td></td><td></td><td></td><td></td><td></td><td></td><td>200</td><td>180</td><td>140</td></tr>
<tr><td>CO</td><td>N/A</td><td>60</td><td>25</td><td>21</td><td>15</td><td>7</td><td>2.72</td><td>2.20</td><td>2.0</td><td>1.0</td></tr>
<tr><td>HC</td><td>N/A</td><td rowspan="2">15</td><td rowspan="2">8</td><td rowspan="2">7</td><td rowspan="2">5</td><td rowspan="2">2.5</td><td rowspan="2">0.97</td><td rowspan="2">0.50</td><td>0.20</td><td>0.10</td></tr>
<tr><td>NO_X</td><td>N/A</td><td>0.25</td><td>0.08</td></tr>
</table>

4.2 How to Reach those Standards

A lot of improvements on the technology of engines:

- Direct fuel injection
- Air filters
- Calibration of air intakes and exhaust
- e.t.c

Improvements on gasoline octane ratio, additives

Improvements on lubricants

Introduction of catalytic convertors

All those evolutions are linked to each other thus new vehicles with improved engines will not perform well if filled with old generation gasolines and lubricating oils.

Those changes are aimed at

- Reducing the fuel consumption thus reducing the amount of exhaust gases per km
- Eliminating the dangerous gases, and this is achieved by the use of catalytic convectors

4.3 What is a Catalytic Converter

It is a very fine mesh made either of ceramics or of thin metal sheets.

This ceramic or metal mesh is thinly coated with precious metals (Platinum, Rhodium, Palladium) (1.5 to 2 grammes for one catalyst)

The catalyst pot is inserted in the exhaust system of the vehicle as near as possible to the engine so that the hot exhaust gases pass through it.

The mesh is so thin that the total area of contact between the mesh and the gases is around 8000 sq.m

4.4 How Does a Catalytic Converter Function

The layer of precious metals induces a thermo — chemical reaction which operates between 300¡C and 800¡C to reduce the dangerous gases CO, HC and Nox into CO_2, H_2O and N_2 which are innocuous.

It takes about 60 seconds after starting to reach its minimal functioning temperature.

Oxygen sensors are fitted on the exhaust pipe to check the proper combustion of the air/fuel mix. If the oxygen ratio varies the sensors will react on the ignition calculators and on the injection system.

The European regulation demands a life span of 80 000km for the catalysts but the actual performance achieved today is 50% to 100% higher, provided the vehicle is used and maintained properly.

4.5 The Possible Causes of Failure of a Catalytic Converter

Rupture due to impact (fast driving on bad roads)

Fusion of the mesh due to bad ignition :

- Damaged or sooted up spark plugs (bad gasoline)
- Non conforming spark plugs
- Failure of injectors
- Bad maintenance of the air filter

All those defects would provoque an increase of unburnt fuel which would burn in the catalyst thus overheat it.

- Destruction of the precious metals layer
  - due to the poisoning of the catalyst by the use of leaded gasoline
  - due to the use of unleaded gasoline with prohibited additives (MMT , FERROCENE, etc)
  - due to a high sulfur content in the gasoline
  - due to poisoning by the use of poor quality lubricant with high phosphorus content (higher than 0. 05%)
- Failure of the oxygen sensors
  - due to phosphate deposits on the sensor platinum active tip caused by the use of poor quality lubricants or bad gasoline (with prohibited additives)
  - if the sensors fail, they will send a wrong signal to the calculator and the injectors thus affecting the air / fuel mix ratio.

4.6 Conclusion

The introduction of catalytic converter on the Nigerian market is required if there is a wish to reduce the environment pollution. But, it must be carefully planed and prepared by :

- Introduction, well in advance of good quality unleaded fuel
- Availability of this fuel throughout the country.
- Availability of suitable lubricants
- Intensive training and teaching of the distributors, dealers, repair garage and <u>vehicles users</u> for a proper use and maintenance of their vehicles.

4H VEHICULAR EMISSION: ENVIRONMENTAL AND HEALTH IMPLICATIONS

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INTRODUCTION

Vehicles and power plants derive their energies from the combustion of fossil fuel in their internal combustion chambers. If it was possible to achieve complete combustion, the fuel applied will be completely converted to energy to create the desired motion in case of automobile and to convert it to other forms of energy for various purposes like providing light etc. In the process of combustion, a number of changes occur. Some of the fuel is passed out unburned; partly burnt fuel changes form into a number of gases, impurities combine in the process principally with air to form other compounds e.g. oxides of sulphur, nitrogen from the air participate in the combustion process to form oxides of nitrogen NO, NO2 depending on the prevailing conditions in the combustion chamber. The products of combustion mainly gases/particular are then emitted into the environment as exhaust gases.

Vehicular emission is of concern particularly in urban environment that has low assimilative capacity. The emissions react forming various species in various meteorological conditions interfering with man s activities. To counter some of these effects like fog and breathing excessive amounts of these gases, researchers are trying to discover new sources of energy and power. There are now vehicles run entirely on natural gas as opposed to petrol.

Vehicular emission in typical urban centre constitute over 60% of total pollutant emission compared to industry, power plants, space heating, refuse disposal etc. See table 1 and 2. Hydrocarbons and nitrogen dioxide emitted principally from automobiles are the major ingredients of photochemical smog. This is evidence by the prevalence of smog problems in most down town areas of developed countries. Sizeable quantities of poisons such as aldehyde, lead, etc are also emitted by automobiles. From the two tables below, the significant contribution to emission from vehicles and in comparison with other sources is worrisome.

TABLE 1: Major sources of Emission in USA 1965 (million tons/year)

	Carbon Monoxide	Sulphur Oxide	Hydro Carbon	Nitrogen Oxide	Particulate Matter	Total	%
Motor Vehicle	66	12	6	1	1	86	60
Industry	2	9	4	2	6	23	17
Power Plants	1	12	1	3	3	20	14
Space Heating	2	3	1	1	1	8	6
Refuse Disposal	1	1	1	1	1	5	3
Total	72	26	19	13	12	142	100

Source: Atmospheric Pollution by W. Bach

TABLE 2: Comparison of average daily emission/tons

	Motor Vehicle	Power Plant	Jet Aircraft
Particulate	43	1	11
Carbon Monoxide	9.282	-ve	24
Nitrogen Oxide	624	135	7
Hydrocarbon	1,677	4	61
Sulphur dioxide	31	30	3

Source: Atmospheric Pollution by W. Bach

TRANSPORTATION

Mode of transportation in Nigeria is largely by road and air with little water transport in the coastal areas. The fleet of road vehicles has steadily increased from the 1950 to date. A study by Obio and Adegbulugbe in 1997 indicate that from 1950 to 1992, cars increased from 12,544 to 623,113, trucks 444 to 54,587, motorcycles 4,387 to 675,637 and that a total of 38451 vehicles in 1950 rose to 1,666,731 in 1992. This increase in 40 years has accounted for the rise in petrol consumption form 560,000 m3 in 1970 to 6,000,000 m3 in 1996. Consumption is projected to reach 10 million m3 in 2010 based on growth rate of 3% observed between 1985 — 1996.

TABLE 3: Road vehicle fleet (all types)

Year	Total
1950	38451
1955	62009
1960	152296
1965	284203
1970	410078
1975	1,035,966
1980	2,045,997
1985	2,758,953
1990	2,004,118
1992	1,666,731

Source: Obio & Adegbulugbe

The effect of all these is increased emission particularly with the prevalence of second-hand vehicles as old as 20 years being imported to this country. With the pegging of the age of second-hand vehicle to 5 years as allowable age to this country, we could have a sizeable reduction of emission.

O & M AND EMISSION

Maintenance is key to efficient vehicle performance. A well-tuned vehicle is fuel-efficient and generates minimal emission. Unfortunately the mechanics we have are better described as destroyers. You need to visit one of them twice and the third time if you do not change, you must be fairly ignorant of what needs to be done. The result is that most of our vehicles are performing below standard, consuming excessive fuel and emitting excessive gaseous/ particulates matter. The remedy lies in establishing credible maintenance workshops to service the fleet of vehicles in this country. Vehicle vendors should be compelled to establish workshops, as a follow-up action to sales of vehicles to customers and maintenance workshops should be licensed and vehicles now maintained by ill-equipped, ill-trained persons be stopped. This reasonable cost to discourage roadside ill-equipped patronage.

HABIT OF VEHICLE OPERATIVES

Personal driving habits as well as operating conditions can have marked effect on fuel economy and exhaust gas generation. The followings have influence on fuel economy and rate of generation of exhaust gases.

- Load —The vehicle tare weight from manufacture has the minimum fuel consumption. As load is increased, the engine has to do more work to pull the weight along. The energy to do this comes from burning more fuel, which is accompanied by emission. Depending on the fuel used, leaded and unleaded fuel, various gases/particulate like sulphur oxides, oxides of nitrogen (NOx) lead particulate are given off.

- Cold and hot starting — Cold starting of an engine has high fuel consumption. We should avoid rapid acceleration and sudden starts as these will result in high fuel consumption. Once the engine has been started, commence driving rather than accelerate rapidly standing which some people refer to as warming the engine. Apart from excessive cylinder wear, high fuel consumption result accompanied by emissions.

- Idling, city traffic shifting —All these are accompanied by high fuel consumption resulting in generation of exhaust gas and environmental pollution.

- Speed — Driving at high speeds for extended period apart from wearing the engine burns more fuel and therefore vent high volumes of gaseous/particulate matters with attendant environmental pollution. Slight release of the accelerating pedal on long distance travel saves significant amount of fuel. Tyres that are not properly gauged increas the inertia which has high energy demand and therefore high emission. More fuel is therefore expended in moving vehicles with lower than recommended tyres pressure apart from the effects on tyre wear and stability on the road.

LEAD IN PETROL

Petrol as derived from the earth s crust may contain lead depending on the constituent of the formation. This is usually small and in most cases insignificant. The petrol used in the internal combustion engines has to conform to certain specification to generate power. In processing the crude, some fractions of low molecular weight easily come out but with low rating referred to as the octane number. For this faction to be useful for powering automobiles, the octane number has to be raised. To do this a compound of lead called Tetraethyl lead (Tel) is used. This introduces lead into the petrol raising the octane number and functions as lubricant for valve seats. With these two beneficial qualities, we should have no problem in promoting leaded petrol.

The combustion of petrol is inefficient in most cases and gases and particulates are emitted as exhaust gas/particulate. One of the perturbing ones is lead particulate, which has detrimental physiological affects. Ingestion of lead has been link to several physiological disorders in man such as interference with IQ of children of school age, gastrointestinal disorder, nausea, circulatory collapse, fatigue, blindness, CNS disorder, anaemia etc.

The use of leaded petrol therefore needs to be review in this country like in other countries of the world to reduce the health effects. It is possible to produce petrol of high and desirable octane number without the use of lead tetraethyl using appropriate technology e.g. cracking of higher molecular crude, use of methyl tetra-butyl ether (MBTE), Fluid Catalytic Cracker (F.C.C.) etc.

In Nigeria, except the Warri and old Port Harcourt refineries, the new Port Harcourt and Kaduna refineries are designed to produce unleaded petrol if the FCC are functioning properly although meeting demand may constrain the use of easier process.

City	Range
Lagos	24.98-121.61 mg/kg
Ibadan	22.41-164.85 "
Kaduna	14.40-126.81 "
Abuja	5.24- 89.92 "
Port Harcourt	28.38- 67.78 "
Aba	2.34- 55.01 "

Removing lead does not remove vehicular emission as hydrocarbon; oxide of sulphur and nitrogen will still be emitted. There will be need to do something about these too since they also present environmental problems aiding photochemical reaction mentioned earlier.

The defunct Federal Environmental Protection Agency undertook a study of levels of lead in six towns of Lagos, Aba, Abuja, Ibadan, Kaduna and Port Harcourt. The soil samples were taken from roadside, motor parks, markets, etc. The lead content were staggering as well as frightening as tabulated below

SUGGESTIONS/RECOMMENDATIONS

- While writing this paper, I was overwhelmed by the graduation ceremony I watched on television of graduates from Peugeot Automobile Nigeria (PAN) Technical School Kaduna of automobile technicians. This ties up with the call in this paper for proper servicing of vehicles for optimum performance and should be encouraged.
- The refineries in this country should be fully evaluated with the aim of redesigning them to produce entirely unleaded petrol in the very near future. The phase out should be gradual, over at least five (5) years to take care of those vehicles presently suited to leaded petrol. Availability of leaded and unleaded petrol in filling station throughout the gradual phase out period should be ensured.
- The use of catalytic converters in vehicles that use unleaded petrol to control photochemical seeding.
- Give incentive to encourage change over to the unleaded petrol e.g. differential pricing in favour of the unleaded. The refineries should all be reviewed, equipped and re-engineered to produce the desired unleaded petrol.
- Importation to supplement local production if necessary should be unleaded as far as possible.
- Reliable mass transport system will greatly reduce the number of vehicles on our roads at any given time and therefore emissions.
- Communication systems particularly wire and wireless will greatly reduce travelling within and outside our places of abode and will reduce emission. The GSM cellular phone system is already coming in nicely and should rapidly expand to all nooks and corners to curtail movement and reduce vehicular emissions

All said and done, we should all endeavour to obey rules and regulations which at present is a let down in all facets of our lives. We all stand to benefit from the proceeds of a healthy environment but we must first cultivate the seeds.

Thank you for your audience and God bless.

4.12 LEAD PHASE-OUT IN GASOLINE IN NIGERIA

J.E. Gaius-Obaseki, JP
Group Managing Director
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LEAD PHASE-OUT IN GASOLINE IN NIGERIA

J.E.GAIUS-OBASEKI, JP
GROUP MANAGING DIRECTOR
NIGERIAN NATIONAL PETROLEUM CORPORATION

16TH NOV 2001

-1-

INTRODUCTION

- DRIVERS FOR PHASE-OUT OF LEAD
  - RISE IN LEVEL OF AWARENESS AND CONCERN FOR HSE ISSUES
  - INCREASING GLOBALISATION AND MARKET DE-REGULATION DRIVING INDUSTRY TO ADOPT WORLD-WIDE STANDARDS IN PRODUCT SPECIFICATIONS
  - INCREASING RECOGNITION OF CUSTOMER FOCUS AND DRIVE FOR QUALITY AS COMPETITION STRATEGY

-2-

SUPPLY & DEMAND OF GASOLINE

UP TO 1965: -
IMPORT DEPENDENT
- NO PIPELINES
- DUAL GRADES, LEAD NOT AN ISSUE

- 1965: -
- OPHR DOMESTIC PRODUCTION STARTED, (35,000bpd)
  - DUAL GRADES FROM IMPORTS AND PRODUCTION
- 1965-78:
- DEMAND INCREASED, REFINING CAPACITY AT 60KBPD
  - PIPELINE DISTRIBUTION, SOME PRODUCTS IMPORTED
  - INCREASING DEMAND FOR HIGHER OCTANE NUMBER
  - INCREASE IN LEAD INJECTION, LITTLE CONCERN FOR LEAD

-3-

SUPPLY & DEMAND OF GASOLINE

- 1978-89:
- WRPC COMMISSIONED 1978, KRPC IN 1980, NATIONAL REFINING CAPACITY INCREASED TO 295,000bpd
  - MORE CONVERSION UNITS(FCCUs IN BOTH WRPC & KRPC)FOLLOWING INCREASING DEMAND FOR HIGHER OCTANE .
  - SOME CONCERN FOR LEAD. STANDARD SET AT 0.45gPb/l
  - BOTH WRPC AND KRPC WERE CONFIGURED TO PRODUCE GASOLINE WELL BELOW THIS LEVEL; (KRPC –0.2gPb/l AND WRPC- 0.15gPb/l)

- 1989-1993:
- NPHR COMMISSIONED
  - GREATER CONCERN FOR LEAD & HSE WORLD-WIDE
  - CLEAN AIR ACT INTRODUCED IN USA
  - DEMAND FOR LEAD PHASE-OUT INCREASED RAPIDLY DURING THIS PERIOD

-4-

SUPPLY & DEMAND OF GASOLINE

1993- 2000:

- POOR FUNDING AND POOR MAINTENANCE LED TO EXTENSIVE DETERIORATION AND LOSS OF CAPACITY INSPITE OF INCREASED DEMAND
- IMPORTATION OF PMS INCREASED FROM ABOUT 20% IN EARLY 1990s TO 70% IN 2000

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CURRENT SITUATION

- INSTALLED GASOLINE CAPACITY = 22 MILLION l/day (ASSUMED THE PLANTS ARE WORKING OPTIMALLY AT FULL CAPACITY)
- GASOLINE DEMAND = 25 MILLION l/day
- AVAILABLE CAPACITY = 13 MILLION l/day
- LEAD CONTENT IS 0.2 gPb/l for KRPC & WRPC AND ZERO FOR PHRC

-6-

ON-GOING EFFORTS

- REFURBISHING WRPC AND KRPC PLANTS AND UTILITIES ESPECIALLY FCCU AND CRU

TO BE COMPLETED END 2002

THIS EFFORT IS EXPECTED

  - TO INCREASE THE CAPACITY UTILISATION TO 90% OF INSTALLED CAPACITY
  - YIELD AND QUANTITY TO BE OPTIMISED TO INCREASE GASOLINE CAPACITY TO 20 million liters
  - LEAD CONTENT OF 0.15gPb/l max.
  - REDUCE IMPORT OF PMS TO 20%

- BEYOND 2002 SOME INVESTMENT IS NECESSARY TO ELIMINATE LEAD

-7-

ON-GOING EFFORTS

- THE FOLLOWING PROJECTS ARE CURRENTLY UNDER CONSIDERATION
- INSTALLATION OF ISOMERIZATION PLANTS IN BOTH KRPC AND WRPC TO UPGRADE RON OF LIGHT NAPHTHAs
- TO UPSIZE AND UPGRADE THE CRU TO CCR PLANTS TO RUN IN BALANEC WITH CDUs AT 100% THROUGHPUT AT BOTH REFINERIES
- UPSIZE THE FCCU IN WRPC AND UPGRADE THE CONVERTER TECHNOLOGY OF THE KRPC FCCU
- INSTALLATION OF RFCCU IN AT LEAST ONE REFINERY

-8-

ESTIMATED TOTAL COST?

- US $200M FOR ISOMERISATION AND CCR UNITS
- TIME FRAME 2-3 YEARS
- $250 - $300 Million FOR FCCUs
- TIME 2-3 YEARS

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CONCLUSION

- NNPC MANAGEMENT IS COMMITTED TO PHASE-OUT LEAD FROM THE GASOLINE POOL IN NIGERIA
- DEREGULATION AND PRIVATISATION ARE EXPECTED TO BOOST THE LEAD PHASE-OUT PPROGRAM
- NIGERIA REMAINS THE KEY REFINING CENTRE IN THE W. AFRICAN SUB-REGION

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CONCLUSION cont'd

- THE INCREASING ECONOMIC TURNAROUND IN THE REGION, DEMANDS FOR HIGHER QUALITY GASOLINE AND COMPETITION FROM OTHER SUB-REGIONS WILL ALSO DRIVE THE PROCESS FORWARD
- THE CURRENT CONCERTED EFFORTS INVOLVING KEY PLAYERS IN THE INDUSTRY AND THE RELEVANT MINISTRIES (PR, ENV, IND, HEALTH, TRASPORT etc) IS THEREFORE TIMELY AND MOST WELCOMED BY NNPC.
- WITH THIS LEVEL OF COPERATIVE EFFORTS, WE SEE NO DIFFICULTIES IN ACHIEVING TOTAL LEAD PHASE-OUT IN NIGERIAN GASOLINE WITHIN THE NEXT 3-4 YEARS

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THANK YOU FOR LISTENING

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4.13 CLOSING REMARKS

Chief Ojo Maduekwe
Honourable Minister of Transport

It is indeed an honour and a most cherished privilege to witness this memorable moment marking the closing session of the conference on the Phase-out of Leaded Gasoline in Nigeria.

During the conference, we have learned of the various direct adverse health impacts, which the use of Leaded Gasoline has silently been having on the citizenry of this country, its contribution to our environmental degradation as well as its indirect negative contribution to productivity in general. It is really disheartening to hear that lead affects the mental and physical development of children, causes the elevation of blood pressure, cardio vascular conditions neurological and kidney diseases among adults. Equally, it is striking shocking, as the studies vindicate higher concentration of both airborne lead and blood lead levels in some major Nigerian cities.

It therefore has become apparent that we should take all necessary steps to ensure that the source of lead ingestion by our population is drastically reduced if not totally eliminated.

The major source of lead ingestion is airborne lead, of which over 90% is produced through exhaust from vehicles using leaded gasoline. However, in order for our economic life to flourish, there is need for transportation with heavy energy demand. At the same time we need to maintain an environment which is friendly and which is necessary for sustainable development. There is therefore need to strike a balance through the enunciation of workable policies that will make the realisation of our objectives under the three issues feasible.

Gasoline has been the predominant source of energy available not only to the rail and road transportation. It has equally been the source to the rail and road transportation. It has equally been the source to the manufacturing industry as an alternative to electricity. Attacking the root cause of lead pollution therefore becomes easy even though costly. Lead-free gasoline must be produced and all the chains of its distribution up till it reaches the pump must be cleaned. This needs a lot of financial outlay by the oil refining companies and the petroleum marketers. This Conference has addressed the issue and it is gratifying to note that the initiative had even been taken before now by the Nigerian National Petroleum Company (NNPC) to gradually reduce the lead content in gasoline it produces.

There is cause for concern by the end users of gasoline since there will be need to make engines of vehicles adapt to consumption of lead free gasoline. For this reason, the systematic phasing out of leaded gasoline is the only option as the minds of consumers have to be prepared and for them to also build this factor into their financial plans. It is worthy of note that other stakeholders including vehicle assembly companies and transporters are part of this Conference. There is the added need for a vigorous media campaign on this issue in order to educate all and sundry.

This brings me to other measures, which we at the Federal Ministry of Transport have been advocating for some time now that would become part of our National Transport Policy in order to establish a clean environment. The bicycle as a mode of transportation apart from being a non-pollutant equally improves the health of the user. It also reduces the traffic congestion especially in urban centres. In order to guarantee the safety of riders however, Government will consciously build in bicycle lanes in all future road networks in our urban areas.

It is my hope that relevant agencies will take a challenge from the outcome of the deliberations of this Conference to collectively work towards reducing or eliminating other sources of environmental pollution including other sources of lead ingestion by humans such as paints and cosmetics (e.g. kohl), other harmful automotive exhausts (nitrogen-oxide, carbon monoxide and hydrocarbons) etc.

During the course of the Conference, I have no doubt that a workable Action Plan for the phasing-out of lead in our gasoline had been agreed. It is paramount to carry along those neighbouring Countries who are dependent on our country for their refined oil imports in order for them to also put in place appropriate machinery for the new product.

Government of Nigeria is surely a listening government, and I can assure you of prompt action in whatever areas are designated as its responsibility.

Honourable Ministers, Permanent Secretaries, Distinguished participants, invited guests, members of the Press, Ladies and Gentlemen, I thank you all and wish you safe journey back to your respective destinations. Thank you and may the Almighty God bless us all.

I thank you for your attention.

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PREVIOUS WORKING PAPERS ON THE CLEAN AIR INITIATIVE IN SUB-SAHARAN AFRICA AVAILABLE FROM THE WORLD BANK

- **Working Paper No. 1**: Clean Air Initiative in Sub-Saharan African Cities - Dakar Seminar, December 17 & 18, 1998 - Urban Transport and Air Quality in Dakar - Proceedings (SSATP - Urban Mobility, September 1999).
- **Working Paper No. 2**: Air Quality Studies in Urban Context - Dakar and Ouagadougou Cases - Final Reports (SSATP - Urban Mobility, February 1999).
- **Working Paper No. 3**: Clean Air Initiative in Sub-Saharan African Cities - Work in Progress (January 2000).
- **Working Paper No. 4**: Air Quality Study in Urban Context - Cotonou Case - Synthesis (October 2000).
- **Working Paper No. 5**: Clean Air Initiative in Sub-Saharan African Cities - Regional Conference on the Phase-Out of Leaded Gasoline in Sub-Saharan Africa, Dakar, Senegal, June 26-28, 2001 — Proceedings (December 2001)

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