

# Environmental Health and Conservation News

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EXXON RESEARCH AND ENGINEERING CO. • ENVIRONMENTAL AFFAIRS PROGRAMS

## LEAD IN GASOLINE

Questions regarding lead in gasoline and its possible contribution to adverse health effects in humans have been raised in many countries where Exxon markets gasoline. This article discusses what is and what is not known about environmental contributions to body burdens of lead from various sources and the health implications of these burdens.

Lead is a useful metal, an integral part of the economy of both industrialized and developing countries. Many of its uses, however, may result in lead release and environmental contamination. This is most evident in urban areas, but even some remote areas show lead levels above the natural background. Thus, all members of the general population are exposed to a greater or lesser extent to lead. The major source for most people is food. This in turn comes from several sources. Food cans sometimes are manufactured with soldered joints which contain lead, some of which may be leached out into the contents. Food processing equipment may also contribute to lead levels. In addition, even fresh foods may have taken up lead from the soil, or been dusted with lead-containing particulate in the atmosphere. Finally, drinking water supplied through lead pipes will also contain some leached metal.

Other lead sources include, for children, the ingestion of leaded paint from walls and furniture. This is a major cause of overt lead poisoning. Children may also take in lead-containing soil and dust. Some adults may receive additional lead exposure in the workplace, and/or via tobacco smoke. Finally, everyone inhales finely-divided lead-containing airborne particulates.

The primary exposure route for lead in gasoline is from the atmosphere following fuel combustion. Finely divided particulates can remain suspended for long periods of time, and contribute to the inhalation burden just mentioned. Most of the emitted lead, however, is in the form of larger particulates that fall to the surface near roadways. It is this material that can contribute to body burdens from soil ingestion by children or by eating food from crops grown near roadways.

The effects of lead on the human body are readily detected at the high levels associated with acute intoxication. The causes, such as workplace exposure or childhood ingestion of paint, are also fairly easily defined, and not associated with lead in gasoline. It is the chronic, low-level exposures to lead, leading to relatively small increases in body burdens, which present the more puzzling diagnostic problem. The currently accepted medical

criteria for undue lead absorption in children include a blood lead concentration of 30 ug./dl. or more, coupled with biochemical indications of changes in red blood cell formation. It is believed that these findings constitute an early state of a continuous process that could culminate in a diseased condition. However, some researchers are now claiming harmful physical effects at levels even below 30 ug./dl. In addition, some studies have recently suggested adverse behavioral and cognitive consequences of childhood exposure to lead. Current research emphasis is aimed at clarifying these mental and low exposure physical effects in children. Blood cell formation can also be affected in adults, at approximately the same levels as in children. Some studies have also been carried out indicating the possibility of adverse chromosomal and reproductive effects at blood levels below 50 ug./dl.

Because of the numerous sources of lead exposure, and the uncertainties regarding adverse health effects from low-level exposure, it is not possible to derive a risk/benefit relationship for the continued use of leaded gasoline. Although we know such use does add incrementally to lead uptake from inhaled particulates and ingested food and soil, it does not appear to be a major factor over-

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## INCREASED GOVERNMENTAL AND INSTITUTIONAL PARTICIPATION BEING CONSIDERED FOR EXXON'S ENVIRONMENTAL RESEARCH

The newly established Contract Research Office (CRO) in Exxon Research and Engineering Company has developed a plan for 1980 and beyond. One of the key subject areas included in the CRO Plan is that of environmental assessment, toxics and safety. This article, based largely on the plan, describes CRO's overview of U.S. government and trade association activity in this area and some ER&E projects chosen for further implementation in 1980 into possible research proposals.

In the U.S. some sixteen federal agencies conduct environmental research and development, in-house or through contractors. In fiscal year 1980 they requested about \$2.4 billion for this work. Most of the programs of interest to Exxon are conducted in the Environmental Protection Agency, and the Departments of Energy and the Interior. The EPA R&D budget for 1980 totals approximately 340M\$, with energy, air and water the largest areas. Toxic substances is the fastest growing budget segment, however. The Energy Department environmental budget contains about 75M\$ in areas of direct Exxon interest. It emphasizes the generation of information aimed at assuring minimal environmental impact from the development of energy technologies. The DOE is also working on a liquified fuels safety assessment covering LNG, LPG, H<sub>2</sub>, NH<sub>3</sub> and alcohols, as well as comparing the relative merits of using chemical dispersants in fresh water environments for oil spill control. The Interior Department's Office of Water

Research and Technology budget contains about 11M\$ for water R&D, including saline water technology development.

Among U.S. trade associations, the Electric Power Research Institute, the American Petroleum Institute, and the Coordinating Research Council, through its Air Pollution Research Advisory Committee (APRAC), are most relevant to Exxon's interests. EPRI's environmental budget for 1979 was about 15M\$. It consisted of three basic areas: physical and ecological factors in coal combustion, and assessments of emerging technologies. The 1980 budget has not been finalized as of this writing. The API environmental budget for 1980 is some 5.8M\$, about equally divided between Environmental Affairs and Medical and Biological Sciences. (A description of the API's Environmental Affairs Department programs appeared in our last issue. A description of MBS Department programs appears in this issue.) The API, in addition, contributes 1.8M\$ to the CRC-APRAC effort. The latter work encompasses contract projects dealing with engineering, atmospheric and medical aspects of air pollution. The other half of CRC-APRAC's 3.6M\$ 1980 budget is supplied by the Motor Vehicle Manufacturers Association.

Based on this overview of outside needs and interests, and on an internal survey of Exxon's needs, interests and capabilities, a number of specific environmentally-related projects were identified for further development into possible contract proposals. These areas, listed and briefly summar-

ized below, run the gamut from well-defined programs with considerable R&D background in ER&E to speculative ideas which may well be eliminated upon further consideration.

- Programmed Combustion

A laboratory-demonstrated concept of sequential combustion capable of controlling emissions from fuel-bound sulfur and nitrogen. This project is aimed at demonstrating feasibility in a retrofitted industrial furnace.

- Thermal DeNOx Coal-Fired Boiler Test

The Thermal DeNOx process for control of NOx emissions from oil-fired boilers has already been demonstrated. It is expected that demonstrating this technology on coal-fired boilers will be conducted under proprietary auspices. Should this not be possible, however, a government-sponsored project will be sought.

- Development of Analytical Methods for Heterocyclic PNA Compounds

Work has already been initiated under Exxon support, to develop analytical techniques for these classes, which are present in petroleum products and may include carcinogenic members. The API has expressed interest in supporting this type of work and a contract will be sought in 1980.

- CO<sub>2</sub> Greenhouse Effect

Exxon-supported work is already underway to help define the seriousness of this problem.

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Such information is needed to assess the implications for future fossil fuel use. Government funding will be sought to expand the use of Exxon tankers in determining the capacity of the ocean to store CO<sub>2</sub>.

- Development of Short-Term Bio-Assay Methodology

Present test methods for carcinogen screening are expensive and time-consuming. At the same time, it is recognized that short-term tests are not reliable. If sufficient Exxon resources and incentives are identified for conducting a government supported method development program, outside funding will be sought.

- Evaluation of the Physical Behavior of Spilled Oil

In view of the world-wide concern over oil spill impacts, a

broadly supported fundamental study of the physical behavior of these spills would be useful. Various U.S. government agencies will be contacted regarding their interest in supporting a study of experimental systems capable of determining the emulsion-forming and sedimentation behavior of spilled oils.

- Model Validation for Vapor Travel From Cryogenic Liquid Spills

Exxon has an on-going program to develop estimation methods for storage tank spills. Because of the general interest in this problem, government and/or industry support will be sought to leverage Exxon funds and to broaden the scope of existing marine transport studies underway elsewhere.

- Control of Diesel Particulates

Several techniques have been suggested for controlling diesel particulate emissions. Exxon has an interest in the progress of these methods because of the potential impact on fuel quality requirements. In view of the lack of incentive for proprietary device development, however, government support will be sought.

- Adaptation of FCCU Scrubbing Technology to Coal Fired Boilers

Exxon has developed extensive know-how in jet ejector venturi scrubbing technology. This work would be a natural extension of that knowledge to help solve another environmental problem. If government interest is found, support would be sought for a pilot plant and system design/cost comparison study.

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## THE MEDICINE AND BIOLOGICAL SCIENCES DEPARTMENT OF THE AMERICAN PETROLEUM INSTITUTE—a review

The previous issue of this Newsletter described the organization of the API's environmental health and conservation activities, under the aegis of its Health and Environmental Sciences Committee. These activities are divided into the Environmental Affairs (DEA) and the Medicine and Biological Sciences (DMBS) Departments. The previous issue also outlined the activities of the DEA and the level of Exxon participation. The current article will complete this subject by outlining the work of the DMBS.

The DMBS effort is headed by a General Committee. There are also six technical committees. Exxon plays a major role in the work of these groups, with representatives from Exxon Corpora-

tion, Exxon Company, U.S.A., ER&E and Imperial Oil. Thus, Exxon has three members on the General Committee and is also well represented on the technical committees. The number of Exxon people on each committee are shown in parentheses below. Each technical committee is responsible for the planning and implementation of a variety of individual research projects. The total 1980 budget for such research and special projects is 3.4M\$, anticipated to increase to over 5M\$ in 1981.

- Occupational Health and Safety Committee (1)

Two projects are currently underway in this area; epidemiology studies of crude oil

workers and of other petroleum industry workers. Although the initial focus of both investigations will be on cancer incidence, other diseases will also be assessed. Proposals for future expansion of this epidemiology approach include studies of benzene and marine transport workers, a general population group residing near a petroleum refinery, and the occurrence of birth defects among industry worker offspring.

- Industrial Hygiene Committee (4)

Current projects under the IH Committee include work aimed at characterizing the physical

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and chemical agents that are associated with common refinery maintenance procedures. This will add to the body of knowledge already accumulated on the industrial hygiene of normal operations. Another project is evaluating sampling and analytical procedures which may be needed in the eventual development of control measures for workers involved in petroleum coking operations. A third program is determining worker exposures during sampling and gauging operations. Proposals for new work include the evaluation of possible worker hazards associated with refinery waste disposal, emissions during transfer and loading operations, and handling and disposal of catalysts.

● Toxicology Committee (3)

This area represents the single largest effort within the DMBS, accounting for some 2.3M\$ in 1980. The study of generic refinery streams and products accounts for the major share of these expenditures. Investigations are underway on effects such as carcinogenicity, mutagenicity, teratogenicity, polyneuropathy, reproductive problems, and various other acute, sub-chronic and chronic toxic manifestations. Among the streams and products being studied are such pure compounds as hexane, cyclohexane and benzene; petroleum coke; crude oil fractions; and various fuel, solvent and lube base-stocks and products as well as refinery catalysts. Not all effects are being studied on all materials of course, although one program is aimed at applying a full spectrum of toxico-

logical tests to some 20 generic refinery streams. The single largest program is devoted to a sub-chronic and chronic study of benzene toxicity, aimed at developing guidelines for permissible worker exposure and work practices, and medical monitoring procedures.

Some proposed areas for future study include the effect of petroleum hydrocarbons on behavior, as a function of developmental and life cycle stages; the determination of needed toxicological data in connection with forthcoming EPA regulations governing motor fuels, lubes and their emissions; the metabolism of hydrocarbons, including benzene; development of in-vitro bioassay test methods, particularly for carcinogenicity; and the immunologic effects of hydrocarbons.

● Regulatory Affairs Committee (1)

This group is charged with reviewing health-related legislation and regulations, coordinating the utilization of research findings and the development of responses, recommendations and research plans with other DMBS committees.

● Analytical Committee (1)

Currently sponsored efforts include the development of methods for heterocyclic compound measurement in petroleum, and the analysis of oil shales and retort oil for polycyclic aromatic hydrocarbons.

● Environmental Biology and Community Health (2)

Work underway includes a study of the metallic and organic composition of urban suspended particulate, and its

fate in the human lung; development of realistic bioassay methods for the toxicologic evaluation of petroleum industry solid waste leachate; preparation of monographs dealing with water and air quality, based on the collected literature; and the retention of expert consultants as needed to review and critique health-related governmental documents and proposed regulations which may adversely impact the petroleum industry. The Committee also hopes to generate a new project aimed at the assessment of present techniques used for the sampling, storage and mutagenicity testing of aqueous industrial effluents. If needed, improved methods will be sought.

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all. Removal of lead from gasoline would of course eliminate even the possibility that this incremental lead could aggravate adverse health effects. However, from a practical standpoint, given the benefits derived from lead's anti-knock properties, attention should first be devoted to minimizing exposure from the more significant and probably less useful sources.

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EAP is interested in printing pertinent articles submitted by others. Items of about 100-1000 words are requested, and the author will be identified. Articles, as well as comments and format, should be sent to E. L. Holt or R. V. Trense of EAP, Florham Park.