



TESTIMONY OF

Richard A. Lemen

Assistant Director

National Institute for Occupational Safety and Health

Centers for Disease Control

Public Health Service

Before the

Subcommittee on Health and Safety

Committee on Education and Labor

July 12, 1989

REPRODUCED BY  
U.S. DEPARTMENT OF COMMERCE  
NATIONAL TECHNICAL  
INFORMATION SERVICE  
SPRINGFIELD, VA 22161

I am Richard A. Lemen, Assistant Director of the National Institute for Occupational Safety and Health (NIOSH) of the Centers for Disease Control, in the Public Health Service of the Department of Health and Human Services. I appreciate this opportunity to report to you on the health effects of workers exposed to diesel exhaust.

NIOSH first made recommendations regarding exposure to diesel exhaust in 1976. NIOSH notified the Mine Enforcement Safety Administration (the forerunner of the Mine Safety and Health Administration) about the health effects of long-term exposure to a combination of coal dust, an agent known to cause the chronic lung disease - coal workers' pneumoconiosis, and the gases and vapors of diesel exhaust known to be pulmonary irritants. We recommended informing all concerned in the coal mining industry that, pending completion of adequate animal and human studies, further introduction of diesel equipment into underground coal mines might result in future economic disruption if their use was found to pose a health risk.

In the years following, several federal research groups evaluated the research on the health effects of exposure to diesel exhaust. These evaluations revealed few conclusive findings in the area. The data suggested that certain acute health effects were associated with exposure. There was concern about its potential carcinogenicity, and about minimizing miners' and other workers' exposure. However, animal studies had produced no unequivocal evidence of carcinogenicity.

In March 1986, NIOSH published a "white paper" on the effects of diesel exposures: Evaluation of the Potential Health Effects of Occupational Exposure to Diesel Exhaust in Underground Coal Mines. In that paper, NIOSH stated that there are few definitively proven associations between exposure to diesel exhaust and adverse health effects in humans. Among workers, there was evidence of an association between exposure to diesel exhaust and eye irritation, and reversible decrements in breathing capacity. In animals, an association between exposure to diesel exhaust and both obstructive and restrictive nonmalignant respiratory disease was documented. An association between exposure to whole diesel exhaust and cancer was not documented.

However, based on the results of studies of the effects of exposure to extracts of diesel exhaust on animals, such an association was plausible.

Areas where further research was needed were identified, and we concluded that NIOSH could neither affirm nor condemn use of diesel fuel in underground coal mines. As a matter of prudent public health policy, we recommended that exposure to diesel exhaust in mines should be maintained below those levels specified in existing standards promulgated by MSHA or, where more protective, below recommended exposure limits developed by NIOSH.

In August 1988, NIOSH issued the Current Intelligence Bulletin (CIB) #50: Carcinogenic Effects of Diesel Exhaust, representing a major development in NIOSH policy on diesel exposure. We recommended that whole diesel exhaust be regarded as a potential occupational carcinogen. As such, we recommended that employers should assess the conditions under which workers may be exposed to diesel exhaust and reduce exposures to the lowest feasible limit.

The development of this policy was based on the findings from five animal studies\* completed after publication of our White Paper, in which laboratory animals were exposed to diesel exhaust by inhalation. In these studies,

---

\*Referenced and summarized in the Appendix.

exposures of up to 30 months to various concentrations of primarily unfiltered diesel exhaust resulted in significantly increased incidence of malignant tumors, non-malignant tumors, and the total number of tumors in the animals.

The following is a brief discussion of these studies:

Heinrich et al. (1986) exposed rats, mice and hamsters to filtered and unfiltered diesel exhaust for up to 140 weeks. Among animals exposed to unfiltered and filtered exhaust, researchers found a significantly increased incidence of malignant lung tumors. Among animals exposed to unfiltered exhaust, researchers also found a significantly increased incidence of benign tumors squamous carcinomas.

Mauderly et al. (1987) found that high-level exposure to unfiltered diesel exhaust for 30 months led to statistically significant increases in malignant and benign lung tumors in rats. Intermediate-level exposure led to statistically significant increases in non-malignant tumors and in the total number of tumors. Low-exposure did not result in significant increases in benign or malignant tumors.

Brightwell et al. (1986) found high-level and moderate-level exposure to unfiltered exhaust for 24 months led to undefined tumors in rats.

Ishinishi et al. (1986) found that high-level exposure to unfiltered exhaust for up to 30 months led to significant increases in lung tumors in rats. Exposure to filtered exhaust did not result in a statistically significant increase in lung tumors.

Iwai et al. (1986) found that exposure to unfiltered exhaust for 24 months led to significant increases in lung tumors in rats. They also found significantly increased malignant lymphoma of the spleen, and increased incidence of total tumors (malignant and non-malignant combined) outside of the lung. Rats exposed to filtered exhaust showed minimal histopathologic changes in the lung, significantly increased malignant lymphoma of the spleen, and increased incidence of other tumors.

In addition to these animal studies, the current NIOSH policy also takes into account two epidemiologic studies conducted by Harvard University researchers published in 1987 and 1988. In 1987, Garshick et al. conducted a case-control study of deaths among U.S. railroad workers to test the hypothesis that lung cancer is associated with exposure to diesel exhaust. The study compared male railroad workers (such as engineers, firemen, brakemen, conductors, locomotive repair workers, and hostlers) whose jobs had

involved exposure to diesel exhaust with deceased workers not having occupational exposure to diesel exhaust (such as clerks and station agents). Among workers in occupations involving exposure for 20 years, who died before the age of 65, the researchers found a statistically significant increase in the relative risk of developing lung cancer.

In 1988, Garshick et al. conducted a retrospective cohort study of 55,407 railroad workers to confirm the results of the case-control study. The subjects were white males, aged 40 to 64 in 1959, who had started railroad service 10 to 20 years earlier. The researchers controlled for asbestos exposure, and although they could not eliminate effects from cigarette smoking, findings from a survey conducted in 1982 had revealed equal prevalence of cigarette smoking among 517 railroad workers with and without potential diesel exhaust exposure. The researchers found the workers in 1988 study also had a higher relative risk of developing lung cancer.

Although both epidemiologic studies were subject to limitations that restrict us from interpreting their findings as definitive evidence that diesel exhaust is an occupational carcinogen, the evidence suggests an association between occupational exposure to diesel engine emissions and lung

cancer. Considered in conjunction with the findings of the recent animal research findings, it supports the NIOSH recommendation that diesel exhaust be treated as a potential occupational carcinogen.

In addition to the publication of the Current Intelligence Bulletin, NIOSH has continued its efforts to address research and other needs associated with preventing occupational disease associated with diesel exhaust exposures.

In 1988, we provided technical assistance to the Mine Safety and Health Administration's "Advisory Committee on Standards and Regulations for Diesel-Powered Equipment in Underground Coal Mines." We advised the Secretary of Labor on health and safety standards related to the use of diesel-powered equipment in underground mines. The Committee provided its report to the Secretary in July 1988, recommending the initiation of a regulatory process and specific regulatory measures to control diesel exposures for the protection of workers.

In 1987, NIOSH completed a health hazard evaluation in Pennsylvania to investigate potential exposures of dock workers to exhaust emissions from diesel-powered forklift trucks and reported health effects. NIOSH

investigators found that measured airborne contaminants were below the relevant criteria, and nitrogen dioxide exposure that may have been high enough among some employees to cause complaints of irritation. Acute irritative health effects among workers consistent with symptoms of exposure to whole diesel exhaust were found. In concordance with NIOSH policy on the carcinogenic risks of this exposure, measures to reduce exposures were recommended. These recommendations included changes in work practices; improving ventilation and reducing the rate of exhaust emissions (with the assistance of the forklift manufacturers); and phasing out the use of diesel-powered forklift trucks in favor of propane or otherwise powered units. NIOSH is in the final review stage of a health hazard evaluation at a second trucking terminal located in Illinois.

In a third evaluation, NIOSH is investigating exposures at a diesel truck repair facility in Ohio. In a fourth, we are investigating exposures and reported potential health effects at a maintenance and administration facility of a municipal transit system in Wisconsin that uses diesel-powered buses.

Preliminary results from these evaluations indicate that a potential health hazard exists, based on the NIOSH recommendation that whole diesel

exhaust be regarded as a potential occupational carcinogen. In two of the evaluations, acute irritative health effects consistent with exposure to diesel exhaust has been reported. For each facility, we will recommend specific measures to reduce exposures to the lowest feasible limits.

NIOSH, in collaboration with the National Cancer Institute, also recently has completed a case-control study of lung cancer deaths in the Teamsters Union which compares the lung cancer risk of truck drivers with that of other job categories. The objective of the study is to investigate the effects of exposure to diesel exhaust. No direct exposure data was available on diesel exhaust. Instead, workers potentially exposed to diesel exhaust through driving, maintaining, or working in the vicinity of diesel trucks were compared with workers who had never held a job with potential for diesel exposure.

In our preliminary findings, no job category had a significantly elevated overall risk of lung cancer, compared with the non-exposed study group. However, we found a significant positive trend for long-haul truck drivers with increasing years of employment after 1959, when long-haul trucking fleets were converted to diesel. Workers who primarily drove diesel trucks showed a

similar increased risk with increased duration of employment, although the trend was not significant. Overall, the preliminary findings suggest that some types of truck drivers have an excess risk of lung cancer. This excess may be confined to truck driving after 1959 and may be confined to drivers of diesel trucks. The actual level of exposure is unknown. NIOSH is presently collecting data on diesel exposures in the trucking industry.

NIOSH has also been engaged in a cooperative endeavor with MSHA, the Bureau of Mines, and the Environmental Protection Agency to obtain the scientific basis needed to develop a sampling and analytical method for diesel emissions. We are currently preparing a research protocol for the development of this method.

Thank you for this opportunity to testify. I will be pleased to answer any questions.

APPENDIX

Heinrich et al. (1986). Chronic effects on the respiratory tract of hamsters, mice, and rats after long-term inhalation of high concentrations of filtered and unfiltered diesel engine emissions. *J Appl Toxicol* 6(6):383-395.

Researchers exposed laboratory animals (male and female rats, mice and hamsters) to filtered and unfiltered diesel exhaust ( $4 \text{ mg/m}^3$ , 19 hr/day, 5 days/week) for up to 140 weeks. Among animals exposed to unfiltered and filtered exhaust, researchers found significantly increased incidence of malignant lung tumors (adenocarcinomas, squamous cell carcinomas) and of the total number of tumors. Among animals exposed to unfiltered exhaust, researchers also found significantly increased incidence of benign tumors (benign squamous cell cysts).

Mauderly et al. (1987). Diesel exhaust is a pulmonary carcinogen in rats exposed chronically by inhalation. *Fund Appl Toxicol* 9:208-221.

Researchers found that high level exposure to unfiltered diesel exhaust ( $7 \text{ mg/m}^3$ , 7 hr/day, 5 days/week) for 30 months led to statistically significant increases in malignant and benign lung tumors in rats (adenocarcinomas, benign squamous cell cysts, squamous cell carcinomas). Intermediate-level exposure ( $3.5 \text{ mg/m}^3$ ) led to statistically significant increases in malignant tumors and the total number of tumors. Low-exposure ( $0.35 \text{ mg/m}^3$ ) did not result in significant increases in benign or malignant tumors.

Brightwell et al. (1986). Neoplastic and functional changes in rodents after chronic inhalation of engine exhaust emissions. Proceedings of the Symposium on Toxicological Effects of Emissions from Diesel Engines, Tsukuba City, Japan, July 26-28. New York, NY: Elsevier Science Publishers, pp. 471-487.

Researchers found that high-level ( $6.6 \text{ mg/m}^3$ , 16 hr/day, 5 days/week) and moderate-level ( $2.2 \text{ mg/m}^3$ ) exposure to unfiltered exhaust for 24 months led to significant increases in undefined tumors in rats.

Ishinishi et al. (1986). Long-term inhalation studies on effects of exhaust from heavy and light duty diesel engines on F344 rats. Proceedings of the Symposium on Toxicological Effects of Emissions from Diesel Engines, Tsukuba City, Japan, July 26-28. New York, NY: Elsevier Science Publishers, pp. 329-348.

Researchers found that high-level ( $4 \text{ mg/m}^3$ , 16 hr/day, 6 days/week) exposure to unfiltered exhaust for up to 30 months led to significant increases in lung tumors in rats (adenomas, adenocarcinomas, squamous cell carcinomas, adenosquamous carcinomas). Exposure to filtered exhaust ( $.019 \text{ mg/m}^3$ ) did not result in a statistically significant increase in lung tumors.

Iwai et al. (1986). Long-term inhalation studies of diesel exhaust on F344 SPF rats. Incidence of lung cancer and lymphoma. Proceedings of the Symposium on Toxicological Effects of Emissions from Diesel Engines, Tsukuba City, Japan, July 26-28. New York, NY: Elsevier Science Publishers, pp. 349-360.

Researchers found that exposure to unfiltered exhaust (4.9 mg/m<sup>3</sup>, 8 hr/day, 7 days/week) for 24 months led to significant increases in lung tumors in rats (adenomas, adenocarcinomas, adenosquamous carcinomas, squamous carcinomas, and large cell carcinomas). They also found significantly increased malignant lymphoma of the spleen, and increased incidence of tumors outside of the lung. Rats exposed to filtered exhaust showed minimal histopathologic changes, and also showed significantly increased malignant lymphoma of the spleen, and increased incidence of other tumors.

