The study group included 185 uranium miners who developed lung cancer. Smoking history, exposure to radiation in working level months (WLM), and tumor type were documented on each miner. One case of lung cancer was found in the non-cigarette smokers who were exposed to 1 to 300 WLM, while four cases were found among the smokers. The group exposed to 301 to 1000 WLM yielded two lung cancer cases in the non-cigarette smokers, and 36 in the cigarette smokers. Uranium miners with 1001 to 2000 WLM exposure developed five lung cancer cases in the non-cigarette smokers, and 30 in the cigarette smokers. The group receiving more than 2001 WLM exposure yielded 17 cases of lung cancer in the non-cigarette smokers, and 45 in the cigarette smokers. A slight increase in small cell cancers was found among the heavy cigarette smokers who were exposed to large doses of radiation.

SENSORY IRRITATION FROM EXPOSURE TO COMMON ORGANIC COMPOUND MIXTURES

To gain insight regarding the causes of "indoor climate symptoms" suffered by human subjects, studies were conducted at the Institute of Hygiene of the University of Aarhus, in Aarhus, Denmark. L. Mølhave, B. Bach and O. F. Pederson described the research at the Indoor Air and Human Health Symposium held in Knoxville, Tenn., Oct. 29-31. A brief summary follows:

> Sixty-two individuals with symptoms attributed to the indoor climate were exposed to various total concentrations (0, 5, 25 mg/m^3) of a mixture of 22 common indoor air pollutants in a climate chamber. Performance tests and investigations of irritation to the trigeminal nerve endings were undertaken as well as several subjective and objective measurements. The digit span test and the test of memory impairment showed significantly decreased scores during exposure to organic gases and vapors, whereas the graphic continuous performance test and the test of the ability to concentrate showed no significant effect of exposure. In two tests (Stinger's and the nasal spray test) designed to evaluate the sensitivity to irritation of the trigeminal nerve, no significant effects of exposure were found.

Industrial Hygiene News Report Jan. 1985

EVIDENCE FOR THE CARCINOGENICITY OF CADMIUM OXIDE

Citing a recent epidemiological study that has demonstrated a statistically significant excess of lung cancer mortality among workers exposed to cadmium oxide (CdO), the Nation Institute for Occupational Safety and Health has issued Current Intelligence Bulletin #42 recommending that cadmium and its compounds be regarded as potential occupational carcinogens. A recent epidemiological study reported by M. J. Thun, T. M. Schnorr, A. B. Smith, W. E. Halperin and R. A. Lemen that has been accepted for publication by the Jou nal of the National Cancer Institute, provides more persuasive evidence for the carcinoge city of cadmium oxide according to the NIOSH Bulletin which gives the following informatic

> Subsequent to a 1976 report of a study of workers in a cadmium production facility, the cohort was expanded from the original 292 workers to 602 white males who had worked at least six months between 1940 and 1969 in the cadmium production area of the cadmiu smelting plant. This expanded cohort was followed through 1978. Of the 602 workers, 345 had two or more years of total employment, including some for whom records w r not available at the time of the earlier study; the remaining 257 were short-term worke employed for six months to two years. Mortality from cancer of the respiratory tract was significantly greater in the entire cohort than would have been expected from rates in the general United States population (20 observed vs. 12.15 expected, standardized mortality ratio [SMR] = 165, 95% confidence interval [CI] = 101-254). All respiratory

cancer deaths were due to cancer of the lung, trachea, or bronchus. Within the subset of cadmium production workers employed at least two years, the SMR for lung cancer was 265 (20 observed vs. 7.60 expected, 95% CI = 162-409) and a significant excess was seen among those hired both before (four observed vs. 0.56 expected, SMR = 714, 95% CI = 195-1829) and after (16 observed vs. 7.00 expected, SMR = 229, 95% CI = 131-371) the cessation of arsenic smelting.

In this study, lung cancer mortality was also found to increase with increasing cumulative exposure to cadmium. Using categories based on a 40 year time weighted average at a given exposure concentration, SMRs were 53 at ≤ 40 $\mu g/m^3$, 152 at 41 to 200 $\mu g/m^3$, and 280 at >200 $\mu g/m^3$; the 95% CI at >200 $\mu g/m^3$ was 113-577. A regression slope calculated for directly standardized rate ratios (SRR) was 7.33×10^{-7} ($p = 0.0001$) with elevated lung cancer mortality at 41 to 200 $\mu g/m^3$ and >200 $\mu g/m^3$. The investigators stated that data provided by the company on smoking and on exposure to residual arsenic did not appear to account for the observed excess of lung cancer mortality. The findings of other recent epidemiological studies were said to be compatible with these results and provide limited additional epidemiological evidence for excess lung cancer mortality.

OIL SHALE PROCESSING OCCUPATIONAL CANCER RISKS FROM PAH

A scenario for the hydrocarbon-induced cancer risks for the occupational workforce for a one million barrels per day steady state production envisioned in the future was presented in Honolulu at the International Congress Dec. 16-21 by Paul Cho of the U.S. Department of Energy's Office of Health and Environmental Research (ER-73, Washington, DC 20545) and Lawrence B. Gratt of IWG Corporation, San Diego. A summary follows:

> The potential occupational cancer risks from polynuclear aromatic hydrocarbons (PAHs in the oil shale processing were assessed using surrogate industry epidemiologic studie and toxicologic data. For a future industry producing one million BPD of synfuel products, it was estimated that an excess cancer mortality of three to four cases per year would occur in the 15,000 person workforce at risk. This risk was based on various cancer sites (lung, stomach, kidney, brain, and skin). The cancer hazards do not appear substantial when compared with those of dust-induced diseases. Uncertainties in the analysis and the implications of the risk are intended as an aid in the formulation and management of a continuing health and environmental research program.

Two conclusions were drawn from this analysis of cancer in the oil shale workforce. First there is substantial uncertainty due to potential inaccuracy in health risk estimates for refinery workers, a paucity of data on exposure levels, and a lack of toxicologic data which can be linked to worker exposures. Second, in spite of these uncertainties, the analysis suggests that cancer hazards are not substantial, at least in comparison with dust-induced disease. In fact, risks of the predicted magnitude would be difficult if not impossible to detect using standard epidemiologic techniques. The upper bound estimates are less reassuring but also less probable than the "best estimates" which were presented.

> This analysis has provided an estimate of future risks and, by consideration of areas of uncertainty, provided suggestions for needed research. First, the accuracy of risk estimates among refinery workers needs to be improved. This is an area of active research and new results should be incorporated into future analyses. Second, realistic exposure estimates are needed for the oil shale industry workers. Systematic industria hygiene surveys are essential to establish better risk estimates and to prioritize control technology requirements. While toxicology studies have evaluated shale oil and