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INTERNATIONAL SALT COMPANY
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NIOSH INVESTIGATORS
RICK P. FERGUSON, IHIT
ELIZABETH B. KNUTTI, RN

I. Summary

In January 1988, the Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health (NIOSH), received a request for a health hazard evaluation from the International Chemical Workers Union (ICWU). NIOSH was requested to evaluate exposures to asbestos and diesel emissions at four salt mines located in Kansas, Texas, and Louisiana. On April 13, 1988, NIOSH conducted a walk-through survey at the International Salt mine and mill located on Avery Island, Louisiana. On November 29-30, 1988, medical and environmental evaluations were conducted at the International Salt mine and mill. The environmental evaluations consisted of personal, breathing zone and area air samples collected for coal tar pitch volatiles (CTPV), polynuclear aromatic hydrocarbons (PNA's), diesel particulates, oxides of nitrogen (NO, NO_2), carbon monoxide, and asbestos.

At International Salt, the only detectable overexposures were to coal tar pitch volatiles (CTPV) and nitrogen dioxide (NO_2). Nitrogen dioxide and CTPV's are by-products of combustion of petroleum based fuels. Fourteen CTPV samples were collected; eight personal and six area. Three of the fourteen samples had no detectable CTPV's. The remaining eleven samples ranged from 0.06 to 0.46 milligrams per cubic meter of air (mg/m^3), with ten exceeding NIOSH's Time-Weighted Average (TWA) recommended exposure limit (REL = 0.1 mg/m^3) and eight exceeding the MSHA Standard, 0.2 mg/m^3 as a TWA.

Nine full-shift personal NO_2 samples were collected on equipment operators; concentrations ranged from 2.2 to 3.5 parts per million (ppm) with a mean exposure of 2.9 ppm. All nine samples exceeded NIOSH's ceiling REL of one part per million. None of the samples exceeded MSHA's Standard (5 ppm as a ceiling limit).

Asbestos was not detected above the NIOSH/MSHA evaluation criteria in 13 airborne samples collected in the mill areas. However, chrysotile asbestos was identified in three air samples and in four of five bulk/settled dust samples collected from the #2 tower office, transite siding, and steam hoist area. Transite siding was being removed by a contractor on the day of this survey at the steam hoist house and from the old part of the mill housing the boilers.

All employees of the International Salt mine and mill were asked to participate in the medical portion of the health hazard evaluation. The medical evaluation consisted of a Medical Research Council (MRC) questionnaire on respiratory symptoms, smoking habits, demographic information and work history; chest x-rays; and pulmonary function tests. Of the approximately 240 employees, 159 (66%) participated. This number was almost evenly split between surface and underground workers, with 80 working underground and 78 working on the surface; one participant was a retiree. Forty-six (29%) employees were smokers, forty-nine (31%) were ex-smokers, and sixty-four (40%) claimed to have never smoked. The prevalences of chronic cough (13%) and chronic phlegm (17%) reported by International Salt workers were not statistically significant when compared to a group of non-exposed blue-collar workers. Underground workers complained more frequently of eye irritation and tearing of the eyes which is consistent with exposure to diesel by-products.

Pulmonary function results showed fourteen workers with mild obstruction, one with moderate obstruction and one with severe obstruction. All were over 40 years old and with one exception were either current or ex-smokers. There were two with mild restriction of lung volume. Of 159 chest x-rays, two were positive for pneumoconiosis with one having a median reading of $\geq$ 1/0 and one $\geq$ 1/1. Both occurred in underground workers who had a mean mining tenure of 34 years. Both workers also showed a mild obstructive pattern on their pulmonary function tests.

According to NIOSH/MSHA Evaluation Criteria, overexposures to CTPV existed in the mine during the survey. Overexposures to NO_2 in excess of the NIOSH REL were also measured.

Airborne asbestos exposures in the mill were below NIOSH/MSHA exposure criteria, but chrysotile asbestos was identified in air samples and samples of bulk materials and settled dust. Recommendations for reducing occupational exposures to these workplace contaminants and to conduct a follow-up medical questionnaire survey can be found in section VII of the report.

KEYWORDS: SIC 1479 (Salt Mines), Diesel Exhaust, Coal Tar Pitch Volatiles, PNA's, Asbestos, Oxides of Nitrogen.

II. Introduction

In January 1988, the Division of Respiratory Disease Studies, National Institute for Occupational Safety and Health (NIOSH), received a request for a health hazard evaluation from the project director, International Chemical Workers Union (ICWU) located in Akron, Ohio. NIOSH was requested to evaluate exposures (medically and environmentally) to asbestos and diesel emissions at four salt mines located in the states of Kansas, Texas, and Louisiana. NIOSH was also requested to evaluate the synergistic effects of exposure to asbestos/diesel. The synergistic effects were not evaluated because of insufficient numbers of study participants with exposures to the substances of concern. On April 13, 1988, NIOSH conducted a walk-through at the International Salt mine and mill located on Avery Island, Louisiana. The walk-through was used to help determine potential exposures to the ICWU workforce and to assist in the planning of the medical and environmental evaluations to be conducted at the mine and mill. The environmental and medical evaluations were conducted at this mine and mill (International Salt) on November 29-30, 1988.

III. Background

Avery Island is near Vermillion Bay on the Gulf of Mexico, about 125 miles west of New Orleans. Avery Island covers 2500 acres. Avery Island is a piercement salt dome which has pierced through overlying strata to reach the surface. This salt piercement actually created the island from the marsh as it rose 152 feet above the surrounding swamps. International Salt has been mining the salt dome since 1899 and has extracted millions of tons of rock salt. The first shaft was sunk 550 feet and eventually carved out rooms of salt up to 100 feet high. In 1973, a second shaft was sunk 1000 feet. The mine workings today extend a mile across the dome at its widest point.

In mine areas, the mass of the salt dome absorbs the humidity keeping it low and comfortable while the temperature usually stays a constant 70^0 F year round. On Avery Island, surface temperature ranged from 82 to 85^o F and a relative humidity ranging from 28 to 49%.

To enter a salt mine, miners go down a shaft to the salt bed. One side of this shaft is used to transport miners, and the other side is used to transport materials and equipment and to hoist mined salt. These shafts are usually 12 to 18 feet across. Salt is normally mined by the room and pillar method where solid salt pillars are left for roof support. At International Salt, the room height was 100 to 120 feet, and the haulage ways for transport vehicles were 40 to 60 feet wide. The volume of air moving through these rooms during this survey, per management measurements, averaged 355,000 cubic feet per minute (cfm).

The first step in the mining process is undercutting. Undercutting is accomplished by using an electrically driven machine to cut a 10 foot deep slot under a salt wall. This leaves a smooth floor for picking up the salt after blasting. Next, holes are drilled into the salt wall to a depth of 10 feet or more and explosives are inserted. At the end of the work shift, the explosives are detonated. International Salt works two production shifts four days a week; day and afternoon. There are a total of 33 miners on each shift. During the survey, International Salt had eight pieces of diesel equipment operating. After loading, the transport trucks haul the salt to a combination crusher/feeder which crushes the salt into smaller pieces and feeds the salt onto a conveyor belt. The conveyor belt carries the salt to a series of crushing and screening stations for further sizing, as needed, and then to a storage area. The salt is hoisted to the

surface in "skips" (large bins). Next, the salt is dumped onto a conveyor belt and transported to bins/silos for further processing.

The above ground processing of rock salt consist of sorting the mined salt which is 98% pure, into various marketable sizes. When sized, the salt is either packaged or sold in bulk and shipped by rail, truck, or barge.

IV. Methods

A. Environmental

On November 29-30, 1988, environmental samples were collected at the mine and mill on the day shift for exposures to coal tar pitch volatiles (CTPV), polynuclear aromatic hydrocarbons (PNA's), diesel particulates, nitric oxide (NO), nitrogen dioxide (NO_2), carbon monoxide (CO) and asbestos. At the mine, full-shift personal breathing zone samples were collected for NO/NO_2 and diesel particulates. Full-shift area samples for CTPV and PNA's were collected on the equipment. Partial-shift samples for carbon monoxide were collected on the equipment for four hours using solid sorbet tubes. Full-shift samples were normally placed on the equipment adjacent to the operator and within three feet of his breathing zone. On the surface, full-shift personal and area samples were collected for asbestos. Area samples were positioned mainly in the immediate work area.

The PNA samples were collected using a sampling pump calibrated at a flow rate of 2.0 lpm in-line with a 37 mm PTFE laminated filter with a 2.0 micrometer (um) pore size.[2] Connected to the filter was an Orbo-43 solid sorbet tube. The CTPV samples were collected at the same flow rate as the PNA samples and with the same type filter, except that it did not include the sorbet tube.[2] The diesel particulates were collected with a 1-stage, single-jet impactor that is inserted into a respirable dust sampling train (cyclone followed by an impactor followed by a filter). The effective cut-off diameter (ECD) for the impactor is 1.0 um aerodynamic diameter. The impactor consists of three parts. The first part is a 37 mm cassette with a modified orifice (0.1 cm diameter). The second part is a spacer, and the third part consists of a greased pre-weighed aluminum foil impaction plate containing four holes approximately 0.64 cm in diameter at 90° apart, and 1.14 cm from the plate's center. Air is pulled through the cyclone, impactor, and filter at a flow rate of 2.0 lpm.[3]

Nitric oxide and nitrogen dioxide were collected using the Palmes[4,5] passive dosimeter. The passive dosimeters are rigid, cylindrical, plastic tubes with a mesh screen at one end of the tube that is coated with triethanolamine. In the nitric oxide dosimeter, there is an impregnated filter containing chromic acid which is placed on top of the coated mesh screen. Carbon monoxide was monitored using a sampling pump calibrated at 20 cubic centimeters per minute in-line with a Drager long-term tube.[6]

Asbestos was collected using a sampling pump calibrated at a flow rate of 2.0 lpm in-line with a 25 mm, three piece cassette with a 50 mm electrically conductive extension cowl, mixed cellulose ester filter, (0.45 to 1.2 um pore size), and a backup pad.[2] Settled dust samples for asbestos were collected using a sampling pump calibrated at a flow rate of 4.0 lpm in-line with a 37 mm, two piece cassette containing a mixed cellulose ester filter with a backup pad. Preceding the filter, a plastic disposable syringe tip was used as a vacuum nozzle to collect the dust. This syringe tip was changed each time a sample was collected. The methods used to analyze the mine and mill environment are summarized in Table I.[2,3,4,5,6]

B. Medical

All employees of the International Salt Company in Avery Island, Louisiana were asked to participate in the medical portion of the health hazard evaluation.

A mobile trailer equipped with spirometers and an x-ray machine was parked at the mine site for the medical survey. After receiving an explanation of the tests and consenting to participate, each volunteer had standing height measured, received a posteroanterior chest radiograph, performed spirometry, and was administered a standardized questionnaire.

A modified version of the Medical Research Council (MRC) questionnaire on respiratory symptoms, supplemented with questions concerning smoking habits, demographic information, and occupational history, was administered by trained interviewers (Appendix I). In addition, participants were asked to classify the frequency of eleven acute symptoms experienced at work as "never/rarely", "sometimes", or "often". For purposes of this analysis, "chronic cough" was defined as a cough on most days for as much as three months each year. "Chronic phlegm" was defined as the production of phlegm on most days for as much as three months each year. "Chronic shortness of breath" meant having to stop for breath when walking at his/her own pace on level ground [Medical Research Council 1960].[7]

Spirometry was performed using a dry rolling-seal spirometer interfaced to a computer terminal with tape and disk storing capabilities. At least five maximal expiratory maneuvers were recorded for each person. All values were corrected to BTPS (body temperature, pressure, saturated with water vapor). The largest forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), and peak flow (PF) were selected for analysis regardless of the curves on which they occurred. The spirometer and methods met the quality control recommendations of the American Thoracic Society (ATS).[8]

Each chest radiograph was read independently by certified pneumoconiosis "B" readers who, without knowledge of the subjects' ages, occupations, or smoking histories, classified the films according to the 1980 ILO International Classification of Radiographs of the Pneumoconioses.[9] It is now extensively used internationally for epidemiological research, for the surveillance of those in dusty occupations and for clinical purposes. Parenchymal and pleural abnormalities are recorded. If there was a disagreement between the two readings, a third reading was obtained and the median profusion of the three readings was used for analysis. A chest radiograph was defined as positive for pneumoconiosis if at least two of the three "B" readers categorized small opacity profusion as 1/0 or greater.

To evaluate the potential for acute respiratory effects from occupational exposures, at the International Salt Company, the participants were compared with workers in nonexposed blue-collar occupations. Likelihood ratio tests for goodness-of-fit were used to compare the responses to questions about chronic cough and chronic phlegm to the prevalences expected if the workers at the International Salt mine had the same symptom prevalences reported by the non-exposed blue-collar workers.[10] Knowledge of each employee's smoking history was used to calculate the expected prevalences of these respiratory symptoms. Percent predicted pulmonary function values were calculated using Knudson's prediction equations.[11] The observed lung volume or flow rate converted to BTPS was divided by the predicted value and multiplied by 100 to obtain the percentage. In the absence of airway obstruction, a restrictive ventilatory impairment is present when the FVC is less than 80% of predicted. An obstructive ventilatory impairment is defined as an FEV_1 of less than 80% of predicted or an FEV_1/FVC% less than 70%. However, an occasional individual may be slightly below the normal value and not have a respiratory disorder. An analysis of covariance was used to determine if age-, height-, and smoking-adjusted mean pulmonary function values were different between surface and underground workers.

V. Evaluation Criteria and Toxicology

A. Criteria

Evaluation criteria are used as guidelines to assess the potential health effects of occupational exposures to substances and conditions found in the work environment. These criteria are generally established at levels that can be tolerated by most healthy workers occupationally exposed day after day for a working lifetime without adverse effects. Because of variations in individual susceptibility, a small percentage of workers may experience health problems or discomfort at exposure levels below these criteria. Consequently, it is important to understand that these evaluation criteria are guidelines, not absolute limits between safe and dangerous levels of exposure.

The primary sources of environmental evaluation criteria used in this report are: (1) NIOSH Recommended Exposure Limits (REL's), and (2) Mine Safety and Health Administration (MSHA) Standards. In evaluating the exposure levels and any recommendations for reducing the levels found in this report, it should be noted that the metal/non-metal surface and underground mining industry is mandated to meet the MSHA Standards (these MSHA Standards are adopted from criteria established in the 1973 ACGIH TLV's).[12] Often, the NIOSH REL's are lower than the corresponding MSHA Standards. NIOSH recommended exposure limits are usually based on the most recent information available and on the concerns related to the prevention of occupational disease.

A time-weighted average (TWA) exposure in this report refers to the average airborne concentration of a substance during a normal eight to ten-hour workday. Some substances have recommended short-term exposure criteria or ceiling (C) values which are intended to supplement the TWA where there are recognized toxic effects from high exposures. These exposure criteria and standards are commonly reported as parts per million (ppm), or milligrams per cubic meter of air (mg/m^3).

B. Toxicology

The following information describes the possible toxicological and physiological effects to workers exposed to the substances monitored during this survey. These effects are described so workers will be familiar with the symptoms and consequences of overexposure. The effects depend upon such factors as contaminant concentration, length of exposure, workload, individual susceptibility, and synergistic or additive effects of more than one substance.

Coal Tar Pitch Volatiles/Polynuclear Aromatic Hydrocarbons

Coal tar pitch volatiles (CTPV's) and polynuclear aromatic hydrocarbons (PNA's) are terms frequently encountered when dealing with coal tar and petroleum products. CTPV's are products from the combustion of petroleum products or the destructive distillation of bituminous coal. CTPV's contain polynuclear aromatic hydrocarbons (PNA's). These hydrocarbons sublime readily, thereby increasing the amounts of carcinogenic compounds in working areas.[13] Epidemiological evidence suggests that workers intimately exposed to the products of combustion or distillation are at an increased risk of cancer at such sites as the respiratory tract, kidney, bladder, and skin.[13] Coke oven workers, for which the CTPV standard was developed, have been found to be at the highest risk for lung and kidney cancer if employed for 5 or more years. While the agents responsible for cancers among coke oven workers are unidentified, it is suspected that several of the PNA's in CTPV's are involved. The primary hydrocarbons that are suspect human carcinogens are chrysene and benzo (a) pyrene.[14,15] These hydrocarbons are small in size, readily inhaled and typically represents 15-65% of the diesel exhaust particulates emitted from diesel powered vehicles.[16]

Diesel Particulates

Emissions from diesel engines consists of both gaseous and particulate fractions. The gaseous constituents include carbon dioxide, carbon monoxide, nitric oxide, nitrogen dioxide, oxides of sulfur and polynuclear aromatic hydrocarbons. Particulates in diesel exhaust are composed of solid carbon (soot) which tend to form clusters during combustion. As much as 15 to 65% of the diesel emissions are made up of organic compounds adsorbed onto the surface of particulates.[16] More than 95% of these particulates are less than one micron in size.[17] It has been suggested that the diesel exhaust acts as a carrier for the gaseous fractions of diesel emissions by transporting these fractions and other exhaust pollutants deeper into the lower regions of the lung. From animal studies, toxicological and epidemiological findings suggests that a potential health risk exists from exposure to diesel exhaust.[16] These studies serve as the basis for the current NIOSH conclusion that exposure to whole diesel exhaust is associated with the risk of cancer.

Nitric Oxide

Nitric oxide is a by-product of both combustion and the detonation of explosives. Nitric oxide (NO) is converted spontaneously in air to nitrogen dioxide and both gases are usually present together. At concentrations less than 50 ppm, this conversion is usually slow and can result in negligible quantities of nitrogen dioxide.[18] Animal experimental data indicates that nitric oxide is about one-fifth as toxic as nitrogen dioxide.[19] At 175 ppm, guinea pigs lived for an indefinite period, while at 322 ppm, methemoglobinemia was produced in 60% of the guinea pigs.[19] Methemoglobinemia results when oxygen in

the blood can not combine with the hemoglobin thus impairing the transport of oxygen. Information suggests that in mixtures with carbon monoxide and nitrogen dioxide, an additive exposure effect can occur. At concentrations less than 25 ppm, there is very little concern with chronic effects in humans.[19]

Nitrogen Dioxide

Nitrogen dioxide is formed from nitric oxide, a by-product of combustion of petroleum based fuels. Nitrogen dioxide is an irritant to the mucous membranes and may cause coughing accompanied by a mild or transient headache. The symptoms will usually subside after a few hours upon cessation of exposure. If exposure is long enough and the concentrations high enough, dyspnea (shortness of breath), persistent cough, cyanosis, bronchitis, and pulmonary edema can occur.[20] There have been several studies on the effects of continuous exposure at low concentrations.[19] One study found that rats exposed to 0.8 ppm had elevated respiratory rates and at 2.0 ppm, there were slight lung changes, but no effect on their life spans. Another study using mice found that at 0.5 ppm for 6, 18, and 24 hour daily exposures for three to twelve months, that there was an expansion in the alveoli of the lungs. Lesions appeared as would be consistent with the development of early focal emphysema. Several studies of higher concentrations have also been conducted. One study with rats using pure NO_2 at concentrations of 1, 5 and 25 ppm for 18 months showed no chronic effects. However, there were transient, acute changes in the lungs at weeks end.[19]

Industrial data on human exposures have not been conclusive; however, animal research has developed several important principles. First, intermittent NO_2 exposures are considerably less toxic than continuous exposure. Second, the hazard associated with NO_2 during continuous exposure is primarily determined by the peak and not by the average concentration.[18] The latter is supported by data that indicates an equivalent effect on the severity of respiratory infections from continuous exposures at 2.0 ppm and 0.5 ppm, with 1-hour peaks at 2.0 ppm, and that brief high level exposures are more hazardous than longer exposures at low concentrations.[20] There is a noted reduction in pulmonary function among normal adult males exposed to 4-5 ppm NO_2 for 10-15 minutes. Studies on individuals with bronchitis exposed to NO_2 concentrations above 1.5 ppm (not at or below this level) resulted in increased airway resistance.[20]

Carbon Monoxide

Carbon monoxide (CO) can be formed from the incomplete combustion of petroleum based fuels. Exposure to CO decreases the ability of the blood to carry oxygen to the tissue. Typical symptoms of acute CO poisoning are headache, dizziness, fatigue and nausea.[21] High concentrations of CO may be rapidly fatal without producing significant warning symptoms. Exposure to the gas may aggravate heart disease and artery disease and may cause chest pain in those with pre-existing heart disease. The MSHA Standard for CO is 50 ppm as a TWA. NIOSH recommends a TWA exposure limit of 35 ppm for CO to 1) prevent acute CO poisoning, 2) to prevent myocardial alterations by maintaining carboxy-hemoglobin at less than 5 percent, and 3) to prevent adverse behavioral effects.[2,13]

Asbestos

Increased health risk resulting from occupational exposure to asbestos has been well-documented in the scientific literature. Asbestos is associated with a chronic and debilitating lung disease which normally occurs following long-term exposures to high levels of asbestos fibers. More recently, asbestos has also been linked to several types of cancer, including mesothelioma and cancers of the lung, esophagus, stomach, and colon. These cancers usually appear many years after the initial contact with asbestos, and sometimes result from short-term and/or low-level exposures. This indicates that there may not be a "safe" level of exposure to asbestos for the elimination of all cancer risk. This risk is also greatly enhanced by cigarette smoking.[22]

NIOSH currently recommends that occupational exposure to asbestos be kept to the lowest feasible level that can reliably be determined.[22,24] This recommendation is based on the proven human carcinogenicity of asbestos and on the absence of a known threshold exposure level below which there is no risk of cancer. For most industrial settings, the lowest feasible limit for reliable detection of asbestos corresponds to a level of 0.1 fibers/cc.

VI. Results and Discussion

A. Environmental

The operation of diesel equipment at International Salt, Avery Island, was minimal. There could have been nine pieces of equipment operating; however, four pieces of equipment were in the shop for repairs or maintenance. Five pieces of equipment were monitored during the survey; three trucks and two loaders. Samples were also collected in the shop where the diesel equipment was being repaired.

Temperatures in the mine ranged from 82 to 85^{o} F over the shift, and the volume of air flowing through the mine, per management measurements, averaged 355,000 cfm. The room height throughout the areas monitored ranged between 100 to 120 feet and the haulage ways averaged between 40 to 60 feet wide. Because of the larger physical dimensions of dome salt mining, greater volumes of air are needed to move air to working sections in order to dilute/remove contaminants.

Three short-term nitrogen dioxide detector tube measurements were taken underground between the 900/1100 bench at 6:40 am, 8:00 am, and at 2:30 pm. NO_2 concentrations ranged from 0.5 to 4.0 ppm. Short-term detector tube measurements for carbon monoxide were also collected at these times with levels ranging from one to five ppm. Nitrogen dioxide (NO_2) levels became more elevated over the shift, and this indicates the air was not being directed to the work areas is sufficient quantities to dilute buildup of these exhaust gases. Nitrogen dioxide dosimeter samples worn by the equipment operators over the shift ranged from 2.2 to 3.5 ppm. None of the long-term dosimeter measurements or short-term detector tube samples for NO_2 exceeded MSHA's ceiling standard, 5 ppm. Two of the short-term detector tube samples and all of the long-term NO_2 dosimeter samples exceeded the NIOSH REL, 1 ppm as a ceiling concentration. Carbon monoxide did not exceed either NIOSH/MSHA criteria.

Coal Tar Pitch Volatiles/Polynuclear Aromatic Hydrocarbons

At the International Salt mine/mill, fourteen area samples were collected and analyzed for the benzene soluble CTPV's. The CTPV samples ranged from below detectable limits to 0.46 mg/m^3. Eight of the fourteen samples were personal samples; CTPV exposures ranged from 0.13 to 0.46 mg/m^3. All eight samples, worn by operators working the 900/1100 bench, exceeded NIOSH's REL (0.1 mg/m^3 as a TWA) and seven exceeded the MSHA Standard for CTPV (0.2 mg/m^3 as a TWA). Only one of the area samples in the maintenance shop exceeded NIOSH's CTPV REL. Those sampling results can be found in Table III and Summary Table X.

Twelve area PNA samples were also collected underground on the equipment or in the maintenance shop. Of 16 different PNA's analyzed on each sample, five were present at detectable levels in the underground samples. These PNA's were naphthalene, acenaphthene, acenaphthylene, fluorene and phenanthrene. Naphthalene concentrations ranged from ND (less than 0.001 mg/m^3) to 0.04 mg/m^3, well below the MSHA Standard of 50 mg/m^3. The other PNA concentrations ranged from ND (less than 0.001 mg/m^3) to 0.02 mg/m^3. The PNA levels (while low) did find quantifiable levels above the limit of detection (LOD) of the analytical procedure.

Naphthalene, technically, is not considered a PNA because it has only two fused benzene rings (a true PNA has three or more).[23] Because naphthalene is analyzed as a PNA, it's reported with PNA compounds. The PNA concentrations found in Table IV are the sum of the gaseous state PNA's collected on the back-up sorbet tube. No particulate PNA's were collected on the filter samples. Of the five PNA's detected, phenanthrene is considered a suspect carcinogen.[13,14] However, phenanthrene concentrations in air were low, at the detection limit for the analytical procedure (0.001 mg/m^3).

Diesel Particulate

Seven personal, breathing zone samples were collected from the operators of the trucks and loaders. The reason for sampling for diesel particulates was to determine the diesel fraction of the mine dust. The diesel fraction has been found to be in the submicron range, thus having the potential for reaching the lower airways of the lung. The diesel fraction is composed of solid carbon (soot), with organic compounds adsorbed onto its surface. The diesel fraction ranged from 0.07 to 0.25 mg/m^3, and the organic content of the diesel fraction ranged from 70 to 88%. Since there was no diesel operating outdoors during the survey, no diesel particulate samples were collected. There is currently no occupational standard for exposures to diesel particulates.

Nitric Oxide

Nine personal full-shift samples for nitric oxide were collected underground at the International Salt mine. The personal time-weighted average (TWA) concentrations ranged from 10.9 to 20.5 ppm. None of the samples exceeded the MSHA or NIOSH evaluation criterion of 25 ppm. The results are found in Table VI and Table X. No outdoor samples were collected.

Nitrogen Dioxide

At International Salt, nine full-shift personal samples for nitrogen dioxide were collected on the equipment operators. These nine personal samples ranged from 2.2 to 3.5 ppm, with a mean exposure of 2.9 ppm. The levels found indicate that the contaminants are not being effectively diluted by the volumes of air being moved through the mine. All nine samples exceeded NIOSH's ceiling REL of one ppm, but did not exceed MSHA's Standard, (5 ppm as AC) (see Table VI). Short-term detector tube readings taken over the shift also revealed that nitrogen dioxide was higher in the afternoon than in the morning, indicating that mine ventilation was inadequate to dilute contaminants.

Carbon Monoxide

On the first day, one short-term sample, collected 90 minutes after being underground, found five ppm of CO. Six long-term samples collected over the shift at the 900 bench, maintenance shop, and stock pile, had CO concentrations ranging from 1.4 to 7.0 ppm. On the second day, a short-term sample taken immediately after being underground, found one ppm of CO. The long-term CO sampling results ranged from 1.4 to 11.8 ppm. The only outdoor sample was below detectable limits for CO. None of the CO samples exceeded NIOSH/MSHA evaluation criteria. Sample results are found in Table VII and the summary Table X.

Asbestos

Thirteen airborne samples, six personal and seven area, were collected through out the mill, hoist house, control office, #2 tower and maintenance shop for asbestos. Five bulk samples of material thought to contain asbestos were collected from the #2 tower, steam hoist cylinders, and transite siding from the old mill (being removed by a private contractor at the time of the survey). The airborne samples were analyzed by transmission electron microscopy (TEM) which counts and identifies all of the fibers in a sample. The concentration of fibers on the personal and area samples ranged from 0.004 fibers per cubic centimeter (f/cc) to 0.013 f/cc although five samples were void because of an interference from other particulate material. Chrysotile was identified in two area air samples and one personal air sample, but the results were below NIOSH/MSHA evaluation criteria. (The NIOSH REL for asbestos is 0.1 f/cc as a TWA; the MSHA Standard for chrysotile asbestos is 2.0 f/cc.) Four of the five bulk samples identified chrysotile at concentrations ranging from < 1% to 50%. Two of the four bulk samples were vacuum samples of settled dust. Asbestos found in air and settled dust samples indicates that at some point in time, (1) that asbestos was friable and became airborne, or (2) that there has been repair or removal of asbestos containing material that released airborne asbestos fibers to settle on ledges, floors, light fixtures, etc. When disturbed by air currents or employees, this asbestos can become airborne and present a potential hazard. The asbestos sampling results can be found in Tables VIII and IX.

B. Medical

One hundred fifty-nine employees (66%), 155 males and 4 females, participated in the medical survey. This number was almost evenly split between surface and underground workers, with 80 working underground and 78 working on the surface; one participant was a retiree. The group had a mean age of 43 years. Forty-six (29%) employees were smokers, forty-nine (31%) were ex-smokers, and 64 (40%) claimed to have never smoked (Table XI).

The prevalences of chronic cough (13%) and chronic phlegm (17%) reported by the International Salt workers were not statistically different when compared to nonexposed blue-collar workers (Table XII). Chronic symptoms of cough and phlegm reported by the underground and surface workers were also very similar except for nonsmoking surface workers who reported a much lower rate. Questionnaire results indicated increased prevalences of chronic cough and phlegm among smokers. Shortness of breath was practically nonexistent with only one worker responding positively. When asked about acute symptoms related to their work, the responses for "often" were quite similar between surface and underground workers, except for eye irritation and tearing of the eyes. The underground workers complained more of these symptoms (Table XIII).

Of the 159 chest films taken, two were positive for pneumoconiosis, with one having a median reading of $\geq$ 1/0 of irregular shaped and the other $\geq$ 1/1 of rounded opacities. Both occurred in the underground workers who had a mean mining tenure of 34 years. Both workers also showed a mild obstructive lung disease pattern on their pulmonary function tests.

Table XIV contains the mean of pulmonary function results by smoking status. Mean height-, age-, and smoking-adjusted pulmonary function values were not significantly different between surface and underground workers (Table XV). Pulmonary function results showed 14 workers with mild obstruction, one with moderate obstruction and one with severe obstruction. All were over 40 years old and with one exception were either current or ex-smokers. A mild obstruction is defined as a FEV_1/FVC ratio between 61 to 69%. A moderate obstruction is defined as a FEV_1/FVC ratio between 45 and 60% and a severe obstructive pattern would fall below 45%. Normal is $\geq$ 70%. In restrictive pattern the ratio is normal, but the FVC falls below the lower limit of normal for that individual. In the case of a mild restrictive, the FVC observed/FVC predicted percent would fall in the 66 to 79% range.

VII. Conclusions/Recommendations

A. Environmental

Overexposures were found to CTPV's and NO_2 by NIOSH evaluation criteria. Eight CTPV samples exceeded the MSHA exposure standard. Because of studies which have been conducted with animals and humans, at various concentrations, it is NIOSH's position that no worker be exposed to NO_2 above the NIOSH REL of one ppm.[19,20] Nitrogen dioxide is a by-product from the combustion of fossil fuels, such as diesel. Its presence is indicative that more dilution ventilation is needed.

Because of the limitations in diesel technology, we can not confidently recommend control measures that would completely eliminate the exposures to diesel exhaust. It is NIOSH's position that materials contained in diesel exhaust are potential occupational carcinogens.[13,14,16] There is no safe or threshold concentrations for occupational exposure to carcinogens at this time. However, the following recommendations should minimize these exposures and related occupational health risk: (1) increase the volume of air in the working sections of the mine using portable fans with brattice cloth extensions to direct the air flow better, (2) continue scheduled engine maintenance, and (3) install engineering controls (scrubbers, filters, catalytical purifiers) to help reduce pollutants emitted.

Asbestos was identified in both air and settled dust samples. International Salt should inform the employees working in those areas about the presence of asbestos. More extensive asbestos abatement activities are recommended to prevent release of asbestos into the work environment.

B. Medical

Results indicate very little difference between surface and underground workers for prevalences of chronic cough and phlegm except for nonsmoking surface workers who reported a lower rate. The prevalences were not statistically different when compared to a nonexposed population, although current smokers at this mine reported higher prevalences of these chronic symptoms than ex- and nonsmokers. Underground workers complained more frequently of eye irritation and tearing of the eyes which is consistent with exposure to diesel by-products.

Radiographic evidence of pneumoconiosis was found in 1.3% (2/159) of the chest films taken of the current workers as compared to a 0.2% (3/1422) prevalence found in blue-collar workers with a minimal history of exposure to respiratory hazards.[25] Both positive x-rays occurred in underground workers with average mining tenures over 34 years.

Pulmonary function showed no difference between underground and surface workers. There were 16 cases of an obstructive lung disease pattern and two cases with restricted volume. All but one of the obstructed cases were either current or ex-smokers. Of the cases with restricted volumes, one was a current smoker and one had never smoked. In a group of nonexposed blue-collar workers the prevalences of an obstructive lung disease pattern was 8.1% compared to 10.1% observed in this group of workers (16/159). All of the mean FVC and FEV_1 percent predicted values (Table XIV) were greater than 100% for all smoking categories.

Considering the observed complaints of nasal and eye irritation in underground workers, a medical questionnaire survey should be conducted after the implementation of exposure controls to determine if these symptoms have been resolved. If these symptoms have not resolved, then further environmental and medical evaluation is indicated.

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IX. Authorship and Acknowledgements

Evaluation Conducted and Report Prepared by:	Rick Ferguson, IHIT Elizabeth Knutti, RN Respiratory Disease Hazard Evaluation and Technical Assistance Program Clinical Investigations Branch Division of Respiratory Disease Studies National Institute for Occupational Safety and Health Morgantown, West Virginia 26505
Statistical Analysis:	Kathleen B. Kinsley
Originating Office:	Hazard Evaluations and Technical Assistance Branch Division of Surveillance, Hazard Evaluations and Field Studies

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Copies of this report have been sent to:

1. AKZO Salt, Clarks Summit, Pennsylvania
2. Safety Director, Avery Island, Louisiana
3. ICWU, Akron, Ohio
4. ICWU, Local #27, Avery Island, Louisiana
5. MSHA District Office, Baton Rouge, Louisiana
6. Salt Institute, Alexandria, Virginia
7. NIOSH Regional Office IV

For the purpose of informing affected employees, copies of this report should be posted by the employer in a prominent place accessible to the employees for a period of 30 calendar days.

TABLE I

SAMPLING AND ANALYTICAL TECHNIQUES
International Salt Company
Avery Island, Louisiana

RDHETA 88-389

Agent/Substance Sampled	Sample Flow Rate(LPM)	Sampling Media	Analytical Method and Reference
Coal Tar Pitch volatiles	2.0	PTFE Laminated Membrane Filter	NIOSH Method 5023 Using Benzene as Extractor[2]
Polynuclear Aromatic Hydrocarbons	2.0	PTFE Filter/Orbo-43 Solid Sorbet Tube	NIOSH Method 5515/Gas Chromatography FID[2]
Diesel Particulate	2.0	Cyclone/Impactor PVC Filter	Gravimetric/LTA[3] NIOSH Method 7500[2]
Oxides of Nitrogen ($N0_x$, NO, NO_2)	---	Chromic acid disc Triethanolamine (Passive Dosimeter)	Visible Absorption Spectrophotometry[4,5]
Nitrogen Dioxide	100 cc/stroke	Short-Term Detector Tube	Direct Reading[6]
Carbon Monoxide	0.02	Long-Term Detector Tube	Direct Reading[6]
Carbon Monoxide	100 cc/stroke	Short-Term Detector Tube	Direct Reading[6]
Asbestos	2.0	Mixed Cellulose Esther Filter, Pore Size 0.8 um 25 mm Diameter	NIOSH Methods 7400/7402, Using "A" Rules[2]

Notes: LPM (Liters Per Minute)
NO_x, NO, NO_2 (Oxides of Nitrogen, Nitric Oxide, Nitrogen Dioxide)

TABLE II

EVALUATION CRITERIA
International Salt Company
Avery Island, Louisiana

RDHETA 88-389

Substance	NIOSH[24]	MSHA STANDARD[12]
Coal Tar Pitch Volatiles	0.1 mg/m^3 (TWA)	0.2 mg/m^3 (TWA)
PNA's	Lowest feasible limit	None
Diesel Particulates	Lowest feasible limit	None
Nitric Oxide	25 ppm (TWA)	25 ppm (TWA)
Nitrogen Dioxide	1 ppm (C)	5 ppm (C)
Carbon Monoxide	35 ppm (TWA)	50 ppm (TWA)
Asbestos	0.1 f/cc > 5 um in length	2.0 f/cc > 5 um in length

NOTE: References are listed in Section 7 of this report.
C (ceiling), TWA (time weighted average), f/cc (fibers per cubic centimeter greater than 5 um in length).

TABLE III

COAL TAR PITCH VOLATILES
International Salt Company
Avery Island, Louisiana

November 29-30, 1988
RDHETA 88-389

Date	Location	Job	Concentration (mg/m^3)
11/29/88	Mill	High Lift (A)	0.06
	900 Bench	Truck 220 (P)	0.39
	Maint.Shop (near office)	Area	0.30
	900 Bench	Truck 219 (P)	0.41
	Stock Pile	Loader 18 (P)	0.13
	900 Bench	Loader 21 (P)	0.36
	Outside (main parking lot)	Control (A)	ND
11/30/88	1100 Level	Truck 220 (P)	0.46
	1100 Level	Truck 221 (P)	0.45
	Stock Pile	Loader 18 (P)	0.35
	Outside (mill office)	Control (A)	ND
	Mill/Dump	High Lift (A)	ND
	Maint.Shop (on railing)	Area	0.15
	1100 Bench	Loader 220 (P)	0.41
	Limit of Detection (LOD) (mg/m^3)		0.06

ND (not detected), mg/m^3 (milligrams per cubic meter)

A (area), P (personal)

TABLE IV

POLYNUCLEAR AROMATIC HYDROCARBONS
International Salt Company
Avery Island, Louisiana

November 29-30, 1988
RDHETA 88-389

Date	Job/ Location(A)	Naphthalene (mg/m^3)	Acenaphthylene (mg/m^3)	Acenaphthene (mg/m^3)	Phenanthrene (mg/m^3)	Fluorene (mg/m^3)
11/29/88	High Lift	0.003	ND	ND	ND	ND
	Loader 20	0.03	0.02	0.01	0.002	0.001
	Truck 219	0.03	0.02	0.01	0.003	0.001
	Truck 220	0.03	0.02	0.01	0.004	0.001
	Maint.Shop	0.04	0.02	0.01	0.003	0.001
	Loader 18	0.03	0.02	0.01	0.001	0.001
	Outdoors	ND	ND	ND	ND	ND
11/30/88	Loader 18	0.03	0.02	0.01	0.001	0.001
	Truck 220	0.04	0.02	0.01	0.003	ND
	Loader 20	0.04	0.01	0.005	0.001	0.001
	Maint.Shop	ND	ND	ND	ND	ND
	Truck 221	0.04	0.02	0.01	0.002	ND
	High Lift	ND	ND	ND	ND	ND
	Limit of Detection (LOD) (mg/m^3)	0.001	0.001	0.001	0.001	0.001

Notes: A (area samples), ND (not detected), mg/m^3 (milligrams per cubic meter), PNA (polynuclear aromatic hydrocarbons)

Of 16 PNA's analyzed on each sample, five were detected. Only Naphthalene has an exposure limit of 50 mg/m^3 per the MSHA Standards. The 16 PNA's analyzed were:
(1) Benz(a)anthracene, (2) chrysene, (3) benzo(b)fluoranthene, (4) benzo(k)fluoranthene, (5) benzo(e)pyrene, (6) benzo(a)pyrene, (7) indeno(1,2,3-cd)pyrene, (8) dibenz(a,h)anthracene, (9) naphthalene, (10) acenaphthylene, (11) acenaphthene, (12) fluorene, (13) phenanthrene, (14) anthracene, (15) fluoranthene, (16) pyrene.

Table V

Diesel Particulate/Fraction
International Salt Company
Avery Island, Louisiana

November 29-30, 1988
RDHETA 88- 389

Date	Job (P)	Total Respirable Particulate (TWA) (mg/m^3)	Diesel Fraction (mg/m^3)	Fraction Percent
11/29/88	Truck Oper.(220)	0.90	0.25	72
	Truck Oper.(221)	1.03	0.15	86
	Loader Oper.(18)	0.80	0.24	70
11/30/88	Loader Oper.(20)	0.62	0.07	88
	Loader Oper.(18)	0.59	0.10	83
	Truck Oper.(221)	0.76	0.12	84
	Truck Oper.(220)	0.95	0.15	84
	Limit of Detection(LOD) (mg/m^3)	0.06		

Note: P(personal sample), mg/m^3 (milligrams per cubic meter)

TABLE VI

NITRIC OXIDE/NITROGEN DIOXIDE
International Salt Company
Avery Island, Louisiana

November 29-30, 1988
RDHETA 88-389

Date	Job/Vehicle No. (P)	NO_x Conc. TWA (ppm)	NO_2 Conc. TWA (PPM)	NO Conc. TWA (ppm)
11/29/88	Truck Oper.(220)	22.0	3.5	14.2
	Truck Oper.(221)	30.0	3.3	20.5
	Loader Oper.(18)	17.7	3.5	10.9
	Truck Oper.(219)	26.0	3.1	17.6
	Bobcat Oper.	21.0	3.3	13.6
11/30/88	Loader Oper.(18)	22.0	2.9	14.7
	Truck Oper.(221)	22.0	2.3	15.2
	Loader Oper.(20)	19.0	2.2	12.9
	Truck Oper.(220)	19.1	2.3	12.9

NOTES: NO_x (total oxides of nitrogen), NO_2 (nitrogen dioxide), NO (nitric oxide), ppm (parts per million), TWA (time weighted average), P (personal).

Nitric oxide (NO) is calculated from the E.D. Palmes[5] formula: $NO=NO_x-NO_2 \div 1.3$.

TABLE VII

CARBON MONOXIDE
International Salt Company
Avery Island, Louisiana

November 29-30, 1988
RDHETA 88-389

Date	Time	Location	Job(A)	Short Term Conc. (ppm)	Long Term Conc. (ppm)
11/29/88	0740-1400	Stock Pile	Loader 18	NT	5.0
	0800	Stock Pile	Area	5.0	NT
	0725-1420	900 Bench	Loader 20	NT	7.0
	0700-1400	Maint.Shop (near office)	Area	NT	4.8
	0715-1420	900 Bench	Truck 220	NT	4.7
	0720-1425	900 Bench	Truck 219	NT	4.7
	0800-1100	Stock Pile	Bobcat	NT	1.4
11/30/88	0600-1320	1100 Level	Truck 221	NT	8.5
	0605-1320	1100 Level	Truck 220	NT	11.8
	0540-1325	Stock Pile	Loader 18	NT	8.0
	0552-1255	Maint.Shop (railing)	Area	NT	4.8
	0617-1320	1100 Bench	Loader 20	NT	5.0
	0637	1100 Bench	Area	1.0	NT
	0700-1425	Outside (parking lot)	Control	NT	ND

NT (none taken), PPM (parts per million), ND (none detected)

(A) - All samples were collected on operated equipment or in areas where equipment was operating.

TABLE VIII

Airborne Asbestos Exposures
International Salt Company
Avery Island, Louisiana

November 29-30, 1988
RDHETA 88-389

Date	Location	Job	Ambient Conc. (f/cc)	Fiber Identification (TEM)
11/29/88	Outdoors	Area	0.004	Cellulose
	Near Bagging	Weight Checker (P)	Void	Void
	Loading Floor	Forklift Oper.(P)	Void	Void
	Hoist House	Area	0.013	Cellulose, Fiberglass, Chrysotile
	Mill	Mechanic (P)	Void	Void
11/30/88	Outside Mill (office)	Area	0.005	Fiberglass, Cellulose
	Outside	High Lift (Area)	0.009	Cellulose
	Control Oper. (office)	Area	0.008	Cellulose, Chrysotile
	Production Hoist House	Area	0.004	Cellulose
	Mill	Mechanic (P)	Void	Void
	Mill	Forklift Oper.(P)	Void	Void
	#2 Tower	Rockscreen Oper.(P)	0.02	Fiberglass, Cellulose, Chrysotile
	Maint.Shop	Area	0.004	Cellulose
	Limit of Quantitation (LOQ)		0.004 f/cc	

NOTES: Void (means the sample had an excess of particulate material other than fibers and a fiber count or identification could not be made).

F/cc (fibers per cubic centimeter greater than 5 um in length), P (personal sample), Area (area sample), TEM (transmission electron microscope).

TABLE IX

Bulk Asbestos Analysis

International Salt Company
Avery Island, Louisiana

November 29-30, 1988
RDHETA 88-389

Location	Sample	Type Asbestos/Material	Approx. Percent
#2 Tower (office)	Vac	Chrysotile	< 1
East Side Steam Cylinder	Vac	Chrysotile	10 to 20
Old Mill (Transite removal)	Bulk	Chrysotile	40 to 50
#2 Tower (office)	Bulk	Chrysotile	3 to 5
Steam Hoist (floor)	Bulk	ND	ND

Note: ND (none detected), Vac (vacuum sample), Bulk (piece of material).

TABLE X

SUMMARY SHEET
International Salt Company
Avery Island, Louisiana

November 29-30, 1988
RDHETA 88-389

Agent	Number of Samples	Concentration Range	MSHA TLV	NIOSH REL
Coal Tar Pitch Volatiles (UG)	14	ND to 0.46 mg/m^3	0.2 (TWA)	0.1 (TWA)
PNA's (UG)	12	ND to 0.04 mg/m^3	none	LFL
Diesel Particulates (UG)	7	0.07 to 0.25 mg/m^3	none	LFL
Nitric Oxide (UG) (PD)	9	10.9 to 20.5 ppm	25 (TWA)	25 (TWA)
Nitrogen Dioxide (UG) (PD)	9	2.2 to 3.5 ppm	5(C)	1(C)
Nitrogen Dioxide (UG)(ST)	3	0.5 to 4.0 ppm	5(C)	1(C)
Carbon Monoxide (UG)(LT)	11	1.4 to 11.8 ppm	50 (TWA)	35 (TWA)
Carbon Monoxide (UG)(ST)	2	1.0 to 5.0 ppm	50 (TWA)	35 (TWA)
Asbestos (S)	13	0.004 to 0.02 f/cc	2.0 f/cc (TWA)	0.1 f/cc (TWA)

Note: ND - none detected
LT - long term tube
ST - Short term tube
UG - underground
S - surface
C - ceiling
TWA - time weighted average
F/cc - fibers per cubic centimeter greater than 5 um in length
Mg/m^3 - milligrams per cubic meter
PPM - parts per million
LFL - lowest feasible limit
PD - passive dosimeter

TABLE XI

DEMOGRAPHIC CHARACTERISTICS BY SMOKING AND CURRENT JOB

International Salt Company
Avery Island, Louisiana

RDHETA 88-389

	SMOKERS		EX-SMOKERS		NONSMOKERS	
	UNDERGROUND	SURFACE	UNDERGROUND	SURFACE	UNDERGROUND	SURFACE
	N = 23 MEAN (SD)	N = 22 MEAN (SD)	N = 23 MEAN (SD)	N = 26 MEAN (SD)	N = 34 MEAN (SD)	N = 30 MEAN (SD)
AGE	41 (9.9)	49 (8.0)	44 (12.1)	44 (7.8)	40 (9.9)	44 (10.1)
HEIGHT (CM)	172 (6.4)	173 (5.8)	175 (6.8)	171 (6.3)	172 (7.0)	173 (7.8)
	%	%	%	%	%	%
RACE						
WHITE	39 (2H)	68 (3H)	78 (2H)	62 (4H)	44 (3H)	77 (1H)
BLACK	61	32 (1H)	22	38	56 (1H)	20 (1H)
ASIAN/PACIFIC						3
SEX						
MALE	100	100	100	92	100	93
FEMALE	--	--	--	8	--	7

H denotes Hispanic origin

TABLE XII

PERCENTAGE REPORTING CHRONIC SYMPTOMS BY SMOKING STATUS
International Salt Company
Avery Island, Louisiana

RDHETA 88-389

	INTERNATIONAL SALT MINE			BLUE COLLAR STUDY		
	SMOKERS	EX-SMOKERS	NONSMOKERS	SMOKERS	EX-SMOKERS	NONSMOKERS
CHRONIC COUGH	22 (10/45)	4 (2/48)	12 (8/64)	19.5	8.2	7.8
CHRONIC PHLEGM	30 (13/44)	19 (9/48)	6 (4/62)	17.7	13.1	7.6
CHRONIC SHORTNESS OF BREATH	0 (0/46)	0 (0/49)	2 (1/64)	3.4	3.4	1.6

TABLE XIII
NUMBER AND PERCENTAGE OF ACUTE SYMPTOMS REPORTED "OFTEN" BY CURRENT JOB CATEGORY

INTERNATIONAL SALT COMPANY
Avery Island, Louisiana

NOVEMBER 29-20, 1988
RDHETA 88-389

	SURFACE WORKERS N=76		UNDERGROUND WORKERS N=80	
ACUTE SYMPTOMS	N	(%)	N	(%)
COUGH	1	(1)	3	(4)
NOSE TICKLED/IRRITATED	4	(5)	4	(5)
SNEEZE	4	(5)	4	(5)
EYES ITCH/BURN	0	(0)	10	(12)
TEARING OF THE EYES	2	(3)	10	(12)
SORE THROAT	0	(0)	4	(5)
DIFFICULT/LABORED BREATHING	0	(0)	1	(1)
TIGHT/CONSTRICTED CHEST	0	(0)	0	(0)
UPSET STOMACH	0	(0)	1	(1)
CHEST WHEEZING/WHISTLING	0	(0)	1	(1)
HEADACHE	7	(9)	9	(11)

TABLE XIV

PULMONARY FUNCTION TEST RESULTS VS SMOKING STATUS
International Salt Company
Avery Island, Louisiana

RDHETA 88-389

	SMOKING STATUS					
	NEVER N=64		EX N=49		CURRENT N=46	
	MEAN	SD	MEAN	SD	MEAN	SD
FVC (l)	4.67	0.81	4.78	0.93	4.39	0.79
PERCENT PREDICTED FVC	111.8	14.9	115.3	18.6	111.9	20.4
FEV_1 (l)	3.83	0.66	3.73	0.70	3.34	0.72
PERCENT PREDICTED FEV_1	111.3	15.2	109.6	18.6	103.2	21.6
FEV_1/FVC RATIO (%)	82.2	5.5	78.3	6.3	76.0	9.6

NUMBER OF WORKERS: 159

TABLE XV

HEIGHT-, AGE-, AND SMOKING-ADJUSTED MEAN VALUES OF PULMONARY FUNCTION CLASSIFIED BY CURRENT JOB
MEAN (SE)
International Salt Company
Avery Island, Louisiana

RDHETA 88-389

	FVC (l)	FEV_1 (l)	FEV_1/FVC (%)
UNDERGROUND	4.62 (0.08)	3.63 (0.06)	78.9 (0.7)
SURFACE	4.62 (0.08)	3.68 (0.06)	79.5 (0.7)

APPENDIX 1

I, _____, voluntarily agree to participate in this Health Hazard Evaluation conducted by the National Institute for Occupational Safety and Health (NIOSH). I understand that I will be asked some questions about my work history, health and use of tobacco. I will also have my height and weight measured, a chest x-ray taken, and perform a simple pulmonary function test. I will receive my individual test results and, if I want, a copy of my results will be sent to my doctor. I have the right to ask questions of NIOSH and am free to terminate my consent and discontinue participation at any time without prejudice to myself.

Every effort will be made to safeguard the confidentiality of information collected in this survey, in accordance with the Privacy Act of 1974. The information will be used for statistical purposes and will not be disclosed in a manner which will identify me as an individual, except with my written permission or as requested by law to protect me and others.

Signature: _____ Date: _____

Investigator: _____

REQUEST AND AUTHORIZATION FOR RELEASE OF INFORMATION:

I _____, hereby request and authorize the Project Director to inform the following physician whose name and address I have entered below of any significant findings.
(Do not leave blank. Write "NO" if you do not wish to give a name and address)

Dr. _____

Street: _____

City/State: _____

SIGNATURE: _____ DATE _____

A. IDENTIFICATION

1. NAME (Last) (First) (Middle Initial)	3. PHONE NUMBER	4. SOCIAL SECURITY NUMBER**
2. CURRENT ADDRESS (Number, Street, or Rural Route, City or Town, County, State, Zip Code)	5. BIRTHDATE (Month, Day, Year)	6. AGE LAST BIRTHDAY
	7. SEX 1 ☐ MALE 2 ☐ FEMALE	8. STANDING HEIGHT ..... (cms.)
		9. WEIGHT ..... #
	10. RACE ☐ White ☐ Black ☐ Asian/Pac. ☐ Am. Indian/Eskimo ☐ Other Hispanic Origin Y/N	

ID #			
Date	MO	DAY	YR
Interviewer #			
PFT #			
X-ray #			
Before/After Shift, Neither	B A N		

B. OCCUPATIONAL HISTORY TABLE

Complete the following table showing the entire work history of the individual from present to initial employment. Sporadic, part-time periods of employment, each of no significant duration, should be grouped if possible.

INDUSTRY & LOCATION	TENURE OF EMPLOYMENT		SPECIFIC OCCUPATION	CODE	IF OCCUPATION IS MINING, INDICATE:				
	From 19—	To 19—			ORE	TRANS	MAINT	MISC	NON ORE
		Pr.							

B. OCCUPATIONAL HISTORY (Continued)

IDENTIFICATION NO

Record on lines the number of years in which subject has worked in any of the below listed industries.

Have you ever worked:

9. In any other type of mine? 1 ☐ Yes 2 ☐ No No. Yrs. .....

10. In a quarry? 1 ☐ Yes 2 ☐ No No. Yrs. .....

11. In a foundry? 1 ☐ Yes 2 ☐ No No. Yrs. .....

12. In a pottery? 1 ☐ Yes 2 ☐ No No. Yrs. .....

13. In a cotton, flax or hemp mill? 1 ☐ Yes 2 ☐ No No. Yrs. .....

14. With asbestos? 1 ☐ Yes 2 ☐ No No. Yrs. .....

15. In any other dusty job? 1 ☐ Yes 2 ☐ No No. Yrs. .....

(Specify) .....

.....

TOTAL NUMBER OF YEARS .....

C. SYMPTOMS

I am now going to ask you some questions, mainly about your chest. I would like you to answer "YES" or "NO" whenever possible.

COUGH

1. Do you usually cough first thing in the morning (on getting up*) in the winter? 1 ☐ Yes 2 ☐ No

   Count a cough with first smoke or on first going out of doors.

   Exclude clearing throat or a single cough.

2. Do you usually cough during the day (or at night*) in the winter? 1 ☐ Yes 2 ☐ No

   Ignore an occasional cough.

   If "No" to both questions 1 and 2, go to question 4.

   If "Yes" to either question 1 or 2:

3. Do you cough like this on most days (or nights*) for as much as three months each year? 1 ☐ Yes 2 ☐ No 9 ☐ NA

PHLEGM

4. Do you usually bring up any phlegm from your chest first thing in the morning (on getting up*) in the winter? 1 ☐ Yes 2 ☐ No

   Count phlegm with first smoke or on first going out of doors.
   Exclude phlegm from the nose. Count swallowed phlegm.

*For individuals who work at night.

PHLEGM (Continued)

5. Do you usually bring up any phlegm from your chest during the day (or at night*) in the winter?

   1 ☐ Yes 2 ☐ No

   Accept twice or more.

   If "No" to both questions 4 and 5, go to question 7.

   If "Yes" to either question 4 or 5:

6. Do you bring up phlegm like this on most days (or nights*) for as much as three months each year?

   1 ☐ Yes 2 ☐ No 9 ☐ NA

7. In the past three years have you had a period of (increased**) cough and phlegm lasting for three weeks or more?

   1 ☐ Yes 2 ☐ No

   If "No" to question 7, go to question 9.

   If "Yes" to question 7:

8. Have you had more than one such period?

   1 ☐ Yes 2 ☐ No 9 ☐ NA

9. Have you ever coughed up blood?

   1 ☐ Yes 2 ☐ No

   If "No" to question 9, go to question 11.

   If "Yes" to question 9:

10. Was this in the past year?

    1 ☐ Yes 2 ☐ No 9 ☐ NA

BREATHLESSNESS

11. Are you troubled by shortness of breath when hurrying on level ground or walking up a slight hill?

    1 ☐ Yes 2 ☐ No ☐ *** Disabled

    If "No" or "Disabled" to question 11, go to question 14.

    If "Yes" to question 11:

12. Do you get short of breath walking with other people of your own age on level ground?

    1 ☐ Yes 2 ☐ No 9 ☐ NA

    If "No" to question 12, go to question 14.

    If "Yes" to question 12.

13. Do you have to stop for breath when walking at your own pace on level ground?

    1 ☐ Yes 2 ☐ No 9 ☐ NA

WHEEZING

14. Does your chest ever sound wheezing or whistling?

    1 ☐ Yes 2 ☐ No

    If "No" to question 14, go to question 16.

    If "Yes" to question 14:

15. Do you get this most days — or nights?

    1 ☐ Yes 2 ☐ No 9 ☐ NA

*For individuals who work at night. **For individuals who usually have phlegm. ***Disabled from walking by any conditions other than heart or lung disease.

IDENTIFICATION NO.

WHEEZING (Continued)

16. Have you ever had attacks of shortness of breath with wheezing? 1 ☐ Yes 2 ☐ No

If "No" to question 16, go to question 18.

If "Yes" to question 16:

17. Is was your breathing absolutely normal between attacks? 1 ☐ Yes 2 ☐ No 9 ☐ NA

WEATHER

18. Does the weather affect your chest? 1 ☐ Yes 2 ☐ No
Only record "Yes" if adverse weather definitely and regularly causes chest symptoms.

If "No" to question 18, go to question 21.

If "Yes" to question 18:

19. Does the weather make you short of breath? 1 ☐ Yes 2 ☐ No 9 ☐ NA

20. What kind of weather? ..... 9 ☐ NA

NASAL DRAINAGE

21. Do you usually have a stuffy nose or drainage at the back of your nose in the winter? 1 ☐ Yes 2 ☐ No

22. Do you have this in the summer? 1 ☐ Yes 2 ☐ No

If "No" to both questions 21 and 22, go to question 24.

If "Yes" to either question 21 or 22:

23. Do you have this on most days for as much as three months each year? 1 ☐ Yes 2 ☐ No 9 ☐ NA

CHEST ILLNESSES

24. During the past three years have you had any chest illness which has kept you from your usual activities for as much as a week? 1 ☐ Yes 2 ☐ No

If "No" to question 24, go to question 27.

If "Yes" to question 24; ask questions 25 and 26.

25. Did you bring up more phlegm than usual in any of these illnesses? 1 ☐ Yes 2 ☐ No 9 ☐ NA

If "No" to question 25, go to question 27.

If "Yes" to question 25:

26. How many illnesses like this have you had in the past three years? _____ 9 ☐ NA

C. SYMPTOMS (Continued)

HAVE YOU EVER HAD (Insert proper code, questions 27 through 36)

27. An injury or operation affecting your chest?	☐	32. Pulmonary tuberculosis?	☐
28. Heart trouble?	☐	33. Bronchial asthma?	☐
29. Bronchitis?	☐	34. Emphysema?	☐
30. Pneumonia?	☐	35. Bronchiectasis?	☐
31. Pleurisy?	☐	36. Other chest trouble?	☐

Code 0 = No. 1 = Once. 2 = Twice 9 = Nine or more times Codes only 0 or 1 for questions 27, 28, 32, 33, 34 and 35

37. Have you ever been exposed regularly to irritating gas or chemical fumes? 1 ☐ Yes 2 ☐ No

38. Have you ever been exposed (within 30 feet) to the smoke of an underground cable fire? 1 ☐ Yes 2 ☐ No 9 ☐ NA
If so, how many .....

D. TOBACCO SMOKING

1. Do you now smoke cigarettes? 1 ☐ Yes 2 ☐ No

   If "Yes" to question 1, go to question 4.

   If "No" to question 1:

2. Have you ever smoked cigarettes? 1 ☐ Yes 2 ☐ No 9 ☐ NA

   If "Yes" to question 2, go to question 4.

   If "No" to question 2:

3. Have you smoked at least as many as five packs of cigarettes, that is, 100 cigarettes during your entire life? 1 ☐ Yes 2 ☐ No 9 ☐ NA

   If "Yes" to question 3, go to question 4.

   If "No" to question 3, go to question 9.

4. How old were you when you started smoking cigarettes regularly?
   If an ex-cigarette smoker, ask: ..... (Age in years)

5. How old were you when you last gave up smoking cigarettes? ..... (Age in years)

5a. During the years that you smoked, did you ever quit for a year or more? 1 ☐ Yes 2 ☐ No
If yes, how long? .....

6. How much do/did you smoke on the average? ..... (Cigarettes a day)

7. Do/did you inhale the cigarette smoke? 1 ☐ Yes 2 ☐ No

8. What do/did you mostly smoke? 1 ☐ Filters 2 ☐ Non-Filters
   1 ☐ Regular 2 ☐ King Size 3 ☐ 100 Millimeter

D. TOBACCO SMOKING (Continued)

IDENTIFICATION NO.

9. Do you now smoke a pipe? 1 ☐ Yes 2 ☐ No

If "Yes" to question 9, go to question 11.

If "No" to question 9:

10. Have you ever smoked a pipe? 1 ☐ Yes 2 ☐ No 9 ☐ NA

11. How many bowlsful a week do /did you smoke? _____

12. Do you now smoke cigars? 1 ☐ Yes 2 ☐ No

If "Yes" to question 12, go to question 14.

If "No" to question 12:

13. Have you ever smoked cigars? 1 ☐ Yes 2 ☐ No 9 ☐ NA

If "Yes" to question 13, go to question 14.

If "No" to question 13, end interview.

14. How many cigars a week do/did you smoke? _____

Use "did" only for ex-smokers.

E. ACUTE SYMPTOMS

1. While at work in your present job, how often do you have any of the following symptoms? (Circle only ONE number per line)

	Never or Rarely	Sometimes	Often
Cough	1	2	3
Nose Tickled or Irritated	1	2	3
Sneeze	1	2	3
Eyes Itch or Burn	1	2	3
Tearing of the Eyes	1	2	3
Sore Throat	1	2	3
Difficult or Labored Breathing	1	2	3
Tight or Constricted Feeling in the Chest	1	2	3
Upset Stomach	1	2	3
Chest Sound Wheezing or Whistling	1	2	3
Headache	1	2	3

2. Do you have any other medical complaints related to your job?

_____

_____