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PREFACE

The Hazard Evaluation and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 660(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer and authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The Hazard Evaluations and Technical Assistance Branch also provides, upon request, medical, nursing, and industrial hygiene technical and consultative assistance (TA) to federal, state, and local agencies; labor; industry; and other groups or individuals to control occupational health hazards and to prevent related trauma and disease.

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Exxon Chemical Company
Pottsville Film Plant
Polyethylene Film Department
Mar-Lin, Pennsylvania
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SUMMARY

In June 1992, the Division of Respiratory Disease Studies (DRDS), National Institute for Occupational Safety and Health (NIOSH) received a request from the Oil, Chemical and Atomic Workers International Union (OCAW) to conduct a health hazard evaluation at the polyethylene department of Exxon Chemicals, Pottsville Film Plant, Mar-Lin, Pennsylvania. Employee complaints identified in the request were respiratory problems, noise, skin irritation, and carpal tunnel syndrome. NIOSH investigators conducted an initial site visit and walk-through on October 15, 1992. An environmental and medical survey of respiratory complaints was conducted June 7-9, 1993.

The medical portion of the survey consisted of a medical questionnaire for current employees and telephone interviews of former employees. Thirty-seven of the 41 current employees of the polyethylene department participated in the study. Twenty-eight current employees reported exposure to irritating gases or chemical fumes during their work. Irritant symptoms, especially eye and nasal irritation were the symptoms reported most frequently. The percentage of former employees contacted was low (43%). Several former employees with pulmonary diseases reported that they had minimal exposure to the blown film process, and others had lung diseases consistent with prior work exposures or smoking. There was no evidence of any long term adverse health effects associated with work in the Exxon polyethylene department, either in current or former workers.

Personal breathing zone and area environmental air sampling was conducted for formaldehyde, arcolein, and hydrocarbons (volatile organic compounds). Formaldehyde was detected above the NIOSH REL of 0.016 ppm on three area air samples. Since the formaldehyde concentrations of those three samples were between the LOD and LOQ of the sampling method, they were considered as semi-quantitative estimates. However, this does not change the importance of the fact that the results were still above the NIOSH REL and indicate the potential for formaldehyde exposures. Trace amounts of the hydrocarbons 1,1,1-trichloroethane, cyclohexane, toluene, perchloroethylene, xylene isomers, and hexane were detected; but the amounts were insufficient to quantify. Total hydrocarbons, using n-octane as a standard, ranged from non-detected (ND) to 0.07 ppm.

The industrial hygiene findings of this health hazard evaluation (HHE) suggest that there is a potential for exposure to formaldehyde within the polyethylene film department. Irritant symptoms were reported, but there was no medical evidence of any long term adverse health effects associated with work in the Exxon polyethylene department, either in current or former workers. Recommendations include the continuation of company environmental monitoring and medical surveillance programs. It is also recommended that all process technicians receive periodic training on the company's Safety Critical Procedure of "Removing Stagnant Bubble Air." If after following this training, employees are still experiencing respiratory and eye irritation, it may be necessary to reevaluate and revise that policy to require the use of full face respiratory protection when working with or near bubble breaks.

Keywords: SIC Code 3081(Unsupported Plastic Film and Sheets), formaldehyde, acrolein, hydrocarbons, blown film, polyethylene.

INTRODUCTION

In June 1992, NIOSH received a request from the Oil, Chemical and Atomic Workers International Union (OCAW) on behalf of Local 8-719 to investigate employee complaints of respiratory problems, noise, skin irritation, and carpal tunnel syndrome in the polyethylene department of Exxon Chemicals in Mar-Lin, Pennsylvania. The request also asked that a group of retirees who have developed lung diseases be included in the medical evaluation.

On October 15, 1992, two NIOSH investigators, an industrial hygienist and a physician visited the Exxon plant. The NIOSH team conducted an opening conference with representatives of labor and management, toured the polyethylene department, and conducted brief interviews with several employees.

In response to this HHE request, medical and industrial hygiene surveys were conducted June 7-9, 1993. The medical survey consisted of a questionnaire asking employees about their health history and any respiratory symptoms they may have had in relation to their work. The industrial hygiene survey consisted of personal and area exposure assessments for formaldehyde, acrolein, and total hydrocarbons.

PROCESS DESCRIPTION

The polyethylene department currently employs 53 workers. These employees have an average age of 43 years and an average of 15.5 years of service. Five of these individuals are involved in bulk handling of the resin pellets and eight are involved in packaging of the final product. The 36 technicians are the individuals who actually operate the blown film machines. The remaining four employees are team leaders who have a supervisory role.

The polyethylene filming process operates 24 hours a day, seven days a week and is carried out by workers in eight-hour rotating shifts. The polyethylene film department is divided into two sections; the P-Lines and the 500 Lines. Both lines use basically the same process to produce a film bubble. The P-Lines are of an older technology and are somewhat limited on the width size of film which can be produced. The 500 Lines are of a newer technology and can produce large widths of polyethylene film.

Resin pellets produced at an Exxon facility in Baton Rogue, Louisiana, are usually shipped to the Pottsville plant by rail. Color concentrate and pellets made of recycled plastics arrive by truck. Recycled materials have been used in the plant for about a year and a half.

The bulk handlers deliver the resin pellets by forklift to each of the ten blown film machines. There are two electric and ten propane forklifts in the polyethylene department. Pellets are gravity-fed into most machines, except for those on the upper level to which pellets are air-pumped. Once in the machine, a combination of heat and pressure is used to melt the pellets. The machine is heated to 350°F and heat from friction raises the temperature of the molten resin to about 410°F. The molten material is then extruded through a die which has a chilled air ring. As this occurs, the material takes the shape of a bubble. This is a continuous sheet of polyethylene which ranges from 20-40 feet high depending on the machine set-up. On the five older machines (P-Line), the bubble air cools. The five new machines (500 Line) have a cooling stack inside the bubble. At the top of the polyethylene sheet is a series of rollers which collapse the bubble. The polyethylene then passes through another series of rollers where it receives an electrostatic charge which roughens the surface to allow it to accept printing ink applied by the customer. The air gap for this charge is 1/16 of an inch. The polyethylene tube is then slit to make two polyethylene sheets, which are then wound on a cardboard core. Any excess from the trimming process is returned to the extrusion area to be re-used. The machines located on the upper level operate in the same manner except that the melting and extrusion occur on the upper level and the slitting and winding occur on the lower level.

Employee concerns center around the problem of trapped gas being released from a bubble. The bubble does not spontaneously break, but is pierced by the operator. This may occur during a controlled shut down for a product change on the line or in the event of a "wrap-up" (film becomes entangled in the roller system). The company has a 'Safety Critical Procedure' designed to allow air trapped inside the bubble to dissipate before the bubble is pierced. Several

employees reported that they do not follow this procedure because it is not practical. Other employees reported no difficulties with this procedure.

Environmental sampling results from two studies conducted by Exxon were reviewed. The first study, conducted in October 1990, focused on potential bubble emissions. Samples were collected for formaldehyde, acrolein, and hydrocarbons.

Results showed that concentrations *within* the bubble ranged from 0.28 to 4.58 ppm for formaldehyde, 0.3 to 8.45 ppm for acrolein, and 10.58 to 364.7 ppm for total hydrocarbons. That study indicated a potential for exposure to operators working around the bubble, particularly if the bubble were to break.

The second assessment was conducted in March 1991. During that assessment, personal breathing zone samples were collected on "process technicians" within the polyethylene film department. Samples were collected for formaldehyde, acrolein, and hydrocarbons. Sampling times varied, with a maximum sampling period of 240 minutes. In addition, two short term samples of 29 and 30 minutes were collected on operators working near bubble breaks. Exposure concentrations ranged from 0.028 to 0.245 ppm for formaldehyde, 0.03 to 0.3 ppm for acrolein, and 0.37 to 0.98 ppm for total hydrocarbons.

METHODS

Industrial Hygiene

On June 8-9, 1993, environmental air samples were collected during the day shifts in the polyethylene department to evaluate exposures to formaldehyde, arcolein, and total hydrocarbons. Personal breathing zone air samples for formaldehyde and arcolein were collected on employees working on both the 500 Lines and the P Lines of the polyethylene department. In addition, area samples were collected throughout both lines to assess the potential for exposures to formaldehyde, arcolein, and total hydrocarbons.

Formaldehyde and Acrolein

Full shift personal breathing zone and area samples for formaldehyde and acrolein were collected on solid sorbent tubes (ORBO-23) using a constant flow sampling rate of 100 cubic centimeters per minute (cc/min). The collected samples were analyzed for each analyte utilizing a gas chromatograph equipped with a nitrogen-phosphorus detector according to NIOSH Analytical Methods 2501 and 2541.[1] The limit of detection (LOD) of this analytical procedure for formaldehyde and acrolein were 0.7 micrograms per sample (µg/sample) and 1.0 µg/sample, or approximately 0.013 ppm and 0.01 ppm; respectively. The limit of quantitation (LOQ) for this

formaldehyde and acrolein analysis was 2.1 µg/sample and 3.4 µg/sample, or approximately 0.04 ppm and 0.03 ppm; respectively. The LOD is defined as the smallest amount of analyte which can be distinguished from background. The LOQ is defined as the lowest amount of analyte that can be reported with acceptable precision.

General work area samples for formaldehyde were also collected using an impinger series containing a 1% sodium bisulfite ($NaHSO_4$) collection media and analyzed according to NIOSH Analytical Method 3500.[1] Two, 4-hour sets (for a total of 8 hours) of impinger series samples were collected at a flow rate of 400 cubic centimeters per minute (cc/minute) at each location sampled. After sampling, the collection media from each impinger was transferred to polyethylene vials for shipment to the laboratory. Analysis consists of adding a chromotropic acid-sulfuric acid solution to the absorbing solution which causes formaldehyde to react forming a colored chromogen. The absorbance of the colored solution was read by spectrophotometry and is proportional to the quantity of formaldehyde in the solution. The LOD and LOQ for this analysis was 1.0 µg/sample, or approximately 0.009 ppm and 3.1 µg/sample, or approximately 0.026 ppm, respectively.

Total Hydrocarbons

Full shift area samples for the estimation of potential total hydrocarbon exposure were collected on charcoal sorbent tubes at constant air flow sampling rates of 50 and 200 cc/min on 100 mg / 50 mg coconut shell charcoal tubes. Sampling times varied between 7-8 hours. Samples were qualitatively and quantitatively analyzed according to NIOSH Analytical Method 1501 using gas chromatography / mass spectrometry (GC/MS).[1] Bulk air samples were collected at the higher flow rate to saturate the sampling tube. These bulks are qualitatively screened using a gas chromatograph equipped with a flame ionization detector (GC/FID). If no hydrocarbon peaks are detected on the high flow rate samples during the initial screening; then no peaks would be expected to be detected on the lower flow (50 cc/min) samples. If hydrocarbon peaks are identified from the screening, then the lower flow sample would be analyzed and quantitated by the GC/MS for the specific compounds detected during the screening. Identification is made by matching the sample spectra to reference spectra. Once identified, the peaks are converted to concentrations for each hydrocarbon collected.

Medical

OSHA 200 logs for the years 1990, 1991, and through October 1992 were reviewed during the initial NIOSH visit. During the walk-through visit, brief confidential interviews were conducted with several employees. A list of 43 prior employees was provided by the union and each was sent a letter describing the NIOSH study and inviting them to participate by talking with a NIOSH physician.

During the medical survey of June 7-9, 1993, confidential interviews were held with employees from all shift teams. The medical survey consisted of a questionnaire asking employees about respiratory symptoms they had experienced in association with their work, and also about respiratory conditions such as asthma, chronic cough, and chronic phlegm.

EVALUATION CRITERIA

General Guidelines

As a guide to the evaluation of the hazard posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for assessment of a number of chemical and physical agents. These criteria are intended to suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It is important to note that not all workers will be protected from adverse health effects if their exposures are maintained below these levels. These evaluation criteria are guidelines, not absolute limits between safe and dangerous levels of exposure. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

In addition, some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the level set by the evaluation criterion. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental Industrial Hygienist' (ACGIH) Threshold Limit Values (TLVs)[2], and 3) the U.S. Department of Labor (OSHA) occupational health standards.[3] Both NIOSH recommendations and current ACGIH TLVs usually are lower than OSHA permissible exposure limits (PELs) because the OSHA standards may be required to take into account the feasibility of controlling exposures in various industries where the agents are used. The NIOSH recommended exposure limits (RELs), by contrast, are based primarily on concerns relating to the prevention of occupational disease. In evaluating the exposure levels and the recommendations for reducing these levels found in this report, it should be noted that industry is legally required to meet those levels specified by an OSHA standard.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended short-

term exposure limits (STEL) or ceiling (C) values which are intended to supplement the TWA where there are recognized toxic effects from high short-term exposures.

Formaldehyde

Formaldehyde is a colorless gas with a strong, pungent odor detectable at low concentrations; its odor threshold is approximately 0.8 ppm. Formaldehyde is an intense irritant of the eyes and upper respiratory tract; it causes both irritant and allergic contact dermatitis; and at high levels, it is carcinogenic in experimental animals and is considered a suspected human carcinogen.[4]

Because formaldehyde is such a strong irritant, actue systemic poisoning by inhalation is unlikely since workers would be compelled to leave the exposure area before levels sufficient to cause it were reached. Exposure to formaldehyde can cause a variety of symptoms. The first symptoms noticed on exposure at concentrations ranging from 0.1 to 5 ppm are burning of the eyes, tearing, and general irritation of the upper respiratory tract. Exposures on the order of 10 to 20 ppm are associated with coughing, tightness of the chest, feeling of pressure in the head, and palpitation of the heart.[5] A number of studies have suggested that formaldehyde causes asthma and/or exacerbates preexisting respiratory conditions. Small, transient declines in lung function parameters over the course of a workshift have been the most consistent finding.[4]

Exposure to formaldehyde can also occur through skin absorption. Allergic contact dermatitis due to skin contact with formaldehyde solutions and formaldehyde- containing resins is a well-recognized problem. Following skin contact, a symptom-free induction period typically ensues for 7 to 10 days. With subsequent contact, itching, redness, swelling, multiple blisters, and scaling occur in sensitized individuals. Repeated contact tends to cause more severe reactions, and sensitization usually persists for life.[6]

NIOSH, OSHA, and ACGIH have classified formaldehyde as a potential occupational carcinogen. NIOSH recommends that exposures to formaldehyde be controlled to the "lowest feasible limit" through the use of engineering controls. The lowest feasible limit typically refers to the limit of detection of the analytical method, which for formaldehyde is generally around 0.016 ppm. On May 27, 1992, OSHA amended its existing regulation (29 CFR 1910.1048) for occupational exposure to formaldehyde to take effect on June 26, 1992. The final amendments lowered the 8-hour PEL for formaldehyde from 1 ppm to an 8-hour TWA of 0.75 ppm.[7] The amendments also added medical removal protection provisions to supplement the existing medical surveillance requirements for those employees suffering significant eye, nose, or throat irritation, and for those suffering from dermal irritation or sensitization from occupational exposure to formaldehyde. Additional hazard labeling, including a warning that formaldehyde presents a potential cancer hazard, is required where formaldehyde air concentrations, under reasonably foreseeable conditions of use, may potentially exceed 0.5 ppm. The final amendment also provides for annual training of all employees exposed to airborne formaldehyde concentrations of 0.1 ppm or higher. The ACGIH has recommended that occupational exposure

to formaldehyde be controlled at a ceiling level so that no exposure exceed 0.3 ppm for any period of the work shift.

Acrolein

Acrolein, another acutely toxic aldehyde, produces intense irritation to the eyes and mucous membranes of the respiratory tract. Because of acrolein's pungent, offensive odor and the intense irritation of the conjunctiva and upper respiratory tract, severe toxic effects from acute exposure are rare as workers will not tolerate the vapor even in minimal concentrations. Acute exposure to acrolein may cause bronchial inflammation, resulting in bronchitis or pulmonary edema. The carcinogenic potential of acrolein has not been adequately determined, but one of its potential metabolites, glycidaldehyde, is considered to be carcinogenic.[8,9] Acrolein has been found to be mutagenic to bacteria and to induce sister chromatid exchange in vitro.[10] The NIOSH REL, ACGIH TLV, and the OSHA PEL for occupational exposure to acrolein is 0.1 ppm for a time-weighted exposure.

Hydrocarbons

Hydrocarbons describe a large class of chemicals which are organic (i.e., containing carbon) and have sufficiently high vapor pressure to allow some of the compound to exist in the gaseous state at room temperature. Not all hydrocarbons exhibit the same toxicological effects; therefore, exposure criteria are dependent on the particular hydrocarbon and toxic effect. Generally, overexposure to these substances may cause irritation of the eyes, respiratory tract, and skin. Since they are central nervous system depressants, overexposure may also cause fatigue, weakness, confusion, headache, dizziness, and drowsiness.

RESULTS

Industrial Hygiene

The potential for exposure to formaldehyde and acrolein during bubble cutting or breaking has been documented through previous Exxon sampling. For the sampling results reviewed, records indicate that personal exposure concentrations to formaldehyde were above the NIOSH REL of 0.016 ppm, but were below the OSHA PEL of 0.75 ppm. Acrolein exposures were measured above the OSHA, NIOSH, and ACGIH exposure criterion on two personal breathing zone air samples.

Formaldehyde

A total of 14 full shift personal breathing zone air samples for formaldehyde were collected on ORBO-23 sampling tubes during this investigation. Results from those samples, along with

sampling locations are shown in Table 1. In summary, 79% (11/14) samples showed no detectable formaldehyde concentrations. The remaining 21% (3/14) showed trace levels of formaldehyde; with all values falling between the LOD and LOQ for this analytical method. Values falling between the LOD and LOQ limits are considered as a semi-quantitative estimate. A semi-quantitative estimate of formaldehyde exposure from those three personal breathing zone samples were approximately 0.013 to 0.016 ppm. Two personal breathing zone sampling results were at the NIOSH REL of 0.016 ppm. No sampling results were above, or even approached, the OSHA PEL for a TWA occupational exposure to formaldehyde.

A total of 15 full shift work area samples were also collected for formaldehyde throughout the polyethylene department. Ten of these samples were collected using impingers and five on ORBO-23 sorbent tubes to determine the potential for formaldehyde exposures within the department. Results from those samples, along with sampling locations are shown in Table 2. In summary, all 10 area impingers samples showed trace amounts of formaldehyde, with all values falling between the LOD and LOQ of the analytical method. A semi-quantitative estimate of formaldehyde exposure from the 10 impingers samples ranged from approximately 0.009 to 0.018 ppm. Three work area samples exceeded the NIOSH REL for a TWA occupational exposure to formaldehyde. No sampling results were above, or even approached, the OSHA PEL for a TWA occupational exposure to formaldehyde. The five work area samples collected on the solid sorbent media also show similar results. One of the five sample showed a trace amount of formaldehyde, with the value falling between the LOD and LOQ for the analytical method.

Acrolein

A total of 14 full shift personal breathing zone air samples and 15 work area samples were collected to determine acrolein exposure. These samples were analyzed from the same solid sorbent media (ORBO-23) used for the formaldehyde analysis, thus the sampling locations shown in Table 1 and 2 would be the same. No acrolein was detected on any of the samples collected.

Hydrocarbons

Ten charcoal tube samples were collected at the work locations shown in Table 2. Of those ten samples, four were high volume bulk samples. These high volume bulk air samples were qualitatively screened for hydrocarbon peaks using GC/FID and GC/MSD analysis. Trace amounts of 1,1,1-trichloroethane, cyclohexane, toluene, perchloroethylene, xylene isomers, and hexane were detected on the high volume bulk samples. Since only trace quantities of various types of hydrocarbons were detected, and the analytical response factors vary for different types of hydrocarbons, i.e., aromatic, aliphatic, and chlorinated hydrocarbons, n-octane was chosen as

the standard to approximate the amount of total hydrocarbons on each low volume sample. The LOD and LOQ for this semi-quantitative analysis of total hydrocarbons, using n-octane as the standard, was 3 µg/tube and 9 µg/tube, or 0.03 ppm and 0.08 ppm; respectively. Results of this analysis showed that of the 10 samples, 7 had detectable trace quantities of hydrocarbons and 3 had no detectable hydrocarbons. Sample concentrations ranged from ND to 0.07 ppm of total hydrocarbons, with all values between the LOD and LOQ of the analytical method.

MEDICAL

Review of OSHA 200 logs

Review of the OSHA 200 logs for 1990, 1991, and through October 1992 revealed no reported respiratory conditions. As of the review date there had been four OSHA reportable injuries and illnesses in 1992, all lacerations. Only one injury involved lost or restricted work time, that being a hand laceration resulting in 18 days of restricted work. In 1991 there were eight OSHA reportable conditions, two lacerations, two musculoskeletal disorders, and four individuals who had standard hearing threshold shifts. A total of 84 days of restricted work and no lost days was reported for 1991. There were nine OSHA reportable injuries and illnesses in 1990 resulting in 55 days of restricted work activity and no lost days. The 1990 reports included one chemical burn, three lacerations, one upper extremity fracture, and four other musculoskeletal injuries. Of note, although carpal tunnel syndrome was mentioned in the health hazard evaluation request, no cases of carpal tunnel syndrome have been entered on the OSHA 200 logs for the past three years. These OSHA 200 logs are for the entire facility, not just the polyethylene department.

Former Employees

Letters were sent to each of the 43 former employees identified by the union. Former employees who did not respond by letter were contacted by telephone if a phone number had been provided. No contact was made with 23 of the 43 former employees. Eight of the prior employees indicated that they did not have lung problems. One individual contacted by telephone refused to participate in the study. One individual is deceased.

Five prior employees reported having lung problems which were we judged unlikely to be related to their work at Exxon. Three of these individuals had previous employment as coal miners, one for 10 years, one for 20 years, and one for 35 years. One of these individuals has been told that he has "black lung disease," and another has a chest x-ray felt by his physician to be consistent with pneumoconiosis. Two other individuals, one who has had a partial lobectomy for cancer and one who has had a laryngectomy, reported that they had little contact with the blown film machines.

This leaves three individuals with respiratory disease for which a cause has not been determined. For one, the only information available was from his daughter, who knew only that he had lung disease. The second individual stated that he had emphysema before he began work at Exxon, but that his condition was aggravated by his work, specifically by dust blown out of the grinders. The third employee worked in the blown film department for 24 years and has a diagnosis of recurrent vocal cord polyposis.

Medical Survey of Current Employees

Six employees were interviewed at the time of the walk-through survey, five who worked on the blown film machines and one bulk handler who delivers resin pellets to the machines. Four of the five blown film machine workers said that they had noted an irritant effect due to gas released after they pierced a bubble. Three of the four mentioned only tearing of the eyes as an irritant response, while the fourth mentioned "burning in the throat." The bulk handler felt that some of the resins have more dusts than others but had never experienced any respiratory or eye problems. None of the workers interviewed had ever had to leave work due to respiratory problems nor did they know of any fellow employees who had to do so.

Of the 41 employees of the polyethylene department, 37 participated in the study; 2 were on vacation or out-of-town assignment, and 2 declined to participate. Participants included 34 men and 3 women; their average age was 41 years. Employees had worked at Exxon for an average of 13.4 years, with a mean tenure in the polyethylene department of 11.6 years. Current smokers made up 46% of the group. Sixteen percent of respondents reported that they were ex-smokers, and 38% reported smoking less than five packs of cigarettes during their entire life and were therefore classified as never smokers.

Of the twenty-eight (76%) respondents who reported exposure to irritating gases, or vapors during their work, 64% reported that this had occurred within the last month, and 86% had experienced such an exposure within the past year. All workers who reported exposure to irritating gases or chemical vapors associated with work at Exxon described this in the setting of the release of gas from the polyethylene bubbles. The most common symptom reported in association with exposure to bubble gas was eye irritation (68%), followed by nasal irritation (35%), and shortness of breath or chest tightness (27%).

All workers, including those who did not report exposure to irritating gases or chemical vapors, were asked to complete a checklist indicating how often they had experienced a number of work-related symptoms. The symptoms included cough, chest tightness, shortness of breath, nasal irritation, eye irritation, wheezing, sore throat, and headache. Possible responses were never/rarely, sometimes, and often. Only ocular irritation was reported to occur sometimes or often by more than 50% of survey participants. Nasal irritation (46%), headache (41%), and cough (41%) were the next most common symptoms. No other symptom was reported to occur sometimes or often by more than 25% of the respondents (Table 3). In a separate question, 11 individuals reported symptoms of nasal irritation which improved when they were away from

work. Eight individuals reported red, itchy, or watery eyes which improved when they were away from work. Six individuals reported other symptoms which they felt to be job-related. Of these, only nosebleed, reported by two individuals, is likely to be associated with exposure to irritant gases.

Questions about chronic cough, chronic phlegm, dyspnea, chest tightness, wheezing, and attacks of shortness of breath were asked to assess the general pulmonary health of the study group. Six individuals reported chronic cough, defined as a cough on four or more days per week, totalling at least three months for at least the past two years. Four individuals reported chronic phlegm production, which was defined similarly. Eleven individuals reported "Grade 1 dyspnea," defined as shortness of breath when hurrying on level ground or walking up a slight hill, and two reported "Grade 2 dyspnea," defined as shortness of breath when walking on level ground with people one's own age. While eight individuals reported occasional chest tightness, none reported a temporal association between this and work. Ten individuals indicated that they have had wheezing or whistling noises in their chest, but only one has ever had an asthmatic attack as defined by attacks of shortness of breath with wheezing. No individual reported a history of asthma. Five individuals reported seeing a physician in the past year for respiratory problems, including allergies, colds, pneumonia, and one report of shortness of breath. No employee sought medical attention for eye irritation. Four individuals reported taking cough/cold preparations, antihistamines, or decongestants; none had a pulmonary condition which required the use of inhaled steroids, bronchodilators, or theophylline preparations.

The only statistically significant association between chronic conditions and symptoms suggestive of irritant exposures at work was that between chronic phlegm and sore throat at work ($p=.016$). Although chronic cough was related to experiencing chest tightness, shortness of breath, and wheezing at work, this association is often seen in the absence of irritant exposures. Not surprisingly, chronic cough was associated with cough at work and dyspnea on exertion was associated with shortness of breath at work. Individuals who reported nasal irritation at work were more likely to have visited a physician in the past year than those without nasal irritation, but none of the other work-related symptoms was associated with physician visits. There was no significant relationship between symptoms experienced at work and self-reported medications. Smoking status was not related to any job-related symptoms, to physician visits, or to use of medications. However, smokers were more likely to experience chronic cough ($p=.018$) and wheezing ($p=.032$) than were never smokers.

CONCLUSIONS AND RECOMMENDATIONS

Industrial Hygiene

The potential for exposure to formaldehyde and acrolein during bubble cutting or breaking has been documented through previous Exxon sampling and this NIOSH HHE investigation. Sampling results from this HHE investigation show that the potential for formaldehyde

exposures exists within the polyethylene department. Two personal breathing zone and three work area sampling results showed formaldehyde exposure at or above the NIOSH REL. No air sampling results for formaldehyde or acrolein exceed OSHA exposure criteria. It is important to note that not all workers will be necessarily protected from adverse health effects even if their exposures are maintained below these levels. These evaluation criteria are guidelines, not absolute limits between safe and dangerous levels of exposure. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

It is recommended that all process technicians receive periodic training on the company's Safety Critical Procedure of "Removing Stagnant Bubble Air." If after following this training, employees are still experiencing respiratory and eye irritation, it may be necessary to reevaluate and revise that policy to require the use of full face respiratory protection when working with or near bubble breaks. If respiratory protection is used, employees must be properly fit tested and trained. A respiratory protection program, as outlined in 29CFR 1910.134 should then be followed.

Medical

Approximately 75% of current polyethylene department workers who participated in this survey reported exposure to irritating gases or chemical vapors during their work, and 64% reported that they had experienced such an exposure within the last month. A high percentage of workers reported symptoms such as eye irritation, nasal irritation, headache, and cough in association with their workplace. The only association between a chronic condition and irritant symptoms was the relationship between chronic phlegm and sore throat. While this is a biologically plausible relationship, it is found in a series of multiple comparisons, and thus, may represent a chance finding.

Based on the findings of this survey, it appears that most current workers experience irritant effects in association with exposure to gas released from the polyethylene bubbles. However, there is no evidence that this leads to longterm adverse health effects.

The percentage of former employees contacted is too small (43%) and underepresentative to generalize about the respiratory health of this group as a whole. While several individuals have pulmonary diseases, these are likely to be associated with previous jobs or smoking. Other individuals have pulmonary disease, but report little or no exposure to the blown film process. Based on the information available, it does not appear that former employees of the Exxon polyethylene department have pulmonary diseases associated with work-related exposures at Exxon.

NIOSH recommends that medical surveillance be made available to all workers subject to occupational exposure to formaldehyde concentrations above the REL.[11] This medical

surveillance program is similar to that required by OSHA's 29 CFR 1910.1048 for occupational exposure to formaldehyde. It is recommended that Exxon continue its own environmental monitoring and medical surveillance program of workers exposed to bubble gases. This program should continue until air sampling results show exposure concentrations of formaldehyde and acrolein below the NIOSH REL's.

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1. Union Representative, OCAW Local 8-719
2. Plant Manager, Exxon Chemical Company, Pottsville Film Plant
3. Exxon Chemical Americas, Houston, Texas
4. OSHA Region III

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

Table 1.

Exxon Pottsville Film Plant
Polyethylene Film Department
Mar-Lin, PA
HETA 92-0297

Personal Sampling Results for Formaldehyde and Acrolein

DATE	SAMPLE NUMBER	SAMPLE VOLUME (liters)	LOCATION	ACROLEIN EXPOSURE (ppm)	FORMALDEHYDE EXPOSURE (ppm)
Jun 8	AR-15	40.7	Process Tech - P Line	ND	ND
Jun 8	AR-09	40.9	Process Tech - P Line	ND	ND
Jun 8	AR-06	40.5	Process Tech - P Line	ND	ND
Jun 8	AR-07	39.1	Process Tech - 500 Line	ND	ND
Jun 8	AR-10	40.4	Process Tech - 500 Line	ND	ND
Jun 8	AR-04	39.9	Process Tech - 500 Line	ND	ND
Jun 8	AR-08	39.8	Process Tech - 500 Line	ND	ND
Jun 9	AR-22	43.3	Process Tech - P Line	ND	ND
Jun 9	AR-33	43.1	Process Tech - P Line	ND	(0.016)
Jun 9	AR-37	43.1	Process Tech - P Line	ND	(0.013)
Jun 9	AR-26	41.9	Process Tech - 500 Line	ND	(0.016)
Jun 9	AR-11	43.3	Process Tech - 500 Line	ND	ND
Jun9	AR-29	42.3	Process Tech - 500 Line	ND	ND
Jun 9	AR-23	42.2	Process Tech - 500 Line	ND	ND

ND = Not Detected
( ) = Values falling between the LOD and LOQ limits are considered as a semi-quantitative estimate

Table 2.

Exxon Pottsville Film Plant
Polyethylene Film Department
Mar-Lin, PA
HETA 92-0297

Area Sampling Results for Acrolein, Formaldehyde, and Total Hydrocarbons

DATE	LOCATION	ACROLEIN (ppm)	FORMALDEHYDE (ppm)	TOTAL HYDROCARBONS (ppm)
Jun 8	P-6 Control Panel	ND	(0.018)†	(4)
Jun 8	P-4 Control Panel	ND	(0.009)†	(8)
Jun 8	P-3 Control Panel	ND	(0.013)†	(6)
Jun 8	P Line Smoking Area	ND	(0.018)†	(4)
Jun 8	P-1 Control Panel	ND	(0.017)†	(3)
Jun 9	501 Control Panel	ND	ND	ND
Jun 9	503 Control Panel	ND	(0.014)†	(5)
Jun 9	504 Control Panel	ND	(0.015)†	(4)
Jun 9	505 Control Panel	ND	(0.015)†	ND
Jun 9	505 Augar	ND	(0.015)†	ND
Jun 9	501 Top Deck	ND	ND‡	NS
Jun 9	503 Top Deck	ND	ND‡	NS
Jun 9	504 Top Deck	ND	ND‡	NS
Jun 9	505 Top Deck	ND	ND‡	NS
Jun 9	505 2nd Deck	ND	(0.013)‡	NS

† = Impinger sampling method
‡ = ORBO 23 sampling method

ND = Not Detected
NS = Not Sampled
( ) = Values falling between the LOD and LOQ limits are considered as a semi-quantitative estimate

Table 3.

Exxon Pottsville Film Plant
Polyethylene Film Department
Mar-Lin, PA
HETA 92-0297

Frequency of Symptoms While in Present Job
(N=37)

SYMPTOMS	NEVER OR RARELY	SOMETIMES	OFTEN
Cough	**60%**	**30%**	**11%**
Chest Tightness	**78%**	**16%**	**5%**
Shortness of Breath	**76%**	**19%**	**5%**
Nose Irritation	**54%**	**35%**	**11%**
Eyes Burning or Tearing	**46%**	**41%**	**14%**
Wheezing	**87%**	**14%**	**0%**
Sore Throat	**81%**	**16%**	**3%**
Headache	**60%**	**30%**	**11%**