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INTERNATIONAL ASSOCIATION OF FIRE FIGHTERS (IAFF)
HENDERSON, NEVADA

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I. SUMMARY

On May 16, 1991, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from the International Association of Fire Fighters (IAFF), on behalf of members in the Clark County, Nevada, and the City of Henderson, Nevada, fire departments. Fire fighters in these departments responded on May 6, 1991, to a chlorine leak at the Pioneer Chlor Alkali plant located just outside the Henderson city limits. The IAFF reported that several fire fighters who responded to this incident had developed respiratory symptoms that they attributed to chlorine exposure.

On May 28-29, 1991, three weeks after the incident, NIOSH investigators held joint meetings with representatives from the Henderson Fire Department (HFD) and the Clark County Fire Department (CCFD) management, the City of Henderson, and the two IAFF locals; in addition, separate meetings were conducted with representatives of the Clark County Health District and Pioneer Chemical. Private interviews were conducted with 10 HFD fire fighters and the physicians who had treated fire fighters during/after the incident. Information from these meetings, various records, and interviews were used to reconstruct events and procedures used during the incident response and to review incident medical care and fire fighter symptoms. Six months following the chlorine leak of May 6, 1991, 150 medical questionnaires were sent by mail to the involved police and fire departments for completion by workers potentially exposed during the incident.

According to available figures, approximately 200 fire fighters were involved in the response to this emergency. Eleven fire fighters were hospitalized or held for observation, and several others were reportedly injured by exposure to the chlorine. Many of the fire fighters complained of skin irritation and respiratory difficulty, even though they were wearing self-contained breathing apparatus (SCBA) and structural fire fighter's protective clothing. Although a Community Awareness and Emergency Response (CAER) plan had previously been devised by the chemical manufacturers at the industrial complex where the Pioneer plant is located and the local emergency response units, this plan was reportedly not activated. Air monitoring performed by the Clark County Health District (CCHD) indicated that chlorine concentrations during the incident ranged from less than 0.2 to 17 parts per million (ppm). Due to the weather conditions, the chlorine plume was unpredictable, and the command post was relocated on four occasions. Representatives from the responding agencies indicated that there were several instances of coordination and communication difficulties. Reported

concerns and problems encountered during the incident response included delays in the response of the hazardous materials teams, deployment, and use of appropriate personal protective equipment; the lack of a common communications frequency for all participating agencies; and the need for appropriate decontamination procedures.

NIOSH received a total of 59 completed questionnaires: 42 from fire fighters and 17 from individuals other than fire fighters. Most fire fighters responding to the questionnaire reported inhaling chlorine gas, even though most used respirators during the incident. Symptoms included coughing, tightness in the chest, wheezing, tearing eyes, sore throat, and/or headache after exposure to chlorine. Among the questionnaire respondents, symptom occurrence and severity were greatest among those stationed at the leak site. The duration of symptoms also appeared to increase with proximity to the chlorine leak. Symptom resolution was faster among respondents who did not wear respirators, which may suggest that the intensity of exposure experienced, the personal perception of respirator need, and improper respirator use were related to symptom duration.

Several fire fighters who responded to this incident experienced adverse health effects from chlorine gas exposure, including hospitalization and persistent respiratory symptoms. Many of the fire fighters complained of skin irritation and respiratory difficulty, even though they used SCBA's and their structural fire fighter's protective gear. The questionnaire data indicated that the duration and severity of respiratory symptoms tended to increase with the proximity to the leak site despite the use of respirators. However, the low response rate to the questionnaire survey and potential selection biases, limited the ability to further generalize the questionnaire data. Possible explanations for the occurrence of symptoms include the improper fit of, or delays in donning of, respiratory protection and the use of structural fire fighter's protective gear instead of appropriate chemical protective clothing. Recommendations regarding the response to this incident are presented in Section VIII of this report.

KEYWORDS: SIC 9224 (Fire Protection), fire fighters, firefighters, chlorine, respiratory symptoms, police, incident command system, health effects, self-contained breathing apparatus.

II. INTRODUCTION

On May 16, 1991, the National Institute for Occupational Safety and Health (NIOSH) received a request for a health hazard evaluation (HHE) from the International Association of Fire Fighters (IAFF), on behalf of members in the fire departments of Clark County, Nevada (CCFD), and the City of Henderson, Nevada (HFD). Fire fighters in these departments responded on May 6, 1991, to a chlorine leak at the Pioneer Chlor Alkali plant, which is located in a large industrial complex adjacent to the Henderson city limits but within Clark County's jurisdiction. The IAFF reported that several fire fighters had developed respiratory symptoms attributed to chlorine exposure. The IAFF requested that NIOSH evaluate the adequacy of procedures followed during the fire departments' response to this leak and to evaluate the medical care and monitoring provided to all exposed fire fighters.

On May 28-30, 1991, NIOSH investigators conducted an initial site visit to the HFD in Henderson and the CCFD in Las Vegas. During the visit, the NIOSH investigators held meetings with representatives from the fire departments' management, the City of Henderson, and IAFF locals 1883 and 1908. In addition, separate meetings were conducted with representatives of the Clark County Health District and Pioneer Chemical. Private interviews were conducted with 10 Henderson fire fighters. Physicians who had treated fire fighters were interviewed by telephone, and additional information, including incident, medical, and compensation reports, was collected to reconstruct the events during the chlorine leak and subsequent health effects. After the initial site visits, the NIOSH investigators designed and distributed questionnaires to fire fighters involved with this incident response to investigate the respiratory protection of workers and respiratory symptoms related to the incident.

III. BACKGROUND

On the morning of May 6, 1991, beginning around 1:10 a.m., a leak developed in a chlorine transfer pipe at the Pioneer Chlor Alkali Plant located at the Basic Management Incorporated (BMI) complex in Henderson, Nevada. The BMI complex is a private organization of four companies (Timet, Stouffer, Kerr McGee, and Pioneer) that operate chemical and fuel production facilities adjacent to Henderson, Nevada. The chlorine leak occurred in a pipe that connects a chlorine storage tank to a heat exchanger. Chlorine is separated from aqueous solutions of sodium chloride, commonly called brine, by electrochemical decomposition. The resultant chlorine is cooled in a heat exchanger and is then piped to a storage tank. A transfer pipe, leading to a chlorine storage tank containing approximately 150 tons of liquid chlorine, had corroded and developed a one-inch hole, which began leaking the chlorine gas. The

leak resulted in the uncontrolled release of chlorine gas, which eventually spread beyond the boundaries of the plant. At 2:14 a.m., the CCFD was notified by a citizen's complaint of a noxious odor.

Although a Community Awareness and Emergency Response (CAER) plan had been devised by the chemical manufacturers at the BMI complex and the local emergency response units, this plan was reportedly not activated by the Pioneer Chlor Alkali plant staff. Since this plan had not been activated, and since the CCFD receives approximately 50 complaint calls of this type per year involving the BMI complex, the first CCFD fire fighters to arrive at the BMI complex stopped at the guard shack to inquire about the presence of a leak. A team of two fire fighters was questioning the Pioneer personnel at the guard shack when an alarm sounded as chlorine from the leak reached the guard shack. The two fire fighters were immediately overcome by the chlorine, which resulted in coughing, tearing of the eyes, and bloody sputum. Due to the proximity of the HFD to the BMI complex, the CCFD requested mutual aid from the HFD, which dispatched a rescue squad. The rescue squad assisted the downed fire fighters and transported them to a nearby hospital. Units from both fire departments arrived to assist, and a team of two fire fighters was sent into the site with self-contained breathing apparatus (SCBA) to find people affected by the cloud of gas and to investigate the source of the leak.

Concern for the general population led to a discussion of an evacuation of nursing homes, hospitals, and residential homes, and additional units of fire fighters were dispatched to the immediate area surrounding the leak. The evacuation of citizens from residential areas and municipal buildings was eventually ordered as the chlorine plume migrated outside the borders of the BMI complex. Twenty schools in the Clark County School District were closed. According to available figures, approximately 200 fire fighters were involved in the response to this emergency, with fire fighters from Clark County, Henderson, Las Vegas, Nellis Air Force Base, and Boulder City participating. The emergency response units initially located a command post site at a power plant near the entrance to Pioneer Chemical. As the chlorine gas spread, fire fighters were forced to successively relocate the command post first to a convenience store parking lot, then to a Henderson Fire Department station, and finally to a race track. The final command post at the race track was located two miles southeast of the BMI complex. Wind changes occurring during the night resulted in chlorine contamination beyond the original area. Fire fighters manning rescue vehicles were exposed in previously safe decontamination areas when they removed their SCBAs and were exposed to chlorine gas which had accumulated in spaces in their vehicles during rescue operations. Eleven fire fighters were hospitalized or held for observation as a result of chlorine gas exposure. Police officers who were participating in traffic control or evacuations were also exposed during the performance of their tasks, as were corrections officers who

evacuated inmates, and communications center workers when chlorine gas contaminated municipal buildings. A list of the responding agencies and the number of employees involved is included in Table I.

Beginning at 5:00 a.m., the Clark County Environmental Health staff began to collect air samples using colorimetric indicator tubes throughout the cities of Henderson, Green Valley, and East Las Vegas. During the collection, respiratory protection was worn because concentrations of chlorine gas exceeding 0.5 parts per million (ppm) were routinely encountered. The results of these air samples are listed in Table II. Throughout the morning, the chlorine concentrations were relayed back to the command post. At 8:05 a.m., a flange was placed in the leaking pipe, shutting off the leak. With the flange applied, the sun rising, and the wind velocity increasing, the chlorine cloud dissipated within 30 minutes.

The Pioneer Chlor Alkali Company estimated that 70 to 100 tons of chlorine were released. There was immediate concern from community residents about the incident, with the odor still detectable, and the major highways closed until 10:30 a.m.. Many residential areas were blanketed by the cloud, and the majority of calls to 911 dispatchers related to complaints of community residents having difficulty breathing. Aid stations, where oxygen was available, were set up around the community. On the day of the leak, a total of 317 medical reports were filed in local hospitals relating to the incident.

Liquid chlorine was not present at the site following the leak; only chlorine vapor had escaped. Regardless of this, fire fighters involved in the immediate area were hosed down with water following the incident, and 18 sets of fire fighter's turnout gear were "decontaminated." This decontamination of the turnout gear was performed mostly by commercial washing. Several fire fighters on the scene were sent to the hospital for evaluation, including 17 from Henderson and 28 from Clark County. Four fire fighters from Clark County were admitted to a hospital, and six others were held overnight for observation. None of the fire fighters from Henderson were hospitalized; however, one was held several hours in the emergency room for observation before being released. Some city employees also reportedly developed symptoms the day after the incident when they reported to work in municipal buildings and were allegedly exposed to residual chlorine still present in the buildings.

IV. METHODS

On May 28-29, 1991, three weeks after the incident, NIOSH investigators met with the union representatives and fire chiefs from the Clark County and Henderson City fire

departments, with representatives from the Clark County Health District and the City of Henderson being present. This meeting was arranged to discuss the incident chronology, the extent of the chlorine leak, procedures used during the response, and the effects of the leak on the various fire fighters that were involved. The NIOSH investigators spent additional time during these two days interviewing various fire fighters who were at the incident and reviewing records obtained by the City of Henderson and Clark County relating to the incident. These included incident reports and witnesses' statements that were attached to 110 compensation reports for employees of the City of Henderson. Physicians who had treated fire fighters were also interviewed by telephone. This information was used to reconstruct events and procedures used during the incident response, to evaluate the fire fighters' symptoms, and to review the medical care and monitoring provided to all exposed fire fighters.

Based on the information obtained from the interviews with the fire fighters, the medical records that were reviewed, and the discussion with the physicians caring for the exposed individuals, the NIOSH medical investigators designed a questionnaire to investigate the respiratory protection of workers and respiratory symptoms related to the incident. Six months following the chlorine leak, questionnaires were sent by two separate mailings to the involved police and fire departments for distribution to approximately 150 of their employees who were at the incident scene. The questionnaire was designed to investigate the relationship of: 1) the location of the individual during the leak; 2) the time the individual was exposed to the gas; 3) whether, and what type of, respiratory protection was used; 4) how much time the individual took to put on respiratory protection; and 5) the type, severity, and duration of respiratory symptoms following the leak. The questionnaire requested information on coughing, chest tightness, wheezing, tearing eyes, sore throat, headache, runny nose, and sneezing. Additionally, respondents were asked to describe symptoms not specifically listed. A copy of the questionnaire is included in the Appendix.

V. EVALUATION CRITERIA

Fire fighters work in varied and complex environments that increase their risk of on-the-job death and injury. Every day, fire fighters in the United States are injured in the line of duty, some so severely that they can never return to work.[1] In 1993, according to the Bureau of Labor Statistics, fire fighters incurred a relatively small number of fatalities (39), as compared to other dangerous occupations, but their rate of fatal injury on the job, 16 fatalities per 100,000 employed, was three times the national rate and was highest among the protective service occupations.[2] In addition, there were 101,500 fire fighters injured in the line of duty in 1993.[1] According to 1992 National Safety Council statistics, the occupational injury and illness incidence rate for fire fighters was 8.2 cases per 100 full-time employees, with 3.5 cases per 100 employees involving days

away from work and deaths.[3] Fire fighters face many health hazards, including inhalation of a wide variety of toxic combustion products; chemical exposures by inhalation and direct skin and eye contact; physical hazards, including heat, cold, noise, and falling objects; and exposure to carcinogenic chemicals or combustion products. In over 200 residential fires in Boston, air monitoring (which focused on a small fraction of the possible combustion products) found varying airborne concentrations of carbon monoxide, carbon dioxide, hydrogen cyanide, benzene, nitrogen dioxide, hydrogen chloride, and acrolein.[4,5] Other toxic components of smoke can include ammonia, acrylonitrile, halogen acids, sulfur dioxide, aldehydes, isocyanates, methylene chloride, particulates, and hydrocarbons.[6-8]

Exposures to respiratory irritants such as acrolein, hydrogen chloride, and nitrogen dioxide may lead to acute and chronic respiratory problems. Disability due to pulmonary disease has long been recognized as a potential work-related hazard for fire fighters. There is an increasing concern about a fire fighter's exposures to carcinogens released from the combustion of synthetic materials used in building construction.[9] This concern has been compounded by mortality and morbidity studies of fire fighters, which, although they have produced inconsistent evidence, have raised the possibility of increased risks of cardiovascular disease, respiratory disease, and cancers of the nervous, hematopoietic/lymphatic, respiratory, and gastrointestinal systems, which may be attributable to exposures to the components of smoke.[10-25] Several recent studies have suggested an increased risk of brain cancer among Washington fire fighters; brain, prostrate, colon, and lung cancer among Los Angeles fire fighters; and digestive tract cancers.[19,21,23,26]

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the 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, however, important to note that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. 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 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 recommended exposure limits (RELs),[27] 2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs™)[28], and 3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs).[29] In July 1992, the 11th Circuit Court of Appeals vacated the 1989 OSHA PEL Air Contaminants Standard. OSHA is currently enforcing the 1971 standards which are listed as transitional values in the current Code of Federal Regulations; however, some states operating their own OSHA approved job safety and health programs continue to enforce the 1989 limits. NIOSH encourages employers to follow the 1989 OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criterion. The OSHA PELs reflect the feasibility of controlling exposures in various industries where the agents are used, whereas NIOSH RELs are based primarily on concerns relating to the prevention of occupational disease. It should be noted when reviewing this report that employers covered by OSHA are legally required to meet those levels specified by an OSHA standard and that the OSHA PELs included in this report reflect the 1971 values.

In most cases, these environmental evaluation criteria are listed as time-weighted average (TWA) exposures. A 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 values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term. For the fire fighters responding to this chlorine leak, a STEL would be the most applicable criterion. A STEL is the concentration to which workers can be exposed continuously for a short period of time without suffering from: 1) irritation, 2) chronic or irreversible tissue damage, or 3) narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency, and provided that the daily TWA is not exceeded.[28] STELs are recommended only where toxic effects have been reported from high short-term exposures in either humans or animals. A STEL is defined as a 15-minute TWA exposure which should not be exceeded at any time during a workday even if the 8-hour TWA is not exceeded. Exposures above the TWA up to the STEL should not be longer than 15 minutes and should not occur more than four times per day. There should be at least 60 minutes between successive exposures in this range.[28]

In the event of hazardous materials incidents such as the chlorine leak, the use of the immediately dangerous to life or health (IDLH) criterion should be considered. IDLH concentrations represent the maximum concentration from which, in the event of respirator failure, one could escape within 30 minutes without a respirator and without experiencing any escape-impairing or irreversible health effects.[30] These values were determined during the Standards Completion Program, a joint effort by NIOSH and the

Department of Labor to develop supplemental requirements for the environmental exposure standards adopted by OSHA in 1971, but only for the purpose of respirator selection.

Chlorine and Pulmonary Toxicity

Chorine is the most abundant halogen and among the most reactive of all elements.[31] Chlorine gas consists of molecules of two chlorine atoms, thus its chemical abbreviation Cl_2. At room temperature, chlorine is a greenish-yellow gas that has a conspicuous, pungent odor, and is 2.5 times heavier than air.[32,33] The range of reported odor thresholds for chlorine is 0.03 to 3.5 ppm; however, because of olfactory fatigue, odor does not always serve as an adequate warning of exposure. There is some evidence that olfactory fatigue may occur at low concentrations and that a tolerance is built-up in exposed workers.[34] The acute effects of exposure to chlorine depend on the duration of exposure and the concentration of the chlorine, with effects being more severe following longer exposures and higher concentrations. Symptoms typically begin moments after exposure. Chlorine is irritating to the eyes and skin, producing excessive tearing (lacrimation) and dermatitis upon contact.[32,35,36] Mild mucous membrane irritation may occur at 0.2 to 16 ppm, eye irritation occurs at 7 to 8 ppm, throat irritation at 15 ppm, and coughing at 30 ppm. A level of 1000 ppm is fatal after a few deep breaths.[34] Other studies have shown that at least some subjects can develop eye irritation, headache, and coughing at concentrations as low as 1 to 2 ppm.[32] The long-term effects of chlorine exposure depend on the amount of damage to the lungs.[37]

Upon absorption into the tissue fluids, chlorine undergoes a series of reactions to produce hydrochloric acid (HCl), hypochlorous acid (HOCl), and nascent oxygen (O). Each of these chemicals damages biologic tissue.[38] The level of exposure and intensity of exposure determines the degree of inflammatory reaction that develops in the airways.[39] The initial mucous membrane injury is probably due to the oxidizing effect of nascent oxygen, liberated by a combination of water and the chlorine gas. Then, hydrochloric acid production causes further irritation and exacerbates the initial injury.[40]

Severe, acute effects from accidental exposures to chlorine gas have been documented since World War I, when 1,843 of 70,742 total U.S. military casualties resulted from gassing by chlorine.[41] Among the 838 cases studied, there were 28 deaths, 4 of which were attributed to "late" sequelae of gassing: bronchopneumonia, lobar pneumonia, purulent pleurisy, and tubercular meningitis. Nine persons were discharged from the military because of disabilities precipitated by gassing, which included pulmonary tuberculosis, a flare-up of former lung disease, bronchitis, pleurisy, tachycardia, dyspnea, and nephritis. Thirty-nine others were disabled at the time of discharge with similar conditions due to gassing.[42] Health effects resulting from severe acute

exposures have been reported after several transportation and industrial accidents.[36] These exposures have caused cough, dyspnea (shortness of breath), cyanosis (a blue discoloration of skin and mucous membranes due to inadequate transfer of oxygen from the lungs to the blood), tracheobronchitis, hypoxemia (decreased oxygen in the blood), obstructive and restrictive abnormalities of pulmonary function, pulmonary congestion and edema developing after a latent period of several hours, pneumonitis, and deaths. In most of these studies, the respiratory distress generally subsided within days after exposure, and pulmonary function returned to normal after several months, with some exceptions among those with preexisting respiratory conditions. However, in one study, the pulmonary effects cleared within three months, except for four chlorine workers who still showed reduced airway flow and mild hypoxemia after 12 to 14 months.[43] Another study found decreased lung capacity in a number of workers three years after a moderately severe acute exposure.[44]

Several epidemiologic studies in chemical plants, pulp and paper mills, and chlor-alkali plants have shown no significant dose-response correlations between chlorine exposures and specific pulmonary function tests, and no evidence of permanent lung damage.[41] NIOSH concluded in 1976 that there was not then enough evidence to determine whether there is a potential for chronic impairment of pulmonary function following acute or chronic chlorine exposure.[36]

The upper and lower respiratory tract mucosa is an extremely effective barrier to toxic gas insults. At times this protective barrier is overcome by an especially high level of exposure, resulting in mucosal irritation, bronchitis, bronchoconstriction, laryngotracheobronchitis, noncardiogenic pulmonary edema, and death. The respiratory system has the potential to recover completely after such an insult, and in most cases this is to be expected. Sometimes though, long-term sequelae, such as chronic bronchitis, bronchiectasis, bronchiolitis obliterans, emphysema, or interstitial fibrosis, may result. Brooks and colleagues initially described ten cases of airway injury that followed transient exposure to highly concentrated respiratory irritants. This “reactive airway dysfunction syndrome” (RADS) was characterized by coughing, shortness of breath, and wheezing.[45] In all cases, symptoms developed within 12 to 24 hours of exposure and persisted for at least 3 months.

Acute symptoms following the inhalation of irritant gases like chlorine are felt to be a result of airway inflammation. Transbronchial lung biopsies performed in two of the workers in Brooks' study 9 and 33 months after the injury showed respiratory epithelial injury with a chronic unspecific airway inflammatory response. Several other investigations have suggested that inflammation is responsible for a change in the airways responsiveness, possibly due to the superficial location of irritant subepithelial receptors, and the associated bronchial inflammatory response that might occur after heavy irritant exposure.[46,47]

Presently, the OSHA PEL for chlorine is 1 ppm as a ceiling limit. The NIOSH REL and ACGIH TLV for chlorine are 0.5 ppm as a TWA; however, the REL is based on a 10-hour workday while the TLV is based on an 8-hour workday. In addition, both NIOSH and the ACGIH have established a 1 ppm 15-minute STEL. The IDLH for chlorine is 10 ppm and is based on acute inhalation toxicity data in humans.[48-50]

VI. FINDINGS AND DISCUSSION

A. Organizational and Environmental Aspects

The initial response to the noxious odor complaint was made by the CCFD Battalion 3. When this battalion arrived on the scene, there was reportedly no detectable chlorine odor or observable plume. The fire fighters proceeded to the guard shack to question employees that had gathered. As they were questioning the employees about the presence of a chlorine leak, an alarm sounded when chlorine reached the guard shack. The fire fighters of Battalion 3 were not able to don their SCBAs, which were located in their vehicle, before they were overcome. The injured fire fighters were then transported off-scene and an incident command system was initiated. Although a Community Awareness and Emergency Response (CAER) plan had previously been devised by the chemical manufacturers at the BMI complex and the local emergency response units, this plan was reportedly not activated by the Pioneer Chlor Alkali plant staff.

There were several agencies and companies that responded in some capacity to this chlorine leak. Table I lists the agencies that responded to the incident, the number of employees involved, and the number hospitalized. For some of the responding agencies, the total number of employees involved was not available. These latter agencies were primarily involved with support activities and not with the direct response. As noted in Table I, the employee numbers for these agencies were either estimated or not provided. Employees of the City of Henderson and Clark County were requested to file an accident report, and these were reviewed and used to compile the information for these agencies.

During the incident, the Clark County Health District (CCHD) performed air monitoring to track the chlorine plume and coordinated their efforts with the incident command. Due to the weather conditions, the chlorine plume was unpredictable. This resulted in the command post being relocated on three occasions. The CCHD began air monitoring at approximately 5:30 a.m. and continued until the end of incident. The airborne chlorine concentrations (Table II) were determined using colorimetric indicator sampling tubes and ranged

from less than 0.2 to 17 ppm. Five of the six samples taken from 8:25 a.m. to the end of the incident showed no detectable chlorine concentrations; one sample collected at 9:10 a.m. indicated a chlorine concentration of 3 ppm. The remaining eight samples were all collected before 8:25 a.m. and had chlorine concentrations ranging from 0.5 to 17 ppm. One concentration exceeded the 10 ppm IDLH, and six others equaled or exceeded the 1 ppm STEL. All these samples were collected using colorimetric indicator tubes for chlorine at locations outside of the BMI complex. These colorimetric indicator tubes are not as accurate as other air sampling methods and may be subject to interferences. Therefore, the actual concentrations encountered by the response personnel may have been higher or lower than those measured, depending on their locations during the incident.

During the meetings and private interviews conducted as part of the investigation, several individuals expressed concern about the preparedness and response of the different fire departments which were involved in the incident. Participants from different agencies had differing levels of hazardous materials training. Some had participated in 24-hour courses, while others had received 80 hours of training. The management of the Henderson Fire Department indicated that they did not send all their first response units for longer hazardous materials training because they believed that the mutual aid agreement in the area would provide adequate response from a fully-trained hazardous materials unit operated by Clark County. Fire fighters from Henderson were concerned that because of its location, there would be a 30-minute travel time for the Clark County hazardous materials team. Although Clark County had primary responsibility for responding to hazardous materials incidents in the industrial park, Henderson fire fighters were responsible to civilians living immediately adjacent to the complex. Thus, an incident such as this one, with exposures outside the industrial park, would involve the Henderson fire fighters. Perhaps in recognition of this, Henderson Fire Department management mentioned their plans to send several fire captains for additional hazardous materials training. Fire fighters also cited delays in the response of the hazardous materials teams, deployment of proper protective suits, and the setting up of weather stations.

Some fire fighters felt that they were deployed into areas for which they were not equipped with appropriate personal protective equipment. Those voicing this concern expressed their belief that Kevlar® turnout gear was not recommended for protection against chlorine gas. Fire fighters also expressed concern that the SCBA units could not be relied upon to provide adequate protection without prior fit testing, a procedure which was not routine in all departments visited. Some fire fighters reported that they could smell chlorine while wearing their respirators. It was also reported (and noted in medical records) that SCBA units

were not always available for off-duty fire fighters who were summoned to the incident. SCBA units and fully-encapsulated protective clothing should be worn for chlorine spills and leaks with no fire.[51] Structural fire fighter's protective clothing is considered not effective for exposure to chlorine, but it will provide limited protection for short-term exposures.[51] Full protective clothing, including SCBA, rubber gloves, boots, and bands around legs, arms, and waist should be provided so that no skin surface is exposed because chlorine gas can condense on the skin and cause irritation and burns.[52,53]

Several fire fighters were concerned that appropriate decontamination procedures were not always implemented. It was reported that fire fighters exposed to chlorine were hosed down with water and that several sets of the turnout gear were eventually decontaminated by commercial washing. According to the Agency for Toxic Substances and Disease Registry (ATSDR), victims exposed only to chlorine gas who have no skin or eye irritation do not need decontamination.[53] Victims who do experience skin or eye irritation should have exposed skin and hair flushed with plain water for 2 to 3 minutes, washed twice with mild soap, and then rinsed thoroughly with water.[53] Exposed or irritated eyes should be irrigated with plain water or saline for 15 minutes.[53]

To assist in the management, especially in the operation, coordination, and effectiveness, of wide-scale fire suppression activities, a system was developed for controlling personnel, facilities, equipment, and communications. This system is known as the Incident Command System (ICS).[54] A further refinement of the ICS by fire service organizations addresses all types of emergency incidents, including hazardous material situations, and includes performance criteria for the components of a system that incorporates specific safety and health objectives. This has been developed into a nationally recognized standard known as the Incident Management System (IMS).[55] The NFPA has documented the consequences of operating without an IMS, which may result in injuries and deaths of fire fighters.[55,56]

The IMS establishes standard procedures to manage activities during emergency situations. This system includes provisions for establishing an appropriate command structure, such as single, unified, or lead agency. The IMS also dictates that during complex incidents the incident commander should delegate authority to a command staff consisting of safety, liaison, and information officers, and establish the functional components of planning, logistics, operations, communications, staging, and, if necessary, finance.

During the response to the chlorine leak, both the HFD and CCFD implemented the components of the IMS, including multi-agency coordination. Some of those fire fighters interviewed expressed satisfaction at the way the IMS had been successfully expanded to encompass the growing response to the incident. However, some of the descriptions that were reported suggest that organizational problems remain. The investigators were told that there was not a common communications frequency for all participating agencies. As a result, some agencies were late in learning of developments in the situation. Several fire fighters recounted their impression that activities at the command posts were often disorganized. This may, in part, have resulted from the command post being moved so frequently. Some fire fighters reported receiving orders to demobilize without being given instructions for decontaminating their personal gear or vehicles, while others were released without being given information about the medical screening that had been established.

The representatives from the fire departments and the union felt that the overall management of the incident was appropriate for the complex situations encountered. However, the union representatives from the Henderson Fire Department expressed their concern regarding the proximity of the HFD to the BMI complex. Although the HFD is immediately adjacent to the BMI complex, the complex is within the jurisdiction of the Clark County Fire Department which is located several miles away in Las Vegas. The concern of the Henderson fire fighters is that, due to the mutual aid response, the proximity of the HFD predisposes them to be the first responders. Over the year prior to the chlorine leak, the HFD had responded over 170 times to various calls at the BMI complex. The Henderson fire fighters felt they did not have adequate training to be first responders to many hazardous situations, such as the present chlorine leak, that require additional hazardous materials training and equipment. The union representatives were also concerned with the number of fire fighters who experienced symptoms, even though they were wearing SCBAs. Other concerns included the use of turnout gear instead of other protective clothing, proper decontamination procedures, and the effect of chlorine exposure on the integrity of the turnout gear.

B. Health Effects

Five hospitals in the Henderson area were utilized to manage the triage of patients from the incident scene. Medical records were reviewed for 18 patients whose files were available at the Henderson City Offices. The majority of these noted throat, eye, lung, sinus, and skin irritation, headaches, and nose bleeds. Many of

the fire fighters complained of skin irritation and respiratory difficulty, even though they put on SCBA's and protective clothing.

Three pulmonary physicians, who saw the majority of patients on the day of the incident and in follow-up appointments, were interviewed over the telephone. They reported that most of the patients had sore throats, headaches, coughing, burning sensation in lungs and throat, frequent colds, aggravation of allergies, and exacerbations of chronic obstructive pulmonary disease (COPD) following the leak.

Confidential medical interviews were conducted with 10 Henderson fire fighters who were involved in the incident response and available during the NIOSH investigation. Eight reported experiencing burning irritation of the eyes, nose, and/or throat, usually with coughing. Five of the ten reported shortness of breath or chest tightness during the exposure; four were treated with bronchodilating medications for up to 1½ weeks after the incident. At the time of the interviews, one fire fighter reported persistent throat irritation with a cough, but the other nine said their symptoms had completely resolved. Two fire fighters said they had not experienced any health effects during or after the exposure.

The initial response to the questionnaire was not satisfactory to the NIOSH investigators; therefore, a second set of questionnaires was sent to representatives of the two IAFF locals for distribution among all the fire fighters involved during the incident. Still, NIOSH received a total of only 59 completed questionnaires. Because of this low response rate, the questionnaire data are of limited epidemiologic use. Therefore, the following discussion is a descriptive account based on information from the questionnaires, the interviews with exposed fire fighters, the interviews with physicians who treated exposed workers, and the review of available medical records. NIOSH received 42 completed questionnaires from the 174 CCFD and HFD fire fighters involved in this incident, and an additional 17 questionnaires from individuals other than fire fighters. Since this investigation was requested by the IAFF, this account focuses on the fire fighters, and only the information reported in the 42 questionnaires completed by fire fighters is presented below.

Of the 42 respondents at the scene of the chlorine leak, most were stationed within 0.5 miles of the leak, with 16 being stationed near the actual leak site at some point during the incident. Half the fire fighters reported being exposed to chlorine gas for at least 3.0 hours. These estimated exposures ranged from 2 minutes to 14 hours. Forty-one respondents reported inhaling chlorine gas, although most used some type of respirator during the exposure. A comparison of respirator use and

distance from the chlorine leak indicated that fire fighters stationed nearer the chlorine leak were more likely to have worn respirators.

Twenty-three respondents reported that they saw a physician following their chlorine gas exposure, while ten reported being hospitalized. Seven of the fire fighters who reported being hospitalized were stationed at the leak site, while the remaining three were stationed elsewhere within a half mile of the leak. Nine of the hospitalized fire fighters reported using a respirator during this incident.

Of the eight specific symptoms (coughing, chest tightness, wheezing, tearing eyes, sore throat, headache, runny nose, and sneezing) included on the questionnaire, cough, sore throat, chest tightness, and headache were the most frequently reported symptoms. Other reported symptoms included phlegm production, dizziness, feeling hoarse, shortness of breath, chlorine taste, bleeding from the lungs, feeling lightheaded, nausea, sweating, frequent chest colds after exposure, vomiting, fatigue, inflamed sinus, asthma/severe respiratory distress, severe chills, and throat/nose irritation. A majority of the respondents experienced symptoms associated with both the upper and lower respiratory systems. Nine of the fire fighters who were hospitalized reported both upper and lower respiratory symptoms. The remaining fire fighter who was hospitalized reported no symptoms; no additional information was available as to why he was hospitalized.

All respondents stationed at the leak site reported respiratory symptoms of some kind. In contrast, 4 of 24 participants who gave their location as at least 0.25 miles away from the leak site did not report any symptoms. Duration of the symptoms also appeared to increase with proximity to the chorine leak. Three respondents were still experiencing symptoms at the time they completed the questionnaire, and all three were stationed at the leak site and had used a respirator. One participant reported wheezing; another reported dizziness, hoarseness, and being short of breath; and the third reported coughing, headache, and tiring easily. Symptoms had resolved in the remaining 34 respondents. Although contrary to the protection provided by respirator use, the symptoms of those fire fighters who did not wear respirators appeared to resolve more rapidly than those who did wear respirators. This may indicate greater intensities of exposure in locations where fire fighters wore respirators; non-use of respirators because of the misperception of an environment as non-hazardous; and/or improper use or fit of respirators.

VII. CONCLUSIONS

Several fire fighters experienced adverse health effects from chlorine gas exposure, including hospitalization and persistent respiratory symptoms. Many of the fire fighters complained of skin irritation and respiratory difficulty, even though they used SCBA's and their structural fire fighter's protective gear. The questionnaire data indicated that the duration and severity of respiratory symptoms tended to increase with the proximity to the leak site despite the use of respirators. However, the low response rate to the questionnaire survey and potential selection biases limited the ability to further generalize the questionnaire data. Possible explanations for the occurrence of symptoms include delays in the donning or improper fit of respiratory protection and the use of structural fire fighter's protective gear instead of fully-encapsulated protective clothing at the leak site. In addition, some limitations regarding the application of incident command procedures were identified. These included the CAER plan reportedly not being activated, delays in the response of the hazardous materials teams, the confusion created by the unpredictability of the chlorine plume and subsequent relocation of the command post on three occasions, and the lack of a common communications frequency for all participating agencies.

VIII. RECOMMENDATIONS

Based on the initial findings of this investigation, preliminary recommendations regarding the chlorine leak response were made at the end of the site visit. The following recommendations include the preliminary recommendations, as well as recommendations based on further analysis of the available information, and previous NIOSH investigations pertaining to fire fighter activities, and are offered to help prevent future fire fighter injuries.

1. Since the Community Awareness and Emergency Response (CAER) plan for the BMI complex was reportedly not activated during this incident, the HFD and CCFD should review this CAER plan to ensure that it would be properly activated and implemented for any future incident. The types of incidents that require the activation of the CAER plan and appropriate implementation timetables should by clearly defined to ensure the proper activation and implementation of the CAER plan.

   The CAER pre-planning for the BMI complex should be a joint effort between the HFD and CCFD due to the HFD's proximity to the site and the likelihood of future mutual aide responses. Both the HFD and CCFD should review their current hazard communication programs to ensure that emergency response pre-planning has been conducted for all sites within their jurisdictions where such pre-planning is warranted. These sites would include all businesses and properties where there are hazardous materials. The emergency response plans should be developed by each site's responsible party and reviewed by the fire department. In addition, the HFD and CCFD should investigate the existence of emergency response plans for sites outside their jurisdiction where there is a probability of receiving a request for mutual aide. These efforts should be coordinated with the fire departments of neighboring communities which have mutual aide agreements.

2. Fire fighters, police, and paramedics often face serious exposures when responding to incidents such as the chlorine leak because they lack appropriate protective equipment. To prevent these emergency personnel from sustaining undue exposures during these types of incidents, hazardous materials response teams should be established. Because of the close proximity of the BMI complex to the HFD and the distance involved for the response of the CCFD hazardous materials team, the HFD should establish a hazardous materials response team. The basic minimum elements for establishing such a response team are outlined in National Fire Protection Association (NFPA) Standards 471 and 472.[57,58]

3. The pre-planning process should address the feasibility of conducting training programs and routine practice drills with hazardous materials team members and other fire fighters. The feasibility of joint training programs and practice drills with hazardous materials team members and other emergency response personnel from all parties likely to be involved in any future incident at the BMI complex should be investigated as part of the CAER plan.

4. The establishment of a hazardous materials response team should not preclude appropriate training and equipment for other fire fighting units to handle chemical incidents. Often these other units arrive on-scene at such incidents before the hazardous materials response team and may perform support activities in the event of a large incident.

5. Comprehensive reviews of the HFD and CCFD respiratory protection programs and standard operating procedures should be conducted to ensure that fire fighters are properly using their SCBAs, that they are equipped with respirators that have been fit-tested, and that they have been receiving effective training.

6. Because fire fighters (as well as other emergency and rescue personnel) are exposed to many hazardous materials during routine fire fighting and hazardous materials incidents, a program of routine medical surveillance should be established. An example of such a program is outlined in NFPA 1582.[59] Additional monitoring may be appropriate for fire fighters who are members of a hazardous materials team.

7. According to a representative of Du Pont, the manufacturer of Kevlar®, chlorine gas could theorectically have some affect on this material.[60] However, a relatively short-term, one time exposure to chlorine gas should not significantly affect the overall integrity of the Kevlar® turnout gear over the normal life of the garment. Both hydrochloric acid and hypochlorous acid (present in chlorine bleach) do affect the integrity of Kevlar® and can be formed when chlorine reacts with water. Theoretically, these acids could have been formed if residual chlorine was present when the turnout gear was hosed down with water or if the chlorine was able to penetrate the garment and react with water retained in the Kevlar® fibers. However, the number of chlorine ions available to form these acids would likely be insufficient to damage the the overall integrity of the turnout gear. The manufacturers of Kevlar® and the fire fighter's turnout gear should be contacted to further investigate the effect of chlorine and other chemical exposures on suit integrity. The existence of appropriate decontamination or cleaning procedures for various chemical exposures should also be investigated by the fire departments.

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Copies of this report have been sent to:

1. International Association of Fire Fighters,
   Department of Occupational Health and Safety
2. IAFF, Locals 1883 and 1908
3. City of Henderson Fire Department
4. Clark County Fire Department
5. City of Henderson, Nevada
6. Clark County Health District
7. Pioneer Chlor Alkali Company, Inc.
8. OSHA, Region IX

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 I

Responding Agencies and Number of Employees Involved*

Pioneer Chemical Chlorine Leak
Henderson, Nevada
HETA 91-0230
May 6, 1991

AGENCY	# OF EMPLOYEES	HOSPITAL ADMISSIONS
Clark County FD	139	10**
City of Henderson FD	35	1†
City of Las Vegas FD	15	0
Nellis Air Force Base FD	18	0
Boulder City FD	5	0
Pioneer Complex (not including work shift)	6	0
U.S. National Park Service	33‡	0
American Red Cross (including volunteers)	36‡	0
Clark County Health District	4	0

FD - fire department

*Representatives from the following agencies and companies also responded in some capacity during the incident: Nevada Highway Patrol, Henderson Police Department, Clark County Sheriff's Department, Metro Search & Rescue, EPA Region 9, Mercy Ambulance, Clark County School District, Centel, and other various city/county officials.

**Four Clark County fire fighters were actually admitted, and six were held overnight for observation.

†One Henderson fire fighter was also held for observation until 10:00 p.m. on the day of the incident, but was not admitted or held overnight.

‡Number of employees involved during the incident was estimated from reviewed reports.

TABLE II

Summary of Airborne Chlorine Concentrations Monitored by the Clark County Health District[1]

Pioneer Chemical Chlorine Leak
Henderson, Nevada
HETA 91-0230
May 6, 1991

LOCATION	TIME	CHLORINE CONCENTRATION (ppm)
Boulder Hwy./Lake Mead Drive	5:40 a.m.	3
Boulder Hwy./Pabco Rd.	5:47 a.m.	3
Boulder Hwy./Coogan Dr.	5:50 a.m.	17
Lake Mead Dr./Gibson Rd.	6:45 a.m.	5
Russell Rd./Mountain Vista	7:00 a.m.	1
U.S. 95 - 1 mile north of Lake Mead Dr.	7:45 a.m.	1
Lake Mead Dr./Hillcrest	7:50 a.m.	6
Milon Rd.	8:15 a.m.	0.5
Boulder Hwy./Lake Mead Dr.	8:25 a.m.	ND
Boulder Hwy./Nellis Rd.	8:45 a.m.	ND
U.S. 95/Sunset Rd.	9:10 a.m.	3
Harmon/Jimmy Durante Dr.	9:15 a.m.	ND
Sams Town RV Park	9:20 a.m.	ND
Boulder Hwy./Skyline Casino	9:45 a.m.	ND*

[1]Source: Clark County Health District, P.O. Box 426, 625 Shadow Lane, Las Vegas, Nevada 89127. Memorandum regarding environmental health staff response to the Pioneer Chlor-Alkali Chlorine Release Incident - May 6, 1991.

ppm - parts per million
ND - not detected (indicator tube effective range: 0.2 - 30 ppm)
*chlorine was not detected, but light chlorine odor was present.

APPENDIX

DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Centers for Disease Control
National Institute for Occupation.
Safety and Health – ALOSH
944 Chestnut Ridge Road
Morgantown, WV 26505–2888

October 29, 1991
RDHETA 91-230

0021

Dear Employee:

The National Institute for Occupational Safety and Health (NIOSH) has been requested to evaluate health complaints which may be related to the chlorine spill that occurred at Pioneer Chemical in Henderson, Nevada, on May 5, 1991.

NIOSH recently sent a questionnaire out to some of the employees involved in the exposure, but did not contact many of the firemen in the Henderson City and the Clark County units involved. This repeat questionnaire is being sent to the fire stations for a distribution to the involved personnel.

This evaluation will be done by NIOSH personnel. As a first step, it is necessary to get an idea of the type and frequency of problems experienced by employees. Therefore, it is important for you to fill out the enclosed questionnaire. A review of completed preliminary questionnaires will assist us in determining how to proceed with the evaluation.

All medical and other personal information you provide NIOSH is considered confidential in accordance with the Privacy Act of 1974 (Public Law 93-579). Unless written permission is given, this information is not released except as required by law or court order. The information you provide NIOSH may be used for statistical and research purposes and is summarized so that no individual is identified.

Please complete and return the questionnaire to NIOSH by November 15, 1991. An envelope is provided for your convenience.

Employee and management representatives will be kept informed of the non-confidential aspects of the NIOSH evaluation and subsequent recommendations. If you have any questions, or if NIOSH can be of any assistance, please feel free to contact me at (304) 291-4223, or FTS 923-4223.

Sincerely,

Steven R. Short, D.O.
Project Officer
Respiratory Disease Health Hazard Evaluations and
Technical Assistance Program
Clinical Investigations Branch
Division of Respiratory Disease Studies

Enclosures

Initial Questionnaire

****** General Tips before You Start ******

This questionnaire will ask you mainly about your health.

Read the whole question before making an answer.

Try to answer all questions unless you are told to skip them.

If you cannot decide whether to answer YES or NO, leave the question blank.

If there are several responses, select the one which best describes your situation or symptoms, unless you are told to choose multiple answers.

IDENTIFICATION

1. NAME: _____ _____ _____

(Last) (First) (Middle Initial)

2. SOCIAL SECURITY #: _____ ____ _____

3. BIRTH DATE: ____/____/____

(Month/Day/Year)

4. CURRENT ADDRESS: _____

(Number, Street, or Rural Route)

_____

_____

(City or Town, State, Zip Code)

5. HOME PHONE: (_____) _____ - _____

6. SEX
   - 1.☐ MALE
   - 2.☐ FEMALE

7. RACE
   - 0.☐ White
   - 1.☐ Black
   - 2.☐ Asian/Pac.
   - 3.☐ Am Ind/Eskimo
   - 4.☐ other

7a. Are you of hispanic origin?
   - 1.☐ NO
   - 2.☐ YES

8. MARITAL STATUS
   - 1.☐ MARRIED
   - 2.☐ DIVORCED
   - 3.☐ NEVER MARRIED
   - 4.☐ WIDOWED
   - 5.☐ SEPARATED

9. STANDING HEIGHT

_____(Inches)

10. WEIGHT

_____(Lbs.)

10. How long have you been a fireman? _____ (Years)

Have you been exposed to any toxic chemicals other than the exposure in the chlorine spill that occurred on May 5, 1991 ? _____

If so, please give the dates of each exposure and substances.

_____

_____

_____

_____

11. WHAT WAS THE HIGHEST GRADE OF SCHOOL YOU COMPLETED?

_____(years)

(Mark 12 if you have a high school diploma, 13 to 15 if you also have technical or associate training, 16 for a college degree, etc.)

12. We would like to be able to keep you up to date on the results of the study. If you move, is there someone who would know your new address? (For example: parents, child, friend)

NAME: _____ RELATIONSHIP:_____

ADDRESS: _____

(Number, Street, or Rural Route)

_____

(City or Town, State, Zip Code)

PHONE NUMBER: (_____) _____ - _____

QUESTIONNAIRE REGARDING RESPIRATORY COMPLAINTS FROM THE PIONEER CHEMICAL SPILL

1. Were you present during the chlorine gas leak at Pioneer chemical plant which occurred on May 5, 1991?

   If no, do not continue

   1. ☐ Yes 2. ☐ No

2. What was your exact location, (be detailed, ie: 1 mile west/ 1/2 mile north) the morning of the chlorine leak?

   _____

3. About how long were you exposed to the chlorine gas?
   ____Hours ____Minutes

   3a. Did you breath the chlorine gas? 1. ☐ Yes 2. ☐ No

   3b. Did you wear a respirator? 1. ☐ Yes 2. ☐ No

   If yes:

   3b1. During the leak, what percentage of time did you wear the respirator

   - ☐ 1. 0%-25%
   - ☐ 2. 25%-50%
   - ☐ 3. 50%-75%
   - ☐ 4. 75%-100%

   3c. Did you use a SCBA respirator? 1. ☐ Yes 2. ☐ No

   If no:

   Did you use another respirator? 1. ☐ Yes 2. ☐ No

   If you did use another respirator, what type? _____

   3d. How long did you breathe the chlorine gas before putting on the respirator? _____ Hours _____ Minutes

   3e. Were you seen by a physician following the exposure?

   1. ☐ Yes 2. ☐ No

   Name:_____

   3f. Were you hospitalized? 1. ☐ Yes 2. ☐ No

   Where: _____

4. DID YOU EXPERIENCE THE FOLLOWING SYMPTOMS FOLLOWING EXPOSURE TO THE CHLORINE?

			HOW LONG DID THESE SYMPTOMS PERSIST?
	YES	NO	DAYS
Cough			
Tightness in your chest			
Wheezing sounds in your chest			
Tearing eyes			
Sore throat			
Headache			
Runny nose			
Sneezing			
Other symptoms experienced. (Please specify what symptoms you experienced.) _____ _____			

5. Have you ever smoked cigarettes regularly?

1.□ YES
2.□ NO

IF YOU ANSWERED NO TO QUESTION 5, SKIP TO QUESTION 6.

IF YOU ANSWERED "YES" TO QUESTION 5, PLEASE ANSWER QUESTIONS 5a thru 5d.

5a) How old were you when you first started smoking cigarettes regularly?

_____ YEARS OLD (AGE)

5b) Do you still smoke cigarettes?

1.□ YES

2.□ NO: IF "NO", how old were you when you last gave up smoking?

_____ YEARS OLD(AGE)

5c) During the years that you smoked, did you ever quit for 6 months or more?

1.□ YES: IF "YES", how long did you quit for altogether?

_____ YEARS

2.□ NO

5d) Over the years that you smoked, on the average approximately how many cigarettes per day did you smoke?

_____ Cigarettes per day.

6. Do you now smoke a pipe or cigar?

1.□ YES
2.□ NO