

HETA 2000-0169-2854
Riverside County Regional Medical Center
Riverside, California

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PREFACE

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ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Calvin K. Cook and Robert Malkin of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Analytical support was provided by Data Chem Laboratories, Inc. Desktop publishing was performed by Robin Smith. Review and preparation for printing were performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation

Evaluation of 2-Diethylaminoethanol (DEAE) Exposures at Riverside County Regional Medical Center

This health hazard evaluation was requested by union representatives at Riverside County Regional Medical Center located in Riverside, California, to investigate building-related illnesses experienced by employees. Employees believed their illnesses were caused by DEAE present in boiler steam used to humidify air in patient care units in the hospital.

What NIOSH Did

- We tested the air for DEAE.
- We collected wipe samples for DEAE on work surfaces.
- We took measurements for humidity.
- We reviewed the building's ventilation system.
- We talked to 41 employees.

What NIOSH Found

- Boiler steam containing DEAE was used to humidify air in some patient care units.
- No DEAE in the air.
- Boiler mechanics wore gloves made of neoprene and latex rubber while handling DEAE. These materials will not keep hands from being exposed to DEAE.
- Boiler mechanics were potentially exposed to high levels of noise from diesel-powered generators.
- Diesel exhaust from diesel-powered generators can re-enter the building's ventilation system and affect the hospital's air quality.
- Symptoms of interviewed employees included: skin irritation, eye irritation, runny nose, stuffy nose, headaches, and increased allergies.

What Riverside County Medical Center Managers Can Do

- Stop using boiler steam containing DEAE to humidify the building.
- Supply boiler mechanics with gloves made of nitrile or butyl rubber. These will protect hands from DEAE.
- Continue plans to move the diesel-powered generators to an area that would least likely to allow diesel exhaust from entering the hospital's ventilation system.
- Check the noise exposures of boiler mechanics who enter the generator housing. Start a hearing conservation program for them if necessary.

What the Riverside Hospital Employees Can Do

- Boiler mechanics should always wear a protective face shield and gloves made of nitrile or butyl rubber when working with DEAE.
- Boiler mechanics should consider wearing hearing protection when entering the generator housing during testing procedures.
- Boiler mechanics should always use the more reliable colorimetric test kit to determine the pH in boiler water.
- All hospital employees should report work-related health problems to a physician.



What To Do For More Information:
We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513/841-4252 and ask for HETA Report # 2000-0169-2854



Health Hazard Evaluation Report 2000-0169-2854

**Riverside County Regional Medical Center
Riverside, California
September 2001**

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SUMMARY

In March 2000, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Service Employees International Union (SEIU) local 1997 to conduct a health hazard evaluation (HHE) at Riverside County Regional Medical Center in Riverside, California. NIOSH was asked to evaluate potential exposures to 2-diethylaminoethanol (DEAE) in patient care areas of the hospital that were humidified. While at work some hospital employees experienced dry cough, sneezing, wheezing, tearing of the eyes, headaches, skin irritation, and asthma, which they believed to be caused by exposures to DEAE in the workplace air. Steam, delivered from hot water boilers containing DEAE (a corrosion inhibitor), is used to increase humidity in several patient care areas of the hospital. Most rooms humidified in these areas were isolation rooms, recovery rooms, and operating rooms (OR). The hospital's air quality was reportedly being affected by diesel exhaust that entered the ventilation system from diesel-powered generators.

On May 2-4, 2000, NIOSH investigators made a site visit to the hospital to inspect the heating, ventilating, and air-conditioning (HVAC) system, collect air samples and surface wipe samples for DEAE in humidified areas, and measure temperature and relative humidity. Two unoccupied isolation rooms in the ACCU were used to evaluate the highest possible DEAE concentrations generated when humidity levels were increased to up to 55%. None of the 34 air samples had detectable amounts of DEAE (the minimum detectable concentration [MDC] was 0.02 parts per million [ppm] for the sample set). Three of 14 wipe samples revealed the presence of trace amounts of DEAE on ceiling diffusers located in the NICU and the two isolation rooms in the ACCU, suggesting that DEAE was being delivered to these areas. All other wipe samples showed no DEAE. Temperature and relative humidity in patient care areas were within the acceptable range recommended by the American Society for Refrigeration and Heating Engineers (ASHRAE).

During the site visit confidential interviews were conducted with 41 employees. The most prevalent symptoms included: irritated eyes-10 employees (including tearing and burning of the eye), nasal symptoms -9 employees, skin irritation-7 employees, increased allergies (itchy skin, sneezing, and tearing eyes)-5 employees, and headache-3 employees. Six employees had no symptoms that they attributed to the workplace. Interviewed employees were self-selected, however, and there was no evidence that the symptom prevalence was greater in the hospital than in other work settings in California.

Based on the air sampling results for this HHE, there is insufficient data to positively link DEAE exposure with reported symptoms. However, although no detectable air concentrations of DEAE were measured, employees reported symptoms that were consistent with exposure to DEAE, as reported in other NIOSH studies. NIOSH investigators recommend that humidification with boiler steam containing DEAE be discontinued. Other suggestions to improve indoor environmental quality and worker health and safety are offered in the Recommendations section of this report.

Keywords: [SIC 8062, \(general medical hospital\)](#) 2-diethylaminoethanol, DEAE, relative humidity, boiler water, diesel exhaust, irritation, asthma, allergies, headache.

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INTRODUCTION

In March 2000, the National Institute for Occupational Safety and Health (NIOSH) received a request from the Service Employees International Union (SEIU) local 1997 to conduct a health hazard evaluation (HHE) at the Riverside County Regional Medical Center in Riverside, California. While at work, some hospital employees reportedly experienced symptoms of respiratory irritation, which they believed were caused by exposures to diethylaminoethanol (DEAE), a chemical used in boilers as a corrosive inhibitor. Boiler water was used to humidify certain areas of the hospital.

BACKGROUND

Since occupying the newly constructed building in March 1998, some hospital employees have reported dry cough, sneezing, wheezing, tearing of the eyes, headaches, and skin irritation. During safety meetings held in November 1999 and January 2000, employees discovered that many of them were experiencing common symptoms that had not been officially reported. Employees suspected their symptoms were related to exposures to DEAE, which was present in steam used to humidify certain areas of the hospital. NIOSH investigators were told by both employees and their union that most symptomatic employees worked in areas that were humidified, including the neo-natal intensive care unit (NICU), the operating rooms (ORs) and, to a lesser extent, the adult critical care unit (ACCU). Approximately 50 employees worked in both the NICU and the OR, and approximately 70 employees worked in the ACCU.

Facility Description

Built in 1998, the Riverside County Regional Medical Center is a modern 364-bed, four-story 540,000 square-foot facility located in a rural agricultural area. The building is divided into six areas: A, B, C, D, E, and F. The heating,

ventilating, and air-conditioning (HVAC) needs of the hospital are served by 14 air handling units (AHUs) located on the roof. Each AHU delivers a constant volume air flow (24 hours a day, 7 days a week) with outside air dampers opened to allow 30% outside air. The heating and cooling needs of the building are met by passing air across coils (containing hot boiler water or chilled water, depending on the season) in the AHUs. Temperatures are maintained at about 68°F in the OR, 74°F in pediatric nursery rooms, and 73°F in all other areas of the hospital.

Boiler steam (containing DEAE) is used to increase humidity levels in several patient care areas, including the NICU, the pediatric intensive care unit (PICU), the ACCU, the OR, and the progressive care unit (PCU). Most humidified spaces are isolation rooms, recovery rooms, and operating rooms. Steam is piped to mixing boxes located above the suspended ceiling of each room being humidified. These mixing boxes contain coils with a steam ejector valve that opens to deliver steam directly into the supply-air of the space being humidified. Each humidified room has a dedicated humidistat set to maintain a minimum of 10% relative humidity, which is connected to a centralized computer system that is controlled by boiler mechanics. The system does not activate until the relative humidity level drops below the humidistat setting.

In March 1998, the humidification system was initially set to maintain a minimum of 30% relative humidity in the entire NICU, PICU, and ACCU, and some rooms in the PCU. At that time, the humidification system was set to maintain a minimum of 60% relative humidity in the ORs. Shortly thereafter, the humidification system was re-set to maintain a minimum of 30% relative humidity in the ORs to address nurses' complaints of skin and eye irritation, sore throat, and coughing. In January 2000, after employees began to suspect their health problems may be related to exposure to DEAE, hospital management lowered the humidification settings to maintain a minimum of 10% in all areas being humidified.

The boiler room is located in the Central Plant area of the hospital and has three 1780-gallon boiler tanks that circulate hot water throughout the building for use in hot water heaters, sterilizers for surgical instruments, cooking, and steam humidification. DEAE is used as a corrosion inhibitor to protect the condensate return lines. Stored in 30-gallon tanks equipped with chemical feed pumps, DEAE is delivered to high-pressure steam headers of the boilers. A crew of nine boiler mechanics and one supervisor over three 8-hour shifts each day perform boiler maintenance duties that include monitoring a computerized HVAC system, conducting chemical testing on boiler water, testing the diesel-powered generators, and trouble shooting. The amount of DEAE delivered to boiler tanks is regulated by checking the pH level of boiler water, with a pH of 8.0 to 8.4 being the desired range. When handling DEAE during chemical testing, boiler mechanics are required to wear personal protective equipment, including a face shield and gloves made of powder-free latex and low-gauge polyvinyl chloride (PVC) materials. Some boiler mechanics reported skin problems, believed by them to be caused by exposure to DEAE present in boiler water.

The amount of DEAE used by the hospital has decreased over the past three years as the amount of humidification has decreased. The hospital currently uses about 100 gallons of DEAE per year. According to hospital management, since the humidification system does not activate until the indoor relative humidity levels drops below 10%, very little boiler steam is used to humidify the indoor air; the system was reportedly turned on only twice in the month preceding the NIOSH site visit.

The indoor air quality was also being affected by diesel exhaust that entered the hospital's ventilation system from three diesel-powered generators used to provide emergency power for the hospital. Housed in a small brick building, the generators have exhaust stacks that are about one story in height. The generators are located west of the hospital, upwind of the prevailing winds.

Each week the generators are performance-tested for about 1-hour, and the prevailing western winds carry diesel exhaust to the AHUs on the roof. Management became aware of this problem in April 1998, and they plan to relocate the generators to a location that would be least likely to allow diesel exhaust to enter the ventilation system.

METHODS

Industrial Hygiene Evaluation

On May 3-4, 2000, a total of 28 full-shift general area air samples for DEAE were collected for 8-hour periods. Fifteen general area air samples were collected in isolation rooms of the ACCU, five were collected in recovery rooms of the OR, five were collected in the NICU, and three were collected in the boiler room. Of the 15 general areas air samples collected in the ACCU, 8 samples were collected in two unoccupied isolation rooms in which NIOSH investigators staged a simulated worst-case exposure to DEAE. In these rooms the humidity was increased to 55%, the highest that could be achieved. Additionally, six short-term personal breathing-zone (PBZ) air samples were collected on boiler mechanics to evaluate their exposures to DEAE during chemistry testing and blowdown procedures. Short-term sampling periods ranged from 10 to 50 minutes.

Air samples for DEAE were collected on silica gel tubes (300 milligrams [mg]/150 mg) that were connected to battery-powered air sampling pumps pre- and post calibrated at a flow rate of 200 cubic centimeters per minute (cc/min). To determine possible DEAE contamination on high contact surfaces (i.e., desk tops and tables) and ceiling supply-air diffusers, 14 wipe samples were collected using Whatman® filter paper wetted with distilled water. In accordance with the NIOSH Manual of Analytical Methods (NMAM) No. 2007, each air and wipe sample collected was

immediately treated with 20 micro-liters (μ l) of a hydrogen chloride (HCL) solution (12 normal, 38%).¹ These samples were later analyzed by gas chromatography.

Relative humidity measurements were made in the ACCU, NICU, and OR where air samples for DEAE were collected. Relative humidity measurements were made for more than 48 consecutive hours using HOBOS[®] H8 Pro Series instruments (Onset Computer Corporation, Bourne, Massachusetts) that are capable of continuously collecting real-time data for both temperature and relative humidity over time.

Medical Evaluation

Confidential medical interviews were conducted among employees who worked in areas that were humidified with DEAE containing steam. A NIOSH medical officer asked if employees had symptoms or illnesses when humidity levels were high in the past, if they had those symptoms presently, and if the symptoms had gotten better or worse during that period. Rosters of all employees working in the ACCU, OR, and NICU were given to the NIOSH medical officer by the management, and all workers working on the day of the evaluation were eligible for the interview. In addition, all workers in the boiler room were invited to participate in the interviews.

Interviews were voluntary and the interviewed workers were self-selected. Since the NIOSH investigators were interested in the scope and severity of the reported health problems, every effort was made to interview employees who were reporting symptoms to their union. Workers were relieved of their job duties so they could be interviewed.

EVALUATION CRITERIA

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 increases 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),² (2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs[®]),³ and (3) the U.S. Department of Labor, OSHA Permissible Exposure Limits (PELs).⁴ Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criterion.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm [Occupational Safety and Health Act of 1970, Public Law 91-596, sec. 5.(a)(1)]. Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees

from hazards, even in the absence of a specific OSHA PEL.

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 STEL or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

2-Diethylaminoethanol (DEAE)

DEAE is mainly used as an anti-corrosive agent in humidifiers and in water-based steam heating systems. DEAE reacts with acidic gases such as CO₂ and prevents mineral buildup and corrosion of metal-containing parts, such as boilers or pipes, in the heating system or air-conditioning system. The alkanolamines (of which DEAE is one) are also used in the chemical and pharmaceutical industries.⁵ DEAE can be an irritant of the skin, mucous membranes, and eyes and may cause permanent eye damage.⁶ The odor threshold for DEAE is 0.01 parts per million (ppm). Both the NIOSH recommended exposure limit (REL) and the Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for DEAE are 10 ppm, as an 8-hour time-weighted average.

Temperature and Relative Humidity

Temperature and relative humidity measurements are often collected as part of an indoor environmental quality investigation because these parameters affect the perception of comfort indoors. The perception of thermal comfort is related to one's metabolic heat production, the transfer of heat to the environment, physiological adjustments, and body temperature.⁷ Heat transfer from the body to the environment is influenced by factors such as temperature, humidity, air movement, personal activities, and clothing. The

American National Standards Institute (ANSI)/ASHRAE Standard 55-1992 specifies conditions in which 80% or more of the occupants would be expected to find the environment thermally acceptable. Assuming slow air movement and 50% relative humidity, the operative temperatures recommended by ASHRAE range from 68-74°F in the winter, and from 73-79°F in the summer.⁸ The difference between the two is largely due to seasonal clothing selection. ASHRAE also recommends that relative humidity be maintained between 30 and 60%. Excessive humidity can support the growth of microorganisms.

RESULTS

Industrial Hygiene

DEAE was not detected in any of the 34 air samples collected (the minimum detectable concentration [MDC] for the sample set was 0.02 ppm). These none-detectable values were expected for air samples collected from patient care areas because the humidity levels did not drop below 10% to activate the humidification system. Of the 14 wipe samples collected, 3 showed the presence of trace amounts of DEAE; 1 on ceiling diffusers in the NICU and 2 in the isolation rooms of ACCU where we staged potential exposure to DEAE. All other wipe samples showed no DEAE. In the ACCU, NICU, and OR, relative humidity levels ranged from 32-35%, and temperatures ranged from 69°F to 73°F. These measurements were at the lower end of the comfort range recommended by ASHRAE.

During the course of the HHE other health and safety issues were identified. Some boiler mechanics reported that they sometimes experienced skin irritation after handling DEAE-containing solutions during chemistry testing procedures. For hand protection boiler mechanics wore gloves made of latex rubber and polyvinyl chloride (PVC). These glove materials do not adequately protect workers from skin exposures to DEAE.⁹ Gloves made of butyl rubber or nitrile

materials are impermeable to DEAE and will provide better skin protection.

It was also learned that boiler mechanics who routinely enter the generators' housing may be exposed to hazardous noise levels during testing procedures. Although noise measurements inside the housing were not made during the HHE, the noise levels were perceived by NIOSH investigators to be loud enough to warrant taking noise measurements to determine whether boiler mechanics should be included in a hearing conservation program.

Medical Evaluation

On May 2, 2000, we conducted an opening meeting with union officials, hospital management, and employees in attendance. Union representatives from the NICU and the OR reported that their members were complaining about their health since moving to the new hospital in March 1998. They stated that employees did not have the same symptoms while working in the old hospital, and felt that symptoms were possibly related to the steam used for humidification. According to the union, symptoms in the NICU included dry cough, sneezing, wheezing, and cold symptoms. Symptoms among OR employees were reported by the union to be skin irritation, headaches, shortness of breath, and tearing eyes. According to management, there was no centralized employee health facility and workers saw their own private physicians.

Employee Interviews

Confidential medical interviews were conducted with 41 employees (of approximately 90), who worked in the NICU, OR, ACCU, and boiler room on the day shift of May 2 or 3, 2000. The reported health complaints and symptoms covered a wide variety of organ systems and are presented in Table 1. The most prevalent symptoms (in order of decreasing frequency) included: (1) irritated eyes (including tearing and burning of the eye),

(2) nasal symptoms (including runny nose and stuffed nose), (3) skin irritation, (4) increased allergy symptoms (such as sneezing, itchy skin, wheezing), and (5) headache. No skin symptoms were reported to be present on the days of the evaluation. Seven employees reported that their symptoms were improved at home. Two employees reported adult onset asthma, one reported asthma-like symptoms (without a diagnosis of asthma), and one reported wheezing. Six employees reported no symptoms that they thought were related to working at the hospital. Nine employees reported that there was less of a problem with symptoms now than previously, particularly when humidity levels were 60% in some areas. Seven employees reported that their symptoms were related to the use of diesel-powered generators. These generators had to be tested for one hour on a weekly basis. The air-intake grilles for the hospital apparently re-entrained the exhaust from the generator and created an odor problem and increased symptoms among employees in the hospital. Smelling diesel fumes was accompanied by headache (5 workers), nasal symptoms (2 workers), and sneezing (3 workers).

DISCUSSION

Since 1978, NIOSH has responded to more than 15 HHE requests involving humidification with DEAE and other boiler additives such as cyclohexylamine and morpholine. Based on the findings of these HHE's, NIOSH has repeatedly recommended that steam from boilers should not be used to humidify indoor environments. It is preferable to use steam humidifiers that have a separate water supply which is free from potentially irritating agents. NIOSH reported in 1985 that a manufacturer of DEAE had issued a warning to its customers not to use steam containing DEAE for building humidification.¹⁰

Although all air samples for DEAE collected during this HHE showed non-detectable concentrations, this does not rule out the presence of DEAE in patient care areas of the hospital.

DEAE could be present in concentrations below the minimum detectable concentration of 0.02 ppm. And although it is unlikely that most employees would experience irritative effects from low DEAE concentrations, it is possible that some might.

Another possible explanation for our inability to measure DEAE may be the limitations of the current NMAM No. 2007 for DEAE. In 1988, NIOSH research chemists modified NMAM No. 2007 in an attempt to improve DEAE sample stability during shipment.¹ Finally, it was uncovered after this evaluation that less than a normal amount of DEAE was present in boiler water during our site visit. On May 8, 2000, four days following our visit, a representative for the DEAE supplier company made a monthly service visit and discovered that the pH of the boiler water was considerably lower than normal. This was brought to the attention of boiler mechanics who later realized that an improperly calibrated electronic pH meter had been used during chemistry testing instead of the usual colorimetric pH test kit. This resulted in less than the normal amount of DEAE being delivered to boilers, which would result in a lower concentration of DEAE in the air in humidified areas of the hospital. A letter from the DEAE supplier recommended that the hospital use the more reliable colorimetric pH tester and discontinue using the electronic pH tester. Also, because the humidification settings were lowered to 10% to minimize DEAE exposures, this could result in the indoor air being too dry (i.e., less than 30% relative humidity).

There are several approaches which can be used to humidify both commercial and industrial environments. Direct steam humidifiers are the preferred method to humidify commercial spaces because heated water kills nearly all of the organisms in the water.¹¹ Misting humidifier systems, which use pressurized air to atomize

¹ To improve DEAE stability, the silica gel sorbent tubes used in this evaluation were treated with 20 µl of hydrochloric acid immediately following air sampling periods.

water into small droplets, are not recommended because of the potential for microbiological contamination. In addition, the relatively large airborne droplets created by a mist system (compared to a steam system) can settle out of the air relatively quickly, condensing on duct liners, filters, or other surfaces. Evaporative humidification systems, in which air passes through a moistened material, also have a potential for bacterial and fungal contamination. Regardless of the type of system selected, the building must first be evaluated to ensure that indoor environmental quality is not adversely affected through the addition of a humidification system.

In January 2000, management decided to lower the humidity settings in the hospital to 10% before the humidification system was activated; this apparently resulted in fewer reported symptoms in at least some of the interviewed workers. Nine employees stated that symptoms were worse when the humidity was higher in the hospital, and felt that their symptoms were related to DEAE humidification. The symptoms reported by these employees (skin, eye, and nasal irritation, headaches and increased allergies) are consistent with symptoms ascribed to DEAE exposures as reported in other NIOSH Health Hazard Evaluations^{10,12,13} where steam containing DEAE was used to humidify buildings. Some of the symptoms reported in this study are frequently reported by building occupants; their prevalence here appeared to be lower than what was reported in a NIOSH study of 80 office buildings. In that study of office buildings, fatigue was reported by 42% of all workers and headache was reported by 35%.¹⁴ At Riverside County Medical Center, no interviewed employee reported fatigue and only 7% reported headache not associated with diesel exhaust.

NIOSH investigators did not measure diesel exhaust in this study since the original request mentioned only DEAE exposure. Some workers, however, reported that their symptoms were related to smelling odors from the diesel-powered generators that consists of both gaseous and

particulate fractions. The gaseous constituents include carbon dioxide, carbon monoxide, oxides of nitrogen, oxides of sulfur, formaldehyde, methane, benzene, phenol, 1,3-butadiene, acrolein, and polynuclear aromatic hydrocarbons.¹⁵ Some of these substances are irritants. NIOSH, however, recommends that diesel exhaust be regarded as a "potential occupational carcinogen," based on findings of carcinogenic and tumorigenic responses in rats and mice exposed to diesel exhaust.¹⁶

A limitation of the medical evaluation is that we interviewed self-selected workers. It is possible that workers without health problems were less likely to request an interview from NIOSH, which would lead to an overestimate of the problem. It is also possible that some symptomatic workers were not present on the days of the evaluation, which would lead to an underestimate of the problem. To reduce this potential selection bias, we made every effort to interview all employees working in the affected areas (NICU, OR, ACCU), but due to the employee work load and scheduling this was not possible. We do not know the absentee rates among employees of the hospital on the days of the evaluation.

NIOSH investigators also did not have a comparison group that was not exposed to DEAE. Without such a group, we could not determine if the symptom rates were elevated for employees in the studied areas of the Riverside Medical Center compared to rates for employees in other areas where DEAE was not used. Nevertheless, the information gathered was useful for assessing the nature and severity of the symptoms among affected workers.

CONCLUSIONS

Based on the air sampling results for this HHE that showed no DEAE in air, there is insufficient data to positively link DEAE exposure with symptoms reported by employees at Riverside County Medical Center. However, trace amounts found on supply-air diffusers in the NICU and

ACCU are evidence that DEAE had been delivered to these areas. Employees reported symptoms that are consistent with exposure to DEAE. Employees reported irritant health effects that could be caused or exacerbated by exposure to DEAE, and health complaints reportedly lessened after boiler steam was no longer used for humidification. Although a direct relation between DEAE use and employee symptoms cannot be established, a possible relationship between previous irritant symptoms and a low-level exposure to DEAE cannot be dismissed.

RECOMMENDATIONS

1. Discontinue using boiler steam containing DEAE to humidify any area of the hospital, regardless of the infrequent use of the humidification system. An alternative is to use a separate water source, such as direct-steam injection, that is free of DEAE and other potentially irritating compounds.
2. Maintain humidity levels between 30% and 60% for thermal comfort and to avoid microbial contamination.
3. Continue with the plans to relocate the diesel-powered generators to prevent their exhaust from entering the building's ventilation system. An ideal location would be east of the building, downwind from prevailing westward winds. A qualified ventilation engineer should be consulted.
4. Perform noise monitoring on boiler mechanics who routinely enter the housing of the diesel-powered engines to determine if a hearing conservation program is needed. The OSHA Noise Exposure Standard (CFR 1910.95) requires exposure monitoring, audiometric testing, employee training, record keeping, and the use of hearing protectors in high noise areas.
5. Discontinue supplying boiler mechanics with gloves made of latex rubber and PVC rubber materials because these material are not impermeable to DEAE. Instead, boiler mechanics

should be supplied with glove materials made of butyl rubber or nitrile rubber, which are proven to provide adequate skin protection to DEAE.

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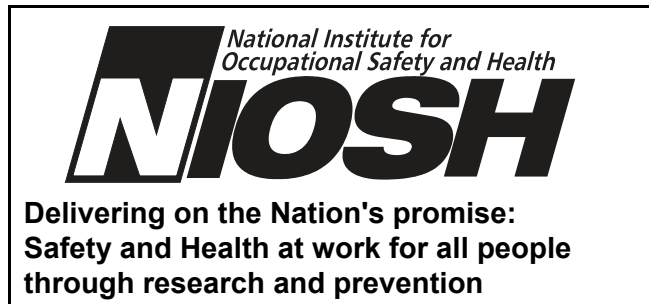
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Table 1
Health Complaints
Riverside County Regional Medical Center
Riverside, California
May 5, 2000
(Number of employees interviewed = 41)

Symptom	Number Reporting	Percent of those Interviewed
symptoms subsided with decreased humidity	9	22%
eye symptoms (irritated and/or itchy eyes, red eyes, watery eyes, and burning eyes)	8	20%
nasal symptoms (sneezing, runny nose, stuffy nose)	8	20%
skin symptoms (irritated skin and itchy skin)	8	20%
symptoms reported to be related to diesel exhaust	7	17%
increased allergy symptoms	5	12%
headache (not associated with diesel exhaust)	3	7%
adult onset asthma	2	5%
no symptoms	6	15%

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