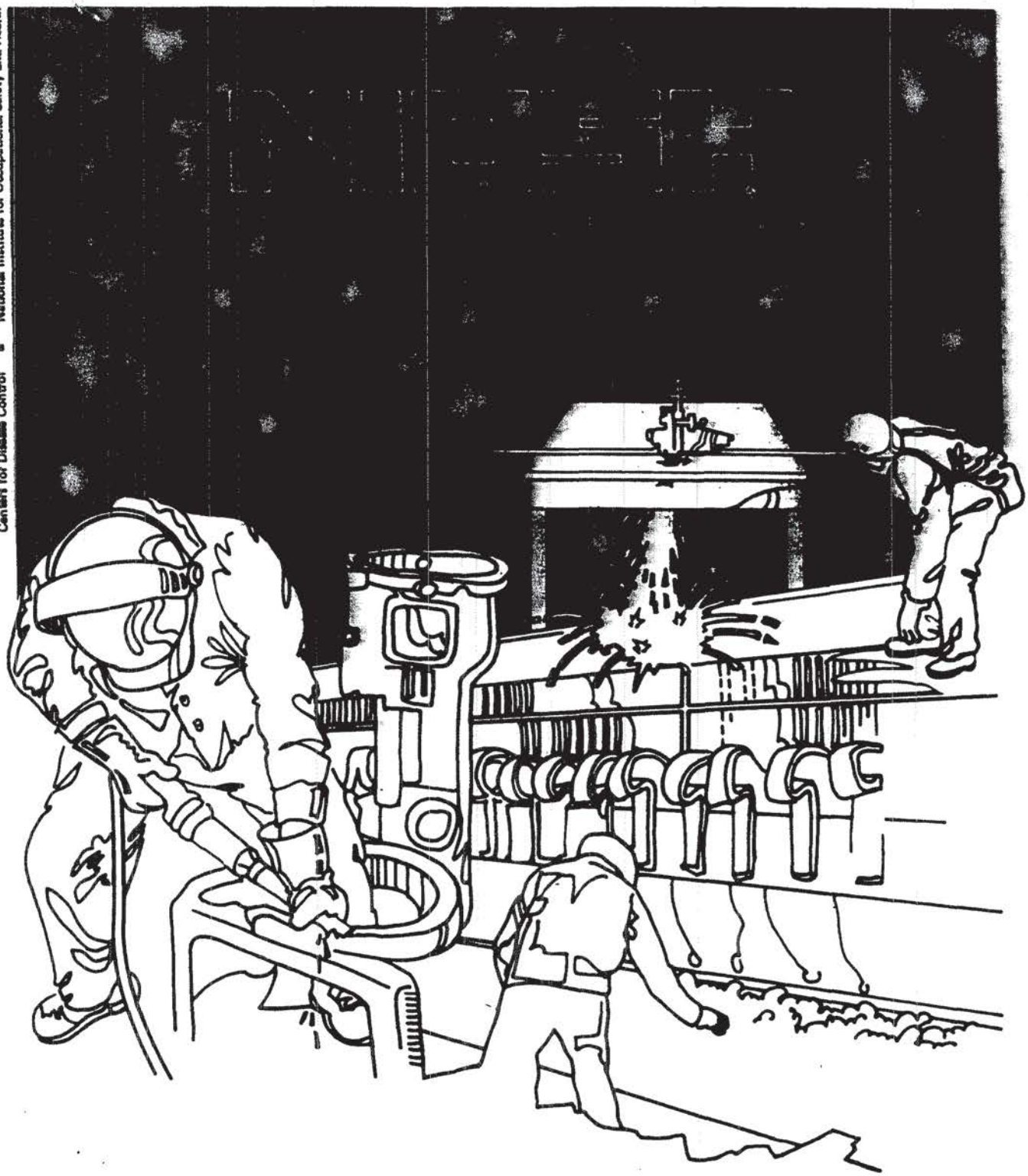
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES ■ Public Health Service
Centers for Disease Control ■ National Institute for Occupational Safety and Health



# Health Hazard Evaluation Report

HETA 81-247-958
BOEHRINGER INGELHEIM, LTD.
RIDGEFIELD, CONNECTICUT

## PREFACE

The Hazard Evaluations and Technical Assistance Branch of NIOSH conducts field investigations of possible health hazards in the workplace. These investigations are conducted under the authority of Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C. 669(a)(6) which authorizes the Secretary of Health and Human Services, following a written request from any employer or authorized representative of employees, to determine whether any substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

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

HETA 81-247-958
September 1981
Boehringer Ingelheim, Ltd.
Ridgefield, Connecticut

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## I. SUMMARY

On March 23, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request for a Health Hazard Evaluation from Boehringer Ingelheim, Ltd., Ridgefield, Connecticut. The request stated that approximately 15 employees in the office support area of a production building had been experiencing rashes since the beginning of March, 1981.

Initial site visits were made by NIOSH on March 25 and 27, 1981. Environmental sampling was conducted on April 6 and 7, 1981. A medical evaluation, consisting of interviews, skin examinations, and a review of medical records, was conducted on April 6 and 16, 1981.

The evaluation indicated that the rashes had developed after a change in chemicals used in the water treatment for the steam generators. Diethylaminoethanol was identified as the only volatile component of the new water treatment. Environmental sampling did not reveal any diethylaminoethanol in air samples. However, results of sampling suggested the presence of a conjugated amine which possesses acidic properties. The specific agent could not be identified.

Medical complaints consisted of burning and itching of the exposed skin with a red rash, dry throat, headache, chest tightness, and high blood pressure. Skin examinations revealed an irritant-type rash on the exposed areas of the face, neck, and hands. The distribution of the rash was consistent with and suggestive of a phototoxic skin reaction. Systemic health complaints were inconsistent between employees; no pattern of systemic health problems could be verified among the exposed employees.

Both the environmental and medical evaluations indicated the source of the dermatitis to be the air handling system. However, no specific etiologic agent has been identified. This determination was made as a result of the elimination of symptoms after the boiler water treatment chemical, which is released into the air handler during steam humidification, was removed. The information in this report suggests that a condensation or reaction product of diethylaminoethanol was likely responsible for the reported symptoms. The chemical(s) resulted in primary irritation of the exposed skin and possibly a phototoxic skin reaction. No systemic effects could be documented. NIOSH recommends that an alternative method of boiler water treatment be substituted, or an alternative method of humidification be installed.

KEYWORDS: SIC 2834, DEAE, Diethylaminoethanol, 2-methylaminoethanol, Steam humidification, Boiler water treatment, Skin irritation, Phototoxicity.

## II. INTRODUCTION -- STATEMENT OF REQUEST

On March 23, 1981, the National Institute for Occupational Safety and Health (NIOSH) received a request from Boehringer Ingelheim, Ltd., Ridgefield, Connecticut, concerning skin rashes among office personnel. The rashes primarily affected secretaries in the support area of a production building. The request noted that the rash affected the exposed areas of the bodies of the employees. The number of persons affected and the severity of the rash had increased since the first reported case on March 2, 1981. Prior to the request the company had engaged the services of a dermatologist and an environmental consultant who failed to identify the source of the rashes.

NIOSH environmental and medical investigators intially visited the site on March 25, 1981. On March 27, they returned to meet with all the employees to explain the nature of the investigation and answer questions. Environmental sampling was conducted on April 6 and 7, 1981. The NIOSH investigator also contacted the environmental consultant engaged by the company. The NIOSH medical evaluation was conducted on April 6 and 16, 1981. Employees were interviewed and had skin examinations. Company medical records were reviewed.

During the course of the NIOSH investigation, Boehringer Ingelheim, Inc., changed the chemicals in the water treatment for the steam humidification system and increased the amount of fresh air in the support area. Since these changes were made, the problem has apparently resolved.

## III. BACKGROUND

Boehringer Ingelheim, Ltd., is a major manufacturer of pharmaceutical products. This facility, which was completed in mid-1980, packages pharmaceutical products produced at other facilities. Major products processed during late 1980 and early 1981 include Dulcolax (brand of bisacodyl) and Persantine (brand of dipyridamole). The 225,000 square foot building was occupied in October 1980. The building construction is concrete blocks outside with Robertson panels covering the inside walls. Two-thirds of the building is used for warehousing and manufacturing, while one-third is the support area. The support area is three floors which house the administrative, clerical, and quality assurance staff. The warehouse area has approximately 30 employees; the manufacturing and packaging areas - 60 employees, and the support area - approximately 40 employees, including corporate management personnel.

The entire building is centrally air conditioned, employing 14 air handlers for this purpose. The support area uses two of these air handlers and recirculates 90% to 95% of the air in the building. The manufacturing area of the building uses 100% fresh air at all times. The warehouse has about 50% fresh air and 50% recirculated air. Until the middle of February 1981, the vents of the air handler supplying air to the support area were open within the building penthouse. It drew air through the penthouse, rather than directly from outside to prevent freezing of cooling coils. During February, the air handler was closed up and balanced.

Also until mid-February 1981, the boiler system was treated with chemicals that included hydrazine as the anti-corrosion agent. As a result of the Federal Drug Adminstration's (FDA's) ban on the use of hydrazine in these types of establishments, the boiler additive was changed. The new boiler treatment uses diethylaminoethanol instead of hydrazine. The chemical additives were added by batch until March 19, when a continuous feeding method was begun.

Starting Monday, March 2, 1981, employees on the third floor began reporting burning and red rashes on the exposed areas of the face, neck, and arms. A few persons noted having eye irritation, headache, and mild chest tightness. Employees initially affected were five secretaries working under skylights on the third floor. Over the next three weeks, approximately 15 employees on other parts of the third floor and the second floor were affected. A few employees in the production area were affected during late March. The company engaged a dermatologist who visited the facility and examined several of the employees. He felt the dermatitis was due to a primary irritant in the air and noted that employees seemed to improve upon leaving the facility. Employees were encouraged to visit the nurses station if they felt any symptoms. Persons with continuing rashes, headaches, or hypertension were sent home. During the next two weeks, several employees continued to be affected and were sent home from work.

On March 13, maintenance employees changed bag filters on the air handler for the support area. At the time, these employees developed transient itching and a red rash on their exposed skin. The rashes resolved over that evening. It is unclear whether their rashes were the same as those of the other employees. The bag filters have a paper exterior with fibrous glass inside.

The environmental conditions of the support building were monitored beginning March 5. From March 5 until March 20, the temperature ranged from an average low of 72°F to an average high of 80°F. The humidity averaged 35% during this period, except during March 5 and 6 when the humidity was temporarily increased to 54%. The environmental consultant engaged by the company sampled for particulates and organic vapors on March 19, 1980. The consultant found no particulates and only trace amounts of 1,1,1-trichloroethane.

On March 18, 1981, Boehringer Ingelheim, Ltd., wrote NIOSH requesting its assistance in the investigation.

## IV. EVALUATION DESIGN AND METHODS

### A. Environmental

During the initial site visit, the NIOSH industrial hygienist took direct reading measurements using colorimetric detector tubes for carbon monoxide, ozone, nitrogen oxides, dimethylacetamide, and acetic acid.. Bulk air samples were collected on charcoal tubes for gas chromatography and mass spectrophotometry analysis. Bulk air samples were also collected on filter paper for dust identification. Samples of the boiler water, boiler condensate, and boiler additive were collected for laboratory analysis. Raw material inventories were assembled, and ventilation blue prints were reviewed.

On subsequent visits, air samples were collected on oxalic acid-coated silica gel tubes and molecular seive media for diethylaminoethanol (DEAE) analyses(1). The environmental consultant for the company collected air samples on silica gel and in distilled water for DEAE analysis. NIOSH collected wipe samples on surfaces on the third floor of the building for laboratory identification of particulate matter.

For general analysis of organics, the charcoal tube samples were desorbed in 2 milliliters (ml) of carbon disulfide and analyzed by gas chromatography (P&CAM Method No. 127). A portion of one of the samples was concentrated and analyzed by gas chromatography and mass spectrophotometry (GC/MS).

A Hydrazine tube was desorbed in 1 ml deionized distilled water and analyzed by gas chromatography using flame ionization detection (GC/FID).

The AA filter sample was extracted with 1 ml of 1 Normal (1N) sulfuric acid for one hour and then made basic (pH-10) with 1N potassium hydroxide (KOH). This sample was then analyzed for DEAE by GC/FID.

Each of the bulk liquids were made basic, if necessary, by addition of 1N KOH before analysis. Each was analyzed by GC/FID for identification of unknowns, with particular attention to DEAE.. All of these samples were injected directly onto the column.

The five oxalic acid-coated silica gel samples and one spiked sample (boiler additive added to the tube) were desorbed in 1 ml deionized distilled water for one hour. The solution was made basic with 1N KOH before analysis of DEAE by GC/FID.

A dry Whatman filter wipe sample was collected from a spot light next to a skylight in the open office on the third floor of the support building. It was mounted on a glass slide and examined by reflected polarized light microscopy. The remaining Whatman filter paper wipe sample, collected from a desk top in the same area, and the boiler condensate bulk liquid sample were analyzed for DEAE using a colorimetric method(2).

The molecular seive samples were analyzed for nitrogen-containing compounds using an experimental nitrogen detecting devise developed by the New England Institute for Life Sciences, Waltham, Massachusetts.

B. Medical

During the initial site visit, the NIOSH medical investigator met with the company nurse and consulting dermatologist. Affected employees still at work were interviewed and had skin and mucous membrane examinations. Virtually all employees in the support area were interviewed, as well as a representative sample of employees in each work station in the warehouse and production areas.

NIOSH identified two management employees working in offices within the packaging (production) area who were affected with the skin rash. No other employees in that area were affected. They both reported eating lunch in the cafeteria in the support area, rather than in the production area. They also made several trips daily to the offices in the support area. After receiving company approval, NIOSH requested that these two employees avoid entering the support area for 1 week.

NIOSH contacted local area physicians for reports of medical evaluations performed on employees. Efforts were made to coordinate such evaluations with the on-going NIOSH and company investigations.

On April 6, the medical investigator again interviewed and examined employees. The two previously identified employees were re-examined. The dispensary log and medical records of all affected employees were reviewed and abstracted for name, age, sex, work location, dates of onset of symptoms, and blood pressure - if recorded.

By April 16, most affected employees had returned to work after the company had made provisions for them to work in another building on the same site. The NIOSH consulting dermatologist and medical officer visited the facility and examined the affected employees.

## V. EVALUATION CRITERIA

The employees developed burning and a skin rash apparently due to exposure within the workplace. The characteristics of a dermatitis (skin rash) can sometimes indicate the nature of the exposure. Most occupational skin disease results from contact with chemical substances(3). The majority of these problems are due to primary irritation of the skin by the substance. Approximately 80% of all cases of occupational contact dermatitis result from contact with primary irritants(3). In the remainder of cases, the dermatitis results from an allergic reaction by the exposed individual to a particular chemical. Thousands of different chemicals have the potential of causing a primary irritant reaction or an allergic reaction of the skin(4).

The appearance of the two types of contact dermatitis are similar, consisting of erythema (redness) with itching or burning and, possibly, various-sized vesicles (small blisters) or papules (small bumps). The rash developes in the areas of the skin exposed to the chemical substance. The dermatitis usually resolves following cessation of exposure. With prolonged or repeated exposure, the skin develops chronic dermatitis -known as eczema- where it becomes dry, scaly, rough, and thickened. These changes resolve only gradually after exposure has ended. The differentiation of primary irritant versus allergic dermatitis is usually made based on the clinical history and pattern of persons affected in the workplace.

Another kind of skin reaction due to some chemical substances is phototoxicity. In these cases, the skin reacts severely to visible or ultraviolet light after it has been contaminated with a phototoxic chemical. Clinically, the eruption usually resembles an exaggerated sunburn, but may range from only itching to the formation of large blisters(4). The rash also affects the exposed areas of the skin; however, it characteristically spares the skin behind the ears, under the chin, and in the folds of the eye lids. The substances that can cause this reaction are usually chemically complex, consisting of one or more carbon rings or multiple double bonds. Some phototoxic chemicals can also act as primary irritants, even without subsequent exposure to light.

During the initial site visit, diethylaminoethanol was identified as a volatile component in the treatment for the steam humidification system. DEAE is an primary irritant of the eyes, mucous membranes, and skin in animals(5). Severe exposure could cause the same effects in humans. Inhalation of high levels (ten times the Federal occupational standard) for a brief period of time caused nausea and vomiting in a laboratory worker(6). DEAE is not known to cause phototoxicity. Its chemical structure, as a tertiary amine without any carbon rings or double bonds, suggests that is unlikely to cause phototoxicity unless it is first altered by a chemical reaction.

The Federal occupational standard for airborne exposure to DEAE as promulgated by the Occupational Safety and Health Administration (OSHA), U.S. Department of Labor (29 CFR 1910.1000) is 50 milligrams per cubic meter of air ($mg/m^3$), determined as a Time Weighted Average (TWA) concentration for a 8-hour work shift in a 40-hour work week. The Threshold Limit Value (TLV) recommended by the American Conference of Governmental Industrial Hygienist is the same. The recommended TLV was set to prevent eye and nasal irritation(7).

## VI. RESULTS AND DISCUSSION

### A. Environmental

Colorimetric detector tubes did not give a positive response for carbon monoxide, sulfur dioxide, ammonia, ozone, hydrazine, hydrocarbons, nitrogen oxides, or hydrogen sulfide. A positive indication (color change) was observed in the following tubes: dimethyl acetamide and acetic acid. However, the color change observed was different than expected in both cases(8). The acetic acid tube changed from purple to red, and was designed to change to yellow. The manufacturer suggests that this may be due to a stronger acid interference. Likewise, the dimethyl acetamide (DMA) tube changed from yellow to green, when yellow to blue was expected. The manufacturer lists other "amines" as possible interferences. The absence of response on the ammonia and hydrazine tubes (which contain the same chemical indicator as in the dimethyl acetamide tube) rules out the presence of other "free amines" in the air. The DMA tube employs two chemical reactions to produce a response. First, air is drawn through a pre-tube containing sodium hydroxide which will react with DMA and release a free amine. The free amine then reacts in the second (indicator) tube to produce a color change. These sampling results suggest the presence of a bound-up amine which possesses acidic properties.

GC/MS analysis of the concentrated portion of the charcoal tube sample identified three major peaks: 1,1,1-trichloroethane, trichloroethylene, and toluene. Each was present at less than 12 $mg/m^3$. (These values range from 1/25 to 1/200 of their Federal occupational standards.) Minor peaks detected were: xylene, cellosolve acetate, molecular weight 120 aromatics, and alkanes (mainly C9-C12).

No peaks other than those associated with the reagent blank were detected on the AA filter sample or the Hydrazine tube sample.

No diethylaminoethanol or any other compounds were detected in the GC/FID analysis of any of the bulk liquids except the boiler additive itself. GC/MS analysis of this sample confirmed the presence of DEAE.

No peaks other than those associated with the reagent blank were detected on the oxalic acid-coated silica gel samples. DEAE was detected on the spiked sample.

The major contaminants found on the dry Whatman filter paper sample collected from the spotlight were small particles of soil and rust (possibly iron and copper oxides) which were sparsely scattered on the filter surface. A few synthetic fibers, such as rayon or nylon, were also observed. No identifiable inorganic compounds were observed.

Standards of diethylaminoethanol - which were prepared and analyzed according to the colorimetric method(2) - gave a linear standard curve when absorbance at 540 nanometers (nm) was plotted against milligrams of DEAE per sample. The boiler condensate bulk liquid also showed absorbance at 540 nm; however, since the absorbing compound could not be positively identified by any other means and no DEAE was detected by GC/FID, the absorbing compound is likely an interference in the non-specific colorimetric procedure. The desk top wipe sample showed no significant absorbance at 540 nm.

No peaks were observed on the molecular seive samples analyzed by the New England Institute for Life Sciences.

B. Medical

During four site visits, the NIOSH medical investigator interviewed and examined employees with both acute and chronic skin reactions. The affected employees initially felt itching or burning of the face and burning of the eyes, followed by the development of erythema and, in some cases tiny vesicles, on exposed areas of the face, neck, and hands. Several persons demonstrated an erythematous rash which generally affected the exposed skin, but spared the postauricular and submental skin, as well as the eye lid folds. Most persons reported that the rash initially became worse after lunch, but improved upon leaving the building. Over time, the rash seemed to develop earlier in the day, become more severe, and resolve much more slowly, if at all. The more severely affected employees were sent home and were out of the building during much of March. Some of these employees, and some others who were affected mildly but stayed at work, eventually demonstrated red, dry, and scaly skin on the face and neck. The basic distribution of the rash remained the same.

The NIOSH dermatologist examined several affected employees on April 16, 1981. Based on the clinical appearance of the eruptions and the work locations of the affected employees, the dermatologist concluded, "The data points strongly to a phototoxic reaction, caused by some chemical in the forced air heating system."

Overall, the symptoms and clinical appearance of the rash are indicative of a contact dermatitis. The sparing of submental and hair covered skin is suggestive of a phototoxic effect as well. Specific skin testing to evaluate phototoxicity can be done only after tentatively identifying a chemical agent. NIOSH concludes that an agent present in the air caused a irritant contact dermatitis. It is likely that the agent was also responsible for a phototoxic skin reaction.

During the NIOSH interviews, several affected employees also reported experiencing headaches, fatigue, slight chest tightness, and "high blood pressure". They noted developing red spots around the neck and chest area. The reported symptoms varied greatly among the employees and did not fit any consistent pattern. The general concern about "high blood pressure" was primarily based on reports of high blood pressure among some of the first affected employees. Several employees had their blood pressure monitored at the nurses station when they developed a rash (see below). The "red spots" were evaluated by NIOSH and the consulting dermatologist for the company. Only some persons reported having the spots and they each had only a few. The spots were red macules which blanched with pressure. They were located on the lower neck and upper chest, including skin areas covered by shirts or blouses. These spots are consistent with angiomas or secondary telangiectasias. They are commonly seen on fair-skinned individuals as a result of aging and sun exposure(4). They were likely present before the occupational exposure and not due to the exposure. Therefore, no health effects beyond the skin and mucous membrane irritation (and possible phototoxic skin reaction) could be verified through employee interviews and examinations.

The two office employees working in the production area were examined after avoiding the support area for one week. They ate lunch in the production area or outside. During that week, they were still affected after lunch in the afternoons. However, their symptoms and rashes were very much milder. Their experience indicates that the causative agent was likely present in the offices in the production area, but at a much lower level than in the support area. The increase in the rash during the early afternoon could have been related to their eating lunch outdoors.

A review of the dispensary log indicated that approximately 24 persons reported to the nurses station with the dermatitis - 18 females and 6 males. The employees initially affected during the week of March 2, worked in an open office space on the third floor underneath skylights. All were female. Five of six persons in this area were affected. The sixth person was the only one not working under a skylight. During the next two weeks, other employees on the third floor and employees on the second floor reported rashes, but at a substantially lower attack rate. A few employees in the packaging area reported having the rash toward the end of March. Besides the third floor office, other locations with a substantial number of affected employees included an open office on the north end of the second floor and the quality assurance offices on the second floor. All the secretaries in the open office were females, while the quality assurance staff consisted of approximately half females and half males. No employees working in a laboratory area on the second floor

were affected. The laboratory is the only area in the support building which uses 100% fresh air. The secretarial staff generally work at their desks; however, the quality assurance staff move through all areas of the building during the work day.

The location of the affected employees indicates that the concentration of the irritant vapor was highest in the air of the support area. The two open office areas and the quality assurance offices contained the highest proportion of affected employees. The dispensary log also indicates that three-fourths of the employees who reported having the rash were females. It may be that females were more likely to be affected or to report their symptoms. Irritant vapors are generally more likely to affect fair-skinned persons. On the other hand, only female employees worked in the two open office areas. Among the quality assurance staff, female and male employees were approximately equally affected. Thus, perhaps the concentration of the agent was higher in the open offices, causing the female employees working there to develop symptoms. Based on the available evidence, NIOSH can not determine the respective effects of location (within the support area) and sexual susceptibility.

Because many employees expressed concern about hypertension possibly resulting from the environmental contamination, NIOSH reviewed the dispensary log for recorded blood pressures. Of 24 persons who reported having the dermatitis, 12 had had their blood pressure measured during their visits to the nurse's station. Of these persons, six had previously measured blood pressures recorded in their medical records. The average blood pressure recorded for the 12 employees was 130/83 (respective standard deviations are 13/7.6). Normal blood pressure is considered to be values less than 140/90. Therefore, the average blood pressure recorded for affected individuals, during the times they were experiencing symptoms, was within the medically-accepted normal range.

The six persons with previously measured blood pressures were evaluated for changes in blood pressure by matched-pair analysis. Both systolic and diastolic blood pressure were slightly increased from before March 1981. The systolic pressure increased an average of 8.2 millimeters of mercury (mm Hg) ($p$ 0.05, Student's t-test). The diastolic pressure increased an average of 6.2 mm Hg ($p = 0.05$, Student's t-test). While the recorded blood pressures indicate a slight increase from blood presures measured before March, the differences are unreliable and probably biased for the following reasons: (1) The changes are small relative to the accepted measurement error using a sphygmomanometer (blood pressure cuff) to evaluate blood pressure. Differences of 5 to 10 mm Hg are below the accuracy limits of the sphygmomanometer. (2) The six persons with previously recorded blood pressures may be an unrepresentative sample of the 24 affected employees since only they had been to the nurse's station before March to have their blood pressures checked. The changes in blood pressure for all the affected employees can not be determined retrospectively. It should be noted that the average blood pressure for the larger sample of 12 affected employees was normal. (3) The employees' blood pressures recorded in the nurse's station could have been transiently increased due to the visit alone. Increases in blood pressure of as much as 20 mm Hg can be caused by the anxiety of a visit to a medical office. After a few minutes of rest, the blood pressure decreases

to a baseline level. A procedure of re-checking the blood pressure following a period of rest was not followed during the visits to the nurse's station. Thus the recorded increases may have been transient, occuring as the employee reported to the nurse's station with uncomfortable symptoms. (4) Finally, NIOSH can not rule out observer bias in the recording of the blood pressures during the period of the dermatitis. The company-contracted nurse, as well as many other employees, felt that the environmental agent caused elevated blood pressure. Such a belief could affect the nurse's intrepretation of the blood pressure. NIOSH concludes that the increase in recorded blood pressures is medically insignificant and finds no strong evidence that this increase is related to environmental exposure.

## VII. CONCLUSION

Although no contaminant has been positively identified, the results of this investigation suggest that the cause of the employees' dermatitis is related to the air handling system, specifically the steam humidification aspect. The employee complaints arose shortly after the boiler additive was changed. The area with the highest prevalence of symptoms is the area with the highest relative exposure to the boiler additive, due to having 95% recirculated air. Finally, the employees' symptoms disappeared after the removal of the boiler water treatment chemicals from the humidification system.

The specific contaminant(s) is probably a breakdown or reaction product of diethylaminoethanol (DEAE). DEAE is the only volatile chemical used in the water treatment for steam humidification. It was identified in bulk samples of the boiler additive, but not in other bulk liquids or in the sampled air of the support area. Results of colorimetric detector tube sampling indicate the presence of a bound-up amine in the air. No free amines were detected. It should be noted that DEAE is a tertiary amine.

The clinical appearance of the dermatitis is consistent with exposure to a primary irritant. The distribution of the rash on some persons is also suggestive of a phototoxic skin reaction. DEAE is a known primary skin irritant. It is not known to cause phototoxic skin reactions. Most likely, an amine salt derived from DEAE was responsible for the contact dermatitis. Such a compound could be chemically complex enough to cause a phototoxic skin reaction. This possibility can not be verified without first identifying the specific causative agent.

The medical evaluation indicates that significant health effects were limited to skin and mucous membrane irritation (and possibly phototoxic skin reaction). There was no consistent pattern of systemic health complaints among the employees. The vascular, red spots noted by some employees are likely unrelated to the occupational exposure. The average recorded blood pressure among half of the affected employees was normal. The small increase in recorded blood pressure observed for six affected employees was likely due to artifact. There is no substantial evidence to indicate that blood pressure was increased by the environmental exposure.

## VIII. RECOMMENDATIONS

NIOSH recommends that diethylaminoethanol be permanently removed from the boiler system. Since the purpose of this chemical is to prevent corrosion in the condensate line of the boiler system, a possible solution would be to add a non-volatile corrosion inhibitor directly to the return line.

Another possibility would be to not use the boiler system for humidification. A small steam generator could be installed that does not require a return line, and thus does not need treatment.

## IX. AUTHORSHIP AND ACKNOWLEDGEMENTS


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## X. REFERENCES


1. NIOSH Manual of Analytical Methods, 2nd Edition, Volume 5 (Method No. S140), U.S. Department of Health, Education, and Welfare, PHS, CDC, NIOSH, August 1979 (No. 79-141).

2. Miller, F., Scherberger, R., Tischer, K., and Weber, A., Determination of microgram quantities of diethanolamine, 2-methylaminoethanol, and 2-diethylaminoethanol in air. American Industrial Hygiene Association Journal, 28:330-334, July-August 1967.

3. Adams, R., Occupational Contact Dermatitis, J.B. Lippincott Company, Philadelphia, 1969.

4. Sauer, G., Manual of Skin Diseases, Fourth Edition, J.B. Lippincott Company, Philadelphia, 1980.

5. Proctor, N., and Hughes, J., Chemical Hazards of the Work Place, J.B. Lippincott Company, Philadelphia, 1978.

6. Cornish, H., Oral and inhalation toxicity of 2-diethyl-aminoethanol, American Industrial Hygiene Association Journal, 26:479, 1965.

7. A.C.G.I.H., 2-Diethylaminoethanol, Documentation of the Threshold Limit Values, Fourth Edition, Cincinnati, 1980 (pg. 140).

8. Operating Instructions 234-2801le, First Edition, Dragerwerk, AG, Lubeck, Germany, September 1974.

## XI. DISTRIBUTION AND AVAILABILITY

For the purpose of informing the "affected employees" the employer should post this report for at least 30 days in a prominent place(s) near where employees work.

Copies of this report will be available from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio, 45226, for 90 days. Thereafter, copies will be available from the National Technical Information Service (NTIS), Springfield, Virginia. Information concerning its availability through NTIS can be obtained from the NIOSH publication office at the above Cincinnati address.

Copies of this report have been sent to:

Boehringer Ingelheim, Ltd., Ridgefield, Conneticut
U.S. Department of Labor, Region I
Department of Health, State of Conneticut
Public Health Service, NIOSH, Region I