U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
CENTER FOR DISEASE CONTROL
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CINCINNATI, OHIO 45226

HEALTH HAZARD EVALUATION PROJECT NO.
HE 79-49-631

DANA CORPORATION - SPICER UNIVERSAL JOINT DIVISION
400 SOUTH MILLER AVENUE
MARION, INDIANA 46952

NOVEMBER 1979

I. TOXICITY DETERMINATION

It has been determined, based upon an environmental-medical evaluation, that employees from Department 265 and other areas of the plant were exposed to irritant substance(s) from the compressed-air line system which services air-driven machines. Employee complaints of mucous membrane irritation, headaches, nausea, sore throats, chest tightness, and nosebleeds dated back to November 1978. The effects of the contaminant appeared to be essentially limited to acute irritation of the mucous membranes. There is no substantial information at this time suggesting that systemic toxicity was a problem.

Environmental evaluations conducted by NIOSH in February and March 1979 were unable to document or identify the irritant substance(s). Breathing zone and general area samples taken for carbon monoxide, ozone, oxides of nitrogen, sulfur dioxide, hydrogen sulfide , methyl chloroform, and petroleum naptha were well within established environmental criteria. No potential toxicants were detected based on a gas chromatographic/mass spectrographic analysis of bulk air samples collected on charcoal and silica gel media. A qualitative examination of a bulk residue taken from the compressed air system revealed the presence of phthalic anhydride, a potent irritant and a possible decomposition product of the synthetic compressor oil.

Once company officials were aware that there was a problem with the compressed air system, appropriate efforts were undertaken to rectify the situation. As of March 22, 1979, no exposures to irritant gases were being reported in Department 265 or other areas of the plant. Recommendations have been presented in this report in the event that further employee exposure to the irritants occurs.

II. DISTRIBUTION AND AVAILABILITY

Copies of this Determination Report are currently available upon request from NIOSH, Division of Technical Services, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After 90 days, the report will be available through the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22151. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office at the Cincinnati address.

Copies of this report have been sent to:

a Allied Industrial Workers of America; Cincinnati, Ohio
b. Local 113, Allied Industrial Workers
c. Dana Corporation
d. U. S. Department of Labor, OSHA, Region V
e. NIOSH, Region V

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

III. INTRODUCTION

Section 20(a)(6) of the Occupational Safety and Health Act of 1970, 29 U.S.C.669(a)(6), authorizes the Secretary of Health, Education, and Welfare, following a written request by an 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.

On January 30, 1979, NIOSH received a request from the Allied Industrial Workers of America for a health hazard evaluation in Department 265 and other areas of the Dana Corporation-Spicer Universal Joint Division. The request alleged employee exposure to unknown substances resulting in mucous membrane irritation, headaches, nausea, sore throats, tightness in the chest, and nosebleeds.

An irritant odor was first noticed after a four-day shutdown in November, 1978. Also, the union was concerned that two cases of pneumonia had recently developed and one employee suffered a heart attack. The heart attack victim and one case of pneumonia were in Department 265, the other case of pneumonia was in an adjacent area. Union representatives suspected that the source of exposure was the compressed-air lines which service the air-driven machines in Department 265.

Before NIOSH was contacted, two private consultants and two product manufacturers' representatives had been asked by company officials to review the situation. Their findings were generally inconclusive.

One private consultant conducted environmental surveys on January 16, and February 6, 1979, but was unable to document exposure to potential toxicants. A qualitative laboratory investigation revealed that phthalic anhydride was liberated during the thermal decomposition of the synthetic compressor oil.

Another consultant conducted an environmental survey on January 15, 1979. A 100-minute sample collected in the breathing zone of an air-vice operator revealed a total suspended particulate concentration of 1.7 mg/m^3. A 97-minute sample collected in the breathing zone of a Nunnaly* press operator indicated a concentration of less than 0.7 mg/m^3 total suspended particulates. These results were well below established evaluation criteria.

Interim Report #1, dated February 1979, was submitted to the requestors and plant management. This report provided preliminary medical results and results of environmental measurements for carbon monoxide (CO), oxides of nitrogen (NO, NO_2), ozone (O_3), and sulfur dioxide (SO_2). Recommendations designed to alleviate the exposure problem were presented.

IV. HEALTH HAZARD EVALUATION

A. Process Description - System Configuration

The company is engaged in the assembly and machining of universal joints, propellar shafts, and end yokes. There are approximately 990 production and maintenance personnel employed in this plant on three shifts. The plant occupies a 25-acre site; Figure 1 depicts the general layout of the facility at the time of the survey.

Department 265 is located adjacent to the general offices; approximately 58 production personnel are employed in this area. Production is limited to the assembly of universal joint parts by three types of air-driven machines: Nunnaly presses, needle loaders, and air vices. Compressed air is supplied through a vertical run of 3/4 inch pipe from the overhead distribution system and is used to inject grease into bearings, stabilize and actuate needles and snap rings, and perform other mechanical functions. No chemicals are used in this department.

*Mention of commercial names or products does not constitute endorsement by NIOSH.

Three 1500-cubic-feet-per minute (CFM) electric motor-driven reciprocating compressors (designated Nos. 1, 2, 3) are located outside of the plant in the boiler house. Normally, two compressors are operated simultaneously at three-quarter capacity and supply the system with approximately 2250 CFM at 95 to 105 pounds per square inch guage (PSIG). The air stream is passed through a Freon*-cooled chiller-dryer (Ingersoll-Rand Thermomass Model R-15*) before entering the plant.

In January, 1979, the chiller-dryer unit was bypassed and opened for cleaning after it was discovered that a sample of chiller-dryer condensate exhibited an odor similar to the offending odor noted at the compressed air discharge point in Department 265. Because of continued complaints, on January 29, 1979, two portable screw-type rental compressors were set-up inside the plant to service the machines in Department 265, and airlines which serviced this Department were replaced with new airlines. Compressor No. 1 supplied air to the remainder of the plant while No. 3 was partially disassembled for maintenance and repair. No. 2 was shutdown for reserve in the event No. 1 failed. On January 25, 1979, Dana stopped using a synthetic compressor oil and switched to a mineral-based oil.

In addition to machining, processes occurring in other departments include welding, grinding, metal coating, and metal degreasing with methyl chloroform.

B. Evaluation Design

A team of NIOSH industrial hygienists and medical personnel met with union and management officials and conducted an initial survey on February 5-6, 1979. Initial information from union and company personnel indicated that the health problem to be investigated was occurring primarily in Department 265, although cases of exposure to the irritant(s) were also reported from other areas, and that the suspected source of exposure was the compressed-air system. Company and union officials indicated that with the introduction of the rental compressors and new air lines, conditions in Department 265 had improved. When the meeting adjourned, NIOSH personnel conducted a walk-through survey of Department 265 and other areas of the plant.

1. Initial Environmental

NIOSH industrial hygienists conducted a walk-through survey of the Department 265 production area, the boiler room which housed the three compressors, and the boiler room roof. Names

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and addresses of manufacturers of the chemicals used in processes were obtained. Bulk samples of the various compressor oils and air line condensate were obtained.

Personal breathing zone and area (bulk air) samples from Department 265 and adjacent areas were obtained using silica gel and charcoal as media to assess employee exposure to the unknown environmental contaminant. Detector tube measurments for CO, oxides of nitrogen, ozone, and sulfur dioxide were performed. Potential sources of fumes, vapors, or odors were investigated.

2. Medical

In addition to observing the production processes and the plant's physical environment, the medical team's activities included (a) a questionnaire survey of all 16 employees present in Department 265 during the evening shift on February 5; (b) informal interviews with numerous employees in Department 265 during the day shift on February 6; (c) interviews with several employees of other departments on both shifts; (d) review of available medical records, including the nurse's log, the OSHA Log of Occupational Injuries and Illnesses (Form 200), and information in personnel files; and (e) odor identification tests.

3. Follow-up Environmental

On March 22, 1979, a NIOSH industrial hygienist conducted a follow-up environmental survey. Union officials indicated that conditions in Department 265 had improved since the initial NIOSH survey but that some exposure was occurring in other areas of the plant serviced by the original compressed air lines and compressors. As part of an effort to isolate and identify the contaminant, the NIOSH industrial hygienist had union officials identify three locations which had purportedly received recent exposure to the contaminant. Personal breathing zone and area samples were conducted at these locations in order to assess employee exposure to the oxides of nitrogen and hydrogen sulfide, potential decomposition products of the synthetic and mineral based oil.

A bulk sample of synthetic oil residue, located the lower east return pipe to the chiller, was collected in a quart glass jar, sealed and stored by company officials on March 8, 1979, and given to the NIOSH industrial hygienist for the purpose of laboratory analysis. Plant personnel stated that the residue sample originally "exuded" an irritant odor.

C. Evaluation Methods

1. Initial Environmental Sampling

On February 6, low flow personal sampling pumps operating at approximately 50 cubic centimeters per minute (cc/minute) were placed on two employees in Department 265, one in Department 270, and one in Department 478. Each employee wore two pumps and each pump used either activated charcoal or silica gel as a collecting medium. Six high-flow sampling pumps operating at approximately 0.9-1.35 liters per minute with either silica gel or activated charcoal as a collecting medium were used to collect bulk air samples in the three departments. The charcoal and silica gel tubes were desorbed and analysed at NIOSH's Cincinnati laboratories by gas chromatographic and mass spectographic (GC/MS) techniques. The desorbing agents for the charcoal and silica gel were, respectively, carbon disulfide and methanol.

Colorimetric detector tube tests for SO_2, NO, NO_2, CO, and O_3 were made with a National Draeger* detector tube system.

Four bulk compressor-oil samples and one bulk water condensate were submitted to the NIOSH laboratory for identification of volatiles released during heating. Portions of the oils were put in sealed vials and heated in a hot wax bath held at 160-170 degrees centigrade (^{o}C). Analyses off the volatiles were performed by taking headspace air samples from these heated vials with a gas-tight syringe and injecting these directly into a gas chromatograph/mass spectrophotometer for identification. The bulk water condensate was extracted with methylene chloride and analysed by gas chromatography.

2. Medical

a. Questionnaire Survey

On February 5, all employees working in Department 265 during the evening shift were interviewed privately. The questionnaire was primarily concerned with information about symptoms (descriptions, temporal characteristics) and unusual odors (description, location).

b. Interviews with Department 265 Day-Shift Employees

Since the results of the questionnaire survey were in substantial agreement with prior information concerning (a) the nature and duration of symptoms, and (b) the source of odors, and since this survey suggested that there would not be an appreciable number of asymptomatic day-shift employees, a

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formal questionnaire survey of the Department 265 day shift was not conducted. Instead, on February 6, numerous employees of Department 265 were informally interviewed. The interviews were unstructured and were conducted at the work site, often with other employees present. Because the symptoms were not of a "personal" nature (they were, in fact, frequently discussed among the employees), and because there was more interest, by this time, in qualitative data, the judgement was made that there was no need for private interviews. These interviews, like the questionnaire survey, focused on symptoms and odors.

c. Interviews With Employees of Other Departments

On both February 5 and 6 several employees of other departments were interviewed (adjacent to and distant from Department 265), mainly those who were identified as having symptoms.

d. Review of Medical Records

The following records were reviewed: (1) the OSHA Log of Occupational Injuries and Illnesses (Form 200) for January, November and December 1978 and for all of 1979 up to the time of the investigation, (2) the company nurse's log from November 1978 up to the time of the investigation, and (3) medical information in personnel files, which consisted mostly of physicians' statements and insurance reports. Outside medical records concerning certain employees were obtained.

e. Odor Identification Test

Samples of three lubricating oils were obtained: the synthetic oil used in the permanent compressors prior to January 25, 1979, the mineral oil used in the permanent compressors since January 25, and the mineral oil used only in the temporary compressor (since January 29). Four Department 265 day-shift employees volunteered to participate in the test; three were selected by an employee representative, himself a participant, because he thought that they met the criteria of (a) being able to smell the odor readily, and (b) not having severe symptoms.

Each sample was smelled at room temperature, then heated in a stoppered flask to the point where it began to "decompose," as indicated in the case of the mineral oils by darkening; the synthetic oil did not change color but produced visible vapors. Each participant then smelled the vapors. One sample, the synthetic oil, was also smelled after an equal amount of water was added (so as to simulate moisture in the compressed air lines) and the mixture reheated. The employees did not know the identities of the various samples.

3. Follow-up Environmental Sampling

On March 22, low-flow personal sampling pumps operating at

23-56 cc/minute were placed on one employee in Department 225, one in Department 260, and one in Department 230. Each employee wore two separate sampling pump configurations. One was designed to assess exposure to hydrogen sulfide via a colorimetric, long-term detector tube; the other was designed to assess exposure to NO, NO_2, via an impregnated solid sorbent tube. The sorbent tubes were analysed at the NIOSH laboratory by the NIOSH Spectophotometric Method P&CAM 231[1]. Four low flow sampling pumps were located in Department 230 and 225 in order to collect area samples for hydrogen sulfide, NO, and NO_2.

The synthetic oil bulk residue sample collected by company officials and submitted to the NIOSH industrial hygienist was submitted to the NIOSH laboratory for analyses. Portions of the residue were put into sealed vials, heated in a water bath (65°C), and headspace samples were analysed by GC. Another portion of the sample was extracted with carbon disulfide and analysed by both infra-red and GC/MS. Portions of the residue were also heated in sealed vials in a hot wax bath (160°C), and headspace samples were analysed by GC/MS.

D. Evaluation Criteria

A number of sources recommend airborne levels of substances under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effect. Such airborne levels are referred to as standards or threshold limit values. Due to variations in individual susceptability, a small percentage of workers may experience effects at levels at or below the threshold limit; a smaller percentage may be more seriously affected by aggravation of a pre-existing condition or by a hypersensitivity reaction.

The three main sources of criteria for this study are: (1) NIOSH Criteria Documents with recommended standards for occupational exposure; (2) General Industry Safety and Health Standards, U. S. Department of Labor, OSHA[2]; (3) Threshold Limit Values (TLVs), and their supporting documentation, issued by the American Conference of Governmental Industrial Hygienists (ACGIH)[3].

Carbon monoxide (CO) is a colorless, odorless, tasteless gas. The typical signs and symptoms of acute CO poisoning are headache, dizziness, drowsiness, nausea, vomiting, collapse, coma, and death[4]. The NIOSH recommended standard is 35 parts of carbon monoxide per million parts of contaminated air (ppm) by volume, determined as a time-weighted average (TWA) concentration for up to a 10-hour workday, 40-hour workweek. The NIOSH maximum allowable ceiling level for CO is 200 ppm[5]. The current OSHA standard is 50 ppm, determined as an 8 hour TWA[2].

Oxides of nitrogen are potential decomposition products of the synthetic oil. Nitric oxide (NO) is a colorless gas and it combines with oxygen to form nitrogen dioxide (NO_2) which is a reddish-brown gas with a characteristic odor. Oxides of nitrogen gases may produce irritation of the eyes and mucous membranes. Exposure to high concentrations of these gases may result in pulmonary irritation[4]. NIOSH has recommended a maximum allowable ceiling level of 1 ppm for NO_2, and a level of 25 ppm for NO, determined as a TWA concentration for up to a 10-hour workday, 40 hour workweek[6]. The OSHA standards are NO_2-25 ppm, NO-5 ppm, determined as an 8 hour TWA[2].

Ozone (O_3) is a bluish gas with a characteristic pungent odor. Typical signs and symptoms of acute ozone poisoning include irritation of the eyes and mucous membranes, headache, malaise, and shortness of breath[4]. The current OSHA standard is 0.1 ppm, determined as an 8-hour TWA[2].

Sulfur dioxide (SO_2) is a colorless gas with a characteristic strong suffocating odor. Gaseous sulfur dioxide is particularly irritating to mucous membranes of the upper respiratory tract. The NIOSH recommended standard is 0.5 ppm, determined as a TWA concentration for up to a 10-hour workday, 40 hour workweek[7].

Hydrogen sulfide (H_2S) is a flammable colorless gas with a characteristic rotton-egg odor. Typical signs and symptoms of acute H_2S exposure include irritation of the eyes and respiratory tract. Acute exposures may cause immediate coma or death[4]. NIOSH has recommended a maximum allowable ceiling level of 10 ppm (equal to 15 milligrams/cubic meter)[8]. The current OSHA Standard is 20 ppm acceptable ceiling concentration; 50 ppm maximum acceptable peak concentration[2].

Methyl chloroform (CH_3CCl_3; 1,1,1-trichloroethane) is a colorless, nonflammable liquid with a odor similar to chloroform. Upon contact with hot metal or exposure to ultraviolet radiation, it will decompose to form the irritant gases hydrochloric acid, phosgene, and dichloroacetylene. The liquid and vapor are irritating to the eyes on contact. Other symptoms of acute exposure include dizziness, incoordination, unconsciousness, and death[4]. NIOSH has recommended a maximum allowable ceiling level of 350 ppm[9]. The current OSHA standard is 350 ppm, determined as an 8-hour TWA[2].

Petroleum naphthas (mineral spirits) are liquids used as organic solvents. Naphthas are irritating to the skin, conjunctiva, and mucous membranes of the upper respiratory tract. Sufficient quantities of naphthas cause central nervous system depression[4]. The NIOSH recommended standard is 350 mg/m^3, determined as a TWA concentration for up to a 10-hour workshift, 40 hour workweek[10]. The OSHA standard for petroleum naphtha is 2000 mg/m^3 (500 ppm), determined as an

8-hour TWA[2].

Phthalic anhydride is a white lustrous solid with needle like crystals, and, in the form of a dust, fume, or vapor, is a potent irritant of the eyes, skin, and respiratory tract. Hypersensitivity may develop. Inhalation of the dust or vapors may cause coughing, sneezing, and a bloody nasal discharge. Repeated exposure may result in bronchitis, emphysema, allergic asthma, hives, and chronic eye irritation[4]. The current OSHA standard is 12 mg/m^3 (2ppm), determined as an 8-hour TWA[2]. The ACGIH standard is the same.

Nuisance particulates (total suspended particulates) -- Excessive concentrations of nuisance particulates in the workroom air may cause unpleasant deposits in the eyes, ears, and nasal passages, or cause injury to the skin or mucous membranes by chemical or mechanical action[3]. The current OSHA standard is 15 mg/m^3, determined as an 8-hour TWA[2]. ACGIH recommends a threshold limit value of 10 mg/m^3, determined as an 8-hour TWA[3].

E. Results and Discussion

1. Environmental

The presence of an irritant gas or aerosol was verified by a NIOSH Industrial hygienist. The observation was made two feet from a compressed-air serviced needle-loader machine in Department 265. Actual exposure to the irritant substance(s) occurred on an intermittant basis, approximately three times every forty-five minutes, and lasted approximately one minute. The apparent source of exposure was the compressed-air system which serviced the machine.

Laboratory analysis of the personal and area (bulk air) samples collected on February 6 were negative except for trace amounts of methyl chloroform and mineral spirits. Results are shown in Table 1. All seven full-shift time-weighted average exposures to methyl chloroform and mineral spirits were well below the evaluation criteria.

Detector tube samples of air collected on February 6 from the compressor line for the oxides of nitrogen (NO, NO_2) showed levels which ranged from 0.75 to 2.0 ppm. Ambient air detector tube measurements showed 0.75 ppm. Ambient air measurements for NO_2 measured less than 0.25 ppm. These results were below established criteria and are shown in Table 2. During the March 22 survey, solid sorbent tubes were used to assess exposure to NO and NO_2. Results from the personal breathing zone and area samples revealed levels which were well below established criteria. Results are shown in Table 3.

Ambient air detector tube measurements (taken on February 6)

for the mucous membrane irritants ozone (O_3) and sulfur dioxide (SO_2) revealed levels of less than 0.05 ppm and 1.0 ppm, respectively. The results were below evaluation criteria and are shown in Table 4. During the March 22 survey, long-term detector tubes were used to assess exposure to hydrogen sulfide. No H_2S was detected. Results are shown in Table 5.

A qualitative analysis of the volatiles released during heating (160-170°C) of the mineral oils revealed that hydrogen sulfide was the major component released. No major volatiles were detected during heating of the synthetic oil. No extractable organics were detected in the bulk water condensate.

A qualitative analysis of a CS_2 extract from the synthetic oil residue indicated the presence of phthalic anhydride.

As of March 22, 1979, no exposures to the irritant substances were being reported in Department 265 or other areas of the plant.

2. Medical

a. Evening-Shift Questionnaire Survey

The evening-shift work force consisted of 23 employees, including the foreman. Three had been on sick leave for at least seven months; one was on sick leave for almost two weeks for a disorder unrelated to the problem under investigation. Three were absent, one for a reason other than illness and two for unknown reasons. All 16 employees present were interviewed.

All interviewed employees worked at the plant at least ten years. They ranged in age from 33 to 54 years, with a median of 42. All were men. Thirteen had eye, nose, or throat irritation at work in the recent past. Two others had no symptoms at work, and the remaining employee had only symptoms other than eye, nose, or throat irritation.

Of the thirteen employees with mucous membrane irritation, twelve also had other symptoms on more than one occasion; these included chest discomfort or "tightness" (6 persons), cough (3), nasal/sinus congestion (2), bloody nasal mucus (5), hoarseness (2), unusual taste (2), headache (2), nosebleed (1), skin irritation (1), fatigue (1), and "cold blister" (1). Excluding one of the 13 who had worked in Department 265 for only two weeks, the times of onset were summer 1978 - 1 case, between Thanksgiving and Christmas 1978 - 4, since Christmas - 5. In one case the time of onset was at an undetermined time during the winter, and in the remaining case the information was not obtained.

Nine of the fourteen symptomatic employees specifically

reported that their symptoms began early in the shift. No consistent temporal pattern of severity of symptoms during the shift was discerned. Two employees said that their symptoms were not as severe after more than two days off work; another reported that after one day off work his symptoms were worse. In general, however, no changes in severity from day to day were found. Three employees related that their symptoms resolved within an hour or two after leaving the plant, but such information was not obtained from the others.

Nine of the sixteen employees detected an unusual odor during the preceding two months. Two described the odor as similar to "burnt oil," and two others mentioned oil or petroleum while attempting to describe the odor. Other descriptions included ammonia (3), skunk (1), sewer gas (1), chlorine (1), and plastic (1). (Some employees used more than one of these terms in attempting to describe the odor).

While one person considered the possibility that his symptoms might be psychogenic, and five did not know the origin, nine of the sixteen interviewed employees thought that the source of their symptoms and/or the odors was the compressed-air system. Eight employees reported odors and/or symptoms to be worse around the Nunnaly or needle-loader machines, including five who did not work primarily at these machines. Eight employees said that their symptoms decreased when use of the new compressed-air system began, four reported no change, one was not working at the time, and information is lacking in one case.

b. Interviews with Department 265 Day-Shift Employees

All of the Department 265 day-shift employees were men; they seemed to be similar to the evening-shift employees with respect to age and seniority. The interviews indicated that day-shift employees seemed to have more severe symptoms and perhaps a somewhat greater prevalence and variety of symptoms other than mucous membrane irritation, but there was no evidence that contradicted the findings that the source of the unusual odor was the compressed-air system and that the odors were worse around the Nunnaly and needle-loader machines. Only an occasional employee reported no symptoms or no awareness of unusual odors.

c. Interviews with Employees of Other Departments

These employees tended to report symptoms similar to those of Department 265 employees. However, this is the reason that they were brought to our attention. Many of these employees described symptoms that could not be distinguished from those of common respiratory disorders, and whether the problem affecting Department 265 did or did not extend beyond that Department's immediate vicinity could not be determined from this information. The NIOSH medical team was not prepared to

do a plant-wide survey to answer this question.

d. Review of Medical Records

In January, 1978, there were 19 entries in the OSHA Log of Occupational Injuries and Illnesses; only one concerned an "illness" - a dermatologic problem. In contrast, in January, 1979, there were 30 entries, 8 of which were "illnesses." Of these, 5 were related to the problem under investigation. Four were from Department 265: 3 respiratory problems and 1 headache/chest pain. The 5th was a respiratory problem in an employee in an adjacent department. (The 3 unrelated "illnesses" were dermatologic and eye problems in distant departments.) November and December 1978 had 30 and 22 entries, respectively, with 4 and 2 entries, respectively, for "illness" - all dermatologic problems.

The nurse's log indicated relatively infrequent visits to the clinic by Department 265 employees in November and December 1978. Visits for illnesses (as opposed to injuries) became more frequent beginning around January 4 and 5, and were quite numerous on January 17 and 24. There were no visits on January 29 (the first day the new compressed-air system was used), but by January 30 the visits were back to the usual level for January 1979.

On January 17 a Department 265 employee had a heart attack before starting work on the day shift. He died on January 24. Prior to this, numerous Department 265 employees had left work because of medical complaints. On January 23 a Department 265 employee left work because of an illness that was diagnosed later that day as pneumonia. Less than a week earlier an employee from an adjacent department was admitted to a hospital for pneumonia.

e. Odor Identification Test

All participants agreed that none of the three oils had an odor at room temperature. After heating, the vapors from all three samples had an acrid smell. The participants all agreed that the odor from each was similar to the odor from the compressed-air lines but that the odor from the lines was "musty." The heated mixture of synthetic oil and water approximated this "musty" odor.

All participants agreed that the odor from the two mineral oils was closer to the odor from the compressed-air lines than was that of the synthetic oil. However, the synthetic oil did not change color, so it may not have been heated enough to simulate conditions of presumed decomposition in the air compressor. Three of the four participants could not tell the difference between the two mineral oils, but one said that the odor of the oil used in the temporary compressor was closest to the odor

from the compressed-air lines. (Inhalation of the vapors induced coughing in one of the participants, who was smoking a cigarette during the test, but not in the others; the coughing ceased after the test).

It is possible that the participants identified a mineral oil as the one responsible for the odor in the compressed-air lines because the mineral oils had been used exclusively in the preceding week. Also, the test conditions were crude and perhaps inadequate to comparably heat and decompose the three oils. Thus, the results of the odor identification test, while informative, are not conclusive.

F. Summary and Conclusions

1. Exposure to the irritant substance(s) could have resulted from thermal decomposition of the synthetic compressor oil by one or more compressors and distribution of contaminants throughout the entire compressed-air system. This hypothesis is supported by the following observations:

a. There was a temporal association between the occurrence of symptoms and the presence of odors from the compressed-air system. This would explain both the greater severity of the problem on the day shift (greater use of compressed-air because of more production activity) and the increased odors in the area of the Nunnaly presses, which emit a steady stream of compressed-air, and the adjacent needle-loader machines.

b. A decrease in frequency and severity of symptoms occurred when use of the new compressed air system began. (Connections between the new and old compressed-air lines were discovered and could have allowed contamination of the new air lines by air (and any contaminant) from the old lines and could thus account for the continued problem in Department 265).

c. Exposure to an irritant occurred in the boiler room when a pipe connection to the chiller-dryer ruptured, and a similar exposure occurred when an aftercooler pipe from compressor No. 2 was disassembled. Also, an irritant odor was discovered within the cylinders of the disassembled chiller-dryer.

d. Compressor oils thermally decompose to produce potent irritants. A consultant discovered that phthalic anhydride was liberated during the thermal decomposition of the synthetic compressor oil, and a qualitative analysis by NIOSH of the carbon disulfide extract from the synthetic oil residue indicated the presence of this chemical. The symptoms exhibited by the workers are compatible with the irritant effects of phthalic anhydride, which could conceivably still have been present in the old air lines even after the source (the synthetic oil) was no longer used.

2. On the basis of the available medical data, one of the two "pneumonia" cases might have been a chemical or hypersensitivity pneumonitis caused by the putative environmental contaminant. The other case was most likely infectious in origin and unrelated to the contaminant. While it is conceivable that exposure to an irritant substance may have been a contributory factor in making the respiratory tract less resistant to infection, this is purely speculative.

3. While theoretically possible, it is extremely unlikely that exposure to the putative contaminant was in any way related to the heart attack incident.

4. The effects of the contaminant in the compressed-air system seemed to have been essentially limited to acute irritation of mucous membranes. There is no substantial information at this time suggesting that systemic toxicity was a problem. However, chronic exposure to an irritant could presumably result in irreversible damage to mucous membranes. Furthermore, if phthalic anhydride was, in fact, the substance responsible for the problem, repeated exposure could result in sensitization, with subsequent exposures inducing episodes of asthma.

5. Once company officials were aware that there was a problem and that the problem was widespread and due to an environmental contaminant, appropriate efforts were undertaken to isolate the source of exposure, identify the contaminant, and rectify the situation. As of March 22, 1979, the company was in the process of making the following modifications:

a. Existing contamination was being cleaned from the compressors and all system components located with the boiler room facility.

b. Coalescing filters, designed to prevent the transportation of compressor lubrication oil and contaminants into the workroom air via the compressed-air delivery system, were to be installed beyond the chiller-dryer.

c. Each compressor was to be provided with over-temperature shutdown devices backed up by indicating thermometers to monitor exhaust air stream temperature.

6. The company will attempt to rely upon the continuous supply of uncontaminated air to eventually purge any residual contamination located in the plant-wide air line distribution system. Single use, disposable, half-face respirators have been made available to all employees.

G. Recommendations

1. If further employee exposure to the irritant occurs, the

company should either clean the existing air-supply system or replace the system entirely. The company should be especially sensitive to any exposure which may occur this winter when doors and windows remain shut.

2. If a decision is made to replace or clean the air-supply lines, sufficient precaution should be instituted to protect anyone repairing the line from residual contamination. An air-line respirator or self-contained breathing apparatus should be utilized by individuals who weld or torch-cut the supply line.

3. Because it is conceivable that phthalic anhydride was an air line contaminant and may still be present, any employee who is still symptomatic should be medically evaluated, preferably by a pulmonary or allergy specialist, with attention to the possibility of hypersensitivity to phthalic anhydride.

V. REFERENCES

1. P&CA Method No. 231: NIOSH Manual of Analytical Methods, Volume 1, DHEW (NIOSH) Publication No. 77-157-A, (April 1977)

2. General Industry Standards: Occupational Safety and Health Administration Safety and Health Standards (29CFR1910) revised January 1976

3. American Conference of Governmental Industrial Hygienists: Documentation of Threshold Limit Values, 3rd Edition, (1971)

4. Occupational Diseases, a Guide to Their Recognition: Revised Edition, DHEW(NIOSH) Publication No. 77-181 (June 1977)

5. Criteria for a Recommended Standard..Occupational Exposure to Carbon Monoxide: NIOSH Publication No. 73-11000, (1973)

6. Criteria for a Recommended Standard..Occupational Exposure to the Oxides of Nitrogen, NIOSH Publication No. 76-149, (1976)

7. Criteria for a Recommended Standard...Occupational Exposure to Sulfur Dioxide, NIOSH Publication No. 74-111, (1974)

8. Criteria for a Recommended Standard...Occupational Exposure to Hydrogen Sulfide, NIOSH Publication No. 77-158, (1977)

9. Criteria for a Recommended Standard...Occupational Exposure to 1,1,1-Trichloroethane (Methyl Chloroform), NIOSH Publication No. 76-184, (1976)

10. Criteria for a Recommended Standard..Occupational Exposure to Refined Petroleum Solvents, NIOSH Publication No. 77-192, (1977)

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HHE 79-49
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TABLE 1
RESULTS OF ENVIRONMENTAL SAMPLES ON FEBRUARY 6, 1979
FOR IDENTIFIABLE ORGANIC CONTAMINANTS

JOB/LOCATION	SAMPLE MEDIUM	TIME OF SAMPLE	TOTAL VOLUME SAMPLED(M3)	METHYL CHLOROFORM (ppm)	PETROLEUM NAPTHA (mg/M3)	TYPE OF SAMPLE
Machine operator/ Dept. 270	C	0800-1440	0.021	1.0	9.6	BZ
Machine operator/ Dept. 478	C	0810-1430	0.018	0.80	16.2	BZ
Assembler/ Dept. 265	C	0806-1437	0.023	1.0	8.7	BZ
Nunnaly Operator/ Dept. 265	C	0814-1440	0.022	1.3	8.9	BZ
Bulk air/Dept.270	C	0843-1434	0.273	1.0	8.0	A
Bulk air/Dept.478	C	0850-1445	0.319	0.6	8.7	A
Bulk air/Dept.265	C	0848-1433	0.311	1.3	ND	A
NIOSH RECOMMENDED STANDARD:				350	350	
OSHA STANDARD:				350	2000	

ABBREVIATIONS:
M^3 = cubic meter
ppm = parts per million parts of air
mg/M^3 = milligrams per cubic meter of air
BZ = breathing zone sample
A = area sample
ND = none detected
C = charcoal (activated)

HHE 79-49
DANA CORPORATION
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TABLE 2
RESULTS OF DETECTOR TUBE SAMPLES TAKEN ON
FEBRUARY 6, 1979, FOR OXIDES OF NITROGEN AND NO_2

LOCATION	SOURCE OF AIR	OXIDES OF NITROGEN (NO_1, NO_2 COMBINED) (ppm)	NITROGEN DIOXIDE (NO_2) (ppm)
Nunnaly machine Dept. 265	From Airline	2.0	ND
Nunnaly machine Dept. 265	Ambient	0.75	ND
Needle loader machine Dept. 265	Ambient	0.75	ND
Nunnaly machine Dept. 265	Ambient	0.75	ND
NIOSH RECOMMENDED STANDARD:		*	1
LIMITS OF DETECTION:		0.50	0.05

ABBREVIATIONS: * = There is no separate criteria for exposure to a combination of NO_1, NO_2. The results from NO_2 tube measurements indicate that the majority of the positive reading is due to presence of NO or interferences.

ppm = parts per millions parts of air

HHE 79-49
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TABLE 3
RESULTS OF SOLID SORBENT TUBE SAMPLES TAKEN ON
MARCH 22, 1979, FOR NITROGEN OXIDE (NO) AND NITROGEN DIOXIDE (NO_2)

JOB/LOCATION	SAMPLE NO.	TIME OF SAMPLE	TOTAL VOLUME SAMPLED (L)	NITROGEN OXIDE NO (ppm)	NIITROGEN DIOXIDE NO2 (ppm)	TYPE OF SAMPLE
Blaster operator/Dept. 225	1,6	0810-1312	13	ND	ND	BZ
Lathe operator/Dept. 260	2,7	0814-1315	10	ND	ND	BZ
Grinder operator/Dept. 230	3	0816-1316	18	ND	ND	BZ
Near Blaster/Dept. 225	4	0818-1300	12	ND	ND	A
Near Grinder- Dept. 230	5	0822-1305	9	ND	ND	A
NIOSH RECOMMENDED STANDARD:				25	1	
LIMIT OF DETECTION:				0.20	0.20	

ABBREVIATIONS: ND = none detected
BZ = breathing zone sample
A = area sample
L = liters

TABLE 4
RESULTS OF DETECTOR TUBE SAMPLES TAKEN ON
FEBRUARY 6, 1979, FOR SULFUR DIOXIDE (SO_2) AND OZONE (O_3)

LOCATION	SOURCE OF AIR	SULFUR DIOXIDE (SO_2) (ppm)	OZONE (O_3) (ppm)
Nunnaly Machine, Dept. 265	Ambient	ND	ND
Needle Loader Machine Dept. 265	Ambient	ND	ND
Nunnaly Machine Dept. 265	Ambient	ND	ND
NIOSH AND OSHA STANDARD:		0.5	0.1
LIMITS OF DETECTION:		1.0	0.05

ABBREVIATIONS: ND = none detected
ppm = parts per million parts of air

TABLE 5
RESULTS OF LONG TERM DETECTOR TUBE SAMPLES TAKEN ON
MARCH 22, 1979, FOR HYDROGEN SULFIDE

JOB/LOCATION	TIME OF SAMPLE	TOTAL VOLUME SAMPLED (L)	HYDROGEN SULFIDE (H_2S) (ppm)	TYPE OF SAMPLE
Blaster operator/ Dept. 225	0810-1312	6.2	ND	BZ
Lathe operator/ Dept. 260	0814-1315	10	ND	BZ
Grinder operator/ Dept. 230	0816-1316	18	ND	BZ
Near Blaster - Dept. 225	0818-1300	12	ND	A
Near Grinder - Dept. 230	0822-1305	9	ND	A

NIOSH RECOMMENDED STANDARD: 10
LIMITS OF DETECTION: 0.8

ABBREVIATIONS: ND = none detected
ppm = parts per million
BZ = breathing zone sample
A = area sample
L = liters

Figure I

General Plant Layout
Dana Corpoaration, Marion, Indiana