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 DETERMINATION
REPORT NO. 76-24-350

DANA CORPORATION
TIPTON, INDIANA

DECEMBER 1976

I. TOXICITY DETERMINATION

An evaluation of employee exposure to chlorinated solvent vapors generated at three degreaser operations has been completed at the Dana Corporation located in Tipton, Indiana. A National Institute for Occupational Safety and Health (NIOSH) investigator visited the facility on March 16-18, 1976. The following determinations have been made with regard to potential hazards to employee health:

1. The open-detrex degreaser operator is exposed to concentrations of trichloroethylene vapor in excess of the 8-hour time-weighted average (TWA) and ceiling value criteria as recommended by NIOSH for this substance. Based upon the (a) daily symptoms of nausea and dizziness with less frequent incidents of headache and light-headedness, (b) environmental measurements, and (c) review of the toxicological literature on this substance, it has been determined that the operator is exposed to toxic concentrations of trichloroethylene vapor under the conditions used and found.

2. The manpro-degreaser operator is exposed to concentrations of trichloroethylene vapor in excess of the ceiling value criteria as recommended by NIOSH; the 8-hour TWA criteria was not exceeded. Based upon the (a) daily symptoms of nausea and dizziness with less frequent incidents of headache and light-headedness, (b) environmental levels measured, and (c) review of the toxicity literature on this substance, it has been determined that the operator is exposed to toxic concentrations of trichloroethylene under the conditions used and found.

3. The valve-guide degreaser operator is not exposed to concentrations of 1,1,1-trichloroethane vapor in excess of the 8-hour TWA and ceiling value criteria as recommended by NIOSH. Based upon the (a) negative health questionnaire response, (b) review of the toxicological literature on this substance, and (c) low environmental measurements, it has been determined that the operator is not exposed to toxic concentrations of 1,1,1-trichloroethane under the conditions studied.

4. Employees working in areas adjacent to the open-dextrex and manpro degreaser operations are not exposed to concentrations of trichloroethylene and 1,1,1-trichloroethane in excess of the 8-hour TWA and ceiling value criteria as recommended by NIOSH. Based upon the

(a) negative health questionnaire response, (b) review of current literature on the toxicities of these substances, and (c) low air concentrations measured, it has been determined that these workers are not exposed to toxic concentrations of trichloroethylene and 1,1,1-trichloroethane under the conditions studied. However, based upon a (a) qualitative air motion study conducted at the open-detrex degreaser and (b) complaints of occasional nausea, these employees may be exposed during the summer months to solvent vapor levels resulting in mild acute toxicity.

5. The two deaths resulting from cancer consisted of one case of multiple myeloma and one case of lung cancer located in the superior solcus. Because these two cancers are not uncommon and are very different, and because neither worker had any particular exposure to trichloroethylene by history of job classification, it cannot be concluded that exposure to trichloroethylene was the cause of malignancies in these two workers. Due to the small number of employees, it is not suitable for a retrospective mortality study. This type of study would be needed to determine if excess mortality has occurred in the plant among persons exposed to trichloroethylene. Until completion of such a study, the association between trichloroethylene and human cancer mortality will not be known. NIOSH is currently looking for a cohort of exposed workers to provide additional data for ascerting the relationship between trichloroethylene exposures and the development of cancer in humans.

Part VI of this report offers recommendations for (a) control of environmental exposures and (b) employment of respiratory protective equipment until engineering controls can be instituted or existing ones improved.

II. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

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

A. Dana Corporation, Tipton, Indiana
B. Authorized Representative of United Steel Workers of America, Local No. 2754
C. U.S. Department of Labor - OSHA - Region V
D. NIOSH - Region V

For the purpose of informing the approximately twenty "affected employees", this Determination Report shall be "posted" for a period of at least thirty calendar days in a prominent place(s) readily available to the workers.

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 a substance normally found in the place of employment has potentially toxic effects in such concentrations as used or found.

The National Institute for Occupational Safety and Health received such a request from an authorized representative of United Steel Workers of America, Local No. 2754, regarding two deaths of employees who operated or worked near two degreasers using trichloroethylene and one using 1,1,1-trichloroethane as solvents; both deaths were due to cancer.

IV. HEALTH HAZARD EVALUATION

A. Process Description

The Dana Corporation is engaged in the production of compression rings, valve guides and seals, and differential shims. The manufacturing process involves the machining, buffing, polishing, and degreasing of unfinished grey iron castings into final products which are packaged for shipment.

The company employs 157 persons. Of these, 12 are indirectly and 8 are directly affected by the alleged hazards. The former includes persons working in areas surrounding the degreasers. The latter includes the degreaser operators: one open-detrex, two manpro (1 person, 2 shifts), and five valve guide. The five valve guide operators rotate on a weekly basis, i.e. each person works as the operator every fifth week.

Casting cleaning is accomplished at three degreasers, Of these, two (open-detrex and manpro) use trichloroethylene and the other (valve guide) uses 1,1,1-trichloroethane as the degreasing solvents. The open-detrex and manpro degreasers are used for cleaning compression rings, which account for approximately 75 per cent of the product volume. The remaining 25 per cent is assumed by the valve guide degreaser used for differenential shims, valve guides and seals. The open-detrex and valve guide degreasers are standard open surface tanks, in which the work is introduced and removed manually or with a simple hoist, respectively. The manpro is a completely enclosed vibratory type degreaser. It consists of a conveyor that carries the castings onto a chute which leads into the degreaser; the castings drop off the chute onto the base of an upward vibrating steel spiral rack positioned in the vapor cloud; after cleaning, the castings automatically move up the vibrating spiral and drop onto a conveyor which transports them to a receiving bin.

B. Health Hazard Identification

The distance of approximately 150 feet which separates the degreasers appears sufficiently adequate to prevent a combined employee exposure to the halogenated solvents. It is most likely that the open-detrex and manpro operators are solely exposed to trichloroethylene vapors, and the valve guide operators to 1,1,1-trichloroethane. In addition to the standard exposures associated with such an operation, the open-detrex and manpro operators experience peak exposures while performing certain duties. Such exposures of the open-detrex operator occur (1) during cleaning of metal storage pans when they are loaded into the degreaser causing an upward burst of a vapor cloud, (2) upon unloading from escaping vapors, and (3) while draining and refilling the degreaser known as "degreaser cleaning". The manpro operator is also exposed to peak levels during "degreaser cleaning". The procedure involves reaching through a window positioned at the upperface of the degreaser and "fishing" via a metal hook for the rings that have fallen off the spiral rack. The operation is conducted once per shift, taking 5 to 10 minutes.

The persons in the surrounding work areas also may be exposed to vapors of the solvent used in the degreaser in their respective areas. Dispersion of ventilation smoke plumes indicated that the latter may result from air currents across the tank surface which lift the vapors out of the tank by a sort of venturi effect. The cross drafts, in part, develop from an open over-head door in the open-detrex area and from open windows in the valve guide degreasing area. The interviewees stated that the problem is more prevalent during the summer months when the door and windows are open.

C. Evaluation Design

An environmental field investigation was conducted during March 16-18,1976. The visit provided (a) background information on processes, materials and work schedules; (b) data on airborne exposure levels of trichloroethylene and 1,1,1-trichloroethane; and (c) medical data on affected workers elicited via health questionnaires.

Written inquiries were made of the deceased workers personal physicians (medical releases were obtained) to obtain death certificates and past medical histories.

Based on review of the above information, it was concluded that sufficient environmental/medical data had been gathered on exposures to both degreasing solvents by past and present employees to make a Toxicity Determination.

D. Evaluation Methodology

1. Environmental Evaluation

a. Trichloroethylene [1]: The vapors were collected on a 150 mg activated charcoal tube placed at the breathing zone of the worker. A low flow (200 cc/min) vacuum pump was used to obtain consecutive air samples ranging from 0.7 to 2.7 hours. A high flow vacuum pump was used to obtain 10 minute samples necessary to address the trichloroethylene ceiling value. The vapors collected on the charcoal were desorbed with carbon disulfide prior to analysis using a gas chromatograph. The limit of detection reported for this analytical technique was 0.05 mg trichloroethylene per sample. Direct reading NIOSH certified Draeger gas detector tubes (Certification No. TC-84-050) also were used to estimate peak levels and concentrations in work areas surrounding the degreaser. Basically, a certified tube must have ± 35% accuracy at 1/2 the exposure limit and ± 25% at 1 to 5 times the limit [2].

b. 1,1,1-Trichloroethane [1]: The vapor levels during suspected peak exposure times (introduction and removal of parts) were estimated with direct reading Draeger tubes; the tubes were not certified by NIOSH. Based on the measured concentrations (<50 ppm), sampling was not conducted to address the NIOSH recommended ceiling value. Consecutive air samples (ranging from 0.6 to 3.0 hours) were collected by drawing air at 200 cc/min through a 150 mg activated charcoal tube to trap the contaminant vapors. The analyte was desorbed from the charcoal with carbon disulfide and analyzed by gas chromatography. The limit of detection reported was 0.05 mg 1,1,1-trichloroethane per sample.

2. Medical

Health questionnaires were completed on all environmentally sampled persons, plus others working in areas surrounding the degreasers. A non-directed questionnaire was completed for each person to elicit any symptoms or medical problems of significant magnitude to come spontaneously to mind. A subsequent directed questionnaire was completed only if the former indicated a need for more specific questions. Information on past work history and death certificates were obtained on the two deceased workers. Additional information on the deceased persons was obtained from their personal physicians. This included the patients medical and smoking histories, results of tumor biopsy, and the clinical course of the patients final illness.

3. Ventilation

Severe deficiencies of lateral exhaust hoods include interferences of hood draft by cross drafts [14]. Behavior of the room air motion as it passed over the open-face lateral exhaust hood were determined qualitatively. The qualitative determination was made using a visual smoke tracer released through a small-diameter hand-held probe. The visual flow study showed that a significant fraction of the exhaust air entering the hood did not pass over the tank surface and thus did not contribute to direct removal of vapors. The greatest portion of the dispersed plume flowed into the Oil and Roll Department.

E. Evaluation Study Criteria

a. Environmental Criteria

The criteria for assessment of acceptable environmental levels of trichloroethylene and 1,1,1-trichloroethane are those recommended by NIOSH in 1973 and 1976, respectively. These recommendations are based on the most current state of knowledge concerning the toxicity of these substances and are designed to protect the health of workers for an 8-hour or up to a 10-hour workday, respectively, 40-hour week over a normal working lifetime.

The NIOSH criteria document for trichloroethylene recommends that no workers 8-hour exposure exceed a time-weighted average of more than 100 ppm nor a peak concentration of 150 ppm, as measured by a maximum sampling time of 10 minutes [3]. The NIOSH criteria document for 1,1,1-trichloroethane recommends that no worker's 10-hour exposure exceed a time-weighted average of more than 200 ppm nor a ceiling concentration of 350 ppm as determined by a 15 minute sample [4].

b. Medical Criteria

The Medical criteria used to determine a toxic response to the substances under investigation consist of the symptoms and signs which each substance produces when toxic exposure occurs. A brief review of the known pathophysiological effects of the substances and supplemental references follows:

1. Trichloroethylene: Inhalation of trichloroethylene vapor has a depressant action on the central nervous system [3,5,6]. Manifestations of overexposure include headache, dizziness, vertigo, tremors, nausea and vomiting, sleepiness, fatigue, a feeling and appearance of light-headedness or drunkenness increasing to unconsciousness. Odor is detectable at 20 ppm, which is 20% of the NIOSH recommended standard of 100 ppm 8-hour T.W.A. No reports have been found of occupational intoxication brought about through absorption of toxic amounts through the skin.

Such effects as have been reported for contact of the substance with the skin were burns and general dermatitis [7]. Although no toxic effects were found reported due to absorption of trichloroethylene through the skin, a report was found suggesting that absorption of any trichloroethylene through the skin would be inconsequential as a source of toxic amounts in the body [8].

A preliminary evaluation of the carcinogenic - cancer-producing - activity of trichloroethylene was conducted by the National Cancer Institute's (NCI) Carcinogenesis Bioassay Program [9]. In this experiment, a significant increase of hepatocellular carcinomas - liver tumors - were found in mice but not in rats as compared to controls. The Industry-Wide Studies Branch of NIOSH is attempting to initiate a retrospective cohort study of mortality among workers exposed to this petrochemical. The U.S. Department of Labor - OSHA - feels it is inappropriate at this time to treat trichloroethylene as a human carcinogen based solely upon preliminary information now available [10].

Inhalation studies conducted at Dow Chemical Laboratories, showed that trichloroethylene was not teratogenic - production of physical defects in offspring in utero - in mice or in rats at 300 ppm [11].

2. 1,1,1-Trichloroethane: Inhalation of this halogenated solvent has a narcotic effect on the central nervous system [4,8]. Effects of dizziness, incoordination, drowsiness, and unconsciousness have been reported from acute exposures. Cardiovascular effects manifested by rapid fall in blood pressure have been reported for exposure concentrations of 8,000 ppm during exposure periods of 5 minutes [12]. Respiratory irritation has been reported in man and several other species. At 400 ppm eye, nose and throat irritation have been experienced. There is a wide variability in odor threshold values. The perceived range is roughly between 100 to 400 ppm.

F. Results and Discussion

1. Environmental

Vapor concentrations of trichloroethylene were measured at the breathing zone of the open-detrex and manpro degreaser operators using consecutive and peak period sampling strategies. Consecutive samples were collected to determine if the workers cumulative exposure exceeded the 100 ppm NIOSH recommended standard determined as a time-weighted average (TWA) exposure for an 8-hour workday. Peak period exposure levels were determined by a 10-minute sample necessary to address the 150 ppm ceiling value. The air concentrations are reported in Tables I and II, respectively.

A total of seven consecutive air samples were taken at the breathing zone of the open-detrex operator on March 17 and 18, 1976. The vapor levels for the actual sampling periods ranged from 63 to 125 ppm

(mean=82) and 81 to 178 ppm (mean=124), respectively. The respective 8-hour TWA exposures are 80 and 132 ppm. Thirteen peak period samples were collected. Of these, two while the operator was cleaning the degreaser and eleven while degreasing casting pans. The levels ranged from 218 to 297 ppm (mean=257) and 25 to 377 ppm (mean=136), respectively. The data demonstrate that the operator is exposed to varying concentrations of trichloroethylene vapor which exceed the 8-hour TWA and ceiling values recommended by NIOSH. The intra and inter day fluctuations in vapor concentrations may be attributed to one or a combination of things. Several are listed below with others discussed in Part VI of this report. Included are (1) vertical rate of movement of work during degreaser loading and unloading, and (2) height of the vapor cloud.

Exposure to trichloroethylene by the manpro operator was determined by obtaining seven consecutive and two peak period air samples. The consecutive period samples reported vapor concentrations ranging from 7 to 18 ppm (mean=15) on March 17 and 7 to 85 ppm (mean=36) on March 18. The respective 8-hour TWA exposures are 15 and 28 ppm, which are below the recommended occupational health criteria. The peak period levels ranged from 136 to 797 ppm; the latter value exceeded the ceiling value. The distinct difference in reported levels is due to improper positioning of the sampling port on March 17, i.e. the sampling port was positioned such that when the operator reached into the degreaser window, it remained outside. Based on the levels of trichloroethylene (>400 ppm) sured at the operators breathing zone using colorimetric detector tubes on March 18, it is concluded that the reported level of 797 ppm is representative of the actual exposure level.

Six consecutive period air samples were collected to determine if the cumulative exposure to 1,1,1-trichloroethane by the valve guide degreaser operator exceeded the 200 ppm NIOSH criteria determined as a TWA for up to a 10-hour workday. Of these, four were obtained on March 17 and the remainder on the following day. The reported exposure concentrations measured at the operators breathing zone are contained in Table III. The levels ranged from 7 to 37 ppm (mean=16) on March 17 and 9 to 28 ppm (mean=18) on March 18. The workers cumulative time-weighted exposure on March 17 was 17 ppm, which is 8.5% of the NIOSH recommended criteria. Because of insufficient data, an 8-hour TWA was not calculated for the exposure levels on the second day; however, it would be less than 9% of the NIOSH criteria.

Limited monitoring of trichloroethylene and 1,1,1-trichloroethane vapors at the work areas surrounding the respective degreasing tanks was conducted. It included consecutive period sampling at a chamfer lathe positioned within five feet of the valve-guide degreaser and spot sampling of the general work-room air in the areas surrounding the solvent tanks.

Detailed sampling was not undertaken because of (1) low ambient temperatures which required the doors and windows to be closed, eliminating the cross drafts alledgedly responsible for vapor distribution to surrounding areas and (2) low contaminant concentrations as estimated by colorimetric detector tubes.

Exposure of the chamfer lathe operator to vapors of 1,1,1-trichloroethane was measured by obtaining seven samples at the workers breathing zone on March 17 and 18 (Table IV). The reported levels ranged from 4 to 24 ppm (mean=11) and 10 to 15 ppm (mean=12), respectively. The respective 8-hour TWA exposures are 11 and 12 ppm, which are both 6% of the 200 ppm NIOSH criteria. The work area levels of this contaminant were estimated at less than 10 ppm. Those reported for trichloroethylene in an area (Oil and Roll Dept.) down-wind of the open-detrex degreaser were less than 15 ppm. These vapor concentrations measured may or may not be representative of those that exists during the summer months. Based on the following rationale NIOSH did not conduct a follow-up environmental survey to elucidate the levels during such a period. (1) Sufficient data had been obtained to establish that the open-detrex and manpro degreaser operators were exposed to trichloroethylene at levels well in excess of the NIOSH criteria. Thus, by controlling exposures at the source, those of personnel in the peripheral areas also would be controlled. (2) In view of relatively low levels of 1,1,1-trichloroethane measured, existing vapor control mechanisms and work techniques observed, and indications by the company concerning relocation of the degreaser along a wall to eliminate cross drafts, further study was not deemed necessary.

2. Medical

A health questionnaire was completed on eight employees from the first shifts on March 17 and 18. The interviewed cohort included each of the three degreaser operators, a chamfer lathe machinist and four persons from the peripheral degreasing areas. The manpro and open-detrex operators complained of daily symptoms of nausea and dizziness with less frequent incidents of headache and lightheadedness. The symptomatologies are characteristic of acute intoxication that may occur from inhalation of trichloroethylene vapors at the measured concentrations. The remaining six interviewees did not report any symptoms of solvent intoxication other than nausea occurring occasionally during the summer months.

The two deaths resulting from cancer consisted of one case of multiple myeloma and one case of lung cancer located in the superior solcus. Both workers were white males employed by the Dana Corporation for 11 and 43 years, respectively. According to their job classification histories, neither employee worked at the manpro or open-detrex degreasers. Thus, they most likely were not exposed to high levels of trichloroethylene. However, they could have been exposed to low levels while working in areas adjacent to the degreasers contaminated by crossdrafts as discussed in Part IV, Section B of this report. Because these two cancers are not uncommon and are very different, and because neither worker had any particular exposure to trichloroethylene by history of job classification, it cannot be concluded that exposure to trichloroethylene was the cause of malignancies in these two workers.

Due to the small number of employees (about 150 persons including administrative, clerical, etc.), the population at this plant is not suitable for a retrospective mortality study. This type of study would be needed to determine if excess mortality has occurred in the plant among persons exposed to trichloroethylene. Until completion of such a study, the association between trichloroethylene and human cancer mortality will not be known. NIOSH is currently looking for a group of exposed workers to provide additional data for ascerting the relationship between trichloroethylene exposures and the development of cancer in humans.

SUMMARY AND CONCLUSIONS

The processes and associated potential health hazards pursuant to Health Hazard Evaluation Request No. 76-24 have been studied by NIOSH during a field investigation conducted on March 16-18, 1976. The study consisted of evaluating exposure to trichloroethylene and 1,1,1-trichloroethane by employees working at degreasers using one of these solvents or in surrounding areas.

Vapor concentrations of trichloroethylene were measured at the breathing zone of the open-detrex and manpro degreaser operators using consecutive and peak period sampling strategies. Consecutive samples were collected to determine if the workers cumulative exposure exceeded the 100 ppm NIOSH recommended standard determined as a time-weighted average exposure for an 8-hour workday. Peak period exposure levels were determined by a 10-minute sample necessary to address the 150 ppm ceiling value. Both operators are exposed to levels of airborne trichloroethylene which exceed the ceiling value. Also, the open-detrex operators cumulative exposure exceeds the 8-hour TWA; the manpro-operators exposure does not exceed this criteria. Based upon the (a) daily symptoms of nausea and dizziness with less frequent incidents of headache and light-headedness, (b) review of the toxicological literature, and (c) environmental measurements, it has been determined that the open-detrex and manpro degreaser operators are exposed to toxic concentrations of trichloroethylene under the conditions as used and found.

Consecutive period air samples were collected to determine if the valve-guide degreaser operator exposure to 1,1,1-trichloroethane exceeded the 200 ppm NIOSH recommended standard determined as a time-weighted average

for up to a 10-hour workday. The workers cumulative time-weighted average exposure was less than 9% of the NIOSH recommended criteria. Based upon the (a) negative health questionnaire response, (b) available literature on the toxicity of this substance, and (c) low environmental measurements, it is concluded that the operator is not exposed to toxic concentrations of 1,1,1-trichloroethane under the conditions studied.

Limited air monitoring of trichloroethylene and 1,1,1-trichloroethane levels at the work areas around the respective degreasing operations was conducted. The measured concentrations were less than 16 and 7% of the NIOSH recommended health criteria, respectively. Based upon the (a) negative health questionnaire response, (b) review of current literature on the toxicity of these substances, and (c) low air concentrations measured, it has been determined that these workers are not exposed to toxic concentrations of trichloroethylene or 1,1,1-trichloroethane under the conditions studied. However, based upon the (a) air motion study conducted at the open-detrex tank and (b) complaints of occasional nausea, these employees may be exposed during the summer months to solvent vapor concentrations resulting in mild acute toxicity.

The two deaths resulting from cancer consisted of one case of multiple myeloma and one case of lung cancer located in the superior solcus. Because these two cancers are not uncommon and are very different, and because neither worker had any particular exposure to trichloroethylene by history of job classification, it cannot be concluded that exposure to trichloroethylene was the cause of malignancies in these two workers.

Part VII of this report offers recommendations for (a) control of environmental exposures, and (b) employment of respiratory protective equipment until engineering controls can be instituted or existing ones improved.

VI. RECOMMENDATIONS

The following recommendations for control of employee exposure to vapors of trichloroethylene are patterned after those contained in the NIOSH Criteria Document for this substance [3], Federal Occupational Health Standard 29 CFR 1910.94 [13], and Recommended Industrial Ventilation Guidelines published by NIOSH [14].

A. Environmental

1. Open Detrex Operation: A thorough inspection and evaluation of both existing lateral exhaust systems should be conducted to insure that conditions such as obstructions (due to improperly positioned blast gates) creating system inbalance, leaking duct connections, fan operation, etc. are not preventing the attainment of maximum efficiency. Testing including air flow (volume and velocity) and pressure measurements should be conducted to determine if the system is operating at its designed efficacy. Based on the results and conclusions of the evaluation consideration should be given to the following recommendations.

a. System modification should follow OSHA Occupational Health Standard 29 CFR 1910.94 which prescribes specific ventilatory exhaust volume criteria for lateral hoods. The standard states that the quantity of air in cubic feet per minute necessary to be laterally exhaust per square foot of tank area in order to maintain the required capture velocity should be determined (from Table G-15 of the standard) for all variations in ratio of tank width (W) to tank length (L). The total quantity of air in cubic feet per minute required to be exhausted per tank should not be less than the product of the area of tank surface times the cubic feet per minute per square foot of tank area, determined from Table G-15. Examples of lateral hood designs are depicted in Figures 1, 2, and 3. However, it must be realized that these illustrations and associated criteria are intended as guides for design purposes and apply to typical operations. Where the specified requirements are insufficient to maintain air contaminant concentrations below exposure limits because of special conditions, i.e. crossdrafts, modifications may be necessary.

b. Open-surface tanks with lateral exhaust are vulnerable to crossdrafts which may cause severe deficiencies in their control efficiency. Thus crossdrafts must be kept at a minimum. The qualitative visual flow study conducted at the open-detrex degreaser showed that the over-head door located behind the tank creates such an air motion when open. Three control alternatives should be considered: (1) Eliminate the source of the crossdraft. (2) Install buffers at each end of the tank. (3) Reposition the degreaser.

c. A review article by Skinner [15] points out that an important source of air contaminant exposure at many degreasing operations may be "drag-out" of solvent vapor when the material being degreased is removed from the tank. It is readily apparent from the vapor concentrations measured during loading and unloading of casting pans that drag-out is occurring at the open-detrex tank (Table I). The effect of "drag-out" is determined primarily by the speed with which an item is removed from the solvent bath, the projected area of the item being moved, and its wetted surface area. Consideration should be given to the above listed factors in designing a work practice program.

d. Pursuant to the OSHA Occupational Health Standard 29 CFR 1910.94 [13] any vapor degreasing tank equipped with a condenser as exists at the open-detrex degreaser, the condenser shall keep the level of vapors below the top edge of the tank by a distance at least equal to one-half the tank width or at least 36 inches, whichever is shorter. The tank width is 24 inches and the vapor level measured from the top edge of the tank ranged from 4 to 9 inches. Thus, correction procedures should be instituted to lower the vapor cloud level below 12 inches.

e. Esman and Clearwater [16] have shown that the use of a cover on vapor degreasers can result in a significant reduction in solvent losses and in airborne vapor levels. The feasibility and applicability of using a tank cover should be determined. Consideration may want to be given to the cover design suggested in the referenced article.

f. The lateral hood positioned next to the open-detrex degreaser should be lowered approximately three feet to more effectively control the vapors from the degreased materials temporarily stored in this area. Lateral hoods are designed to move air horizontally, not vertically, as is required by its present height.

2. Manpro Operation: The environmental data collected demonstrate that the existing vapor control mechanisms are effectively controlling the air contaminant levels during normal operating conditions. Operator exposure to peak concentrations of airborne trichloroethylene during "degreaser cleaning" most likely results from improper work practice, i.e. " degreaser cleaning" as described in Part IV, Section B of this report is conducted without turning off the steam heating coils. It is recommended that prior to cleaning the degreaser the heating coils be turned off and the degreasing solvent be permitted to cool. The extent to which these work practice techniques will reduce the vapor levels is not known. Thus, quantitative air sampling should be completed to establish these levels.

B. Respiratory Protection

a. Until further environmental controls are implemented or existing ones improved, a conscientious respirator program should be initiated and enforced by management with support from the union. OSHA through 29 CFR Part 1910.134, established the requirement for conducting a formal respiratory protection program for control of occupational diseases caused by breathing air which contains certain contaminants. A NIOSH document, titled "A Guide to Industrial Respiratory Protection", will serve as a reference source with information for establishing and maintaining a respirator program which meets the requirements of 29 CFR Part 1910.134 [17].

b. Selected respirators should be approved by NIOSH and have been approved to provide sufficient protection at the concentrations of trichloroethylene occurring in the work area in which used. Based upon the concentrations of trichloroethylene measured at the breathing zone of the open-detrex and manpro degreaser operators a chemical cartridge respirator with organic vapor cartridge(s) or a Type C demand type supplied air respirator with half mask facepiece respirators are applicable.

c. Respirators should be issued with caution. There might be individuals in this group for whom wearing a respirator carries certain specific dangers, i.e. highly increased resistance to airflow in a person with compromised pulmonary function may be associated with acute respiratory insufficiency. Therefore, pulmonary function testing should be carried out prior to requiring any person to wear a respirator.

C. Environmental and Medical Surveillance

Part I, Sections 1, 2 and 8 of the NIOSH Criteria Document for Trichloroethylene should be used as a guide for establishing environmental and medical surveillance programs.

D. Apprisal of Employees of Hazards from Trichloroethylene

All employees working at and around open-surface tank operations must be instructed as to hazards of their respective jobs, and in the personal protection and first aid procedures applicable to these hazards as required by OSHA Occupational Health Standard 1910.94 (d)(7)(ii). An apprisal is outlined in Appendix III in the NIOSH Criteria Document for Occupational Exposure to Trichloroethylene [3].

VII. AUTHORSHIP AND ACKNOWLEDGEMENTS

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Management and Union:

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TABLE 1

Vapor Concentrations of Trichloroethylene
Measured at the Breathing Zone of the Open-Detrex Degreaser Operator

Dana Corporation
Tipton, Indiana

March 17 and 18, 1976

Date	Sample No.	Sample Period	Sample Volume Liters	*Concentration ppm	Comments
3/17	CT-100	0712-0932	32	63	
3/17	CT-101	0932-1150	23	125	
3/17	CT-102	1235-1425	22	70	
3/17	CT-103	1431-1510	10	70	
3/17	CT-104	0832-0842	10	72	
3/17	CT-106	0932-0942	10	216	Degreasing of Casting Pan
3/17	CT-107	1005-1015	10	297	Cleaning of Degreaser
3/17	CT-108	1055-1105	10	43	Cleaning of Casting Pan
3/17	CT-109	1130-1140	10	198	" " " "
3/17	CT-110	1250-1300	10	117	" " " "
3/17	CT-111	1335-1345	10	377	" " " "
3/17	CT-112	1425-1435	10	102	" " " "
3/18	CT-120	0710-0950	17	148	
3/18	CT-121	0950-1150	27	81	
3/18	CT-122	1235-1515	35	178	
3/18	CT-125	0755-0810	10	102	
3/18	CT-126	0815-0825	10	114	Degreasing of Casting Pan
3/18	CT-127	0920-0930	10	125	" " " "
3/18	CT-128	1002-1012	10	218	Cleaning of Degreaser
3/18	CT-129	1120-1130	10	26	Degreasing of Casting Pan

*Parts of trichlorethylene per million parts of air sampled.

TABLE II

Vapor Concentrations of Trichloroethylene
Measured at the Breathing Zone of the Manpro Degreaser Operator

Dana Corporation
Tipton, Indiana

March 17 and 18, 1976

Date	Sample No.	Sample Period	Sample Volume Liters	* Concentration ppm	Comments
3/17	CT-1	0710-0955	35	17	
3/17	CT-2	0955-1150	24	18	
3/17	CT-3	1237-1429	26	16	
3/17	CT-4	1433-1515	6	7	
3/17	CT-5	0957-1007	10	136	Cleaning of Degreaser
3/18	CT-20	0715-0955	37	16	
3/18	CT-21	0956-1150	26	85	
3/18	CT-22	1237-1515	36	7	
3/18	CT-25	1000-1010	10	797	Cleaning of Degreaser

*Parts of trichloroethylene per million parts of air sampled.

TABLE III

Vapor Concentrations of 1,1,1-Trichloroethane
Measured at the Breathing Zone of the Valve Guide Degreaser Operator

Dana Corporation
Tipton, Indiana

March 17 and 18, 1976

Date	Sample No.	Sample Period	Sample Volume Liters	* Concentration ppm
3/17	CT-200	0714-0943	32	37
3/17	CT-201	0943-1150	26	17
3/17	CT-202	1237-1428	24	4
3/17	CT-203	1433-1505	13	7
3/18	CT-220	0715-0952	36	28
3/18	CT-222	1235-1510	35	8

*Parts of 1,1,1-trichloroethane per million parts of air sampled.