HEALTH HAZARD EVALUATION REPORT

HETA 94-0312-2512
SQUARE D COMPANY
OSHKOSH, WISCONSIN

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 and 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.

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SQUARE D COMPANY
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I. SUMMARY

In June 1994, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request for a health hazard evaluation (HHE) at Square D Company in Oshkosh, Wisconsin. An HHE request was also received from the management at Square D Company in November 1994. Both requests concerned respiratory symptoms potentially associated with isocyanate and polyamide-imide resin exposures during brazing and welding operations. In addition, a variety of other health effects were reported.

On December 13-15, 1994, NIOSH investigators conducted an initial site visit at the Square D Company. The industrial hygienists reviewed Material Safety Data Sheets (MSDSs) and manufacturing processes, and evaluated employee exposure to toluene diisocyanate (TDI). Personal breathing zone (PBZ) air samples were collected, during simulated brazing operations, at the entrance of the flexible duct of the portable filtration unit, one foot prior to the entrance, and in and near the exhaust. TDI was not detected in any of the air samples.

The medical investigators distributed and reviewed respiratory symptom/allergy questionnaires, reviewed the Occupational Safety and Health Administration (OSHA) Log and Summary of Occupational Injuries and Illnesses (Form 200), nurse's logs, workers' compensation claims, and employee medical records, and interviewed employees.

From January 1992 through December 1994, there were six OSHA Form 200 entries involving respiratory problems; two were described as asthma attacks, two were for smoke inhalation, one was recorded as "respiratory problems," and one recorded as allergic pneumonitis. The remaining 107 entries were primarily musculoskeletal injuries, lacerations, and contusions. There were no entries with respiratory symptoms in the nurse's First Aid Treatment Logs from January 1992 - December 1994. Sixty-nine percent (138/201) of Square D Company's hourly employees returned the respiratory symptom/allergy screening questionnaire. Twenty of the 138 respondents (14%) reported experiencing three or more respiratory symptoms including shortness of breath, difficulty breathing, chest tightness, and wheezing in the past year. Nine reported physician-diagnosed asthma. Five of those nine were currently taking prescribed asthma medications. Twenty-one (15%) employees reported dermatologic symptoms. The

NIOSH medical investigators interviewed 20 employees. The most prevalent symptoms among the 15 symptomatic employees were upper respiratory irritation and skin problems such as rashes, hives, and eczema.

Based on the data collected during this survey, the NIOSH investigators did not find any evidence of a current health hazard from brazing-related TDI exposure, and were unable to determine the frequency and severity of past TDI exposures. Square D employees do appear to have respiratory symptoms that could be associated with the brazing and winding operations. Exposure to the many constituents of welding and brazing fumes is a possible cause of these symptoms. Recommendations are offered to reduce workers' exposures when performing these operations.

KEYWORDS: SIC (3677), isocyanates, diisocyanates, TDI, transformers, occupational asthma, brazing, welding.

II. INTRODUCTION

In June 1994, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request which was followed by a management request in November 1994, for a health hazard evaluation (HHE) at Square D Company in Oshkosh, Wisconsin. The requestors indicated concern about possible exposures of winding and brazing personnel to toluene diisocyanates (TDI) and polyamide-imide resins resulting in upper respiratory symptoms and asthma.

On December 13-15, 1994, NIOSH investigators conducted a medical and industrial hygiene evaluation at Square D Company. The NIOSH investigators met with management and International Brotherhood of Electrical Workers Local 2373 representatives in an opening conference. Investigators discussed the HHE requests and gathered information about the manufacturing processes, toured the facility, interviewed employees, reviewed injury and illness records and performed an industrial hygiene assessment.

III. BACKGROUND

Process Description

The Square D Company in Oshkosh, Wisconsin, manufactures dry-type industrial electrical transformers and circuit breaker systems. The building has approxi- mately 86,000 square feet of floor space. Square D employs 201 employees in the manufacturing area over three shifts; 81 employees on the first shift, 65 on the second shift, and 55 on the third shift.

Square D receives aluminum and copper wires of various gauge from outside vendors. Some of the copper wire is coated with a polyamide-imide resin before arriving at the facility. The wire is wrapped with Nomex®, an insulating paper, on wire wrapping machines at the plant. The winding machine contains the core/shape for the coil, and a spool of copper wire. Operators coil the wire on winding machines and then insert fiberglass insulating "bones" between the coiled layers. The winders braze the wire end to end to lengthen the wire and also braze copper taps onto the copper wires at various points. During tap installation, the operator stops winding and tapes off an area on the wire where the tap will be inserted. Inside the taped area, the Nomex® sheath is split and stripped away from the wire. The tap brazing operation is performed as follows: the operator heats the wire with a brazing torch, applies the brazing compound, heats the tap, presses the tap on the brazed surface, sprays the brazed area with water and wipes it clean, and wraps the brazed area with electrical tape. The brazing procedure is performed in less than two minutes per tap. When brazing, the worker dons safety glasses. Aluminum coils are sent to welding booths where aluminum taps are welded to the coils. The amount of brazing being performed at this facility is declining with the introduction of “loop taps.”

A portable exhaust ventilation unit (referred to as a "smoke-eater") is used during brazing operations to control worker exposure to the brazing fumes and gases. This consists of a flexible duct which conveys the captured fume through a filtration unit and exhausts the filtered air into the workplace.

The coils then go to the assembly stacking area for core assembly. The copper coils go to a brazing booth where the terminal board and coil wires are brazed using oxyacetylene brazing techniques. The aluminum coils are welded to their terminal boards in a welding booth.

Both types of coils are then dipped in a water-based varnish and oven-dried. Sheet metal is formed in the fabricating department and fitted to the coil unit. The assembled transformer is electrically tested, coated with an anti-oxidant compound, and boxed for shipment.

Previous Evaluations

A private consultant assessed employee exposures to copper, hydrogen fluoride, varnish makers and painters naphtha, xylenes, and TDI at Square D Company on July 15-16, 1992. Their report dated August 18, 1992, showed that all exposures were below the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs) and Short-Term Exposure Limits (STELs). OSHA surveys conducted on July 16, 17, and 28, 1992, also showed that all exposures were below the PELs.

Another private consultant conducted an industrial hygiene exposure study during January, February, and March 1994. The consultant concluded that, with the exception of dust in the powder paint department and noise in some areas, all exposures were below OSHA PELs. The consultant noted that although "TDI is not listed as a potential byproduct or constituent of any of the materials used in the transformers," an area sample collected during brazing operations on February 10, 1994, indicated a TDI concentration at 0.0029 parts per million (ppm). No PBZ results had detectable TDI.

IV. METHODS

Industrial Hygiene Evaluation

Due to production scheduling, no taps were being brazed during the NIOSH site visit. Thus, NIOSH conducted air sampling for TDI during simulated brazing operations with different configurations of wire, coating, and varnish. The following is a description of the brazing configurations studied during this simulation:

1. A total of 11 taps were sequentially brazed onto a single strand of two-gauge copper wire with a varnish coating; the Nomex® sheath was removed.

2. Same design as the above #1, except the taps were brazed onto a double strand of the varnish-coated wire. The double strand requires extra heating time during brazing, so only seven taps were brazed.

3. Eleven taps were brazed onto a double strand of two-gauge copper wire, without the varnish coating and Nomex® .

4. To determine if Nomex® was a potential source of TDI, several sheaths of Nomex® were burned with the brazing torch.

The purpose of collecting air samples during these brazing configurations was to determine if any TDI evolves during brazing with materials presently used at Square D. Air samples for TDI were collected from the same locations during the four brazing configurations. These samples were collected according to NIOSH Method 5522 which samples TDI using impingers with analysis by high performance liquid chromatography and fluorescence detection and NIOSH Method 2535 which samples TDI using a sorbent tube, with analysis by high performance liquid chromatography and ultraviolet light detection.[1] The locations of the air samples were in the breathing zone of the worker performing the brazing (sorbent tube), in the entrance to the flexible duct capturing the brazing fumes and gases (sorbent tube), one foot below the entrance of the flexible duct (impinger), in the exhaust from the filtration unit (sorbent tube), and one foot from the filtration unit's exhaust (impinger). The samplers in the worker's breathing zone, at the flexible duct entrance, and one foot from flexible duct entrance were changed after each brazing configuration. The air samplers in and near the filtration unit's exhaust ran continuously through the four brazing operations.

Medical Evaluation

A screening questionnaire addressing respiratory symptoms was distributed to 201 hourly employees prior to the NIOSH site visit by the Square D safety director and a union representative. One hundred thirty-eight (69%) employees returned their questionnaires to the union representative in sealed envelopes, which were later given to the NIOSH medical officer. NIOSH investigators also reviewed MSDSs, OSHA 200 logs, medical records, and nurse's logs, and interviewed 20 first- and second-shift employees selected from those who completed questionnaires.

V. EVALUATION CRITERIA

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff use established environmental criteria for the assessment of a number of chemical and physical agents. These criteria suggest levels of exposure to which most workers may be exposed up to 10 hours per day, 40 hours per week for a working lifetime without experiencing adverse health effects. It should be noted however, that not all workers will be protected from adverse health effects even though their exposures are maintained below these levels. A small percentage may experience adverse health effects because of individual susceptibility, a pre-existing medical condition, and/or a hypersensitivity (allergy).

Some hazardous substances may act in combination with other workplace exposures, the general environment, or with medications or personal habits of the worker to produce health effects even if the occupational exposures are controlled at the applicable limit. These combined effects are often not considered in the evaluation criteria. Also, some substances are absorbed by direct contact with the skin and mucous membranes, and thus potentially increase the overall exposure. Finally, evaluation criteria may change over the years as new information on the toxic effects of an agent become available.

The primary sources of environmental evaluation criteria for the workplace are: (1) NIOSH Criteria Documents and recommendations;[2] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH) Threshold Limit Values (TLVs);[3] and (3) the U.S. Department of Labor, OSHA Permissible Exposure Limits (PELs)[4]. In July 1992, the 11th Circuit Court of Appeals vacated the 1989 OSHA PEL Air Contaminants Standard. OSHA is currently enforcing the 1971 standards which are listed as transitional values in the current Code of Federal Regulations; however, some states operating their own OSHA approved job safety and health programs continue to enforce the 1989 limits. NIOSH encourages employers to follow the 1989 OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criterion. The OSHA PELs reflect the feasibility of controlling exposures in various industries where the agents are used, whereas NIOSH RELs are based primarily on concerns relating to the prevention of occupational disease. It should be noted when reviewing this report that employers are legally required to meet those levels specified by an OSHA standard and that the OSHA PELs included in this report reflect the 1971 values. A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal eight to ten-hour workday. Some substances have recommended short-term exposure limits (STEL) or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Diisocyanates (TDI)

Exposure to the diisocyanates produces irritation to the skin, mucous membranes, eyes, and respiratory tract. High concentrations may result in chemical bronchitis, chest tightness, nocturnal dyspnea, pulmonary edema, and death.[5,6] The most common adverse health outcome associated with diisocyanate exposure is increased airway obstruction (asthma), and to a lesser extent dermal sensitization and hypersensitivity pneumonitis.[6-8]

Diisocyanate-induced Sensitization

Probably the most debilitating health effects from workplace exposure to diisocyanates are respiratory and dermal sensitization. Sensitization can result depending on the type of exposure, the exposure concentration, the route of exposure, and individual susceptibility. Dermal sensitization can result in such symptoms as rash, itching, hives, and swelling of the extremities.[5,8] Respiratory sensitization from exposure to diisocyanates results in the typical symptoms of asthma. Estimates of the prevalence of diisocyanate-induced asthma in exposed worker populations vary considerably; from 5% to 10% in diisocyanate production facilities,[9,10] to 25% in polyurethane production plants[9,11] and 30% in polyurethane seatcover operations.[12]

A worker suspected of having diisocyanate-induced sensitization will present with symptoms of traditional acute airway obstruction; e.g., coughing, wheezing, shortness of breath, tightness in the chest, nocturnal awakening, etc.[5,7] Upon first exposure to diisocyanates, the worker may develop an asthmatic reaction immediately or several hours after exposure, after the first months of exposure, or after several years of exposure.[5,7,10,13,14] Some evidence exists which suggests that the onset of sensitization occurs after a mean exposure interval of 2 years.[15] After sensitization, any exposure, even to levels below any occupational exposure limit or standard, can produce an asthmatic response which may be life threatening. This asthmatic reaction may occur minutes after exposure (immediate), several hours after exposure (late), or a combination of both immediate and late components after exposure (dual).[7,13] Recurrent nocturnal asthma has been described in workers sensitized to TDI and diphenylmethane diisocyanate (MDI).[16,17] An improvement in symptoms may be observed during periods away from the work environment (weekends, vacations).[5,7,13]

Diisocyanates can evoke the body to increase serum concentrations of IgE and/or IgG antibodies. Specific IgE and IgG antibodies to isocyanates have been measured in exposed workers, but are not always detected in sensitized workers.[16,18-28] Workers exposed to diisocyanates, even at levels below recognized occupational exposure limits and standards, may have elevated serum concentrations of these antibodies. Considerable evidence exists indicating that sensitized workers, with IgG or IgE antibodies specific for one diisocyanate exhibit cross-reactivity when challenged with other diisocyanates.[29-32] This cross-reactivity occurs independent of workplace exposure to the other diisocyanates. Currently, the measurement of specific antibodies to diisocyanate-protein conjugates is considered an indicator of diisocyanate exposure,[28,33] and requires other diagnostic tools to determine and confirm cases of diisocyanate-induced sensitization (asthma).

Diisocyanate-induced Hypersensitivity Pneumonitis

Hypersensitivity pneumonitis (HP) has been described in workers exposed to diisocyanates.[34-42] Currently, the prevalence of diisocyanate-induced HP in the worker population is unknown, and is considered to be a rare event when compared to the prevalence rates for diisocyanate-induced asthma.[8] Whereas asthma is an obstructive respiratory disease usually affecting the bronchi, HP is a restrictive respiratory disease affecting the lung parenchyma (bronchioles and alveoli).

The symptoms associated with diisocyanate-induced HP are flu-like; including shortness of breath, non-productive cough, fever, chills, sweats, malaise, and nausea.[7,8] In general, the flu-like symptoms and pulmonary decrements tend to reverse within a few weeks of exposure avoidance. Tobacco smoking and other chemical exposures are risk factors in the induction, progression, and severity of HP.[7]

After the onset of HP, prolonged and/or repeated exposures may lead to the gradual development of an irreversible, chronic form of the disease.[7,8] Initially, the worker experiences persistent, low-level flu-like symptoms, with the development of dyspnea. In the later stages, the disease progresses to diffuse interstitial fibrosis, with a restrictive impairment and decreased lung compliance.

Many aspects of HP, i.e., the flu-like symptoms and the changes in pulmonary function, are manifestations common to many other respiratory diseases and conditions. In addition, chest x-rays are not definitive, as they can vary from no abnormality to diffuse interstitial fibrosis. A diagnosis of diisocyanate-induced HP is dependent on associating the flu-like symptoms and pulmonary decrements with exposure to the causative agent.[7,8] Thus, the work/exposure history and/or workplace exposure data must confirm a potential for exposure to diisocyanates. A common feature which may be useful in diagnosing HP is the presence of serum levels of precipitating antibodies specific for the diisocyanate species. As previously discussed, the role of this marker in diagnosing HP is limited, since many asymptomatic workers with exposure also have detectable serum levels of these precipitating antibodies.

TDI Carcinogenicity

Recent animal studies have demonstrated that commercial-grade TDI is carcinogenic in both rats and mice.[43] Statistically significant excesses of liver and pancreatic tumors were observed in male and female rats and female mice that received TDI by gavage (route of exposure via the digestive tract). Commercial-grade TDI was found to have a dose-dependent mutagenic effect on two strains of *Salmonella typhimurium* in the presence of a metabolic activator (S-9 liver fractions from rats or hamsters treated with Aroclor 254).[44]

Based on these animal and *in vitro* studies, NIOSH concluded that sufficient evidence exists to classify TDI as a potential occupational carcinogen.[45] Considering this, NIOSH recommends that occupational exposures to TDI be reduced to the lowest feasible concentrations. It is important to note that no epidemiologic data exist which links TDI exposure to elevated cancer rates in exposed workers.

The ACGIH TLV for TDI is an 8-hour TWA exposure of 36 $\mu g/m^3$, and a 15-minute STEL of 140 $\mu g/m^3$.[3] The OSHA PEL for TDI is a ceiling limit of 140 $\mu g/m^3$.[4] Neither OSHA nor ACGIH consider TDI to be an occupational carcinogen.[3,4]

Welding and Brazing Fumes

The composition of welding fume will vary considerably depending on the alloy being welded, the process, and the electrodes used.[3,46] Many welding processes also produce other hazards, including toxic gases such as ozone or nitrogen oxides, and physical hazards such as intense ultraviolet radiation. Of particular concern are welding processes involving stainless steel, cadmium- or lead-coated steel, and metals such as nickel, chromium, zinc, and copper. Fumes from these metals are considerably more toxic than those encountered from welding iron or mild steel. Epidemiological studies and case reports of workers exposed to welding emissions have shown an excessive incidence of acute and chronic respiratory diseases.[46] These illnesses include metal fume fever, pneumonitis, and pulmonary edema. The major concern, however, is the increased incidence of lung cancer among welders. Epidemiological evidence indicates that welders generally have a 40% increase in relative risk of developing lung cancer as a result of their work.[46] Because of the variable composition of welding emissions, and epidemiological evidence showing an increased risk of lung cancer, NIOSH recommends that exposures to welding or brazing emissions be controlled to the lowest feasible concentration. Exposure limits for each individual chemical or physical agent should be considered upper boundaries of exposure. The ACGIH TLV and OSHA PEL for total welding fume, which applies only to manual metal-arc or oxy-acetylene welding of iron, mild steel or aluminum, is 5 mg/m^3 as an 8-hour time-weighted average.[3, 47]

VI. RESULTS AND DISCUSSION

Industrial Hygiene Evaluation

No TDI was detected in any of the worker breathing zone or area air samples collected during the four brazing operations. The minimum detectable concentration (MDC) for the sorbent tube samples collected using NIOSH Method 2535 ranged from 1.4 to 8.7 micrograms of TDI per cubic meter of air (µg/m^3), with a mean MDC of 5.5 µg/m^3; the MDCs for the impinger samples collected using NIOSH Method 5522 ranged from 6.6 to 38.5 µg/m^3, with a mean MDC of 23.7 µg/m^3. A MDC is interpreted as the minimum airborne concentration of a substance that can be reliably detected by a given sampling and analytical method; the actual concentration (if any) is lower than the MDC.

The NIOSH investigators observed that the visible smoke plume emitted by the brazing process was effectively captured by the flexible duct. It is reasonable to conclude that any TDI evolved during brazing should be collected in the air samples taken in the entrance to the duct. The MDCs for the air samples collected in the entrance to the duct, per brazing operation, ranged from 4.9 to 8.7 µg/m^3.

TDI is a gas at room temperature and will pass through the filters and be exhausted from the filtration unit. Thus, any TDI evolved during brazing should also be detected in the air samples in and near the exhaust. The air samples collected in and near the filtration unit's exhaust had MDCs of 1.4 and 6.6 µg/m^3, respectively. These air samples were collected during all four brazing operations.

TDI was not detected in any of the worker breathing zone air samples collected during the four brazing operations. The MDCs for these samples ranged from 4.7 to 7.7 µg/m^3. These concentrations are well below the OSHA PEL and ACGIH TLVs for TDI. Some evidence was found suggesting that TDI exposures may have occurred in past brazing operations. The HHE requesters provided NIOSH with two material MSDSs indicating that TDI can be evolved when heating the coating on the copper wire. This coating was not being used at the time of the NIOSH site visit but area air sampling conducted by one of the consultants on February 10, 1994 found a brazing-related TDI concentration of 0.0029 parts per million (20.6 µg/m^3).

Medical Evaluation

Forty-four OSHA Form 200 entries were logged in 1992, 30 entries in 1993, and 40 in 1994 (up to December). The majority of these entries were for injuries, musculoskeletal problems, lacerations, and contusions. In 1992, the one respiratory-related illness was described as "Allergic Pneumonitis." In 1993, the one respiratory-related illness was described as "respiratory problems." In 1994, there were four respiratory problem entries; two were described as asthma attacks and two as smoke inhalation. The nurse's logs did not list any respiratory-related employee visits. The medical records of five employees reporting severe respiratory conditions indicated diagnoses of chronic respiratory disease, including hypersensitivity pneumonia, although the exact nature of the diagnoses varied. The disorders have both occupational and non-occupational etiologies and may be exacerbated by exposures at work.

Sixty-nine percent (138/201) of Square D Company's hourly employees returned the respiratory symptom/allergy screening questionnaire. Twenty of the 138 respondents (14%) reported experiencing three or more respiratory symptoms including shortness of breath, difficulty breathing, chest tightness, and wheezing in the past year. Nine reported physician-diagnosed asthma. Five of those nine were currently taking prescribed asthma medications. Twenty-one (15%) employees reported dermatologic symptoms.

NIOSH medical investigators interviewed 20 employees, including several employees who requested interviews as well as symptomatic and asymptomatic employees chosen at random from those who completed the screening questionnaire. Five employees reported no work-related health problems. Among the other 15 employees, 14 reported respiratory tract problems including sinusitis, rhinitis, and bronchitis, as well as eye and throat irritation. Seven of those with respiratory symptoms had physician-diagnosed asthma and five were currently using prescribed asthma medications. Six of the seven work as winders and four are currently using respirators at work. Three employees reported intermittent skin reactions on the upper extremities such as rashes, hives and eczema. These employees felt that their symptoms were caused by fiberglass dust from the "bones" and from machine oils.

Other problems reported in the interviews included upper extremity musculoskeletal disorders (e.g. carpal tunnel syndrome, trigger finger), joint pain, headaches, fatigue, hyperthyroidism, reflux gastritis, and hearing loss. Most employees interviewed, as well as management, mentioned that numerous changes had been made in the materials used, ventilation, plant layout, and manufacturing processes in the last several years. These changes resulted in visible improvement in the apparent air quality. A number of employees were concerned about cigarette smoke exposure and felt that the second hand smoke aggravated their symptoms. Employees also expressed complaints of "stuffy, dead" air due to air recirculation, inadequate fresh air ventilation and inoperative vents, diesel fumes from trucks at the loading dock (particularly when the doors are closed), and contaminated air from the humidifiers. Employees felt that the water-based varnish currently used is more irritating than the previously used resin-based varnish and caused tearing of eyes and runny noses. Several employees mentioned that although the welding hoods vent to the outside, their stacks are too short resulting in the welding fumes re-entering the building through the fresh air ventilation intakes, and that the varnish oven filters plug up very quickly and become ineffective.

Safety and Health Program Management

The Square D Company has a functional safety management program. Program elements include written policies and procedures, MSDSs, worker safety programs, respirator fit testing, and health training. The facility manufacturing engineer conducts investigative (complaint) exposure monitoring, but most exposure assessments are conducted by contract industrial hygiene firms after problems are reported. Considerable industrial hygiene monitoring data, both personal and area air sampling, are available for various processes and activities at the facility. Safety glasses and steel-toed shoes are required in all production areas. Half-face respirators with organic vapor cartridges are required in the painting department. Although not required, some employees in the winding department use half-face respirators with organic vapor cartridges and dust and mist filters.

Procedural/Housekeeping

Housekeeping was satisfactory throughout the facility. Aisles were clear and work-stations were kept free of clutter. Smoking is allowed in the manufacturing areas and is not restricted except for areas where there is a potential safety (fire/explosion) hazard.

VII. CONCLUSIONS

Based on the data collected during this survey, the NIOSH investigators did not find any evidence of a current health hazard from brazing-related exposures to TDI. The NIOSH investigators were unable to determine the frequency or severity of past exposures to TDI. The evidence suggests that any past exposures were probably low and/or infrequent. It is possible, however, that a small percentage of workers become sensitized to TDI at exposure concentrations below the current exposure limits. Many of the symptoms that employees considered work-related fall in the general category of irritative or allergic symptoms of the eyes, upper respiratory tract, and skin. These symptoms have many causes, including exposure to workplace fumes, dusts and vapors. Dusts may produce both mechanical effects and skin irritations. Airborne particles may also induce mucosal or airway irritation, and some substances can cause asthma.

VIII. RECOMMENDATIONS

1. All welding and brazing operations/stations should be equipped with fixed-station local exhaust ventilation systems that exhaust the air outside of the workplace. In situations where this is not feasible, a movable hood with a flexible duct may be used. The hood design, flow rate, and capture velocity at the point of welding/brazing should be designed to effectively capture and remove contaminants away from the worker. These local exhaust systems should have in-line duct velocities of at least 3000 feet per minute to prevent particulate matter from settling in horizontal duct runs. Some examples of recommended design of local exhaust ventilation systems for welding/brazing operations can be found in the text "Industrial Ventilation: A Manual of Recommended Practice." This manuscript can be obtained by writing to: ACGIH, Sales Department, 6500 Glenway Avenue, Building D-7,
Cincinnati, Ohio, 45211; or by contacting the ACGIH at (513) 742-2020.

2. A qualified Heating, Ventilation, and Air Conditioning (HVAC) firm should be contracted to conduct a mechanical system audit of the ventilation system to verify that the system is adequately sized and designed for current application. Re-evaluations should be conducted as applications are changed or added.

3. All components of the HVAC systems should be placed on a preventive maintenance (PM) schedule. This schedule should include: policing of units for

debris accumulations, checks on systems to ensure proper operation, checks on the filters for air bypassing and general condition, yearly cleaning and calibration of control systems, and monthly inspection and cleaning of coils, condensate pans and drains. Coils and condensate pans should be thoroughly cleaned and disinfected with a biocide (e.g. 5-10% solution of bleach); air grills should be vacuumed with a HEPA-filtered vacuum cleaner, plenums for return air should be thoroughly cleaned, and low efficiency air filters should be upgraded to the maximum efficiency possible without affecting the performance of the ventilation system. Equipment manufacturers should initially be consulted for recommended PM practices and time frames for components. Eventually, experience will dictate a time frame for PM functions that is applicable to the building's mechanical systems.

4. The use of cooling fans near local exhaust ventilation ducts or hoods should be prohibited. Cross-drafts from these fans may reduce the capture effectiveness of the duct/hood and may also increase the probability of exposing nearby workers to these contaminants.

5. MSDSs for incoming products should be carefully examined to ensure that these products do not form hazardous decomposition products when heated (e.g., during brazing).

6. Routine industrial hygiene surveys of workers performing welding and brazing operations should be conducted to determine the extent of exposure to airborne contaminants. Surveys should be performed semi-annually or whenever changes in the work processes or conditions are likely to change worker exposures. Though not all workers have to be monitored, a sufficient number of samples should be collected to characterize the exposures to all workers potentially exposed. Variations in work habits, production schedules, worker locations, and job functions should be considered when making decisions on sampling locations, times, and frequencies.

7. Employees with work-related health complaints should be evaluated by a health care provider knowledgeable in occupational medicine.

8. The preferable treatment for a worker with a respiratory hypersensitivity disorder is cessation of exposure to the causative agent. Any worker with such a condition should be offered an assignment to a non-exposure job without reduction in pay or seniority.

9. Management should stress a proactive approach to recognize and ameliorate potential health problems. An integrated health and safety program with participation by the union, employees, and the medical department would provide a mechanism for employees to communicate their concerns to management and

allow management to address these concerns appropriately. Better communication can foster a sense of shared responsibility for maintaining a safe and comfortable work environment and assure that workplace concerns are communicated. In addition, the medical department should be more involved with occupational health programs, especially to identify symptoms and health concerns, and to provide input on the health effects of exposures in training programs. Supervisors and managers should receive the same training as workers to make them aware of workers' concerns.

10. Ergonomic issues such as repetitive motion, lifting, and awkward postures, should be evaluated. Tasks with exposures to ergonomic risk factors should be identified and evaluated, and risk factors controlled.

11. Tobacco use at the worksite should be eliminated. NIOSH considers environmental tobacco smoke (ETS) to be a potential occupational carcinogen and recommends that workers not be voluntarily exposed. NIOSH has determined that ETS poses an increased risk of lung cancer and possibly heart disease to occupationally exposed workers. Employees should be protected from exposure to ETS by isolating smokers. This can be accomplished by restricting smoking to separately ventilated enclosed areas not used for other purposes. The best method for controlling worker exposure to ETS is to eliminate tobacco use from the workplace and to implement a smoking cessation program. Until tobacco use can be completely eliminated, Square D Company should make efforts to protect nonsmokers from ETS by isolating areas where smoking is permitted. Restricting smoking to designated areas outside the building (away from entrances, air intakes, and operable windows) or to separate enclosed indoor smoking areas with dedicated ventilation are two ways to do this. Air from smoking areas should be exhausted directly outside and not recirculated within the building or mixed with the general dilution ventilation for the building. The air from these areas should be exhausted directly to the outside at a location where re-entrainment of ETS will not present a problem. A negative pressure in the smoking area relative to adjacent locations should be provided to prevent airflow back into the non-smoking workplace.

12. Currently, Square D purchases standard lengths of fiberglass bones, and cuts these bones to the desired length. This operation has the potential to

generate fiberglass dust. Since the bones can be purchased pre-cut to Square D's desired length Square D should consider purchasing the pre-cut bones to eliminate the potential for fiberglass dust exposure.

IX. REFERENCES

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