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NORTHLAND TERRACE NURSING AND REHABILITATION CENTER
COLUMBUS, OHIO

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I. SUMMARY

On August 27, 1990, the National Institute for Occupational Safety and Health (NIOSH) conducted a Health Hazard Evaluation (HHE) at Northland Terrace Nursing and Rehabilitation Center in Columbus, Ohio. The HHE request, submitted by the management of this center, concerned the development of headaches by employees in the new laundry facility, and upper respiratory infections associated with distributing Attends® disposable briefs. During the NIOSH site visit an investigation was conducted in the laundry, and the delivery of Attends® was observed.

The laundry evaluation consisted of employee interviews, environmental monitoring, and an assessment of the adequacy of the design and performance of the heating, ventilating, and air conditioning (HVAC) system. All seven of the employees reported experiencing headaches while present in this building. The environmental monitoring included carbon dioxide (CO_2), carbon monoxide (CO), respirable particulate, temperature, and relative humidity (RH) measurements.

The CO_2 concentrations measured during this survey exceeded 1,000 parts per million (ppm), a guideline used by NIOSH to evaluate the adequacy of ventilation systems. However, CO_2 may not be an effective indicator for this building since the occupant density was relatively low. (The CO_2 concentrations may underestimate the degree of the ventilation deficiency.)

Biologically significant CO concentrations were not observed during this investigation, but under certain conditions vehicle exhaust might be entrained into the ventilation system air intake. The concentrations of respirable particulate matter, measured with a direct reading aerosol monitor, were insignificant.

The temperatures in the laundry rooms ranged between 86 and 92°F and between 78 and 80°F in the supply, purchase and requisition department (SPD). Relative humidities in the laundry and SPD area were observed to range from 48 to 56%. Although heat stress was not evaluated during this survey, the potential exists for heat stress conditions in the laundry during the summer.

Air monitoring performed for total dust during the distribution of the Attends® diapers revealed an employee exposure of 0.07 mg/m^3. Employee interviews suggested that respiratory symptoms may have been associated with exposure to this product. It is unclear whether the reported symptoms were due to the dust or the fragrance associated with Attends®. Northland Terrace stopped using Attends® and the symptoms subsided. Hence, the NIOSH investigation regarding exposure to Attends® at this facility was discontinued.

On the basis of this evaluation, NIOSH investigators concluded that an inadequate supply of outside air was provided in the laundry and basement areas. Exposure to Attends® briefs during distribution may have been associated with the reported respiratory symptoms. Relocation of the outside air intake, increasing the outside air ventilation rate, and proper balancing of the ventilation system are among the recommendations provided in Section VII of this report.

Keywords: SIC 8051 (skilled nursing and rehabilitation), secondary SIC 7211 (commercial laundry), headaches, carbon dioxide, temperature, relative humidity, ventilation, outside air intake; Attends® disposable briefs, respiratory symptoms.

II. INTRODUCTION

On August 27, 1990, the National Institute for Occupational Safety and Health (NIOSH) conducted a Health Hazard Evaluation (HHE) at Northland Terrace Nursing and Rehabilitation Center in Columbus, Ohio. The HHE request was submitted by the management of this center and identified two separate concerns. The first was the development of headaches by employees in the new laundry facility. The other concern was associated with distributing Attends® disposable diapers, which were suspected of causing upper respiratory infections. During the NIOSH site visit an investigation was conducted in the laundry (and adjacent basement areas), and the delivery of Attends® was observed.

This evaluation consisted of employee interviews, environmental monitoring, and an assessment of the adequacy of the design and performance of the heating, ventilating, and air conditioning (HVAC) system. The environmental monitoring included carbon dioxide (CO_2), carbon monoxide (CO), respirable particulate, temperature, and relative humidity (RH) measurements utilizing direct reading instrumentation.

On the evening of August 27, 1990, distribution of the Attends® diapers was observed and air monitoring was performed for the diaper dust. Employees were also interviewed regarding their exposure to these diapers and any symptoms which may have been associated with this exposure. In late September 1990, Northland Terrace stopped using Attends® and switched to alternative products. Because the symptoms subsided once this occurred, the NIOSH evaluation regarding Attends® was discontinued.

III. BACKGROUND

Northland Terrace is a nursing and rehabilitation center which offers intermediate and skilled care to patients with short and long-term needs. The 260 bed facility contains five patient care units, a kitchen, a recreation/dining area on the first floor, and an administrative office area on the second floor. Support services including the laundry facility, supply, purchase and requisition department (SPD), and maintenance shop are located in the basement and were the focus of the ventilation evaluation. Employees who work in the laundry facility have reported that they experience headaches while present in this area. The laundry facility was renovated in October, 1989. Prior to this date, Northland Terrace had a contractual agreement with a laundry service to perform this work.

IV. LAUNDRY AREA EVALUATION

During the NIOSH visit, an investigation was conducted in the basement area, including the laundry. This investigation included environmental monitoring for CO_2, CO, temperature, RH, and particulates, as well as an inspection of the area, evaluation of the ventilation system, and employee interviews. Employees were potentially exposed to acids, solvents, sodium hydroxide, and chlorinated compounds present in the laundry detergents, bleaches, and sanitizers (primarily via skin contact). Inhalation exposure was minimal so air monitoring was not performed.

Although the laundry facility was not a typical indoor air quality environment, such as an office, the adequacy of the ventilation supplied to this area was a concern because of

the reported symptoms. The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) has published recommended building design criteria, regarding ventilation of indoor spaces including commercial laundries, which can be used for evaluating HVAC system design and performance.[1]

The basis for monitoring individual or classes of environmental parameters will be presented in a separate section of this report.

Employee interviews

A total of eight employees in the laundry and SPD were interviewed regarding the indoor environment and any symptoms they may have experienced. One employee, whose first day of the job was the day of this survey, was not included in the analysis. The most frequently reported symptoms included headache (all employees), and a dry, irritated throat (3 of the 7). Other health effects that were cited by 1 or 2 employees included dizziness, drowsiness, dry itchy eyes, nausea, and a bronchial infection. The majority of these employees
(6 of the 7) described the symptoms to be temporally related to their presence in the basement. Employees also reported that vehicular exhaust entered the laundry work area.

Carbon dioxide

Real-time CO_2 levels were determined using a Gastech Model RI-411A, Portable CO_2 Indicator (a direct reading instrument). This portable, battery-operated instrument monitors CO_2 via non-dispersive infrared absorption with a range of 0-4975 parts per million (ppm) and a sensitivity of 25 ppm. Instrument zeroing and calibration were performed prior to use with a CO_2 filter and a known CO_2 span gas
(800 ppm). Confirmation of calibration was conducted throughout the instrument use period.

Carbon dioxide, a normal constituent of exhaled breath, can be used as a screening technique to evaluate whether adequate quantities of outside air are being introduced into an occupied space. ASHRAE's most recently published Ventilation Standard, ASHRAE 62-1989, Ventilation for Acceptable Indoor Air Quality, recommends outdoor air supply rates of 20 cubic feet per minute per person (cfm/person) for office spaces, 15 cfm/person for reception areas, classrooms, libraries, auditoriums and corridors, and 25 cfm/person for commercial laundries.[1]

Indoor CO_2 concentrations are normally higher than the generally constant ambient CO_2 concentration (range 300-350 ppm). When indoor CO_2 concentrations exceed 1000 ppm in areas where the only known source is exhaled breath, inadequate ventilation is suspected. Elevated CO_2 concentrations suggest that other indoor contaminants may also be increased. Maintaining the recommended ASHRAE outdoor air supply rates should provide for acceptable indoor air quality when the outdoor air is of good quality and there are no unusual indoor emission sources.

Carbon dioxide measurements were made throughout the basement areas including the sorting room, washer room, dryer room, folding room, SPD, and connecting hallway. Measurements were collected throughout the day and included measurements obtained after the employees had left for the day. The CO_2 levels in the laundry areas ranged

from 575-1050 ppm, and from 850-1100 ppm in the SPD. Since the monitoring did not start until noon, the CO_2 concentrations had already stabilized. As expected, after some of the employees had left for the day, CO_2 concentrations decreased. The highest concentrations observed in the laundry occurred in the folding room, where six or seven employees were stationed. The CO_2 concentrations ranged from 575-925 ppm in the sorting, washing, and drying rooms, where only one or two employees worked.

The CO_2 concentrations exceeded 1000 ppm in some locations, which suggests the outside air supplied to these areas was inadequate. Carbon dioxide is not an effective indicator if the ventilated area is vacated. On the day of this investigation, the work areas were not densely populated. This was especially true for the SPD, and the sorting, washing, and drying areas of the laundry. Hence, CO_2 may not have been an effective indicator of ventilation effectiveness in these locations (and may have underestimated the degree of the ventilation deficiency). Should the staffing numbers increase substantially, a reevaluation of the outside air supply may be warranted.

Carbon monoxide

Real-time CO concentrations were determined using a Drager Model 190, CO dosimeter (a direct reading instrument). This portable, battery-operated instrument monitors CO via diffusion into a electrochemical reaction cell with a range of 0-999 parts per million (ppm), and a sensitivity of 1 ppm. Instrument zeroing and calibration were performed prior to use with ambient air and a known CO span gas (20 ppm). Confirmation of calibration was conducted throughout the instrument-use period.

Carbon monoxide was monitored because headaches were reported by employees (one symptom of CO exposure), and the clothes dryers were fired using natural gas. Inefficient combustion of a carbonaceous material (such as natural gas) will generate CO. Measurements for CO were conducted throughout the laundry areas, including the equipment closet housing the dryers. Carbon monoxide concentrations were 1 ppm or non-detectable. The OSHA permissible exposure limit (PEL) for CO is a 35 ppm time-weighted average for an 8-hour period, or a ceiling limit of 200 ppm not to be exceeded even momentarily.[2] The World Health Organization lists CO concentrations less than 11 ppm to be of limited or no concern for non-industrial indoor environments.[1]

Temperature and relative humidity

Real-time temperature and relative humidity measurements were conducted using a Vaisala, Model HM 34, battery-operated meter. This meter is capable of providing direct readings for dry bulb temperature and relative humidity ranging from -4 to 140^{o}F, and 0 to 100%, respectively.

The perception of thermal comfort is related to one's metabolic heat production, the transfer of heat to the environment, physiological adjustments, and body temperatures. Heat transfer from the body to the environment is influenced by factors such as temperature, humidity, air movement, personal activities, and clothing. ANSI/ASHRAE Standard 55-1981 specifies conditions in which 80% or more of the occupants would be expected to find the environment thermally acceptable.[3] These temperatures range from 68-74^{o}F in the winter, and from 73-79^{o}F in the summer. The difference between the two is largely due to seasonal clothing selection. In a separate document, ASHRAE also recommends that relative humidity be maintained between

30 and 60%.[1] Excessive humidity can support the growth of microorganisms, some of which could be pathogenic and allergenic.

Temperature and RH measurements were obtained throughout the laundry and SPD. The temperatures in the laundry rooms ranged between 86 and 92°F. Overall, the temperatures recorded in the laundry exceeded the upper value of the thermal comfort guidelines for summer (73 to 79°F), as published by ASHRAE. The temperatures in the SPD area were measured to be 78-80°F, which straddle the upper value of the ASHRAE thermal comfort criteria. Relative humidities in the laundry and SPD areas were observed to range from 48 to 56%. The RH approached 60% in the basement hallway. Although these RH values are within the range recommended by ASHRAE, many of the measurements were near the upper limit of this recommendation.

The ASHRAE thermal guidelines were designed for occupant comfort. There are other guidelines that are available which protect against heat-related illnesses, such as heat stroke, heat exhaustion, heat syncope, and heat cramps. These include wet bulb globe temperature (WBGT), Belding-Hatch heat stress index (HSI), and effective temperature (ET).[4] Although heat stress was not evaluated during this survey, the potential exists for heat stress conditions in the laundry during the summer. Both NIOSH and ACGIH recommend the use of the WBGT index to measure environmental factors because of its simplicity and suitability in regards to heat stress.[5,6] If the time-weighted average WBGT measurement exceeds 79°F (for acclimatized workers performing a moderate work load), NIOSH recommends the implementation of one or more interventions which will be discussed in the Recommendation section of this report.

Particulates

Real-time respirable suspended particulate (RSP) concentrations were measured using a direct reading GCA Environmental Instruments Model RAM-1 monitor. This portable, battery-operated instrument assesses changes in particle concentrations via an infrared detector, centered on a wavelength of 940 nanometers. Air is sampled (at 2 liters per minute) through a cyclone preselector, which restricts the penetration of particles greater than 9 micrometers. The air sample then passes through the detection cell. Operating on the 0-2 milligram per cubic meter (mg/m^3) range with a 32-second time constant yields a resolution of 0.001 mg/m^3.

Respirable suspended particles (smaller than 2.5 micrometers) are associated with combustion source emissions. The greatest contributor to indoor RSP is environmental tobacco smoke. In buildings where smoking is not allowed, RSP concentrations are influenced by outdoor particle concentrations, with minor contributions from other indoor sources. In buildings with oil, gas, or kerosene heating systems, increased RSP concentrations associated with the heating source may dominate. Particles smaller than 10 micrometers in diameter (PM_{10}) combine combustion, soil, dust, and mechanical source particle contributions. The larger particles are associated with outdoor particle concentrations, mechanical processes, and human activity. When indoor combustion sources are not present, indoor particle concentrations generally fall well below the Environmental Protection Agency's (EPA) ambient air quality standard for respirable particulate matter of 150 micrograms per cubic meter (ug/m^3) averaged over

24 hours. The OSHA permissible exposure limit (PEL) for respirable particulates, not otherwise regulated, is a 5.0 mg/m^3 eight-hour average.[2]

The concentrations of respirable particulate matter in the basement locations, measured with a direct reading aerosol monitor, ranged from 5 to 30 (ug/m^3), well below the EPA criteria, and the OSHA PEL.

Airborne bioaerosols

Monitoring for airborne microbial contamination was not performed since visible evidence of microbial contamination, standing, or leaking water was not apparent. Although the washers empty into an open drain, microbial growth in this drain would not likely be a problem since the washer water often contains detergents, bleaches, and sanitizers.

Ventilation evaluation

A qualitative evaluation of the ventilation systems was performed during this investigation. This evaluation consisted of a review of the technical specifications, an indirect performance evaluation via CO_2 concentrations, measurement of the air flow rate of the supply ventilation, and a visual inspection.

A mechanical ventilation system for the SPD area and the maintenance shop did not exist. Therefore, the following discussion regarding the ventilation system is only pertinent to the laundry areas. The laundry was serviced by one ventilation system, which had small supply air ducts in each of the four work rooms -- sorting, washing, drying, and folding rooms. The return air vents were located in the walls of the equipment room and were not ducted. Neither blueprints nor any other schematics of the ventilation system were available. The system reportedly supplied 20-25% outside air, with the remainder of the air being recirculated.

A Kurz Model 491 hot wire anemometer was used to measure the air velocity of the supply air vent diffusers. Six measurements were collected at different sections of the diffuser opening, and the average of these measurements was calculated. The average air velocity was multiplied by the diffuser face area to yield a crude estimate of the air flow rate in terms of cubic feet per
minute (cfm). Assuming that 20-25% of this flow rate is outside air (as reported by the facility's environmental services manager), the rate of outside air introduced into the laundry is below the ASHRAE guideline for commercial laundries (25 cfm outside air per person). The folding room, where the majority of the laundry employees worked, had less than 50 cfm outside air delivered to this space. Four to six employees were typically working in this area during the NIOSH visit, a staffing level which would require 150 cfm outside air to maintain the outside air supply as recommended by ASHRAE. The washer and dryer rooms each had less than 50 cfm of outside air supplied to these areas, while the sorting room air diffuser was obstructed, preventing any air flow (including recirculated air) into this room. The elevated CO_2 concentrations in the laundry, which were above 1000 ppm, support the conclusion that the laundry was not receiving adequate ventilation. Since the SPD and maintenance shop were without mechanical ventilation and opening windows, these areas were also inadequately ventilated.

A number of deficiencies were noted during the visual inspection of the ventilation system and ductwork. In addition to the inadequate outside air ventilation volume, the distribution of air supply may be ineffective. The supply diffusers were located in the corners of their respective rooms, which may not allow the air to be properly delivered throughout the entire room. Air flow through the sorting room diffuser was negligible, as demonstrated by smoke tubes and the hot wire anemometer.

The location of the outside air intake was of particular concern. This intake was near the kitchen at ground level, in a location where delivery vehicles unload. This arrangement increases the likelihood for entrainment of vehicular exhaust, including CO, into the laundry and basement areas. Hemoglobin has a much higher affinity for combining with CO than oxygen, thereby disrupting the transport and delivery of oxygen to tissues. Exposure to exhaust from internal combustion engines could result in headaches, weakness, dizziness, nausea, confusion, unconsciousness and, in extreme cases, death. Excessive exposure to high concentrations of CO may be rapidly fatal without adequate warning or may permanently affect the central nervous system. Although the CO measurements obtained on the day of the NIOSH visit were of no concern, the potential does exist for vehicular exhaust to enter this air intake. In addition to the close proximity to the delivery area, waste cooking oil drums were in the immediate vicinity of the air intake, which could cause odors to enter the basement area. A ventilation fan exhaust was also near the intake; this could short circuit the system from distributing "fresh" outside air.

The maintenance shop, which was located across the hallway from the laundry, did not have a local exhaust ventilation system. Painting, varnishing, gluing, and other activities that may occur in this area could generate air contaminants. Without removing these contaminants at their source of generation using exhaust ventilation, the contaminants may travel to other locations.

V. ATTENDS® DELIVERY

Environmental evaluation

On the evening of August 27, 1990, distribution of Attends® diapers was observed. This operation was of concern due to employee reports of frequent respiratory "infections," allegedly due to exposure to Attends® products.

Initially, the absorbent material of Attends® was thought to contain super absorbent polymers (SAPs). Eye irritation, upper respiratory irritation, and constricted breathing were symptoms suspected to be caused by exposure to SAPs. Contact with the manufacturer of this product, however, revealed that Attends® does not contain SAPs.[7] Instead of SAPs, a mixture of polyethylene and cellulose with large pore sizes is used. Although Attends® does not contain SAPs, exposure to the dust containing its absorbent material could possibly cause drying of mucous membranes, such as those associated with the respiratory tract, which could result in irritative symptoms.

Air monitoring was performed for the diaper dust using Gillian model HFS 513A air sampling pumps and 5 micron PVC (polyvinyl chloride) filters. A gravimetric analysis was performed on the samples to measure for total dust. The personal exposure to total dust was determined to be 0.07 mg/m^3 during the 2.5-hour time period necessary to deliver a few cases of Attends®. According to the employee who delivered the

diapers, a considerably larger number of cases are distributed on other nights, especially Fridays. Because Attends® do not contain SAPs, analysis for these polymers was not conducted. An exposure criterion for the dust generated by Attends® is presently unavailable. The OSHA permissible exposure limit (PEL) for a particulate, not otherwise regulated, is 15.0 mg/m^3 eight-houraverage.[2] The ACGIH recommended Threshold Limit Value (TLV) for exposure to a particulate, not otherwise classified, is
10.0 mg/m^3.[8] These are generic criterion for airborne dusts which do not produce significant organic disease or toxic effect when exposures are kept under reasonable control.[9] These criteria are not appropriate for dusts that have a biologic affect and may not be appropriate for evaluating synthetic diaper dust exposure.

There are close to 30 chemical constituents present in the Attends® fragrance in quantities greater than 0.5%.[7] Air samples were not collected for any of these components during the initial NIOSH visit.

Medical evaluation

Only three employees delivered Attends® briefs at Northland Terrace. These three workers were interviewed by telephone. All of these employees described symptoms which were temporally related to the delivery of Attends® diapers. Symptoms apparently began and then increased in severity over several weeks after the nursing home began to use Attends®. All three workers experienced the onset of symptoms within 10 minutes to 1 hour after beginning to deliver the Attends®; all three described symptoms of upper respiratory irritation, including burning eyes, sore throat, stuffy nose and sinuses, and headache. Two workers also described shortness of breath and chest tightness. Symptoms began to resolve within several hours of the employees' leaving work and were completely resolved upon their awakening the next morning. None experienced delayed onset of symptoms, and all denied other respiratory symptoms. All were free of symptoms on days when they did not deliver Attends® (days not at work or days performing other duties at work). None had any previous history of asthma or other respiratory disease, and only one had a history of allergy with respiratory symptoms.

All three workers described a fragrance or perfume which they associated with the Attends®; some also said that a dust "came off" the Attends® when they were taken from the box. Two workers suggested that the fragrance was responsible for their symptoms, while the third was not certain whether the fragrance or the dust caused the symptoms. The workers interviewed all described a strong association between exposure to Attends® and the symptoms they experienced. The upper respiratory symptoms described included stuffy nose, sore throat, and headache. The lower respiratory symptoms of chest tightness and shortness of breath indicate an effect on the air passages of the lung. Because the nursing home gradually increased the number of Attends® to be delivered, it is not clear whether the development and increased severity of symptoms was related to increased sensitivity to an offending substance or to increased contact time with that substance. The medical histories related by these workers do not allow us to determine whether these symptoms were caused by exposure to an irritant or to an allergen. However, the occurrence of symptoms in all three employees who delivered Attends® suggests an irritant is more likely, as allergic reactions tend to be more variable depending upon the allergic sensitivity of the individual.

In late September 1990, Northland Terrace stopped using Attends® and switched to a combined use of two products, a Guards At-Ease® diaper and a separate underpad. The new diapers are packed in plastic-sealed bundles of 10 or 12 diapers; the worker delivering these diapers drops off an intact bundle and does not come in contact with individual diapers. Underpads are handled individually. All three workers reported that their symptoms completely ceased when they stopped delivering Attends® and switched to the new product. The fact that all workers stopped experiencing symptoms when Attends® were discontinued suggests that the cause of the symptoms was some substance associated with that product. Given the current absence of symptoms among the workers delivering diapers, there is little reason to conduct further environmental or medical investigations. Should symptoms recur, the NIOSH investigators should be contacted.

VI. CONCLUSIONS

1. All of the employees in the laundry and SPD reported they experienced headaches while at work. A majority of these employees reported a temporal association of the symptoms with their presence in the building.

2. An inadequate supply of outside air appears to be delivered by the ventilation system in the laundry. A mechanical ventilationsystem is not present in the SPD area or maintenance shop. (Carbon dioxide concentrations in the laundry and SPD were measured in excess of 1000 ppm.)

3. The outside air intake is in an extremely poor location, increasing the probability for entrainment of air contaminants.

4. Distribution of the air supply in the laundry areas may be inadequate. The supply diffuser vents were located in the corner of the rooms, which may not properly distribute air to all work areas throughout the laundry. Sharp turns, long lengths of ducts or some other obstruction may have restricted air flow to the vent in the sorting room.

5. Solvent vapors from painting and gluing activities in the maintenance shop are not removed by local exhaust ventilation.

6. The room temperature exceeded the ASHRAE thermal comfort range for summer in all of the laundry areas and was marginal in the SPD. The relative humidity in the basement areas was marginally within the upper limit of the criteria recommended by ASHRAE. The potential exists for the heat stress conditions to occur in the laundry during the summer.

7. The laundry detergents, sanitizers, and conditioners contain acids, caustics (corrosives), alcohols, and chlorinated compounds, some of which may be volatile. The waste water of the washing machines empties into a drain trench that is covered with an open grating which may allow some of these volatile components to enter the laundry air.

8. Biologically significant carbon monoxide exposure was not measured during the NIOSH survey, but under certain conditions vehicle exhaust might be entrained in the air intake.

9. Respirable particulate concentrations were well below the EPA criteria for ambient respirable particulates.

10. Visible evidence of microbial contamination, leaking, or standing water was not apparent.

11. The employees who distributed Attends® described an association between exposure to Attends® and the respiratory symptoms they experienced. The fact that all workers stopped experiencing symptoms when Attends® were discontinued suggests that the cause of the symptoms was associated with exposure to that product.

VII. RECOMMENDATIONS

1. Modify the existing ventilation system in the laundry areas to provide additional outside air which satisfies the criterion established by ASHRAE for commercial laundries (25 cfm outside air/person). The system should be designed, installed, and balanced by a competent engineering firm that is certified for this type of work.

2. Install a ventilation system in the SPD department that provides sufficient outside air as recommended by ASHRAE for office environments (20 cfm outside air/person).

3. Relocate the outside air intake so it is removed from potential sources of air contamination, such as vehicle exhaust.

4. Provide and locate air diffusers so the air will be adequately distributed throughout the entire room.

5. Ensure that the ventilation filters are routinely inspected and changed when soiled. Use filters with a dust spot efficiency rating of 35-60%, as recommended by ASHRAE.

6. Install local exhaust ventilation in the maintenance shop to remove air contaminants, such as paint and adhesive vapors.

7. Consider installing equipment to provide moisture control in the laundry.

8. Evaluate the conditions in the laundry on a hot day to determine if the employees are exposed to excessive heat stress. Should the time-weighted average WBGT measurement exceed 79^{o}F (for acclimatized workers performing a moderate work load), consider implementing engineering controls, such as air conditioning, radiant heat shields, or space cooling fans. If engineering controls are not technically feasible or are economically prohibitive, one or more of the following administrative controls should be implemented:

    a. Ensure full acclimatization of workers.

    b. Adjust work/rest cycle to reduce the peak physiological strain and improve recovery.

c. Provide even distribution of work over the entire work shift.

d. Schedule hot jobs (or strenuous ones) during the coolest part of the day.

e. Provide breaks (preferably) in cool rooms and ample drinking water. Drinking water should be cool, potable water that is available with individual drinking cups. The use of salt tablets or salted fluids should be avoided since this could irritate the stomach. The relatively high salt content of the average American diet should provide the workers adequate amounts of salt to replenish that which is lost by perspiration.

f. Ensure the use of appropriate clothing, and provide protective clothing, if warranted.

8. Install a safety/eye wash in the washer room where corrosive laundry solutions are used.

9. Modify the washer drain so that it is enclosed and not open to the atmosphere.

10. Ensure adequate make-up air is provided in the dryer area to allow efficient and effective operation of the gas-fired dryers.

11. Should employees delivering disposable briefs become symptomatic again, a request for HHE should be re-submitted to NIOSH.

VIII. REFERENCES

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