HETA 99-0163-2771
Superior Drywall, Inc.
Millsboro, Delaware

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PREFACE

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

HETAB also provides, upon request, technical and consultative assistance 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. Mention of company names or products does not constitute endorsement by NIOSH.

ACKNOWLEDGMENTS AND AVAILABILITY OF REPORT

This report was prepared by Josh Harney and Elena Page of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS) and by John McKernan, of the Surveillance Branch, DSHEFS. Analytical support was provided by Ardith Grote, Division of Physical Sciences and Engineering. Desktop publishing was performed by Denise Ratliff. Review and preparation for printing was performed by Penny Arthur.

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Highlights of the NIOSH Health Hazard Evaluation

Adhesive Vapor Exposure Among Drywall Hangers
May 19-20, 1999

During the two days of this study, a National Institute for Occupational Safety and Health (NIOSH) doctor interviewed ten drywall hangers about possible work-related health effects. NIOSH industrial hygienists measured chemicals that evaporate from the drywall adhesive used in hanging drywall.

What NIOSH Did

Interviewed drywall hangers about possible work-related health effects.

Reviewed personal medical records and company Occupational Safety and Health Administration (OSHA) 200 logs.

Took air samples to see how much adhesive solvent vapor drywall hangers are exposed to.

What NIOSH Found

No solvent-related health effects were found.

Chemical exposures were within NIOSH and OSHA limits.

Empty DSA-20 tubes still let off some adhesive vapors.

What Superior Drywall Managers Can Do

Develop a hazard communication program according to OSHA standards.

Supply all subcontractors with information about possible dangers of adhesives used and about how to protect themselves.

Consider switching to a water-based drywall adhesive.

What Superior Drywall Employees Can Do

Put empty DSA-20 tubes outside.

Keep working with outside doors and windows open when possible.

Minimize time spent in small, poorly ventilated areas like closets or bathrooms while adhesive is drying.

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CENTERS FOR DISEASE CONTROL AND PREVENTION

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We encourage you to read the full report. If you would like a copy, either ask your health and safety representative to make you a copy or call 1-513/841-4252 and ask for HETA Report #99-0163-2771

National Institute for Occupational Safety and Health
NIOSH

Health Hazard Evaluation Report 99-0163-2771
Superior Drywall, Inc.
Millsboro, Delaware
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SUMMARY

The National Institute for Occupational Safety and Health (NIOSH) received a confidential Health Hazard Evaluation (HHE) request in March 1999, from employees of Superior Drywall, Millsboro, Deleware. The request named drywall hanging as a job of concern for possible exposure to vapors from drywall adhesive. On May 19-20, 1999, NIOSH investigators conducted a site visit at Superior Drywall operations. Environmental monitoring was conducted at different work sites for organic vapors evolving from drywall adhesive. The NIOSH physician interviewed drywall hangers and reviewed the Occupational Safety and Health Administration (OSHA) Log and Summary of Occupational Injuries and Illnesses (Form 200) for the years 1997 and 1998.

Although the material safety data sheets (MSDS) for the drywall adhesive listed hexane, cylcohexane, and n-heptane specifically as its major components, thermal desorption tube samples (collected on the first day of the site visit) showed that in some areas other hexane isomers, toluene, and benzene vapors were present in the air in greater relative abundance than were cyclohexane or n-heptane individually. Quantitative analysis therefore was made only for "total hexanes," n–hexane, toluene, and benzene.

There were no personal exposures to individual solvents above relevant occupational exposure criteria. The highest full-shift concentration, 37.7 parts per million (ppm) of n-hexane, was measured by an area sample in the hall bathroom: a small, enclosed area with poor ventilation. The lowest vapor concentrations both days were from personal breathing zone (PBZ) samples collected on drywall hangers.

PBZ samples for combined exposure ranged from about 20-80% of the "mixture recommended exposure limit" (REL), 20-70% of the "mixture threshold limit value" (TLV), and 2-6% of the "mixture permissible exposure limit" (PEL). Therefore, during full-shift sampling there were no over exposures based on the potential combined effects of toxicologically similar compounds. All PBZ concentrations for n-hexane, toluene, benzene, and "total hexanes" were at least one order of magnitude below their respective PEL, and none exceeded their REL or TLV.

One short-term sample collected in the box used to store expended adhesive tubes demonstrated that solvent vapors continue to off-gas from the used tubes. This may contribute a small amount to the ambient levels, in addition to what comes from the adhesive applied during drywall installation. To minimize potential exposures, emptied tubes should be removed from the work area and stored outside until they can be disposed. Drywall hangers should continue to work with windows and doors open when possible, to facilitate general ventilation. Based on the conditions witnessed during this evaluation, it is unlikely for hangers to be over exposed during normal work activities. If solvent exposures continue to be a concern of the workers, it may be beneficial to switch from a volatile, organic solvent-based adhesive to a water-based adhesive. Superior should develop a hazard communication program dealing with any hazardous chemicals used by their employees.

There was no evidence that workers were experiencing adverse health effects secondary to solvent exposure on the job.

The major adhesive vapors found during this evaluation were n-hexane, "total hexanes," toluene, and small amounts of benzene. No over exposures to individual or combined solvent vapors were found. Emptied adhesive tubes should be removed from the work area and stored outside until disposed and hangers should work with widows and doors open where possible. It may be beneficial to switch to a lower solvent content adhesive, for example, a water-based one. Superior Drywall should develop a hazard communication program for their employees and contractors. No evidence of a health hazard from solvent vapors from the adhesive was found.

Keywords: SIC 1742 (Plastering, Drywall, Acoustical, and Insulation Work) adhesive, hexane, benzene, drywall, construction, toluene

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INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) received a confidential Health Hazard Evaluation (HHE) request in March 1999, from employees of Superior Drywall, Millsboro, Delaware. The request named drywall hanging and drywall finishing as jobs of concern for possible exposure to vapors from a drywall adhesive (DSA-20, TACC International, Rockland, Massachusetts). Drywall hangers working for Superior use the adhesive (along with drywall nails and screws) to affix drywall sheets to wooden wall studs, joists, and rafters in residential homes. No health effects from work-related activities were reported by the requesters. Telephone calls to the requesters, however, revealed the possibility of health effects among other workers.

On May 19-20, 1999, NIOSH investigators conducted a site visit at Superior Drywall operations. An opening conference was held at Superior Drywall offices on the morning of May 19, 1999. Environmental monitoring was conducted for organic vapors evolving from drywall adhesive at different work sites, and the NIOSH physician interviewed drywall hangers and reviewed the Occupational Safety and Health Administration (OSHA) Log and Summary of Occupational Injuries and Illnesses (Form 200) for the years 1997 and 1998. An interim letter providing preliminary findings and recommendations was sent to all involved parties on June 28, 1999.

BACKGROUND

Superior Drywall, Inc., is a privately owned company that installs drywall primarily in newly constructed housing. The size of the workforce fluctuates according to the demand for this service. Superior directly employs approximately 10 full-time permanent employees, most of whom are drywall finishers. The number of drywall hangers, all of whom are private subcontractors, ranges from 5 to 40, depending on the amount of work available at any one time. The drywall hangers work in teams of two, and typically only one team works at each site. Work rates for hanging drywall sheets using the adhesive vary, depending on factors such as the internal construction of each house and the amount of time spent cutting out holes in the wallboard for electrical and plumbing services. The work rate for each two-man team observed on two days was between 50 and 70 8' x 4' sheets of drywall per day. In hanging this amount of drywall, the workers used between 12 and 20 29-ounce tubes of adhesive per day. Hangers are paid based on the total number of sheets they hang, with higher rates being paid for hanging drywall above the standard 8' ceiling level.

The drywall is hung by first applying a bead of adhesive to each wooden wall stud, joist, or rafter that will be covered by drywall, then by nailing the sheet of drywall in place, and finally by finishing with several drywall screws. The material safety data sheets (MSDS) for the drywall adhesive listed hexane, cylcohexane, and n-heptane, which are organic solvents, as its components. Dermal contact with the adhesive is minimal. It is possible for one worker alone to hang the lower sheets along the baseboard by using a foot-jack to lift the drywall off the floor and hold it while nailing it into place. Workers work together to complete the higher parts of the wall and ceiling. Hanging drywall on these elevated areas sometimes requires the use of stilts, scaffolding, and/or a mechanical drywall lift.

METHODS

Industrial Hygiene

At two sites the first day, and one site the second day, area air samples were collected (based on NIOSH Manual of Analytical Methods [NMAM] Method 2549) using thermal desorption tubes and low flow air pumps calibrated to 50 cubic centimeter per minute (cc/min).[1] These air samples were analyzed by gas chromotography/mass spectroscopy by NIOSH chemists in order to identify other possible contaminants besides those listed on the MSDS. The compounds registering on the chromatograms were primarily C-6 and C-7 hydrocarbons. Quantitative analysis of the charcoal sorbent tubes was therefore requested

for n-hexane, benzene, toluene, and "total hexanes." "Total hexane" is the sum of all peaks in the chromatogram eluting between, but not including, n-hexane and n-heptane. Because it was analyzed separately, benzene is not included in "total hexane."

For quantitative analysis, personal breathing zone (PBZ) and area air samples were collected on charcoal sorbent tubes with the low flow pumps at a flow rate of 200 cc/min according to NIOSH Method 1500.[2] These samples were analyzed by NIOSH's contract lab for the chemicals that registered major peaks on the thermal desorption tube analysis, utilizing a combination of conditions from NIOSH Methods 1550, 1500, and 1501 with modifications.[2,3,4] The charcoal tubes were desorbed with carbon disulfide and analyzed with a Hewlett-Packard Model 5890A gas chromatograph equipped with a flame ionization detector. All analytes were quantitated against n-hexane standards. The limit of detection (LOD) and limit of quantitation (LOQ) for total hexanes were 0.003 and 0.01 milligrams (mg) per sample, respectively. Based on an average sample volume of 35 liters (L), the minimum detectable concentration (MDC) and the minimum quanti-fiable concentration (MQC) were 0.09 milligrams per cubic meter of air (mg/m^3) (0.026 parts per million, [ppm]) and 0.29 mg/m^3 (0.08 ppm), respectively. The LOD and LOQ for n-hexane were 0.0003 mg and 0.001 mg per sample, respectively. Based on an average sampling volume of 35 L, these translate into an MDC of 0.0086 mg/m^3 (0.0024 ppm) and an MQC of 0.029 mg/m^3 (0.008 ppm). Both benzene and toluene had the same LOD and LOQ: 0.0004 and 0.001 mg per sample, respectively. Using an average sample volume of 35 L sets the MDC and MQC for benzene at 0.0114 mg/m^3 (0.0032 ppm) and 0.029 mg/m^3 (0.009 ppm), respectively. Likewise, the MDC and MQC for toluene were 0.0114 mg/m^3 (0.003 ppm) and 0.029 mg/m^3 (0.008 ppm), respectively.

The sampling trains for PBZ samples were placed so that the charcoal tube rested in the lapel area on either the right or left side of the worker's breathing zone. The work day for each drywall hanging crew ranged from 6 to 9 hours, including a break for lunch. If workers left the work site during a break, the sampling train was removed and the pump paused until their return. Only the actual sampling time was used to calculate the exposure data.

Medical

The number of drywall hangers working for Superior varies according to workload. At the time of the visit, there were 10 hangers, all of whom were interviewed by the NIOSH physician. OSHA logs from 1997 and 1998 were also reviewed. Medical records were reviewed for one worker.

EVALUATION CRITERIA

Occupational Exposure Limits

As a guide to the evaluation of the hazards posed by workplace exposures, NIOSH field staff employ environmental evaluation criteria for the assessment of a number of chemical and physical agents. These criteria are intended to 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 is, however, important to note 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). In addition, 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 level set by the criterion. 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 increases 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 Recommended Exposure Limits (RELs), (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®), and (3) the U.S. Department of Labor, OSHA Permissible Exposure Limits (PELs).[5,6,7] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criterion.

OSHA requires an employer to furnish employees a place of employment that is free from recognized hazards that are causing or are likely to cause death or serious physical harm.[8] Thus, employers should understand that not all hazardous chemicals have specific OSHA exposure limits such as PELs and short-term exposure limits (STELs). An employer is still required by OSHA to protect their employees from hazards, even in the absence of a specific OSHA PEL.

A time-weighted average (TWA) exposure refers to the average airborne concentration of a substance during a normal 8- to 10-hour workday. Some substances have recommended STELs or ceiling values which are intended to supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

Solvents

The term "solvent" applies to any substance that dissolves another substance, yielding a solution. Solvents can be water-based (aqueous) or hydrocarbon-based (organic). Most industrial solvents are organic, and are used for tasks such as cleaning, degreasing, thinning, and extraction. Solvents are classified into functional groups according to their chemical structure. The basic types of hydrocarbons are aliphatic (linear or branch chained), alicyclic (having both aliphatic and ring structures), and aromatic (includes a benzene ring in its structure).[9] According to the MSDS, the solvents in DSA-20 are composed primarily of aliphatic hydrocarbons.

Inhalation is a main route of exposure to organic solvents in industrial settings because they are generally volatile liquids. Absorption through the skin depends upon the degree of skin contact and the lipid and water solubility of the solvent.[9] Almost all organic solvents cause irritation of the skin because they dissolve fat or lipids, and thus cause skin dryness. Very few solvents cause allergic contact dermatitis. In addition, any organic solvent can irritate the respiratory system to some degree; this irritation often involves the upper airways, mucous membranes, and eyes.[9]

Acute central nervous system (CNS) effects include dizziness, lightheadedness, headache, nausea and vomiting, euphoria, irritability, depression, disorientation, and confusion similar to the effects of alcohol intoxication.[9] This can lead to coma and death in cases of severe exposures. Potential health effects related to chronic solvent exposure are not as clearly documented. Chronic solvent exposure has been reported to lead to toxic encephalopathy, which presents as chronic fatigue, irritability, depression, headaches, poor concentration, and memory loss.[10]

Certain solvents, such as n-hexane, methyl-n-butyl ketone (MnBK), and carbon disulfide, can also affect the peripheral nervous system (PNS). MnBK and n-hexane are both metabolized to 2,5-hexanedione, which is responsible for the neuropathy.[10] There are many causes of peripheral neuropathy -- a partial list includes inflammatory disorders, metabolic disorders, alcohol abuse, hereditary conditions, vascular conditions, and occupational and environmental exposure to neurotoxic agents.[11,12,13] One half to two thirds of all polyneuropathies are idiopathic despite a thorough evaluation, therefore, the absence of an alternate cause does not necessarily implicate a toxicant.[14]

Hexanes

Hexane is an aliphatic alkane, C-6 hydrocarbon that, in its commercial form, is commonly found as a mixture of hexane, cyclopentane, pentane,

cyclohexane, and heptane.[15] The commercial grades are commonly used as solvents for many different products such as adhesives, vegetable oils, and paints. Many industrial hexacarbon solvents such as n-hexane were thought to have little potential hazard.[16] Vapor concentrations of many hundreds of parts per million (ppm) can be tolerated for several minutes without significant health effects among the workers.[16,17,18] Case studies have reported that chronic exposures have been associated with sensorimotor or motor polyneuropathies.[19,20]

NIOSH currently has an REL of 50 ppm TWA for n-hexane, and 100 ppm TWA and 510 ppm ceiling for total hexane isomers.[5] Similarly, the ACGIH lists a TLV of 50 ppm TWA for n-hexane, and 500 ppm TWA for hexane isomers.[6] The OSHA PEL is 500 ppm TWA for n-hexane; no STEL or ceiling value is given.[7] Both the TLV and the PEL have a skin notation, indicating that dermal exposure can occur.

Benzene

Benzene is an aromatic organic hydrocarbon containing a six-carbon ring with alternating double bonds. Benzene was formerly a more widely used solvent, especially in the rubber and surface coating industries. Now it is rarely used as a solvent because of its toxicity. It is, however, present in gasoline and as a contaminant in other petroleum solvents.[20]

Benzene is classified by the International Agency for Research on Cancer (IARC) as a known human carcinogen and has been associated with irreversible bone marrow injury, including aplastic anemia and leukemia in humans.[19,20,21] NIOSH classifies benzene as a human carcinogen, and recommends that occupational exposures be controlled to prevent employees from being exposed to concentrations greater than 0.1 ppm, determined as a TWA concentration for up to a 10-hour work shift in a 40-hour work week. NIOSH further recommends a 15-minute STEL of 1.0 ppm. Although NIOSH has established these guidelines, which should not be exceeded, the Institute still urges that exposures be reduced to the lowest feasible concentration. The OSHA PEL is 1 ppm for an 8-hour TWA, with a 15-minute STEL of 5 ppm.[22] The current ACGIH TLV is 0.5 ppm; ACGIH lists benzene as a confirmed human carcinogen.[6]

Toluene

Toluene is a highly flammable, volatile liquid. Approximately 7-10% of the total amount of toluene produced in the U.S. each year is used in products such as paints, oils, adhesives, resins, inks, and detergents, and the other 90% is used to formulate gasoline.[20,23] It is a component of cigarette smoke, and is commonly intentionally inhaled to produce euphoria. Acute CNS effects from over exposure to toluene are the same as those described above. Chronic CNS effects may include ataxia, tremors, visual impairment, deafness, and neurobehavioral abnormalities.[23] The NIOSH REL for toluene is 100 ppm for an 8-hour TWA.[5] NIOSH has also set a recommended STEL of 150 ppm for a 15-minute sampling period. The OSHA PEL for toluene is 200 ppm for an 8-hour TWA.[7] The recently adopted ACGIH TLV of 50 ppm for an 8-hour exposure level was set primarily to prevent CNS depression.[20] The TLV carries a skin notation, indicating that cutaneous exposure contributes to the overall dose and may cause systemic effects.

Solvent Mixtures

When different components in a vapor exposure exert a toxicologic effect on the same organ or organ system, it is appropriate to determine the occupational exposure limit of the mixture. In the general case where the airborne concentration of each component is known, the basic formula for the TLV of the mixture is $C_1/T_1 + C_2/T_2 + ... + C_n/T_n = 1$ where C_n is the measured concentration of a component and T_n is the exposure limit value [REL, PEL, TLV, etc.] for that component. This creates a unitless proportion that serves as the exposure limit for the mixture. If the result of this addition exceeds unity (1), then the exposure limit for the mixture should be considered to be exceeded.[6] Because toluene, n-hexane, and the other hexane isomers included in "total hexanes" do in fact have similar central nervous system effects, considering their additive effects should be given primary consideration over their

individual effects. There is no PEL for "total hexanes," so only the toluene and n-hexane values are used in calculating the "mixture PEL." Therefore, the "mixture PEL" calculation will underestimate exposure to this mixture.

RESULTS AND DISCUSSION

Superior Drywall is classified within standard industrial code 1742, "Plastering, Drywall, Acoustical, and Insulation Work". According to the Bureau of Labor Statistics (BLS) annual "Occupational injury and illness rate by industry" report, contractors in this category have an elevated injury and illness rate when compared to all construction trades. The injury and illness rate for these contractors in 1996 was 10.4 per 100 full- time workers, compared to a rate of 9.9 for all construction.[24] It has been hypothesized that the increased injury and illness rate for the entire construction industry is related to exposure to physical and chemical agents found on construction sites. It has also been reported that construction environments have a greater potential for exposure to selected chemical agents such as hazardous solvents.[25,26]

Industrial Hygiene

Air Sampling

Results are shown in Table 1 for exposure to individual solvents, and in Table 2 for exposure to mixed solvents. PBZ samples were obtained for three drywall hangers. For the fourth hanger (Hanger #3), an area sampler was kept nearby, and was moved when the hanger moved. Each sample result listed in Table 1 is the product of two short-term samples (a morning sample and an afternoon sample). The sampling period was divided to assure that the charcoal tubes did not become saturated and so that break-through would not occur. Table 1 results were calculated by: average concentration = $(C_1T_1+C_2T_2)/(T_1+T_2)$, where C_1 and C_2 are the concentrations occurring during the sampling intervals T_1 and T_2. This average concentration is the time-weighted average over the total time sampled for that particular day, and is not an 8-hour TWA. Drywall hangers are paid on a piece rate and may occasionally hang drywall for up to eight hours, but they did not during this HHE. Their actual daily work time is variable through any given week, therefore the exposure data in Table 1 are listed as the average exposure for the day and are not adjusted to reflect an 8-hour work time. If this were done, and it was assumed that worker exposure was "0" for the remainder of the 8-hour day after they were actually finished working, the resulting concentrations would be even lower.

PBZ results for combined exposures [Table 2] ranged from about 20-80% of the "mixture REL," 20-70% of the "mixture TLV," and 2-7% of the "mixture PEL." When using the REL, the mixture exposure calculation did reach unity for an area sample in the hall bathroom; workers spent less than one hour working in this area. Exceeding unity in this case reflects the total hexane REL, which is lower than the total hexane TLV. This indicates that if workers worked in poorly ventilated areas for a longer portion of the day, their overall exposure would likely be higher than observed during the HHE.

All personal exposures for individual contaminants were below relevant occupational exposure criteria. The highest full-shift concentration was measured by an area sample in the hall bathroom, a small, enclosed area with poor ventilation. The lowest vapor concentrations both days were the PBZ samples collected on the drywall hangers. All PBZ samples were at least one order of magnitude below their respective PEL. With the exception of two area samples, one collected in the glue box, collected on May 20, all benzene measurements were two or more orders of magnitude below the most conservative exposure criterion. Specifically, n-hexane concentrations ranged between 9.1 and 37.5 ppm on both days, excluding the glue box sample. Also, "total hexanes" ranged from 3 to 25.3 ppm, and toluene ranged from 0.009 to 0.3 ppm, both excluding the glue box sample. For those calculations in which one of the two samples [either the morning or the afternoon sample] had no detectable analyte, the MDC was used. For those calculations in which one of the samples had a "trace" concentration, the

MQC was used in determining the average concentration.

Residual adhesive was visible inside each discarded adhesive tube. One short-term sample collected in the box used to store expended adhesive tubes demonstrated that solvent vapors continue to off-gas from the used tubes. The vapor concentrations measured in the box were 97 ppm for n-hexane, 46 ppm for "total hexanes," 0.4 ppm for toluene, and 0.02 for benzene. Because only one short-term sample was taken, it is unclear how long it takes for the residual glue in the used tubes to dry and stop off-gassing. These results from the glue box should not be treated as exposure data, but are useful to demonstrate what is perhaps an unanticipated source of air contamination.

Temperature and relative humidity (RH) measurements were taken with a Vaisala HM 34. On May 20, the indoor temperature was 70° F and the RH ranged from 46 to 51%. On May 21, the indoor temperature ranged from 68 to 71° F, while the RH ranged from 75 to 82%.

Medical

Of the 10 hangers interviewed, all were subcontractors and had been drywall hangers from 1 month to 22 years, with a median of 14.5 years. All reported having used drywall adhesive to assist in hanging drywall for as long as they had been doing the work. All but one worker reported generalized muscle and joint pain, including back pain, related to hanging drywall. Eight reported itchy, watery eyes at work related to dust, and four reported itchy, runny noses that they also related to dust in the work environment. One worker reported gastrointestinal and a number of other nonspecific symptoms, for which he had several medical evaluations that he reported had identified no specific cause. Review of medical records for this individual revealed an extensive work-up, but the findings were not consistent with an occupational etiology. None of the other workers had sought medical care for work-related illness or injury. Review of the OSHA 200 logs documented several acute injuries such as sprains and strains, but there was no documentation of solvent related health effects.

CONCLUSIONS AND RECOMMENDATIONS

There were no over exposures of drywall hangers to organic solvents during this HHE and no evidence of solvent-related health effects. PBZ and full-shift area samples for toluene, n-hexane, benzene, and "total hexanes" were all below relevant occupational exposure limits. In addition, in all PBZ samples the combined solvent exposure was below unity. A short-term sample taken in the box used documented that the "empty" adhesive tubes continue to off-gas solvents after they are used. This may contribute to the ambient solvent levels, as does the adhesive applied during drywall installation.

Workers reported acute irritative symptoms related to dust and musculoskeletal symptoms related to physical exertion, but there was no evidence that workers were experiencing adverse health effects secondary to occupational solvent exposure.

The OSHA Hazard Communication standard requires that the hazards of chemicals imported by an employer be communicated to the employees.[27] For multi-employer workplaces, for example, where employees of a construction subcontractor may encounter chemicals in products provided by the lead contractor, the written program must include a description of the means by which this information is transmitted to the employees of these other subcontractors. At a minimum, the program should include a system of labeling chemicals like adhesives, providing MSDS, training employees about the potential hazards of such chemicals, and about precautionary measures they can take to protect themselves. Such a program should be implemented by Superior Drywall. This program should be used for Superior employees and could be used by any subcontracting companies hired by Superior to train their own employees.

Based on the conditions witnessed during this evaluation, it is unlikely for hangers to be over exposed during normal work activities. Nonetheless, exposure to solvent vapors can be

minimized through the following recommendations:

- Implement an effective Hazard Communication program.
- Minimize the amount of time spent in small, poorly ventilated areas like the hall bathroom or closets, while adhesive is drying.
- Remove empty tubes from the work area and store them outside until they can be disposed.
- Continue to work with windows and exterior doors open when possible, to facilitate general ventilation.
- Consider switching from a volatile, organic solvent-based adhesive to a water-based one.

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Table 1 - Personal and Area Air Sampling Results for Adhesive Solvents
Superior Drywall, Inc.
Millsboro, Delaware
HETA 99-0163-2771
May 19-20, 1999

Sample location	total sample time (min)	n-hexane [ppm]	total hexanes* [ppm]	toluene [ppm]	benzene [ppm]
May 19, 1999					
hanger #1	298	9.1	3	0.013	nd
hanger #2	312	25.8	10.4	0.098	trace
area, for hanger #3	295	9.4	2.6	0.009	nd
hanger #4	320	27.7	9.5	0.115	trace
open window	319	25.5	7.7	0.108	trace
bedroom ceiling	319	35.4	11.8	0.151	trace
May 20, 1999					
hanger #1	354	11.9	4.1	0.03	nd
hanger #2	350	12.7	5.2	0.119	trace
area, for hanger #3	350	18.6	7.0	0.060	trace
hanger #4	353	22.3	8.7	0.086	trace
above fireplace	413	18.1	6.9	0.073	trace
hall bathroom	438	37.5	25.3	0.3	0.016
glue box	83	97	46	0.4	0.02
Evaluation Criteria **(ppm)**	**NIOSH REL** **ACGIH TLV** **OSHA PEL**	50 50 500	100 500 none	100 50 200	0.1 0.5 1

all vapor concentrations given above are the average concentration for the total time sampled
mdc = "minimum detectable concentration"; calculated by dividing the analytical limit of detection by the average volume of air sampled for a particular sample set, in this case 35L.
mqc = "mimimum quantifiable concentration"; calculated by dividing the analytical limit of quantification by the average volume of air sampled for a particular sample set, in this case 35L.
nd = "not detected"; analyte concentration calculated to fall below the MDC
trace = analyte concentration calculated to fall between the MDC and the MQC
** = exludes n-hexane and benzene*

Table 2 - Combined Exposures to Airborne Adhesive Solvents
Superior Drywall, Inc.
Millsboro, Delaware
HETA 99-0163-2771
May 19-20, 1999

Combined exposure limit not to exceed '1'*			
May 19, 1999			
	mixture REL	***mixture TLV***	***mixture PEL***
hanger #1	0.21	0.19	0.02
hanger #2	0.62	0.54	0.05
area, for hanger #3	0.21	0.19	0.02
hanger #4	0.65	0.57	0.06
open window	0.63	0.57	0.06
BR ceiling	0.83	0.73	0.07
May 20, 1999			
hanger #1	0.28	0.25	0.02
hanger #2	0.8	0.7	0.07
area, for hanger #3	0.44	0.39	0.04
hanger #4	0.53	0.46	0.04
above fireplace	0.43	0.38	0.04
hall bathroom	1	0.81	0.08
in glue box	2.4	2.04	0.2
Toxicant	***REL [ppm]***	***TLV [ppm]***	***PEL [ppm]***
toluene	**100**	**50**	**200**
n-hexane	**50**	**50**	**500**
total hexanes	**100**	**500**	**none**

**In the general case where the airborne concentration of each component is known, the basic formula is $C_1/T_1 + C_2/T_2 + ... + C_n/T_n = 1$ where C_n is the measured concentration of a component and T_n is the exposure limit value [REL, PEL, TLV, etc] for that component. If the result of this addition exceeds unity, then the threshold limit of the mixture should be considered to be exceeded. Because toluene, n-hexane, and the other hexane isomers included in "total hexanes" do in fact have similar toxicologic effects, considering their additive effects should be given primary consideration over their individual effects.*

For Information on Other
Occupational Safety and Health Concerns

Call NIOSH at:
1–800–35–NIOSH (356–4674)
or visit the NIOSH Website at:
www.cdc.gov/niosh

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