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## SUMMARY

On April 9, 1993, the National Institute for Occupational Safety and Health (NIOSH) was requested to conduct a health hazard evaluation (HHE) during the renovation of an antique residence in Atlanta, Georgia. The HHE, requested by the owner of a wood flooring and restoration company, asked NIOSH to assess potential exposures during the use of an experimental solvent to remove paint from the floor of the building undergoing renovation. Although the purpose of the renovation project was to refinish the wood floor, analysis of a paint sample from the room undergoing renovation indicated the paint contained lead. Therefore, the HHE also included an evaluation of exposure to lead.

On June 3, 1993, a NIOSH investigator met with the requestor to obtain information about the solvent stripper application process, the facility undergoing renovation, and the amount of lead potentially present in the paint. On November 27 and December 14, 1993, both personal breathing zone and area air sampling was conducted for lead, n-methyl pyrrolidinone ([NMP] the primary component of the experimental solvent), and formic acid, during the use of the experimental solvent. Bulk samples of the solvent and paint samples from the floor were also obtained, and wipe sampling was conducted to assess surface lead dust contamination.

The results of the air sampling showed that personal exposure to NMP averaged 3.3 parts per million (ppm) on November 22, and 4.0 ppm on December 14. There is currently no NIOSH Recommended Exposure Limit (REL) or Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) for airborne exposure to NMP. Area samples for NMP, collected in the room where the paint stripping activity took place, averaged 3.6 and 3.9 ppm (two sampling locations) on November 22, and 7.7 ppm on December 14. Personal exposure to formic acid averaged 1.4 ppm on November 22, and 2.5 ppm on December 14. Because formic acid was detected on the backup sections of the field samples in amounts exceeding 5% of the total sample, these results should be considered minimum concentrations. The NIOSH REL and OSHA PEL for formic acid is 5 ppm as a full shift time-weighted average (TWA). Area sampling detected 2.3 ppm of formic acid on November 22, and 4.1 ppm on December 14. As with the personal formic acid samples, these results should be considered minimum concentrations.

No detectable lead was found in the personal breathing zone or area air samples. Wipe samples collected prior to the renovation process found a surface level of 158 micrograms per square foot ( $\mu\text{g}/\text{ft}^2$ ) from a section of baseboard, and an estimated 47  $\mu\text{g}/\text{ft}^2$  from a fireplace mantle in the room undergoing renovation. Although regulatory standards for surface samples have not been established, the Department of Housing and Urban Development (HUD) has recommended "interim" guidelines for lead dust levels of 200  $\mu\text{g}/\text{ft}^2$  (floor), 500  $\mu\text{g}/\text{ft}^2$  (window sills), and 800  $\mu\text{g}/\text{ft}^2$  (window wells). The HUD guideline is intended to be used as clearance criteria for lead abatement projects, and not as an occupational exposure guideline. Four paint chip samples from the floor of the room undergoing renovation indicated that the paint contained 0.19% - 0.28% lead. A paint sample obtained from the floor of the hallway outside the room undergoing renovation showed a lead concentration of 0.69%. Paint containing more than 0.5% lead by weight is currently defined as lead paint (Consumer Product Safety Commission, HUD).

A half-mask air-purifying respirator equipped with organic vapor cartridges was used by the floor refinisher during the paint stripping process. Protective gloves were used intermittently. There

was no mechanical ventilation used during the renovation.

Environmental sampling found detectable levels of n-methyl pyrrolidinone (NMP) during the passive refinishing process. The potential health hazard associated with these exposures, however, is not clear. Measured formic acid concentrations were below recommended levels, however, it is possible some sample loss occurred and that actual concentrations may have been higher than those measured. Although no measurements were taken, the characteristic odor associated with the paint stripper was detected in other areas of the residence soon after it was used. Exposures to these components is likely to vary depending on the area undergoing renovation. For this reason, as well as concern for other occupants of the building, additional precautions should be implemented to reduce potential exposures when conducting the passive refinishing process. At this residence, the presence of lead has been identified in an area outside the room undergoing renovation, and remedial action should be considered. Recommendations for controlling exposures to the paint stripper, as well as lead remediation, are provided in the Recommendation section of this report.

**KEYWORDS:** SIC 1752 (Floor Laying and Other Floor Work, Not Elsewhere Classified); n-methyl pyrrolidinone, formic acid, lead, floor refinishing and restoration, paint removal.

## **INTRODUCTION**

NIOSH received a management request on April 9, 1993, to evaluate the health hazards associated with using an experimental paint stripper to renovate wood floors. The requestor had previously used this paint stripper on a trial basis, and was concerned that exposure to solvent vapors during use may present a health hazard. The requestor subsequently asked NIOSH to evaluate exposures to the volatile components of the paint stripper, and recommend additional control measures if necessary, prior to increasing the use of this material in the wood floor renovation process. As the floor undergoing renovation contained lead-based paint, the request also asked NIOSH to evaluate the potential for exposure to lead-containing dust.

On November 22 and December 14, 1993, NIOSH conducted surveys at an antique residence undergoing renovation where the experimental paint stripper was used. Personal and area air samples were collected, as well as bulk samples of the paint stripper, and paint chips. Work practices and personal protective equipment use were reviewed. An interim report describing preliminary findings, recommendations, and future actions was sent to the requestor on January 13, 1994.

## **BACKGROUND/PROCESS DESCRIPTION**

The paint stripping activity is referred to as "passive refinishing", and entails applying a thick layer of the solvent mixture (full strength) to the floor from a 2-quart open container with a brush. The paint stripping is conducted on an incremental basis with each treatment area consisting of approximately 75 square feet (ft<sup>2</sup>). The solvent is allowed to stay in contact with the floor for 30-60 minute. A powered electric buffer with bristle attachments is then used to agitate the treated area to dislodge the loosened paint. A rubber squeegee is used to remove the majority of the spent solvent/paint mixture which is then mixed with sawdust and placed in bags for disposal. Sawdust is then applied over the treated area, scrubbed with a wire brush, and removed with a putty knife. Following this, a small amount (100-200 milliliters) of a 1:5 isopropyl alcohol:water mixture is sprayed over the treated area, and additional sawdust is applied. The electric buffer with an abrasive disc attachment is then used to scour this area. Depending on the type of paint being removed, the process may need to be repeated over the same area. The "passive refinishing" process is considered to be more suitable for restoration of wood floors because it is faster, ensures uniform removal of paint, and is less dusty than sanding or other mechanical removal methods.

According to the manufacturer (National Brands, Inc.), the experimental paint stripper (Experimental Solvent System Formula MPB) contains 65-79% n-methyl pyrrolidinone (NMP), 5-10% formic acid, 15-20% propylene carbonate, and 1-5% ethyl 3-ethoxypropionate. The solvent mixture is a viscous (similar to molasses) amber liquid with a pH of 2-3 and a vapor pressure of 5-6 mm Hg (20° C). Based on the relative proportion of the individual components of the solvent mixture, and the potential for generating airborne contaminants, air sampling was conducted for NMP and formic acid.

The industrial hygiene evaluation of this activity was conducted at an occupied antique (1882 construction) residence in Atlanta, Georgia. The floor of an upstairs room (~500 ft<sup>2</sup>, one door, one outside window) was being renovated using the passive refinishing process. The floor was constructed of aged yellow pine, and contained 4-6 layers of paint that had been applied over the years. Prior to the NIOSH survey, a single sample of paint chips, collected by the requestor from the floor of this room, was analyzed and found to contain 1.5% lead by weight. Although the

paint was found to contain lead, the purpose of the work was to refinish the wood floor, and not lead abatement. All work was conducted by the company owner. Other areas of the residence were being renovated by the tenant.

### **EVALUATION PROCEDURES**

The NIOSH investigation consisted of the following elements:

1. A process review to identify all chemicals and contaminant sources, and environmental air monitoring to assess worker exposure to the following contaminants during the floor refinishing process:
  - ! n-methyl pyrrolidinone (NMP)
  - ! formic acid
  - ! lead
2. Analysis of a bulk sample of the experimental solvent mixture to verify components. Collection and analysis of paint chips obtained from the floor of the room undergoing renovation to assess for the presence of lead.
3. Surface monitoring to determine surface (removable) lead dust contamination levels in the room prior to beginning restoration activities.
4. An assessment of work practices followed during the floor renovation process, and personal protective equipment (PPE) used.

### **Air Sampling**

On November 22 and December 14, 1993, environmental monitoring was conducted to assess airborne personal exposures to various compounds used during the floor renovation process. The monitoring was conducted using established analytical protocols (NIOSH analytical methods) as well as methods developed specifically for the compounds suspected to be present.<sup>1</sup> Calibrated air sampling pumps were placed on the belt of the worker and connected, via tubing, to sample collection media placed in the worker's breathing zone. Monitoring was conducted throughout the duration of the activity. After sample collection, the pumps were post-calibrated and the samples submitted to the NIOSH laboratory or the NIOSH contract laboratory (Data Chem, Salt Lake City, UT) for analysis. Field blanks were submitted with the samples. Specific sampling and analytical methods used during this survey were as follows:

#### **NMP**

Integrated air samples for NMP were collected using constant-volume SKC model 223 low-flow sampling pumps. Nominal flow rates of 200 cubic centimeters per minute (cc/min) were used to collect the samples. Sample media was changed approximately every 50 minutes to obtain a collection volume of 10 liters per sample. The pumps are equipped with a pump stroke counter and the number of strokes necessary to displace a known volume of air was determined during calibration. This information was used to calculate the air per pump-stroke "K" factor. The pump stroke count was recorded before and after sampling and the difference used to calculate the total volume of air sampled. Standard charcoal tubes (100 milligrams front section/50 milligrams backup) were used as the collection media. NIOSH has not developed a sampling

and analytical method for NMP. The method used was developed by the Occupational Safety and Health Administration (OSHA stop-gap method M139).

#### Formic Acid

Integrated air samples for formic acid were obtained using SKC low-flow constant-volume pumps. A nominal flow rate of 200 cc/min was used for sample collection. A combination of analytical methods was used for the collection and analysis of formic acid. The samples were collected on a washed silica-gel (400 milligrams front section/200 milligrams backup) sorbent tube (Supelco ORBO® 53) according to NIOSH method 7903 (inorganic acids) and analyzed according to NIOSH method S173 (formic acid). The washed silica-gel (NIOSH method 7903) was used in place of the Chromosorb 103 required by NIOSH method S173 (formic acid).<sup>1</sup>

#### Lead

Air sampling for lead dust was conducted using Gilian HFS 513A sampling pumps with a flow rate of approximately 2 l/m. The samples were collected on 0.8 µm pore size mixed cellulose ester (MCE) filters and analyzed according to NIOSH method 7082.

### **Surface Sampling**

Surface wipe samples were collected to determine the extent of removable lead dust in the room prior to beginning the renovation process. These samples were collected with Wash & Dri pre-moistened towlettes. 100 square centimeters (cm<sup>2</sup>) of surface area, determined with a template, were sampled with each towlette. After collecting the samples, the towlettes were placed in individually labeled plastic bags and submitted, with blanks, to the NIOSH contract laboratory for analysis. The sampling was conducted according to the surface sampling protocol described in the Occupational Safety and Health Administration (OSHA) Industrial Hygiene Technical Manual, and NIOSH method 0700 (Draft), Lead in Surface Wipe Samples.<sup>2</sup>

## **EVALUATION CRITERIA**

### **General**

As a guide to the evaluation of the hazards posed by work place 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 if their exposures are below the applicable limit. A small percentage may experience adverse health effects due to individual susceptibility, pre-existing medical conditions, and/or hypersensitivity (allergy).

Some hazardous substances or physical agents may act in combination with other work place exposures or the general environment to produce health effects even if the occupational exposures are controlled at the applicable limit. Due to recognition of these factors, and as new information on toxic effects of an agent becomes available, these evaluation criteria may change.

The primary sources of environmental evaluation criteria for the work place are: 1) NIOSH Criteria Documents and recommendations, 2) the American Conference of Governmental

Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs), and 3) the U.S. Department of Labor Occupational Safety and Health Administration (OSHA) standards.<sup>(3-5)</sup> Often, NIOSH recommendations and ACGIH TLVs may be different than the corresponding OSHA standard. Both NIOSH recommendations and ACGIH TLVs are usually based on more recent information than OSHA standards due to the lengthy process involved with promulgating federal regulations. OSHA standards also may be required to consider the feasibility of controlling exposures in various industries where the hazardous agents are found; the NIOSH Recommended Exposure Limits (RELs), by contrast, are based primarily on concerns relating to the prevention of occupational disease.

### **N-methyl pyrrolidinone (NMP)**

NMP, classified as a cyclic amide with a mild amine odor, is miscible in water, combustible, and has a relatively low vapor pressure of 0.334 mm Hg at 25° C.<sup>6,7</sup> Exposure to NMP may produce mild skin irritation and severe eye irritation on contact. Inhalation studies with laboratory animals showed that rats exposed to a concentration of 1 milligram per liter (246 parts per million [ppm]) for 6 hours a day for four weeks experienced lethargy, difficulty breathing, and increased mortality.<sup>8</sup> No carcinogenic effects were observed in a 2-year study of exposed rats.<sup>8</sup> There is little data available on the effects of exposure on humans, and occupational exposure data is also lacking. However, one investigation in the semiconductor industry reported that workers exposed to NMP experienced severe eye irritation and headaches at concentrations as low as 0.7 ppm for periods as short as 30 minutes.<sup>9</sup> Based on these findings, the investigators recommended controlling worker exposure to NMP to less than 0.1 ppm.

Occupational exposure standards have not been established for NMP. There is currently no Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) or NIOSH REL for airborne exposure to NMP. Previously, the ACGIH had proposed a TLV of 100 ppm for NMP.<sup>10</sup> The proposal, however, was dropped, apparently because the vapor pressure of NMP was so low, it was felt the proposed TLV could not be exceeded.<sup>11</sup>

### **Formic Acid**

Formic acid is a colorless liquid with a pungent, penetrating odor. Exposure to formic acid vapor can cause severe irritation of the eyes, mucous membranes, and skin.<sup>6,12,13</sup> Exposure can result in lacrimation, nasal discharge, throat irritation, and cough. Skin contact with concentrated solutions causes severe irritation and blistering.<sup>13</sup> The OSHA PEL, ACGIH TLV, and NIOSH REL for formic acid vapor are all 5 ppm as a full shift time-weighted average.<sup>3,5,12</sup> The ACGIH has also set a 15 minute Short Term Exposure Limit (STEL) of 10 ppm for formic acid.<sup>12</sup>

### **Lead**

Lead is a bluish-gray heavy metal with no characteristic taste or smell. Although lead is a naturally occurring element, most exposures to lead occur from human activities.<sup>14</sup> Lead was a major ingredient in house paint for years prior to 1950, at which time other pigment materials became more popular, although lead-based paint was still used.<sup>15</sup> In 1973, the Consumer Product Safety Commission established a maximum lead content in paint of 0.5% by weight for household paint, and further lowered the allowable level to 0.06% in 1978. The definition of lead-based paint is currently 0.5% by weight, or 1.0 milligram per square centimeter, and it is estimated that some 42 million homes contain lead-based paint.<sup>15</sup> Activities involving abatement of lead-based paint have been increasing in recent years, and have received regulatory attention.

Guidelines have been established for assessing and removing lead-based paint, and more specific requirements, such as training of personnel in the lead-removal industry, have been established by some states (Maryland and Massachusetts), and are likely to be promulgated at the federal level.<sup>15</sup>

Lead can enter the body by inhalation or ingestion and can adversely affect numerous body systems. Skin absorption does not occur except for certain organo-lead compounds such as tetraethyl lead. Inhalation is considered to be the most important occupational exposure route. Lead is a systemic poison that serves no useful function after absorption in the body; health consequences can occur after periods of exposure as short as days or as long as several years.<sup>16</sup> Once absorbed, lead is excreted from the body very slowly. Absorbed lead can damage the kidneys, peripheral and central nervous systems, and the blood forming organs (bone marrow).<sup>6,12,14</sup> These effects may be felt as weakness, tiredness, irritability, digestive disturbances, high blood pressure, mental deficiency, or slowed reaction times. Damage to the central nervous system in general, and the brain (encephalopathy) in particular, is one of the most severe forms of lead poisoning.<sup>6,16</sup> Chronic lead exposure is associated with infertility and with fetal damage in pregnant women.<sup>6,14</sup> Although the hazards of lead have been known for some time, occupational exposure to lead is still a significant problem in some industries. In 1990, NIOSH established a national goal to eliminate worker exposures resulting in blood-lead concentrations greater than 25 micrograms per deciliter ( $\mu\text{g}/\text{dl}$ ).<sup>17</sup> The current NIOSH REL for lead is 100 micrograms per cubic meter of air ( $\mu\text{g}/\text{m}^3$ ).<sup>3</sup> However, NIOSH is currently re-evaluating this REL.

The Occupational Safety and Health Administration (OSHA) has established a comprehensive regulation for lead that applies to both general industry and, due to a recent amendment, to construction. The standard establishes a PEL of  $50 \mu\text{g}/\text{m}^3$ , and an action level of  $30 \mu\text{g}/\text{m}^3$ .<sup>16,18</sup> The action level is the level at which an employer must begin certain compliance activities. One of the most significant requirements is to provide medical surveillance that includes assessing blood-lead levels in exposed employees. Full medical surveillance is required for employees with blood-lead levels over  $40 \mu\text{g}/\text{dl}$ .

### Surface Sampling

Regulatory standards defining "acceptable" levels of surface contamination have not been established. However, wipe samples can provide information regarding the effectiveness of housekeeping practices, the potential for exposure to contaminants from other exposure routes (e.g., surface contamination on a table that is also used for food consumption), the potential for contamination of worker clothing and subsequent transport of the contaminant, and the potential for non-process related activities to generate airborne contaminants (e.g. sweeping).

Although regulatory standards have not been established, "interim" guidelines for lead in dust wipe samples have been developed by the Department of Housing and Urban Development (HUD).<sup>15</sup> The HUD criteria is intended to provide guidance for determining acceptable clearance levels in residential dwellings, and not for the evaluation of potential occupational exposures. The "interim" guidelines established by HUD are as follows:

|                 |  |
|-----------------|--|
| ! Floors:       | 200 micrograms per square foot ( $\mu\text{g}/\text{ft}^2$ ) |
| ! Window Sills: | 500 $\mu\text{g}/\text{ft}^2$                                |
| ! Window Wells: | 800 $\mu\text{g}/\text{ft}^2$                                |

## **RESULTS AND DISCUSSION**

### **Air Sampling**

The results of the air sampling for NMP and formic acid are depicted in Tables 1 and 2. These results show that on November 22, personal exposure to NMP ranged from 1.4 - 5.2 ppm, with a cumulative average of 3.3 ppm for the duration of the monitoring. Area samples obtained at the window sill (~2 feet off of the floor) and the fireplace mantle (~5 feet off of the floor), detected similar concentrations. The relatively higher levels were detected during sampling periods where a coat of paint stripper was applied. The lowest concentrations were detected when the room window was opened and no paint stripper was applied. Approximately 1.5 gallons of stripper were used on November 22. Personal exposure to formic acid on November 22 was 1.4 ppm, and an area sample obtained from the window sill showed a concentration of 2.3 ppm. The formic acid results should be considered *minimum concentrations* because formic acid was detected on the backup sections of the field samples in amounts exceeding 5% of the total sample. It is not known whether formic acid migrated to the backup section after sample collection or because of front section overloading during sampling. Because of this uncertainty regarding potential sample loss, the formic acid results should only be considered semi-quantitative.

Personal breathing zone and area sampling conducted on the afternoon of December 14 in the same room showed higher concentrations of both NMP and formic acid than those detected on November 22. This was not a surprising result as the window was kept closed for the duration of the floor stripping process due to inclement weather (rain), and the room door was also kept closed in an attempt to contain solvent emissions within the room and reduce migration to other areas of the house. Personal exposure to NMP and formic acid on December 14 was 4.0 ppm (range = 3.1 - 5.2 ppm) and 2.5 ppm respectively. Area samples collected at the window sill showed an average NMP concentration of 7.7 ppm (range = 6.0 - 9.3 ppm), and a formic acid concentration of 4.1 ppm for the duration of the stripping activity. As previously noted, the formic acid concentrations should be considered to be semi-quantitative only, and minimum concentrations.

Although sampling for airborne lead was conducted, the potential for generating substantial airborne particulate levels during the passive refinishing process is low. This is because the solvent binds the removed material, and appears to contain the sawdust added during the use of the buffing machine. Two air samples for lead (personal and area) collected on November 22 showed that concentrations were below the analytical limit of detection (less than 4  $\mu\text{g}/\text{m}^3$ ).

### **Bulk Samples**

Three bulk paint chip samples were obtained from the room undergoing renovation by scraping a 4 square inch area of floor to remove all paint layers down to the bare wood. Samples were obtained from randomly (adjacent fireplace, center, adjacent door) selected areas in the room. One sample was also collected from the hallway at the top of the stairwell outside this room. The results are shown in the following table:

| <b>Sample #</b> | <b>Location</b>                 | <b>% Lead by Weight</b> |
|-----------------|---------------------------------|-------------------------|
| Bulk 1          | SW corner of room adjacent door | 0.28                    |

|        |                                      |      |
|--------|--------------------------------------|------|
| Bulk 3 | NE corner of room adjacent fireplace | 0.19 |
| Bulk 4 | Center of room                       | 0.24 |
| Bulk 6 | Outside Room in stairwell hall       | 0.68 |

As shown in the above table, the percentage of lead in the paint samples collected inside the room undergoing renovation is below the 0.5% HUD definition of lead-based paint. However, the paint sample collected outside this room (0.63%) exceeds the 0.5% criteria. All samples were below the 1.5% lead concentration that was found in a paint sample previously collected and analyzed by the HHE requestor.

Analysis of the bulk solvent stripper confirmed the presence of the major components as listed in the product Material Safety Data Sheet (NMP, propylene carbonate). Formic acid could not be identified because the analytical methodology used (liquid chromatography/mass spectrometry) would not detect this compound.

### Surface Sampling

Two surface wipe samples in the room undergoing renovation were collected prior to beginning the floor refinishing process. 100 cm<sup>2</sup> (0.1076 square feet) areas were sampled from a section of baseboard underneath the window, and the top of the fireplace mantle. Seventeen micrograms of lead were detected on the baseboard sample, which, for comparison with the HUD criteria, equates to 158 µg/ft<sup>2</sup>. An estimated 5 micrograms of lead were detected on the sample collected from the top of the fireplace mantle, which equates to 47 µg/ft<sup>2</sup>. This result is considered an estimate as the amount of lead detected was between the analytical limit of detection (LOD = 2 micrograms) and the limit of quantification (LOQ = 6.4 micrograms).

### Personal Protective Equipment/Observations

During most of the treatment periods the floor refinisher wore a half-mask air-purifying respirator equipped with organic vapor cartridges and pre-filter (TC-23C-40). Inspection of this respirator indicated the inhalation and exhalation valves were in good condition, and the respirator appeared clean. The floor refinisher indicated that cartridges were changed upon detection of breakthrough (odor). Protective gloves were worn intermittently while using the stripper. The type of glove (i.e., polymer), however, was not determined.

The door leading to the room undergoing treatment was kept closed most of the time. The characteristic odor associated with the stripper was immediately noticeable (both in the room and in the stairwell directly outside the room) after the first application, and appeared to increase in intensity throughout the day (on both days sampled). On November 22, the window was kept closed due to outside weather conditions until approximately 1:30 PM, and the odor appeared to dissipate somewhat after it was opened. As previously noted, the window was kept closed (again due to weather conditions) all day on December 14.

### CONCLUSIONS

The health hazard associated with exposure to the measured levels of NMP is not clear, as only limited occupational exposure data is available, and exposure limits have not been established. One investigation, however, found that workers exposed to NMP at concentrations of less than 1 ppm experienced adverse health effects (eye irritation, headache). As previously discussed, the

formic acid results should be considered minimum concentrations as it is possible some sample loss occurred and that actual concentrations may have been higher than those measured.

The effect of passive ventilation (open window) in reducing concentrations of contaminants can be seen when the sampling conducted on November 22 is compared with the sample results of December 14. The NMP concentration detected on samples obtained before and after the window on was open on November 22 also show this reduction.

Although air monitoring was not conducted outside the room undergoing renovation, the characteristic odor associated with the paint stripper was detected in other areas of the residence soon after it was used. This occurred even when the door to the room was kept closed to try and contain any generated vapors. This type of work, therefore, is not only a concern from the standpoint of worker health and safety, but to other occupants of the residence undergoing renovation.

Although no measurable overexposure to the components of the paint stripper was identified, work conditions and practices will vary considerably depending on the building/area undergoing renovation. Therefore, exposures to these components are likely to vary. For this reason, as well as concern for other occupants of the building undergoing renovation, additional precautions should be implemented to reduce potential exposures when conducting the passive refinishing process.

Although lead abatement was not the intent of the renovation project, and no measurable exposures to lead were found, the presence of lead paint on surfaces undergoing renovation needs to be considered for all future work. Specific precautions and regulations must be followed when dealing with lead paint.

At this residence, the presence of lead has been identified in an area outside the room undergoing renovation, and remedial action should be considered. Although the extent of lead paint in the residence is unknown, conservative precautions (blood lead testing, comprehensive inspection) should be taken to ensure the occupants and their children are protected from potential lead hazards.

## **RECOMMENDATIONS**

### **Occupational**

1. To avoid solvent loss, and reduce the potential for generating vapors, all containers containing solvent should be kept closed whenever they are not in use. Excess stripper can be poured back into the original container, or the secondary container should be covered.
2. Provide as much ventilation as possible during treatment with the NMP-based stripper. This type of paint stripping is conducive to generating vapors (large open surface area covered with volatile solvent), and actions such as ensuring all windows are open, or providing auxiliary ventilation such as a powered fan to increase room exhaust, can help reduce the buildup of vapors within the room undergoing treatment. At this time, a specific air volume or ventilation rate cannot be provided as a target concentration (NIOSH REL, OSHA PEL, etc.) has not been defined. However, it is good industrial hygiene practice to maintain concentrations of atmospheric contaminants as low as practical. Providing auxiliary ventilation will help reduce vapors in the treatment area. Any additional ventilation

- provided should exhaust the room air directly outside.
3. Eye protection should be worn at all times when working with the paint stripper.
  4. The potential for encountering lead-containing paint should be evaluated for all future renovation work. Removal and renovation of surfaces containing lead-paint requires specific safeguards and protocols in order to reduce the potential for worker exposure, waste disposal, and prevention of contamination of the building undergoing renovation. Attending a training course on lead paint abatement (hazards, abatement techniques, regulations, etc.) is recommended. Information on courses can be obtained from the EPA Lead Hotline (1-800-LEAD-FYI), or the Georgia Tech Research Institute (404-894-3806). Note that recently introduced legislation (Georgia House Bill 1270, Georgia Lead Poisoning Prevention Act), will mandate training, licensing, and certification for workers performing lead hazard reduction activities.

### **Residential**

5. Precautions should be taken to prevent the residents of the home from being exposed to contaminants generated during paint stripping. Whenever possible, the residence should be vacated when work is underway, and the treated area isolated by keeping the door closed at all times. Auxiliary ventilation will also help in isolating the area.
6. After completion of the paint stripping project, wipe samples should be obtained to ensure lead dust levels are acceptable. The Department of Housing and Urban Development (HUD) guidelines for lead dust levels should be used as criteria.

Samples should be obtained and analyzed according to established protocols, such as those described in the HUD Interim Guidelines for Lead Abatement document.<sup>15</sup>

7. The building occupants should be advised to have their children periodically tested (blood lead levels) for lead. Prevention of childhood lead poisoning is an established national health priority.<sup>14</sup> The Centers for Disease Control and Prevention (CDC) in 1991 established a goal to reduce childrens blood lead level to below 10 µg/dl. This was a downward revision because of scientific evidence concerning the adverse effects of low level lead exposure. Additionally, the paint sample obtained in the hallway outside the room undergoing renovation shows that lead is present in other areas of the residence. A more comprehensive assessment of lead paint (e.g., deteriorating paint) in this residence, and surrounding soil (e.g., childrens play area) should be conducted, and controls/abatement implemented where necessary. Qualified personnel with training and experience in lead paint assessment and abatement should be utilized.

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1. Rosebud Company, Atlanta, GA
2. Department of Labor/OSHA Region IV
3. PHS/NIOSH Region IV
4. Occupant - Antique Residence

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

Table 1  
n-Methyl Pyrrolidinone and Formic Acid Sampling Results  
Rosebud Corporation: HETA 93-0844  
November 22, 1993

|  | N-METHYL PYRROLIDINONE SAMPLING |                                  |                                 | FORMIC ACID SAMPLING                       |                                  |
|--|---------------------------------|----------------------------------|---------------------------------|--|----------------------------------|
| Sample Description   | Time (min)                      | Concentration (ppm) <sup>1</sup> | Cumulative Average <sup>2</sup> | Time (min)                                 | Concentration (ppm) <sup>1</sup> |
| Personal Sample from worker applying NMP-based paint stripper to floor of antique residence. Applied in approximately 75 ft <sup>2</sup> areas with brush, used powered buffer. No ventilation controls. | 09:45-10:33 (48)                | 2.3                              | 3.3                             | 09:45 - 12:09 (144)<br>13:30 - 16:11 (101) | >1.4                             |
|  | 10:35-12:08 (93)                | 4.3*                             |                                 |  |                                  |
|  | 13:30-14:34 (64)                | 1.4**                            |                                 |  |                                  |
|  | 14:36-15:22 (46)                | 5.2*                             |                                 |  |                                  |
| Area sample obtained from the top of the fireplace mantle (~5 ft. off of the floor) in one corner of the room  | 09:45-10:25 (40)                | 2.7                              | 3.6                             | No sample collected                        |                                  |
|  | 10:27-11:25 (48)                | 4.1*                             |                                 |  |                                  |
|  | 11:27-13:34 (127)               | 4.6                              |                                 |  |                                  |
|  | 13:36-14:24 (48)                | 2.5**                            |                                 |  |                                  |
|  | 14:26-15:14 (48)                | 2.6*                             |                                 |  |                                  |
| Area sample obtained from window sill in center of back wall, ~2 ft off of the floor   | 09:45-10:27 (42)                | 2.9                              | 3.9                             | 09:45 - 15:07 (337)                        | >2.3                             |
|  | 10:29-11:28 (59)                | 3.6*                             |                                 |  |                                  |
|  | 11:30-13:36 (126)               | 4.5                              |                                 |  |                                  |
|  | 13:39-14:27 (48)                | 2.2**                            |                                 |  |                                  |
|  | 14:30-15:16 (46)                | 5.1*                             |                                 |  |                                  |

1. ppm = parts of gas or vapor per million parts air
2. Cumulative average concentration (E) for the combined sampling period is computed as follows:

$$E = \frac{(C_a T_a + C_b T_b + \dots + C_n T_n)}{(T_a + T_b + \dots + T_n)}$$

Where:  $C_a T_a$  is the concentration detected during period a and multiplied by the sampling time for that period

\* = Applied a coat of NMP-based stripping solution during this sampling time period

\*\* = Opened the window in the room undergoing treatment

> = Greater Than

Table 2  
n-Methyl Pyrrolidinone and Formic Acid Sampling Results  
Rosebud Corporation: HETA 93-0844  
December 14, 1993

|  | N-METHYL PYRROLIDINONE SAMPLING |                                  |                                 | FORMIC ACID SAMPLING |                                  |
|--|---------------------------------|----------------------------------|---------------------------------|----------------------|----------------------------------|
| Sample Description   | Time (min)                      | Concentration (ppm) <sup>1</sup> | Cumulative Average <sup>2</sup> | Time (min)           | Concentration (ppm) <sup>1</sup> |
| Personal Sample from worker applying NMP-based paint stripper to floor of antique residence. Applied in approximately 75 ft <sup>2</sup> areas with brush, used powered buffer. No ventilation controls. Windows and door were closed during activity. | 13:27 - 14:14 (47)              | 3.1*                             | 4.0                             | 13:29 - 15:52 (143)  | >2.5                             |
|  | 14:16 - 15:08 (52)              | 5.2*                             |                                 |                      |                                  |
|  | 15:09 - 15:52 (43)              | 3.5*                             |                                 |                      |                                  |
| Area sample obtained from window sill in center of back wall, ~2 ft off of the floor   | 13:29 - 14:12 (43)              | 6.0                              | 7.7                             | 13:27 - 15:47 (140)  | >4.1                             |
|  | 14:14 - 15:01 (46)              | 7.9                              |                                 |                      |                                  |
|  | 15:05 - 15:47 (42)              | 9.3                              |                                 |                      |                                  |

1. ppm = parts of gas or vapor per million parts air
2. Cumulative average concentration (E) for the combined sampling period is computed as follows:

$$E = \frac{(C_a T_a + C_b T_b + \dots + C_n T_n)}{(T_a + T_b + \dots + T_n)}$$

Where: C<sub>a</sub>T<sub>a</sub> is the concentration detected during period a and multiplied by the sampling time for that period

\* = Applied a coat of NMP-based stripping solution during this sampling time period

> = Greater Than