# NIOSH HEALTH HAZARD EVALUATION REPORT

## HETA #2004-0160-2962
## Truth Hardware
## West Hazelton, Pennsylvania

## April 2005

**DEPARTMENT OF HEALTH AND HUMAN SERVICES**
**Centers for Disease Control and Prevention**
**National Institute for Occupational Safety and Health**

# PREFACE

The Hazard Evaluation 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 (OSHA) 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 employers 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 Ronald M. Hall, Chad Dowell, and Rick Driscoll of HETAB, Division of Surveillance, Hazard Evaluations and Field Studies (DSHEFS). Desktop publishing was performed by Robin Smith. Editorial assistance was provided by Ellen Galloway.

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## Highlights of the NIOSH Health Hazard Evaluation

# Evaluation of Occupational Exposures during Zinc Casting and Ink Pad Stamping Operations

NIOSH evaluated worker exposures to carbon monoxide (CO) and elements (metals) in the zinc casting department and volatile organic compounds (VOCs) during ink pad stamping operations.

### What NIOSH Did

- We sampled for CO and metals in the zinc casting department.
- We sampled VOCs during ink pad stamping operations.
- We interviewed employees to find out about work related symptoms.

### What NIOSH Found

- The CO results indicated that workers in the zinc casting department may be exposed to CO concentrations exceeding applicable occupational exposure criteria when doors in the plant are shut.
- Symptoms mentioned in the original HHE request (i.e., blurry vision, headaches, dizziness, and nausea) are consistent with CO exposure.
- Metal sample results indicated concentrations well below applicable occupational exposure criteria.
- VOC sample results indicated concentrations well below applicable occupational criteria.

### What Truth Hardware Managers Can Do

- During warm weather leave the doors open in the zinc casting department to increase natural ventilation.
- Hire an engineering consultant firm that specializes in industrial ventilation to determine the best method to control CO in the plant.
- Use proper ventilation techniques to control CO in the plant.
- Evaluate CO exposures after ventilation changes have been made.
- Perform periodic CO monitoring in plant to assure that CO emissions are maintained to acceptable levels.

### What the Truth Hardware Employees Can Do

- Report potential ventilation problems to management.
- Follow health and safety procedures in the plant.
- Tell management about health and safety concerns.

**What To Do For More Information:**
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 #2004-0160-2962

# Health Hazard Evaluation Report 2004-0160-2962
# Truth Hardware
# West Hazelton, Pennsylvania
# April 2005

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## SUMMARY

In February 2004, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request for a Health Hazard Evaluation (HHE). The request concerned potential worker exposures in the zinc casting department at Truth Hardware in West Hazelton, Pennsylvania. The HHE request mentioned that workers had experienced vision blurring, burning eyes, headaches, dizziness, and nausea. On June 29-30, 2004, NIOSH conducted an HHE at this plant.

Carbon monoxide (CO) and element (metals) air samples were collected in the zinc casting department. In addition, air samples were collected using thermal desorption tubes and charcoal tubes during ink pad operations and analyzed for volatile organic compounds (VOCs). CO area results (collected when the doors were shut in the plant) indicated that workers may be exposed to concentrations exceeding the NIOSH recommended exposure limit (REL) and the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®). In addition, the CO results indicate the potential to approach the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PEL).

Air sampling results indicated element (metals) concentrations at low detectable levels or below the limit of detection for the analytical method (well below applicable occupational criteria). VOC results in the ink pad operations indicated concentrations well below applicable occupational exposure criteria.

Sampling results indicate a hazard from overexposure to CO. In the winter when the plant windows and doors are closed and natural ventilation is at a minimum, the CO concentration may be higher. Recommendations to help reduce CO emissions are provided in the report.

Keywords: carbon monoxide, zinc casting, elements (metals), volatile organic compounds (VOCs), vision blurring, burning eyes, headaches, dizziness, and nausea
SIC: 3364 Nonferrous Die-Castings, Except Aluminum

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# INTRODUCTION AND BACKGROUND

In February 2004, the National Institute for Occupational Safety and Health (NIOSH) received a confidential employee request for a Health Hazard Evaluation (HHE) at Truth Hardware in West Hazelton, Pennsylvania. The request concerned potential worker exposures in the zinc casting department. The HHE request mentioned that workers had experienced vision blurring, burning eyes, headaches, dizziness, and nausea. On June 29-30, 2004, NIOSH conducted an HHE at this plant.

Truth Hardware has approximately 130 employees with approximately 29 employees working in the zinc casting department. In the zinc casting department, zinc ingots are melted in a pot at 800 to 850 degrees Fahrenheit. The melted zinc is transferred to die casting machines where it is injected into dies to form a runner system that incorporates the component parts (window locks). The runner system containing the component parts is then automatically separated from the dies. The parts are then separated from the runner system by one of four methods. The four methods for separating the parts from the runner system include mechanical knock off arms, hydraulic trim press equipment, drum mixer, and hand separation. After the parts are separated from the runner system the runners are sent to the re-melt furnace to be recycled. The zinc parts are then transferred to a drum tumbler to de-burr flash and remove zinc overflows, or the parts are transferred to a vibrator operation (a less aggressive polishing operation) to de-burr and remove part overflows. The parts and zinc overflows are sent to a shaker/sort machine which separates the part from the overflow pieces. The parts are then sent to inventory.

# METHODS

We sampled for carbon monoxide (CO) and elements (metals) in the zinc casting department and volatile organic compounds (VOCs) during ink pad stamping operations where the parts are marked. We also conducted confidential interviews with workers to determine whether they were experiencing symptoms as a result of workplace exposures.

## *Carbon Monoxide (CO)*

CO was measured in the general area of the zinc casting department for two days with a hand-held, battery operated, TSI Q-Track™ (Model 8554) indoor air quality (IAQ) monitor. This portable monitor uses an electro-chemical sensor to measure CO in the range of 0-500 parts per million (ppm). The real-time CO monitor was set to take a sample every minute during the sampling periods on both days. On the first day CO was measured for approximately five hours and on the second day CO was measured for seven hours and 20 minutes.

## *Elements (Metals)*

Personal breathing zone (PBZ) air samples for elements were quantitatively analyzed for silver, aluminum, arsenic, beryllium, calcium, cadmium, cobalt, chromium, copper, iron, lithium, magnesium, manganese, molybdenum, sodium, nickel, phosphorus, lead, platinum, selenium, tellurium, thallium, titanium, vanadium, yttrium, zinc, and zirconium using a Perkin Elmer Optima 3000 DV inductively coupled plasma spectrometer according to NIOSH Method 7300.[1] These samples were collected on 37-millimeter (mm) diameter, 5-micrometer (μm) pore-size polyvinyl chloride (PVC) filters, using sampling pumps calibrated at 2 liters per minute (Lpm).

## *Volatile Organic Compounds (VOCs)*

We collected area air samples during ink pad operations on thermal desorption tubes to identify VOCs for charcoal tube analysis. The stainless steel thermal desorption tubes were attached by Tygon® tubing to sampling pumps calibrated at a flow rate of 50 cubic centimeters per minute (cc/min). These tubes were then qualitatively analyzed by the

NIOSH laboratory using a Perkin-Elmer ATD 400 automatic thermal desorption system and a gas chromatograph with a mass selective detector by NIOSH Method 2549.[1]

PBZ and area charcoal tube samples were also collected during ink pad operations. Charcoal tubes were attached by Tygon® tubing to sampling pumps calibrated at a flow rate of 200 cc/min. The charcoal tubes were sent to a NIOSH contract laboratory (Datachem Laboratories, Inc., Salt Lake City, Utah) to be quantitatively analyzed for the compounds of interest identified on the thermal tubes, including xylenes, ethyl benzene, n-butyl acetate, trimethyl benzenes, diacetone alcohol, toluene, propylene glycol and methyl ethyl acetate (PGMEA) by a combination of NIOSH methods including 1501, 1450, and 1402.[1] A Hewlett-Packard model 5890A gas chromatograph equipped with a flame ionization detector was used for this quantitative analysis.

### *Epidemiologic Evaluation*

Confidential interviews were conducted with ten workers who were selected by union representatives as employees who had work related symptoms and workers who wanted the opportunity to talk with a NIOSH representative. Workers were asked to describe any health concerns that they would attribute to exposures at Truth Hardware.

## EVALUATION CRITERIA

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] (2) the American Conference of Governmental Industrial Hygienists' (ACGIH®) Threshold Limit Values (TLVs®),[3] and (3) the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PELs).[4] Employers are encouraged to follow the OSHA limits, the NIOSH RELs, the ACGIH TLVs, or whichever are the more protective criteria.

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 [Occupational Safety and Health Act of 1970, Public Law 91–596, sec. 5(a)(1)]. 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 STEL or ceiling values which are intended to

supplement the TWA where there are recognized toxic effects from higher exposures over the short-term.

### Carbon Monoxide (CO)

CO is a colorless, odorless, tasteless gas produced by incomplete burning of carbon-containing materials (e.g., natural gas). The initial symptoms of CO poisoning may include headache, dizziness, drowsiness, and nausea. These initial symptoms may advance to vomiting, loss of consciousness, and collapse if prolonged or high exposures are encountered. Coma or death may occur if high exposures continue.[5,6,7,8,9,10]

Exposure to 50 parts per million (ppm) of CO for 6-8 hours among non-smokers results in carboxyhemoglobin (COHb) levels of 8% to 10%.[5,11,12] One study reported that headache, fatigue, dizziness, paresthesias, chest pain, palpitations, and visual disturbances were associated with chronic occult carbon monoxide exposure.[13] Carboxyhemoglobin levels were measured in 14 of the patients in this study and their levels ranged from 8.8% to 36.8% with a mean of 15.1%.[13]

The NIOSH REL for occupational exposures to CO in air is 35 parts per million (ppm) for full shift TWA exposure, and a ceiling limit of 200 ppm, which should never be exceeded.[2] The NIOSH REL of 35 ppm is designed to protect workers from health effects associated with COHb levels in excess of 5%.[5] The ACGIH recommends an 8-hour TWA TLV for occupational exposure to CO of 25 ppm.[3] The OSHA PEL for CO is 50 ppm for an 8-hour TWA exposure.[4]

## RESULTS

### Carbon Monoxide (CO)

CO was measured in the general area of the zinc casting department for two days. The real-time CO monitor was set to take a sample every minute during the sampling periods on both days. On the first day CO was measured for approximately five hours and the real-time results indicated a minimum concentration of 21.7 ppm, a mean of 41.3 ppm, and a maximum of 90.3 ppm. On the first day we opened the doors allowing natural ventilation, and measured CO concentrations for approximately one hour. With the doors in the zinc casting department open the CO concentrations declined to a mean of 6.2 ppm (minimum of 4.0 ppm, maximum of 9.1 ppm). On the second day we measured CO for seven hours and 20 minutes, with a minimum of 11.5 ppm, a mean of 44.3 ppm, and a maximum of 141.3 ppm (measurements were collected when the doors were shut).

### Elements (Metals)

During the 2-day survey we collected 18 PBZ samples on workers in the zinc casting department. The majority of the air samples indicated element concentrations at low detectable levels or below the limit of detection for the method. A few of the more commonly found elements, such as aluminum and zinc, were detected on the samples. Aluminum concentrations ranged from 0.002 milligrams of aluminum per cubic meter ($mg/m^3$) of air (the minimum detectable concentration for the method) to 0.02 $mg/m^3$. Occupational exposure criteria for aluminum is 10 $mg/m^3$ (measured as total aluminum dust) for the NIOSH REL), the OSHA PEL, and the ACGIH TLV. Zinc air concentrations ranged from 0.003 $mg/m^3$ to 0.19 $mg/m^3$. The occupational exposure criteria for zinc include a NIOSH REL and ACGIH TLV of 10 $mg/m^3$ (total metal dust) and an OSHA PEL of 15 $mg/m^3$ (total metal dust).

### Volatile Organic Compounds (VOCs)

VOC results are listed in Table 1. During the 2-day survey we collected four PBZ samples on two workers during ink pad operations. In addition, we collected an area air sample (in the middle of the secondary assembly area) for VOCs each day. The VOC results were well below applicable occupational exposure limits.

### *Confidential Interviews*

Several workers reported prior incidents of injury, two workers complained of chronic sinusitis (one of whom also had headaches), two workers had backaches that they attributed to long hours of standing at their work station, and one worker reported eye irritation. Three of the workers interviewed had no health concerns.

## DISCUSSION AND CONCLUSION

The CO results (collected when the doors were shut) indicate that workers are exposed to CO concentrations exceeding the NIOSH REL and the ACGIH TLV. The results also indicate the potential to approach the OSHA PEL. The HHE request mentioned that workers had experienced blurry vision, headaches, dizziness, and nausea. These symptoms are consistent with overexposure to CO. In the winter when the plant windows and doors are closed and natural ventilation is at a minimum, the CO concentration may even be higher.

The best way to control CO is at the source with local exhaust ventilation (LEV). This may be accomplished by using LEV systems that have been specifically designed for casting machine operations. There are two examples in the ACGIH Ventilation Manual (a fixed position die casting hood [VS-55-20], and a mobile die casting hood [VS-55-21]).[14] Another option may be canopy type hoods that are designed to capture the convection currents generated from the combustion sources. These hoods would need to be designed for a hot process so the exhaust flow rate is greater than the convection currents that are generated from the combustion source. In addition, the canopy hoods would need to be designed to capture the plume from the combustion source, allowing that the plume expands at an angle of about 5 degrees from the heat source.[15]

Another option that may help reduce CO concentrations would be general dilution ventilation with make-up air. If the make-up air is heated during the winter months, this could replace the need for the gas-fired space heaters in the plant (which are another potential source of CO exposure). Air exhausted from the building should be replaced with tempered air from an uncontaminated source. This air could also be directed to operator work areas to help provide a cleaner environment and employee work stations. Ideally the tempered make-up air system should be designed to create linear flow through the plant to the exhaust fans, and thus minimize eddy currents or turbulent air mixtures. One way to achieve a linear air flow is to supply the air near the floor level and have exhaust fans located near the ceiling. This may allow the air to travel from the bottom of the plant to the top to be discharged, taking advantage of the natural convection currents from the hot processes which rise up toward the ceiling.

The ACGIH Ventilation Manual describes several general dilution ventilation principles, including locating the exhaust openings near the source of contamination, if possible, in order to obtain the benefit of "spot ventilation."[14] The ACGIH Ventilation Manual also mentions locating the air supply and the exhaust outlets such that the air passes through the zone of contamination. The workers should remain between the air supply and the source of the contaminant.[14] The American Foundrymen's Society "Foundry Ventilation Manual" recommends that general ventilation rates of 20-50 cubic feet per minute (CFM) per square foot ($ft^2$) of floor area be used to control emissions in pouring areas.[16]

Air sampling results indicated element concentrations at low detectable levels or below the limit of detection for the method. A few of the more commonly found elements, such as aluminum and zinc, were detected on the samples at levels well below applicable exposure criteria. VOC results in the ink pad operations indicated concentrations well below applicable occupational exposure limits.

# RECOMMENDATIONS

The following recommendations are provided to reduce CO concentrations in the zinc casting department.

(1) While the weather is warm, open the doors to increase the natural ventilation, which should help reduce CO concentrations in the plant.

(2) Management should hire an engineering consulting firm that specializes in industrial ventilation to help determine the best method to control CO emissions.

(3) Conduct a more intensive CO exposure assessment during the winter (when the doors and windows in the plant are closed) or after ventilation changes have been made to make sure that CO emissions are at levels below occupational criteria. In addition, conduct CO exposure assessments periodically throughout the year to assure that CO emissions are maintained at acceptable levels within the plant.

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**Table 1. VOC Air Sampling Results**
**Truth Hardware in West Hazelton, Pennsylvania**
**HETA 2004-2160-2962**

| | Air Concentrations, parts per million (ppm) | | | | | | |
|---|---|---|---|---|---|---|---|
| Location | Xylene | Ethyl Benzene | n-Butyl Acetate | TMB | Toluene | DAC | PGMEA |
| Worker 1 (mixing room) (06/29/04) | 0.040 | 0.008 | 0.52 | 0.40 | 0.0035 | 0.20 | 0.42 |
| Worker 2 (stamping room) (06/29/04) | 0.038 | 0.007 | 0.019 | 0.009 | 0.003 | ND | 0.020 |
| General Area in Secondary Assembly (06/29/04) | 0.007 | (0.0013) | 0.005 | 0.0032 | (0.003) | ND | (0.003) |
| Worker 1 (mixing room) (06/30/04) | 0.040 | 0.008 | 0.35 | 0.34 | (0.0018) | 0.13 | 0.33 |
| Worker 2 (stamping room) (06/30/04) | 0.080 | 0.015 | 0.047 | 0.029 | (0.002) | 0.008 | 0.020 |
| General Area in Secondary Assembly (06/30/04) | 0.007 | (0.0015) | 0.0057 | 0.004 | ND | ND | (0.006) |
| NIOSH REL (ppm) | 100 | 100 | 150 | 25 | 100 | 50 | None |
| OSHA PEL (ppm) | 100 | 100 | 150 | none | 200 | 50 | None |
| ACGIH TLV (ppm) | 100 | 100 | 150 | 25 | 50 | 50 | None |

TMB = trimethyl benzene (mixed isomers)
DAC = diacetone alcohol
PGMEA = propylene glycol monoethyl ether acetate
( ) = These concentrations were detected at the Mimimum Detectable Concentration for the method.
ppm = parts of contaminant per million parts of air
NIOSH REL = NIOSH Recommended Exposure Limit
OSHA PEL = OSHA Permissible Exposure Limit
ACGIH TLV = ACGIH Threshold Limit Value

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