IN-DEPTH SURVEY REPORT

CONTROL TECHNOLOGY FOR REMOVING LEAD-BASED PAINT FROM STEEL STRUCTURES POWER TOOL CLEANING

AT

Muskingum County, Ohio, Bridge MUS-555-0567 and MUS-60-3360
Olympic Painting Company, Inc
Youngstown, Ohio

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INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) is the primary federal organization engaged in occupational safety and health research It is located in the Department of Health and Human Services (DHHS), Centers for Disease Control and Prevention (CDC) An important area of NIOSH research deals with methods for controlling occupational exposure to potential chemical and physical hazards The Engineering Control Technology Branch (ECTB) of the Division of Physical Sciences and Engineering has been given the lead within NIOSH to study the engineering aspects of hazard control

Because of increased reports of lead poisoning and silicosis among workers in the steel structures painting industry, researchers from ECTB developed a project to evaluate engineering controls in this industry [1] A basic need for nearly all steel structures is protection from corrosion Historically, lead-containing coating systems were used because they were low cost, aesthetically appealing, and corrosion resistant To adequately prepare the steel surface to receive a new coating system, the old coating must be removed [2] The cleaning process has traditionally been achieved by abrasive blasting Abrasive blast devices are designed to deliver a high-velocity stream of abrasive to remove the coating as well as impart an anchor pattern on the metal surface The workers direct the blasting nozzles at the surface to be cleaned As the paint is removed small particles of lead paint, silica (silica from abrasive or from surface coatings), and other debris become airborne Lead poisoning and silicosis are not uncommon among workers who remove lead-based paints from bridges and other steel structures

Two environmental requirements have been the driving force for contractors to contain paint chips, dust, and used abrasive during paint removal processes The Resource Conservation and Recovery Act (RCRA) requires that waste material must be collected, tested, and classified as hazardous or not hazardous [3] Secondly, the Clean Air Act limits levels of particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers (PM10) to a maximum of 150 $\mu g/m^3$ average concentration over a 24-hour period [4] The Clean Air Act also limits the amount of airborne lead to 1 5 $\mu g/m^3$, evaluated as a maximum arithmetic mean averaged over a calendar quarter The containment structures used to collect waste materials and control emissions have increased workers' risk of occupational exposure to lead and other waste materials, by concentrating these agents in and around the paint removal containment structures

Support personnel as well as workers doing surface preparations are at risk of high exposures to potentially hazardous particulate mentioned above Support personnel may also receive exposure when containment structures (which may contain or be contaminated with residual lead and silica particles) are disassembled and moved or when handling abrasive and waste materials High exposures have been observed for auxiliary equipment operators and for those cleaning up the site after paint removal has been completed [5]

Lead exposures during hand-held power tool use were evaluated during the removal of lead-containing paint The power tools used at this site included an electric wire brush, and a pneumatic hammer (chisel) Also, two workers used 4-inch hand scrapers to remove paint from small isolated areas prior to painting and one worker used compressed air to remove dust and paint chips from the surfaces after power tool cleaning and before painting

BRIDGE SITE AND PROCESS DESCRIPTION

The paint removal work was done at two separate bridges which were situated on state roads spanning small streams Both bridges were last painted with a lead-based paint The existing coatings on these bridges were in relatively good condition, with only minor deterioration due to weathering Most of the weathering was confined to the load-bearing areas of the bridge These areas of deterioration were to be power tool cleaned to prepare the surface for painting Areas on the bridge which did not show signs of deterioration were not scraped or power tool cleaned After cleaning, the newly prepared surface was painted with a nonleaded paint

At the MUS-555-0567 bridge (bridge site 1) on Route 555 in Muskingum County, sections of the steel were power tool cleaned and repainted only where paint had deteriorated At the MUS-60-3360 bridge (bridge site 2) on State Highway 60 in Muskingum County, sections of the steel were power tool cleaned and repainted only where old paint had deteriorated

The electric wire brush consisted of a Black & Decker heavy duty grinder (Automotive series 6147, type 100, 120 volt A C , 6 0 Amp, 10,000 r p m) with a 4 5-inch wire brush attachment There was no ventilated exhaust on this power tool or shields to direct the dust flow The power was supplied by an electric generator with 120 volt output The pneumatic hammer was approximately 2 feet long with an 18-inch long chisel with a 1-inch wide tip There were no product markings on the hammer and no engineering controls were attached to the equipment The hammer was powered by an air compressor with output pressure of 120 pounds per square inch (Ingersoll Rand, 75 Prestige series)

SAMPLING METHODS

This paint removal technique was evaluated by collecting and analyzing bulk samples of paint, personal breathing zone (PBZ) air samples of the wire brush operator, pneumatic hammer operator, and hand scraper operators, and area air samples Work practices and personal hygiene practices were also observed and wipe samples were taken from the dashboards of company trucks

BULK SAMPLES

Old paint was collected from the bridge by scraping the surface with a sharp chisel The bulk paint collection process removed all of the top and intermediate paint coatings, leaving a metal surface with only traces of the primer coating (less than 10 percent of the surface was covered by thin traces of paint) Samples were taken from locations where the paint was being removed Areas with both intact and deteriorated paints were sampled

PERSONAL SAMPLES

PBZ samples were collected on 37-mm diameter, mixed cellulose ester membrane, 0 8-µm pore-size filters in closed-face cassettes using personal sampling pumps (Model 224-PCXR7, SKC Inc , Eighty Four, Pennsylvania) each operating at 2 0 liters per minute (lpm) The sample cassettes were attached to the lapel of the worker

AREA SAMPLES

Area samples for total lead and total dust samples were collected in the work area under the bridge, on top of the bridge, and near the parked vehicles 200 feet from the work site One additional inhalable dust sample was collected in the work area under the bridge The area total lead samples were collected using the same equipment as for the PBZ samples The total dust samples were collected on preweighed 37-mm, 0 5-µm pore-size, PVC filters in a closed-face cassette, at a flow rate of 2 0 lpm The inhalable dust sample (SKC, Eighty Four, Pennsylvania) designed by the Institute of Occupational Medicine (IOM), Edinburgh, was used to collect inhalable dust (particles with equivalent aerodynamic diameters of up to approximately 100 μm) Air was drawn with a personal sampling pump (Model P2500, Ametek, Largo, Florida) at 2 0 lpm The collection medium was a 25-mm diameter, 0 5-µm pore-size, PVC filter The IOM samples were weighed to determine the amount of inhalable dust, then analyzed to determine the amount of inhalable lead

Wipe samples were taken of the dashboards in two paint contractor's trucks and in the inspector's truck Approximately one square foot of each dash area was wiped with a separate Wash-n-Dry individually wrapped towel The towel was wiped in an s-pattern over the area on the dash was folded in half with the dirty side in, wiped in an s-pattern but at 90 degrees to the first wipe pattern, folded in half again, wiped in the same pattern as the first wipe pattern, and finally folded in half and placed in a sealable bag Blanks were folded in half three times and placed in a sealable bag while in the field

SAMPLE ANALYSIS

Analyses of air samples for lead and other elements were conducted using NIOSH Method 7300,[6] which utilizes inductively coupled argon plasma atomic emission spectrometry, when the lead results were below the limit of detection (LOD), samples were reanalyzed using graphite furnace atomic absorption spectroscopy, NIOSH Method 7105 [7] Total dust and inhalable dust analyses were performed using NIOSH Method 0500 with a limit of detection of 0 02 mg [8]

EXPOSURE EVALUATION CRITERIA

The OSHA PEL for lead in the construction industry during this survey was 50 µg/m^3 as an 8-hour TWA [9] The 50 µg/m^3 exposure limit is currently recommended for the construction industry by NIOSH as a more protective criteria and is used in this study as the evaluation criteria for personal exposures [10] The OSHA PEL for total particulate not otherwise regulated is an 8-hour TWA of 15 mg/m^3

Presently, the only wipe sample evaluation criteria is found in guidelines written by the Housing and Urban Development (HUD) These guidelines state that surface lead concentration should be below 2 2 mg/m^2 for wipes taken from the floor and about 2 5 and 4 times that value for window sills and window wells, respectively [11]

RESULTS

BULK SAMPLES

Table I presents results of bulk sample analyses of paint scraped from the bridges The two samples of tightly held paint both contained 30-percent lead by weight The deteriorated paint from the bridges contained an average of 16-percent lead by weight (range 6 8% - 24%)

Table I

Bulk Sample Type	Bridge	Lead in Paint Concentration, ppm
Tightly held	1	300,000
Loosely held (with rust)	1	68,000
Loosely held (with rust)	1	240,000
Tightly held	2	300,000
Loosely held (with rust)	2	170,000

PERSONAL AIR SAMPLES

Table II presents the results of PBZ air sampling during this paint removal process The power wire brush operator PBZ lead concentration was 2500 µg/m^3 at bridge site 1 and 5000 µg/m^3 at site 2 The pneumatic hammer operator PBZ lead concentration was 190 µg/m^3 at the first bridge site and 220 µg/m^3 at site 2

Table II

Job	Bridge	Time (min)	Lead Concentration ($\mu g/m^3$) During Sampling*	Lead Concentration ($\mu g/m^3$) 8-hour TWA**	Respirator Used
Power wire brush	1	170	2500	890	Half-mask
	2	202	5000	2100	air-purifying HEPA filter
Pneumatic hammer	1	172	190	68	Single-use
	2	86	220	103	particulate
Supervisor,	1	180	390	150	Single-use
Blow down	2	164	54	19	particulate
Scraping and laborer	1	156	57	19	None
Hand scraping and	1	175	18	6	Single-use
painting	2	231	100	48	particulate
Hand scraping and	1	170	250	87	Single-use
painting	2	231	440	210	particulate
Inspector	1	156	7 9	2 6	None

* Lead concentration during sampling period
** 8-hour TWA extrapolated values assuming no other airborne lead exposure during the work shift

The PBZ lead concentration for the hand scrapers was 100 $\mu g/m^3$ (geometric mean) with a range of 18 to 440 $\mu g/m^3$ The PBZ lead concentration for the blower operator was 390 $\mu g/m^3$ at the first site and 54 $\mu g/m^3$ at the second site

AREA SAMPLING

Airborne lead and aerosol concentrations from area sampling are presented in Table III Area samples taken under the bridge approximately 20 feet from the work area at bridge one and approximately 30 feet from the work area at bridge two resulted in total lead concentrations of 63 and 9 $\mu g/m^3$ for bridge one and two, respectively Total dust concentrations of 4700 and 700 $\mu g/m^3$ were collected under the bridges of site one and two, respectively The inhalable lead concentration was 150 $\mu g/m^3$ and the inhalable dust concentration was 42,000 $\mu g/m^3$ at the first bridge site

Table III

Location	Bridge	Time (min)	Concentration (µg/m³)			
			Total Lead	Total Dust	IOM Lead	IOM Dust
Under the bridge	1	138	63	4700	150	42000
	2	196	9.1	700	-	-
Top of bridge	1	144	8.9	600	-	-
	2	218	25	800	-	-
Near autos 200 feet from the work	1	149	<0.7	<70	-	-
	2	194	<0.5	80	-	-

DISCUSSION

The bulk samples scraped from locations on the bridge where paint was visually deteriorating had lower lead levels than the intact paint samples. This is most likely due to a larger percentage of the deteriorated paint samples consisting of ferric oxide, thus, dilution of the lead level in the paint sample.

The wire brush operator experienced the highest airborne lead concentrations of the persons sampled at this site. The swarf from the rotating wire brush was not controlled in any way. The brush propelled dust and debris into the operator's breathing zone and into the general work area. Based on visual observation, the airborne dust generated by the wire brush may have been a major contributor to increased lead and dust concentrations throughout the work area. However, the testing of this hypothesis was not the goal of this survey. Engineering controls should be used to collect the particulate generated during this operation. Power tools equipped with local exhaust ventilation are readily available.

The chiseling action of the pneumatic hammer did not generate a large amount of visible dust. The long narrow shaft of the chisel reached into areas which were inaccessible to the wire brush. The operator cleaned hard-to-reach areas which required more time per square foot of steel cleaned. This reduced production rate and the chipping action of the chisel resulted in a very low amount of visible dust generated by the pneumatic hammer. However, the hammer operator worked in close proximity to the wire brush operator. Based on the visual observation, it is hypothesized that a large portion of the hammer operator's airborne lead concentration may be attributed to the lead generated by the wire brush. If the wire brush operation is effectively controlled, then the lead concentration at the hammer operator may be effectively reduced as well. This should be verified by air monitoring the hammer operator in the absence of the wire brush or after the wire brush is effectively controlled.

The scraper operators did not generate visible dust when scraping chips of paint from the structure There were fewer paint chips generated by the scraper and the chips were larger than the particulate generated by the power wire brush It is hypothesized that a major source of the scraper operators' airborne lead concentration came from the power wire brush However, this was not proven during this short site visit Data on the proximity of the scrapers to the wire brush operator was not collected If the wire brush operation is effectively controlled, then the lead concentration of the scraper and painter may be effectively reduced as well This should be verified by sampling the scraper and painters in the absence of the wire brush or after the wire brush is effectively controlled

The work supervisor at this site also performed compressed-air blow down after the cleaning was complete and prior to inspection The blow-down process took approximately 15 to 20 minutes The rest of the time the supervisor was in and out of the work area doing many other tasks to support the cleaning process There was a large amount of visible dust generated during the blow-down process and a large portion of the supervisor's exposure may be attributed to this short, but dusty task Vacuuming the dust with an appropriately designed collection system would reduce or eliminate this dust generation and reduce exposures

The inspector was located about 30 to 40 feet from the work area most of the time but occasionally approached the paint removal area The inspector evaluated the cleaned surface prior to painting The TWA concentration for the inspector was well below the OSHA PEL

The samples collected under bridge one indicate that the inhalable sampler collected more lead and dust than the 37-mm, closed-face cassettes used for total lead and total dust collection Because lead is a systemic health hazard, inhalable particulate (diameters less than 100 µm), as well as respirable particulate, may contribute to the workers' risk of lead exposure The inhalable sampler may give a better indication of worker exposure because the inhalable sampler is more effective at collecting a larger range of particulate IOM sampler lead results were higher than the total lead and total dust results

Area dust levels were almost two orders of magnitude greater than lead levels In general, in areas where visible dust levels were high, a correspondingly high lead and dust concentration were determined by personal and area sampling

The workers used personal protective equipment, including cotton work cloths, disposable earplugs, and respirators provided by the contractor A disposable paper dust mask with only one elastic strap and with no exhalation valve was worn by the majority of workers It was observed that the disposable respirator did not sit snugly on the face of the worker Because of the poor fit, these respirators probably provided very little protection for those workers who wore them Lead concentrations were as high as 400 $\mu g/m^3$ for one of the scraper-painters As a minimum, for this level of exposure, a properly fitted air-purifying respirator with high efficiency particulate air filter (HEPA) should be selected and worn An air-purifying respirator with HEPA filters was used by the wire brush operator With lead concentrations as high as 5000 $\mu g/m^3$, the air-purifying respirator was incorrectly selected for this job A respirator with a higher protection factor must be used Better yet, controlling the lead and dust at the generation point by local exhaust ventilation will reduce or eliminate the need for respirators during this process Testing should be done after installing the engineering controls prior to reducing the level of respiratory protection

Wipe sample lead results were 1 3 milligrams of lead per square meter of surface wiped (mg/m^2) for the dashboard of the inspector's truck and 47 and 8 9 mg/m^2 from the dashboard of the contractor's two trucks The Department of Housing and Urban Development clearance standard for lead on floors is 2 1 mg/m^2 Using this standard, the inspector's truck was clean, however, the contractor's trucks should be cleaned

No personal hygiene facilities were provided on site Since workers did not change clothing at the site the dust could be carried by the workers to their automobiles, housing, and laundry facilities

CONCLUSIONS AND RECOMMENDATIONS

Lead concentrations during the use of an electric power wire brush were thousands of micrograms per cubic meter of air Power tools equipped with local exhaust ventilation are readily available and should be used to reduce airborne lead concentrations during power tool lead-based paint removal The effectiveness of the engineering control should be verified by air monitoring

A comprehensive lead protection plan including a respirator selection program based on air-monitoring data should be implemented Personal hygiene facilities should be provided at the work site Vehicles should be cleaned to reduce the level of lead on inside surfaces This may reduce the risk of take-home lead which could expose workers and their families

REFERENCES

1 NIOSH [1991] NIOSH Alert Request for assistance in preventing lead poisoning in construction workers Cincinnati OH U S Department of Health and Human Services, Public Health Service. Centers for Disease Control, National Institute for Occupational Safety and Health DHHS (NIOSH) Publication No 91-116

2 McGannon HE [1970] The making, shaping and treating of steel 9th ed Pittsburgh, PA The United States Steel Corporation, Herdick and Held Publishers, p 986

3 Code of Federal Regulations 40 CFR 260 (1990) *Hazardous Waste Management System* Washington, DC U S Government Printing Office, Office of the Federal Register

4 Code of Federal Regulations 40 CFR 50 (1990) *National Primary and Secondary Ambient Air Quality Standards* Washington, DC U S Government Printing Office, Office of the Federal Register

5 CONSAD Research Corporation [1992] Lead in construction - site visit #11 Research performed for the U S Department of Labor, Occupational Safety and Health Administration, Office of Regulatory Analysis, Contract J-9-F-0011, March 10

6 National Institute for Occupational Safety and Health *Elements (ICP) Method 7300* In NIOSH manual of analytical methods 3rd rev ed , edited by P M Eller (DHHS/NIOSH Pub No 84-100) Cincinnati, OH U S Department of Health and Human Services, Public Health Service Centers for Disease Control, National Institute for Occupational Safety and Health, 1984

7 National Institute for Occupational Safety and Health *Lead Method 7105* In NIOSH manual of analytical methods 3rd rev ed , edited by P M Eller (DHHS/NIOSH Pub No 84-100) Cincinnati, OH U S Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health. 1984

8 National Institute for Occupational Safety and Health *Nuisance Dust, Total, Method 0500* In NIOSH manual of analytical methods 3rd rev ed , edited by P M Eller (DHHS/NIOSH Pub No 84-100) Cincinnati, OH U S Department of Health and Human Services, Public Health Service. Centers for Disease Control, National Institute for Occupational Safety and Health, 1984

9 "OSHA Lead Exposure in Construction, Interim Final Rule," Federal Register. Department of Labor, Title 29, Pt 1926 62 Tuesday, May 4, 1993

10 National Institute for Occupational Safety and Health and Occupational Safety and Health Administration *Working With Lead in the Construction Industry* Washington, DC U S Government Printing Office, U S Department of Labor, Occupational Safety and Health Administration U S Department of Health and Human Services, National Institute for Occupational Safety and Health, 1991

11 Department of Housing and Urban Development *Lead-based paint Interim Guidelines for Hazard Identification and Abatement in Public and Indian Housing* Washington, DC U S Department of Housing and Urban Development, Office of Public and Indian Housing September 1990