ELEVATED BLOOD LEADS IN THE IOWA CONSTRUCTION INDUSTRY

CDC/NIOSH GRANT KO1 OH00137-03

FINAL REPORT

DECEMBER 20, 1996

PRINCIPLE INVESTIGATOR:

STEPHEN J. REYNOLDS, PH.D., CIH, ASSOCIATE PROFESSOR

CO-INVESTIGATORS:

WILLIAM CLARKE,PH.D., PROFESSOR
LAURENCE FUORTES, MD, MS, ASSOCIATE PROFESSOR
NANCY SPRINCE, MD, MPH, ASSOCIATE PROFESSOR

DEPARTMENT OF PREVENTIVE MEDICINE AND ENVIRONMENTAL HEALTH
THE UNIVERSITY OF IOWA
140 IREH
IOWA CITY, IA 52242-5000

I. SIGNIFICANT FINDINGS

- Blood lead levels (BLL) of midwestern construction workers differed by trade. Geometric mean blood lead concentrations by trade group were: laborers (7.6 ug/dL, n=80); painters (5.9 ug/dL, n=83); ironworkers (5.2 ug/dL, n=87); plumbers (4.4 ug/dL, n=82); electricians (2.4 ug/dL, n=91). Blood lead levels for laborers and painters were significantly higher than other trade groups, and blood lead levels for electricians were signficantly lower ($p < 0.01$) differing little from the average for U.S. adults.

- In addition to trade, the most important work related risk factors for elevated BLL were found to include: highway/bridge repair or renovation; new construction of highways/bridges; commercial or industrial demolition; residential remodeling; and generation of lead dust or fumes during work activities. Even taking into account risk factors at work, living in an older home was also a significant predictor of elevated BLL and for elevated FEPs. Hobbies involving work with lead (such as stained glass, riflery/shooting, casting/smelting lead for bullets or sinkers) also were important risk factors.

- Compliance with the requirements of OSHA's Interim Construction Lead Standard, and implementation of good occupational health and safety practices in general, was poor. Thirty eight percent reported ever having had training or receiving written information concerning lead hazards or regulations.While 88% of workers reported using respirators, only 65% had ever been fit tested, 76% had been trained, and 49% had been examined by a physician. Of those receiving medical exams only 4% reported that pulmonary function testing was included. On the most recent job only 22% of those using respirators had been fit tested. Washing of hands before eating, drinking, or smoking was reportedly low (64% to 8%) and 36% reported smoking at work, 25% biting their nails, and 10% chewing on plastic coated electric wires. Only 3% showered before going home, and 68% never changed out of work clothes. Environmental testing for lead (7% of most recent jobs) or air sampling to evaluate occupational exposure (13% of most recent jobs) to lead was rarely performed.

- Although the numbers of workers performing lead abatement projects were small, the trend for lower BLL in this group provides evidence that training, implementation of engineering controls, and proper use of personal protective equipment such as respirators is effective in controlling lead poisoning.

- The Iowa Department of Public Health's Adult Blood Lead Surveillance Project data base appeared to be of limited use in identifying and mitigating occupational lead poisoning in construction workers. This may be due to insufficient resources and staffing available for this project, and to a lack of awareness among physicians and laboratories concerning reporting requirements. This surveillance project could be an important resource and efforts to educate physicians and enhance support at IDPH are recommended.

II. USEFULNESS OF FINDINGS

While the prevalence of elevated blood lead levels in these midwestern construction workers appears to be low overall, the risk of lead poisoning in certain trades specifically related to high risk projects is a significant problem. In addition to the workers themselves, their families and communities are also at risk due to the poor implementation of control measures. It is also apparent from the results of this project that lead containing materials continue to be commonly found throughout the construction industry. While this study focused on union members working on small to midsized projects in the midwest, the following recommendations should be useful to both union and non-union construction workers throughout the U.S.

- Educational programs and information on lead sources, hazards, and controls should be disseminated to construction workers, contractors, and other professionals such as architects and engineers responsible for planning and conducting construction projects. Educational and informational programs should also be targeted at physicians and other health care providers.

- Implementation and enforcement of current regulatory requirements should be target at job sites likely to involve exposure to lead such as bridges, and renovation/remodeling of commercial and industrial sites.

- Specifications for lead hazard identification and management programs, such as that recommended by the Center to Protect Worker Rights, should be required in bid specifications before projects are awarded to contractors.

- Development of engineering controls currently being conducted by NIOSH should received continuing priority and support.

- Identification and labeling of lead containing products, or substitution of non-lead materials either voluntarily by industry or in response to proposed legislation (Lead Exposure Reduction Act) would also be an effective intervention.

- The level of support for the Iowa Department of Public Health's Adult Blood Lead Surveillance Project should be increased to at least 1.0 FTE to ensure that this important surveillance activity is effective in identifying problems with elevated blood leads and capable of initiating intervention.

III. ABSTRACT

Sentinel data from case reports and surveillance indicate that workers in some construction trades experience serious illness from exposure to lead. While research to date has focused on selected construction activities, there remains a need to determine the true scope of the problem. The objectives of this project were to: characterize the prevalence of elevated blood lead concentrations in high risk construction trades in Iowa; identify risk factors that may contribute to occupational exposure to lead in construction; and evaluate compliance with the OSHA construction lead standard. A sample of 432 workers was selected from the total population of all union members in the following trade groups: painters, plumbers/pipefitters, ironworkers, laborers, and electricians. Venous blood samples were collected from each participant and analyzed for lead using atomic absorption spectroscopy. Information on demographics, symptoms, occupational history, work practices, personal protective equipment, and training were gathered using questionnaires. Geometric mean blood lead concentrations by trade group were: painters (5.9 ug/dL, n=83); plumbers (4.4 ug/dL, n=82); laborers (7.6 ug/dL, n=80); ironworkers (5.2 ug/dL, n=87); electricians (2.4 ug/dL, n=91). Blood lead levels for painters and laborers were significantly

higher than other trade groups, and blood lead levels for electricians were signficantly lower ($p < 0.01$). Participants reported working primarily on commercial and industrial projects including new construction, renovation, and demolition. There were significant differences between the types of projects performed by different trade groups with laborers performing more bridge renovation ($p < 0.01$), and plumbers reporting more residential remodeling ($p = 0.05$), repair of water lines containing lead ($p = 0.04$), or work on lead joints ($p < 0.01$). In addition to trade, elevated blood lead levels were associated with the type of construction project (especially bridge renovation and residential remodeling), activities including welding,cutting, rivet busting, and the age of the home in which the worker lived. Compliance with OSHA's Construction Lead Standard was poor. Suggestions for intervention include more effective dissemination of information and training, improved enforcement of existing standards, labeling of lead containing materials, replacement or elimination of lead containing materials, development and use of improved engineering controls, inclusion of specifications for lead managment programs in bid specifications.

IV. BODY OF REPORT

A. Background

Lead poisoning is a serious hazard for construction workers. It is estimated that over 900,000 U.S. construction workers are at risk of lead poisoning. [Occupational Safety and Health Administration, 1993]. Exposure assessments reported by the National Institute for Occupational Safety and Health (NIOSH) and the Occupational Safety and Health Administration (OSHA) indicate that construction workers performing certain tasks may be exposed to airborne lead at concentrations hundreds of time greater than accepted limits. At selected construction sites where air monitoring has been performed, 65% of airborne concentrations of lead have exceeded OSHA's pre-1993 Construction Lead Standard of 200 ug/m^3 [Robinson et al., 1990]. Airborne lead concentrations as high as 29,000 ug/m^3 have been reported inside confined areas during abrasive blasting, and lower levels associated with demolition (200 - 300 ug/m^3), steel cutting and rivet busting (1500 ug/m^3) still greatly exceed the current OSHA PEL of 50 ug/m^3 [Occupational Safety and Health Administration, 1993; Robinson et al., 1990; National Institute for Occupational Safety and Health, 1991]. In addition, surveillance systems indicate that construction workers in selected trades are experiencing some of the most severe cases of lead poisoning reported. While the true extent of lead exposure among trades involved in different types of construction is unknown,

reports to date have indicated that construction activities involving lead-based materials can result in severe lead poisoning for workers, their family members, and nearby communities [Occupational Safety and Health Administration, 1993; Robinson et al., 1990; Grandjean and Bach, 1986; Landrigan et al., 1982; Pollock and Ibels, 1986; Fischbein et al., 1984; National Institute for Occupational Safety and Health, 1991; Centers for Disease Control, 1992; Piacitelli et al., 1995]. The true extent, or prevalence, of lead poisoning in construction workers and the risk factors that contribute to this problem are not known.

B. Specific Aims

The specific aims of this project were to:

1. Characterize the prevalence of elevated blood lead concentrations and FEP levels in Iowa construction workers in selected high risk trades including painters, ironworkers, plumbers and pipefitters, laborers, and electrical workers.

2. Identify and evaluate risk factors such as work practices, use of engineering controls and personal protective equipment, that may contribute to occupational exposure to lead in these construction trades.

3. Evaluate the utility of using the Iowa Department of Public Health (IDPH) Adult Blood Lead Surveillance Project and The University of Iowa Hospitals Clinical data bases to identify and mitigate cases of occupation lead poisoning in the construction industry.

4. Evaluate compliance with OSHA's lead standard for the construction industry.

5. Collect, organize, and disseminate information concerning lead hazards and control methods by adding this information to the National Hazard Communication Resource Center and delivering presentations to construction workers.

6. Generate data to be used in planning future projects to quantitatively evaluate occupational exposure, and develop intervention strategies.

C. Procedures and Methodologies

I. Personnel

Personnel participating in the project (all from the Department of Preventive Medicine and Environmental Health) included:

Principle Investigator:

Stephen J. Reynolds, Ph.D., CIH, Associate Professor - Industrial Hygiene

Co-Investigators:

LaURence Fuortes, M.D., MS, Associate Professor - Occupational Medicine

Nancy Sprince, M.D., MPH, Associate Professor - Occupational Medicine

William Clarke, Ph.D., Professor - Biostatistics

Staff and Student Graduate Research Assistants:

Sunita Dhawan, M.S. - GRA

Rick Garrels, M.D., M.S. - Resident;

John Johnson - GRA, PhD Candidate

Stephanie Leonard, M.S. - Industrial Hygienist

Jason Stookesbury - GRA

Laurie Walkner, R.N - nurse.

II. Blood Sampling Protocols. A standard operating procedure for collection of blood samples was developed in October 1993. When permission was obtained from CDC/NIOSH to add ZPP analysis, the procedure was modified to include the heparinized tube. Protocols for labeling, shipping, analyzing, and reporting blood lead results were established with the University Hygienic Laboratory (UHL) in November 1993. Samples were collected in 3 cc edta vacuum tubes, and labeled with bar-coded labels identifying each subject. Samples and chain of custody forms were dropped off at the Oakdale Campus office of the UHL for delivery to Des Moines. The UHL analyzes samples for blood lead and reports results directly to Dr. Reynolds. The UHL also provided information on their QA/QC procedures, and analyzed field blanks, spikes, and replicates. After approval had been obtained in February 1994, procedures for handling and analysis of blood samples for ZPP were agreed upon with the UI Department of Pathology. Samples were collected in heparinized tubes, labeled, and delivered with a chain of custody form. When the first results were received it turned out that the Department of Pathology was actually analyzing samples for

FEP not ZPP. This remained consistent throughout the remainder of the project at Dr. Reynolds request. The Department of Pathology has provided a copy of their certifications from the College of American Pathologists Commission on Laboratory Accreditation and Department of Health and Human Services (CLIA).

III. Questionnaire. The questionnaire was developed based upon several sources: examples of questionnaires used by other researchers; review of the literature; guidance from other researchers; interviews and site visits by Dr. Reynolds; and the OSHA Construction Lead Standard. Questionnaires used by other researchers in this field were reviewed to provide sources that had been standardized, or at least tested in the field. Sources have included: 1990 U.S. Census, National Health Interview Survey 1988 and 1991, the Center to Protect Worker's Rights (IBEW Survey), NIOSH questionnaires (HETA 93-502, HETA 94-0093), Dallas Health Department (Dallas Lead Exposure Study), Mount Sinai (Stephen Levin - Manhattan Bridge Rehabilitation Project), Massachusetts Department of Labor and Industries (Richard Rabin - Occupational Lead Poisoning Registry Industrial Hygiene Interview, Industrial Hygiene Investigation Data), The University of Iowa/Center to Protect Worker's Rights Construction Survey (Tom Cook, John Rosecranse). In addition to reviewing the scientific, and construction profession literature, Dr. Reynolds sought advice on content from individuals in a variety of government, academic, and professional settings. Reports of site visits provided by R. Leroy Mickelson (NIOSH), and Pam Susi/Scott Schneider (Center to Protect Workers Rights) were particularly helpful. Dr. Reynolds also spent a significant amount of effort visiting architects, local construction union representatives, and non-union construction representatives to learn more about the practices and tasks involved in construction. As part of these discussions Dr. Reynolds visited a number of construction sites, observing and interviewing workers on-site. Additional content for the questionnaire was developed based upon the information on tasks and projects provided in OSHA's Construction Lead Standard 29 CFR 1926.62. An initial draft of the questionnaire was pilot tested by members of the Iowa City Laborers Union in April 1994. Based on this pilot test, and additional discussion with business managers from the other local unions (electricians, painters, plumbers, ironworkers) the questionnaire was further revised and sent to collaborators in the University of Iowa and outside (not participating in the project) peer reviewers in early May 1994. Comments were received from a total of 8 outside peer reviewers. They included: Lynda Ewers

(NIOSH), Jane Gittelman (NIOSH), Linda Goldenhar (NIOSH), R. Leroy Mickelson (NIOSH), Linda Ogilvie (The University of Iowa), Richard Rabin (Massachusetts Department of Labor), John Rosecrance (The University of Iowa), and David Valiante (NJ Department of Health). Based on the advice of the reviewers extensive changes were made in the questionnaire. The questionnaire underwent further pilot testing and modification for skip patterns, and coding for data entry before being implemented. It is important to note that the questionnaire was administered by Dr. Reynolds, and was not completed by subjects on their own. Although it is long in terms of pages, was intended that workers complete only the sections on specific tasks appropriate for their trade and were able to skip the remainder of the sections on specific tasks. Subjects were usually able to complete the questionnaire within 20 to 30 minutes. Painters and laborers in particular had a more difficult time, possibly because of a lower reading skill level. A copy of the questionnaire is attached to this report

IV. Project Promotion. Promotion of the project was initiated in November 1993, and continued as recruitment of subjects proceeds. On November 17, 1993 Dr. Reynolds organized a one day session on "Health Issues in Construction - Emphasis on Lead" at the Iowa Governor's Safety Conference in Des Moines, Iowa. This project was discussed as part of that session. Approximately 50 people participated representing union construction workers, non-union construction workers, industrial hygienist, safety specialists, nurses, physicians, and regulators. As a result of this session, Dr. Reynolds developed additional contacts within the construction industry and was invited to visit several construction sites. A press release describing the project was prepared by The University of Iowa's public relations department in December 1993. This was printed in newspapers such as the Iowa City Press Citizen, and the Cedar Rapids Gazette which serve the area in which potential subjects live. Several radio stations from around eastern Iowa followed up with interviews. Dr. Reynolds also promoted the project by speaking to workers at 12 local union meetings. The intent was to describe the project and it's importance, answer questions, and gauge the level of support. Joint promotional letters from Dr. Reynolds and the business agents for several trade groups including electricians, painters, plumbers, and ironworkers were mailed to all members as recruitment progressed.

V. Selection of Subjects.

Subject selection and recruitment was extremely time-consuming and challenging due to differing acceptance of the local business agents and board members who are the key persons controlling access to the union members. **Table I.** (attached at end of this document) summarizes the recruiting efforts, demographic makeup of the union populations, number of members recruited, and number of sampling trips conducted.

Most unions are protective of their membership lists, and each has different procedures for allowing access to their members. The electricians were very excited about this project and were the first group selected for participation. Electricians Local #405 had a total of 475 active members. Their business agent requested that we provide them with a list of 100 random numbers, and they provided the names, addresses, and phone numbers for the individuals at these positions on the list. Upon receiving this list, we sent recruitment letters (as approved by the University of Iowa IRB) and followed up with repeated phone calls to confirm participation and scheduling. In our first session, 32 subjects participated. Those choosing to not participate were replaced by selection of new random numbers. As the required level of 100 workers was approached it became much more difficult and time consuming to recruit the randomly selected workers and repeated generation of new random numbers has resulted in essentially inviting the whole population to participate. A total of 92 electricians from this union participated (20% of the total eligible population).

Ironworkers Local 89 was also very excited about participating in this project, and subject selection and sampling proceeded according to the original strategy of randomly selecting 100 subjects from their total membership list (n = 109). Sixty six members (61%) from this Local participated. Additional Ironworkers were then recruited from Local 111 which had a total of 220 members. Twenty two (10%) of the 39 recruited chose to participate. A total of 88 Ironworkers from these two Locals participated in the study.

Painters local 447 in Cedar Rapids had a total of 93 members with only 70 active, all of whom were invited. 25 chose to participate. To meet our need for additional painters Dr. Reynolds

approached painters locals in Des Moines, IA, and Davenport, IA/Rock Island, IL. Painters Local 676 in Davenport/Rock Island agreed to participate and requested that we recruit members at the union hall as they attended meetings, rather than sending letters and calling. Of a total membership of 300 we were able to recruit 73 (24%). Using this strategy we actually recruited approximately 50% of the painters who were contacted. The total number of painters participating from these two Locals was 102.

The business agents for the plumbers in Cedar Rapids and for the laborers in Cedar Rapids were not responsive to this project and prevented access to their membership. The Plumbers Local 25 in Davenport/Rock Island agreed to participate and asked us to mail an invitation to all members (n = 350), with a card that could be returned indicating the members interest in participating. A total of 51 (15%) from this Local participated. Additional plumbers were recruited from Locals 66 (Davenport, IA) and 387 (Dubuque, IA) using the same approach for a total of 82 plumbers.

The most problematic trade group was laborers. Several weeks were spent mailing invitations to all 100 members of the Laborers Local 1238 in Iowa City followed by repeated phone calls. Many letters were returned indicating that the subject had moved, and a significant proportion had no phone. Only 4 showed up for sampling. The same problem was anticipated by the business agent for Laborers Local 309 in Rock Island, Il and he requested that we recruit members at the local union hall as they arrived looking for work in the morning. Recruiting as they walked in the door, we had a participation rate of approximately 40% of those contacted and sampled a total of 62 (7%). Additional laborers were added to the study through access to a bridge renovation site which had been identified when one of the study staff (Dr. Garrels) diagnosed lead poisoning in several workers. A total of 80 laborers were sampled.

To help assess the representativeness of our sample, the business agents provided information on demographics of their membership. We also attempted to gather information on the characteristics of individuals who refused to participate in the study. Of those who refused, most were simply not interested, too busy, or averse to giving blood.

V. Data Collection, Blood Lead, FEP Analysis.

Data collection began on August 2, 1994 with Electricians local #405 and concluded on August 1996. A total of 45 sampling sessions were conducted (**Table I**). A total of 459 construction workers participated in the study including: 102 painters, 82 plumbers, 80 laborers, 88 ironworkers, 93 electricians, and 14 in other trades such as carpenter, operator, engineer, safety professional. Not all completed both questionnaires and blood sampling.

After subjects had signed informed consent documents, they were asked to complete the questionnaires with the assistance of Dr. Reynolds or other project staff. In most cases groups of participants worked on completing the questionnaires during a joint session. Venous blood samples were collected from the cubital vein in the arm or from the back of the hand in separate 3cc vacuum tubes containing either ethylenediamine tetraacetic acid (EDTA) for the lead analysis or Heparin for the zinc protoporphyrin (ZPP) analysis. Lead analysis was performed by Graphite Furnace Atomic Absorption (GFAA) following a method recommended by the Centers for Disease Control and Prevention (CDC) for blood lead analysis [New York State Department of Health, 1991]. No problems were encountered with either blood lead or FEP analysis. FEP results were reported as both ug FEP/gram HB, and ug FEP/ 100 ml RBCs. No samples clotted or were lost. All blanks submitted were below detectable levels. The protocols and systems developed for blood sample collection, handling, chain of custody, shipping, and reporting worked extremely well and communications with the University Hygienic Lab and the UI Pathology Lab peforming the analyses were excellent and timely.

VI. Data Entry and Statistical Analysis.

Data was entered into an Epi Info data base developed to include blood lead and FEP concentrations as well as the questionnaire data. Data was then analyzed using SAS 6.1. Both programs were run on the local area network at the Institute for Rural and Environmental Health (renamed in 1995) within the Department of Preventive Medicine and Enviromental Health. Data was entered by the Graduate Research Assistants, with quality control being implemented by Dr. Reynolds and Paul Whitten. Backup files of data were made daily, and photocopies of

questionnaires were also made and kept in locked files. Accuracy of data entry was confirmed by a second staff person on a regular basis, with more than 10% of all files validated for quality control.

Descriptive statistics (Univariate) were used to evaluate the distributions of the data. If the data were not normally distributed, they were log transformed prior to conducting further analyses. Non-parametric tests were also used since log-transformations did not result in normal distributions for blood lead levels and FEPs. Proportions of categorical responses were evaluated over all workers and by construction trade for demographics and for most sections of the questionnaire. Differences in proportions among trades were evaluated using Chi-square tests. Kruskall Wallace (Npairways ANOVA) and Wilcoxon Rank Sum Scores were used to test for differences in blood lead levels and FEPS among all trades and between individual trades, and by season. T-Tests or Paired Signed Rank Tests (nonparametric T-Test) were used to test for differences in blood lead and ZPP measures over time for a subset of data from Bridge workers, and T-Tests were used to test for differences in blood lead and ZPP for cases reporting symptoms compared to non-cases. Spearman correlations were calculated to evaluate relationships between blood lead levels or FEPs and potential predictor variables, while stepwise multiple linear regression was used to evaluate the relationships between multiple predictor variables and blood lead level or FEPs.

VII. Followup/Letters to Subjects.

Results of blood lead and FEP measurements were mailed to subjects immediately after receipt from the laboratories. Examples of results letters are attached to this report. Separate letters were sent to subjects with blood lead concentrations below and above 20 ug/dL. In several cases of elevated blood lead levels, the investigators participated in intervention including continued clinical evaluation and treatment (one subject was chelated), training, development of a Lead Compliance Program, and exposure assessment. The publication *Lead Poisoning Among Construction Workers Renovating a Previously Deleaded Bridge. Am J Ind Med, in press.* attached to this report describes in detail the most extensive intervention conducted.

D. Results and Discussion

Results are organized in this section primarily according to the specific aims of this project. Tables of results are attached at the end of this report.

I. Demographics

Table II. Presents demographic results by trade. Participants were overwhelmingly white (94.8%) and male (97%). They ranged in age from 19 to 74 years, with an average age of 42 years. Most had either a high school education, some college, or trade school. The number of years employed in construction ranged from less than 1 to 49, with a mean of 18.8 years. Participants had work for an average of 2.2 different employers in the previous year. There were no significant differences between trades for these variables except for education with more electricians and plumbers reporting some college or trade school ($p < 0.01$). Comparison to the demographics reported by Business Agents in **Table I.** indicates that participants are representative of the racial and gender characteristics of the full union membership. Detailed information on non-participants was collected primarily for plumbers and electrical workers **Table III.** and indicated that these refusals were slightly younger (mean age = 37 years) than participants and that more (29.7%) were apprentices.

II. Blood Lead Levels and FEPs

Specific Aim 1: Characterize the prevalence of elevated blood lead concentrations and FEP levels in Iowa construction workers in selected high risk trades including painters, ironworkers, plumbers and pipefitters, laborers, and electrical workers.

Blood lead levels (BLL) and FEPs, overall and by trade, are presented in **Tables IV, V, and VI.** Both arithmetic and geometric means are reported since blood lead levels are often lognormally distributed in populations. The overall geometric mean BLL was 4.7 ug/dL, slightly higher than the U.S. national average of 3 ug/dL reported in NHANES III. Laborers had the highest BLL (gm = 7.6 ug/dL), while electricians had the lowest (gm = 2.4 ug/dL). Laborers also had the highest percentage of participants with BLLs exceeding 10 ug/dL (30.0%) and 20 ug/dL (15.0%). Overall the differences between trades (Npairways ANOVA - Kruskall Wallace) were significant ($p = 0.0001$). FEP1, expressed as ug FEP/gram HB, was very similar among the five trades targeted (gm = 1.4 to 1.5), as was FEP2 (gm = 45.6 to 48.9). Blood lead levels were not correlated with

FEPs, although, not unexpectedly FEP1 and FEP2 were highly correlated ($r = 0.998$, $p < 0.0001$). **Table VII.** presents the individual Wilcoxon Rank Sum Scores comparisons between individual trades as well as the overall comparisons. For BLL, laborers were significantly higher than plumbers, ironworkers, and eletricians, but not painters or other trades. Painters had higher BLL than plumbers, and electricians, but not ironworkers. A different pattern was seen for FEPs, with no significant differences between trades, except for other trades being significantly lower. Although not all trades were sampled in all four seasons, there were statistically significant differences in BLL and FEPs for plumbers, laborers, ironworkers, and electricians depending on the season **Table VIII.** Blood lead levels measured in the fall were highest for all trades, while the pattern of seasonal differences in FEPs varied depending on the trade.

In general, blood lead levels were lower than expected among this population of midwest construction workers, while the rank order of BLLs was consistent with that hypothesized based on the literature.

III. Risk Factors

Specific Aim 2: Identify and evaluate risk factors such as work practices, use of engineering controls and personal protective equipment, that may contribute to occupational exposure to lead in these construction trades.

Table IX presents information concerning work practices and occupational health based on question numbers 18 through 41 of the questionnaire. These questions pertained to practices over the whole course of the participants career in construction. There were significant differences between trades who had received training or written information concerning lead hazards and regulations. Seventy four percent of painters and 53% of ironworkers had received training or written information on lead, while the proportions in other trades were much lower. Overall, only 38% of those responding had received written information or training.

Eighty eight percent of respondents had used a respirator or dust mask, and of those answering in the affirmative 88% used a single strap dust mask, 89% used a 2-strap dust mask, 70% used an air purifying respirator, 62% used supplied air, 18% used SCBA, 28% used powered air purifying respirators. There were differences between trades in respirator use patterns. Of those who used

respirators only 65% had been fit tested, 76% had been trained, and only 49% had been examined by a physician and of these only 4% reported having undergone pulmonary function testing. Forty percent of respirator users cleaned them only once a week or less, 29% stored the respirator in a locker, 66% in their car, 63% in a clean area. Ten percent reported having a beard while wearing a respirator and 51% reported having a mustache.

Ninety seven percent of respondents did not shower at work before going home, and 68% reportedly never change out of work clothes before going home. Only 12% usually or always changed. Fourteen percent used disposable clothing at work. Sixty four percent washed their hands more then half the time before eating at work, 33% do so more than half the time before drinking, but only 8% wash more than half the time before smoking at work. Thirty six percent smoke at work, 25% bite their nails, and 10% (31% of electricians) chew on plastic coated electric wires (which may contain lead).

Overall, 18% had a previous blood test for lead, but painters had a much higher rate of 54%. Sixty percent of these had been tested as part of a regular testing program at work. Only 4% reported having been told they had an elevated BLL and 2% reported having been treated for lead poisoning.

Table X presents results from question 42. which asked: *during the last 3 months have you had any of the following symptoms for more than a week?* The most common symptoms reported included: excessive tiredness (11%), unable to sleep (11%), headache (16 %), irritability (10%), muscle aches/pains (24%), joint pain (27%), numbness of hands and feet (12%), and forgetfullness (10%). In a more detailed evaluation of a subgroup of workers from a bridge site (see attached manuscript) 6 of 20 workers completing this section of the questionnaire indicated that they had experienced a variety of symptoms with stomach pain, headache, irritability, and muscle aches being most common. These were also the most common symptoms verbally reported by the individuals initially complaining on this job site, but who did not complete the questionnaire. Although only 20 individuals completed this section of the questionnaire, there was a significant difference between the mean blood lead for the six workes reporting three or more symptoms (29.7 ug/dL) and the mean blood lead for those with no symptoms (9.5 ug/dL) at $p = 0.0005$, T-Test.

There was no significant difference in mean ZPP (symptoms = 26.2 ug/g Hg, no symptoms = 22.0 ug/g Hg). **Table XI** shows that 6% reported having trouble conceiving children.

Table XII presents project and practice information specific for the workers most recent job. Although there were statistically significant differences between trades for both the type of construction and the type of project most worked in commercial or industrial settings on new construction or renovation/remodeling. Painters worked primarily in commercial (60%) and industrial (24%) settings with 46% involved in new construction and 34% in remodeling. Plumbers also worked mostly in commercial (44%), industrial (41%), and residential (15%) settings, with 45% involved in new construction and 37% in remodeling. Laborers worked in commercial (34%), industrial (22%), highways/streets (18%), and bridge (14%) settings with 43% involved in new construction and 30% in remodeling. Ironworkers worked mostly in commercial (47%) and industrial (47%) settings with 74% involved in new construction and 17% in remodeling. Electricians worked primarily in commercial (49%) and industrial (47%) settings with 52% involved in new construction and 44% in remodeling/renovation. Overall 13% reported that lead dust or fumes were generated in their work on this job; 55% did not know. Medical exams were provide for only 7% of the respondents (mostly laborers). Training on working safely with lead was provided to 12% overall, 21% of painters and 18% of ironworkers. Training on respirator use was provided to 14%. Written information on lead hazards, such as Material Safety Data Sheets, was reported by 38% of all respondents, and 16% reported that warning signs were posted in lead containing areas. Of the 18% reporting using respirators on this most recent job, only 22% had been fit tested. Coveralls or protective clothing was reportedly used by 19%, and controls such as clothes changing facilities (19%), water for washing hands/face (61%), showers (15%), separate eating facilities (39%) were seldom available. Air monitoring was conducted on only 13% of these projects and environmental (bulk/surface) monitoring for lead was conducted on only 7% of the sites.

Table XIII provides more detailed information on these most recent projects, including the numbers of workers in each trade by project type. Again, the majority of these union members were involved highway/bridge repair (26), commercial and industrial demolition (70), indoor industrial maintenance/renovation (115), outdoor industrial maintenance/renovation (58), industrial

process equipment manufacturing/maintenance/repair (51), new commercial construction (141), new industrial construction (133), new residential construction (32), commercial industrial remodeling (60), and residential remodeling (29). Much smaller numbers were involved in projects specifically involving lead materials such as repair/removal of lead water lines (10), lead joint work on pipes (9), installation of radiation shielding (2), and installation of lead waterproofing or shower pans (4). It should be noted that many workers classified the most recent job as meeting more than one category, however the followup detailed task questions usually combined these similar categories.

Table XIV provides very specific information on the tools, respirators, engineering controls, and hygiene controls used on these most recent jobs. As can be seen, a large variety of tools were used although the most common included torches, arc welders, grinders, disc sanders, and drills. The most common respirators used, in rank order, were: none; dust masks; and half mask air purifying respirators. Supplied air and blasting helmets were also used, but less frequently. Engineering controls reported included local or mechanical ventilation, HEPA vacuums, shrouds/vacuum, and wetting agents with the most diverse and frequent applications occuring in new construction and industrial/commercial. Hygienic controls consisted primarily of water for washing hands.

In addition to job activities, information about potential risk factors off the job are presented in **Table XV**. Seven seven percent of the participants completing the questionnaire owned their homes, 81% of which were single family dwellings. Of the 391 participants answering question 60 about home age, 327 lived in homes built before 1980 and therefor potentially containing lead-based paint. A large number (187) had done remodeling which included paint removal (88), plumbing (120), soldering/welding (98), and 156 had done the work themselves. A significant number engaged in hobbies such as stained glass, riflery/shooting, casting/smelting lead with potential for exposure to lead. **Table XV** also presents information on exposures to pesticides, solvents, and other materials with potential for neurotoxic effects, as well as information on dependents. The potential for exposures of dependents to take-home lead is being explored by a graduate student, John Johnson, as part of a followup study to be incorporated in his Ph.D. dissertation.

Associations between BLL or FEPs and potential risk factors were evaluated by calculating Spearman Correlation coefficients - **Table XVI** - followed by multivariate stepwise linear regression analysis - **Table XVII**. Risk factors that were significantly associated by themselves with an increased BLL included: lead dust/fumes generated on most recent job (especially for certain trades); current respirator use; highway/bridge repair; commercial/industrial demolition; new construction of highways/streets and bridges; residential remodeling; repair of lead membrane waterproofing; older residences; casting/smelting lead. Electric cable splicing was associated with lower BLL possibly due to proper work practices by electricians or by chance given the large number of variables evaluated. Significant correlations for FEPs were primarily in the opposite direction of BLL correlations except for residence in an older home. None of the correlation coefficients for BLL were strong, the highest correlations for BLL being for lead dust/fumes generated ($r = 0.54$ for laborers), casting/smelting lead ($r = 0.338$), and older homes ($r = -0.256$). The highest correlation coefficients for FEPs (up to - 0.47) were associated with hobbies.

Construction trade was previously found to be a significant predictor of increasing BLLs and FEPs (**Tables IV, V, VI**) as well as season (**Table VIII**). Blood lead levels and FEP2 were also significantly associated with type of construction on most recent job, type of project, and type of residence when analyzed by nonparametric ANOVA (Kruskall Wallis) **Table XVII.** Demolition, lead abatement, renovation/remodeling on bridges and highways/streets were associated with higher BLL. Characteristics of individuals with BLLs exceeding 20 ug/dL, described in **Table XVIII**, reinforce the association with bridge renovation, specific tasks of welding, cutting, and rivet busting (along with no use of engineering or personal protective equipment controls), and residence in an older home.

Risk factors which were significantly correlated with BLL or FEPs, that represented more than 10 participant responses, were tested using stepwise multiple linear regression models to evaluate their relationships taking into consideration the other risk factors. None of the independent variables or models were significant for FEP1 or FEP2. The model calculated for BLL is presented in **Table XIX.** Risk factors that remained in the final model included: bridge work; new construction (lower risk); lead dust present; plumber (lower risk); laborer; electrician (lower risk); new construction on bridges/highways; residential remodeling; and older homes. This model explains 33% of the

variability in BLLs ($p = 0.055$), and reinforces the importance of risk factors identified through Spearman Correlations and other previous approaches.

IV. Compliance

Specific Aim 4: Evaluate compliance with OSHA's lead standard for the construction industry.

As described above in section III. compliance with the requirements of OSHA's lead standard for the construction industry was poor. See above and **Tables XII, XIV.**

V. Surveillance in Iowa

Specific Aim 3: Evaluate the utility of using the Iowa Department of Public Health (IDPH) Adult Blood Lead Surveillance Project and The University of Iowa Hospitals Clinical data bases to identify and mitigate cases of occupation lead poisoning in the construction industry.

Records of the Iowa Department of Public Health (IDPH) Adult Blood Lead Surveillance Project and The University of Iowa Hospitals Clinical (UIHC) data bases covering the time period of this project were reviewed to determine whether the blood lead measurements conducted in this study were captured by either of these systems. It was anticipated that all of the BLLs would be included in the IDPH Adult Blood Lead Surveillance Project data base since the analyses were conducted by the state University Hygienic Laboratory (UHL) and any levels exceeding 25ug/dL are to be reported in the state of Iowa. Of the 16 construction workers with BLLs exceeding 25 ug/dL found in this study, only one was included on the IDPH Adult Blood Lead Surveillance Project data base, and two were included in the UIHC data base. Several factors may explain the low rate of inclusion on the IDPH Adult Blood Lead Surveillance Project data base: reports were not sent to IDPH or reports did not get entered into the data base. It seems likely that the limited staffing and resources available for the Adult Blood Lead Surveillance Project play a role, in contrast to the Childhood Blood Lead Surveillance Project which is well organized. NIOSH currently provides support for 0.35 FTE for this project, increasing this to at least 1.0 FTE is desirable. In contrast to pediatricians, physicians evaluating adults with potential lead exposures also appear less likely to be aware of the Adult Blood Lead Surveillance Project and the requirement for reporting. Of the 42 adults included on the UIHC clinical records data base, 8 were welders, one was an electrician, and one was a sheet metal worker. Other occupations represented include battery manufacturing (5), radiator shop (9). The Adult Blood Lead Surveillance Project had a total of 342 subjects

listed, with 122 working for one battery manufacturing firm, and many of the others not coded in a manner amenable to determining occupation. Occupation was coded as unknown for the one subject from this study. It appears at this time that the Adult Blood Lead Surveillance Project is of limited use for identifying and mitigating lead poisoning in the construction industry primarily (in our opinion) due to the lack of resources for data management and case followup.

VI. Information Dissemination

Specific Aim 5: Collect, organize, and disseminate information concerning lead hazards and control methods by adding this information to the National Hazard Communication Resource Center and delivering presentations to construction workers.

As described below, 9 presentations or training sessions related to this project have been conducted. Audiences included construction worker, contractors, local union business agents and representatives, health care professionals, and regulatory representatives. In addition to sending a reduced version of this report to each union Local that participated, Dr. Reynolds has offered to attend upcoming union meetings to discuss the project and answer questions; four of the locals have indicated an interest in this followup. Four manuscripts related to this work have been published or accepted for publication, and more than seven are planned, including articles intended for more "popular" construction trade journals.

The original intention to use the National Hazard Communication Resource Center at Iowa to help disseminate this information could not be completed since this resource center is no longer funded or existing. The World Wide Web page for the Consortium for Construction Health and Safety (http://info.pmeh.uiowa.edu/construct/construc/.htm) will be used to help disseminate the findings of this study. Dr. Reynolds is currently working with Dr. Tom Cook (who acted as an advisor for this project) to incorporate appropriate information. This should be completed in the first quarter of 1997.

VII. Recommendations

Specific Aim 6: Generate data to be used in planning future projects to quantitatively evaluate occupational exposure, and develop intervention strategies.

As a result of this project two followup studies were initiated. *Evaluation of the Safety and Effectiveness of Lead Paint Hazard Reduction When Conducted by Homeowners and Landlords* was funded by the CDC through the Iowa Department of Public Health and was completed in 1996 resulting in one Ph.D. dissertation and several publications in progress. The results of this study may have a significant impact on the practices and health of persons involved in one aspect of lead and construction. The intervention conducted in response to identification of a subgroup of bridge workers with elevated BLLs is described in the attached manuscript *Lead Poisoning Among Construction Workers Renovating a Previously Deleaded Bridge*. This intervention provides a model for a collaborative effort involving several occupational health disciplines and combined public and private resources. A followup study focused on evaluating exposures by task and trade group during these types of bridge renovation activities in the midwest has been funded by the Center for Health Effects of Environmental Contaminants and is in progress.

Table XX lists the recommendations of the workers participating in this study for controlling lead exposures. Many of their recommendations basically call for compliance with existing regulatory requirements which are not being implemented. Others such as identifying, labeling, or removing lead materials from use in the construction industry are compatible with proposed federal legislation (Lead Exposure Reduction Act of 1993). Based on the results of this study, development of engineering control such as the efforts currently being conducted by NIOSH should be targeted to the those trades, tasks, tools, and project categories identified as risk factors. Information dissemination and training were the most frequently cited recommendations. A more concerted effort to provide information to union and non-workers, to contractors, and to architects, engineers, and other professionals responsible for planning and conducting construction activities could be most effective.

E. Conclusions

Blood lead levels (BLL) of these midwestern construction workers differed by trade. Geometric mean blood lead concentrations by trade group were: laborers (7.6 ug/dL, n=80); painters (5.9 ug/dL, n=83); ironworkers (5.2 ug/dL, n=87); plumbers (4.4 ug/dL, n=82); electricians (2.4 ug/dL, n=91). Blood lead levels for laborers and painters were significantly higher than other trade groups, and blood lead levels for electricians were signficantly lower ($p < 0.01$) differing little from the average for U.S. adults.

In addition to trade, the most important work related risk factors for elevated BLL included: highway/bridge repair or renovation; new construction of highways/bridges; commercial or industrial demolition; residential remodeling; and generation of lead dust or fumes during work activities. Even taking into account risk factors at work, living in an older home was also a significant predictor of elevated BLL and for elevated FEPs. Hobbies involving work with lead (such as stained glass, riflery/shooting, casting/smelting lead for bullets or sinkers) also were important risk factors.

Compliance with the requirements of OSHA's Interim Construction Lead Standard, and implementation of good occupational health and safety practices in general, was poor. Thirty eight percent reported ever having had training or receiving written information concerning lead hazards or regulations.While 88% of workers reported using respirators, only 65% had ever been fit tested, 76% had been trained, and 49% had been examined by a physician. Of those receiving medical exams only 4% reported that pulmonary function testing was included. On the most recent job only 22% of those using respirators had been fit tested. Washing of hands before eating, drinking, or smoking was reportedly low (64% to 8%) and 36% reported smoking at work, 25% biting their nails, and 10% chewing on plastic coated electric wires. Only 3% showered before going home, and 68% never changed out of work clothes. Environmental testing for lead (7% of most recent jobs) or air sampling to evaluate occupational exposure (13% of most recent jobs) to lead was rarely performed.

Although the numbers of workers performing lead abatement projects were small (n = 10), the trend for lower BLL in this group provides evidence that training, implementation of engineering controls, and proper use of personal protective equipment such as respirators is effective in controlling lead poisoning.

The Iowa Department of Public Health's Adult Blood Lead Surveillance Project data base appeared to be of limited use in identifying and mitigating occupational lead poisoning in construction workers. This may be due to insufficient resources and staffing available for this project, and to a lack of awareness among physicians and laboratories concerning reporting requirements. This surveillance project could be an important resource and efforts to educate physicians/laboratories and enhance support at IDPH are recommended.

Although the prevalence of elevated blood lead levels in these midwestern construction workers appears to be lower than anticipated by the authors based upon the literature, the risk of lead poisoning in certain trades specifically related to high risk projects is a significant problem. In addition to the workers themselves, their families and communities are also at risk due to the poor implementation of control measures. It is also apparent from the results of this project that lead containing materials continue to be commonly found throughout the construction industry. While this study focused on union members working on small to midsized projects in the midwest, the following recommendations may be generalizable to both union and non-union construction workers throughout the U.S.

Recommendations for intervention strategies include: dissemination of educational programs and information to construction workers, contractors, and other professionals such as architects and engineers responsible for planning and conducting construction projects; targeted implementation and enforcement of current regulatory requirements at job sites likely to involve exposure to lead such as bridges, and renovation/remodeling of commercial and industrial sites; specifications for evaluation and control of lead exposures, such as that recommended by the Center to Protect Worker Rights, should be required in bid specifications; development of engineering controls currently being conducted by NIOSH should be continued; identification and labeling of lead containing products or substitution of non-lead materials either voluntarily by industry or in

response to proposed legislation (Lead Exposure Reduction Act) would also be an effective intervention.

V. PUBLICATIONS AND PRESENTATIONS

Publications:

Reynolds, S.J., L.J.Fuortes, R.L.Garrels, P.Whitten, N.L.Sprince: Lead Poisoning Among Construction Workers Renovating a Previously Deleaded Bridge. Am J Ind Med, in press. *

Reynolds, S.J., L. Etre, P.S. Thorne, P. Whitten, M.Selim, W.Popendorf: Laboratory Comparison of Vacuum, OSHA, and HUD Sampling Methods for Lead in Household Dust. AIHAJ, in press. *

Fuortes LJ, Weismann DN, Gergely R, O'Donnell S, Reynolds SJ. Pregnancy, pica, pottery, and PB. J Acad Clin Toxicol. In press. *

Etre, L.: Evaluation of the Safety and Effectiveness of Lead Paint Hazard Reduction When Conducted by Homeowners and Landlords. Ph.D. Dissertation. The University of Iowa, 1996.

* Copies of these manuscripts are enclosed with this report.

Publications planned:

1. Epidemiologic manuscript focusing on blood leads, FEPs for submittal to journal such as APHAJ or AJIM.

2. Exposure assessment/industrial hygiene manuscript describing project and task activities for submittal to journal such as AIHAJ or App Occ Env Hyg.

3. Evaluation of Compliance with OSHA's Construction Lead Standard for submittal to journal such as AIHAJ or App Occ Env Hyg.

4. Risk Factors for Lead Toxicity - based on review of clinical charts at University of Iowa, Hospitals and Clinics, for submittal to occupational medicine journal.

5. Targeted articles for construction trade journals.

6. Four epidemiologic, industrial hygiene, and analytical chemistry manuscripts based on the related project studying lead paint hazard reduction by homeowners.

7. Exposure evaluation manuscript on results of followup project evaluating Exposures and Tasks by Trades Renovating a Bridge in addition to a PhD Dissertation.

Presentations:

Reynolds, S.J.: Lead in the Construction Industry. Research Seminar. Division of Occupational and Environmental Health, The University of Iowa, Iowa City, IA. September 14, 1993

Reynolds, S.J.: Health Issues in Construction: Overview of Lead. Presented at Iowa Governor's Safety Conference, Des Moines, IA. November 18, 1993

Reynolds, S.J.: Lead Exposures in the Construction Industry. Presented at: Current Topics in Occupational Medicine, Iowa City, IA. May 6, 1994

Etre LA, Reynolds SJ. A comparison of sampling methods for lead in dust. Graduate student poster session presented at the American Industrial Hygiene Conference and Exposition (AIHCE): Anaheim, CA; May, 1994.

Reynolds, S.J.: Lead and Asbestos. An awareness level course presented at the Ironworkers Local 89 in Cedar Rapids, IA on May 15, 1995.

Reynolds, S.J. and Etre, L.: Lead Research . Research Seminar. Joseph Stephan Institute - University of Ljubljana, Ljubljana, Slovenia. June 8, 1995.

Reynolds, SJ. Awareness Level Training on Lead Exposure in Construction. Training for employees of Civil Construction; Rock Island, IL; 1995 Sep 19, 1995.

Etre, L., S.J. Reynolds (presenter), L. Burmeister, L.Fuortes.: Evaluation of the Safety and Effectiveness of Lead-Based Paint Removal Conducted by Homeowners. School of Environmental Sciences, Nova Gorica, Slovenia, June 1996.

Reynolds, S.J., L.Fuortes, N.Sprince, W.Clarke, J.Johnson, L.Walkner: Elevated Blood Leads in the Iowa Construction Industry. Submitted for presentation at AIHConference 1997, Dallas, TX.

REFERENCES CITED IN REPORT

Centers for Disease Control (1992): Surveillance of Elevated Blood Lead Levels Among Adults - United States, 1992. MMWR 41(17):285-287.

Fischbein A, Leeds M, Solomon S (1984): Lead Exposure Among Iron Workers in New York City: A Continuing Occupational Hazard in the 1980's. NY State J Med 84:445-448.

Grandjean P, Bach E (1986): Indirect Exposures: The Significance of Bystanders at Work and at Home. Am Ind Hyg Assoc J 47(12):819-824.

Landrigan PJ, Baker EL, Himmelstein JS, Stein GF, Wedding JP, Straub WE (1982): Exposure to Lead from the Mystic River Bridge: The Dilemma of De-Leading. N Eng J Med 306:673-676.

National Center for Health Statistics (1984): Blood Lead Levels for Persons Ages 6 Months - 74 Years: United States, 1976-80. US DHHS, Public Health Service, National Center for Health Statistics, DHHS Pub. No. (PHS) 84-1683.

National Institute for Occupational Safety and Health (1991): Preventing Lead Poisoning in Construction Workers. US Dept HHS/CDC/NIOSH, August 1991, Pub. No. 91-116.

New York State Department of Health (1991) The Lead in Whole Blood procedure used by the University of Iowa Hygienic Laboratory - Des Moines procedure (1993 version) based on the Blood Lead Determination by Electrothermal Atomization Atomic Absorption Spectrometry,.

Occupational Safety and Health Administration (1993): Federal Register. Interim Final Construction Standard, May 4, 1993, pp. 26590-26649.

Piacitelli GM, Whelan EA, Ewers LM, Sieber WK (1995): Lead Contamination in Automobiles of Lead-Exposed Bridgeworkers. Appl Occup Environ Hyg 10(10): 849-855.

Pollock CA, Ibels LS (1986): Lead Intoxication in Paint Removal Workers on the Sydney Harbour Bridge. Med J Aust 145:635-639.

Robinson C, Stern F, Venable H, Frazier T, Burnett C, Lalich N, Sestito J, et al (1990): The Assessment of Hazard in the Construction Industry - A DSHEFS Project (Draft). NIOSH, Division of Surveillance, Hazard Evaluations and Field Studies, May 4, 1990, Cincinnati OH.

TABLE I. SUMMARY OF CONSTRUCTION SAMPLING 1993-1996

Trade Group	Local		Members		Participants		%	Total	Trips
Painters	#447		**93**		**29**		**31**		
			White	*Black*	*Hispanic*	*NatAm*	*Asian*		
	Male	*99%*	*99%*	*1%*	*0*	*0*	*0*		
	Female	*1%*	*100%*	*0*	*0*	*0*	*0*		
	#676		**300**		**73**		**24**	**102**	**13**
			White	*Black*	*Hispanic*	*NatAm*	*Asian*		
	Male	*95%*	*96%*	*2%*	*2%*	*0*	*0*		
	Female	*5%*	*100%*	*0*	*0*	*0*	*0*		
Plumbers	#25		**350**		**51**		**15**		
			White	*Black*	*Hispanic*	*NatAm*	*Asian*		
	Male	*99%*	*92%*	*4%*	*3%*	*1%*	*0*		
	Female	*1%*	*100%*	*0*	*0*	*0*	*0*		
	#66		**93**		**13**		**14**		
			White	*Black*	*Hispanic*	*NatAm*	*Asian*		
	Male	*100%*	*98%*	*1%*	*0*	*1%*	*0*		
	Female	*0*	*0*	*0*	*0*	*0*	*0*		
	#387		**542**		**18**		**3**	**82**	**4**
			White	*Black*	*Hispanic*	*NatAm*	*Asian*		
	Male/female		information not available						
Laborer	#309		**929**		**62**		**7**		
			White	*Black*	*Hispanic*	*NatAm*	*Asian*		
	Male	*97%*	*93%*	*3%*	*3%*	*0.6%*	*0.2%*		
	Female	*3%*	*90%*	*7%*	*3%*	*0*	*0*		
	#1238		**91**		**6**		**7**	**68**	**13**
			White	*Black*	*Hispanic*	*NatAm*	*Asian*		
	Male	*98%*	*87%*	*6%*	*7%*	*1%*	*0*		
	Female	*2%*	*100%*	*0*	*0*	*0*	*0*		
Ironworker	#89		**109**		**66**		**61**		
			White	*Black*	*Hispanic*	*NatAm*	*Asian*		
	Male	*99%*	*99%*	*0*	*1%*	*0*	*0*		
	Female	*1%*	*100%*	*0*	*0*	*0*	*0*		
	#111		**220**		**22**		**10**	**88**	**6**
			White	*Black*	*Hispanic*	*NatAm*	*Asian*		
	Male	*98%*	*80%*	*Not available*					
	Female	*2%*	*100%*	*0*	*0*	*0*	*0*		
Electrical	#405		**475**		**92**		**20%**	**92**	**9**
		White	*Black*	*Hispanic*	*NatAm*	*Asian*			
	Male	*99%*	*98%*	*0.5%*	*1 %*	*0*	*0.5%*		
	Female	*1%*	*100%*	*0*	*0*	*0*	*0*		
						Total		**432**	**45**

TABLE II. SUMMARY OF DEMOGRAPHICS FOR PARTICIPANTS COMPLETING QUESTIONNAIRE

Parameter	All	Trade: Painters	Plumbers	Laborers	Ironworkers	Electricians	Other	Chi-Square P-Value
N	450	88	79	62	89	92	12	
Age - Mean	42	39	46	38	43	41	42	
SD	11	11	9	9	10	11	11	
Range	19 - 74	19-74	25-69	20-60	21-66	20-62	23-60	
Gender - Male	410	83	78	60	88	89	12	p = 0.46
	97%	94%	99%	97%	99%	97%	100%	
Female	12	5	1	2	1	3	0	
	3%	6%	1%	3%	1%	3%	0%	
Race White	400	79	78	57	84	92	10	p = 0.10
	94.8%	90%	99%	92%	94%	100%	83%	
Black	6	2	0	3	1	0	0	
	1.4%	2%	0%	5%	1%	0%	0%	
Hispanic	8	4	0	1	2	0	1	
	1.9%	5%	0%	2%	2%	0%	8%	
Nat. Am.	7	3	1	1	1	0	1	
	1.7%	3%	1%	2%	1%	0%	8%	
Other	1	0	0	0	1	0	0	
	0.2%	0%	0%	0%	1%	0%	0%	
Education								
Grade School	11	4	0	1	5	0	1	p<0.01
	(2.6%)	5%	0%	2%	6%	0%	8%	
Some High Sc.	30	11	1	8	6	2	2	
	(7.1%)	13%	1%	13%	7%	2%	17%	
High School	116	34	13	25	29	12	3	
	(27.6%)	39%	16%	40%	33%	13%	25%	
Some College	109	21	16	17	20	32	3	
	(25.9)	24%	21%	27%	23%	35%	25%	
College	21	2	3	4	5	5	2	
	(5.0%)	2%	4%	6%	6%	5%	17%	
Other/Trade Sc.	134	16	46	7	23	41	1	
	(31.8)	18%	58%	11%	26%	45%	8%	

TABLE II. SUMMARY OF DEMOGRAPHICS FOR PARTICIPANTS COMPLETING QUESTIONNAIRE - CONTINUED

Parameter	All	Trade						Chi-Square P-Value
		Painters	Plumbers	Laborers	Ironworkers	Electricians	Other	
Trade N (%)	450	88 (20.9)	79 (18.7)	62 (14.7)	89 (21.1)	92 (21.8)	12 (2.8)	
Currently Apprentice	54 (13.2%)	11 13%	6 8%	7 12%	10 12%	19 21%	1 9%	p = 0.24
Years Employed In Construction								
Mean	18.8	16.4	23.6	15.5	19.3	18.8	22.0	
SD	10.7	10.6	8.8	9.7	10.8	11.6	11.2	
Range	<1 - 49	1-42	2-42	<1-39	1-49	1-45	8-45	
Number of Employers in Past 12 Months								
Mean	2.2	1.4	1.9	3.2	3.2	1.7	1.8	
SD	1.8	0.9	1.4	2.3	2.3	1.3	1.0	
Range	0 - 12	0-5	0-6	0-10	0-12	0-6	0-3	

TABLE III. DEMOGRAPHICS ON NON-PARTICIPANTS

Parameter	N	Mean	SD	Range
Age	22	37	13	22 - 68
Gender - Male	40			
Female	0			
Race - White	39			
Black	0			
Hispanic	0			
Nat. Am.	0			
Other	0			
Trade Painter	0		Chi- Square p < 0.001	
Plumber	12			
Laborer	3			
Ironwrk	0			
Electric	20			
Other	5			
Apprentice	11 (29.7%)		Chi Square p = 0.032	
Years Employed In Construction	34	18.4	10	1 - 40
Number of Employers in Past 12 Months	17	2.5	4.6	1 - 20

*T- Tests for differences between Participants and Non-Participants for these parameters were not significant at p = 0.05 unless otherwise indicated .

TABLE IV. BLOOD LEAD RESULTS BY TRADE GROUP (ug/dL)

Trade Group	N	GM	Arithm. Mean	Std Dev	Range	Number (%) >10 ug/dL	Number (%) >20 ug/dL
All Groups	437	4.7	6.5	6.4	0.1-50.0	55 (12.6%)	16 (3.7%)
Painters	83	5.9	7.0	4.7	1.5 - 26.3	12 (14.5%)	2 (2.4%)
Plumbers	82	4.4	5.1	3.4	1.4 - 27.0	5 (6.1%)	1 (1.2%)
Laborers	80	7.6	11.2	11.4	1.2 - 50.0	24 (30.0%)	12 (15.0%)
Ironworkers	87	5.2	6.1	3.9	0.9 - 23.2	10 (11.5%)	1 (1.5%)
Electricians	91	2.4	3.4	2.4	0.1 - 13.3	1 (1.1%)	0
Other	14	5.9	6.7	3.7	3.1 - 13.7	3 (21.4%)	0

Npairways ANOVA p = 0.0001

TABLE V. FEP1 RESULTS BY TRADE GROUP (ug FEP/ gram HB)

Trade Group	N	GM	Mean	Std Dev	Range
All Groups	436	1.4	1.6	0.8	0.1 - 4.5
Painters	91	1.5	1.7	0.9	0.2 - 4.5
Plumbers	82	1.4	1.6	0.8	0.4 - 3.8
Laborers	70	1.4	1.7	0.8	0.3 - 4.2
Ironworkers	87	1.5	1.7	0.9	0.1 - 3.9
Electricians	93	1.4	1.6	0.7	0.1 - 1.7
Other	13	0.6	0.7	0.5	0.3 - 0.7

Npairways ANOVA p = 0.0011

TABLE VI. FEP2 RESULTS BY TRADE GROUP (ug FEP/ 100 ml RBCs)

Trade Group	N	GM	Mean	Std Dev	Range
All Groups	447	45.7	53.7	26.4	0.1 - 151.0
Painters	91	48.9	56.7	28.7	6.0 - 151.0
Plumbers	82	46.8	53.3	25.6	14.0 - 106.0
Laborers	80	45.7	53.3	27.0	9.0 - 140.0
Ironworkers	87	47.4	56.8	27.3	0.1 - 99.9
Electricians	93	45.6	53.0	22.0	2.0 - 94.0
Other	14	20.2	23.9	15.5	9.0 - 57.0

Npairways ANOVA p = 0.0005

Blood leads were not correlated with FEPs, FEP1 WITH FEP2 $r = 0.998$, $p < 0.0001$

TABLE VII. WILCOXON RANK SUM SCORES AND KRUSKALL WALLACE COMPARISON OF BLOOD LEAD LEVELS AND FEPS BY TRADE (P VALUES)

Trade Group Comparisons	Blood Lead Level (p)	FEP1 (p)	FEP2 (p)
Overall ANOVA (Wilcoxon Rank Sum)	**0.0001**	**0.0011**	**0.0005**
Painters - Plumbers	**0.0007**	0.4562	0.5530
Painters - Laborers	0.1296	0.9211	0.4819
Painters - Ironworkers	0.1711	0.7694	0.7442
Painters - Electricians	**0.0001**	0.6294	0.6229
Painters - Other	0.9060	**0.0001**	**0.0001**
Plumbers - Laborers	**0.0001**	0.5645	0.9292
Plumbers - Ironworkers	0.0363	0.3276	0.3890
Plumbers - Electricians	**0.0001**	0.6782	0.7341
Plumbers - Other	0.0653	**0.0001**	**0.0001**
Laborers - Ironworkers	**0.0067**	0.7341	0.3500
Laborers - Electricians	**0.0001**	0.4994	0.8121
Laborers - Other	0.4226	**0.0001**	**0.0001**
Ironworkers - Electricians	**0.0001**	0.5490	0.5220
Ironworkers - Other	0.4461	**0.0001**	**0.0001**
Electricians - Other	**0.0001**	**0.0001**	**0.0001**

TABLE VIII. SEASONAL COMPARISONS OF BLOOD LEADS LEVELS AND FEPS OVERALL AND BY TRADE (WILCOXON RANK SUMS/KRUSKAL-WALLIS)

Trade	Season	N	BLL (ug/dL) GM	BLL (ug/dL) GSD	FEP1(ug/g HB) GM	FEP1(ug/g HB) GSD	FEP2 (ug/ 100ml RBC) GM	FEP2 (ug/ 100ml RBC) GSD
Overall								
	Fall	91	6.4	2.1	1.1	2.4	35.4	2.5
	Spring	192	4.1	2.5	1.3	1.6	44.4	1.6
	Summer	81	3.7	2.2	1.6	1.6	52.9	2.3
	Winter	100	4.6	1.8	1.8	1.7	61.7	1.6
			p < 0.001		**p < 0.001**		**p < 0.001**	
Painters								
	Fall	22	6.2	1.6	1.6	1.9	54.9	1.9
	Spring	56	5.6	1.8	1.5	1.7	49.1	1.7
	Unknwn	5	8.4	1.8	0.8	2.2	27.8	2.1
		83	p = 0.304		p = 0.179		p = 0.175	
Plumbers								
	Fall	9	6.9	1.4	2.2	1.2	75.2	1.2
	Spring	52	4.2	1.8	1.1	1.6	37.3	1.6
	Winter	18	3.8	1.6	2.3	1.4	75.1	1.4
	Unknwn	3	4.9	1.8	1.0	1.2	34.0	1.2
		82	**p = 0.006**		**p < 0.001**		**p < 0.001**	
Laborers								
	Fall	12	10.5	3.0	1.2	2.3	39.4	2.1
	Spring	15	5.6	2.0	1.2	1.7	40.3	1.7
	Summer	23	5.6	1.9	2.1	1.4	69.9	1.4
	Winter	9	4.9	1.4	1.8	1.4	62.5	1.4
	Unknwn	21	13.1	2.4	0.9	2.0	30.0	1.8
		80	p = 0.374		**p = 0.019**		**p = 0.010**	
Ironworkers								
	Fall	4	9.7	2.6	0.8	1.3	27.8	1.3
	Spring	28	4.4	1.5	1.2	1.5	42.0	1.5
	Summer	10	4.3	2.0	0.8	2.2	18.7	6.5
	Winter	45	5.7	1.7	2.0	1.7	65.9	1.6
		87	**p = 0.018**		**p < 0.001**		**p < 0.001**	
Electricians								
	Fall	11	3.0	1.9	0.6	2.9	16.6	3.3
	Spring	24	1.4	5.2	1.6	1.3	55.1	1.3
	Summer	39	2.9	2.1	1.7	1.3	58.6	1.3
	Winter	16	2.9	1.8	1.2	1.8	40.8	1.8
	Unknwn	1	2.8		2.4		80.0	
		91	p = 0.915		**p < 0.001**		**p < 0.001**	
Other								
	Fall	11	6.8	1.6	0.6	1.7	19.1	1.7
	Spring	1	4.8		1.7		57.0	
	Unknwn	2	3.1	1.0	0.5	1.3	16.7	1.3
		14	p = 0.468		p = 0.145		p = 0.145	

TABLE IX. WORK PRACTICES AND OCCUPATIONAL HEALTH BY TRADE (CHI-SQUARE)

Question 18 A. Have you ever received any written information or had any training concerning lead hazards or exposures?

Trade	Yes	No	Number responding	
Painter	74%	26%	88	
Plumber	23%	77%	79	
Laborer	21%	79%	58	
Iron Worker	53%	47%	87	
Electrician	12%	88%	86	Chi-square
Other	25%	75%	12	$p < 0.001$
Total	38%	62%	410	

Q. 18bi. If YES, was it written?

Trade	Yes	No	Number responding	
Painter	96%	4%	57	
Plumber	79%	21%	14	
Laborer	90%	10%	10	
Iron Worker	78%	22%	36	
Electrician	54%	46%	13	
Other	100%	0%	1	$p = 0.003$
Total	85%	15%	131	

Q. 18bii. If YES, was it training on lead regulations?

Trade	Yes	No	Number responding	
Painter	89%	11%	54	
Plumber	58%	42%	12	
Laborer	70%	30%	10	
Iron Worker	72%	28%	32	
Electrician	20%	80%	10	
Other	100%	0%	1	$p < 0.001$
Total	74%	26%	119	

Q. 18biii. If YES, was it training on the health effects of lead?

Trade	Yes	No	Number responding	
Painter	91%	9%	56	
Plumber	93%	7%	15	
Laborer	63%	37%	8	
Iron Worker	84%	16%	37	
Electrician	45%	55%	11	
Other	100%	0%	1	$p = 0.003$
Total	84%	16%	128	

TABLE IX. WORK PRACTICES AND OCCUPATIONAL HEALTH BY TRADE (CHI-SQUARE)-CONTINUED

Question 20 A Have you ever used a respirator or dust mask?

Trade	Yes	No	Number responding	
Painter	98%	2%	87	
Plumber	92%	8%	79	
Laborer	84%	16%	58	
Iron Worker	79%	21%	87	
Electrician	89%	10%	84	
Other	50%	50%	12	$p < 0.001$
Total	88%	12%	407	

Question 20bi. If yes, which type of respirator did you use -Single Strap Dust Mask.

Trade	Yes	No	Number responding	
Painter	77%	23%	75	
Plumber	94%	6%	68	
Laborer	85%	15%	39	
Iron Worker	95%	5%	57	
Electrician	88%	12%	60	
Other	100%	0%	6	$p = 0.015$
Total	88%	12%	305	

Question 20bii. If yes, which type of respirator did you use -2 Strap Dust Mask.

Trade	Yes	No	Number responding	
Painter	95%	5%	80	
Plumber	87%	13%	62	
Laborer	82%	18%	44	
Iron Worker	90%	10%	59	
Electrician	85%	15%	59	
Other	100%	0%	5	$p = 0.219$
Total	89%	11%	309	

Question 20biii. If yes, which type of respirator did you use -Air Purifying.

Trade	Yes	No	Number responding	
Painter	89%	11%	75	
Plumber	82%	18%	62	
Laborer	73%	27%	40	
Iron Worker	82%	18%	50	
Electrician	61%	39%	49	
Other	75%	25%	4	$p = 0.007$
Total	79%	21%	280	

TABLE IX. WORK PRACTICES AND OCCUPATIONAL HEALTH BY TRADE (CHI-SQUARE)-CONTINUED

Question 20biv. If yes, which type of respirator did you use -Supplied Air.

Trade	Yes	No	Number responding	
Painter	64%	36%	64	
Plumber	85%	15%	27	
Laborer	53%	47%	34	
Iron Worker	43%	57%	30	
Electrician	43%	57%	42	
Other	67%	33%	3	$p < 0.001$
Total	62%	38%	238	

Question 20bv. If yes, which type of respirator did you use -SCBA.

Trade	Yes	No	Number responding	
Painter	16%	84%	49	
Plumber	14%	86%	43	
Laborer	23%	85%	26	
Iron Worker	15%	85%	27	
Electrician	19%	81%	36	
Other	75%	25%	4	$p = 0.079$
Total	18%	82%	185	

Question 20bvi. If yes, which type of respirator did you use - powered air purifying.

Trade	Yes	No	Number responding	
Painter	36%	64%	53	
Plumber	27%	73%	48	
Laborer	52%	48%	29	
Iron Worker	12%	88%	26	
Electrician	6%	94%	32	
Other	50%	50%	2	$p = 0.001$
Total	28%	72%	190	

Question 21a. If you have used an air purifying respirator was it fit tested?

Trade	Yes	No	Number responding	
Painter	73%	20%	81	
Plumber	76%	13%	63	
Laborer	56%	27%	41	
Iron Worker	46%	31%	54	
Electrician	65%	18%	51	
Other	75%	0%	4	$p = 0.003$
Total	65%	21%	294	

TABLE IX. WORK PRACTICES AND OCCUPATIONAL HEALTH BY TRADE (CHI-SQUARE)-CONTINUED

Question 22A. If you have used a respirator, were you ever trained to wear the respirator?

Trade	Yes	No	Number responding	
Painter	87%	13%	84	
Plumber	84%	16%	68	
Laborer	70%	30%	40	
Iron Worker	62%	38%	53	
Electrician	64%	36%	53	
Other	80%	20%	5	p = 0.003
Total	76%	24%	303	

Question 23A. Do you currently have/use your own respirator?

Trade	Yes	No	Number responding	
Painter	76%	24%	85	
Plumber	19%	81%	70	
Laborer	14%	86%	44	
Iron Worker	10%	90%	63	
Electrician	2%	98%	63	
Other	25%	75%	4	p < 0.001
Total	28%	72%	329	

Question 23b. If yes how often are the respirators cleaned/the filters changed?

Trade	Daily	Every Other Day	Weekly	<Weekly	Number responding
Painter	48%	9%	11%	28%	61
Plumber	15%	8%	15%	31%	13
Laborer	44%	0%	11%	22%	9
Iron Worker	50%	0%	50%	0%	6
Electrician	50%	0%	50%	0%	2
Other	100%	0%	0%	0%	1
				p = 0.135	
Total	43%	8%	15%	25%	92

Question 23ci. When not in use respirator is stored in a locker.

Trade	Yes	No	Number responding	
Painter	21%	79%	29	
Plumber	33%	67%	9	
Laborer	0%	100%	1	
Iron Worker	80%	20%	5	
Electrician	0%	0%	0	
Other	0%	100%	1	p = 0.084
Total	29%	71%	45	

TABLE IX. WORK PRACTICES AND OCCUPATIONAL HEALTH BY TRADE (CHI-SQUARE)-CONTINUED

Question 23cii. When not in use respirator is stored in car.

Trade	Yes	No	Number responding	
Painter	68%	32%	31	
Plumber	50%	50%	8	
Laborer	100%	0%	2	
Iron Worker	50%	50%	2	
Electrician	0%	0%	0	
Other	100%	0%	1	p = 0.605
Total	66%	34%	44	

Question 23ciii. When not in use respirator is stored in clean respirator storage area.

Trade	Yes	No	Number responding	
Painter	65%	35%	34	
Plumber	50%	50%	8	
Laborer	80%	20%	5	
Iron Worker	50%	50%	2	
Electrician	100%	0%	1	
Other	0%	100%	1	p = 0.598
Total	63%	37%	51	

Question 24a. Did a physician exam you to determine if you could wear a respirator?

Trade	Yes	No	Number responding	
Painter	77%	22%	86	
Plumber	51%	47%	70	
Laborer	44%	49%	43	
Iron Worker	24%	68%	62	
Electrician	35%	53%	62	
Other	50%	50%	4	p < 0.001
Total	49%	46%	327	

Question 24b. If yes, was a lung test included as part of the exam?

Trade	Yes	No	Number responding	
Painter	1%	92%	71	
Plumber	2%	78%	45	
Laborer	0%	80%	25	
Iron Worker	8%	62%	26	
Electrician	11%	75%	28	
Other	0%	100%	2	p = 0.011
Total	4%	81%	197	

TABLE IX. WORK PRACTICES AND OCCUPATIONAL HEALTH BY TRADE (CHI-SQUARE)-CONTINUED

Question 25. Do you have a beard when you wear a respirator?

Trade	Yes	No	Number responding	
Painter	16%	84%	82	
Plumber	6%	94%	69	
Laborer	10%	90%	42	
Iron Worker	14%	86%	56	
Electrician	0%	100%	56	
Other	25%	75%	4	p = 0.022
Total	10%	90%	309	

Question 26. Do you have a mustache when you wear a respirator?

Trade	Yes	No	Number responding	
Painter	57%	43%	82	
Plumber	47%	53%	70	
Laborer	50%	50%	42	
Iron Worker	55%	45%	56	
Electrician	43%	57%	56	
Other	25%	75%	4	p = 0.451
Total	51%	49%	310	

Question 27. Do you shower at work before going home?

Trade	Yes	No	Number responding	
Painter	8%	92%	85	
Plumber	1%	99%	76	
Laborer	10%	90%	48	
Iron Worker	0%	100%	72	
Electrician	0%	100%	82	
Other	0%	100%	7	p = 0.002
Total	3%	97%	370	

Question 28. Do you change out of your work clothes into non-work clothes before you leave work?

Trade	Never	Sometimes	Usually	Always	Number responding
Painter	29%	38%	21%	12%	86
Plumber	79%	17%	3%	1%	75
Laborer	63%	19%	8%	10%	48
Iron Worker	84%	14%	1%	1%	73
Electrician	86%	11%	2%	0%	81
Other	88%	12%	0%	0%	8
				p < 0.001	
Total	68%	20%	7%	5%	371

TABLE IX. WORK PRACTICES AND OCCUPATIONAL HEALTH BY TRADE (CHI-SQUARE)-CONTINUED

Question 29. Do you use disposable clothing at work?

Trade	Yes	No	Number responding	
Painter	23%	77%	87	
Plumber	9%	91%	79	
Laborer	29%	71%	56	
Iron Worker	14%	86%%	83	
Electrician	1%	99%	83	
Other	9%	91%	11	$p < 0.001$
Total	14%	86%	399	

Question 30 A. Do you wash your hands at work before eating?

Trade	Never	< half time	> half time	all the time	Number responding
Painter	5%	13%	41%	41%	86
Plumber	3%	34%	30%	33%	76
Laborer	21%	25%	26%	28%	57
Iron Worker	19%	42%	24%	15%	86
Electrician	1%	19%	41%	39%	84
Other	8%	50%	42%	0%	12
				$p < 0.001$	
Total	9%	27%	33%	31%	401

Question 30 B. Do you wash your hands at work before drinking?

Trade	Never	< half time	> half time	all the time	Number responding
Painter	21%	30%	31%	18%	81
Plumber	20%	50%	20%	8%	64
Laborer	43%	23%	20%	14%	44
Iron Worker	47%	41%	10%	3%	73
Electrician	18%	42%	28%	10%	78
Other	33%	33%	33%	0%	9
				$p < 0.001$	
Total	29%	38%	23%	10%	349

TABLE IX. WORK PRACTICES AND OCCUPATIONAL HEALTH BY TRADE (CHI-SQUARE)-CONTINUED

Question 30c. Do you wash your hands at work before smoking?

Trade	Never	< half time	> half time	all the time	NA	Number responding
Painter	23%	27%	5%	5%	38%	73
Plumber	17%	8%	5%	2%	68%	62
Laborer	41%	20%	7%	12%	20%	41
Iron Worker	40%	14%	5%	0%	41%	73
Electrician	16%	10%	3%	1%	70%	67
Other	38%	13%	13%	0%	38%	8
					$p < 0.001$	
Total	27%	15%	5%	3%	49%	324

Question 31 A. Do you smoke at work?

Trade	Yes	No	Number responding	
Painter	53%	47%	86	
Plumber	16%	84%	79	
Laborer	50%	50%	58	
Iron Worker	45%	55%	82	
Electrician	19%	80%	84	
Other	33%	67%	12	$p < 0.001$
Total	36%	64%	401	

Question 32 A. Do you bite your nails?

Trade	Yes	No	Number responding	
Painter	22%	78%	86	
Plumber	28%	72%	79	
Laborer	35%	65%	57	
Iron Worker	23%	77%	88	
Electrician	24%	76%	85	
Other	8%	92%	12	$p = 0.313$
Total	25%	75%	407	

Question 32 B. Do you chew on plastic coated electrical wires or put them in your mouth?

Trade	Yes	No	Number responding	
Painter	4%	96%	84	
Plumber	4%	96%	77	
Laborer	5%	95%	56	
Iron Worker	4%	96%	85	
Electrician	31%	69%	83	
Other	0%	100%	12	$p < 0.001$
Total	10%	90%	397	

TABLE IX. WORK PRACTICES AND OCCUPATIONAL HEALTH BY TRADE (CHI-SQUARE)-CONTINUED

Question 33. Do you have medical insurance?

Trade	Yes	No	Number responding	
Painter	94%	6%	85	
Plumber	97%	3%	79	
Laborer	61%	39%	57	
Iron Worker	97%	3%	88	
Electrician	99%	1%	86	
Other	92%	8%	12	$p < 0.001$
Total	92%	8%	407	

Question 35a. Have you ever had a blood test for lead?

Trade	Yes	No	Number responding	
Painter	54%	42%	85	
Plumber	4%	91%	79	
Laborer	13%	79%	56	
Iron Worker	13%	86%	88	
Electrician	4%	88%	86	
Other	17%	83%	12	$p < 0.001$
Total	18%	77%	406	

Question 35b. If yes was this part of a regular lead testing program at work?

Trade	Yes	No	Number responding	
Painter	66%	26%	47	
Plumber	40%	40%	5	
Laborer	75%	13%	8	
Iron Worker	36%	45%	11	
Electrician	50%	25%	4	
Other	50%	50%	2	$p = 0.769$
Total	60%	29%	77	

Question 36a. Have you ever been told that you had an elevated blood lead level?

Trade	Yes	No	Number responding	
Painter	6%	94%	85	
Plumber	3%	97%	78	
Laborer	9%	91%	55	
Iron Worker	5%	95%	82	
Electrician	0%	100%	81	
Other	0%	100%	12	$p = 0.117$
Total	4%	96%	393	

TABLE IX. WORK PRACTICES AND OCCUPATIONAL HEALTH BY TRADE (CHI-SQUARE)-CONTINUED

Question 36b. Have you ever been told that you had an elevated urine lead level?

Trade	Yes	No	Number responding	
Painter	0%	100%	77	
Plumber	0%	100%	68	
Laborer	2%	98%	50	
Iron Worker	1%	99%	72	
Electrician	0%	100%	77	
Other	0%	100%	11	p = 0.544
Total	1%	99%	355	

Question 37a. Have you ever been treated for lead poisoning?

Trade	Yes	No	Number responding	
Painter	2%	98%	85	
Plumber	1%	99%	78	
Laborer	2%	98%	55	
Iron Worker	2%	98%	85	
Electrician	0%	100%	85	
Other	0%	100%	12	p = 0.795
Total	2%	98%	400	

Question 39. Do you have any medical problems for which you are currently seeing a physician?

Trade	Yes	No	Number responding	
Painter	19%	81%	86	
Plumber	27%	73%	78	
Laborer	17%	83%	54	
Iron Worker	21%	79%	81	
Electrician	19%	81%	84	
Other	17%	83%	12	p = 0.719
Total	21%	79%	395	

Question 40. Do you have any current medical problems for which you are not seeing a physician?

Trade	Yes	No	Number responding	
Painter	6%	94%	84	
Plumber	8%	92%	77	
Laborer	11%	89%	53	
Iron Worker	15%	83%	78	
Electrician	11%	89%	81	
Other	0%	100%	11	p = 0.440
Total	10%	89%	384	

TABLE IX. WORK PRACTICES AND OCCUPATIONAL HEALTH BY TRADE (CHI-SQUARE)-CONTINUED

Question 41. Are you currently using any prescription or nonprescription medicines?

Trade	Yes	No	Number responding	
Painter	22%	78%	83	
Plumber	32%	68%	78	
Laborer	21%	79%	53	
Iron Worker	23%	77%	83	
Electrician	29%	71%	85	
Other	17%	83%	12	p = 0.488
Total	25%	75%	394	

TABLE X. QUESTIONS 42. DURING THE LAST 3 MONTHS HAVE YOU HAD ANY OF THE FOLLOWING SYMPTOMS FOR MORE THAN A WEEK?

Appetite loss

	Trade	Yes	No	Number responding	
Painter	2%	98%		82	
Plumber	3%	97%		79	
Laborer	7%	93%		56	
Iron Worker	1%	99%		83	
Electrician	2%	98%		84	
Other	0%	100%		11	p = 0.402
Total	3%	97%		395	

constipation

Trade	Yes	No	Number responding	
Painter	4%	96%	82	
Plumber	4%	96%	79	
Laborer	5%	95%	56	
Iron Worker	6%	94%	81	
Electrician	2%	98%	84	
Other	0%	100%	11	p = 0.811
Total	4%	96%	393	

Stomach pain

Trade	Yes	No	Number responding	
Painter	6%	94%	82	
Plumber	6%	94%	79	
Laborer	16%	84%	56	
Iron Worker	7%	93%	83	
Electrician	5%	95%	83	
Other	0%	100%	11	p = 0.155
Total	4%	96%	394	

Excessive tiredness

Trade	Yes	No	Number responding	
Painter	6%	94%	82	
Plumber	10%	90%	78	
Laborer	23%	77%	56	
Iron Worker	12%	88%	83	
Electrician	8%	92%	84	
Other	0%	100%	11	p = 0.036
Total	11%	89%	394	

TABLE X. QUESTIONS 42. DURING THE LAST 3 MONTHS HAVE YOU HAD ANY OF THE FOLLOWING SYMPTOMS FOR MORE THAN A WEEK? - CONTINUED

Weakness

Trade	Yes	No	Number responding	
Painter	1%	99%	81	
Plumber	8%	92%	79	
Laborer	16%	84%	55	
Iron Worker	14%	86%	83	
Electrician	5%	95%	84	
Other	0%	100%	11	p = 0.005
Total	8%	92%	393	

Question 42. During the last 3 months have you had any of the following symptoms for more than a week?

Unable to sleep

Trade	Yes	No	Number responding	
Painter	5%	95%	82	
Plumber	9%	91%	79	
Laborer	25%	75%	57	
Iron Worker	10%	90%	82	
Electrician	11%	89%	85	
Other	0%	100%	11	p = 0.006
Total	11%	89%	396	

Headache

Trade	Yes	No	Number responding	
Painter	17%	83%	82	
Plumber	14%	86%	79	
Laborer	27%	73%	56	
Iron Worker	17%	83%	82	
Electrician	11%	89%	84	
Other	0%	100%	11	p = 0.201
Total	16%	84%	394	

Dizziness

Trade	Yes	No	Number responding	
Painter	5%	95%	81	
Plumber	3%	97%	79	
Laborer	13%	87%	55	
Iron Worker	6%	94%	83	
Electrician	2%	98%	83	
Other	9%	91%	11	p = 0.111
Total	5%	95%	392	

TABLE X. QUESTIONS 42. DURING THE LAST 3 MONTHS HAVE YOU HAD ANY OF THE FOLLOWING SYMPTOMS FOR MORE THAN A WEEK?

Nausea

Trade	Yes	No	Number responding	
Painter	5%	95%	82	
Plumber	3%	97%	79	
Laborer	11%	89%	55	
Iron Worker	5%	95%	82	
Electrician	2%	98%	84	
Other	0%	100%	11	p = 0.201
Total	5%	95%	393	

Vomiting

Trade	Yes	No	Number responding	
Painter	2%	98%	82	
Plumber	1%	99%	79	
Laborer	2%	98%	54	
Iron Worker	1%	99%	82	
Electrician	1%	99%	84	
Other	0%	100%	11	p = 0.986
Total	2%	98%	392	

Irritability

Trade	Yes	No	Number responding	
Painter	5%	95%	82	
Plumber	6%	94%	79	
Laborer	24%	76%	55	
Iron Worker	17%	83%	83	
Electrician	5%	95%	83	
Other	9%	91%	11	p = 0.001
Total	10%	90%	393	

Nervousness

Trade	Yes	No	Number responding	
Painter	5%	95%	82	
Plumber	6%	94%	79	
Laborer	21%	79%	56	
Iron Worker	9%	91%	82	
Electrician	4%	96%	83	
Other	0%	100%	11	p = 0.002
Total	8%	92%	393	

TABLE X. QUESTIONS 42. DURING THE LAST 3 MONTHS HAVE YOU HAD ANY OF THE FOLLOWING SYMPTOMS FOR MORE THAN A WEEK?

Muscle aches/pains

Trade	Yes	No	Number responding	
Painter	14%	86%	83	
Plumber	33%	67%	79	
Laborer	24%	76%	55	
Iron Worker	33%	67%	82	
Electrician	18%	82%	84	
Other	0%	100%	11	p = 0.005
Total	24%	76%	394	

Joint pain

Trade	Yes	No	Number responding	
Painter	18%	82%	83	
Plumber	38%	62%	79	
Laborer	22%	78%	55	
Iron Worker	33%	67%	82	
Electrician	26%	74%	85	
Other	0%	100%	11	p = 0.012
Total	27%	73%	395	

Shaking of hands/feet

Trade	Yes	No	Number responding	
Painter	2%	98%	82	
Plumber	4%	96%	79	
Laborer	11%	89%	55	
Iron Worker	6%	94%	83	
Electrician	0%	100%	84	
Other	0%	100%	11	p = 0.034
Total	4%	96%	394	

Numbness hands/feet

Trade	Yes	No	Number responding	
Painter	7%	93%	82	
Plumber	14%	86%	79	
Laborer	18%	82%	55	
Iron Worker	17%	83%	82	
Electrician	8%	92%	83	
Other	0%	100%	11	p = 0.140
Total	12%	88%	392	

TABLE X. QUESTIONS 42. DURING THE LAST 3 MONTHS HAVE YOU HAD ANY OF THE FOLLOWING SYMPTOMS FOR MORE THAN A WEEK?

Weight loss

Trade	Yes	No	Number responding	
Painter	0%	100%	82	
Plumber	1%	99%	79	
Laborer	2%	98%	54	
Iron Worker	0%	100%	82	
Electrician	1%	99%	84	
Other	0%	100%	11	p = 0.754
Total	1%	99%	392	

Blurred eyesight

Trade	Yes	No	Number responding	
Painter	6%	94%	82	
Plumber	6%	94%	78	
Laborer	16%	84%	57	
Iron Worker	10%	90%	82	
Electrician	6%	94%	84	
Other	0%	100%	11	p = 0.217
Total	8%	92%	394	

Forgetfulness

Trade	Yes	No	Number responding	
Painter	6%	94%	82	
Plumber	6%	94%	79	
Laborer	13%	87%	55	
Iron Worker	17%	83%	81	
Electrician	10%	90%	83	
Other	0%	100%	11	p = 0.107
Total	10%	90%	391	

Question 43. Have you ever been diagnosed by a physician as having anemia?

Trade	Yes	No	Don't Know	Number responding	
Painter	1%	99%	0%	80	
Plumber	4%	92%	4%	78	
Laborer	2%	95%	3%	58	
Iron Worker	1%	93%	6%	85	
Electrician	2%	95%	3%	86	
Other	0%	1 %	0%	12	p = 0.428
Total	2%	95%	3%	399	

TABLE XI. PREGNANCY

Question 44a. Have you or your partner ever had trouble getting pregnant?

Trade	Yes	No	Number responding	
Painter	8%	92%	78	
Plumber	6%	94%	77	
Laborer	4%	96%	53	
Iron Worker	10%	90%	84	
Electrician	4%	96%	84	
Other	8%	92%	12	p = 0.643
Total	6%	94%	388	

Question44b. If yes did you or your partner ever have tests to see what the problem was?

Trade	Yes	No	Number responding	
Painter	19%	82%	27	
Plumber	17%	83%	18	
Laborer	4%	96%	23	
Iron Worker	17%	83%	29	
Electrician	11%	89%	19	
Other	33%	67%	3	p = 0.601
Total	14%	86%	119	

TABLE XII. PROJECT INFORMATION AND CONTROLS ON MOST RECENT JOB

Question 46a. Type of Construction

Trade	Commercial	Residential	Industrial	Highways Streets	Highways Bridges	N
Painters	60%	5%	24%	9%	3%	80
Plumbers	44%	15%	41%	0%	0%	73
Laborers	34%	12%	22%	18%	14%	50
Ironworkers	47%	0%	47%	0%	6%	81
Electricians	49%	4%	47%	0%	0%	90
Other	8%	0%	8%	0%	83%	12
Total	47%	6%	37%	4%	6%	386

Chi Square $p < 0.001$

Question 46b. Type of Project

Trade	New Const.	Renovation Remodeling	Demol.	Lead Abate	Asb. Abate	Other.	N
Painters	46%	34%	1%	1%	0%	15%	78
Plumbers	45%	37%	1%	0%	1%	15%	73
Laborers	43%	30%	13%	2%	0%	13%	47
Ironworkers	74%	17%	1%	1%	0%	6%	81
Electricians	52%	44%	0%	0%	0%	4%	89
Other	0%	82%	9%	0%	0%	9%	11
Total	51%	35%	3%	1%	<1%	10%	379

Chi Square $p < 0.001$

Question 46e. Were lead dust/fumes formed in your work area?

Trade	Yes	No	Don't Know	N
Painters	8%	42%	50%	78
Plumbers	15%	49%	36%	72
Laborers	16%	28%	56%	50
Ironworkers	17%	16%	67%	83
Electricians	3%	32%	64%	90
Other	70%	10%	20%	10
Total	13%	33%	55%	383

Chi Square $p < 0.001$

TABLE XII. PROJECT INFORMATION AND CONTROLS ON MOST RECENT JOB- CONTINUED

Question 46m1. Medical examination by physician was provided.

Trade	Yes	No	N
Painters	6%	94%	78
Plumbers	4%	96%	70
Laborers	18%	82%	49
Ironworkers	6%	94%	78
Electricians	1%	99%	89
Other	18%	82%	11
Total	7%	93%	375

Chi Square p = 0.003

Question 46m2. Blood lead measurement provided.

Trade	Yes	No	N
Painters	6%	94%	78
Plumbers	1%	99%	69
Laborers	17%	83%	46
Ironworkers	5%	95%	77
Electricians	0%	100%	89
Other	36%	64%	11
Total	6%	94%	370

Chi Square p < 0.001

Question 46m3. Urine lead measurement provided.

Trade	Yes	No	N
Painters	1%	99%	76
Plumbers	0%	100%	70
Laborers	5%	95%	42
Ironworkers	1%	99%	75
Electricians	0%	100%	89
Other	0%	100%	11
Total	1%	99%	363

Chi Square p = 0.211

Question 46m4. Protoporphyrin test provided (ZPP or FEP).

Trade	Yes	No	N
Painters	1%	99%	74
Plumbers	0%	100%	65
Laborers	14%	86%	44
Ironworkers	1%	99%	71
Electricians	0%	100%	84
Other	20%	80%	10
Total	3%	97%	348

Chi Square p < 0.001

TABLE XII. PROJECT INFORMATION AND CONTROLS ON MOST RECENT JOB- CONTINUED

Question 46m5. Pulmonary function (lung) test provided.

Trade	Yes	No	N
Painters	12%	88%	76
Plumbers	6%	94%	70
Laborers	22%	78%	46
Ironworkers	4%	96%	75
Electricians	0%	100%	87
Other	9%	91%	11
Total	7%	93%	365

Chi Square $p < 0.001$

Question 46m6. Training on working safely with lead provided.

Trade	Yes	No	N
Painters	21%	79%	73
Plumbers	3%	97%	70
Laborers	10%	90%	49
Ironworkers	18%	82%	80
Electricians	5%	95%	88
Other	55%	45%	11
Total	12%	88%	371

Chi Square $p < 0.001$

Question 46m7. Training on respirator use provided.

Trade	Yes	No	N
Painters	31%	69%	77
Plumbers	10%	90%	70
Laborers	16%	84%	49
Ironworkers	3%	97%	78
Electricians	3%	97%	90
Other	18%	82%	11
Total	14%	86%	375

Chi Square $p < 0.001$

Question 46m8. Written information on lead hazards (MSDS) provided.

Trade	Yes	No	N
Painters	40%	60%	73
Plumbers	33%	67%	69
Laborers	13%	87%	46
Ironworkers	53%	47%	75
Electricians	40%	60%	83
Other	40%	60%	10
Total	38%	62%	356

Chi Square $p = 0.001$

TABLE XII. PROJECT INFORMATION AND CONTROLS ON MOST RECENT JOB- CONTINUED

Question 46m9. Warning signs posted in lead-containing areas.

Trade	Yes	No	N
Painters	17%	83%	66
Plumbers	5%	95%	62
Laborers	11%	89%	45
Ironworkers	25%	75%	67
Electricians	17%	83%	64
Other	18%	82%	11
Total	16%	84%	315

Chi Square p = 0.046

Question 46m10. Respirator was used on this job.

Trade	Yes	No	N
Painters	47%	53%	74
Plumbers	10%	90%	69
Laborers	23%	77%	47
Ironworkers	11%	89%	79
Electricians	2%	98%	85
Other	10%	90%	10
Total	18%	82%	364

Chi Square p < 0.001

Question 46m10a. Respirator fit tested.

Trade	Yes	No	N
Painters	38%	62%	61
Plumbers	15%	85%	41
Laborers	21%	79%	42
Ironworkers	14%	86%	42
Electricians	10%	90%	21
Other	14%	86%	7
Total	22%	78%	214

Chi Square p = 0.018

Question 46m11. Coveralls/protective clothing provided.

Trade	Yes	No	N
Painters	31%	69%	75
Plumbers	17%	83%	70
Laborers	14%	86%	49
Ironworkers	25%	75%	80
Electricians	7%	93%	88
Other	10%	90%	10
Total	19%	81%	372

Chi Square p = 0.002

TABLE XII. PROJECT INFORMATION AND CONTROLS ON MOST RECENT JOB- CONTINUED

Question 46m12. Clothes changing facilities provided.

Trade	Yes	No	N
Painters	38%	62%	76
Plumbers	13%	87%	70
Laborers	17%	83%	48
Ironworkers	15%	85%	78
Electricians	15%	85%	88
Other	9%	91%	11
Total	19%	81%	371

Chi Square p = 0.001

Question 46m13. Water for washing hands/face provided.

Trade	Yes	No	N
Painters	73%	27%	78
Plumbers	60%	40%	70
Laborers	41%	59%	49
Ironworkers	56%	44%	81
Electricians	66%	34%	89
Other	73%	27%	11
Total	61%	39%	378

Chi Square p = 0.007

Question 46m14. Showers provided.

Trade	Yes	No	N
Painters	21%	79%	76
Plumbers	9%	91%	69
Laborers	13%	87%	48
Ironworkers	13%	87%	79
Electricians	20%	80%	87
Other	9%	91%	11
Total	15%	85%	370

Chi Square p = 0.255

Question 46m15. Separate eating facilities provided.

Trade	Yes	No	N
Painters	47%	53%	75
Plumbers	43%	57%	70
Laborers	16%	84%	49
Ironworkers	36%	64%	80
Electricians	47%	53%	87
Other	9%	91%	11
Total	39%	61%	372

Chi Square p = 0.001

TABLE XII. PROJECT INFORMATION AND CONTROLS ON MOST RECENT JOB- CONTINUED

Question 46m16. Air monitoring conducted.

Trade	Yes	No	N
Painters	17%	83%	65
Plumbers	12%	88%	68
Laborers	17%	83%	47
Ironworkers	11%	89%	70
Electricians	7%	93%	71
Other	20%	80%	10
Total	13%	87%	331

Chi Square p = 0.479

Question 46m17. Environmental lead testing conducted (dust/paint).

Trade	Yes	No	N
Painters	14%	86%	63
Plumbers	3%	97%	61
Laborers	7%	93%	44
Ironworkers	7%	93%	67
Electricians	2%	98%	63
Other	30%	70%	10
Total	7%	93%	308

Chi Square p = 0.0.006

TABLE XIII. QUESTIONS 51 - MOST RECENT JOB - TYPE OF CONSTRUCTION WORK

Project Type	Number by Trade							Chi-square
	Painter	Plumber	Laborer	Ironwrk	Electrician	Other	Total	p value
Highway/railroad bridge repair/rehabilitation	4	0	11	4	0	7	26	< 0.001
Water tank repainting	0	0	0	0	1	0	1	0.414
Public housing lead abatement/replacement	0	2	1	0	1	0	4	0.558
Private housing lead abatement/replacement	1	3	1	0	1	0	6	0.565
Commercial + industrial demolition	3	16	15	15	20	1	70	0.001
Underground storage tank demolition	0	1	1	1	0	0	3	0.786
Hazardous waste removal or cleanup	2	1	2	1	1	0	7	0.876
Indoor industrial facility maintenance/renovation	19	21	10	28	36	1	115	0.001
Outdoor industrial facility maintenance/renovation	11	9	4	19	14	1	58	0.127
Industrial process equipment manufacturing, maintenance and repair	2	15	3	14	17	0	51	< 0.001
Industrial vacuuming	3	0	5	0	0	0	8	0.002
Transmission/ communication tower maintenance	1	0	0	0	0	0	1	0.653
New construction -- commercial	36	25	16	35	27	2	141	0.405
New construction -- industrial	13	28	11	41	39	1	133	< 0.001
New construction -- residential	6	9	7	1	9	0	32	0.046
New construction -- highway & streets	4	0	9	2	0	0	15	< 0.001

TABLE XIII. QUESTIONS 51 - MOST RECENT JOB - TYPE OF CONSTRUCTION WORK - CONTINUED

Project Type	Number by Trade							Chi-square
	Painter	Plumber	Laborer	Ironwrk	Electrician	Other	Total	p value
New construction -- bridges, tunnels, elevated highways	2	0	7	4	0	0	13	0.001
Elevator cable babitting	0	0	0	1	1	0	2	0.668
Electric cable splicing	1	1	0	0	17	0	19	< 0.001
Reinsulation over existing mineral wool	0	2	0	1	1	0	4	0.655
Commercial + institutional remodeling	17	12	5	7	18	1	60	0.042
Residential remodeling	4	10	5	1	8	1	29	0.048
Repair/removal of water lines containing lead	0	6	1	1	2	0	10	0.041
Lead joint work on cast iron pipes or soil pipes	0	7	2	0	0	0	9	0.001
Installation of radiation shielding	0	0	2	0	0	0	2	0.023
Installation of lead (terne) roofing	0	1	0	0	0	0	1	0.563
Installation of lead membrane waterproofing, lead shower pans	0	3	1	0	0	0	4	0.109
Installation of lead waste and vent pipes	0	2	0	0	0	0	2	0.174
Installation of soundproofing, antivibration pads	0	0	0	0	1	0	1	0.383
Repair of lead (terne) roofing	0	0	0	0	1	0	1	0.383
Repair of lead membrane, waterproofing	0	2	0	0	0	0	2	0.165
Repair of lead waste and vent pipes	0	4	0	0	0	0	4	0.009
Repair of sound proofing, antivibration pads	0	0	0	0	1	0	1	0.383

TABLE XIII. QUESTIONS 51 - MOST RECENT JOB - TYPE OF CONSTRUCTION WORK - CONTINUED

Project Type	Number by Trade							Chi-square
	Painter	Plumber	Laborer	Ironwrk	Electrician	Other	Total	p value
Removal of lead membrane, waterproofing, lead showerpans	0	1	0	0	0	0	1	0.573
Removal of lead waste and vent pipes	0	5	0	0	0	0	5	0.002
Removal of sound proofing, antivibration pads	0	0	0	0	1	0	1	0.383
Repairing, replacing, removing water mains or hydrants	0	5	2	1	0	0	8	0.040

TABLE XIV. TOOLS, RESPIRATORS, ENGINEERING AND PERSONAL CONTROLS BY TYPE OF PROJECT.

Project Type	Tools	N	Respirators	N	Engineering Controls	N	Personal Hygiene	N
New Construction Q55.	Torch	121	None	400	General Vent	57	Wash hnds	63
	Arc welder	49	Dust mask	52	Local Vent	33	Coverals, cloth	18
	Grinder	49	Half cartrg	38	Mech Vent	22	Showers	8
	Disc sander	21	Full face cart	4	HEPA vacuum	6	Separate eating	7
	Bandsaw	12	Suplair	3	Enclosure novn	3	Change cloth	2
	Needle gun	8	Abras. blast	1	Shroud/vacuum	1	Warning signs	2
	Power wire brush	8	Full face sup	1	Extend handle	1	Isolate parking	2
	Compressed air	7			Wetting agnt	1		
	Hacksaw	6			None	255		
	Rotary hammer	6						
	Drill	5						
	Mech. scraper	4						
	Wirewheel	4						
	Scarifiers	2						
	Rotary peeners	1						
	Other	236						
	None	35						

Project Type	Tools	N	Respirators	N	Engineering Controls	N	Personal Hygiene	N
Infrastructure Q. 52	Torch	9	None	16	None	27	Wash hnds	3
	Arc welder	2	Dust mask	5			Warning signs	2
	Grinder	6	Half cartrg	2			Isolate parking	3
	Disc sander	2	Full face cart	3			None	10
	Compressed air	8	Abras. blast	2				
	Wirewheel	1	Full face sup	1				
	Other	13						
	None	1						

Project Type	Tools	N	Respirators	N	Engineering Controls	N	Personal Hygiene	N
Lead Abatement Q. 53.	Grinder	12	None	12	Mech Vent	27	Wash hnds	30
	Bandsaw	2	Dust mask	9	HEPA vacuum	2	None	2
	Needle gun	3	Half cartrg	22				
	Hacksaw	4	Abras. blast	1				
	Rotary hammer	1						
	Mech. scraper	1						

TABLE XIV. TOOLS, RESPIRATORS, ENGINEERING AND PERSONAL CONTROLS BY TYPE OF PROJECT - CONTINUED

Project Type	Tools	N	Respirators	N	Engineering Controls	N	Personal Hygiene	N
Demolition	Torch	39	None	153	General Vent	33	Wash hnds	45
Q.54	Arc welder	17	Dust mask	16	Local Vent	1	Coverals, cloth	1
	Grinder	35	Half cartrg	1	Mech Vent	11	Separate eating	6
	Disc sander	22	Abras. blast	1	HEPA vacuum	3	Isolate parking	1
	Bandsaw	9			None	83	None	
	Power wire brush	8						
	Hacksaw	4						
	Rotary hammer	15						
	Drill	32						
	Mech. scraper	2						
	Wirewheel	2						
	Rotary peeners	1						
	Other	13						
	None	16						

Project Type	Tools	N	Respirators	N	Engineering Controls	N	Personal Hygiene	N
Industrial	Torch	58	None	198	General Vent	43	Wash hnds	70
Commercial	Arc welder	34	Dust mask	49	Local Vent	7	Coverals, cloth	14
Q. 56.	Grinder	74	Half cartrg	15	Mech Vent	34	Showers	2
	Disc sander	19	Full face cart	2	HEPA vacuum	2	Separate eating	15
	Bandsaw	10	Suplair	1	Enclosure novn	1	Change cloth	1
	Needle gun	4	Full face sup	3	Wetting agnt	1	None	41
	Power wire brush	9	Loose helmet	2	None	138		
	Compressed air	4	SCBA	1				
	Hacksaw	8						
	Rotary hammer	12						
	Drill	17						
	Mech. scraper	4						
	Wirewheel	4						
	Scarifiers	2						
	Rotary peeners	1						
	Other	58						
	None	8						

TABLE XIV. TOOLS, RESPIRATORS, ENGINEERING AND PERSONAL CONTROLS BY TYPE OF PROJECT - CONTINUED

Project Type	Tools	N	Respirators	N	Engineering Controls	N	Personal Hygiene	N
Industrial/Comm	Torch	37	None	101	General Vent	26	Wash hnds	11
Residential	Arc welder	6	Dust mask	14	Local Vent	3	Coverals, cloth	5
Q58.	Grinder	21	Half cartrg	3	Mech Vent	8	None	43
	Disc sander	7	Full face cart	1	None	68		
	Bandsaw	8						
	Compressed air	3						
	Hacksaw	4						
	Rotary hammer	12						
	Drill	6						
	Mech. scraper	6						
	Other	53						
	None	7						

TABLE XV. EXPOSURES OUTSIDE THE WORKPLACE

Q59a. Is the home you live in rented or owned?

Trade	Rented	Owned	N
Painters	29%	71%	85
Plumbers	9%	91%	74
Laborers	42%	58%	53
Ironworkers	22%	78%	82
Electricians	16%	84%	90
Other	30%	70%	10
Total	23%	77%	394

Chi Square $p < 0.001$

Q60. What year was the home built?

Decade	Number	
< 1900	37	
1900's	21	
1910's	15	
1920's	33	
1930's	20	
1940's	32	
1950's	39	327 were built before 1980
1960's	54	
1970's	76	
1980's	15	
1990's	19	
don't know	30	
Total	391	

Q61. What type of residence is this?

Trade	Single Family	Duplex	Multi-Family	Condo	Apart-ment	Mobile Home	Other	N
Painters	73%	5%	2%	2%	4%	11%	4%	85
Plumbers	92%	3%	2%	0%	4%	0%	0%	76
Laborers	68%	9%	8%	2%	9%	4%	0%	53
Ironworkers	82%	2%	2%	0%	6%	6%	1%	81
Electricians	87%	3%	2%	0%	6%	2%	0%	90
Other	70%	20%	0%	0%	10%	0%	0%	10
Total	81%	5%	3%	1%	6%	5%	1%	395

Chi Square $p = 0.025$

TABLE XV. EXPOSURES OUTSIDE THE WORKPLACE - CONTINUED

Question	Response	Total N	Differences by Trade Chi-Square (p)
62a. Is exterior of home painted?	Yes = 244 No = 151	395	0.626
62b. If yes would you say it is in:	Excellent condition = 103 Fair condition = 138 Poor condition = 26	267	0.472
63a. Is the interior of home painted or varnished?	Yes = 368 No = 27	395	0.116
63b. If yes would you say it is in:	Excellent condition = 212 Fair condition = 152 Poor condition = 9	373	0.013
64. What type of water pipes does your home have?	Lead = 28	237	0.712
	Plastic = 130	274	0.006
	Galvanized steel = 101	259	0.194
	Copper = 304	334	0.011 fewer Paintr/Laborer
	Iron = 53	238	0.200
	Don't know = 42	128	0.031
	Other = 1	75	0.808
65a. What type of water does your household normally use most for drinking?	Private well = 93	264	0.556
	Public water = 293	349	0.873
	Bottled = 44	232	0.377
	Don't know = 6	105	0.090
	Other = 4	89	0.466
	(Community well, distilled, revers osmosis, filtered)		
65b. What type of water does your household normally use most for cooking?	Private well = 95	262	0.328
	Public water = 300	351	0.653
	Bottled = 15	224	0.113
	Don't know = 2	110	< 0.001
	Other = 3	90	0.267
	(Community well, filtered)		
66a. Has any remodeling or additions been made to your home?	Yes = 187 No = 193 Don't know = 16	396	0.232
66b. If yes, which of the following were done in your home?	Paint removal = 88	154	0.026
	Painting/staining = 138	162	0.331
	Plumbing = 120	161	0.106
	Soldering/welding = 98	151	< 0.001 fewer paintr/laborer
	Other = 54	54	
	(siding, plaster, carpentry, electrical, demolition, roofing)		
66c. Who did the work?	You = 156 Family member = 10 Other = 24	190	0.044

TABLE XV. EXPOSURES OUTSIDE THE WORKPLACE - CONTINUED

Question	Activity	Self	Family Member	At home?
67. In the past 3 months have you or a family member engaged in any of the following activities at home?	Stained glass	15	11	4
	Art (paint/pigmt)	24	23	29
	Toy/craft w lead paint	10	4	4
	Ceramics	12	10	7
	Riflery/shooting	85	27	54
	Casting/smelting lead	17	6	5
	Lead manufacturing	10	4	2
	Battery manufacturing	9	4	1
	Radiator repair	17	8	6
	Leaded gasoline use	84	34	84
	Auto repairs	55	20	53
	Other (possible lead)	20	6	10
	(Brazing, fire fighting, loading shells, melt scrap lead, welding)			

68. In the past 6 months have you or any family member been treated with traditional/folk medicines?	Azarcon	Yes = 0	No = 361
	Greta	Yes = 0	No = 361
	Other	Yes = 7	No = 356
	(Aloh juice, Baceta bark, Clove, Ginseng, Redwill, Hydrogen peroxide, Secrete)		

Question	Response	Total N	Differences by Trade Chi-Square (p)
69. Over your lifetime, as far as you know, have you had any exposure to pesticides including electr. fungicides, insecticides, herbicides through:	Off farm employ = 78	353	< 0.001
	Hobby = 24	347	0.068
	House/yard = 196	367	< 0.001 more plumbrs,
	In military = 40	347	0.745
	Farming = 89	355	0.022 fewer paintrs,
	Other = 26	298	0.775
	(Lived in country, agent orange, cooling towers, worked at chemical factory, navy, weed spraying, ...)		
70. Which of the following pesticide applications have you done in the past 3 months?	Termite control = 13	355	0.169
	Rodent control = 34	359	0.885
	Lawn and garden = 103	372	<0.001 more elect, fewer paintrs
	Fungicides = 11	355	0.829
	Stored grain prot. = 11	356	0.421
	Highway weed control = 4	354	0.367
	Forestry = 1	355	0.254
	Farm crops = 33	358	0.697
	Insecticides = 67 (home, animal)	361	0.471
	Fumigants = 14	353	0.032 labor, iron, electr
	Other = 2	280	0.163

TABLE XV. EXPOSURES OUTSIDE THE WORKPLACE - CONTINUED

Question	Response	Total N yes	Differences by Trade Chi-Square (p)	
71. Have you handled or been exposed to any of the following materials at least once a month for a year or more during your lifetime?	Aerosol/spray paints	174	0.001	more painters,othrs
	Carbon tetrachloride	15	0.635	
	Dry cleaning (worked)	6	0.401	
	Gasoline as cleaning fluid	99	< 0.001	more labor,ironwrk,other
	Kerosene as cleaning fluid	32	0.002	more laborers
	Diesel fuel as cleaning fld		37	0.014 more labor, ironwrk
	Paint remover (mecl2)	93	<0.001	more painters
	Oil-based paints	132	<0.001	more painters
	Radioactive materials	57	0.019	more plumbers
	Photographic chemicals	10	0.563	
	Lubricating oils/greases	151	0.309	
	Hair sprays	87	0.551	
	Cloth/textile dyes	6	0.032	more labor,electric
	Hair dyes	21	0.857	
	Plastic cement	52	0.001	more plumbers
	Insecticides	62	0.278	
	Herbicides	41	0.371	
Q72. Does anyone else in your household work in a lead industry?	Yes = 3 No = 375 Don't know = 4	382	0.762	
Q73. In your household are there any children the age of 6?	Yes = 76 No = 301	377	0.077	fewer plumbers more other
Q73b. How many?	1 = 42 2 = 25 3 = 2 4 = 1	70		
Q74. Have any of the children been tested for lead?	Yes = 28 No = 51 Don't know = 8	87	0.808	
Q74b. How many?	0 = 2 1 = 13 2 = 11 3 = 3 4 = 1	30		

Q74. How many were:	Normal	Elevated	Lead Level (ug/dL)
1st	22	2	13, 50
2nd	8	3	???
3rd	2	1	???
4th	1	0	???

TABLE XVI. SIGNIFICANT SPEARMAN CORRELATIONS OF BLOOD LEAD LEVELS AND FEPS WITH QUESTIONAIRE VARIABLES (1 = yes, 0 = no)

(Q) Variable	BLL r	BLL p	FEP1 r	FEP1 p	FEP r	FEP p
46e. Lead Dust/Fumes Generated in Work Area (on most recent job - 46e)						
Overall	**0.27**	**<0.01**			**-0.16**	**0.04**
Laborers	**0.54**	**0.01**				
Ironworkers	**0.38**	**0.05**				
Electricians	0.30	0.10				
18a. Received written information or training	0.14	0.007	0.09	0.088	0.09	0.06
23a. Currently has/uses respirator	**0.12**	**0.02**				
Symptoms experienced for more than a week during last 3 months.						
42g. Headache			0.09	0.078		
42h. Dizziness	0.091	0.076				
42j. Vomiting			-0.088	0.084	-0.086	0.091
42o. Shaking hands/feet	0.096	0.062				
Most recent project in last 3 months						
51a. Highway/railroad bridge repair	**0.128**	**0.029**			**-0.116**	**0.045**
51f. Commercial/industrial demolition	**0.117**	**0.043**	-0.102	0.076	**-0.114**	**0.046**
51m. Transmission/communication tower maintenance			0.101	0.089	0.101	0.089
51n. New construction/commercial			-0.097	0.085	-0.102	0.072
51o. New construction/industrial	-0.098	0.084				
51q. New construction/highways-streets	**0.127**	**0.032**				
51r. New construction/bridges-tunnels-elevated highways	**0.136**	**0.023**				

TABLE XVI. SIGNIFICANT SPEARMAN CORRELATIONS OF BLOOD LEAD LEVELS AND FEPS WITH QUESTIONAIRE VARIABLES (1 = yes, 0 = no) - CONTINUED

(Q) Variable	BLL r	BLL p	FEP1 r	FEP1 p	FEP r	FEP p
51t. Electric cable splicing	**-0.133**	**0.025**				
51w. Residential remodeling	**0.202**	**<0.001**				
51y. Repair/removal of water lines with lead			-0.111	0.069	-0.105	0.085
51gg. Repair of lead membrane waterproofing	**0.128**	**0.039**				
51nn. Repair/replace/remove water mains or hydrants	0.114	0.068				
Exposures outside the workplace						
Home						
60. What year was your home built? 1 = before 1900 11 = 1990's	**-0.256**	**0.0001**	**-0.119**	**0.025**	**-0.109**	**0.039**
62a. Is exterior of home painted?			0.087	0.086	0.094	0.062
62b. Condition of paint (1 = excellent, 3 = poor)			0.108	0.079	0.101	0.099
63b. Condition of interior paint (1 = excellent, 3 = poor)			**0.177**	**0.0006**	**0.174**	**0.0008**
Hobbys performed in last 3 months						
67ay. Stained glass			-0.321	0.064	-0.286	0.095
67by. Art - paints/pigments			-0.259	0.098	-0.248	0.104
67dy. Ceramics			**-0.395**	**0.023**	**-0.355**	**0.039**
67ey. Riflery/shooting			-0.189	0.057	-0.174	0.079
67fy. Casting/smelting lead	**0.338**	**0.035**				
67gy. Lead manufacturing			**-0.414**	**0.021**	**-0.377**	**0.033**
67hy. Battery manufacturing			**-0.409**	**0.025**	**-0.366**	**0.043**
67iy. Radiator repair			**-0.474**	**0.003**	**-0.431**	**0.008**
67jy. Use of leaded gasoline			**-0.282**	**0.005**	**-0.264**	**0.008**
67ky. Auto repair			-0.220	0.060	-0.197	0.090

TABLE XVII. ASSOCIATIONS OF BLOOD LEAD LEVEL AND FEPS WITH EXPOSURES (WILCOXON RANK SUM - KRUSKAL-WALLIS TEST).

Parameter	Rank Order of Categories	Mean Score	Probability	Biomarker
46a. Type of Construction Most recent job	Bridges/tunnels	280	0.0001	BLL
	Highways/streets	229		
	Residential	203		
	Commercial	184		
	Industrial	168		
46a. Type of Construction Most recent job	Bridges/tunnels	207	0.049	FEP2
	Residential	205		
	Commercial	201		
	Highways/streets	183		
	Industrial	139		
46b. Type of Project	Demolition	268	0.017	BLL
	Lead Abatement	259		
	Other	209		
	Renovation/remodeling	189		
	New Construction	170		
	Asbestos Abatement	141		
61. Type of Residence	Other	286	0.057	BLL
	Duplex/zero lot	210		
	Single family	196		
	Mobile home	194		
	Condominium	176		
	Apartment	160		
	Quadruplex/multifam	107		

TABLE XVIII. CHARACTERISTICS OF PARTICIPANTS WITH BLOOD LEAD LEVELS EXCEEDING 20 UG/DL.

ID	BLL (ug/dL)	Trade	Symptoms in Last 3 Months	Most Recent Job/Tasks	NonWork Activities
176	26.3	Painter	*Questionnaire not completed*		
177	25.4	Painter	None	Residential remodeling	Pre-1900 home/renovation Riflery/shooting
210	27.0	Plumber	*Questionnaire not completed*		Melted scrap for lead ingots
301	39.2	Laborer	Appetite loss, constipation, stomache pain, weakness, unable to sleep, headache, dizziness, nausea, irritable, nervous, muscle aches, joint pain, shaking hands/feet. numb hands/feet, forgetfull.	Bridge Renovation welding/cutting sweeping rivet busting	1920's home renovation
303	32.9	Laborer	Appetite loss, stomache pain, headache, nausea, muscle aches	Bridge renovation welding/cutting sweeping rivet busting	1910's home
304	43.3	Laborer	*No data*	Bridge renovation welding/cutting sweeping rivet busting	*No data*
311	23.2	Ironworker	None	Bridge renovation welding/cutting sweeping rivet busting	1970's home
317	31.1	Laborer	Stomache pain, excessive tiredness, weakness, headache, irritable	Bridge renovation welding/cutting sweeping rivet busting sandblasting	*No data*
329	28.4	Laborer	*No data*	Bridge renovation welding/cutting sweeping rivet busting	*No data*

TABLE XVIII. CHARACTERISTICS OF PARTICIPANTS WITH BLOOD LEAD LEVELS EXCEEDING 20 UG/DL - CONTINUED.

ID	BLL (ug/dL)	Trade	Symptoms in Last 3 Months	Most Recent Job/Tasks	NonWork Activities
332	35.5	Laborer	*No data*	Bridge renovation welding/cutting sweeping rivet busting	*No data*
333	36.5	Laborer	*No data*	Bridge renovation welding/cutting sweeping rivet busting	*No data*
334	31.3	Laborer	*No data*	Bridge renovation welding/cutting sweeping rivet busting	*No data*
335	50.0	Laborer	*No data*	Bridge renovation welding/cutting sweeping rivet busting	*No data*
336	29.0	Laborer	*No data*	Bridge renovation welding/cutting sweeping rivet busting	*No data*
337	44.4	Laborer	*No data*	Bridge renovation welding/cutting sweeping rivet busting	*No data*
338	27.1	Laborer	*No data*	Bridge renovation welding/cutting sweeping rivet busting	*No data*

None of the laborers used respiratory protection during the bridge renovation work.

TABLE XIX. STEPWISE MULTIPLE LINEAR REGRESSION MODEL FOR BLOOD LEAD LEVEL

Dependent Variable	Independent Variables in final model	Coefficient	P	Model R^2	Model P
Blood Lead Level	Intercept	7.420	< 0.001		
	Bridge Work	2.677	0.014		
	New Construction	- 0.928	0.032		
	Lead Dust Present	2.486	< 0.001		
	Plumber (trade)	- 1.322	0.022		
	Laborer (trade)	1.545	0.028		
	Electrician (trade)	- 2.246	< 0.001		
	New construction bridges/highways	6.010	< 0.001		
	Residential remodeling	3.067	< 0.001		
	Year home built	- 0.209	0.004	0.33	0.055

Models for FEPs were not significant.

TABLE XX. PARTICIPANTS RECOMMENDATIONS FOR CONTROLLING LEAD EXPOSURE

A total of 102 responses were recorded for question 75.

Category	Specific Suggestion	Number of Suggestions
Information Dissemination	Education/training	27
	Written information/MSDS	10
	Create local lead hotline	1
	Raise management awareness	2
Control Technology	PPE - clothing, gloves	7
	Respirators	11
	Improve ventilation	4
	Make safety equipment available	2
Management/programs	Control lead work areas	3
	Water for washing hands	4
	Showers	1
	Medical monitoring	1
	Control exposure from adjacent workers	1
	Formal programs	1
	Environmental monitoring/testing	6
	Change system of bid jobs since this encourages cutting corners	1
Products/materials	Ban lead based materials	5
	Substitutes (eg. plastic sealer instead of lead for galvanized metals, do not galvanize areas to be welded)	5
	Label lead based components (eg. identify types of wire with lead)	8
Enforcement	OSHA	1