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Memorandum

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From: Roy M. Fleming, Sc.D., Director, Research Grants Program RMF
Office of Extramural Programs, NIOSH, D30

Subject: Final Report Submitted for Entry into NTIS for Grant 5 R01 OH003177-03.

To: William D. Bennett
Data Systems Team, Information Resources Branch, EID, NIOSH, P03/C18

The attached final report has been received from the principal investigator on the subject NIOSH grant. If this document is forwarded to the National Technical Information Service, please let us know when a document number is known so that we can inform anyone who inquires about this final report.

Any publications that are included with this report are highlighted on the list below.

Attachment
cc: Sherri Diana, EID, P03/C13

List of Publications

Title: Evaluations of Controls Protecting Lead-Exposed Workers
Investigator: Lewis D. Pepper, M.D., M.P.H.
Affiliation: Boston University
City & State: Boston, MA
Telephone: (617) 638-4620
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Abstract:
A cross-sectional study of 90 bridge painters from 13 worksites and 8 contractors in Massachusetts and New Hampshire, was conducted over a two year period from 1994-1995. The aim of the study was to investigate the reasons for persistent elevated blood lead levels among bridge painters involved in lead abatement and bridge painting activities. Abatement activities ranged from complete deleading of the bridges and repainting to repainting previously deleaded bridges. Deleading methods observed included dry blasting, wet blasting, pressure washing, power tooling, and hand tooling. The worksites were evaluated for 14 days during which biological monitoring for blood lead and environmental sampling for ambient, surface and skin lead was conducted. Quantitative and qualitative information on the characteristics of the worksite, personal activities and hygiene, meteorological data, and lead abatement methods were gathered, including interviews with workers and contractors. This information was used to create indices of personal and site hygiene as well as other index variables that were used as exposure modifiers in epidemiologic models of blood lead levels.

Blood lead testing results of interest include the following: (1) Blood lead levels did not differ significantly between the first and second year of the project. (2) Mean blood lead values increased significantly during the 14 day interval. (3) Mean blood lead levels differed by contractor, e.g., there were some "good" and "bad" contractors as reflected in the blood lead values. (4) The blood lead test distribution for the study participants was in excess of OSHA's estimated values based on implementation of the 1993 Construction Lead Standard. In 1994, 19% of all BL tests were in excess of 25 (gm/dl) which increased to 30% of all BL tests in 1995. There is no obvious explanation for this change. (5) Significant predictive factors in explanatory statistical models of the blood lead parameters include cumulative exposure, respirator wipe measurement, smoking on the job, training, use of personal protective equipment, months of bridge work, and years in construction.

There is strong evidence to suggest a potential for bystander exposure and take-home lead. The mean levels of lead found in the clean side of the decontamination unit and the steering wheel of workers' automobiles is quite high, allowing the potential for take home lead through contaminated cars and possibly personal items stored in the decontamination unit. The mean exposure levels for samples taken from less than 20 feet from the containment ranged from 3 ugm/m3 to 132 ugm/m3, thus potentially exposing bystanders

less than 20 feet from the containment to lead dust in excess of the PEL. A second finding of relevance is the wide range in the percent good practice between sites and between indices. The range in percent good practices suggests that there is room for improvement in personal behavior and site hygiene practices. Personal hygiene habits of the workers that were summarized into the personnel hygiene index had a mean percent good practice of a mere 22% in 1994, and improved to 66% in 1995. The same applies to respirator program index which was at 39% in 1994 and improved to 88% in 1995. Improvement in the personal hygiene practices of workers and the respirator program are an important means of reducing exposures. However, the frequency of respirator use and the type of respirators used by workers was not adequate to protect them against exposures in excess of the OSHA PEL. The data shows that in 1994, 34% of the time tasks were performed without the use of a respirators. That was reduced to 24% in 1995. The mean exposure levels were above the PEL for all the tasks except painting rails and assisting painters. Thus, some form of respirator use would be required to protect workers from exposures above the PEL while performing most of the tasks, yet many of the tasks were performed without the use of respirators. In many tasks, even when some form of PPE was used, it was not always of a type adequate to reduce workers' exposures to below the PEL. Finally, the data suggest that personal and site hygiene practices improved greatly from the first sampling year (1994) to the second year (1995). The hand wipes, respirator wipes, car steering wipes and decontamination unit wipes all improved in the second year (1995). Generally, in 1994 a greater percent of the wipe samples were in the high exposure category than in 1995 for all of wipe samples. A similar trend was also observed in the indices of site and personal hygiene which showed a remarkable improvement in all the indices in the second year. This improvement could be attributed to the impact of the new OSHA regulation of lead in construction. However, this conclusion must be drawn with caution as the improvement could also be attributed to the different lead removal methods used in the second year or low exposure activities on the day of sampling.

Publications
No publications to date.

EVALUATION OF CONTROLS PROTECTING LEAD-EXPOSED WORKERS

FINAL TECHNICAL REPORT

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Final Technical Report
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Significant findings and relevance of findings

This study showed several findings that are of importance. Firstly, there is strong evidence to suggest a potential for bystander exposure and take-home lead. The mean levels of lead found in the clean side of the decontamination unit and the steering wheel of workers' automobiles is quite high, allowing the potential for take home lead through contaminated cars and possibly personal items stored in the decontamination unit. The mean exposure levels for samples taken from less than 20ft from the containment ranged from 3 ugm/m^3 to 132 ugm/m^3, thus potentially exposing bystanders less than 20ft from the containment to lead dust in excess of the PEL. A second finding of relevance is the wide range in the percent good practice between sites and between indices. The range in percent good practices suggests that there is room for improvement in personal behavior and site hygiene practices. Personal hygiene habits of the workers that were summarized into the personnel hygiene index had a mean percent good practice of a mere 22% in 1994, and improved to 66% in 1995. The same applies to respirator program index which was at 39% in 1994 and improved to 88% in 1995. Improvement in the personal hygiene practices of workers and the respirator program are an important means of reducing exposures. Thirdly, the frequency of respirator use and the type of respirators used by workers was not adequate to protect them against exposures in excess of the OSHA PEL. The data shows that in 1994, 34% of the time tasks were performed without the use of a respirators. That was reduced to 24% in 1995. The mean exposure levels were above the PEL for all the tasks except painting rails and assisting painters. Thus some form of respirator use would be required to protect workers from exposures above the PEL while performing most of the tasks. Yet many of the tasks were performed without the use of respirators. In many tasks, even when some form of PPE was used, it was not always of a type adequate to reduce workers' exposures to below the PEL. Finally, the data suggest that personal and site hygiene practices improved greatly from the first sampling year (1994) to the second year (1995). The hand wipes, respirator wipes, car steering wipes and decontamination unit wipes all improved in the second year (1995). Generally, in 1994 a greater percent of the wipe samples were in the high exposure category than in 1995 for all of wipe samples. A similar trend was also observed in the indices of site and personal hygiene which showed a remarkable improvement in all the indices in the second year. This improvement could be attributed to the impact of the new OSHA regulation of lead in construction. However, this conclusion must be drawn with caution as the improvement could also be attributed to the different lead removal methods used in the second year or low exposure activities on the day of sampling.

NIOSH recently set a national goal to eliminate exposures to workers that result in blood leads greater than 25 (gm/dl. In pursuit of this goal, OSHA extended its 1978 lead standard to include the construction industry. Similar regulations have been in effect in Massachusetts for some time and have not been able to achieve their goal of reducing lead exposure and elevated lead levels in the at-risk workforce.

Blood lead testing was performed twice, day one and fourteen, over a two-week period. Exposures varied significantly from task to task and from day to day in the higher exposure tasks. Levels of lead in blood may rapidly change as an individual is exposed to high levels of airborne lead.[1] BLL's obtained within a two week span were used to demonstrate relatively short term changes in exposure which might be missed by less frequent testing intervals.

Blood lead testing results of interest include the following:

1. Blood lead levels did not differ significantly between the first and second year of the project.

2. Mean blood lead values increase during the 14 day interval and were significantly higher at time than at time 1.

3. Mean blood lead levels differed by contractor, e.g., there were some "good" and "bad" contractors as reflected in the blood lead values.

4. The blood lead test distribution for the study participants was in excess of OSHA's estimated values based on implementation of the 1993 Construction Lead Standard. In 1994, 19% of all BL tests were in excess of 25 (gm/dl which increased to 30% of all BL tests in 1995. There is no obvious explanation for this change.

5. Significant predictive factors in explanatory statistical models of the blood lead parameters include cumulative exposure, respirator wipe measurement, smoking on the job, training, use of personal protective equipment, months of bridge work, and years in construction.

Abstract

A cross-sectional study of 90 bridge painters from 13 worksites and 8 contractors in Massachusetts and New Hampshire, was conducted over a two year period from 1994-1995. The aim of the study was to investigate the reasons for persistent elevated blood lead levels among bridge painters involved in lead abatement and bridge painting activities. Abatement activities ranged from complete deleading of the bridges and repainting to repainting previously deleaded bridges. Deleading methods observed included dry blasting, wet blasting, pressure washing, power tooling, and hand tooling. The worksites were evaluated for 14 days during which biological monitoring for blood lead and environmental sampling for ambient, surface and skin lead was conducted. Quantitative and qualitative information on the characteristics of the worksite, personal activities and hygiene, meteorological data, and lead abatement methods were gathered, including interviews with workers and contractors. This information was used to create indices of personal and site hygiene as well as other index variables that were used as exposure modifiers in epidemiologic models of blood lead levels.

Personal task samples were collected from as many workers as possible, on tasks performed at that site. A total of 264 task samples were collected from all the sites. Fifty three (n=53) full shift samples were also collected from a few workers at 5 out of the 13 sites. Area samples from inside the containment (n=47), less than 20ft from containment (n=37), and greater than 20ft from the containment (n=35) were also collected. Wipe samples were collected from the workers' hands at break (n=110), and at the end of day from workers' hands (n=89), face (n=25), and neck (n=25), their respirators at the beginning of work shift (n=86) and end of work shift (n=93), the decontamination unit (clean side, n=17) and workers' vehicles (steering wheel, n=43). Workers were also requested to fill out activity-time diaries at the end of every work day in which they recorded the tasks performed, the duration of the task and the type of respirator used during the task. Full shift TWA exposures were calculated for all the workers on all the work days using mean task exposure levels in conjunction with task duration reported on workers' diaries. The mean task levels were obtained by 1. taking means of measured task by site, and 2. developing statistical models to predict mean task levels. Three indices of cumulative exposure were created using 1. measured AM of the tasks, 2. predicted AM of the

tasks, and 3. predicted GM of the tasks. A second set of the three indices of exposure was also calculated that took into consideration workers use of respirators while performing tasks. Thus a total of six indices of exposure were created, some of which will be used in subsequent epidemiologic investigations of predictors of blood lead levels. The questionnaire

Blood lead samples were obtained from the 90 bridge painters and their working contractors at the beginning and end of a fourteen day period (times 1 and 2). Additionally taped semi-structured and structured interviews were administered by an on-site research assistant. Interview results were transcribed, data elements were abstracted, and relevant ethnographic themes were generated by the research team. Questions from the structured questionnaire (see Appendix A) were used to create a series of blood lead modifier indices. Project staff and an expert in construction health and safety identified relevant questions for each potential index. An index of interview questions by category was developed (see Appendix B). Each question was assigned a score of one or zero for yes or no responses respectively. All responses were tabulated for each question grouping for an index score

Industrial hygiene exposure indices, along with questionnaire generated indices, were used in models exploring the change in blood lead levels parameters over the fourteen day interval and over the two study years.

FINAL TECHNICAL REPORT

Background and Significance

It is estimated that 90,000 bridges in the US. are coated with lead-based paints.[2] The deteriorating state of the US. infrastructure and the Surface Transportation Act passed in late 1991 are expected to lead to an increase in bridge and elevated highway repair and renovation projects.

Structural steel repair and renovation projects involve essential features which may create a lead exposure hazard: surface preparation; welding, burning, and torch cutting; and other processes which mechanically disturb lead. A variety of workers are exposed to lead including painters, ironworkers, pipe fitters, carpenters, laborers, and project engineers and inspectors.[3]

Workers removing lead-based paint may be exposed to significant concentrations of lead. Studies of structural steel workers have documented exposures ranging from the Permissible Exposure Limit (PEL) to approximately 100 times the PEL.[4] Worker exposures depend upon the lead content of the undisturbed paint and the particular task the worker performs (e.g., abrasive blasting, burning, or manual or mechanical stripping). Structural steel workers are exposed to both acute, high lead concentrations as well as exposures to lower concentrations of lead over the course of their working lifetime. Case reports of these workers cite acute effects resulting from high level exposures including abdominal colic, headaches, and fatigue. Chronic effects, including kidney and cardiovascular disease, have not been evaluated satisfactorily in this population.

It is possible to conduct industrial hygiene sampling that will allow evaluation of factors which predict airborne lead levels. Industrial hygiene air sampling has most commonly been performed to assure compliance with government regulations and to investigate complaints. Industrial hygienists may occasionally make measurements before and after installation of controls, such as ventilation, to evaluate effectiveness and to justify future expenditures. However, it is rare that industrial hygiene sampling data is collected in such a way that the factors contributing to a worker's exposure can be examined. Perhaps the evaluation of the impact of control techniques and other factors has been most fully explored in the field of retrospective exposure assessment where the lack of measurements has forced industrial hygienists to develop models which predict exposure on the basis of factors for which there is historical information.

A NIOSH Health Hazard Evaluation based on the HUD Lead-based Paint Demonstration Project was produced in 1992.[5] That (HHE) used the area and personal breathing zone samples for lead taken on workers doing lead abatement in public housing projects. The authors determined the important independent variables associated with observed variations in airborne lead concentrations. Independent variables that were examined included abatement method, contractor, housing unit/city, sample volume, pre-abatement soil lead concentration, mean paint lead concentration, median substrate condition, total square feet abated. The results of these analyses indicated that airborne lead concentrations varied significantly among abatement methods and housing units.

Since the method used was an important predictor of airborne exposure level, the mean concentrations for each abatement method were examined. Based on this analysis, it was recommended that heat gun and abrasive removal methods were to be avoided whenever feasible because of their high personal exposure levels. Recommendations that arose from the HHE that are relevant to this bridge workers project include: the importance and lack of adequate washing and decontamination facilities on abatement sites, the question of whether current containment methods are effective in controlling exposures and limiting environmental contamination, the need for more research on the work conditions/practices that result in the highest exposures for each abatement method, and the need for research to determine if respirators are needed during low exposure tasks such as encapsulation and replacement. For each of these recommendations there are parallel concerns for the bridge maintenance and painting workers who have been given a number of guidelines on procedure for bridge lead paint abatement.

Results from blood lead analysis were less enlightening. The failure of blood lead surveillance was attributed to changing job sites, weather related delays, multiple contractors, high employee turnover, and most importantly, the failure of many employers to adequately follow the required medical monitoring protocol.

Notwithstanding the difficulties encountered in the HUD project, blood lead levels (BLL) as an indicator of recent lead exposure may be useful in evaluating the effectiveness of worker protection programs. Regression methods can help determine important independent variables associated with variations in an individual's BLL or change in BLL over time. Potentially important independent variables include the lead content of paint, the job task, personal hygiene (including hand washing, etc.), respirator fit and maintenance, contractor, ventilation, and others. Identification of the factors which impact blood lead permits specific efforts at remediation.

Additionally, the medical monitoring protocol established by HUD did not address the unique characteristics of the construction industry. Because of the special nature, operation, and work within construction, medical surveillance and screening for construction workers should differ from the general industry model. The wide and changing exposure ranges within construction require more frequent medical testing than in most of general industry.

In Massachusetts, many of the approximately 4500 bridges, aqueducts, and steel structures on state highways are at least 40 years old, in need of maintenance and repairs, and covered with layers of lead-based paint. It is estimated that 4000 construction workers in the state are potentially exposed to lead, many of whom are bridge workers. In a report from the Massachusetts Department of Public Health's Lead Registry detailing the first six months of Registry operation, 60% of the individuals reported with blood leads over 40 (gm/dl were in construction, with 24% working as painters.

Historically, guidelines for abatement procedures for lead abatement on bridges have come from several sources; the Massachusetts State Structural Painting Regulations 454 CMR 11.00, the NIOSH Alerts of 1991 and 1992, the Steel Structures Painting Council and the Society for Occupational and Environmental Health. As of 1993, the OSHA Construction Standard for Lead was implemented. With the exception of the new OSHA regulation and Mass Regulation 454 CMR 11.00, all the other documents represent voluntary guidelines for contractors involved in this work.

The Mt. Sinai study[6] of the lead poisoned ironworkers concluded that the construction industries exemption from the OSHA lead standard was unwarranted. The Mt. Sinai authors suggested that the regulation of this industry would in fact prevent lead poisoning. Unfortunately, we are left with the reality that in the face of recommendations for work place controls, medical surveillance programs, and training, clusters of lead poisoning continue to occur in this industry. Although the 1993 OSHA regulations are projected to reduce worker exposure to lead, and consequently, the construction workers' blood lead levels, it is important to monitor the effectiveness of this process.

Researchers from Mt. Sinai School of Medicine studied iron workers employed in the renovation of a large, lead-painted, steel bridge in New York City. Evidence of decreased exposure to lead and a decline in blood lead levels was observed among these workers who were present both before and after the introduction of the OSHA standard, as well as among iron workers newly hired after the OSHA provisions were put in place. They suggested that their findings demonstrated the effectiveness of the OSHA construction lead standard in controlling exposure to lead.[7]

The objective of the Boston University - University of Massachusetts - Lowell project is to evaluate the extent to which the mandatory and voluntary guidelines are in effect during bridge work, to determine the importance of specific procedures in reducing exposures levels, and to investigate why various previous control strategies have failed either in implementation or in prevention of lead poisoning.

Specific Aim#1, Part 1: Perform a set of structured observations work practices, PPE, and control technologies. These observations will be combined into ordinal index variables.

Personal and site hygiene indices were created to be used in epidemiological modeling of blood lead levels. These indices can be used as modifiers of airborne lead exposure to be included in the epidemiologic models. The following types of wipe samples were available from workers and the work place: 1. Hand wipes at the end of work shift after cleanup, 2. Hand wipes during break, 3. Respirator wipes at the end of work shift, 4. Respirator wipes at the beginning of work shift as an index of respirator maintenance, 5. Car wipes from steering wheel, floor and seat, and 6. Decontamination unit wipes from clean side floors and benches or lockers. Indices of exposure were created for the above types of samples by dichotomizing the exposure at the median value into high and low categories. The median exposure level for the above types of samples were: 1. Hand wipes after cleanup=342 ugm, 2. Hand wipes during break=785 ugm, 3. Respirator wipes end of shift=304 ugm, 4. Respirator wipes beginning of shift=138 ugm, 5. Car wipes from steering=136 ugm, and 6. Decontamination unit wipes from clean side floors=110 ugm. Thus each category, high and low had approximately 50% of the data. A ratio of the mean value of the High category to the mean value of the Low category was also calculated. This ratio can be used as an ordinal index in the epidemiological study with the low category having a value of 1 and the high category the value of the ratio, as shown in Table 1. Alternatively, the simple high/low categories can also be used in the epidemiological study. The percent of person day wipes in each site that were in the high exposure category for the above mentioned indices are presented in Tables 1. Also presented in Table 1 is the percent of person day wipes that were in the high exposure category during the first year of sampling (1994) compared to the second (1995).

The percent of samples that were in the high category varied from site to site for all wipe sample types. Generally, sites 1-6 (1994) had a greater percent of samples in the high category than sites 7-13 (1995) for all types of wipe samples. Thus the data suggest that personal hygiene practices represented by hand, respirator and steering wipes, improved in the second year (1995). This improvement could be attributed to the impact of the new OSHA regulation of lead in construction. However, this conclusion must be drawn with caution as the improvement could also be attributed to the different lead removal methods used in the second year or low exposure activities on the day of sampling. Personal difference in the group of workers sampled in the first year compared to the second year could also account for some of the difference observed between the two years, although this would be a minor consideration since many of the workers sampled in the first year were also sampled in the second year. The wipe levels could be used in the epidemiologic study as a continuous variable or as a categorical variable described above. The advantage of using the ordinal index (ratio) over the high/low categories, is that the mean exposure associated with the high category was several times greater (6 - 13 times) than the mean exposure associated with the low category for the various types of wipes. The ratio would reflect the difference between the categories whereas using high/low assumes equality of the categories. Thus the ratio for the various types of wipes were: hand wipes at the end of day = 13, hand wipes during break = 12, respirator wipes end of day = 8, respirator wipes before work = 6, and steering wheel wipe =12, as shown in Table 1.

Qualitative information on the respirator program, wash facility, change facility, containment structure, site cleaning procedure and personnel hygiene were also gathered and indices created. The various indices mentioned above were created from the following information:

1. **Respirator facility index (all responses yes/no)**: respirators cleaned daily, respirator storage available, availability of respirator parts and cartridges.
2. **Wash facility index (all responses yes/no)**: presence of separate hand wash facility, running water available, hot water available, towels available.
3. **Change facility index (all responses yes/no)**: enclosed decontamination facility, running water and hot water for washing/showers in decontamination unit, showers in decontamination unit, towels available, laundry services provided, personal lockers available, work clothes provided.
4. **Containment index**: containment material (rigid or flexible), permeability of material (permeable or impermeable to air), support structure (flexible, rigid, support at the top, support at top and bottom), joints (fully sealed, partially sealed overlapping, no overlap), entryways (fully sealed, partially sealed overlapping, no overlap), makeup air (controlled, open air), air flow (mechanical ventilation, natural plenty air flow, natural little air flow), air pressure (instrument verified, visual verified, no negative pressure), air movement in containment (minimum velocity specified, not specified), exit air collection (air filtration required, not required).
5. **Cleaning procedure index**: debris collection method (no debris, wash, fold tarps, vacuum, sweep and shovel), tarps cleaning procedure (wash, vacuum, sweep and shovel, not cleaned), wet debris before collection.
6. **Personnel hygiene index (all responses yes/no)**: remove coverall before break, wash before break, smoke during day, wash at the end of day, shower at the end of day, clean respirator at the end of day.

Indices of personal and site hygiene where the responses were yes or no, were created by summing all positive responses and converting them into a percent good practice. Positive in this sense refers to qualities that are desirable for that particular activity. An example is given below. In the creation of wash facility index, four variables with yes/no responses were considered, which include presence of wash facility, presence of running water, presence of hot water and whether towels were provided. A positive response is the presence of good practice, in this case corresponded to a "yes" answer to the above four questions. A score of 1 is given to positive responses and 0 to negative responses. Percent good practice is calculated by summing the responses to the four questions, dividing by the number of questions (four in this case), and multiplying by 100. When a question has several levels of responses, an alternative strategy was used to create the indices of hygiene which gave each variable the same total score of 10. In this way, all variables that comprised the index got equal weights. These hygiene indices were created for each site and the percent good practice are presented in Table 2a. Exposure to surface lead levels in the clean side of the decontamination unit and from the steering wheel of workers' automobiles are also presented in Table 2a. Changes in the indices and surface exposure levels from the first to the second sampling year were also investigated and are presented in Table 2b.

The results show a wide range in the percent good practice between sites and between indices. Since the different indices are dissimilar, they could all be used in epidemiological analysis of blood lead levels. The range in percent good practices suggests that there is room for improvement in personal behavior and site hygiene practices. The mean levels of lead found in the clean side of the decontamination unit and the steering wheel of workers' automobiles is quite high. This further suggests the need to reduce these other sources of exposures that are not traditionally included in evaluating workers' exposure. Moreover, there is a great potential for take-home lead from automobiles and items stored in the clean side of the decontamination unit. In evaluating changes in the indices and surface exposure levels from the first to the second sampling year, Table 2b shows a remarkable improvement in all the indices in the second year. The mean surface wipe levels from the clean side of the decontamination unit and steering wheel of workers' cars also showed a great improvement. However, the results should be evaluated with caution as the same concern noted earlier also applies here.

Personal hygiene habits of the workers such as if workers removed their coveralls before break, washed hands before break, smoked during the day, washed and showered at the end of day, and cleaned their respirator at the end of the day were combined into the personnel hygiene index. The mean percent good practice for this index in 1994 was a mere 22%, and improved to 66% in 1995. Improvement in the personal hygiene practices of workers is an important means of reducing their exposure. The same applies to respirator program index which was at 39% in 1994 and improved to 88% in 1995. The activities involved in the respirator program are not optional, but essential in reducing workers' exposure and should be at 100% all the time. The use of respirators was also evaluated and showed that in 1994, 34% of the time tasks were performed without the use of a respirator . This was reduced to 24% in 1995. As shown in Table 3a, most the tasks had mean (AM) exposure levels of greater that 50 ugm/m^3 except painting railings and assisting painter. This suggests that respirators should have been worn during most of the tasks. The cleanup procedures of the sites were also evaluated and summarized in the cleanup procedure index. The average good cleanup procedure was only at 38% in 1994 and improved to 58% in 1995. The index included information on debris collection methods, whether the debris is wet before collection, and tarps cleaning procedures. All these activities are related to dust reduction activities and could be optimized to reduce task exposure levels since all the associated tasks such as setup and take down of tarps had mean exposure levels above the PEL

Specific Aim#1, Part 2: Development of 2 week lead exposure index.

Rationale for task based sampling

Unlike the general industry, construction work is dynamic and extremely variable in nature. The resulting exposures are highly variable as well. The strategy of collecting time integrated full shift samples masks exposure differences that exist between tasks within a day. Thus, a task based sampling approach is particularly useful in the construction environment in understanding the nature of tasks, the causes of high exposures and in designing controls. Generally, task based samples provides more information on the work environment than the full shift samples. In this study, a task based sampling approach was taken to collect personal environmental samples on workers performing specific tasks. The rationale for task based sampling for lead is based on several considerations. First, when task levels are used in conjunction with worker diaries, full shift exposure estimates can be created for individuals. These estimates can be used as indices of exposure in an epidemiologic study. Second, intervention can be efficiently instituted by targeting tasks that contribute the most to the overall daily exposures. Thus workers can be better protected by identifying high exposure tasks, so that appropriate engineering controls and respirator use can be instituted.

Time and Activity Patterns (Diary)

The time diary is a technique used to collect data on how individuals spend their time. The creation of a full shift average concentration from task based sampling requires the accountability of time use. In this study, workers were requested to fill out activity-time diaries at the end of every work day in which they recorded the tasks performed, the duration of the task and the type of respirator used during the task. The diaries were filled out every workday by all the workers present, over the two week follow up period.

Creation of daily TWA concentrations using 1. the simple arithmetic mean (AM) of measured task levels (by site) and worker diaries, and 2 from statistical models of determinants of exposure levels using the estimated arithmetic mean (AM) or the geometric mean (GM) from the predicted task levels and worker diaries.

Full shift TWA exposures can be estimated for all the workers on every workday over the two weeks period using a simple time weighted model shown below:

$$TWA_{reconstructed} = \sum_{task=1}^{n} (c_{task} \times t_{task}) / T \cong TWA_{measured}$$

where,
c_{task} = task concentration
t_{task} = sampling time
T = sum of sampling times for all tasks per day

The reconstructed TWA is the sum of the measured task concentrations multiplied by the sampling time, for all the tasks performed by a worker on a day, divided by the total sampling time. However, not all the tasks performed by every worker over the two week period was sampled, thus task exposure levels and task duration needed to be estimated for days when samples were not collected. A strategy was developed to calculate full shift TWA exposures using mean task levels in conjunction with task duration reported on workers' diaries. The tasks have to be relatively uniformly exposed so that a task mean can be applied to all individuals within it. Thus, the above model was modified by replacing the measured task level (c_{task}) with a mean task level ($\overline{x}_{task}$), and the sampling time (t_{task}) by task duration recorded by workers in their activity-time diaries ($t_{diary-task}$). Two separate methods were used to estimate the mean task levels. The first approach is by taking mean task levels by site and applying the mean of the task to all workers in that site who performed that task. The second approach is to develop statistical models to predict mean task levels. The task means thus obtained can be applied to all workers within that group, and in conjunction with task duration from their diaries, daily TWA estimates can be calculated for all the workers on all the workdays over the two weeks. The reconstructed TWA were calculated according to the simple time weighted expression presented below.

$$TWA_{reconstructed} = \sum_{task=1}^{n} (\overline{x}_{task} \times t_{diary-task}) / T \cong TWA_{measured}$$

In the first case, the mean task levels by site were applied to all workers performing the task within the site, and in conjunction with task time from worker diaries, daily TWA estimates were calculated for all the workers on all the workdays over the two weeks. In the second approach, the mean task levels were estimated from statistical models of determinants of exposure. Once the estimates were predicted, they were used to calculate the full shift TWA as described above. The following is a description of the modeling approach.

It is commonly accepted that environmental exposures are log-normally distributed. Thus, the natural log of the exposure variable were used in all of the models developed, after confirming the underlying distribution by statistical testing and graphing techniques. Statistical modeling of determinants of exposure levels makes the optimum use of available qualitative and quantitative data to predict exposure levels. These models can predict average task exposures for a group of individuals more precisely. Thus, univariate models of all explanatory variables were first evaluated. Variables that were statistically significant determinants of exposure levels were then included in multivariate models. The criteria used for the evaluation of these models was the value of R^2. Several models were used to predict task exposure levels and were applied to each individual who possessed the characteristics specified by the multivariate model. The GLM procedure in SAS was used to develop these models. The model used to predict exposure levels for blasting and assist in blasting tasks is given by equation 1 below. The three variables were all significant at $p<0.05$, and explained 81% of the variability in exposure levels. The model used to predict exposure levels for the task of setting up tarps is described by equation 2 below. The three variables were significant at $p<0.05$ and explained 60% of the variability in exposure levels. The mean exposure levels for tasks associated the use of hand tools and painting such as clean railings, clean surface, paint rails, paint in containment, paint without containment, assist painting and hand tool cleaning were predicted by equation 3 below. The model explained 76% of the variability in exposure levels and all three variables were significant at $p<0.05$. The mean exposure levels for other activities less than or greater than 20 feet from containment and supervise were predicted by equation 4 given below. The model explained 42% of the variability in exposure levels with the last variable being borderline significant. Finally, the mean exposure levels for take down tarps and assist blaster while not blasting were predicted by the model described by equation 5 below. The model explained 46% of the variability in exposure levels with the last variable being borderline significant.

$$\mathrm{Ln}[\mathrm{Pb\ Conc}_{\mathrm{blast}}] = \beta_0 + \beta_1(\mathrm{Method}) + \beta_2(\mathrm{Activity}) + \beta_3(\mathrm{Containment})$$

Equation 1

$$\text{Ln}[\text{Pb Conc}_{\text{set tarps}}] = \beta_0 + \beta_1(\text{Method}) + \beta_2(\text{Activity}) + \beta_3(\text{Tarps})$$

Equation 2

$$\text{Ln}[\text{Pb Conc}_{\text{paint}}] = \beta_0 + \beta_1(\text{Method}) + \beta_2(\text{Activity}) + \beta_3(\#\text{Workers})$$

Equation 3

$$\text{Ln}[\text{Pb Conc}_{\text{other activities}}] = \beta_0 + \beta_1(\text{Method}) + \beta_2(\text{Activity}) + \beta_3(\text{Debris})$$

Equation 4

$$\text{Ln}[\text{Pn Conc}_{\text{takedown trps}}] = \beta_0 + \beta_1(\text{Method}) + \beta_2(\text{Activity}) + \beta_3(\text{Containment}) + \beta_4(\text{Debris})$$

Equation 5

where,
Tarps = tarps handling method
Method = lead removal method
Activity = activity performed within task
Containment = level of containment index
Debris = debris collection method
Workers = number of workers involved in lead removal

The above models were based on the log transformed exposure levels. The exposure estimates that the model predicted were in the logs. The exponent of the logged value is the geometric mean (GM). To obtain arithmetic mean from the logged value, the maximum likelihood estimate (MLE) of the mean was calculated. An approximation of the MLE when the number of samples is large (n>50), is given by the expression presented below (Selvin and Rappaport,1989).

$$\overline{x}_{mle} = \exp(\overline{x}_L + 0.5s_L^2)$$

Once the mean task estimates were predicted by the model and the estimated AM calculated, they were used in conjunction with task times reported in worker diaries to calculate full shift TWA exposures. Both the estimated AM and the GM of the predicted task levels were used to create full shift TWAs.

Three indices of cumulative exposure were created using 1. measured AM of the tasks, 2. predicted AM of the tasks, and 3. predicted GM of the tasks. A second set of the three indices of exposure was also calculated that took into consideration workers use of respirators while performing tasks. The respirator use was recorded by workers in their diaries. Thus the mean task level was divided by the respirator protection factor (RPF) of the specific respirator used by the worker during the task producing three indices of cumulative exposure using 1. measured AM of the tasks/RPF, 2. predicted AM of the tasks/RPF, and 3. predicted GM of the tasks/RPF. Thus a total of six indices of exposure were available to be used in the epidemiologic investigation of predictors of blood lead levels.

The mean of the measured task exposure levels (AM), the standard deviation, the minimum and maximum are presented in Table 3a. Also presented in Table 3a are expected mean exposure levels reported by OSHA, and percent of time the different types of respirators were used when performing certain tasks. The mean exposure levels were above the PEL for all the tasks except painting rails and assisting painters. Thus some form of respirator use would be required to protect workers from exposures above the PEL while performing most of the tasks. Yet many of the tasks were performed without the use of respirators, ranging from 0-100% of the times. Two tasks were always performed with the use of PPE and those were abrasive blasting the use of power tools. The task of supervising was always performed without the use of any form of PPE. The mean exposure level for task of supervise was 154 ugm/m^3, which is above the PEL. Other tasks performed with a high frequency of not using PPE included other activities greater than and less than 20 feet from containment, and cleaning and painting rails. Except for painting rails, the rest of the tasks had mean exposure levels of above the PEL. In many tasks, even when some form of PPE was used, it was not always of a type adequate to reduce workers' exposures to below the PEL. For example, for the task of assist blasting, 62% of the time a respirator with an RPF of 10 was used and 29% of the time respirator with an RPF of 25 was used. The use of these respirators would reduce the mean exposure level of assist blasting to 448 ugm/m^3 and 179 ugm/m^3

respectively, still above the PEL. The same applies to hand tool use which was performed 91% of the time using a respirator with a RPF of 10, resulting in exposure level above the PEL of 272 ugm/m^3. Other tasks that fall under the above scenario include power tool use, pressure washing and takedown tarps.

In addition to inhalable task samples, for a few tasks, respirable samples were also available and presented in Table 3b. For the tasks of assist blasting and takedown tarps, the percent of inhalable lead dust that was respirable was 16% and 12% respectively. These tasks had the least amount of respirable dust as the largest source of dust for there tasks is the abrasive grit. The tasks of setup tarps and other activities less than 20ft had the greatest percent of respirable dust of 35% and 40% respectively. These tasks have little contact with the main dust generating activities, especially since tarps are somewhat cleaned at the end of each work day. The remaining tasks of assist while no blasting, other activities greater than 20ft, and supervise all had mean percent respirable dust around 20%.

Area samples were also collected from each site inside the containment, less than 20ft from the containment and greater than 20ft from the containment. The results of those samples are presented in Table 4. The mean exposure levels for samples of greater than 20ft from the containment ranged from 4 ugm/m^3 to 51 ugm/m^3 between all the sites, while those for less than 20ft from the containment ranged from 3 ugm/m^3 to 132 ugm/m^3 . Thus, despite the containment structure, bystanders less than 20ft from the containment could potentially be exposed to lead dust in excess of the PEL. The mean exposure levels inside the containment were highly variable from site to site depending on the activities being carried out. The mean exposure levels ranged from 8 ugm/m^3 at a site that was only repainting bridges with little lead abatement activities to 5448 ugm/m^3 at a site that was doing abrasive blasting. During abrasive blasting, exposures of grater than 1000 ugm/m^3 are very likely, thus any person entering the containment would require respirator with a protection factor of greater than 20.

Specific Aim#2: Measure lead particle exposure in three particle size fractions and perform surface wipe measurements. Sampling and Analytical techniques.

Environmental Sampling

Environmental sampling for ambient lead was performed using three different samplers. All the samples were analyzed for lead by first digesting them in acid and then analyzing for lead using Flame Atomic Absorption Spectroscopy. Initially, the aim was to collect air samples in the three particle size fractions representing particle deposition in the alveolar, tracheobronchial and nasopharynx regions of the respiratory system. The Anderson 2 stage personal impactor was used to collect lead dust in the three size fractions. However, preliminary sampling results showed a high degree of blockage of the nozzle through which the air flows from one stage to another. This problem could not be overcome without the use of a pre-sampler to capture the large articles. Such modification could not be instituted easily and thus the impactor was substituted by other samplers. Moreover, the mylar filters which are used with the impactor were not easily digested by following the existing methods to facilitate the analysis of lead by Flame AAS.

The IOM sampler was used to collect all the full shift TWA samples, the task samples and the area samples. The IOM sampler was developed by the Institute of Medicine in Edinburgh, Scotland. Its collection efficiency closely tracks the ACGIH and ISO Inhalable Particulate Mass (IPM) curve over the range of particle size. Since lead has a systemic effect, it was thought that an inhalable sampler that collects dust that could be deposited anywhere in the respiratory system, would be the best alternative sampler to use in place of the impactor. Thus samples were collected on 25mm diameter, 0.8um pore size, Mixed Cellulose Ester (MCE) filters in an IOM sampler. The constant flow GilAir personal air sampling pumps form Gilian Instruments were used, set at a flow rate of 2.0 liters per minute. The pumps were calibrated before sampling and the flow rate was checked after sampling and recorded. After sampling, the filters were transferred into petrislides and sent to the laboratory for analysis.

Respirable cyclones were also used to collect personal task samples and area samples in containment. This was done to obtain particle size information during different tasks and in containment. The 37mm diameter, 0.8um pore size, Mixed Cellulose Ester (MCE) filters were used in the respirable cyclone manufactured by BGI with a 50% cut point of 4.0 um, set at a flow rate of 2.2 liters per minute. The rest of the procedures were as described above.

Closed face filter cassette samples were also collected as area samples inside and outside of the containment, side by side with the IOM samples. Samples were collected on 37mm diameter, 0.8um pore size, Mixed Cellulose Ester (MCE) filters as described above. The purpose of collecting closed face area samples was to compare to the IOM samplers.

Personal Breathing Zone Air Samples

Full shift TWA samples. Full shift time weighted average (TWA) samples were collected at 5 of the 13 worksites in the inhalable size fraction using the IOM sampler. A total of 53 TWA samples were available and ranged in ranged in sample time from 21 minutes to 549 minutes. The TWA samples consisted of multiple samples due to the high probability of overloading. The collection of full shift samples was eventually stopped as the samples were often overloaded and it was impossible to get consecutive samples.

Task samples (inhalable). Task samples were collected in the inhalable size fraction using the IOM sampler. A total of 18 tasks were identified and sampled between all the different sites. A total of 264 task measurements were available for analysis and are reported in Table 3a.

Task samples (respirable). Task samples were also collected in the respirable size fraction using the cyclone sampler. A total of 8 tasks were sampled between all the different sites. A total of 39 task measurements were available for analysis and reported in Table 3b.

Area Samples

Inside the containment. Three types of sampling devices were used inside the containment, the IOM sampler, the cyclone and the closed face filter cassette. A total of 19 cyclone and closed face cassette samples and 47 IOM samples were available for analysis. Results of the inhalable samples are reported in Table 4.

Less than 20ft from containment. Two types of sampling devices were used to take air samples from less than 20ft from the containment, the IOM sampler and the closed face filter cassette. A total of 30 closed face cassette samples and 37 IOM samples were available for analysis. Results of the inhalable samples are reported in Table 4.

Greater than 20ft from containment. Only the IOM sampler was used to take air samples from greater than 20ft from the containment. A total of 35 IOM samples were available for analysis and are reported in Table 4..

Surface Wipe Samples

Surface wipe samples were collected using Wash'n Dri towelettes. Using disposable gloves for each sample a 10cm x 10cm template was placed over the area to be sampled. The surface within the template was wiped three times using 3-4 strokes each time. The towelettes were folded with the dirty side inside after each set of 3-4 stokes, place in a plastic bag, sealed and labeled. The template was cleaned for the next use. Two field blanks were also placed in plastic bags with each batch of wipe samples collected for a given day. Surface wipe samples were collected from the floor and the benches/lockers in the clean and the dirty side of the decontamination unit. Summary results for the decontamination unit wipes are presented in Table 2a.

Personal Wipe Samples

Personal wipe samples were collected using Wash'n Dri towelетts. Using disposable gloves for each sample, a towelette was handed to the worker being sampled who wiped his/her skin for 30 seconds. The towelette was then placed in a plastic bag, labeled and sealed. Five different skin wipes were taken from each worker. At the end of day after cleaning up, the workers were asked to wipe their hands, face, neck and arms. A hand wipe sample was also collected during the middle of the work shift, usually during a break. The hand wipe samples were collected using two towelettes while the rest of the samples were collected using a single towelette. Summary results for the skin wipes are presented in Table 1.

Respirator Wipe Samples

Respirator wipe samples were collected using Wash'n Dri toweletts. Using disposable gloves for each sample, a towelette was used to thoroughly clean the inside of the respirator (the part that is placed over the nose and mouth of the worker) for 30 seconds. This process was repeated using a second towelette. The towelettes were then placed in a plastic bag, labeled and sealed. Respirator wipe samples were collected at the end of a shift prior to the respirator being cleaned and at the beginning of the day after the respirator has been cleaned. Summary results for the respirator wipes are presented in Table 1.

Car Wipe Samples

Car wipe samples were collected using Wash'n Dri towelettes. Using disposable gloves for each sample a 10cm x 10cm template was placed over the area to be sampled. The surface within the template was wiped three times using 3-4 strokes each time. The towelettes were folded with the dirty side inside after each set of 3-4 stokes, place in a plastic bag, sealed and labeled. car wipe samples were collected from the car seats, trunk and steering wheel of workers' automobiles. The steering wipe samples were collected by wiping the entire steering wheel three times, folding the towelette after each wipe. Summary results for the car wipes are presented in Table 1.

SPECIFIC AIM #3

Perform a project baseline blood lead on this group, followed by a second measurement 14 days later.

Background:

Blood lead testing was used to measure lead absorption during the two week observation period at each construction site. Two tests were performed. The first test constituted a project baseline. The second test was scheduled to be performed two weeks later.

Existing data indicates that lead exposures in the repair and renovation of steel structures can be extremely high.[8] Exposures can vary significantly from task to task and from day to day and may range from 5,000 to 10,000 (gm/m^3 in the higher exposure tasks. Levels of lead in blood may rapidly change as an individual is exposed to high levels of airborne lead.[9] We proposed obtaining BLL's within a two week span so that we could demonstrate relatively short term changes in exposure which might be missed by less frequent testing intervals.

Humans are primarily exposed to lead via inhalation and gastrointestinal absorption. Occupationally exposed populations typically receive the greater fraction of their exposure via inhalation. In adults, inhalation absorption of lead is more efficient that oral.[10] Occupational exposure studies, which usually measure inhalation exposures, may underestimate actual personal exposure and absorption. Gastrointestinal absorption of lead in the workplace may result from the lack of appropriate personal hygiene and eating facilities

Blood lead levels rise relatively rapidly after exposure and continue to rise as the intake of lead exceeds that which can be excreted. [35,11] The blood lead test, which integrates both inhalation and oral exposure routes, reflects recent absorption better than it does total body burden. The particle size distribution of the airborne lead, which may vary from one job task to another, is an important factor effecting BLL rise.[31] In dramatically changing exposure situations such as bridge maintenance workers encounter, blood lead levels probably fluctuate rapidly. Testing strategies which depend upon infrequent monitoring in such a rapidly changing exposure environment are likely to inaccurately assess biological exposure.

Presently, the BLL remains the best available indicator of current or recent lead absorption and it remains the mainstay of biological monitoring and medical surveillance. There are reasonably good estimates of the BLL range at which many acute and sub-acute health effects occur.[38] However, there is less concordance between BLL and chronic health effects.

In addition to recent exposure, the BLL also reflects an individual's long-term cumulative exposure. Bone lead levels, which increase with age and exposure, act as a pool from which the BLL is replenished at a relatively constant rate.[12] Consequently, depending upon an individual's exposure history (years and intensity of exposure), the BLL will not entirely reflect their most recent exposure. It is suspected that cardiovascular and renal toxicity may be related to chronic low-level lead exposure13 which will not be as readily determined from a BLL.

The testing of a BLL at the beginning and end of a two-week observation period is justified by the need to get a stable estimate of the workers' biological absorption during the study. If the second measured BLL is considerably higher (or lower) than the initial level, then one needs to consider the particular job tasks or other factors which occurred during the study period. If the BLL's are not significantly different among groups with similar job tasks or for specific worksites over the two-week periods, then the analysis can be more straightforward.

Results:

The 90 bridge worker subjects in this study worked for eight different contractors at 13 different worksites. Abatement activities ranged from complete deleading of the bridges and repainting to repainting previously deleaded bridges. Deleading methods observed included dry blasting, wet blasting, pressure washing, power tooling, and hand tooling.

The mean age of the study subjects was 33.6 years (S.D. =9.016496, range 19 - 59). There were 89 men and one woman participants. 85 of the subjects were Caucasian and 5 were non-white.

All blood lead and Zinc protoporphyrin analysis were performed at the laboratory of the Division of Occupational Hygiene (DOH) of the Massachusetts Department of Labor and Industries, Newton, Massachusetts. The DOH laboratory is accredited by the American Industrial Hygiene Association, and it is also an OSHA approved laboratory for blood lead analysis. The blood lead analysis were performed in duplicate by graphite furnace using a Varian Spectre AA 400 Atomic Absorption Spectrophotometer and Zinc Protoporphyrin analysis using an ESA Model 4000 Hematofluorometer. Blood samples will be collected in lead free vacutainer tubes.

The DOH laboratory has a quality assurance(QA) coordinator who is responsible for the conduct of the Industrial Hygiene Laboratory Quality

Assurance Program. The QA program includes provisions for the maintenance of a total analytical quality control system to assure continued precision and accuracy of lab results.

Ninety workers participated in the project during year 1 and 2. The blood lead values for 1994 and 1995 are recorded in Table 5. 46 in year one and 44 in year 2. Two blood lead samples were obtained for 84 subjects. The mean blood lead levels at time 1 and time 2 for the two years were 17.9 (gm/dl (S.D., 8.978411, range 3 - 40) and 19.7 (gm/dl dl (S.D., 8.677977, range 3 - 42) respectively.

In Table 5 the mean blood lead values at time 1 and 2 (BL_1 and BL_2) (only participants with two test values) were tested to determine if there was a significant change from baseline. Paired t-test comparing the means of BL_1 and BL_2 for the two years was 19.8 - 18.3 (n= 84) which was significantly different (p=0.0004). The difference between final and initial blood lead for 1994 and 1995 was 19.5 - 17.1 (n=44) which was significantly different (p=0.0001) and 20 - 19.6 (n=40) which was not significantly different (p=0.4430). Although the mean blood lead values for 1995 were higher than 1994, there was a smaller and statistically insignificant increase (2.4 vs. 0.04) over the 14 day period in 1995.

The OSHA Lead and Construction Standard was published in mid-1993. Full implementation of the standard occurred over the ensuing year. We assumed that many of the changes resulting form the new standard would be seen in the project's second year (FY 94-95). Blood lead levels at times one and two were compared for year one and year two. Therefore, blood lead levels should have been lower in the project's second year if the OSHA standard had an impact. As shown in Table 5, combined blood levels (BL_1 and BL_2) were higher in 1995 (19.6 vs. 18.1), and the mean BL_1 and mean BL_2 were higher in 1995 as well (BL_1; 19. 2 vs. 16.7) and (BL_2; 20 vs. 19.5). However, the absolute difference between BL_1 and BL_2 was slightly smaller in 1995 than 1994 (0.4 and 2.4) and it was not statistically significant.

OSHA estimated the distribution of expected blood lead levels among construction workers following the complete implementation of the new PEL of 50 (gm/m^3. OSHA estimated that the BLL's among construction workers would not exceed 25 (gm/dl once the elements of the new standard, the PEL, medical surveillance, environmental monitoring, personal protective equipment, and engineering controls, are implemented.

We calculated the distribution of all BL tests by year for this group. We assumed that the major elements of the standard would have been sufficiently implemented by the project's second year (1995) to assess OSHA's projection. Table 6 summarizes the distribution for the study subjects.

The resulting blood lead distribution for the study participants, as summarized in Table 6, does not reflect the results OSHA's expected from the implementation of the new standard. In 1994, 19% of all BL tests were in excess of 25 (gm/dl which increased to 30% of all BL tests in 1995. There is no obvious explanation for this change. At this point, we have yet to evaluate whether the increase may be due to the later time in the work year that blood lead tests were taken. Presumably the exposure over time to individuals working throughout the bridge construction season may lead to higher blood lead levels later in the construction season.

AIM #4

Use ethnographic techniques (observation, questionnaires and semi-structured interviews) to assess management and worker awareness of lead poisoning issues associated with bridge repair work practices at each site.

Interviews

The project research assistant conducted semi-structured interviews with all workers at each site concerning beliefs and attitudes about rules of conduct and health regulations on the job, as well as questions about their co-workers and their own compliance with safety regulations. Questions will explore any lead prevention initiatives begun by the construction company, the objectives of those activities, and the means by which the objectives are to be achieved.

The use of an ethnographic open - ended interview to elicit construction workers' conceptions of lead poisoning and their responses to questions regarding work-related risk taking behavior was intended to encourage more explicit explanations of their behavior than our ongoing parallel research activity of the close-ended survey. The goal of the interview has been to elicit the beliefs, behaviors, and interactions of the workers from their point of view within their own personal and cultural context. The data collected focused on everyday work experiences.

Questions for the ethnographic open-ended interview were developed with the advice and expertise of Drs. Lewis Pepper and Susan Woskie who are involved in research and interventions for workers and who are both investigators on the project. Employee questions assessed the amount and frequency of use of protective equipment; personal concerns about getting lead poisoning; knowledge about lead exposure; effectiveness of personal protective equipment in preventing lead exposure and lead poisoning; beliefs about peers' safety behaviors; respondents' safety behavior. In addition to these questions, contractors were asked about their attitudes towards health and safety, how effective training is, and other questions designed to assess their perception of risk for themselves and the workers.

To maintain a collection of comparable qualitative data we developed an interview guide which listed specific questions and topics to be covered in a particular order in the interview. The questions, which developed from the recommendations of Drs. Pepper, Woskie, and Strunin, along with the review of the relevant literature, were also a part of the more structured interview instrument. Worker interviews followed a script and probes were inserted as indicated in the interview guide. Each interview was taped and subsequently transcribed.

The objective of the analysis of the open-ended interviews is to understand and explain the impact of culture and context from the narratives: to find out <u>what is</u> and <u>why it is</u>.

The first step of the descriptive analysis involved the transcription of the tapes. In the second step codes were attached to segments of text. Coding organized the text and helped identify issues and themes of relevance in the text. Each worker interview then was evaluated by a set of thematic codes developed by Drs. Strunin and Pepper (see Appendix C).

The third step goes beyond classification of the data and explores whether or not linkages exist between/among particular categories. The purpose has been to develop propositions or to relate concepts in order to generate hypotheses. At the descriptive level, analysis involves seeing patterns. At the theoretical level, it involves thinking about why things happen. Because of unforeseen delays in the transcription and coding of interviews, we have been unable to complete this very important and necessary step.

AIM #5

To develop predictors of blood lead and air concentrations using industrial hygiene controls, work practice, training and company and worker attitude variables.

We developed blood lead modifier indices using a method similar to the one previously discussed for exposure modification index. Training, personal protective equipment, and hygiene indices were created. Each of these items have been assumed to have an important impact on work performance and health and safety status.[14] For example, Robins, et al.[15] observed a joint labor-management training program and identified issues which were related to beneficial aspects of training. We incorporated into the structured lead construction worker questionnaire modifying them for use in this project.

Questions from the structured questionnaire (see Appendix A) were used to create each of the blood lead modifier indices. Project staff and an expert in construction health and safety identified relevant questions for each potential index. An index of interview questions by category was developed (see Appendix B). Each question was assigned a score of one or zero for yes or no responses respectively. All responses were tabulated for each question grouping for an index score. These scores were used in the regression model which is described later.

The personal protective equipment index has values ranging from 0 to 5. It consists of a sum of the following items; 'Do you wear a coverall', 'Do you wear eye protection', 'Do you wear bootcovers', 'Do you wear gloves', and 'Do you use hearing protection'? The training index also has scores ranging from 0 to 5. It consists of a sum of the following items; 'Did they talk about OSHA, 'Did they cover respirator use in training', 'Did they cover cleaning and maintenance', 'Did they cover storage', and 'Did they cover when to use it (respirator)? Finally, the hygiene index index has values ranging from 0 to 8. . It consists of a sum of the following items; 'Do you shower', 'Before leaving do you change', 'Do you ever wear your work clothes home (negative response)', 'Do you wear your shoes home (negative response)', 'Do you eat on the site (negative response)', 'Do you wash before eating or drinking', "Do you chew tobacco at work (negative response), and 'Do you chew gum at work (negative response)'?

In an earlier section, we described the development of the task characterization and cumulative exposure indices. The daily TWA exposures were recreated using 1. the simple arithmetic mean (AM) of measured task levels (by site) and worker diaries, and 2 from statistical models of determinants of exposure levels using the estimated arithmetic mean (AM) or the geometric mean (GM) from the predicted task levels and worker diaries.

Full shift TWA exposures were estimated for all the workers on every workday over the two weeks period using a simple time weighted model shown below:

$$TWA_{reconstructed} = \sum_{task=1}^{n} (c_{task} \times t_{task}) / T \cong TWA_{measured}$$

where,
c_{task} = task concentration
t_{task} = sampling time
T = sum of sampling times for all tasks per day

The reconstructed TWA is the sum of the measured task concentrations multiplied by the sampling time, for all the tasks performed by a worker on a day, divided by the total sampling time. This exposure data was utilized in our model to evaluate the relationship of the exposure measures to the final blood lead value and/or the change in blood lead over 2 weeks.

The arithmetic mean cumulative exposure index, adjusted for respirator use, was considered as a potential predictor in a step-wise regression. This variable was highly skewed, with few subjects having high values. The variable was log transformed for analysis. respirator wipe before work variable (respbefr) appears to be the strongest predictor of BL_2 as well as the predictor of the change in blood lead level.

Correlations (Spearman) were calculated between the various exposure measures and the blood lead level at follow-up and the change in blood lead level. In Table 7, the cumulative (lnamcume) and respirator wipe (respbefr) are correlated with the follow-up blood lead level. Only the respirator wipe measurement, however, is correlated with change in blood lead levels.

The following variables were included as potential variables in stepwise regressions for change in blood lead level and BL_2.

1. Two exposure variables; arithmetic cumulative exposure, corrected for respirator and the ln of the arithmetic cumulative exposure, corrected for respirator.
2. Respirator wipe before work.
3. Indices; respirator, personal protective equipment, training, and hygiene.
4. Years in construction
5. Months in bridge work
6. Age
7. Lead hobbies
8. Gender - too little variation
9. Smoking
10. Taking lead home (too much missing data).

The following analyses explore two sets of aims: first, differences between 1994 and 1995 in the change in blood lead levels and/or the final blood lead level, were examined through the two-sample t-test. Differences in other factors that may relate to change in the blood levels were also examined. Variation in lead levels across the sites was also examined, through two factor analysis of variance with sites nested within year.

Second, comprehensive models describing the relationship between lead exposure, job characteristics, and personal characteristics, and blood lead levels (change and final level) were developed through regression analysis. Two sets of analyses were performed, one set on all subjects (n= 80 with complete data) and a second set on subjects who had respirator wipes performed (n=54 with complete data). For the analyses on all subjects, potential predictive factors included year, cumulative exposure adjusted for respirator, respirator use index, a personal protective equipment index, training index, hygiene index, age, years of construction, indicator for smoking on the job, an indicator for lead hobbies, and an indicator for perceived risk of exposure. For the analysis on subjects with respirator wipes, a measure of lead exposure from the wipe sample was included. Stepwise backward elimination was used to identify variables with partial contributions to the regression significant at the 0.10 level. Cumulative exposure and respirator wipe were forced into the model.

Finally, differences in lead variables across years and sites, after controlling for the variables identified in the regression models above, was examined through analysis of covariance, with sites nested within years.

blood lead (final or difference) = intercept + B1(cum. lead concentration) + B2(respirator index) + B3(PPE index) + B4(worker previous history) + B5(training index) + B6(age) + B7(lead hobbies) + etc.

Table 8 presents means and standard deviations by year for two exposure variables and three mediator indices. Although no change was found in the cumulative exposure measure between the two years, there was a dramatic reduction in the respirator wipe measure. Also, there was a significant increase, or improvement, in the personal hygiene index.

Blood lead level, final and change, was examined by contractor in Table 9. There was a significant variation across contractor in both change in blood lead levels (borderline, p=0.061) and final BL_2 (p=0.02) after controlling for year. Mean BL_2 by contractor ranged from 7.8 to 21.8 in 1994 and 14.6 to 22.9 in 1995.

In the analysis of the overall sample, the cumulative exposure measure and smoking on the job were significantly predictive of the change in blood lead from time 1 to time 2 (Table 10). When additional variables (year, years working construction, training, and lead-risk hobbies) were added to the model, the Model R-square improved (Table 7).

Respirator wipe estimates, which are not available for the entire group, were evaluated for their predictive value. Respirator wipes were obtained before respirators were first used on a working day. Respirator maintenance, if conducted as instructed and if the respirator is stored in a clean area, should protect not harm the worker. We used this measure to evaluate the blood lead parameters for a portion of the study participants (n=54). Respirator wipe, along with smoking on the job, was a significant predictor of change in blood lead as shown in Table 12.

For the analysis of the overall sample, after controlling for cumulative exposure (lncumex), years of construction work, the training index, lead-risk hobbies, and on-the-job smoking, there was no significant difference in final blood leads across years (p=0.125). However, significant variation across sites remained (p=0.001).

For the subsample with data on respirator wipes available, after controlling for cumulative exposure, respirator wipe, the training index, and lead-risk hobbies, there was still significant variation between years (p=0.012) and across sites (p=0.002).

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Table 1. Percent of person-days in high exposure category for each site and by year of sampling.

SAMPLE TYPE	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5	SITE 6	SITE 7	SITE 8	SITE 9	SITE 10	SITE 11	SITE 12	SITE 13	1994	1995	RATIO
Hand wipe (during break)	90	67	100	56	0		75	100	8	100	50	0	25	54	47	12
Hand wipe(end day)	14	100	100	83	50	33	0	100	50	40	22	25	0	63	34	13
Respirator wipe(before work)	80	100	78	100	54	70		33	0	67	25	0	0	72	23	6
Respirator wipe(end day)	56	100	100	50	86	70	13	70	33	50	13	0	0	73	31	8
Steering wipe	75	75	100	100	100		33	0	0	67	50	0	0	89	20	12

Table 2a. Average % "GOOD" characteristics on each site on sampling days

Site	% good Personnel Hygiene	% good Containment structure	% good Respirator program	% good Changing Facility	% good Washing Facility	% good Cleaning Procedure	Clean side Decon. (ug/100cm^2)	Steering Wipes (ug/wipe)
1	12	48	50	100	0	31	63	680
2	23	53	0	29	0	36	2,693	1,143
3	32	57	75	57	0	51	820	342
4	17	47	50	43	0	33	92	556
5	40	47	50	29	60	32	492	381
6	0	65	25	29	0	36	862	-
7	79	51	100	100	60	65	16	151
8	47	53	50	86	20	47	661	86
9	74	71	100	100	80	71	67	63
10	48	52	75	100	20	62	182	1,080
11	67	75	100	86	40	42	149	114
12	48	49	88	86	40	76	15	6
13	83	53	100	86	47	50	6	13

Table 2b. Average % "GOOD" characteristics by year of sampling

Year	% good Personnel Hygiene	% Good Containment structure	% good Respirator program	% good Changing Facility	% good Washing Facility	% good Cleaning Procedure	Clean side Decon. (ug/100cm^2)	Steering Wipes (ug/wipe)
1994	22	52	39	51	8	38	1,162	619
1995	66	60	88	92	43	58	157	202

Table 3a. Task exposure levels (ug/m^3) compared to OSHA reported expected levels, and the percent of task performed with different types of respirators

TASK	N	Am	Sd	Min	Max	Osha am (sd)	Osha range	% use of types of respirators					
								None	HF (10)	FF (10)	PAPR (25)	BH(25)	BH (50)
Blasting (inside helmet)	12	190	364	5	1,255	-	-	0	0	0	0	36	64
Assist blasting	28	4,479	7,803	21	34,286	26,673 (21,502)	2,188 - 58,700	3	46	16	29	0	6
Assist blast no blasting	10	361	364	50	1,142	504 (92)	13 - 2,100	25	63	3	7	0	3
Clean rail	7	183	171	44	523	45 (63)	6 - 167	43	57	0	0	0	0
Clean surface	2	88	40	60	117	45 (63)	6 - 167	23	55	0	0	23	0
Hand tool use	10	2,716	4,409	65	14,717	45 (63)	6 - 167	7	91	2	0	0	0
Power tool use	11	18,638	23,660	507	76,164	735 (2,794)	1 - 20,600	0	16	3	81	0	0
Other activities <20ft	24	238	771	14	3,832	6 (31)	0.4 - 588	62	37	1	0	0	0
Other activities >20ft	12	58	66	2	239	6 (31)	0.4 - 588	84	16	0	0	0	0
Paint in containment	10	171	354	3	1,146	26 (-)	26 - 26	6	59	17	0	15	2
Paint no containment	8	209	189	25	620	26 (-)	26 - 26	8	67	20	2	4	0
Paint rail	2	47	33	24	70	2 (2)	0.4 - 6	41	55	0	0	3	0
Assist painting	6	35	19	9	54	2 (2)	0.4 - 6	16	82	0	2	0	0
Pressure washing	3	16,228	27,278	232	47,724	6 (31)	0.4 - 588	5	75	20	0	0	0
Assist pressure washing	2	442	150	336	548	6 (31)	0.4 - 588	7	83	2	9	0	0
Setup tarp	71	106	155	6	1,158	504 (92)	13 - 2,100	34	66	0	0	0	0
Takedown tarps	32	760	2,763	14	15,750	504 (92)	13 - 2,100	27	73	0	0	0	0
Supervise	14	154	244	11	873	14 (51)	0.4 - 916	100	0	0	0	0	0

Table 3b. Respirable task exposure levels (ug/m^3) and percent respirable lead by tasks

Task	N	Am	Sd	Min	Max	%resp	Min%	Max%
Assist blasting	6	1,930	3,152	109	8,312	16	1	24
Assist blast no blasting	1	34		34	34	25	25	25
Other activities >20ft	3	9	7	4	17	20	5	43
Other activities <20ft	5	13	10	3	29	40	13	91
Setup tarp	16	12	9	3	32	35	2	163
Takedown tarps	2	30	35	6	55	12	2	23
Supervise	2	9	5	6	13	21	20	21

Table 4. Area exposure levels (ug/m^3) by site

Sample area	Site1	Site2	Site3	Site4	Site5	Site6	Site7	Site8	Site9	Site10	Site11	Site12	Site13
Greater than 20ft from containment	34	30	11	8	31	51	29	20	20	4	20	8	5
Less than 20ft from containment	132	86	16	11	80	126	67	43	3	4	122	8	40
Inside of containment	1,148	162	3,698	577	1,389	2,296	5,406	3,492	71	14	31,154	8	5,448

Table 5 Comparison of 1994-1995

Characteristic	1994 & 1995	1994	1995	p-value 95 - 94
Initial blood level (BL_1), mean	17.9 +/- 9.0 (n=90)			
Final blood level (BL_2), mean	19.7 +/- 8.7 (n=85)			
All blood levels, mean	18.8 +/- 8.9 (n=175) 3	18.1 +/- 7.9 (n=91)	19.6 +/- 9.7 (n=84)	
BL_1, mean		16.7 +/- 8.3 (n=46)	19.2 +/- 9.5 (n=44)	0.0837
BL_2, mean		19.5 +/- 7.4 (n=45)	20 +/- 10.0 (n=40)	0.6906
Change in blood lead levels BL_2 - BL_1			20 - 19.6 (n=40)	0.4430
Change in blood lead levels BL_2 - BL_1		19.5 - 17.1 (n=44)		0.0000
All BL's (BL_1 & BL_2)		17.7	19.5	0.1411 (n=81)
BL_2 - BL_1	19.8 - 18.3 (n= 84)			0.0004
age	33.6 +/- 9.0	32.2 +/-9.5	35.2 +/-8.3	0.1170

TABLE 6: Distribution all BL's, by year

BL, (gm/dl	**1994 n (%)**	**1995 n (%)**
0 - 10	13 (14)	16 (19)
11 - 15	24 (26)	20 (24)
16 - 20	25 (27)	11 (13)
21 - 25	12 (13)	12 (14)
26 - 30	10 (11)	12 (14)
31 - 40	6 (7)	12 (14)
> 40	1 (1)	1 (2)
TOTAL	**91**	**84**

Table 7 : Correlation Blood Lead and Exposure

BL_2				BL_2-BL_1			
	amcumexr	lnamcume	respbefr		amcumexr	lnamcume	respbefr
r	0.352	0.259	0.3255	r	0.1286	0.1766	0.5160
p-value	0.0014	0.0230	0.0163	p-value	0.2557	0.1172	0.0001
n	80	80	54	n	80	80	54

Table 8 : Differences in lead variables, 1994-1995

	1994	1995	p-value
ln Cumulative Exposure	7.1 +/- 1.3	7.0 +/- 1.2	.968
Respirator Wipe	366 +/- 248	124 +/- 164	.001
Personal Protective Equip	3.0 +/- 1.1	3.1 +/- 1.3	.566
Training Index	3.4 +/- 1.6	4.0 +/- 1.6	.102
Hygiene Index	2.4 +/- 1.1	3.6 +/- 1.8	.001

Table 9 : Blood Lead by Contractor

	BL_2		BL_2 - BL_1	
Contractor	Mean/S.D.	Number	Mean/S.D.	Number
1	7.8 +/-2.9	6	-0.5 +/- 2.0	6
2	20.8 +/-9.2	15	0.9 +/-3.4	15
3	21.6 +/-9.1	11	0.7 +/-2.7	11
4	18.8 +/-2.1	4	1.75 +/-1.0	4
5	19.7 +/-8.8	13	4.25 +/-4.0	12
6	14.6 +/-3.6	7	-0.3 +/-1.1	7
7	21.7 +/-10.1	12	3.75 +/-5.8	12
8	22.9 +/-7.2	17	0.3 +/-2.4	17

Table 10 : Change in blood lead (overall sample)

	Parameter Estimate	p-value
Intercept	-4.36	
ln cumulative exposure	0.69	.032
smoke on job	3.03	.001
Model R-square	.018	.001

Table11 : Change in blood lead (overall sample)

	Parameter Estimate	p-value
Intercept	7.08	
ln cumulative exposure	1.66	0.021
Year	3.65	0.066
Years working construction	0.20	0.063
Training Index	-1.77	0.016
Lead-Risk-Hobbies	4.08	0.026
Smoke on the job	3.81	0.057
Model R-square	.27	.001

Table 12 : Change in blood lead (sample with respirator wipe)

	Parameter Estimate	p-value
Intercept	-0.65	
respirator wipe	0.006	0.002
smoke on job	1.8	0.07
Model R-square	0.31	.0001

APPENDIX A

STRUCTURED INTERVIEW/QUESTIONNAIRE WITH PROBES

CASE ID#_____________WORK SITE ___________________________

DATE OF INTERVIEW __________INTERVIEWER_________________

Gender: MALE |_|
FEMALE |_|

BEARD? YES |_|
NO |_|

1) Do you belong to a union?

YES |_|
NO |_|

IF YES:

a. What is your union and local number:
____

2) How long have you worked for _________ Company? |_|_ |_|
(mos)

How long have you been working this season?

When did the season start?

3) What kind of work do you do?

Painter |_|
Cleaner |_|
Other |_|

Probe - Are there other kinds of work that you do?

4) Is there a job you prefer to do more than others? YES |_|
NO |_|

Why?

Do different jobs pay more?

5) Do you like this kind of work? YES |_|
NO |_|

Probe

6) Have you worked with OTHER bridge painting companies in the PAST 5 YEARS?

YES |_|

NO |_|

7) What kind of work did you do for these contractors?

8) How long in total have you worked on bridge painting crews? |_|_ |
(mos)

9) Have you ever been involved in removing lead paint from homes, schools, or offices?

YES |_|
NO |_|

IF YES For how long? |_|_|
When did you do that? (mos)

10) How often?

Activity	Ever done it?	Total No./years	Last time
Lead battery manu-facturing	|_| |_| yes no	|_|_| mon	|_|_| |_|_| mon year
Welding Cutting or torching lead painted objects, cutting steel structure with a torch	|_| |_| yes no	|_|_| mon	|_|_| |_|_| mon year
Plumbing, using lead solder	|_| |_| yes no	|_|_| mon	|_|_| |_|_| mon year
Target shooting in indoor gun range	|_| |_| yes no	|_|_| mon	|_|_| |_|_| mon year
Outdoor gun range			
Other activity involving lead exposure	|_| |_| yes no	|_|_| mon	|_|_| |_|_| mon year

(What was it?) ____

11) In total, how long have you working in construction? |_|_|_|
(#mos)

12) While working for _____ have you had any training for working with lead ?

YES |_|
NO |_|

IF YES, When was that? |_|_| |_|_|
(mon) (yr.)

What did they do in the training?
(OSHA Lead Stnd. ? Respirator Trng?)

Did they talk about any regulations? YES |_|
NO |_|

Did they talk about OSHA? YES |_|
NO |_|

Did they show you how to use a respirator? YES |_|
NO |_|

Did they cover....

Cleaning/maintenance YES |_|
NO |_|

Storage YES |_|
NO |_|

When to use YES |_|
NO |_|

Anything else?

IF NO,

13) Have you had any training for working with lead this season?

YES |_|
NO |_|

14) Has anything changed on the job as a result of the OSHA Regulations?
YES |_|
NO |_|

IF YES, What do you think about that?

Too extreme? For instance...

15) Did you have a blood lead test before you started working on this job?
YES |_|
NO |_|

IF YES
Were you told the results of the blood lead test? YES |_|
NO |_|

What were the results?

Did you have a physical exam YES |_|
NO |_|

16) How many hours a week do you work on this job? HOURS |_|_|

17) What kind of equipment do you use?

Is it provided?

Do you bring any of your own equipment? YES |_|
NO |_|

Probe: If respirator is not mentioned then ask:
Do you use a respirator? etc., etc.,

If so, who provides it?

18) a) How often would you say you use your respirator while working?
Always |_|
Usually |_|
Sometimes |_|
Never |_|

IF NOT ALWAYS Could you explain when you do or don't use it?
----

19) Do you think you are exposed to lead even though you use your respirator?
YES |_|
NO |_|

Probe Why do you think your exposed?

20) Do you use different respirators for different tasks? YES |_|
NO |_|

Probe

What type of respirator?
Was it fit tested?

21) Are filter cartridges provided? YES |_|
NO |_|

22) When you first got this respirator, was it fit tested? YES |_|
NO |_|
NOT SURE |_|

23) Are there things you do to maintain your respirator?
YES |_|
NO |_|

IF YES:
What are they?

How often?

IF NO:
Does it have to be cleaned?

24) Do you ever take it off while working? YES |_|
NO |_|

Probe

When?

Why?

25) Do you wear any protective clothing?

For example:

	PROVIDED? (P) Provided (O) Own	WHO CLEANS? DISPOSABLE? (E) Employer (S) Self	WHY DO YOU USE THEM ? OR WHY NOT?
Full-body overalls			
Head covering			
Protective eye wear			
Boot or shoe covers			
Gloves			

Hearing Protection

Do other people wear these things? YES |_| NO |_|

IF NO, Why wouldn't they?

26) What do you think of the working conditions here?

Probe Good or Bad?

27) What about compared to other sites

28) a) Is there drinking water available here? YES |_| NO |_|

IF YES where is it?

29) What about for washing? YES |_| NO |_|

30) Are there toilets here? YES |_| NO |_|

31) Are there showers here? YES |_| NO |_|

Where are they?

IF YES, Do you shower before leaving work? YES |_| NO |_|

Why/Why not?________________

IF NO, b) Where do you clean up? ______________________________

32) Before leaving here do you change? YES |_| NO |_|

33) Do you wear your work clothes home?

34) How many breaks do you get? | (num)

35) What do you do during this/these break(s)?

36) Do you eat on the site?

Don't eat |_|
In the work area |_|
In a non-work area designated |_|
only for eating and drinking |_|
In my personal vehicle at
the work site |_|
In a company vehicle at the
work site.................................... |_|
Off the work site.. .... |_|
Other.. (specify below)................ |_|

Probe

Does everyone eat here?

Why?

IF NO:
37) Does anyone eat on site?

IF YES:
38) Do they wash before eating?

39) Do you wash before eating or drinking?

YES, Always |_|
Most of the time |_|
Sometimes |_|
NO, never |_|

40) a) Is there an area set aside for eating?

YES |_|
NO |_|
NOT SURE |_|

41) Do people smoke on the site?

YES |_|
NO |_|

IF YES:
42) Do you ?

YES |_|
NO |_|

43) How much do you smoke on the job?

|_|_|
(# of cigarettes)

44) What about in general? |_|_|

(# of cigarettes)

45) How old were you when you started? |_|_| (age)

IF NO:

46) Did you ever smoke? YES |_| NO |_|

47) When did you quit?

48) Do people wash before they smoke? YES |_| NO |_|

49)Do you? YES |_| NO |_|

Why or why not?

Probe

50) Do you chew tobacco? YES |_| NO |_|

51) At work? YES |_| NO |_|

52) Do you chew gum? YES |_| NO |_|

53)At work? YES |_| NO |_|

54) Since January how long have you been doing bridge work? |_|_| (mons.)

55) How many times have you had a blood lead test? |_|_| (# of times)

56) Since doing bridge work, have you <u>ever</u> been told that your blood lead level was high?

YES |_|
NO |_|
NOT SURE |_|

If YES
57) When was that? MONTH |_|_|
YEAR |_|_|

58) Do you know what that level was? NUMBER |_|_|
Did you feel sick?
What happened to you?
Were you treated with anything?
Did you take anything else?

59) Was that the only time? YES |_|
NO |_|

PAM: IF YES, WHEN ETC.,!!!!!

60)Were you told that you were lead poisoned? YES |_|
NO |_|
NOT SURE |_|

61) When was your last blood Lead test? MONTH |_|_|
YEAR|_|_|

62) Do you know what the results were? YES |_|
NO |_|

63)Were you ever lead poisoned as a child? YES |_|
NO |_|
NOT SURE |_|

IF YES:

64) Were you treated then for lead poisoning? YES |_|
NO |_|
NOT SURE |_|

Were you hospitalized (then)? YES |_|
NO |_|
NOT SURE |_|

65) Have you ever had...

high blood pressure (hypertension) : YES |_|
NO |_|
NOT SURE |_|

Now? YES |_| NO |_| NOT SURE |_|

gout: YES |_| NO |_| NOT SURE |_|

Now? YES |_| NO |_| NOT SURE |_|

kidney disease: YES |_| NO |_| NOT SURE |_|

Now? YES |_| NO |_| NOT SURE |_|

heart disease: YES |_| NO |_| NOT SURE |_|

Now? YES |_| NO |_| NOT SURE |_|

66)

Skin Cancer	Why is this a risk for you?
Lung Cancer	Why is this a risk for you?
AIDS	Why is this a risk for you?
Injury due to automobile accident	Why is this a risk for you?
Getting Shot	Why is this a risk for you?
Heart Problems	Why is this a risk for you?
Lead Poisoning	Why is this a risk for you?
Outdoor air pollution	
Stress	
Hearing Loss	

67) Do you think your coworkers are at risk for these? YES |_| NO |_|

68) Which do you think they are at greatest risk for?
Probe Why?

69) Are there other health issues not listed here that your concerned about?

70) Are there any other risks in your job that you are concerned about?

YES |_|
NO |_|

Probe

Why would that happen?
Has any thing happened to you?
Has anything happened to others?
At other sites?

71) Do you and the other guys get together after work? YES |_| NO |_|

What do you do?

72) Do you drink? YES |_| NO |_|

IF NO,

73) Did you used to drink? YES |_| NO |_|

74) When did you stop?

IF YES,

75) What do you drink? (beer, wine, hard liquor etc.)

Anything else?
What kind of beer do you drink?
What size? 16, 32, etc

76) What is the most you have drank in the last month?

|_|_|

77) How many times did you drink that in the past month?

78) About how often do you drink?

Daily or almost daily............... |_|
3 or 4 days/week.. .... |_|
1 or 2 days/week.................. |_|
1 or 2 days/month or less....... |_|

79) On the days that you do drink,

about how many cans of beer
or glasses of wine do you
usually drink?

AND/OR

80) On the days that you do drink, about how many mixed drinks or shots of hard liquor do you usually drink?

81) Where do you live?

Do you live there while working?

What is your zip code? |_|_|_|_|_|

How do you get to the jobsite?

82). In what year were you born? 19 |_|_|

83) Where were you born?

IF FOREIGN, How long have you lived in the US?

84) Are you married?

Single... |_|
Married/living with someone .... |_|
Widowed.. |_|
Divorced/separated....................................... |_|

85) Do you have children?

YES |_|
NO |_|

86) How many are under the age of six? |_|_|

87) Have any of these children ever had a blood lead test?

YES |_|
NO |_|

IF YES:

88a) Have you ever been told that they had an elevated blood lead level?

YES |_|
NO |_|

88b) When was that? 19___

88c) Do you know what the level was? ______

88d) Do you know what the cause was?

89) What racial group do you consider yourself?

WHITE |_|
BLACK |_|
ASIAN |_|
NATIVE AMERICAN |_|
*OTHER*_____ *(SPECIFY)*________________.

90) Any ethnic group?

91) Do you speak any other languages in your home?

YES |_|
NO |_|
NUMBER |_|

IF YES,

91a) Which language?

Why do you speak this language?

92). What is the highest grade in school that you have completed?

Less than 8th grade.............. |_|
9-11 grade.............................. |_|
12th grade .... |_|
GED....................................... |_|
Vocational School............... |_|
Other non-college................ |_|
1+ yrs of college.................... |_|
4 year college degree............ |_|
1+ yrs of graduate work...... |_|

93). Is your salary range ....

Less than $15,000 per year? |_|

$15,000 to $30,000 per year? |_|
$30,000 to $50,000 per year ? |_|
More than $50,000 per year? |_|

APPENDIX B

INTERVIEW QUESTIONS BY CATEGORY FOR INDEX DEVELOPMENT

Index of Interview Questions by category April 3, 1996

Categories:

1. Respirator
2. Personal Protective equipment
3. Training
4. Personal Hygiene
4. Other exposures (non-occupational lead history/hobby)

1. RESPIRATOR

USE_RESP Do you use a respirator?

1. Yes
0. No
2.Sometimes
88) Question not asked
99) Question not answered

RESP_USE How often would you say you use your respirator while working?

1. Always
2. Most of time
3. Some of time
4. Never
88) Question not asked
99) Question not answered

EXP_STILL Do you still think you are exposed even though you use your respirator?

1. Yes
0. No
2. Dont know
88) Question not asked
99) Question not answered

DIFF_RESP Do you use different respirators for different tasks?

1. Yes
0. No
2. Don't know
88) Question not asked
99) Question not answered

RESP_TYPE What type of respirator?

1) Half face with organic cartridges
2) Half face with HEPA filters
3) PAPR
4) Full face mask

5) Air fed helmet
0) Don't wear one

FIT_TEST When you first got your respirator, was it fit tested?

1. Yes
0. No
2. Don't know
88) Question not asked
99) Question not answered

CART_PROV Are filter cartridges provided?

1. Yes
0. No
2. Don't know
88) Question not asked
99) Question not answered

DIFF_CART Do you use different cartridges for different tasks?

1. Yes
0. No
2. Don't know
88) Question not asked
99) Question not answered

MAIN_RESP Are there things you do to maintain your respirator?

1. Yes
0. No
88) Question not asked
99) Question not answered

WHAT_2 What are they?

0) Don't do anything
1) Wash it
2) Wash with alcohol
3) Take it apart
4) Replace parts
5) Store it in a bag
6) Change cartridges
7) Vacuum it

HOW_OFTEN How often?

0) Don't do it
1) More than once a night or day
2) Once a day or night
3) Every other day or night
4) Once a week
5) Once a month
6) Whenever I change respirators

NEED_CLEAN Does it have to be cleaned?

1. Yes
0. No
2. Don't know
88) Question not asked
99) Question not answered

HOW_CLEAN What do you clean it with?

0. Don't wash it
1.Alcohol wipes
2. Water
3. other
88) Question not asked
99) Question not answered

STORE_RESP How and where do you store it?

1.In a bag
2. In my truck
3. In decon trailer
88) Question not asked
99) Question not answered

REM_RESP Do you ever take it off while working?

1. Yes
0. No
88) Question not asked
99) Question not answered

WHY_WOULD Why would you?

0. wouldn't remove
1. Communicate
2. Spit
3. Clean Air
4. Other
88) Question not asked
99) Question not answered

2. PERSONAL PROTECTIVE EQUIPMENT

EQUIP_USED What kind of equipment do you use?

1) Compressor
2) Hand Tools
3) Sprayer
4) Power tool cleaner
5) Blasting equipment
6) Respirator
7) Vacuum
8) other

PROVIDED Is it provided?

1. Yes
0. No
2. Don't know
88) Question not asked
99) Question not answered

PROT_CLOTH Do you wear any protective equipment?

1. Yes
0. No
2 Don't know
3. Sometimes
88) Question not asked
99) Question not answered

COVERALL A coverall?

1. Yes
0. No
2. Don't know
3. Sometimes
88) Question not asked
99) Question not answered

HEADCOVER Do you use the headcover?

1. Yes
0. No
2. Don't know
3. Sometimes
88) Question not asked
99) Question not answered

EYEWEAR Eye protection?

1. Yes
0. No
2. Don't know
3. Sometimes
88) Question not asked
99) Question not answered

BOOTCOVER Bootcovers?

1. Yes
0. No
2. Don't know
3. Sometimes
88) Question not asked
99) Question not answered

GLOVES Gloves?

1. Yes
0. No

2. Don't know
3. Sometimes
88) Question not asked
99) Question not answered

HEAR_PROT Do you use hearing protection?

1. Yes
0. No
2 Don't know
3. Sometimes
88) Question not asked
99) Question not answered

ANY_NOT Does anyone not wear these things?

1. Yes
0. No
2. Dont know
3. Sometimes
88) Question not asked
99) Question not answered

3. TRAINING

EMPR_TRNG While working for XXX have you had any training for working with lead?

1) Yes
0) No
2) Don't know
88) Question not asked
99) Question not answered

WHEN_1 When was it?

0) Didn't have any
1) Less than 1 year ago
2) 1-2 years ago
3) 2-5 years ago
4) Greater than 5 years ago

REV_REG Did they talk about the regulations?

1) Yes
0) No
2) Don't know
3) Didn't have any training
88) Question not asked
99) Question not answered

OSHA Did they talk about OSHA?

1) Yes
0) No
2) Don't know
3) Didn't have any training

88) Question not asked
99) Question not answered

COVER_RESP Did they cover respirator use in the training?

1. Yes
0. No
2) Don't know
3) Didn't have any training
88) Question not asked
99) Question not answered

REV_CLEAN Did they cover cleaning and maintenance?

1) Yes
0) No
2) Don't know
3) Didn't have any training
88) Question not asked
99) Question not answered

REV_STOR Did they cover storage?

1) Yes
0) No
2) Don't know
3) Didn't have any training
88) Question not asked
99) Question not answered

REV_WHEN Did they cover when to use it?

1) Yes
0) No
2) Don't know
3) Didn't have any training
88) Question not asked
99) Question not answered

ANY_TRNG Have you had any training this season?

1. Yes
0. No
88) Question not asked
99) Question not answered
(.) no value yet

4. PERSONAL HYGIENE

YOU_SHOWER Do you shower?

1. Yes
0. No
2. Don't know
88) Question not asked

99) Question not answered

WHY_WHYNOT Why or why not?

0) Don't have one
1) Too cold
2) Inconvienient
3) Don't want to
4) Don't think I need to
5) Other
6) Whenever I work with lead I will shower
88) Question not asked
99) Question not answered

CHNGE_CLTH Before leaving do you change?

1. Yes
0. No
2.Sometimes
88) Question not asked
99) Question not answered

WRK_CLTHS Do you ever wear your work clothes home?

1. Yes
0. No
2. Sometimes
88) Question not asked
99) Question not answered

SHOES What about your shoes?

1. Yes
0. No
2. Sometimes
88) Question not asked
99) Question not answered

LEAD_HOME Do you think you are taking lead home?

1. Yes
0. No
88) Question not asked
99) Question not answered

EAT_SITE Do you eat on site?

1. Yes
0. No
2. Sometimes
88) Question not asked
99) Question not answered

YOU_WSH1 Do you wash before eating or drinking?

1. Yes
0. No

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2. Don't know
3. Sometimes
4. Don't eat
88) Question not asked
99) Question not answered

CHEW_TBCO Do you chew tobacco?

1. Yes
0. No
2. Don't know
88) Question not asked
99) Question not answered

AT_WRK1 At work?

1. Yes
0. No
88) Question not asked
99) Question not answered

CHEW_GUM Do you chew gum?

1. Yes
0. No
88) Question not asked
99) Question not answered

AT_WRK2 At work?

1. Yes
0. No
88) Question not asked
99) Question not answered

5. OTHER EXPOSURES (NON-OCCUPATIONAL LEAD HISTORY)

PB_TARG Target shooting in an indoor gun range?

1) Yes
0) No
88) Question not asked
99) Question not answered

HOW_LNG5 For how long?

0) Didn't
1) Don't know
2) Less than 1 year
3) 1-2 years
4) 2-5 years
5) Greater than 5 years

WHN_LST5 When did you do that last?

0) Didn't
1) Don't know
2) Less than 1 year
3) 1-2 years
4) 2-5 years
5) Greater than 5 years

PB_TARGO Target shooting in an outdoor gun range?

1) Yes
0) No
2) Don't know
88) Question not asked
99) Question not answered

HOW_LNG6 For how long?

0) Didn't
1) Don't know
2) Less than 1 year
3) 1-2 years
4) 2-5 years
5) Greater than 5 years

WHN_LST6 When did you do that last?

0) Didn't
1) Don't know
2) Less than 1 year
3) 1-2 years
4) 2-5 years
5) Greater than 5 years

PB_OTHR Any other activities that would have a lead exposure?

1) Yes
0) No
2) Don't know
88) Question not asked
99) Question not answered

WHAT What was it?

----
0) Didn't

HOW_LNG7 For how long?

0) Didn't
1) Don't know
2) Less than 1 year
3) 1-2 years
4) 2-5 years
5) Greater than 5 years

WHN_LST7 When did you do that last?

0) Didn't
1) Don't know
2) Less than 1 year
3) 1-2 years
4) 2-5 years
5) Greater than 5 years

APPENDIX C

ETHNOGRAPHIC CODES/THEMES

Code List -- DRAFT

I. ALCOHOL

SELFALC	alcohol behavior
PEERALC	peers' hygienic behavior

II. EQUIPMENT

EQUIPBELIEFS	beliefs about equipment (its protective value, etc?)
EQUIPMAINT	equipment maintenance
EQUIPPROV	provision of equipment by boss and self
EQUIPRISKS	risks of equipment (of use?, of using or <u>not</u> using it?)
EQUIPUSE	use of equipment: when, where, why
PEEREQUIP	peer equipment behavior; peer's on job behavior (incl behavior not specifically related to equipment?)
BOSSEQUIP	boss' use of equipment, discussion of equipment

III. HEALTH

SELFHLTH	respondent's own health risks
PEERHLTH	respondent's perceptions of peers' health risks

IV. HISTORY

WORKHIST	work history/occupational history (this would include bridge, construction hist? do we code to include these? or do we leave them out? if we leave them out, then what do we code here?)
BRIDGEHIST	bridge work history
CONSTHIST	construction work history
PEERHIST	respondent's relationship history with peers

V. HYGIENE

SITEHYG	provision of hygiene facilities (according to worker??)
SELFHYG	hygienic behavior
PEERHYG	peers' hygienic behavior
BOSSHYG	do we need this too? or will all boss' hygiene behavior relate to smoking or equip use?

VI. LEAD

LEADBELIEFS	lead concern, lead know (knowledge of lead risks, hazards?)
LEADRISK	
LEADFAMILY	harm to family members; family's response to job includes anything about taking lead home, repro effects, kids, whether wife makes worker take a shower
LEADTRAIN	training for working with lead

VII. OSHA

SELFOSHA	respondent's knowledge, etc. about OSHA
PEEROSHA	respondent's views about peers' knowledge of OSHA
WRKROSHA	workers' perceptions of impact of OSHA reg.s on work?? (PK)
BOSSOSHA	boss' (contractor's) perceptions of OSHA on work

VIII. RESPIRATOR

RESPTRAIN	respirator training
RESPUSE	respirator use
RESPBEL	respirator beliefs
RESPRISK	respirator risk
RESPMAINT	respirator maintenance

IX. RISK

SELFJOBRISK	risks on the job for self
PEERJOBRISK	perceptions of risks on the job for peers
JOBRISK	perceptions of job risk (what risks? incl highway??) in general? how different from selfrisk, peerrisk
SITERISK	safety of workplace

X. SMOKING

SELFSMOKE	respondent's smoking behavior
PEERSMOKE	?respondent's reporting of peers' smoking behavior
BOSSSMOKE	

XI. WORKERS

BOSSWRKRS	boss' concerns about issues such as workers' drinking? do we also need a code for relationship between boss and workers?
WORKSOC	respondent's socializing with peers**

**Shouldn't this be "peersoc" for socializing with coworkers/peers after work? We need one for that and then another code for on-site interations betweeen respondent and other workers and among workers (maybe "sitesoc"?)