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Memorandum

Date: March 14, 2001

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

Subject: Final Report Submitted for Entry into NTIS for Grant 5 R01 CC113060-03.

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

Buchholz B, Moir S, Garrett J: HealthTrak: A Participatory Approach for Ergonomic Improvement in Construction. IN: Implementation of Safety and Health on Construction Sites, (eds. A Singh, J Hinze, RJ Coble), Balkema, Rotterdam, pp. 711-716, 1999

NIOSH Extramural Award Closeout Summary

Title: Intervention Studies for Construction Safety and Health
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Affiliation: University of Massachusetts, Lowell
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Telephone: (508) 934-3241
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Abstract:

Health Trak is a participatory approach that involves construction workers and management, as well as occupational health researchers, in identification, evaluation and control of health hazards. Each eight-week Health Trak cycle has three key components: (1) participatory committee meetings with worker and contractor representatives, (2) toolbox meetings with workers on-site, and (3) participant observation. Ergonomic hazards, such as those that may lead to musculoskeletal disorders, were the primary focus of Health Trak, though sanitary facilities and noise were other health issues that were covered. Five Health Trak cycles were completed as part of this project. In the first cycle, the participants identified the lack of sanitary facilities as the health hazard for study. Though an intervention was not implemented, the efforts of this committee have had a profound impact on the local industry. In the second cycle, the committee focused on ergonomics and was somewhat successful in implementing interventions to control manual material handling hazards. The third cycle examined ergonomic hazards associated with the assembly of gang forms for concrete structures. The Committee delineated numerous hazards associated with this operation and also proposed many potential solutions. One of these solutions, improving laydown areas for materials and equipment, was implemented. The fourth cycle was unique, as it focused on noise. It was more of a focus group discussion of hearing protection rather than a true application of the participatory methodology. No intervention was implemented. The fifth cycle was similar to the third, this time examining hazards associated with a large stage of reiterating concrete structure construction operations. Like in the third cycle, the Committee delineated numerous hazards associated with this operation and also proposed many potential solutions. Two of the proposed solutions were developed further: (1) a box to be used as a platform for work above shoulder height and (2) a plywood walkway for working on rebar mats. The box was implemented, but, because of numerous obstacles, the walkway was not. Similar walkways have been observed on other sites. The results showed that Health Trak had one very important strength and one very important limitation. The major strength was the ability of the committee to identify hazards and propose potential interventions to control the identified hazards. This was primarily the result of having stewards and foremen on the committees. The major limitation of Health Trak was the inability of the process to get controls implemented. The primary barrier appears to be the culture of construction where no one seems willing to take ownership of improving health. The workers have the knowledge but feel they do not have the power and are willing to put up with the status quo. The managers have the power but are unwilling to spend money unless they feel it is necessary.

Publications

Buchholz B, Moir S, Garrett J: HealthTrak: A Participatory Approach for Ergonomic Improvement in Construction. IN: Implementation of Safety and Health on Construction Sites, (eds. A Singh, J Hinze, RJ Coble), Balkema, Rotterdam, pp. 711-716, 1999

Health Trak: A participatory model for intervention on ergonomic and other health hazards in construction

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Final Report on grant number R01 OH13060 (Participatory Safety and Health in the Construction Industry) from the National Institute of Occupational Safety and Health (NIOSH) of the Centers for Disease Control and Prevention.

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A. Moir S, Buchholz B and Garrett J (1997) Health Trak: A participatory model for intervention in construction. <i>International Ergonomics Association 13th Triennial Congress</i>, Tampere, Finland. B. Buchholz B, Moir S and Garrett J (1999) Health Trak: A participatory approach for ergonomic improvement in construction. In <i>Implementation of Safety and Health on Construction Sites</i>, edited by A Singh, J Hinze and RJ Coble, pp. 711-716, Balkema, Rotterdam. C. Health Trak Cycle 1 Final Report: A Participatory Approach to Reducing Health Risks in Construction D. Health Trak Cycle 2 Final Report: A Participatory Approach to Reducing Risks in Construction E. Health Trak Cycle 3 Final Report: Reducing Ergonomic Hazards in Concrete Formwork assembly through Worker Participation F. Health Trak Cycle 4 Final Report: Noise Control in Construction G. Health Trak Cycle 5 Final Report: Ergonomics and Contractor Activity Planning	

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ABSTRACT: Health Trak is a participatory approach that involves construction workers and management, as well as occupational health researchers, in identification, evaluation and control of health hazards. Each eight-week Health Trak cycle has three key components: 1) participatory committee meetings with worker and contractor representatives, 2) toolbox meetings with workers on-site, and 3) participant observation. Ergonomic hazards, such as those that may lead to musculoskeletal disorders, were the primary focus of Health Trak, though sanitary facilities and noise were other health issues that were covered. Five Health Trak cycles were completed as part of this project. In the first cycle, the participants identified the lack of sanitary facilities as the health hazard for study. Though an intervention was not implemented, the efforts of this committee have had a profound impact on the local industry. In the second cycle, the committee focused on ergonomics and was somewhat successful in implementing interventions to control manual material handling hazards. The third cycle examined ergonomic hazards associated with the assembly of gang forms for concrete structures. The Committee delineated numerous hazards associated with this operation and also proposed many potential solutions. One of these solutions, improving laydown areas for materials and equipment, was implemented. The fourth cycle was unique, as it focused on noise. It was more of a focus group discussion of hearing protection rather than a true application of the participatory methodology. No intervention was implemented. The fifth cycle was similar to the third, this time examining hazards associated with a large stage of reiterating concrete structure construction operations. Like in the third cycle, the Committee delineated numerous hazards associated with this operation and also proposed many potential solutions. Two of the proposed solutions were developed further: 1) a box to be used as a platform for work above shoulder height and 2) a plywood walkway for working on rebar mats. The box was implemented, but, because of numerous obstacles, the

walkway was not. Similar walkways have been observed on other sites. The results showed that Health Trak had one very important strength and one very important limitation. The major strength was the ability of the committee to identify hazards and propose potential interventions to control the identified hazards. This was primarily the result of having stewards and foremen on the committees. The major limitation of Health Trak was the inability of the process to get controls implemented. The primary barrier appears to be the culture of construction where no one seems willing to take ownership of improving health. The workers have the knowledge but feel they do not have the power and are willing to put up with the *status quo*. The managers have the power but are unwilling to spend money unless they feel it is necessary.

I. INTRODUCTION

Construction workers are at great risk to injury, disability and early death as a result of exposure to health and safety hazards at work (Center to Protect Workers Rights 1993). The broad goal of this research project was to reduce the incidence and prevalence of injuries and illnesses to construction workers. The barriers to this objective are not primarily technological, but cultural and organizational. A wide range of possible interventions is available to be introduced at the industry, contractor and individual levels (Schneider 1996). These interventions include: technological changes, improved personal protective equipment, and administrative reforms. The imminent question is not so much what to change, but how to change and who will affect that change.

Ringen *et al.* (1995) cite several characteristics which make construction unique, including multiple employers, short-term employment and the ever-changing nature of the construction workplace and its hazards. A compelling body of literature contends that successful introduction of ergonomics into the workplace is preconditioned on participation by the affected workers (e.g. Gjessing *et al.* 1994; Schurman *et al.* 1994). Standard participatory methods are too long and too slow to respond to the rapidly changing construction worksite (Moir and Buchholz 1996). Rapid appraisal uses popular education and participatory techniques in an intensive, systematic and semi-structured method carried out by a team composed of outside researchers and a representative cross-section of the affected population to enter a research setting, do assessment, and introduce and evaluate interventions in the shortest feasible time (e.g. Chambers 1993;

Murray 1994). In this study, rapid appraisal and participatory methods were combined in the design of Health Trak to address the uniqueness of construction. Results from this project have been presented at two conferences: 1) the International Ergonomics Association 13th Triennial Congress (Moir *et al.* 1997) [Appendix A] and 2) the Second International Conference of CIB Working Commission W99 (Buchholz *et al.* 1999) [Appendix B].

II. PARTICIPATORY METHODOLOGY

Each Health Trak cycle is conducted over eight weeks and utilizes three key components: 1) Participatory meetings of Health Trak committees composed of 3-4 workers, the contractor safety representative, and other on-site personnel responsible for production; 2) Toolbox meetings involving larger groups of workers; and 3) Participant observation, focus group meetings and interviews with workers and contractor representatives. These three components are integrated and function concurrently during the cycle (Figure 1).

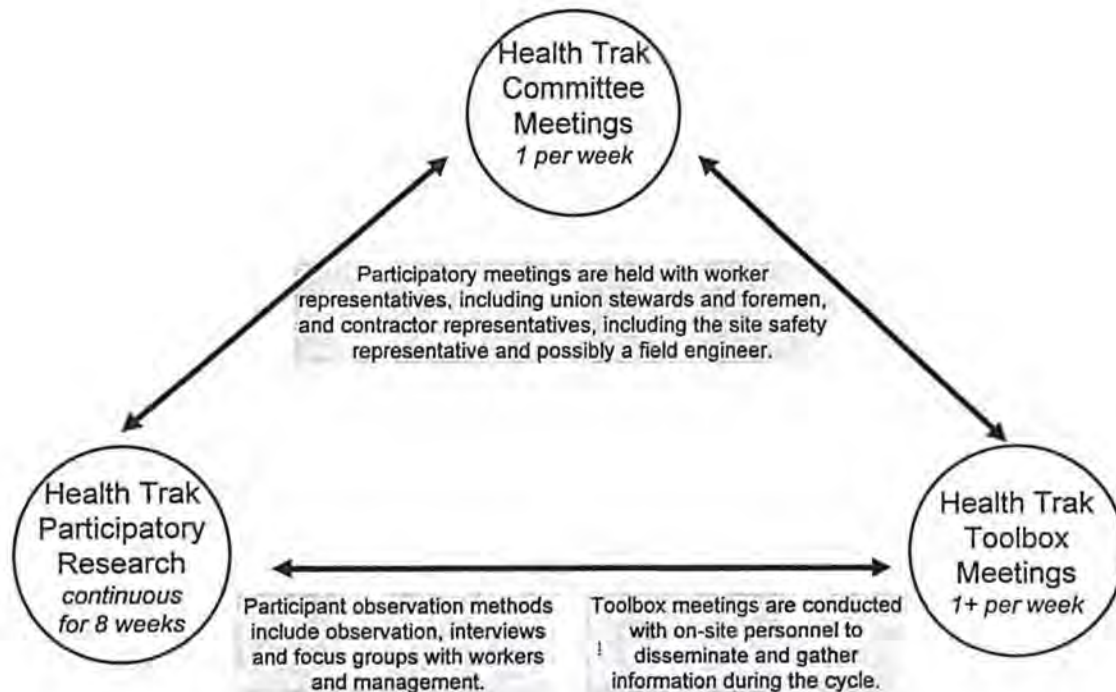


Figure 1. Interaction of the three components of a Health Trak cycle.

1. *Health Trak committee meetings.* Participation on the committee involves attendance at a weekly one-hour meeting, which consists of participatory learner-centered activities, designed to identify and/or solve problems through eliciting the experience of the participants in a group process. These activities include risk mapping of hazards in the workplace, team building exercises, communications skill development, storytelling, role plays and other psychomotor methods for learning and sharing knowledge. As part of each committee meeting, participants design a data collection instrument with which to survey co-workers in the week following the meeting. For example, when participants conduct risk mapping in the Health Trak committee meeting to identify hazards in the workplace, they then take the risk maps with them at the end of the meeting and survey their co-workers. The feedback from this survey is reviewed and evaluated at the next Health Trak meeting. The committee meetings are divided into four steps during the eight-week cycle:

a. *Problem identification and definition (weeks 1-2).* The objective of these sessions is to identify problems with the health component of the current health and safety program. The product of these two weeks is a written definition of the identified health problem, which serves as the “research question” for the participants and will be the focus for the remainder of the Health Trak cycle.

b. *Analysis of hazards and strategies for intervention (weeks 3-5).* The objectives of these weeks are to analyze the written research problem and to develop strategies for intervention. Participants conduct a needs assessment, which is used to assess their current health and safety working conditions relevant to the defined research question, envision possible solutions, and assess potential strategies for change, in order to move from the present conditions to their desired conditions. The product of these sessions is possible interventions that address the research question.

c. *Implementation of proposed intervention (weeks 6-7).* Participants will prioritize interventions and introduce them at the worksite. The product of these sessions will be the intervention and its evaluation.

d. *Evaluation by participants (week 8).* Impact and outcome measures for evaluation include self-assessment by participants of the Health Trak process and their participation in

it, evaluation of changes in the health and safety program, a review of injury data for the eight-week period, and evaluation of the effectiveness of the intervention.

2. *Health Trak toolbox meetings.* At least once a week during each eight-week cycle, a Health Trak researcher conducts a Health Trak participatory “toolbox meeting” for a group of workers not participating in the Health Trak Committee. Toolbox meetings are 10-15 minute lectures (often having a safety component) held on many construction sites before work in the morning. The focus of these toolbox meetings is the research question defined in the committee meeting. A checklist is used by a researcher to identify immediate problems and track the perceptions of changes and response from this larger group of workers. Results of the toolbox meetings are reported to the Health Trak committee for its review and action.

3. *Health Trak participant observation.* Researchers also spend 1-2 days per week on the site using participant observation, interviews and informal focus groups, to collect data about conditions and perceived changes by labor and management during the Health Trak cycle.

III. EVALUATION OF PARTICIPATORY METHODOLOGY

Qualitative and quantitative evaluation occurs at multiple levels:

1. *Surveys of Health Trak committee members.* A survey is administered to each participant before and after each Health Trak cycle. Participants are asked to quantitatively and qualitatively evaluate their workplace health and safety program and the perceived changes that occur as a result of Health Trak.

2. *Quantitative assessment of hazards pre- and post-intervention.* Interventions are evaluated using appropriate ergonomic risk assessment methods. These include structured ergonomic job analyses (Keyserling *et al.* 1991), ergonomic checklists, and PATH, a work-sampling based ergonomic job analysis method (Buchholz *et al.* 1996).

3. *Qualitative analysis of data collected during each Health Trak cycle.* Qualitative evaluation is conducted at the end of each cycle using data collected from committee meetings, toolbox meetings and participant observation. Data include: data from the committee meetings, in the form of transcripts, notes and artifacts from participatory activities; the results of participatory field work conducted by participants in the Health Trak committee; checklists from toolbox meetings; trend in injury data, including OSHA 200 logs, workers’ compensation data,

and Health Trak injury logs; and data collected by researchers in meetings or on-site through participant observation. Outcomes include changes in the perceptions of Health Trak participants and other employees regarding the effectiveness and responsiveness of the health and safety program and changes in exposure to hazards.

4. Site walk-throughs by external occupational health and safety experts. Experts in health and safety (e.g. construction safety consultants, union safety staff, state and federal health and safety professionals) conduct site walk-throughs and give written evaluations of the health and safety programs on these sites.

5. Evaluation by an advisory board. An advisory board is convened twice a year to review and evaluate Health Trak. This board consists of representatives from the participating contractors and unions and experts in occupational health and safety, participatory research, rapid appraisal methods, and evaluation research.

IV. RESULTS

During the course of this research, five Health Trak cycles have been completed. The Boston Central Artery/Third Harbor Tunnel (CA/T) construction project has been the site for these research activities. The CA/T is currently the largest on-going public works project in the United States. The construction project is comprised of numerous individual sites, each with its own general contractor, as well as many smaller sub-contractors. The Massachusetts Highway Department is the project owner and they have hired a firm to manage the project, which oversees all aspects of the construction.

4.1 Results of Cycle 1

The first Health Trak cycle [Appendix C] was held on a site constructing an elevated portion of the Central Artery construction project. A planning meeting was held with the site safety representative, the contractor's corporate safety representative and the assistant resident engineer from the Central Artery project construction management firm and the first cycle began within a month. The Health Trak Committee was composed of a carpenter, an operating engineer, two laborers, the site safety representative and a field engineer.

The weekly Health Trak committee meetings went as planned, with the curriculum specifics unfolding week-to-week. The committee decided during week three that the lack of sanitary facilities on site would be the hazard to prioritize for intervention. The site in question had only portable toilets and, more importantly, no facilities to wash and change before lunch or leaving the site. The next four weeks were spent attempting to develop and implement an intervention for this hazard. Two separate proposals for intervention were developed: one involving connection to the city sewer (~\$150,000) and one using a holding tank (~\$50,000). Two obstacles to implementation were identified: the contractor's concern for cost and acceptable area practice (i.e. sanitary facilities are not normally provided on construction sites). Despite meetings with the contractor, construction manager and owner, the intervention was never implemented. This hazard has continued to be a topic in other Health Trak cycles. The hope for the future is that, at a minimum, the owner will include the need to address the hazard in the bid specifications for new sites on the Central Artery.

In this cycle, the weekly toolbox meetings were used primarily as a communication tool to provide information on the status of Health Trak. Future cycles will attempt to use toolbox meetings as training and education sessions. Both production constraints and requirements for other safety training limit time for this purpose. In addition, more on-site worker involvement will be solicited.

The committee communicated well and labor/management/researcher barriers were not apparent. The committee members were performing research early in the cycle, which underscores this productive relationship. Because an intervention was not successfully implemented and because of the nature of the health hazard, quantitative assessments were not performed. The surveys of workers on the site indicated an increase in awareness of health hazards. The comparison of the pre- and post-cycle evaluations by the independent health and safety expert showed a similar result indicating that this Health Trak cycle had a positive influence on site.

4.2 Results of Cycle 2

The second Health Trak cycle [Appendix D] was held on a utility relocation site on the Central Artery construction project. An orientation meeting was held with the site safety

manager and the cycle began shortly thereafter. The Health Trak Committee was selected by the site safety manager and was composed of a laborer steward, a laborer, an operating engineer, the site safety manager and the owner's environmental health and safety representative.

Representatives from the owner's occupational health clinic observed at five meetings on a rotating basis.

The researchers made a conscious effort to steer the committee towards an ergonomic intervention in this cycle. This was explained to the committee in the first meeting, along with the broader goal of creating a general process for reducing health-threatening exposures. The weekly Health Trak committee meetings went as planned, with the curriculum specifics unfolding week-to-week. In the second week, the committee identified lifting oxygen-acetylene canisters, repetitive shoveling, pressure from rushing their work, and general exposures to dust, noise, fumes, and hot temperatures as important exposures occurring on their site. During the next two meetings, they decided to implement interventions to reduce exposure during manual materials handling tasks. The controls they decided to use were to increase the number of manual materials handling aids on site, to improve housekeeping and to improve work surfaces. Through the participatory process, hand trucks, work surface improvements, and wheel wells were identified as feasible controls. Two hand trucks were purchased at once and the work surface improvements also began immediately. Wheel wells were designed for use during lifting and lowering materials from/to the jacking and receiving pits. However, the redesigned wheel wells were never completed.

Although ergonomics was focused on during this cycle, sanitary facilities were also an issue, as they were in the first cycle. The committee actually recommended that a hand washing station be the first control implemented and though the committee did not spend a lot of time on this issue, the laborer steward worked with the safety manager to create a prototype. Simultaneously, the project owner mandated washing facilities for all Central Artery sites, and lavatories for permanent work areas.

In this cycle, researchers communicated with the 70 other workers on site through the weekly toolbox meetings. These meetings were used to provide limited ergonomic training and to provide information on the status of Health Trak. The researchers also conducted participant

observations, including interviews and focus group meetings, with workers and contractor representatives.

The evaluation by the committee members indicated that the committee and toolbox meetings were successful. The members thought Health Trak was a method that they could adapt and continue to use on their site. The surveys of workers on the site did not show any significant changes in workers' perceptions of health hazards. The comparison of the pre- and post-cycle evaluations by the independent health and safety expert showed an increased awareness of hazards from manual materials handling.

4.3 Results of Cycle 3

Prior to commencing the third Health Trak cycle [Appendix E], the contractor and researchers identified pre-job activity planning as an area that could be strengthened through increased worker involvement. The contractor wanted to work on activity planning in an operation that would be repeated several times; researchers wanted to work on an operation where ergonomic hazards currently existed, but could be reduced through the introduction of worker-generated interventions. For these reasons, the contractor and researchers decided to conduct a Health Trak cycle to reduce ergonomic hazards associated with concrete formwork assembly. In this Health Trak cycle, the Committee met once a week and included a laborer steward, a carpenter steward, a general foreman, a concrete engineer and the site safety engineer.

In order to identify potential ergonomic hazards associated with formwork assembly, the Committee members then spent several weeks creating a "Risk Map" of this operation. This process consisted of three steps: 1) drawing maps of materials, equipment and tools they used in formwork assembly, 2) identifying ergonomic risk factors associated with the operation, and 3) generating ideas for possible solutions to eliminate or reduce these hazards. Hazards and potential solutions were developed for seven tasks in formwork assembly: 1) truck unloading, 2) laydown areas, 3) gang form assembly, 4) placing of the gang form, 5) bracing installation, 6) building bulkheads and 7) putting ties in. From this list of hazards and possible solutions to improve concrete formwork assembly, the Committee chose to focus on improving laydown areas (areas where form materials, tools, and equipment are stored on site) during the remainder

of the Health Trak cycle. The Committee's action items focused on planning and getting needed materials, setting up and laying out the area, and maintaining the area.

As for the specific interventions recommended by the Committee, one particular intervention deserves special attention: grading of work areas. In both this cycle and others, workers frequently raise unlevel surfaces as a commonly accepted hazard that can be easily solved. Non-graded areas can affect both work productivity and can impact the extent of other ergonomic hazards on site (for example, it is difficult to erect a waist-level worktable if the ground below is uneven). In this Health Trak cycle, researchers observed a front-end loader as it graded and then graveled a laydown area; an apparently simple fix to a pervasive problem on many construction sites.

This Health Trak cycle was moderately successful in terms of identification and introduction of interventions to reduce ergonomic hazards in formwork, as well as in the process of involving workers in a joint labor-management committee to address health hazards on site. The Health Trak Committee was extremely proficient in identifying potential solutions for formwork assembly as a whole and laydown area organization in particular. The two previous Health Trak cycles had not been as successful in this regard. Researchers attribute this Committee's success in this cycle to two possible factors:

1. *Strong and experienced Committee members.* In response to lessons learned from previous Health Trak cycles, researchers attempted to bring a committee together consisting of "stronger" members, such as stewards and foremen. Researchers reasoned that this group of workers would have more ability to implement interventions; a less anticipated outcome is that this group had a vast base of practical knowledge that enabled them to generate a more comprehensive list of controls from prior work experience.

2. *Predetermined agenda of formwork.* Also in response to previous Health Track cycles, the focus of the Health Trak committee has narrowed over time. In the first cycle, participants were given the task of improving any health issue on site; in the second they were given the task of improving any ergonomic hazard(s) on site. This time, the Committee's original directive was to improve an ergonomic hazard associated with formwork assembly. By narrowing the focus of the Committee, they appeared to be more successful in plunging right in to hazard identification and remediation through a very rich and detailed risk mapping exercise.

The primary conclusion from this cycle of Health Trak is that eight weeks is too short. The Health Trak Committee identified numerous hazards in formwork assembly, as well as potential solutions for these hazards. The committee implemented one of these solutions, improving the laydown areas for this operation. However, there were numerous potential solutions that were never implemented because of the lack of time. When there is limited time for implementation of solutions, the solutions tend to be “quick fix” solutions in order to meet time deadlines. They are not necessarily the best solutions.

The approach to Toolbox Meetings in this cycle differed from the previous two cycles in that researchers did not take the lead in meetings, but attended these meetings as participant observers. Stewards and foreman took ownership of ergonomic topics in their meetings, resulting in natural dialogues among workers about their work environments and how to improve hazards on site. The researchers were pleased that a previously less-successful part of the Health Trak research design, Participant Observation, was better integrated into this cycle than in past cycles. This was particularly true with respect to Committee members reporting back on toolbox meetings and Committee members participating in the site laydown area walkthrough that was conducted in Week 6 of the cycle.

4.4 Results of Cycle 4

The fourth Health Trak cycle [Appendix F] was unusual because the contractor defined the hazard before the start of the cycle. In this case, management requested a specific focus on noise. The cycle therefore ran for only five weeks, skipping the first three weeks normally used to identify hazards. This Health Trak cycle involved eight stewards from six trades and five safety professionals from the contractor in a five-week series of discussions, interviews, and observations.

At the first committee meeting, participants decided that this cycle would focus on controlling noise in construction of the East Bound side of the highway. They decided that this portion of the site would be more appropriate than the West Bound side because workers were erecting decking on the East Bound side, a noisy operation, while on the West Bound side they were still erecting walls.

Discussions centered on the hierarchy of controls. This principle of occupational health states that hazards should be eliminated or controlled at the source when possible, with controls in the path secondary and personal protective equipment a last resort for cases where elimination or control is not feasible. Based on the questions, opportunities, and obstacles addressed during Health Trak, researchers developed these recommendations for feasible reduction of noise exposure at this site: 1) Incorporate noise reduction into activity planning; 2) Incorporate informal noise monitoring into site walk-throughs; 3) Keep an ongoing record of noise monitoring results; 4) Deliberately seek out the noisiest areas and operations on site, and monitor those; 5) Use monitoring results to identify, post, and enforce “noise perimeter zones” and the maximum exposure time within high noise areas; 6) Ensure that workers receive hearing protection devices with Noise Reduction Ratings adequate for the sound levels they are exposed to; and 7) Institute administrative procedures to tie PPE checkout to equipment checkout (i.e. use a written policy to check out both muffs and plugs with bar locking equipment). Researchers then developed a simple, user-friendly protocol for calculating noise perimeter zones and maximum allowable exposure times.

A major goal of the Health Trak discussions was to work within the Hierarchy of Controls. Researchers encouraged members to focus first on elimination and engineering controls, then move to administrative controls. They recommended using PPE only if other controls could not eliminate the hazard at the source. In this cycle, most of the committee argued that no elimination or engineering controls were feasible and that they could only improve PPE. This led to what a researcher called the “vicious circle of construction and research”, in which researchers propose technical solutions, construction people give reasons why they can not be done, and everything spirals back down again to PPE. However after discussion, participants did recommend job rotation (limiting the length of time any one worker can stay in a noisy area), which is an administrative control and managers agreed to contact manufacturers about the possibility of adding muffling to heavy equipment in addition to what is currently installed.

Health Trak Committees include a majority of workers in order to compensate partly for the imbalance of resources between workers and managers. In this cycle, only one of five committee meetings actually included more workers than managers. Two of the meetings included just one worker. Only the operating engineers steward was able to attend all five meetings. Other

stewards attended only one or two meetings. In some cases, stewards said they had not been informed of meetings. However, the stewards who did attend any given meeting participated and discussed the issues seriously. A researcher observed that stewards on this site act like traditional building trades stewards who take an active role in overseeing working conditions. Workers also had fairly limited control over the Health Trak process in this cycle. Management chose the location and the hazard of focus. Researchers chose the study design. Workers entered a process already designed by others. On the other hand, workers influenced the selection of noise sources to examine. Although researchers repeatedly raised the question of compressors as a noise source, workers did not see them as a major problem.

During the last committee meeting participants shared what they liked about the process and what they would like to change. Several participants agreed that the discussions had helped them think more about hearing protection and continue the process of improving this protection on site. They appreciated researchers showing them aspects of their work that they were not aware of and giving them the opportunity to see the site with new eyes. Participants had no specific suggestions for changing the Health Trak process.

4.5 Results of Cycle 5

Based on injury and illness data, the COHP researchers and the contractor's safety director agreed that the goal of the fifth Health Trak cycle [Appendix G] would be to develop and implement ergonomic controls to reduce workers' exposure to risk factors commonly associated with strain and sprain injuries. The cycle focused on a large stage of reiterating concrete structure construction operations. In addition, management was beginning to employ a new project management software into their procedures and the utility of incorporating ergonomic information into the planning of this stage was viewed as an advantage. To achieve this goal, two objectives were defined: 1) Recognize, evaluate, and control risk for ergonomic injury to the crews on this stage and 2) Expand the contractor's Activity Plan to include recognition and abatement of ergonomic hazards.

The Activity Plan (AP) is one of the contractor's existing tools for anticipating and/or reacting to identified risks. Written by safety management, the AP annotates the anticipated risks and links them with prescribed solutions. All necessary tools and equipment to complete the

tasks are also listed in the AP. The safety management considers the AP to be a working document primarily used by foremen as a field guide to crew safety in a given operation.

During the first three Health Trak meetings, the Committee members (four stewards from three trades and two site safety personnel) reviewed and discussed ergonomic risk factors. From these discussions, a list of hazards was developed. The Committee members considered it unfeasible to address many traditionally accepted risk factors for musculoskeletal disorders. For example, the idea of establishing a lifting limit or guideline was discussed at length during one Health Trak meeting, but the Committee concluded that these interventions would be impossible to implement on-the-job or to incorporate into an Activity Plan. Based on the discussions about ergonomic risk factors, the Committee focussed its attention on three tasks of concern to them that they believed could be redesigned: 1) inserting rebar; 2) chipping concrete spills; and 3) walking on rebar mats.

Of the three tasks that the Health Trak Committee members discussed, they developed and attempted to implement job-specific interventions for two: 1) a raised platform for Ironworkers inserting rebar and 2) a plywood walkway designed to be placed over a rebar mat. The third task of concern, chipping concrete overflows and working in tight spaces, was discussed during the second Health Trak Meeting and put aside because the Committee members felt that no changes could be made to the way the job was done. Concrete form overflow was identified as a major ergonomic hazard for Laborers, as their task is to chip away the overflow to create a smooth edge to the slab. The only viable intervention was to eliminate the hazard at its source by preventing the overflow before it occurs. Researchers presented the Committee with a checklist that could be used to ensure that the form is constructed properly to prevent the overflow.

The interventions that were discussed as potential ways of alleviating worker exposure to awkward postures in all job tasks included job rotation and taking breaks. The Committee members claimed that efforts are made to encourage job rotation when possible (limitations included production pressure, inability to plan ahead due to unforeseen work and overtime). In addition, the Committee members agreed that workers can take breaks whenever they need to. Committee members pointed to the booming economy as being primarily responsible for this “freedom”.

Health Trak Committee members suggested building an “Ironworker Platform” during the first committee meeting. This intervention was designed to reduce the risk of strain to the shoulder of Ironworkers inserting “Dowel-By-Screw-in” (DBS) with both the hands and elbows over shoulder height. The idea was simply to raise the height of the worker to eliminate overhead work. Due to the nature of the task, the Ironworker steward believed that significant risk for musculoskeletal strain could be prevented with this intervention. Inserting DBS rebar involves lifting, holding and manipulating #11 rebar dowels, which weigh 5.3 pounds per foot. The two lengths of dowels used on this site were 11.5 and 14 feet long, weighing 61 and 74 pounds, respectively. Two people were required to handle this material, and therefore, two platforms were needed. By describing this task to the Committee members, the Ironworker steward was able to work directly with the Carpenter representative to design the intervention. The Committee members agreed that the platform should essentially be a box, closed in on all sides, large enough for one worker to stand on, and tall enough to provide relief from the overhead work. As a result of the direct communication between the Ironworker and Carpenter stewards, the Carpenters built two boxes out of 2” x 12” lumber and 1” plywood and fashioned it with a rope handle. The platforms as built (20” x 20” x 11”) raised the surface on which the Ironworkers would stand while they inserted DBS into the slurry wall by 11 inches. This reduced the distance between the lower mat, where the worker stood, and the two higher rows of DBS to 70 and 77 inches. This was a definite improvement, but a six-foot tall worker would still be reaching overhead on the highest inserts.

The second intervention developed by the Health Trak Committee was a plywood walkway to be placed over rebar mat. Stable footing is an issue due to the work that was required to be done while walking or standing on the rebar mat. The Committee’s intent was that the plywood walkway be used by the Carpenters and Laborers during form construction to prevent ankle sprains and leg and groin contusion that result from falls through the rebar mat. The Health Trak Committee struggled to clarify and delineate the methods and use of the plywood walkway, and thus to facilitate and standardize its usage. The Health Trak’s proposed plywood walkway was not accepted because it was seen as an obstruction to the Ironworkers’ task of completing the rebar mat. Although Committee members claimed that walkways were “used all the time”, it was believed that “Ironworkers didn’t want a walkway”. A second barrier to the successful

design of a walkway was the Committee's inability to develop a plan for its easy use during concrete pours. The final, and most important, barrier to the implementation of this intervention was the Ironworker foreman's resistance to the idea, insisting that the walkway was an obstruction to the Ironworkers' tasks during the concrete reinforcement operation. While the Committee members had discussed this specific issue--that the walkway may hinder the Ironworkers--the Ironworker steward on the Committee felt that it would be easy enough to move out of the way, and that the benefits to the other trades outweighed the inconvenience to the Ironworkers. However, the final decision about the use of the intervention fell to the foreman, who was not a member of the Committee.

The Committee members reviewed and approved new items for the contractor's Activity Plan. These items described the use of the two interventions the Committee had developed. These items were passed on to the contractor's safety officers for inclusion in the AP. Repeated discussions about the use of the AP on-the-job kept coming to the same conclusion, the AP's should be shared with the workers and enforced by the foremen and safety officers. However, the members of the Committee had not received copies of the AP, and they felt that for large crews, there was no good way to review its contents with the workers. Though the Activity Plan seems to be the only tool for diffusion of health and safety ideas on site, it is not viewed as practical. In addition they will have no impact if they are not used.

V. SUMMARY AND CONCLUSIONS

Health Trak, a participatory model for intervention in construction that involves construction workers and management, as well as occupational health and safety researchers, has been used to reduce the risk of injuries and illnesses for construction workers. It has three key components: 1) participatory meetings with worker and contractor representatives, 2) toolbox meetings with workers on-site using a checklist which is designed to collect data on worker-identified hazards, and 3) participant observation methods including observation, interviews and focus groups with workers and management.

A total of five Health Trak cycles have been completed. The first two Health Trak cycles provided considerable information, which allowed the process to be greatly improved in the later three cycles. These two cycles were also very different from each other. In the first cycle, the

committee was ambitious, but had no real decision-making authority. They wanted to tackle big issues, but were not successful in generating real change. In the second cycle, the committee was more passive and was only willing to take on small issues. They were moderately successful in developing interventions around these issues, but because the issues were small, they had only a minor impact on exposure to potential health risks. The fourth cycle was unique with its focus on noise. It was more of a focus group discussion of hearing protection, without any real intervention implemented. The third and fifth cycles were by far the most productive, showing both the strengths and limitations of the method. In both of these cycles, the Committee was excellent at delineating hazards and proposing potential solutions, but in both cases they were only moderately successful at implementing the proposed solutions.

Formative analysis of qualitative data from these cycles has provided these significant findings:

1. A strong committee is needed to generate real lasting change. Stewards and foreman play key leadership roles on site and are responsible for the day-to-day negotiations that resolve the constant contradictions arising between production pressure and safety and health. The participation of stewards and foremen, as well as involvement of a management representative with decision-making authority, will produce a strong Health Trak Committee capable of improving health conditions on site.

2. The scope of the goals for each cycle has to be laid out in advance and in proper perspective. If the goals are too large, the committee will be unsuccessful; if the goals are too small, they will have little impact.

3. The Health Trak Committees were excellent at identifying health hazards, as well as proposing potential solutions for these hazards. They were not as good at implementing solutions. This is likely due to the culture of construction and may be hard to overcome.

4. In general, communication is poor on a construction site. This is true of communication between trades and communication between shifts. During the Health Trak Committee meetings, there was good collaboration among the stewards and foremen across trades in the development of intervention ideas. On the other hand, the Health Trak process did not foster communication across shifts. An intervention developed on one shift was dismantled by the next shift for the materials, because no information on its use was provided to the second shift.

5. Toolbox meetings did not prove to be an important component of Health Trak. These meetings were used differently in each Health Trak cycle depending mostly on the contractor involved. In some cases, they were used to provide information on the Health Trak cycle to non-committee member workers or to provide ergonomics training. In other cases, the foremen and stewards took ownership of the toolbox meetings and the researchers attended the meetings as participant observers.

6. Participant observation was a very important part of Health Trak. It was the primary source of data for evaluation of both the Health Trak process and the interventions that were implemented. A number of other evaluation methods are included in the Health Trak process. Some of these were used more successfully than others:

a. Surveys of Health Trak committee members. In practice, this was performed very informally, so only qualitative data resulted.

b. Quantitative assessment of hazards pre- and post-intervention. This should be the primary method for evaluating any implemented intervention and was used for a number of interventions. Unfortunately, not all of the interventions that were implemented had obvious job analysis methodologies for hazard quantification.

c. Qualitative analysis of data collected during each Health Trak cycle. Qualitative evaluation was conducted at the end of each cycle using data collected from committee meetings, toolbox meetings and participant observation. Data in these qualitative analyses included: notes and artifacts from the committee meetings; the results of participatory field work conducted by participants in the Health Trak committee; and data collected by researchers in meetings or on-site through participant observation. Because of the shortness of each Health Trak cycles trends in injury data from various sources, such as OSHA 200 logs and workers' compensation data, were not examined.

d. Site walk-throughs by external occupational health and safety experts. A health and safety expert conducted site walk-throughs both before and after the first two Health Trak cycles. The information obtained during these walk-throughs did not prove to be very valuable, so the process was discontinued for later cycles.

e. Evaluation by an advisory board. An advisory board was convened twice during the development of Health Trak and once following completion of the third cycle. This board

consisted of experts in occupational health and safety, participatory research, rapid appraisal methods, and evaluation research. Representatives from the participating contractors and unions were also invited to participate. This board served to review and evaluate the Health Trak process and was instrumental in fine tuning some of the research methodologies.

Health Trak had one very important strength and one very important limitation. The major strength was the ability of the committee to identify hazards and propose potential interventions to control the identified hazards. This was primarily the result of having stewards and foremen on the committees. The major limitation of Health Trak was the inability of the process to get controls implemented. The primary barrier appears to be the culture of construction where no one seems willing to take ownership of improving health. The workers have the knowledge but feel they do not have the power and are willing to put up with the *status quo*. The managers have the power but are unwilling to spend money unless they feel it is necessary.

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APPENDICES

- A. Moir S, Buchholz B and Garrett J (1997) Health Trak: A participatory model for intervention in construction. *International Ergonomics Association 13th Triennial Congress*, Tampere, Finland.
- B. Buchholz B, Moir S and Garrett J (1999) Health Trak: A participatory approach for ergonomic improvement in construction. In *Implementation of Safety and Health on Construction Sites*, edited by A Singh, J Hinze and RJ Coble, pp. 711-716, Balkema, Rotterdam.
- C. Health Trak Cycle 1 Final Report: A Participatory Approach to Reducing Health Risks in Construction
- D. Health Trak Cycle 2 Final Report: A Participatory Approach to Reducing Risks in Construction
- E. Health Trak Cycle 3 Final Report: Reducing Ergonomic Hazards in Concrete Formwork assembly through Worker Participation
- F. Health Trak Cycle 4 Final Report: Noise Control in Construction
- G. Health Trak Cycle 5 Final Report: Ergonomics and Contractor Activity Planning

APPENDIX A

Moir S, Buchholz B and Garrett J (1997) Health Trak: A participatory model for intervention in construction. *International Ergonomics Association 13th Triennial Congress*, Tampere, Finland.

Health Trak: A Participatory Model for Intervention in Construction

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1. Introduction

Construction workers are at great risk to injury, disability and early death as a result of exposure to health and safety hazards at work (Center to Protect Workers Rights, 1993). The broad goal of the proposed research project is to reduce the incidence and prevalence of injuries and illnesses to construction workers. The barriers to this objective are not primarily technological, but cultural and organizational. A wide range of possible interventions are available to be introduced at the industry, contractor and individual levels (Schneider, 1996), including: technological changes; improved personal protective equipment; and administrative reforms. The imminent question is not so much what to change, but how to change and who will affect that change.

Ringen *et al.* (1995) cite several characteristics which make construction unique, including multiple employers, short-term employment and the ever-changing nature of the construction workplace and its hazards. In this study, rapid appraisal and participatory methods are combined in the design of "Health Trak" to address the uniqueness of construction. A compelling body of literature contends that successful introduction of ergonomics into the workplace is preconditioned on participation by the affected workers (e.g. Gjessing *et al.*, 1994; Schurman *et al.*, 1994). Rapid appraisal uses popular education and participatory techniques in an intensive, systematic and semi-structured method carried out by a team composed of outside researchers and a representative cross-section of the affected population to enter a research setting, do assessment, and introduce and evaluate interventions in the shortest feasible time (e.g. Chambers, 1993; Murray, 1994).

2. Participatory Methodology

Health Trak is developed around eight-week cycles, which utilize three key components: 1) Participatory meetings of Health Trak committees composed of 3-4 workers, the contractor safety representative, and other on-site personnel responsible for production; 2) Toolbox meetings involving larger groups of workers; and 3) Participant observation, focus group meetings and interviews with workers and contractor representatives.

1. Health Trak committee meetings. Participation on the committee involves attendance at a weekly one-hour meeting, which consists of participatory learner-centered activities, designed to identify and/or solve problems through eliciting the experience of the participants in a group process. These include risk mapping of hazards in the workplace, team building exercises, communications skill development, storytelling, role plays and other psychomotor methods for learning and sharing knowledge. As part of each committee meeting, participants design a data collection instrument with which to survey co-workers in the week following the meeting. For example, when participants conduct risk mapping in the Health Trak committee

meeting to identify hazards in the workplace, they then take the risk maps with them at the end of the meeting and survey their co-workers. The feedback from this survey is reviewed and evaluated at the next Health Trak meeting. The committee meetings are divided into four steps during the eight-week cycle:

a. Problem identification and definition (weeks 1-2). The objective of these sessions is to identify problems with the current health and safety program. The final product is a written definition of the identified health problem, which serves as the "research question" for the participants and will be the focus for the remainder of the Health Trak cycle.

b. Analysis of hazards and strategies for intervention (weeks 3-5). The objectives of these weeks is to analyze the written research problem and to develop strategies for intervention. Participants will work through a needs assessment, which is used to assess their current health and safety working conditions relevant to the defined research question, their visions of solutions, and their assessment of potential strategies for change, in order to move from the present conditions to their desired conditions. The product of these sessions is possible interventions that address the research question.

c. Implementation of proposed intervention (weeks 6-7). Participants will prioritize interventions and introduce them at the worksite. The product of these sessions will be the intervention and its evaluation.

d. Evaluation by participants (week 8). Outcome measures include self-assessment by participants of the Health Trak process and their participation in it, evaluation of changes in the health and safety program, a review of injury data for the eight-week period, and evaluation of the effectiveness of the intervention.

2. Health Trak toolbox meetings. At least once a week during each eight-week cycle, a Health Trak researcher conducts a Health Trak participatory "toolbox meeting" for a group of workers not participating in the Health Trak Committee. Toolbox meetings are 10-15 lectures (often having a safety component) held on many construction sites before work in the morning. The focus of these toolbox meetings is the research question defined in the committee meeting. A checklist is used by a researcher to identify immediate problems and track the perceptions of changes and response from this larger group of workers. Results of the toolbox meetings are reported to the Health Trak committee for its review and action.

3. Health Trak participant observation. Researchers also spend 1-2 days per week on the site using participant observation, interviews, and informal focus groups, to collect data about conditions and perceived changes by labor and management during the Health Trak cycle.

3. Evaluation of Participatory Methodology

Qualitative and quantitative evaluation occurs at multiple levels:

1. Surveys of Health Trak committee members. A survey is administered to each participant before and after each Health Trak cycle. Participants are asked to quantitatively and qualitatively evaluate their workplace health and safety program and the perceived changes that occur as a result of Health Trak.

2. Quantitative assessment of hazards pre- and post-intervention. Interventions are evaluated using appropriate industrial hygiene and ergonomic risk assessment methods such as: air sampling, noise dosimetry, vibration exposure assessment, and ergonomic job analysis.

3. Quantitative comparisons of injury and illness data. Injury and illness data, including OSHA 200 and first-aid logs, workers' compensation claims and the Health Trak injury log, are collected from each contractor for the duration of its participation in Health Trak and are analyzed for trends. Comparisons are also made with similar data collected from non-participating contractors who perform nearly identical work.

4. *Evaluation by an advisory board.* An advisory board is convened twice a year to review and evaluate Health Trak. This board consists of representatives from the participating contractors and unions, experts in occupational health and safety, participatory research, rapid appraisal methods, and evaluation research.

5. *Qualitative analysis of data collected during each Health Trak cycle.* Qualitative evaluation is conducted at the end of each cycle using data collected from committee meetings, toolbox meetings and participant observation. Data include: data from the committee meetings, in the form of transcripts, notes and artifacts from participatory activities; the results of participatory field work conducted by participants in the Health Trak committee; checklists from toolbox meetings; injury data, including OSHA 200 logs, workers' compensation data, and Health Trak injury logs; and data collected by researchers in meetings or on-site through participant observation. Outcomes include changes in the perceptions of Health Trak participants and other employees regarding the effectiveness and responsiveness of the health and safety program and changes in exposure to hazards.

6. *Site walk-throughs by external occupational health and safety experts.* Experts in health and safety (e.g. construction safety consultants, union safety staff, state and federal health and safety professionals) conduct site walk-throughs and give written evaluations of the health and safety programs on these sites.

4. Summary

Health Trak, a participatory model for intervention in construction that involves construction workers and management, as well as occupational health and safety researchers, is being used to reduce the incidence and prevalence of injuries and illnesses for construction workers. It has three key components: 1) participatory meetings with worker and contractor representatives, 2) toolbox meetings with workers on-site using a checklist which is designed to collect data on worker-identified hazards, and 3) participant observation methods including observation, interviews and focus groups with workers and management.

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APPENDIX B.

Buchholz B, Moir S and Garrett J (1999) Health Trak: A participatory approach for ergonomic improvement in construction. In *Implementation of Safety and Health on Construction Sites*, edited by A Singh, J Hinze and RJ Coble, pp. 711-716, Balkema, Rotterdam.

Health Trak: A participatory approach for ergonomic improvement in construction

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ABSTRACT: Health Trak is a participatory approach that involves construction workers and management, as well as occupational health researchers, in identification, evaluation and control of health hazards. Each eight-week Health Trak cycle has three key components: 1) participatory committee meetings with worker and contractor representatives, 2) toolbox meetings with workers on-site, and 3) participant observation. Ergonomic hazards, such as those that may lead to musculoskeletal disorders, are the current focus of Health Trak. Two Health Trak cycles have been completed to date. In the first cycle, the participants identified the lack of sanitary facilities as the health hazard for study. Though an intervention was not implemented, the efforts of this committee have had a profound impact on the local industry. In the second cycle, the committee focused on ergonomics and was successful in implementing interventions to control manual material handling hazards.

1 INTRODUCTION

Construction workers are at great risk to injury, disability and early death as a result of exposure to health and safety hazards at work (Center to Protect Workers Rights 1993). The broad goal of this research project is to reduce the incidence and prevalence of injuries and illnesses to construction workers. The barriers to this objective are not primarily technological, but cultural and organizational. A wide range of possible interventions is available to be introduced at the industry, contractor and individual levels (Schneider 1996). These interventions include: technological changes, improved personal protective equipment, and administrative reforms. The imminent question is not so much what to change, but how to change and who will affect that change.

Ringen *et al.* (1995) cite several characteristics which make construction unique, including multiple employers, short-term employment and the ever-changing nature of the construction workplace and its hazards. In this study, rapid appraisal and participatory methods are combined in the design of Health Trak to address the uniqueness of construction. A compelling body of literature contends that successful introduction of ergonomics into the workplace is preconditioned on participation by the affected workers (e.g. Gjessing *et al.* 1994; Schurman *et al.* 1994). Rapid appraisal uses popular education and participatory techniques in an intensive, systematic and semi-structured method carried out by a team composed of outside researchers and a representative cross-section of the affected population to enter a research setting, do assessment, and introduce and evaluate interventions in the shortest feasible time (e.g. Chambers 1993; Murray 1994).

2 PARTICIPATORY METHODOLOGY

Each Health Trak cycle is conducted over eight weeks and utilizes three key components: 1) Participatory meetings of Health Trak committees composed of 3-4 workers, the contractor safety representative, and other on-site personnel responsible for production; 2) Toolbox meetings involving larger groups of workers; and 3) Participant observation, focus group meetings and interviews with workers and contractor representatives. These three components are integrated and function concurrently during the cycle (Figure 1).

1. Health Trak committee meetings. Participation on the committee involves attendance at a weekly one-hour meeting, which consists of participatory learner-centered activities, designed to identify and/or solve problems through eliciting the experience of the participants in a group process. These activities include risk mapping of hazards in the workplace, team building exercises, communications skill development, storytelling, role plays and other psychomotor methods for learning and sharing knowledge. As part of each committee meeting, participants design a data collection instrument with which to survey co-workers in the week following the meeting. For example, when participants conduct risk mapping in the Health Trak committee meeting to identify hazards in the workplace, they then take the risk maps with them at the end of the meeting and survey their co-workers. The feedback from this survey is reviewed and evaluated at the next Health Trak meeting. The committee meetings are divided into four steps during the eight-week cycle:

a. Problem identification and definition (weeks 1-2). The objective of these sessions is to identify problems with the health component of the current health and safety program. The product of these two weeks is a written definition of the identified health problem, which serves as the "research question" for the participants and will be the focus for the remainder of the Health Trak cycle.

b. Analysis of hazards and strategies for intervention (weeks 3-5). The objectives of these weeks are to analyze the written research problem and to develop strategies for

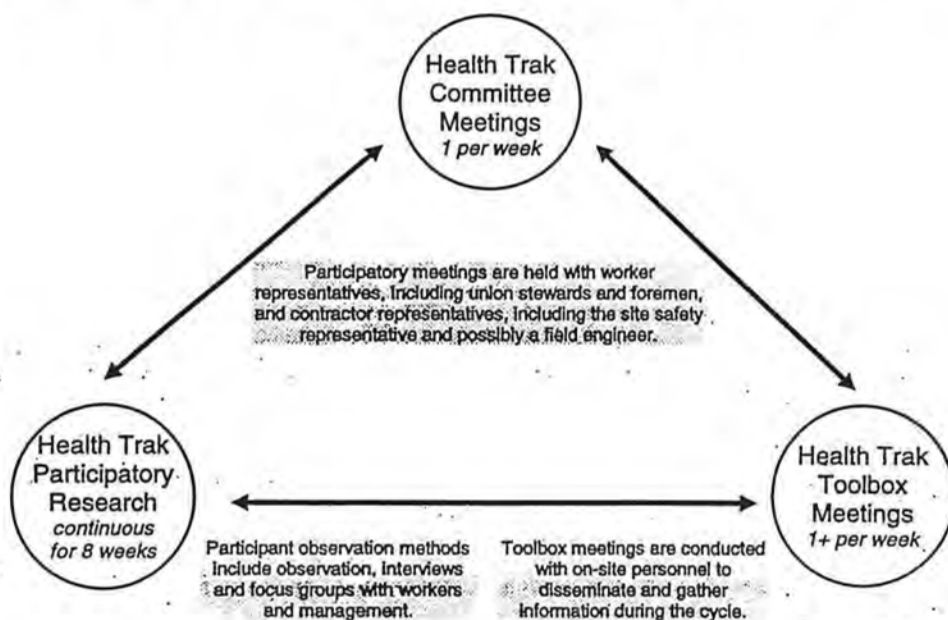


Figure 1. Interaction of the three components of a Health Trak cycle.

intervention. Participants conduct a needs assessment, which is used to assess their current health and safety working conditions relevant to the defined research question, envision possible solutions, and assess potential strategies for change, in order to move from the present conditions to their desired conditions. The product of these sessions is possible interventions that address the research question.

c. Implementation of proposed intervention (weeks 6-7). Participants will prioritize interventions and introduce them at the worksite. The product of these sessions will be the intervention and its evaluation.

d. Evaluation by participants (week 8). Impact and outcome measures for evaluation include self-assessment by participants of the Health Trak process and their participation in it, evaluation of changes in the health and safety program, a review of injury data for the eight-week period, and evaluation of the effectiveness of the intervention.

2. Health Trak toolbox meetings. At least once a week during each eight-week cycle, a Health Trak researcher conducts a Health Trak participatory "toolbox meeting" for a group of workers not participating in the Health Trak Committee. Toolbox meetings are 10-15 minute lectures (often having a safety component) held on many construction sites before work in the morning. The focus of these toolbox meetings is the research question defined in the committee meeting. A checklist is used by a researcher to identify immediate problems and track the perceptions of changes and response from this larger group of workers. Results of the toolbox meetings are reported to the Health Trak committee for its review and action.

3. Health Trak participant observation. Researchers also spend 1-2 days per week on the site using participant observation, interviews and informal focus groups, to collect data about conditions and perceived changes by labor and management during the Health Trak cycle.

3 EVALUATION OF PARTICIPATORY METHODOLOGY

Qualitative and quantitative evaluation occurs at multiple levels:

1. Surveys of Health Trak committee members. A survey is administered to each participant before and after each Health Trak cycle. Participants are asked to quantitatively and qualitatively evaluate their workplace health and safety program and the perceived changes that occur as a result of Health Trak.

2. Quantitative assessment of hazards pre- and post-intervention. Interventions are evaluated using appropriate ergonomic risk assessment methods. These include structured ergonomic job analyses (Keyserling *et al.* 1991), ergonomic checklists, and PATH, a work-sampling based ergonomic job analysis method (Buchholz *et al.* 1996).

3. Qualitative analysis of data collected during each Health Trak cycle. Qualitative evaluation is conducted at the end of each cycle using data collected from committee meetings, toolbox meetings and participant observation. Data include: data from the committee meetings, in the form of transcripts, notes and artifacts from participatory activities; the results of participatory field work conducted by participants in the Health Trak committee; checklists from toolbox meetings; trend in injury data, including OSHA 200 logs, workers' compensation data, and Health Trak injury logs; and data collected by researchers in meetings or on-site through participant observation. Outcomes include changes in the perceptions of Health Trak participants and other employees regarding the effectiveness and responsiveness of the health and safety program and changes in exposure to hazards.

4. Site walk-throughs by external occupational health and safety experts. Experts in health and safety (e.g. construction safety consultants, union safety staff, state and federal health and safety professionals) conduct site walk-throughs and give written evaluations of the health and safety programs on these sites.

5. Evaluation by an advisory board. An advisory board is convened twice a year to review and evaluate Health Trak. This board consists of representatives from the participating

contractors and unions and experts in occupational health and safety, participatory research, rapid appraisal methods, and evaluation research.

4 RESULTS TO-DATE

The Boston Central Artery/Third Harbor Tunnel (CA/T) construction project has been the site for these research activities. The CA/T is currently the largest on-going public works project in the United States. The construction project is comprised of numerous individual sites, each with its own general contractor, as well as many smaller sub-contractors. The Massachusetts Highway Department is the project owner and they have hired a firm to manage the project, which oversees all aspects of the construction.

4.1 *Results of Cycle 1*

The first Health Trak cycle was held on a site constructing an elevated portion of the Central Artery construction project. A planning meeting was held with the site safety representative, the contractor's corporate safety representative and the assistant resident engineer from the Central Artery project construction manager and the first cycle began within a month. The Health Trak Committee was composed of a carpenter, an operating engineer, two laborers, the site safety representative and a field engineer.

The weekly Health Trak committee meetings went as planned, with the curriculum specifics unfolding week-to-week. The committee decided during week three that the lack of sanitary facilities on site would be the hazard to prioritize for intervention. The site in question had only portable toilets and, more importantly, no facilities to wash and change before lunch or leaving the site. The next four weeks were spent attempting to develop and implement an intervention for this hazard. Two separate proposals for intervention were developed: one involving connection to the city sewer (~\$150,000) and one using a holding tank (~\$50,000). Two obstacles to implementation were identified: the contractor's concern for cost and acceptable area practice (i.e. sanitary facilities are not normally provided on construction sites). Despite meetings with the contractor, construction manager and owner, the intervention was never implemented. We have continued to work on solutions to this hazard, with the hope that, at a minimum, the owner will include the need to address the hazard in the bid specifications for new sites on the Central Artery.

In this cycle, the weekly toolbox meetings were used primarily as a communication tool to provide information on the status of Health Trak. Future cycles will attempt to use toolbox meetings as training and education sessions. Both production constraints and requirements for other safety training limit time for this purpose. In addition, more on-site worker involvement will be solicited.

The committee communicated well and labor/management/researcher barriers were not apparent. The committee members were performing research early in the cycle, which underscores this productive relationship. Because an intervention was not successfully implemented and because of the nature of the health hazard, quantitative assessments were not performed. The surveys of workers on the site indicated an increase in awareness of health hazards. The comparison of the pre- and post-cycle evaluations by the independent health and safety expert showed a similar result indicating that this Health Trak cycle had a positive influence on site.

4.2 *Results of Cycle 2*

The second Health Trak cycle was held on a utility relocation site on the Central Artery

construction project. An orientation meeting was held with the site safety manager and the cycle began shortly thereafter. The Health Trak Committee was selected by the site safety manager and was composed of a laborer steward, a laborer, an operating engineer, the site safety manager and the owner's environmental health and safety representative. Representatives from the owner's occupational health clinic observed at five meetings on a rotating basis.

The researchers made a conscious effort to steer the committee towards an ergonomic intervention in this cycle. This was explained to the committee in the first meeting, along with the broader goal of creating a general process for reducing health-threatening exposures. The weekly Health Trak committee meetings went as planned, with the curriculum specifics unfolding week-to-week. In the second week, the committee identified lifting oxygen-acetylene canisters, repetitive shoveling, pressure from rushing their work, and general exposures to dust, noise, fumes, and hot temperatures as important exposures occurring on their site. During the next two meetings, they decided to implement interventions to reduce exposure during manual materials handling tasks. The controls they decided to use were to increase the number of manual materials handling aids on site, to improve housekeeping and to improve work surfaces. Through the participatory process, hand trucks, work surface improvements, and wheel wells were identified as feasible controls. Two hand trucks were purchased at once and the work surface improvements also began immediately. Wheel wells were designed for use during lifting and lowering materials from/to the jacking and receiving pits. However, the redesigned wheel wells were never completed.

Although we focused on ergonomics during this cycle, sanitary facilities were also an issue, as they were in the first cycle. The committee actually recommended that a hand washing station be the first control implemented and though the committee did not spend a lot of time on this issue, the laborer steward worked with the safety manager to create a prototype. Simultaneously, the project owner mandated washing facilities for all Central Artery sites, and lavatories for permanent work areas.

In this cycle, researchers communicated with the 70 other workers on site through the weekly toolbox meetings. These meetings were used to provide limited ergonomic training and to provide information on the status of Health Trak. The researchers also conducted participant observations, including interviews and focus group meetings, with workers and contractor representatives.

The evaluation by the committee members indicated that the committee and toolbox meetings were successful. The members thought Health Trak was a method that they could adapt and continue to use on their site. The surveys of workers on the site did not show any significant changes in workers' perceptions of health hazards. The comparison of the pre- and post-cycle evaluations by the independent health and safety expert showed an increased awareness of hazards from manual materials handling.

5 SUMMARY AND CONCLUSIONS

Health Trak, a participatory model for intervention in construction that involves construction workers and management, as well as occupational health and safety researchers, is being used to reduce the risk of injuries and illnesses for construction workers. It has three key components: 1) participatory meetings with worker and contractor representatives, 2) toolbox meetings with workers on-site using a checklist which is designed to collect data on worker-identified hazards, and 3) participant observation methods including observation, interviews and focus groups with workers and management.

The first two Health Trak cycles were different from each other. In the first cycle, the committee was ambitious, but had no real decision-making authority. They wanted to tackle big issues, but were not successful in generating real change. In the second cycle, the

committee was more passive and was only willing to take on small issues. They were moderately successful in developing interventions around these issues, but because the issues were small, they had only a minor impact on exposure to potential health risks.

Formative analysis of qualitative data from these two cycles has provided two significant findings:

1) A strong committee is needed to generate real lasting change. Stewards and foreman play key leadership roles on site and are responsible for the day-to-day negotiations that resolve the constant contradictions arising between production pressure and safety and health. The participation of stewards and foremen, as well as involvement of a management representative with decision-making authority, will produce a strong Health Trak Committee capable of improving health conditions on site.

2) The scope of the goals for each cycle has to be laid out in advance and in proper perspective. If the goals are too large, the committee will be unsuccessful; if the goals are too small, they will have little impact.

Our efforts to-date have given us an early indication that this participatory methodology will work in construction. Future Health Trak cycles will be modeled using these two findings.

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APPENDIX C.

Health Trak Cycle 1 Final Report: A Participatory Approach to Reducing Health Risks in Construction

Health Trak: A Participatory Approach to Reducing Health Risks in Construction

Report on Cycle 1: February-March 1997

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Preface

While injuries in the construction industry have appeared to decline in recent years, this industry continues to be one of the most hazardous in the United States. In 1993, construction had the highest occupational injury incidence rate at 12.0 per 100 full-time workers (US Department of Labor, 1993). The industry also has some of the highest workers' compensation costs. Many organizational and economic factors contribute to the difficulty of reducing the injury rates. Two major factors are the ever-changing workplace and workers who frequently move from jobsite to jobsite (Schneider, 1995).

In 1992, the Construction Occupational Health Project (COHP) of the Work Environment Department at the University of Massachusetts Lowell was established to address these high injury rates and the difficult-to-study work environment. The COHP utilizes many different research methodologies, including exposure assessment, epidemiology and intervention. One of its intervention activities is Health Trak. Health Trak is an eight-week participatory research project designed to enhance workers' and contractors' capacity to identify and remedy health hazards. For the purposes of this report, Health Trak defines health hazards as cumulative work exposures that exhibit a negative health outcome over time.

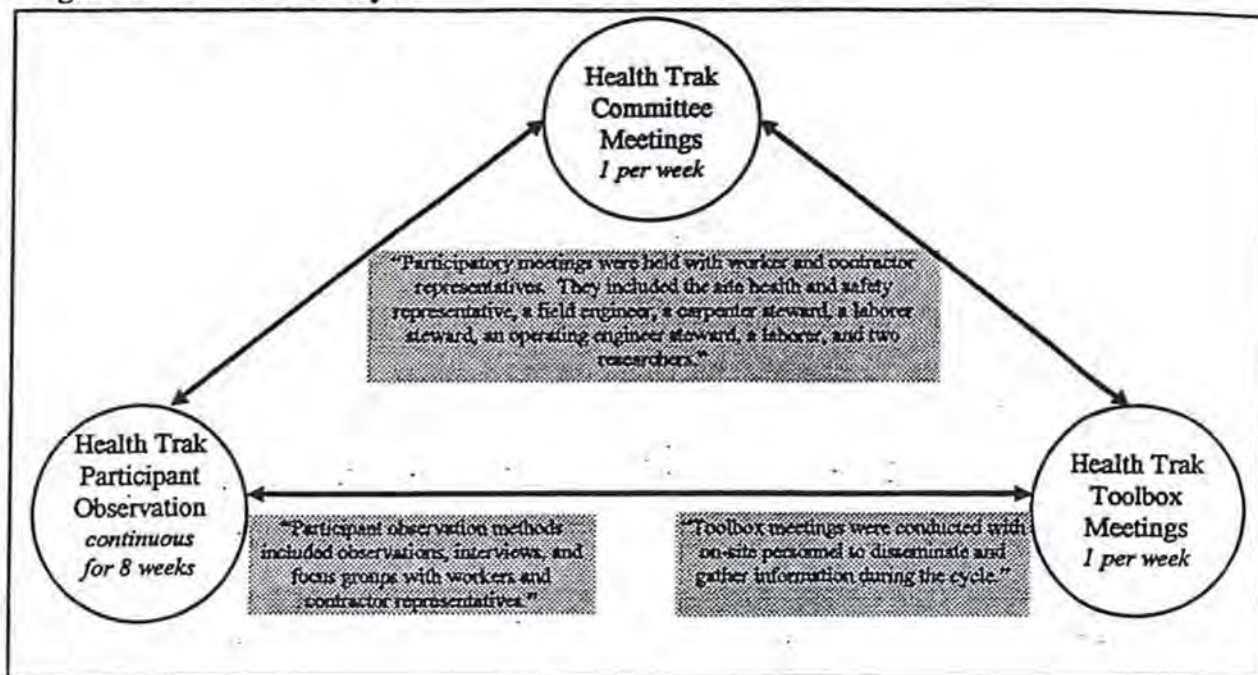
Health Trak operates using participatory research methods that are "learner-centered," which were developed in the field of education. They have been adapted to research under the names of participatory action research (PAR) and action research (AR). PAR studies combine research and intervention in single studies and transform research subjects into participants in the process.

Participatory approaches for reducing occupational health risks are used in many different industries, but they are new to construction. In a participatory approach to occupational health research, worker and contractor representatives (insiders) and researchers (outsiders) are seen as possessing complementary kinds of expertise that are coordinated in a co-learning role (Elden, 1983). A premise is that the likelihood of successful risk reduction increases because worker experience offers a better understanding of problems and their solutions. Since it is inherently difficult as outsiders to solve an insider's problem, Health Trak focuses on the development, implementation, and evaluation of a participatory method.

Health Trak will be conducted 12 times over a three year period. Each cycle consists of an eight-week process where workers and contractor representatives work together to reduce health risks at their site. Each cycle has three key components, which are shown in Figure 1. The first component is the Health Trak Committee, which must be made up of a numerical majority of non-management personnel. These meetings are one hour each week for each of the eight weeks. Researchers facilitate the meetings while the committee members work together on activities that relate to the process. The second key component is the weekly toolbox meetings, which are 15 minute meetings one day each week. The site's entire workforce attends these meetings. Researchers use these meetings to collect data and distribute information about the process. Participant observation – the third key component – includes observations, interviews, and focus group activities with workers and contractor representatives. This is to solicit feedback

from workers and contractor representatives that may not be directly involved with the committee and also to gain trust, which is critical in a participatory process.

Figure 1. Health Trak Cycle



While the three key components are performed over the eight-week process, they are structured toward Health Trak's four phases. These phases are:

1. Problem identification and definition,
2. Analysis of hazards and strategies for intervention,
3. Implementation of proposed intervention, and
4. Evaluation by participants.

During the problem identification and definition phase, the committee's objectives are to identify health hazards and develop definitions for the problems. The next phase's objectives, analysis of hazards and strategies for intervention, are to analyze and develop solutions for problems identified during the first phase. The implementation phase's objectives are to prioritize and introduce the interventions at the worksite. The final phase's objectives, evaluation by participants, are to evaluate the intervention and the eight-week process.

I. Introduction

Health Trak will be conducted 12 times over the next three years. This report covers the first Health Trak cycle. This cycle involved a union contractor replacing a mile-long section of highway that employed approximately 100 workers, including carpenters, laborers, operating engineers, ironworkers, and electricians performing different work tasks from demolition to finish work. Health Trak's objectives at this site were to:

- develop and implement a participatory method and
- identify potential hazards and implement an intervention.

During this cycle, four workers, two contractor representatives and two researchers made up a Health Trak Committee. Worker and contractor representatives worked together to identify, evaluate, and control a work-related health hazard. The researchers served as facilitators and technical assistants.

As this report will show, the Health Trak Committee's process was successful in conducting participatory research. The committee identified and prioritized a hazard for intervention, although they were unable to implement the chosen intervention. Self-administered pre- and post-Health Trak surveys (see Appendix A) indicated a statistically significant increase in workers' perceptions of dust, noise, and manual materials handling and lifting hazards. This suggests that Health Trak's training and education about construction health hazards, and the researchers' presence may have increased worker awareness. Workers who identify hazards perform the first step to solving work-related health problems.

II. Application of the Methods

Cycle One began with the identification of a likely Health Trak contractor. Because this was a new research process with methods largely unfamiliar to the construction industry and no track record, a contractor was intentionally selected for its good reputation for safety and its past high degree of cooperation with the COHP's other research activities. Researchers explained what Health Trak would require and what it would provide to the company during two separate contractor orientation meetings. When the contractor agreed to participate, the next step was selecting the committee members and negotiating the logistics.

The site safety officer, a former laborer now representing the contractor, chose the committee representatives. He selected himself, a field engineer, a carpenter steward, an operating engineer steward, a laborer steward, and an additional laborer. The corporate health and safety director also attended three committee meetings. Two researchers attended all eight weekly meetings. Committee meetings, which are one of Health Trak's three key components (See Figure 1), were held for one hour each week at the main "change shack." There were two other change shacks on-site, which are trailers that provide workers with a place to take breaks and eat lunch. The committee also performed field activities with co-workers outside the committee using data collection tools developed during the meetings.

Because of the work area's mile long size, the site safety officer held three separate toolbox meetings – the second key component – at the change shacks one afternoon each week. The meeting's objectives were to discuss on-site health and safety issues with the

site's entire workforce. One researcher attended these meetings to discuss Health Trak's progress and to gather feedback from non-committee members.

Participant observation – the third key component – included observations, interviews, and focus group activities with workers and contractor representatives. Before performing any participant observations and before beginning Health Trak, the researchers visited the site three times to become familiar with the site's surroundings and to create relationships with the workers. This was to also encourage workers and contractor representatives to become familiar with the researchers and to gain their trust.

Phase One: Problem identification and definition

The committee first came together during an orientation meeting to learn Health Trak's objectives, and to discuss committee members' roles and responsibilities. Each member received a one-inch binder to use each week for the entire Health Trak cycle. As the participatory process developed, information about the Health Trak process, problem solving tools such as risk mapping handouts, data collection summaries, OSHA standards and state worker laws were added to the binders. As would become significant later on, worker representatives raised concerns regarding the adequacy of sanitary facilities during the orientation meeting. Workers and contractor representatives acknowledged that sanitary conditions were a long standing source of controversy on this site.

During the orientation meeting, and every additional meeting, the hour began with agreement on the agenda, which was written on poster paper and hung on the change shack wall. The wall also featured poster paper with other participatory activities, such as symptom surveys and risk maps, to reinforce learning and facilitate the group process. During the first meeting, the committee vetoed one symptom survey activity called Body Mapping. Although COHP researchers use this activity extensively in training and education, Health Trak committee members expressed that the activity would lead to childish vandalism and gather no useful data. As a result, the committee designed its own poster survey around the question, *"When you wake up in the morning and you put your feet on the floor, what hurts?"*, and a researcher posted it in the three change shacks. Pens were hung on a string next to the survey posters, and one of the outside researchers went to each shack to explain the activity's purpose and to solicit non-committee member participation. The survey received minimal feedback. In the following two weeks, the committee developed similar posters for data collection, and a researcher posted these in the change shacks and explained their purpose during the toolbox meetings. These activities failed to generate a response and the change shack posters evolved into announcements designed to keep non-committee members informed of Health Trak's process. The outside researchers' initial assessment of the public data collection failure was that the form ("flipchart and marker"), which is so familiar to many occupational health professionals, was too alien to construction workers. During the evaluation phase of the cycle, Health Trak worker representatives asserted that resistance resulted from the lack of anonymity and the fear of job loss associated with publicly participating in the discussion of hazards and injuries.

The committee decided that a more private survey method might get more results. They developed a new survey question *"What parts of your body do you feel have or will be*

affected by working in construction?" Foremen distributed copies, which were to be returned during the following toolbox meeting. The objectives of this survey were to increase workers' awareness of health hazards on site and to identify health effects that workers may have suffered or feel they might suffer over their working life. Before the foremen distributed the surveys, a researcher posted the question in the three change shacks to provide workers with the opportunity to think about the question. Before collecting the surveys, a researcher reiterated the importance of this feedback during the weekly toolbox meeting. Ten surveys were returned, about 10% of the workforce. Results were vague, with such responses as everywhere and all over, and the activity yielded no useful results.

An attempt to conduct a participatory site Risk Mapping activity with committee members was also not successful largely due to the size of the site and the wide variety of operations. Risk mapping's objective is to identify site areas and their associated hazards. Although the risk mapping activity probably added to the committee members' overall awareness of health hazards, as designed it was too dense and complicated for an eight week program.

At the end of this phase when committee members listed working conditions that were major health concerns, they identified dust, danger of contaminated water, and inadequate sanitary conditions. As previously mentioned, the committee had raised the sanitary facilities issue during the orientation meeting. However, they were also concerned with the dust created during some of the demolition operations. During participatory observation, a worker, not on the committee, brought a sample of potentially contaminated water to the researchers' attention. It was then introduced to the committee as a potential hazard.

Phase Two: Analysis of hazards and strategies for intervention

The researchers facilitated a discussion by the committee of possible criteria for prioritizing hazards. Criteria identified were the number of workers affected; the importance of solving the problem, and the likelihood of solving the problem.

During this phase, the outside researchers woke up to the reality that the committee wanted to take on the sanitary facilities' issue, a widespread and widely ignored health hazard in construction. On-site sanitary facilities were divided into toilet and washing facilities, which consisted of scattered porta-potties that contained waterless hand cleaner dispensers. The researchers were immediately concerned that that this issue might be beyond the committee's capacity for intervention and that the selection of such a politically touchy issue would certainly lead to difficulties for the outside researchers who had access to the committee only through the contractor's permission. At this point the researchers panicked and wasted a week trying to manipulate the Health Trak Committee into choosing dust as the hazard for intervention. However, the committee would not be swayed and the researchers came to their senses, recognized the importance of the Committee's concerns and allowed the participatory process to go forward.

The committee members explored a number of issues with respect to improving the sanitary facilities. These included hygiene, respect, contractor attitudes, cost, compliance and maintenance. They fully discussed the difficulty of attaining flushing toilets and

running water, but still decided to pursue it. All members of the committee – contractor representatives, workers, and the outside researchers – agreed to pursue sanitary issues as the Health Trak intervention.

Over the next two meetings the committee strategized on how to improve the sanitary facilities. To further understand the health risks associated with these inadequate facilities, the researchers provided committee members with a recent Massachusetts Medical Society Publication, which detailed the importance of hand washing to individuals and public health. (See Appendix B.) The Committee also undertook their own research when they sent one member off to a nearby building trades council for a copy of a state law which they believed might prove that the facilities were required. Unfortunately, the law, which was very strong and explicit, had been superseded in 1970 by OSHA's more vague provisions.

Flush toilets and running water for handwashing have not generally been available in construction in this region, but workers and contractor representatives spoke frequently of the high quality sanitary facilities at a new sewer treatment plant being built nearby. Everyone had worked there or knew people who had worked there. Contractor objections, raised in the committee by the contractor representatives, were that sanitary facilities of this quality are too difficult and expensive to build and maintain, although workers knew from the sewer treatment plant that it could be done. Although constructing and maintaining these facilities appeared difficult, the committee thought it was possible to construct semi-permanent sanitary facilities consisting of running water and flushing toilets because they were performing utility relocation work. Workers' past experiences and Health Trak raised expectations that facilities of this quality should be more widely available. Since the committee knew it would be more difficult to improve the toilet facilities than the washing facilities, they opted to first address this larger and more complicated issue, believing that if the contractor did not respond with improvements, the committee could settle for running water for handwashing.

Phase Three: Implementation of proposed intervention

The committee's intervention strategy for improving sanitary facilities relied on displaying the health issue's importance to the contractor's upper level management.

First, the contractor's safety director attended a Health Trak meeting. He agreed with committee members on the importance and justice of the issue, but said it was too expensive, the job was not bid with flush toilets and running water, running water and flush toilets were not required by law, and the owner of the project should be held responsible. By removing the contractor's responsibility, the safety director believed the project owner would increase the contractor's funding through a change order. Requesting change orders sometimes provides additional funds to solve unidentified problems that were not addressed in the contract's initial bid.

Second, the committee sent a worker representative, joined by the contractor safety director and the outside researchers, to meet with owner representatives at a research advisory meeting. These research advisory meetings are used to guide the COHP's research activities. After demonstrating the difficulties through role playing, the Health Trak representative read a statement from the Committee and discussed the need for

improved sanitary facilities. (See Appendix C.) The owners' representatives referred the matter to a project-wide safety committee.

Third, committee members informally investigated state and federal compliance standards. There is some ambiguity regarding toilet facilities, but clearly 29 CFR 1926.51 requires employers to provide workers with the opportunity to wash their hands during the workday. The committee also discovered that this legal requirement is widely ignored through an informal agreement termed "acceptable area practice." In the past year, the Occupational Safety and Health Administration (OSHA) has issued only one citation in this region for inadequate sanitary facilities in highway and street construction. No monetary penalty was assessed.

Finally, the committee fell back to a position that, if it could not attain improved toilet facilities, water should at least be provided for hand washing. During the fifth week a contractor representative promised to provide sanitizing hand towels immediately. They had not yet been made available as of September 17, 1997.

Through the implementation phase, the Health Trak Committee was given many reasons why sanitary conditions could not be improved. The committee distilled the reasons down to two:

- the company's concern for costs
- "acceptable area practice"

These two obstacles reinforce each other. No contractor wants to spend additional funds to improve sanitary facilities unless all their competitors also spend for the same purpose. OSHA's unspoken policy of "acceptable area practice" allows all contractors in the area to be equally out of compliance.

By week seven, it was clear that the intervention would not be successful. Contractor representatives stopped coming to committee meetings, and the committee members and the outside researchers became discouraged. Lack of success was especially discouraging to worker representatives who, at an earlier phase, took a great risk participating in this process. Participating had a negative impact on one of the workers who spoke of a previous health problem related to work during the sixth meeting. The next morning contractor representatives called the committee member into a meeting and questioned his health status. At that time, his union representative cautioned him never to discuss previous health problems.

Phase Four: Evaluation by the Committee

At the final meeting, neither the site safety officer nor the field engineer were present. Therefore, only workers and researchers evaluated Health Trak's success. The participants were asked two open-ended questions: What was helpful in the Health Trak process and what should be changed next cycle? Although disappointed with the lack of a successful intervention, the group reported overall satisfaction with the process. Most of what was helpful concerned the Health Trak process, whereas most of what the Committee representatives recommended for change focused on the lack of an intervention. Highlights of the discussion are presented below.

What was Helpful

As previously mentioned, developing a participatory process was the most important objective of the eight-week cycle. Such a process is designed to allow workers and contractor representatives to work together to solve health-related problems on-site, after the researchers leave.

The committee identified communication between all members, even though they had different backgrounds (i.e., workers, contractor representatives, researchers), as a key to success during the Health Trak process. Since meetings took place in the workers' area (change shacks), potential repercussions to workers from this communication were less threatening. Communication was honest and candid, creating trust within the committee, which increased participation.

The committee's participation (mostly from the workers) steered the process when they began performing research during the fifth week. By researching construction sanitary standards and laws, the workers informed the researchers and the contractor representatives about certain requirements that needed to be followed. Since a researcher reiterated these requirements during a toolbox meeting, the workers on the committee stated that it helped educate on-site workers about what should be available.

What Could Change

Company concerns for costs and acceptable area practice were identified as the major intervention obstacles. From the worker's perspective, these main obstacles can not be ignored. Therefore, the workers stated that Health Trak must involve active support and participation from the project superintendent. Unlike the health and safety officer, the superintendent has the authority to make decisions. Without directly confronting the individual who can make change happen, a decision will always be passed around the organization.

More active participation from on-site workers is also necessary. The lack of participation in surveys and information gathering may have resulted from the minimal contact with on-site workers, which only consisted of small focus groups and toolbox meetings. Because of this, toolbox meetings need to involve more training and education, as opposed to updating sessions. For example, information about the variety of health hazards in construction should be posted in every change shack. This was done to a certain extent, but detailed explanations were not given to on-site workers. Focus groups, conversations, and more detailed information about the change shack postings may have provided more detail about the process, which may have created more ownership in the activities for on-site workers.

More ownership by the unions may have increased support from the business agents and created additional leverage to improving the sanitary facilities when approaching the owners. However, workers stated that jurisdictional issues (situations that require union representation to intervene when members perform job tasks out of their trade's job description) are the priority. Therefore, union representatives are less likely to devote their time to change something that has always been "acceptable area practice."

Although extremely important to the committee and on-site workers, the sanitary facilities' hazard was too large of an issue to address during this first cycle. It is important to prioritize hazards by their severity and the likelihood of reduction or elimination early

on, perhaps through an activity that creates a better understanding of potential obstacles. In this situation, it would have been useful to separate the issue into washing and toilet facilities early in the cycle. This could have allowed the committee to focus solely on washing facilities, while giving up on toilet facilities. Additionally, identifying other cost-effective approaches, such as sanitizing towels, might have provided an intervention which the Committee could claim as a success.

III. Evaluation of the Participatory Method

The researchers assessed Health Trak's effectiveness against its objectives, which were to:

- develop and implement a participatory method; and
- identify a hazard and implement an intervention.

Researchers used two qualitative tools and one quantitative tool to evaluate Cycle One, and to gather data for a long-term summative evaluation of all twelve cycles.

1. Participant Evaluation (qualitative)
2. Pre- and post-surveys from on-site workers (quantitative)
3. Site walk-throughs by an external health and safety expert (qualitative)

Participant Evaluation

As discussed above, researchers asked committee members open-ended questions about Health Trak's overall effectiveness. The objectives were to gauge the cycle's effectiveness and gather feedback for improvement. Although disappointed with the lack of a successful intervention, the Health Trak Committee members reported satisfaction with the process.

The participatory process is often messy and unpredictable. While this can be frustrating to all involved, the researchers learned from the difficulty in identifying an intervention that allowing the committee to control the process is an important part of Health Trak's design. Only when committee members gain the opportunity to identify risks involved in their jobs and work toward eliminating the ones most important to them can real change occur. Because this process continues to grow, it is difficult to capture its full development so soon after the end of the cycle.

Pre- and Post-surveys From On-site Workers

Identical pre- and post-Health Trak surveys were used to assess the effectiveness of the Health Trak process. (See Appendix A.) These self-administered surveys were completed by on-site workers before and after the eight-week cycle. Fourteen of 20, randomly selected, on-site workers filled out a pre-Health Trak survey. Eleven of 15, randomly selected, on-site workers completed the post-Health Trak survey. No surveys were completed by contractor representatives.

The objective was to compare perceptions of construction-related health hazards before and after the eight-week cycle. The health hazards of interest were noise, dust, stress, manual materials handling, chemicals, weather conditions, and sanitation. The questions specifically probed perceptions of how hazardous these problems were to their health, their co-workers' and contractor's concerns for reducing these health hazards, and how much could be done to reduce these hazards. To compare perceptions, parametric two-sample t-tests were conducted. The results yielded a statistically significant increase

between the means of how hazardous certain working conditions were to their health for three of the seven hazard categories: noise ($p < .05$); dust ($p < .02$); and manual materials handling and lifting ($p < .02$). Perhaps because of the small sample size, the remaining four conditions did not yield any statistically significant results. The small sample size may have also affected the other questions (e.g., co-worker's concern), which yielded no statistically significant results for any of the seven conditions.

Pre- and Post-site Walkthroughs by an External Health and Safety Expert

An external health and safety expert also conducted a pre- and post-Health Trak survey. The external health and safety expert evaluates fatalities in the state of Massachusetts for the Massachusetts Department of Public Health. The evaluation objective was identical to the self-administered survey. However, the expert subjectively assessed the workers' perceptions through conversations using the survey form as a guide.

In the pre-Health Trak survey, 12 tradesworkers and two foremen (all with prior health and safety training) were asked various questions drawn from the written survey, but every worker was not asked each question. The results suggested that workers perceived dust to be very hazardous to their health, but they did not perceive inadequate sanitary conditions as very hazardous to their health. Additionally, they did not perceive the contractor and workers to be very concerned about reducing manual materials handling and lifting on site.

In the post-Health Trak survey eight tradesworkers with previous health and safety training were asked questions in the same format as the pre-Health Trak survey. Most thought that the noise problem in construction had improved over the years, although no one wore hearing protection. They felt the majority of the noise came from the nearby highway. These workers did not believe dust, chemicals, stress, manual materials handling or weather to be problems at their work site. They expressed that dust, inclement weather and manual materials handling were "just part of the job."

The major difference between the pre- and post-Health Trak surveys was the workers' perceptions of dust hazards. This may have resulted from the demolition work that was taking place during the beginning of the cycle, which had ceased by the end of the cycle. Additionally, while workers were unclear before and after the cycle why the sanitary facilities were a health issue, the post-Health Trak survey indicated that they believed they should have access to better facilities. They also mentioned that the contractor was doing the best it could to provide better facilities, but the cost was too great.

Health Trak Evaluation Summary

The participant evaluation indicates that Health Trak meetings were successful for the committee. The two other key components, participant observation and toolbox meetings, were less successful. Since the self-administered and expert health and safety surveys failed to identify sanitary conditions as a health problem, the researchers believe the surveys will only effectively evaluate the Health Trak process if the participant observation and the toolbox meetings are more successful. However, if larger sample sizes were possible for the surveys, they may be more likely to accurately evaluate the process. Although a larger sample size is desired, administering these surveys is complicated by the work schedule that does not allow workers to participate while on company time, while it

is also difficult to solicit information during the workers' break time. Therefore, the participant evaluation provides the best evaluation for improving both process and the intervention strategy.

IV. Conclusion

The Health Trak process was successful from the participatory perspective, even though the researchers miscalculated the level of participation for the committee. These miscalculations included the time it would take the committee to identify a hazard, how well they would work together and how they would work outside the committee.

After clarifying the distinction between safety and health in the orientation meeting, workers had little difficulty identifying health hazards. While its importance was unclear to the researchers during the first meeting, sanitary facilities became the focus over the eight weeks. After identifying the hazard, both worker and contractor representatives worked together on the issue in a participatory process.

Early in the cycle, the researchers intended on having workers conduct research activities with on-site workers. However, the group performed unexpected research instead by examining OSHA regulations, and pursuing a business agent for literature and information about state regulations. Therefore, without committee members working closer with on-site employees, as intended, the participant observation component was less successful and possibly a reason for little participation in public data collection activities (e.g., symptom surveys in the change shacks). The committee identified fear and retaliation of job loss as the problem because on-site workers were less trustful of the process and had little understanding of the company's support for this research. Even though participant observation was lower than expected, educating and updating workers during the toolbox meetings increased workers' awareness of the risks involved in their work. The statistically significant increase in workers' perceptions of how hazardous noise, dust, and lifting and manual materials handling are to their health is the first step toward a participatory process of reducing risks.

Although there was company support, the committee identified two major interrelated obstacles for improving sanitary facilities.

- the company's concern for costs
- acceptable area practice

As these intervention obstacles became more evident over the eight weeks, the contractor representatives' participation dropped and the workers' participation controlled the process, with worker attendance (70%) at committee meetings greater than the contractor representatives (50%). Because there was no contractor representation, fear of retribution was minimal and the workers freely discussed cost concerns and acceptable area practice as obstacles to change in construction. Researchers were well aware of cost concerns; however, they were unaware the project superintendent controlled financing. The superintendent also had significant input in the daily activities of the site's workforce. Both worker and contractor representatives, during the implementation phase, suggested this may be different under another superintendent. After experiencing the contractor representatives' decreased participation and attendance, and the financial decision process,

the researchers believe they need to involve higher levels of the contractor's management in the Health Trak process.

Clearly, contractors' aim is to make money and their decision makers must allocate funds appropriately. However, this makes it difficult to justify interventions that reduce health-related risks for workers who typically work for several different employers each year. Additionally, illnesses from inadequate sanitary facilities are more difficult to attribute to the work environment than an acute injury. Because contractor representatives seldom use facilities on-site, but have access to clean facilities in offices, they are less likely to experience an illness that may keep them out of work, which would cost the company lost production time. On the other hand, tradespeople receive no compensation for a missed day of work, creating only indirect costs such as decreased employee satisfaction. The work is either done without them, or another worker is called in from the union hall. As one committee member stated "there will always be these types of problems. It is not about how to change, but how to do it cheaply." For this reason, there is not a great deal of support from the unions. There are hundreds of unemployed workers back in the union halls waiting to work. Business agents and unemployed workers are more concerned with gaining future employment than better sanitary facilities. In addition, some believe that workers who are employed are making plenty of money and no one told them to get into this business. If they complain about the situation, there will always be an unemployed worker to take their place. Therefore, the financial incentive to improve these conditions that may lead to negative health outcome is minimal.

V. Lessons Learned

The eight-week participatory process provided valuable insight for future Health Trak Cycles. The researchers have a better understanding of how a Health Trak Committee can become capable and motivated to conduct research. This involves contractor support, union support, and the ability to freely express their ideas. Without these, standard participatory research methods, such as surveys and group interviews, will threaten job security to the workers on the committee. Excluding the project superintendent may provide the opportunity to freely express ideas, but if it reduces the superintendent's interest it may eventually hinder the process. In this cycle, the superintendent's exclusion from the project was critical to Health Trak's inability to succeed with its prioritized intervention. Because the contractor's upper level of management had little understanding or concern for the scientific justification for improving the sanitary facilities, financial interests prevailed as the decision-making criteria.

In this cycle, company concerns for costs and acceptable area practice were identified as two major obstacles for change. This raises as many questions as it answers for reducing risks. The next cycle will try to answer how much the superintendent should be involved, the power balance between the ability to make financial decisions and the employment position within the company, and how far the safety officer/director can proceed with change.

Health Trak has some design problems that must be addressed in future cycles:

- Participatory activities are often resisted by small groups because there is not enough "safety in numbers." This phenomenon was intensified where workers feared

management repercussions from participating. The contradiction of a small committee and Health Trak's reliance on participatory methods will need to be more closely examined.

- Researchers naively ignored the possibility that participants might have already identified their hazard. We know better now and will integrate that knowledge into future attempts.
- Opening up the 8-week Health Trak process to all potential hazards was much too big and ambitious. The focus will be narrowed in the future.
- Health Trak's reliance on toolbox meetings as a means of communication with greater numbers of workers on-site unexpectedly proved to be more difficult to accomplish than Committee meetings. Toolbox meetings are the main means of communication for the site safety officer and he was reluctant to give up as much of his time as the researchers wanted. This problem will be addressed in future cycles.

As the researchers learned, the statistically significant increase in hazard recognition, through training and education, provided workers with a first step toward solving problems. However, this level of access for site-specific training and education can not be achieved if the two major obstacles are not acknowledged and addressed because of the political pressure involved with the process.

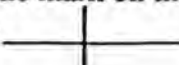
UPDATE ON SANITARY FACILITIES

ON AUGUST 2, 1997, A MEETING TOOK PLACE BETWEEN THE HEALTH AND SAFETY DIRECTOR OF THE PROJECT MANAGEMENT AND ALL SITE SAFETY OFFICERS. DURING THIS MEETING THE DIRECTOR EXPLAINED THAT EACH CONTRACTOR WAS TO SUPPLY WORKERS WITH NON-POTABLE HAND WASHING WATER. NO GUIDELINES WERE GIVEN, BUT CONTRACTORS WERE TOLD THEY MUST BEGIN IMPROVING THESE CONDITIONS AS SOON AS POSSIBLE. IN ADDITION, EACH WORKSITE MUST CONTAIN SEMI-PERMANENT TOILET FACILITIES FOR THOSE WORKERS AT PERMANENTLY STATIONED WORKSITES. A MEMO WAS SENT TO ALL CONTRACTORS INSTRUCTING THEM TO COMPLY WITH OSHA REGULATIONS REGARDING SANITARY AND HANDWASHING FACILITIES. (See Appendix D).

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Appendix A: Pre- and post-Health Trak Evaluation

Answer each of the following questions by placing a tic mark on the line that best represents your opinion. For Example 

- | | | |
|---|------------|-------|
| 1. How hazardous is <u>noise</u> to employee health? | _____ | |
| | Not at All | Very |
| 2. How concerned is management about reducing noise on site? | _____ | |
| | Not at All | Very |
| 3. How concerned are co-workers about reducing noise on site? | _____ | |
| | Not at All | Very |
| 4. How much can be done to reduce noise in construction? | _____ | |
| | Nothing | A Lot |
| 5. How hazardous is <u>dust</u> to employee health? | _____ | |
| | Not at All | Very |
| 6. How concerned is management about reducing dust on site? | _____ | |
| | Not at All | Very |
| 7. How concerned are co-workers about reducing dust on site? | _____ | |
| | Not at All | Very |
| 8. How much can be done to reduce dust in construction? | _____ | |
| | Nothing | A Lot |
| 9. How hazardous is <u>stress</u> to employee health? | _____ | |
| | Not at All | Very |
| 10. How concerned is management about reducing stress on site? | _____ | |
| | Not at All | Very |
| 11. How concerned are co-workers about reducing stress on site? | _____ | |
| | Not at All | Very |
| 12. How much can be done to reduce stress in construction? | _____ | |
| | Nothing | A Lot |
| 13. How hazardous is <u>lifting and manual materials handling</u> to employee health? | _____ | |
| | Not at All | Very |
| 14. How concerned is management about reducing lifting and manual materials handling on site? | _____ | |
| | Not at All | Very |

15. How concerned are co-workers about reducing lifting and manual materials handling on site?	_____	Not at All	Very
16. How much can be done to reduce lifting and manual materials handling in construction?	_____	Nothing	A Lot
17. How hazardous are <u>chemicals</u> to employee health?	_____	Not at All	Very
18. How concerned is management about reducing chemicals hazards on site?	_____	Not at All	Very
19. How concerned are co-workers about reducing chemicals hazards on site?	_____	Not at All	Very
20. How much can be done to reduce chemicals hazards in construction?	_____	Nothing	A Lot
21. How hazardous is <u>weather</u> to employee health?	_____	Not at All	Very
22. How concerned is management about weather hazards on site?	_____	Not at All	Very
23. How concerned are co-workers about weather hazards on site?	_____	Not at All	Very
24. How much can be done about weather hazards in construction?	_____	Nothing	A Lot
25. How hazardous are <u>sanitary</u> hazards to employee health?	_____	Not at All	Very
26. How concerned is management about reducing sanitary hazards on site?	_____	Not at All	Very
27. How concerned are co-workers about reducing sanitary hazards on site?	_____	Not at All	Very
28. How much can be done to reduce sanitary hazards in construction?	_____	Nothing	A Lot
29. How concerned is your present employer about your health?	_____	Not at All	Very

Appendix C: Committee Member's Statement

The scenario you have just been presented with is what we live 8 hours a day, 5 days a week. We are amazed that in 1997, in the city of Boston, we are forced to use the same so-called sanitary facilities that have been around for hundreds of years. In this day of infectious diseases and flesh eating viruses, the idea that we can not have flushing toilets, and hot and cold running water to wash with, is uncomprehendable.

CFR 1926.51 states that:

- if a job site is not provided with a sanitary sewer, then a chemical toilet or any other type of holding tank must be used.
- Lavatories shall be made available in all places of employment, but especially in places where contaminants may be harmful to the employees.

We are handling forms coated with oil. Mechanics are handling hydraulic fluids and diesel fuel. We are all exposed to the dust and dirt, much of which is being trucked to a hazardous waste incinerator to be dumped. We need to be able to wash these contaminants from our hands before we eat lunch and before we get into our vehicles, so we do not infect ourselves and our families.

The contractor tells us that there was nothing in the specs about flushing toilets and running water, so the job wasn't bid with these items in mind. I find it funny that the job office has these modern day conveniences. I am assuming something was in the specs for management to have these amenities. My first reaction was to have the men use the office facilities. Because the office is not on the job site and with the amount of time it would take to get the men there, I was concerned that this might be construed as a work stoppage or slowdown, which is spelled out in the project worker agreement. So I explained to the men that they would have to use these antiquated facilities until we were able to gain more respect and common decency from the contractor.

I have been a steward for almost 12 years. My experience and knowledge are that when the water and sewer connection are brought into the site, a temporary lavatory is built. I understand that the artery is road work, and not a high rise, but I am intrigued by the different conditions that each separate contractor has on the artery.

One site about a mile north of the project has at least 2 lavatory facilities. Just north of that project is another company with the same set up as our sanitary facility. If their chemical toilets had blown over during the last storm we had, as ours did, and there was human excrement all over the sidewalk in the downtown area, do you think those chemical toilets would still be there? I believe they would all be yanked out and a lavatory would be set up immediately.

Downtown workers have other options. There are restaurants, coffee shops, and occasional bars that have public facilities. At our site, those public facilities are few and far between. I am assuming that the options on the night shift downtown are limited, with many places being closed. So I see this being a problem for the duration of the artery project.

I understand that the project overseer is about to implement a drug testing policy. I have not been told any details about this. If they are able to accomplish this now that the work has already begun and several contracts have been completed, I am sure they will be able to implement some sort of change order. This can be reimbursement for the lavatory expenses that were not foreseen. By doing this, they will be showing the work force that they are just as important and necessary as management. This will also ensure a healthier work place with less lost time due to illness. I hope that you can direct us as to whom we should see, so that we may expedite this procedure.

APPENDIX D.

Health Trak Cycle 2 Final Report: A Participatory Approach to Reducing Risks in Construction



Technical Report

Health Trak: A participatory approach to
reducing risks in construction

Report on Cycle 2: June - August 1997

By Joel Garrett & Dana Hanson

July 8, 1998

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I. EXECUTIVE SUMMARY

Health Trak Cycle Two was conducted with a union contractor performing utility relocation work on a large urban highway construction project. The cycle lasted eight weeks between June and August, 1997. Approximately 75 workers, including laborers, operating engineers, tunnelers, and pile drivers, were present on site during the course of the cycle. A laborer steward, a laborer, an operating engineer, the site safety manager, the project owner's environmental health and safety representative, and two university researchers comprised the Health Trak Committee. The aim of this cycle was to have workers and supervisors work on a participatory research project to identify, mitigate, and evaluate the intervention for an ergonomic hazard on site.

Through Health Trak Committee meetings, Toolbox meetings, and Participant Observations, several existing health hazards were identified on site. Of these, six specific hazards were targeted for intervention by the Committee. By the end of the cycle, only two received complete interventions. The final intervention status of all six hazards is summarized in Table 1.

Table 1: Identified Health Risks, Desired Interventions, and Final Status		
Identified Health Risk	Desired Intervention	Final Status
Manually carrying compressor jacks and oxygen acetylene tanks	Acquisition of more manual material handling aids	Two handtrucks were purchased and introduced on site.
Poor working surfaces	Leveling of work surfaces with heavy machinery	Surfaces were leveled on site.
Unsanitary handwashing facilities	Introduction of 4 handwashing stations	One prototype station was designed using a 35-gallon drum and a hand-pump extending from the top. However it was never fully completed or introduced on site.
Inadequate signalmen's skills	Provision of signalman training to everyone	Training did not take place by the end of the cycle although the safety manager had promised it.
Low staffing levels led to manual material handling hazards	Education of foremen on ergonomic risk factors so they would allow workers an extra few minutes to perform their duties	Foremen were encouraged to complete a participatory health and safety audit with workers to identify potential hazards on site; however, they did not do it.
Inadequate wheel-well pulley systems for raising and lowering materials into pits	Improvement to existing wheel well systems and/or acquisition of new systems	Redesign recommendations were made; however, they were not implemented. At the end of the cycle, no improvement to the wheel wells had been made.

One of the strengths of this cycle was that the Committee and workers attending Toolbox meetings generated many ideas for solutions to potential health hazards on site. However, because Committee members were not an established group of leaders (such as stewards or foremen), they were limited in their ability to implement these changes on site. Through this Health Trak cycle, it became clear that the existing organizational hierarchy of the construction industry makes it difficult for rank-and-file Committee members to bring about change. Instead, this Committee's approach to implementing controls on site was necessarily limited to "local" efforts that were not supported by project management.

*Participants' evaluation of the participatory process indicated that two of the three Health Trak components were highly successful—Committee meetings and Toolbox sessions. The third component, Participant Observation, was less successful.

The major lesson learned from this Health Trak cycle is that the composition of the Committee is likely to have an impact on whether recommended interventions are ultimately implemented on site. Specifically, this Health Trak Committee lacked in its ability to negotiate the construction organizational hierarchy in a productive manner. Without the involvement of those players who have a more solidified leadership position on site, such as stewards and foremen, the main Health Trak objective of creating an internal structure to identify and reduce health risks was not fully recognized.

II. BACKGROUND ON HEALTH TRAK

Health Trak is a participatory research project within the Construction Occupational Health Project (COHP) of the Department of Work Environment at the University of Massachusetts Lowell. It is an eight-week process designed to enhance workers' and contractor representatives' capacity to identify and remedy health hazards on construction sites.

Health Trak operates using participatory research methods that are "learner-centered", which were developed in the field of education. They have been adapted to research under the names of participatory action research (PAR) and action research (AR). PAR studies combine research and intervention in single studies and transform research subjects into participants in the process.

Each Health Trak cycle consists of an eight-week program where workers and contractor representatives work together to reduce health risks at their site. Each cycle has three key components:

- **Health Trak Committee Meetings.** One hour each week for each of the eight weeks. The Committee is comprised of 6 to 8 participants and must be made up of a numerical majority of non-management personnel. Researchers facilitate the meetings while the Committee members work together on activities that relate to the process.
- **Weekly Toolbox Meetings.** Fifteen minute meetings one day each week. The site's entire workforce attends these meetings. Researchers use these meetings to collect data and distribute information about the process.
- **Participant Observation.** Includes observations, interviews and focus group activities with workers and contractor representatives. The purpose is to solicit feedback from workers and contractor representatives that may not be directly involved with the Committee; and also to gain trust, which is critical in a participatory process.

While the three key components are performed over the eight-week process, they are structured toward Health Trak's four phases: 1) Problem identification and definition, 2) Analysis of hazards and strategies for intervention 3) Implementation of proposed intervention, and 4) Evaluation by participants.

During the problem identification and definition phase, the Committee's objectives are to identify health hazards and develop definitions for the problems. The next phase's objectives, analysis of hazards and strategies for intervention, are to analyze and develop solutions for problems identified during the first phase. The implementation phase's objectives are to prioritize and introduce interventions at the worksite. The final phase's objective, evaluation by participants, is to evaluate the intervention and the eight-week process.

.III. RECRUITMENT PROCESS AND SITE DESCRIPTION

This cycle was conducted with a union contractor performing utility relocation work on a large urban highway construction project. Because Health Trak was still unfamiliar to most contractors in the city—and to the construction industry as a whole—the contractor was intentionally selected for its good reputation for safety and its past high degree of cooperation with the COHP's other research activities. Researchers explained what Health Trak would require and what it would provide to the company during an orientation meeting with the site safety manager. The safety manager then requested and received permission from the project manager.

Before beginning the 8-week Health Trak cycle, the researchers conducted two site visits to become familiar with the site's surroundings and to create relationships with the workers. This was to also encourage workers and contractor representatives to become familiar with the researchers and to gain their trust, which is critical in a participatory process. During the second visit, one researcher and an external health and safety expert conducted pre-Health Trak surveys to measure workers' perceptions of on-site health hazards, their co-workers' and contractor's concern to reduce hazards, and how much could be done to reduce the hazards. The surveys contained seven hazard categories including noise, dust, stress, manual materials handling, chemicals, weather and sanitary conditions. (See Appendix A.).

The site safety manager, an individual with over 20 years of safety experience, chose the Health Trak Committee representatives: a laborer steward, a laborer, an operating engineer, the project owner's environmental health and safety representative, and two university researchers. Committee members attended one-hour weekly meetings at their construction project's field office for eight consecutive weeks. Additionally, the Committee performed field activities with co-workers using data collection tools developed during the meetings.

Once a week, the safety manager conducted Toolbox meetings with the remaining 70 worker and contractor representatives on site. Researchers participated in these Toolbox meetings by discussing ergonomic issues and conducting activities related to the Committee's progress.

The next four sections of this report will outline the specific activities undertaken during the various phases of the eight week Health Trak cycle.

IV. CYCLE DESCRIPTION

This section will present a week-by-week summary of activities conducted during the Health Trak cycle, followed by an evaluation of whether each of the four Health Trak phase's objectives were met.

Week 1 Health Trak Activities, June 16-20, 1997	
Toolbox (Tuesday)	• Introductions and discussion of Health Trak's main objectives. • Emphasis on the importance of the participatory process.
Committee (Thursday)	• Pre-Health Trak survey distributed to measure perceptions. • Main objectives of COHP and Health Trak discussed. • Activity: Miniature body map where Committee identified those body areas where they have felt pain due to work. • Activity: Discussion of the six ergonomic risk factors.
Commentary on Week 1 The information covered in the Toolbox meeting was limited by time constraints; this would be a persistent challenge during this Health Trak cycle. Furthermore, the setting for Toolbox meetings was an open outdoor area in a busy downtown section of the city, which also posed a challenge to running participatory activities. The risk-mapping activity in the Committee meeting elicited high participation from all members, with the exception of the safety manager. Almost every part of the body was identified as having experienced work-related pain.	

Week 2 Health Trak Activities, June 23-27, 1997	
Toolbox (Thursday)	• Brief presentation of the 6 ergonomic risk factors. Lecture format with open-ended questions.
Committee (Friday)	• Review of the previous week's body map of pain. Discussion of the concept of ergonomic "risk factors". • Activity: Listing job factors that could promote problems identified in the body mapping activity. These factors were then matched with technical terms introduced the previous week. • Activity: Participants were asked to analyze specific jobs according to the following framework: major operation, typical tasks, risk factors, and target areas of the body affected. Responses were recorded on newsprint matrices. • Copies of an ergonomic checklist were handed out. These were to be reviewed by Committee members before the following week's Participant Observation walkthrough.
Commentary on Week 2 The information covered in the Toolbox meeting was once again limited by time constraints. During this week's activities, the Committee identified the following risk factors present on site: lifting oxygen acetylene canisters, repetitive shoveling, pressure from rushing work, and general exposures from noise, fumes, and hot temperatures. In addition, inadequate sanitary conditions were identified, but the Committee decided that this topic was beyond the scope of the project at the time. Time ran out on the Committee meeting before the second activity was completed.	

Week 3 Health Trak Activities, June 30-July 3, 1997	
Participant Observation (Wednesday)	• The safety manager and a researcher conducted a walkthrough using the ergonomic checklist distributed at the previous week's Committee meeting.
Toolbox (Wednesday)	• Researchers presented the site health hazards identified by Committee members in the 2nd Committee meeting.
Committee (Thursday)	• Committee members viewed a video on ergonomics in construction. • Researchers presented a summary of the data collected during the walkthrough session earlier in the week. • The Committee divided the findings into two categories: positive work practices currently taking place and work practices that could change. • Researchers introduced a new activity for the following week, Ergonomic Risk Factor Analysis. The activity's objective was to begin analyzing and prioritizing the ergonomic risk factors on site by considering how many people were affected, the seriousness of the hazard, and the likelihood of reducing the hazard.
Commentary on Week 3 This was the third Toolbox meeting where researchers felt compelled to conduct the meeting in a lecture format due to time constraints. Based on data from the Participant Observation site walkthrough, the Committee identified the following positive factors occurring on site: encouragement to get help from others when lifting, availability of a few hand trucks to assist with transporting heavy materials, delivery of heavy materials close to work areas, and freedom to report negative health symptoms to supervisors. It was noted that positive work practices on site had been reinforced by the ergonomics training that had been taking place in Committee and Toolbox meetings. Factors to change included reducing heavy lifting, relocating materials to waist level, improving working surfaces, and improving signalmen's skills.	

Week 4 Health Trak Activities, July 7-11, 1997

Participant Observation (Monday)	Ergonomic Risk Factor Analysis was conducted by Committee Members.
Toolbox	No meeting this week due to time constraints.
Committee (Friday)	- Researchers presented the results from the Committee's Risk Factor Analysis. - The Committee separated the hazards into two main sections: 1) low staffing levels/rotation and manual material handling (MMH), and 2) operating engineer tasks. - The Committee began ranking the tasks for intervention and developing a game plan for possible actions to be taken.

Commentary on Week 4

Researchers learned that they would be unable to conduct a Toolbox meeting early in the week.

In compiling the data from the Risk Factor Analysis, Committee members identified two major risk categories:

- 1) **Staffing levels/rotation and manual material handling:** constant heavy lifting, carrying compressor jacks and oxygen acetylene tanks, pushing and pulling while performing most work tasks, and repetitive jackhammering inside the jacking/receiving pits.
- 2) **Operating engineer tasks:** ergonomic deficiencies from sitting all day and controlling machinery as well as psychosocial problems from consistent concentration on job tasks to ensure the safety of work area personnel.

In order to introduce interventions for these hazards, the Committee needed to identify the information flow within the company. It was determined that most information is funneled through the following pathway: Project Manager → Superintendent → General Foreman → Foreman → Worker. The Committee then began to formulate preliminary strategies for addressing the health risks that had been identified:

- The safety manager said he would provide signalmen training to everyone to reduce hazards from engineering operator tasks.
- The Committee recognized that increasing staffing levels to reduce MMH hazards would present a considerable cost increase for the company; therefore, they decided that an alternative strategy might be to educate foremen about various risk factors so they would allow workers an extra few minutes to perform their duties.
- The Committee decided to look into the possibility of leveling working surfaces with heavy equipment and obtaining lifting aids for MMH tasks.
- Three Committee members committed to working independently on handwashing facilities during the following week. This was an issue originally raised in the 2nd Committee meeting.

Week 5 Health Trak Activities, July 14-18, 1997

Toolbox (Thursday)	- Continued education on ergonomics—workers were told that sprains and strains can be reduced by use of lifting aids. - Activity: Workers were asked specific questions about what types of lifting aids were needed on site, the adequacy of working surfaces, and their satisfaction with existing handwashing facilities.
Committee (Friday)	- Activity: The researchers asked the following questions about the previous day's Toolbox meeting: "What worked?" and "What are your suggestions?" - The researchers asked the Committee to think about the specific actions to be taken to remedy the concerns raised by the workers. - The Committee decided on three specific intervention activities to work on in the time between this meeting and the next.

Commentary on Week 5

Week 5 of Health Trak is supposed to be the week where a specific intervention is introduced on site, and is intended to mark the beginning of Phase Three of the cycle. This cycle was running behind schedule.

This was the first week where the Toolbox meeting included a participatory activity. The two main areas where workers cited a need for improvements were availability of lifting aids and improvement to working surfaces. In particular, workers cited a new issue regarding lifting aids on site—inadequate wheel well pulley systems for pits.

During the Committee's evaluation of the participatory Toolbox activity, a laborer representative noted that the process was good, but that it could have been better if there was more participation. The issue came up that the location of the Toolbox meeting in the busy downtown area was not always conducive to effective communication. The safety manager defended this program format.

With new input from the workers who participated in the hazard identification activity in the Toolbox meeting, the Committee again tried to prioritize worksite hazards and develop plans for implementing controls. They decided on three specific issues to be addressed: handtrucks, wheel well systems, and working surfaces. Three implementation strategies would be pursued:

- 1) Handtrucks were being ordered by the safety manager.
- 2) A laborer and researcher would work on a design for improved wheel well systems.
- 3) The Committee would look into improving the working surfaces at each of the work sites.

Week 6 Health Trak Activities, July 21-25, 1997

Toolbox (Thursday)	• Activity: Workers broke into four specific worksite groups to evaluate the importance of the three issues the Committee was planning on addressing (handwashing, wheel wells, and working surfaces). On large newsprint, workers were asked to evaluate how important these issues were at the specific job sites.
Committee (Friday)	• Researchers presented results from the previous day's participatory Toolbox meeting. The Committee evaluated the findings. • Committee members gave updates on three proposed interventions. • The Committee discussed an upcoming participatory observation activity—a safety and health audit that would involve use of a modified contractor checklist.

Commentary on Week 6

The researchers used this week's Toolbox meeting to gather more information on the health risks the workers had identified during the previous week. In order to increase individuals' participation and to combat the distractions from the bustling downtown location, the researchers use a small-group activity format. Only a short portion of the 10 minute meeting was devoted to the Health Trak project. It was a major challenge for researchers to concurrently collect data and facilitate a participatory activity under these conditions; however, this activity was successful.

The beginning of this week's Committee meeting was once again devoted to evaluation of the previous day's Toolbox meeting. Members were pleased with the "hands-on" nature of the participatory Toolbox activity.

Updates were given on three interventions that had been initiated:

- Handwashing—a prototype portable handwash station arrived and was going to be retrofitted for one of the work sites.
- Handtrucks—two had been ordered but had not yet arrived. The site safety officer was also looking into a single canister handtruck for oxygen acetylene tanks.
- Wheel wells—a Committee member was assigned the responsibility of ordering wheel wells for sites that needed them.

Week 7 Health Trak Activities, July 28-August 1, 1997

Participant Observation (Tuesday)	A site visit was conducted by the researcher to evaluate the progress on various interventions initiated by the Committee.
Toolbox (Thursday)	- A participatory health and safety checklist was distributed. Foremen were instructed to complete the surveys with input from their site workers. - The foremen were told that the safety manager, the project owner's safety representative, and a researcher would fill out checklists at the same time they did their evaluations.
Committee (Friday)	- Activity: Researchers posed the following question: "What recent interventions have you noticed on site, and how are they working?" - Activity: The Committee debriefed on the previous day's Toolbox meeting. Researchers asked: "What did you like?" and "What would you change?" - Activity: The Committee was asked if they thought this type of participatory process would be used in the future. This activity was designed to help Committee members strategize to solve many of the new problems identified as a result of this week's health and safety audit.

Commentary on Week 7

The participatory health and safety audit activity introduced during this week's Toolbox meeting was not successful, as no foremen completed the audit. Therefore, the only data generated by this audit was that of the three-person team from the Committee.

During the Committee meeting, updates on the interventions were given:

- The handwashing intervention was not yet complete. A carpenter needed to complete the handwashing stand with a lock to prevent the soap from being stolen. The safety manager added that he would like to install a total of 4 handwashing stands on site.
- Two new handtrucks had arrived; there was now at least one handtruck available at each site.
- There had been no progress on wheel well improvement. The safety manager admitted failure and stated that it wasn't going to get done—but then quickly recanted this statement and said that an improved wheel well system would be transferred to one of the active sites in the near future.

The Committee evaluated the failure of the foremen to complete the participatory health and safety audits. They thought the concept of a participatory checklist was a good one, but they saw much room for improvement: better logistics of handing out the survey, getting other subcontractors involved, and having employees evaluate each others' work sites.

A discussion emerged regarding the fact that it is difficult to enforce compliance with basic health and safety issues, never mind filling out an in-depth survey. For example, safety glasses had been made mandatory in the preceding weeks, yet many workers were not yet in compliance. The safety manager acknowledged that this is not surprising considering he had "no meat" for enforcement.

The Committee was left to analyze the single health and safety audit completed by the safety manager, the project owner's safety representative, and the researcher. The checklist identified several issues in need of improvement, including familiar issues (handwashing, staffing levels, housekeeping) and new issues (eye protection, tool placement after use, ventilation, water and cup supply).

Given the fact that new health and safety issues were being identified close to the end of the cycle, the researchers asked the Committee their thoughts on whether the participatory process would continue to be used in the future. The safety manager suggested changing the nature of the program to a Safety Observer Program with more management involvement. There was also a suggestion for safety incentives for workers wearing PPE—but a researcher pointed out that this was an incentive for safe work practices, not an incentive to reduce risks.

Week 8 Health Trak Activities, August 4-8, 1997

Toolbox (Thursday)	• Activity: Every worker who attended the meeting was given an index card and asked to write one thing (positive, negative, or indifferent) about participating in health and safety. The objective was for the Committee to better understand how they could continue the participatory Health Trak process in the future.
Committee (Friday)	• Researchers presented the results from the previous day's Toolbox meeting. • Committee members evaluated the Toolbox activity. • Researchers asked the Committee to review what successful interventions had taken place and what interventions they would like to see in the future. • Researchers asked the Committee for feedback on what was helpful about the participatory process, and what could change. • The Committee members were asked how this process should continue.
Commentary on Week 8 Approximately one half of the workers at the Toolbox meeting participated in writing something about participating in health and safety—only one response was childish. Both the researchers and Committee were pleased by the success of this activity. Data from the Toolbox meeting was presented in the final Committee meeting. Committee members were surprised by some new issues that surfaced at the end of the process—concern over fast cars on site and lack of use of safety vests. The Committee then evaluated the Health Trak cycle as a whole: • Successful interventions included the introduction of two hand trucks for the oxygen acetylene tanks, improved working surfaces, and a hand washing station (with the exception of labels and water). • Interventions the Committee would like to see in the future included improved wheel wells and completion of the handwashing station. • The Committee's evaluation of the participatory process as whole is discussed in the evaluation section of this report.	

ASSESSMENT OF WHETHER PHASE ONE'S OBJECTIVES WERE MET WEEK 1 AND WEEK 2

The goals of Phase One are to identify health hazards and develop definitions for problems. During the first two weeks of Cycle Two, Committee members and workers in Toolbox meetings discussed ergonomic risk factors, which helped all workers begin to develop definitions for problems. Committee members also began to identify health hazards on site; however, Toolbox meetings did not progress to the point where this could occur. In fact, workers in Toolbox meetings would not have the opportunity to identify their own health hazards until a participatory activity in Week 5 of the cycle.

ASSESSMENT OF WHETHER PHASE TWO'S OBJECTIVES WERE MET WEEK 3, WEEK 4, WEEK 5, AND WEEK 6

The goals of Phase Two are to analyze and develop solutions for problems identified during Phase One. Both the Committee and the Toolbox sessions were running behind schedule—by this time, the Committee and Toolbox meetings should have been preparing to focus on evaluation of the intervention. Instead, an intervention had still not been introduced on site.

As this cycle was nearing the implementation stage, the Committee had many "irons in the fire"; however, it was unclear whether any particular issue was the primary focus of the group. Furthermore, attempts at implementation of controls appeared ad hoc; early analysis of how to effectively negotiate the construction hierarchy to change workplace conditions had been abandoned. As the Committee entered the implementation stage of the cycle, it appeared as though there were four controls to be implemented: addition of handtrucks, introduction of a handwashing station, leveling of work surfaces, and improvement to the wheel well system for the pits. The Committee did not have a well-defined game plan for implementation of these specific controls as they entered Phase Three.

ASSESSMENT OF WHETHER PHASE THREE'S OBJECTIVES WERE MET WEEK 7

The goals of Phase Three are to prioritize and introduce interventions at the worksite. Because the cycle was running behind schedule, there was only one week to meet the goals of this phase. At the end of this phase, the only completed intervention was the introduction of handtrucks.

Because researchers were frustrated by the fact that few meaningful interventions had occurred by this point, they tried to engage the workers in yet another round of hazard identification via the participatory health and safety audit. The result of this was the generation of yet more health and safety hazards on site—the question was whether any forum would exist after the completion of the cycle to address these issues.

ASSESSMENT OF WHETHER PHASE FOUR'S OBJECTIVE WERE MET WEEK 8

The goals of Phase Four are to evaluate the intervention and the 8-week participatory process. Because both the Toolbox participants and the Committee successfully completed evaluations of the project, this goal was met by all study participants.

.V. CYCLE EVALUATION

The researchers assessed Health Trak's effectiveness against its objectives, which were to develop and implement a participatory method and identify and implement an ergonomic intervention. Two qualitative tools and one quantitative tool were used to evaluate Cycle Two and to gather data for a long-term summative evaluation of all past and future Health Trak cycles.

1. Participant Evaluation (qualitative)
2. Pre- and post-surveys from on-site workers (quantitative)
3. Site walk-throughs by an external health and safety expert (qualitative)

1) PARTICIPANT EVALUATION

During the Week 8 Committee meeting, Committee members were asked to evaluate the participatory process in terms of what was helpful and what could change. They were also asked how they thought the participatory process could continue after the end of the Health Trak cycle. Allowing the Committee to gauge its overall effectiveness and make suggestions for improvement provides researchers with necessary information to continue improving Health Trak in future cycles.

What was helpful

- The company had sponsored the Health Trak cycle (deemed the most important of all points discussed). Because of this, the Committee felt there was more participation in the Toolbox meetings and the process resulted in a better relationship between the workers and contractor representatives.
- Worker training and education was conducted during the Committee and Toolbox meetings.
- An effective communication system was fostered between workers and contractors.
- Researchers worked with each other, organized the participatory process, knew what they were doing, and were able to transform academic terminology into everyday language.

What Could Change

- Involvement of higher levels of management would provide them with a better understanding of what was taking place. Furthermore, increased steward involvement would potentially reduce fear of retaliation from participation. The safety manager added that this would also increase his ability to perform his job tasks because he would have "more meat."
- The safety manager and the owner's safety representative mentioned that it would be a good idea to rotate the Committee members and also limit discussions so everyone would be more involved.
- The safety manager added that due dates should be assigned to unresolved issues. This was attempted on several occasions. The safety manager always said he would take care of an item, but he rarely did.
- Other ideas relied on safety incentives. However, one researcher explained that these are incentives for safe work practices and not incentives that reduce risks. Therefore, a Committee member suggested that this could include more training

and awareness about health and safety. The safety manager already provides this, but it takes place on Saturdays. Since workers are not paid, they do not attend.

Health Trak's Future

- The safety manager stated that the project manager allotted him the eight hours at the beginning and no more. He stated that he would approach the project manager and explain the positive impact of this program and solicit the continuation of a modified version of Health Trak. If given the opportunity to do so, he will add support from piledrivers, electricians, iron workers and the tunnelers.
- The Committee agreed that it would be more appropriate to hold meetings every other week and rotate members on and off the Committee. By doing so, the process could closely involve those with problems that were deemed reasonable.
- Before identifying new issues, Committee members agreed to deal with old business (wheel wells) and then move on to new business.
- The Committee discussed the structure. One Committee member mentioned they would need a chairperson—the owner's safety representative was nominated. To continue the process, a researcher will provide materials and technical assistance. If any conflicts arise in the process, the Committee agreed that they would do whatever is necessary to work around the problem.

2) PRE- AND POST-SURVEYS FROM ON-SITE WORKERS

Identical pre- and post-Health Trak surveys assessed the effectiveness of the Health Trak process. (See Appendix A.) These self-administered surveys were completed by on-site workers before and after the eight-week cycle. Fourteen of 18 randomly-selected, on-site workers filled out a pre-Health Trak survey. Eleven of 14 randomly-selected, on-site workers completed the post-Health Trak survey. No contractor representative completed a survey.

The objective was to compare perceptions of construction-related health hazards before and after the eight-week cycle. The health hazards of interest were noise, dust, stress, manual materials handling, chemicals, weather conditions, and sanitation. The questions specifically probed perceptions of how hazardous these problems were to their health, their 'co-workers' and contractor's concerns for reducing these health hazards, and how much could be done to reduce these hazards. To compare perceptions, parametric two-sample t-tests were conducted. The results did not yield any statistically significant changes in workers' perceptions for any hazard category.

3) PRE- AND POST-SITE WALKTHROUGHS BY AN EXTERNAL HEALTH AND SAFETY EXPERT

An external health and safety expert also conducted a pre- and post-Health Trak survey. The external health and safety expert evaluates all construction fatalities in the state of Massachusetts for the Massachusetts Department of Public Health. The evaluation objective was identical to the self-administered survey. However, the expert subjectively assessed the workers' perceptions through conversations using the survey form as a guide.

In the pre-Health Trak survey, two piledrivers, one operating engineer, and one laborer were the only workers willing to participate in a discussion with the expert. The discussion followed the seven hazard categories, but each worker was not asked every question. The group acknowledged weather and sanitary problems, but they suggested the hazards were not serious. They also acknowledged noise as a problem, but they believed that the problem could

be dealt with through hearing protection. Dust was always a factor, but not a particular concern. Only the piledrivers mentioned that chemicals might be of concern to welders that may encounter lead. Stress was viewed as the foreman's problem or not a problem. Lifting and manual materials handling were not seen as hazardous in their particular work because materials were moved by machine. In addition, those interviewed had no comment on management's concern about safety, except that hearing protection was always available.

In the post-Health Trak survey the expert conducted the evaluation with four laborers, one laborer foreman, and two operating engineers. They were asked questions in the same format as the pre-Health Trak survey. Consistently, those interviewed indicated noise as a problem in construction. However, they believed they it was under control with the available hearing protection. Dust was an issue for only one laborer, who believed the problem was from jack hammering. He indicated that dust masks help reduce this exposure. No one perceived chemicals as a hazard. Stress was identified by one worker as something that could affect one's health, but it was not a particular concern. Lifting and manual materials handling was a concern if not done correctly. Most of those interviewed said they know how to lift, so they would not become injured. One worker also noted that lifting hazards were a concern of management.

The major difference between the pre- and post-Health Trak surveys was with respect to lifting and manual materials handling. In the first survey the workers did not perceive it as a problem for themselves or for management. However, in the second survey the identified it as a concern for both parties. This may have resulted from the relationship with the ergonomic activities that were conducted during the Toolbox meetings and also the ergonomic interventions that were instituted on site.

4) HEALTH TRAK EVALUATION SUMMARY

The participant evaluation indicates that two of Health Trak's three key components – Committee meetings and Toolbox meetings – were highly successful. The researchers agreed, since the Toolbox meetings complimented the Committee meetings by providing education and training and gathering data that was directly related to the Committee's process. However, the third and final key component, Participant Observation, was less successful. This may result from the difficulty in measuring the component.

At this time, participant evaluation most likely provides the best evaluation for improving both the participatory process and the intervention strategy. The two surveys provide good feedback about how those outside the Committee view on-site hazards, but they do not appear to successfully measure the process created over the eight week period.

VI. LESSONS LEARNED

The eight-week participatory process provided valuable insight for future Health Trak Cycles. This cycle clearly demonstrated the need to involve site leaders in the Health Trak Committee, as this Committee was limited in its ability to institute change on site. Because the safety officer who selected the Committee members was individualistic and chose to work without the partnership of stewards and foremen, the Committee was comprised primarily of rank-and-file workers coming together for the first time. While this Committee was successful in generating several recommendations for change on site, they did not have the tools necessary for effective implementation.

In contrast, the first Health Trak cycle's Committee was selected by a safety officer who had historically worked with site leaders of foremen and stewards. These are the players on construction sites who are responsible for negotiating improvements in all kinds of worksite inadequacies; therefore, they were well-poised to tackle issues pertaining to health and safety

at the onset of the cycle. The Committee in this Health Trak cycle had less experience working on these issues and therefore had a steeper learning curve. This contributed to some of the time delays seen throughout the course of the cycle.

Toolbox meetings in this cycle were participatory in nature when they occurred, but there were difficulties negotiating the time allotted for these sessions. Researchers were pleased that they were able to get feedback from workers during these meetings, and viewed their strategies adopted in this session as an improvement over the previous Health Trak cycle.

VII. IMPROVEMENTS TO BE IMPLEMENTED FOR THE NEXT CYCLE

The main future improvement to Health Trak cycle will consist of trying to influence the site safety officer to select Committee members who are in inherent leadership positions, such as stewards and foremen. Rank-and-file construction workers simply are not in a position to implement change on site without including these leaders in such negotiations.

Although researchers would like to encourage inclusion of stewards and foremen on future Health Trak Committees, they will not *require* the site safety officers to do so. Rather, they will be forthcoming with their findings from previous cycles, indicating that prior cycles have demonstrated that the Committee is most successful when it is comprised of certain players on site.

Both stewards and foremen are workers' support network in the field. Daily hassles that occur in the field are negotiated between these leaders; therefore, many of the decisions to implement the suggestions generated during Health Trak are within their control on site. This is particularly true of those improvements that do not require a capital expenditure, but can be introduced easily once there is buy-in from the leaders on a job site. In cases where it is necessary to involve upper management in budgetary decisions, stewards and foremen will still be in a better bargaining position than would be a Committee fully comprised of rank-and-file employees.

Answer each of the following questions by placing a tic mark on the line that best represents your opinion. For Example _____

Not at All Very

Not at All Very

Not at All Very

Nothing A Lot

Not at All Very

Not at All Very

Not at All Very

Nothing A Lot

Not at All Very

Not at All Very

Not at All Very

Nothing A Lot

Not at All Very

Not at All Very

- | | | | |
|--|-------|------------|-------|
| 15. How concerned are co-workers about reducing lifting and manual materials handling on site? | _____ | Not at All | Very |
| 16. How much can be done to reduce lifting and manual materials handling in construction? | _____ | Nothing | A Lot |
| 17. How hazardous are <u>chemicals</u> to employee health? | _____ | Not at All | Very |
| 18. How concerned is management about reducing chemicals hazards on site? | _____ | Not at All | Very |
| 19. How concerned are co-workers about reducing chemicals hazards on site? | _____ | Not at All | Very |
| 20. How much can be done to reduce chemicals hazards in construction? | _____ | Nothing | A Lot |
| 21. How hazardous is <u>weather</u> to employee health? | _____ | Not at All | Very |
| 22. How concerned is management about weather hazards on site? | _____ | Not at All | Very |
| 23. How concerned are co-workers about weather hazards on site? | _____ | Not at All | Very |
| 24. How much can be done about weather hazards in construction? | _____ | Nothing | A Lot |
| 25. How hazardous are <u>sanitary</u> hazards to employee health? | _____ | Not at All | Very |
| 26. How concerned is management about reducing sanitary hazards on site? | _____ | Not at All | Very |
| 27. How concerned are co-workers about reducing sanitary hazards on site? | _____ | Not at All | Very |
| 28. How much can be done to reduce sanitary hazards in construction? | _____ | Nothing | A Lot |
| 29. How concerned is your present employer about your health? | _____ | Not at All | Very |

APPENDIX E.

Health Trak Cycle 3 Final Report: Reducing Ergonomic Hazards in Concrete Formwork
assembly through Worker Participation



Technical Report

Health Trak Cycle 3 Final Report: Reducing Ergonomic Hazards in Concrete Formwork Assembly Through Worker Participation

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Rick Galletta, S.I.W.P. Safety Engineer
Ken Lieb, S.I.W.P. Concrete Engineer
Mike Okuniewicz, Slattery Corporate Safety Manager
George West, General Carpentry Foreman

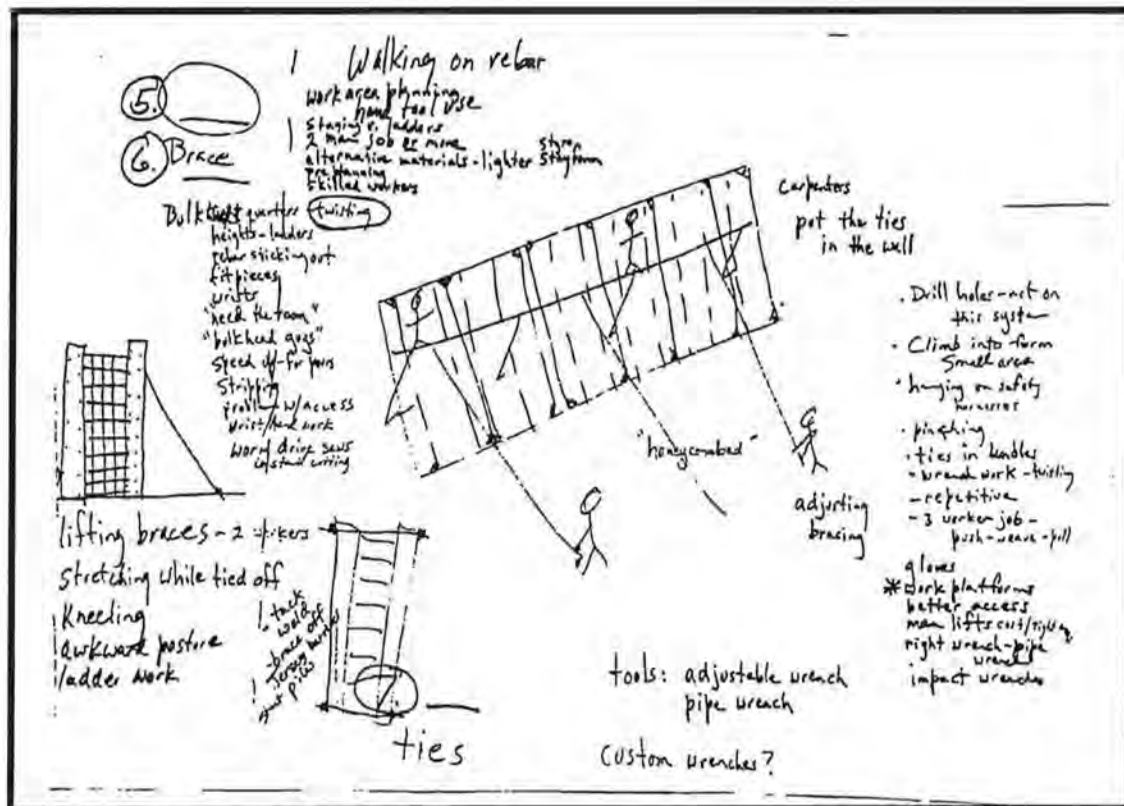
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April 1999

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I. EXECUTIVE SUMMARY



Portion of Health Trak Committee "Risk Map" on Formwork Assembly

I. EXECUTIVE SUMMARY

In the summer of 1998, the Slattery, Interbeton, White, and Perini joint venture (herein referred to as the Contractor) committed to working with the Construction Occupational Health Project at the University of Massachusetts Lowell (herein referred to as COHP) as a Model Contractor. The COHP's Model Contractor Program involves contractors with strong safety programs who have requested that the COHP work with them to strengthen the health component of their work. The Program joins researchers and the construction industry in researching effective systems to construction occupational health through meaningful worker participation in identification and remediation of hazards.

Through the summer and fall, the Contractor and COHP researchers identified pre-job activity planning as an area that could be strengthened through increased worker involvement. The Contractor wanted to work on activity planning in an operation that would be repeated several times; COHP researchers wanted to work on an operation where ergonomic hazards currently existed, but could be reduced through the introduction of worker-generated interventions. For these reasons, the Contractor and COHP researchers decided to conduct a Health Trak cycle to reduce ergonomic hazards associated with concrete formwork assembly. This research project was conducted during the fall and winter of 1998 -1999.

Health Trak is an eight-week participatory research approach to intervention in construction that includes three components: 1) Weekly labor/management committee meetings, 2) Worker toolbox meetings, and 3) Participant observation by committee members. In this Health Trak cycle, the Committee met once a week and included a laborer steward, a carpenter steward, a general foreman, a concrete engineer, the site safety engineer, and three COHP researchers.

HEALTH TRAK: REDUCING ERGONOMIC HAZARDS IN FORMWORK ASSEMBLY

An eight-week participatory research approach to intervention
involving three research activities:

- 1) Weekly labor/management committee meetings
- 2) Worker toolbox meetings
- 3) Participant observation by committee members

The Committee first had an orientation on the general ergonomic risk factors that can lead to sprains and strains and other ergonomic injuries. In order to identify potential ergonomic hazards associated with formwork assembly, the Committee members then spent several weeks creating a Risk Map of this operation. This process consisted of

three steps: 1) drawing maps of materials, equipment and tools they used in formwork assembly, 2) identifying ergonomic risk factors associated with the operation, and 3) generating ideas for possible solutions to eliminate or reduce these hazards.

From the list of possible solutions to improve concrete formwork assembly, the Committee chose to focus on improving laydown areas (areas where form materials, tools, and equipment are stored on site) during the remainder of the Health Trak cycle. The Committee's action items focused on planning and getting what you need, setting up and laying out the area, and maintaining the area. Below is a summary of the general accomplishments and planned work from the Health Trak cycle.

ACCOMPLISHMENTS/PLANNED WORK FROM HEALTH TRAK ON FORMWORK ASSEMBLY

I. Improved Activity Planning

- Revise existing activity plan for general formwork.
- Incorporate findings of Committee into planning for future formwork activities.

II. Improved Lay-Down Areas

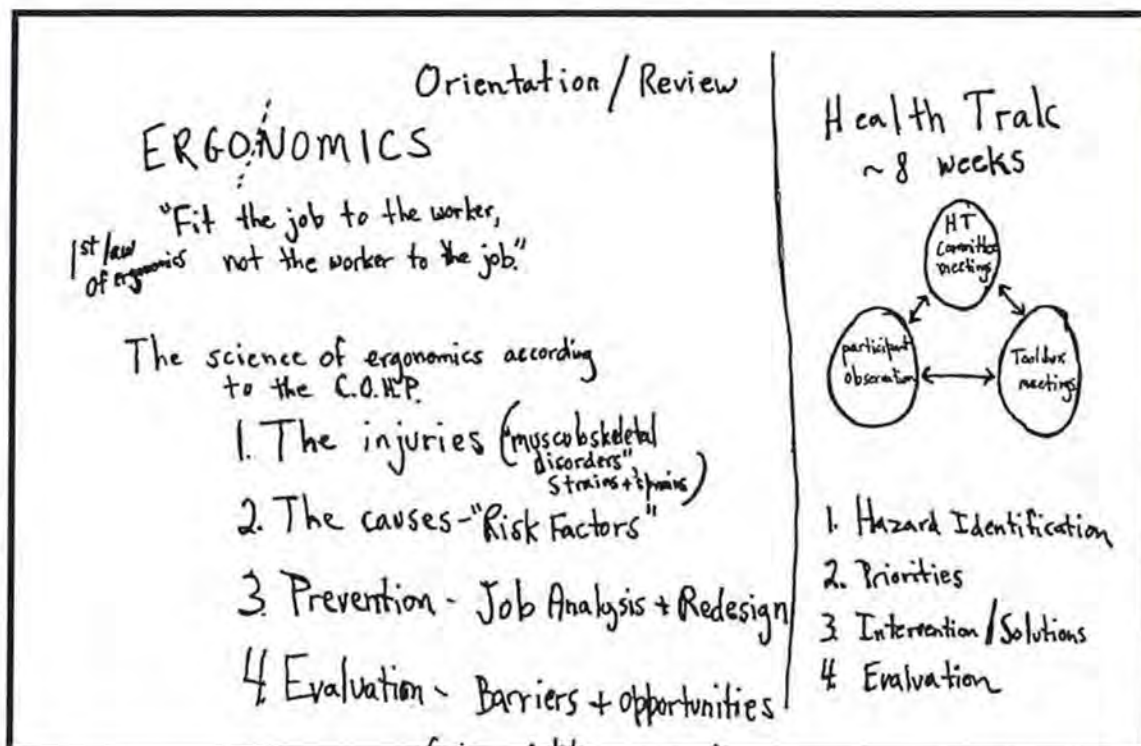
- Continued progress on 7 action items for improving lay-down areas:
 1. Discuss overall plan at Monday safety meetings.
 2. Do form planning with a clean, safe area in mind.
 3. Schedule deliveries for smooth work progress.
 4. Provide receptacles for trash, such as spare skip pans or barrels.
 5. Keep motor vehicle traffic out of laydown areas by cordoning off the area.
 6. Get bucket in area to remove waste and scrap.
 7. Have carpenter foreman talk to laborers to do housekeeping in between other tasks.

III. Improved Site-Wide Ergonomics

- Revise generic activity plan form to include ergonomic hazards and lay-down area planning.
- Pursue the lighter, longer prybar.
- Give ergonomics training to incoming carpenters foremen.
- Provide ergonomics supplement to Contractor's New Worker Orientation booklet.

This report includes a background description of the Model Contractor and Health Trak programs, a week-by-week description of the Health Trak cycle, the Health Trak Committee's evaluation of the process, and COHP researchers' summary and conclusions of the cycle.

II. BACKGROUND ON MODEL CONTRACTOR AND HEALTH TRAK PROGRAMS



Notes on ergonomics and Health Trak from orientation meeting

II. BACKGROUND ON MODEL CONTRACTOR AND HEALTH TRAK PROGRAMS

MODEL CONTRACTOR PROGRAM

The goal of the Model Contractor Program is to work with contractors who are committed to making workplace health and safety improvements through specific intervention activities involving workers. The Model Contractor Program has three phases:

- Phase I. Hazard identification and pre-planning
- Phase II. Control implementation and organizational communication (Health Trak)
- Phase III. Programmatic evaluation

Phase I includes baseline data collection and the development of a contractor-specific intervention plan for joint research. The purpose of the baseline data collection is to spend time getting a better understanding of how the *health* piece of the site-specific safety and health plan is working. Then, informed recommendations can be made to improve the health component of the plan.

SUMMARY OF PHASE I: HAZARD IDENTIFICATION AND PRE-PLANNING

Over a six-week period, COHP researchers reviewed documents, talked with workers and management, and observed site operations. These activities confirmed the strength of the safety program. Field observations and interviews with workers, foremen, stewards, engineers, and managers revealed a relatively high awareness of safety hazards and the methods to prevent or control these hazards. Researchers found less awareness of potential ergonomic and respiratory hazards and ways to reduce these hazards. Review of written documents such as the site-specific safety and health plan, orientation materials, pre-job activity plans, and incident investigations supported these observations.

While health hazard awareness was low, involvement of site personnel in safety-related activities was high. Many workers attended toolbox meetings, felt free to raise safety and health issues at these meetings, and found the meetings useful. Stewards, foremen, safety officers and site superintendents aggressively and actively corrected hazards. Workers and supervisors were able to stop work to correct hazards.

OBSERVATIONS OF THE CONTRACTOR'S HEALTH AND SAFETY SYSTEM

- High awareness of safety hazards among workers.
- Less awareness of ergonomic and respiratory hazards.
- Written documents had strong focus on safety.
- Involvement of site personnel in safety-related activities was high.
- Stewards, foremen, safety officers, and site superintendents aggressively corrected hazards.

Following this data collection period, COHP researchers recommended four integrated strategies to improve the health component of the Contractor's health and safety program: (1) improve new employee and ongoing training; (2) improve activity planning; (3) improve incident investigations; and (4) develop engineering controls. The Occupational Safety and Health Administration (OSHA) stresses the importance of worker and front-line supervisor awareness and involvement in effecting such recommendations. Therefore, a joint labor/management Health Trak participatory research program was recommended to the Contractor to promote more worker involvement, greater on-site technical expertise, and ongoing feedback on solutions.¹

The Contractor had previously identified activity planning as a priority area for improvement; therefore, they selected this as the focus of the Health Trak program. In trying to identify a specific operation to improve through activity planning, the Contractor expressed an interest in finding an ongoing operation on site. Concrete formwork was identified as a possible process since there was a substantial amount of this work planned for the upcoming months. Furthermore, COHP researchers' field observations from previous research on other sites indicated that carpenters and laborers building concrete forms are exposed to important ergonomic risk factors (awkward postures, forceful exertions, repetitive or prolonged activities, contact stresses, and temperature extremes).^{2,3} These risk factors could lead to sprains and strains and other ergonomic injuries, and these risk factors could potentially be reduced or eliminated through better activity planning.

As a result of collaborative planning, COHP researchers and the Contractor agreed to (1) improve activity planning by assembling a Health Trak committee, and (2) have the committee focus on concrete formwork.

¹ Noll, M., Moir, S., Hanson, D., Azaroff, L., A good contractor safety system made better: initial program evaluation, *COHP Technical Report T-39*, April 1999.

² Punnett, L., Paquet, V., Ergonomic exposures to carpenters and carpentry laborers in tunnel construction, In A. Mital, et al., editors, *Advances in occupational ergonomics and safety I (proceedings of the Xith International Occupational Ergonomics and Safety Conference*, Amsterdam, IOS Press, 1996.

³ DesMarais, T., McDonald, S., Ergonomic Job Analysis: Laborers constructing concrete base structures, *COHP Technical Report T-26*, April 1998.

HEALTH TRAK PROGRAM

The Health Trak program is an eight-week intervention research project designed to enhance workers' and contractor representatives' capacity to identify and remedy health hazards on construction sites. It uses participatory research methods that are "learner-centered", which were developed in the field of education. They have been adapted to research under the name participatory action research (PAR). PAR studies combine research and intervention in single studies and transform research subjects into participants in the process.

Each Health Trak cycle consists of an eight-week program where workers and contractor representatives work together to reduce health risks at their site. Each cycle has three key components:

- **HEALTH TRAK COMMITTEE MEETINGS.** The committee meets one hour each week for each of the eight weeks. The committee is composed of 6 to 8 participants and must be made up of a numerical majority of non-management personnel. Researchers facilitate the meetings while the committee members work together on activities that relate to the process.
- **WEEKLY TOOLBOX MEETINGS.** The trades' toolbox meetings usually happen one day each week. Committee members and researchers use these meetings to collect data and distribute information about the process.
- **PARTICIPANT OBSERVATION.** Includes observations, interviews and focus group activities with workers and contractor representatives. The purpose is to solicit feedback from workers and contractor representatives that may not be directly involved with the committee; and also to gain trust, which is critical in a participatory process.

While the three key components are performed over the eight-week process, they are structured toward Health Trak's four phases: 1) Problem identification and definition, 2) Analysis of hazards and strategies for intervention, 3) Implementation of proposed intervention(s), and 4) Evaluation by participants.

HEALTH TRAK'S FOUR PHASES

- 1) Problem identification and definition
- 2) Analysis of hazards and strategies for intervention
- 3) Implementation of proposed intervention(s)
- 4) Evaluation by participants

During the problem identification and definition phase, the Committee's objectives are to identify health hazards and develop definitions for the problems. The next phase's

objectives, analysis of hazards and strategies for intervention, are to analyze and develop solutions for problems identified during the first phase. The implementation phase's objectives are to prioritize and introduce interventions at the worksite. The final phase's objective, evaluation by participants, is to evaluate the intervention and the eight-week process.

The Contractor helped COHP researchers identify appropriate members for the Health Trak Committee. The Committee included a laborer steward, a carpenter steward, a general carpenter foreman, a concrete engineer, the site safety engineer, and three COHP researchers.

HEALTH TRAK COMMITTEE MEMBERS	
	Laborer steward
	Carpenter steward
	General carpenter foreman
	Concrete engineer
	Site safety engineer
	Three COHP researchers

The remainder of this report summarizes the activities undertaken during the eight-week Health Trak project on activity planning in concrete formwork assembly (Phase II of the Model Contractor Program). Because the COHP's relationship with this Model Contractor is ongoing, Phase III has not yet occurred and is not reported in this publication. This report also does not cover ergonomics awareness training for foremen, an outcome of the Health Trak process projected to begin shortly following publication.

III. WEEK-BY WEEK HEALTH TRAK PROCESS AND RESULTS



Contractor and Labor Health Trak Committee Members

III. WEEK-BY-WEEK HEALTH TRAK PROCESS AND THE RESULTS

This section of the report outlines the activities of the Health Trak Committee week by week, beginning with the orientation meeting. The graphic below is an overview of the Committee's activities over the duration of the research project.

HEALTH TRAK CYCLE 3 WEEKLY OVERVIEW

Phase 1: <i>Problem ID and Definition</i>	Phase 2: <i>Analysis of Hazards and Strategies for Intervention</i>	Phase 3: <i>Implementation of Interventions</i>	Phase 4: <i>Evaluation by Participants</i>
<u>Orientation</u> <u>Week 1</u>	<u>Week 2</u> <u>Week 3</u> <u>Week 4</u> <u>Week 5</u>	<u>Week 6</u>	<u>Week 7</u> <u>Week 8</u>

PHASE 1: ORIENTATION WEEK

Present: Carpenter Steward, Laborer Steward, Safety Engineer, Concrete Engineer, COHP Researchers

Agenda

Review of Health Trak process

Introduction to ergonomics

Scheduling of future sessions

Comments

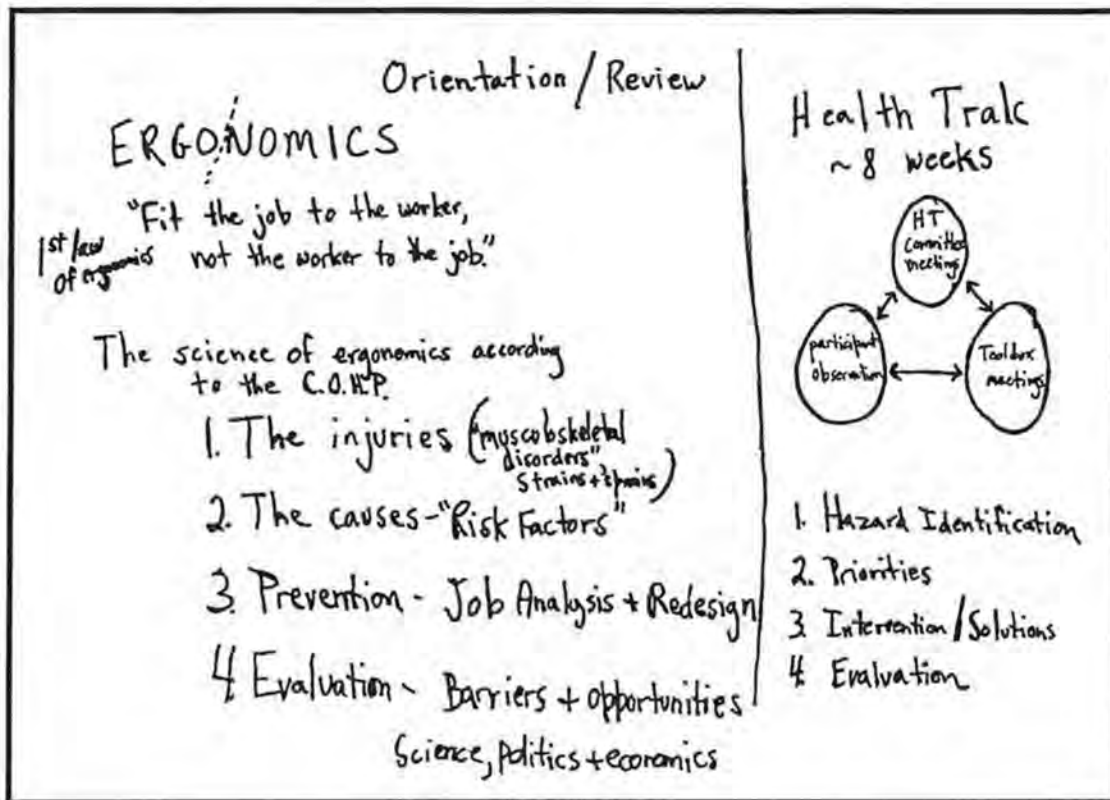
- This was the first time the Health Trak Committee met. The meeting was pulled together in an impromptu fashion at the end of the Contractor's monthly safety meeting. The General Carpentry foreman could not make it because of short notice.
- The purpose of this meeting was to orient Committee members to the purpose of Health Trak.
- COHP researchers handed out some toolbox talk materials on ergonomics that Committee members could share with other workers on site. These materials were used extensively by Committee members in their toolbox meetings for the rest of the Health Trak cycle.

Health Trak Committee (all members)



ORIENTATION WEEK (CONT.)

Notes on ergonomics and Health Trak from orientation meeting



Sample and list of toolbox topics handed out to the Committee during the orientation

TOPICS OF TOOLBOX TALK MATERIALS:

- "How to get through a day's work and still have something left over"
- "Balanced tool belts can start your back off in the right position"
- "Job rotation gives your body a break"
- "Using a pipe carriage prevents back, shoulder, and wrist fatigue"
- "Suspending tools prevent back, arm, and shoulder fatigue"
- "Overcome the 'Don't sit on the job' attitude and your body will thank you"
- "Shovel design can help to reduce forces on the lower back and hands"
- "Reduce your risk of back injury—let your equipment do the work."

Toolbox talk materials used in Health Trak were developed by the Workers Compensation Board of British Columbia and are included in their "Constructive Ideas" series on reducing soft tissue injuries in the construction industry.



PHASE 1: WEEK 1 MEETING

Present: Carpenter Steward, Laborer Steward, Safety Engineer, Concrete Engineer, General Carpentry Foreman, COHP Researchers

Agenda

- Pre-meeting orientation for new members
- Review of Health Trak process and ergonomic risk factors
- Forms presentation by Concrete Engineer
- Activity planning presentation by Safety Engineer

Comments

- During the review of ergonomics, Committee members said that they had shared some of the ergonomic toolbox talk materials with workers on site. Ergonomics information was well-received by workers, but a lot of the concepts were not new—just presented in researchers' words.
- Learning about formwork was the first step in *identifying ergonomic hazards*. The Concrete Engineer provided an introduction to the different kinds of form systems used on site. He described the system to be used for a major upcoming formwork project. The group discussed how forms are assembled for such an operation.
- The Safety Engineer shared the activity plan for "oddball" form assembly. Again, this was a step in *identifying ergonomic hazards* associated with formwork assembly. The activity plan included a section on sprains and strains—it said to lift with your knees, not your back; and to get help from other people if necessary. The Safety Engineer noted that activity plans are dynamic documents and that they can be adjusted to add more things as they come up.
- During this meeting, there appeared to be an undercurrent of skepticism that the Committee would be able to come up with realistic solutions to ergonomic hazards in formwork assembly. As one Committee member said, "*You're trying to live in the perfect world. You're telling us that your maximum lift is 50 pounds; the average guy won't get hurt on the job. It's not the real world. Sometimes we lift more and we get hurt.*"

WEEK 1 MEETING (CONT.)

Quotes of the week

ON ERGONOMICS IN TOOLBOX MEETINGS:

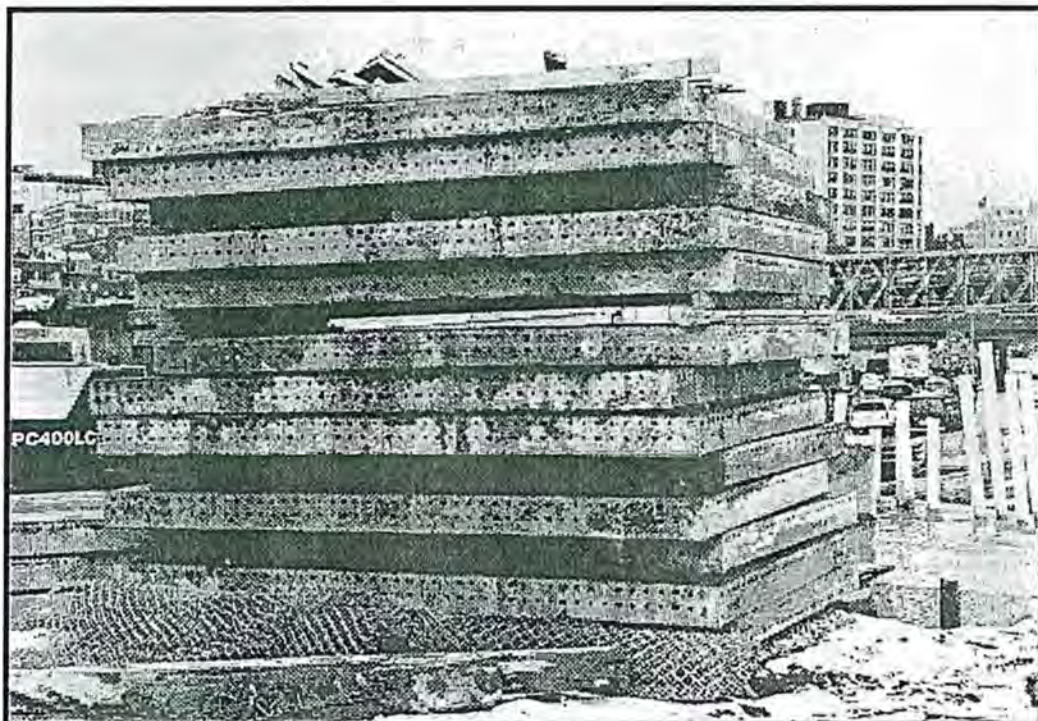
"The information that you're giving me here, I'll pass on to the laborer foreman because after a while you get done talking about belts, tagging, and nails sticking up—what else is there? You've given us a basis for some other stuff."

Laborer Steward

"We talked about using a pipe wrench instead of vice grips...don't strain yourself...if you need help, ask for it. People said yeah, okay, good."

Carpenter Steward

Stack of steel form panels



PHASE 2: WEEK 2 MEETING

Present: Carpenter Steward, Laborer Steward, Safety Engineer, Concrete Engineer, General Carpentry Foreman, COHP Researchers

Agenda

Distribute more handouts for toolbox meetings

Map risks and identify possible interventions for formwork assembly

Select one toolbox talk to do next week

Comments

- The Committee described and drew the following steps in formwork assembly: truck unloading, lay-down areas, gang form assembly, form placement, and form bracing.
- Then, the Committee began to *identify ergonomic hazards and solutions* for each step. (See completed Risk Map, Summary of Hazards, and List of Solutions on pages 23-28.)
- The Committee selected the toolbox talk *How to get through a days work and still have something left over*, to go over at the next week's toolbox meetings. (See quotes on page 16.)
- At the end of the meeting, the Safety Engineer noted that the risk mapping activity was a good exercise since there was "a lot of input from everyone".

COHP researcher talking with Laborer Steward on site



WEEK 2 MEETING (CONT.)

Quotes of the week

ON THE TOOLBOX TALK “HOW TO GET THROUGH A DAYS WORK AND STILL HAVE SOMETHING LEFT OVER”:

“Something should be added: how to get to 55 and have something left. Take a big old guy like me...if I had to keep going with my tools, I couldn’t.”

General Carpentry Foreman

REASON FOR NOT SELECTING THE TOOLBOX TALK ON JOB ROTATION:

“You have to balance taking it easy on a guy’s job and getting it done. If I have to rotate a fresh guy in, I’ll never get it done. The crew themselves will direct themselves. Some people you can’t stop. They just bang away all day long—they don’t stop. Other people want to switch out and that’s okay. It all averages out.”

General Carpentry Foreman

REASON FOR NOT SELECTING THE TOOLBOX TALK ON BALANCING TOOL BELTS:

“Any time you try to balance a tool belt, as soon as you twist or take one tool out, you’re unbalanced.”

Carpentry Steward

Tasks in formwork identified by the Committee

IDENTIFIED TASKS ASSOCIATED WITH FORMWORK ASSEMBLY

1. Truck unloading
2. Laydown area organization
3. Gang form assembly
4. Placing gang forms
5. Installing bracing
6. Building bulkheads
7. Putting ties in

PHASE 2: WEEK 3 MEETING

Present: Safety Engineer, Concrete Engineer, General Carpentry Foreman, COHP Researchers

Agenda

Feedback on toolbox talk topic from last week

Discussion of how do you know when it's too heavy to lift an object

Continue mapping risks and identifying interventions for formwork assembly

Discussion of hand tools

Comments

- The two stewards could not make it to this meeting.
- The General Carpentry Foreman had covered *How to get through a days work and still have something left over* in his toolbox meeting. He and his crew expanded the topic to *How to get to 55 years old and still have something left over*. The crew was receptive to asking for help and switching off hazardous job tasks.
- The Committee discussed how workers know when something is too heavy to lift. Some thought experience is important; others thought you just know by looking at it—"common sense". However, when you have large crews of new workers, it's harder to rely on this common experience and injuries may be more likely.
- The General Carpentry Foreman noted that the current "core" carpenter crew of about 12-15 workers would soon be foremen on this job since there were 150-200 carpenters scheduled to be on site at the peak of an upcoming major formwork job. This gave researchers the idea to suggest an ergonomics training session for the carpenter foremen.
- The Committee continued to *identify ergonomic hazards and solutions* for the following formwork assembly tasks: unloading the truck, materials storage, lay-down areas, and gang-form assembly. (See *completed Risk Map, Summary of Hazards, and List of Solutions on pages 23-28.*) Using the seven formwork assembly tasks identified in the previous week's meeting, COHP researchers generated a list of open questions for the Committee to consider during the risk mapping activity. (See *page 18.*)
- During the discussion on gang form assembly, the Committee got on the topic of hand tools. The COHP researchers offered to evaluate tools for the General Carpentry Foreman.

WEEK 3 MEETING (CONT.)

Quote of the week

ON DOING THE TOOLBOX TALK “HOW TO GET THROUGH A DAYS WORK AND STILL HAVE SOMETHING LEFT OVER”:

“We covered that one in our safety meeting. We expanded it to not just getting through the day, but getting through to being 55 years old. Everyone was receptive to asking for help. We talked about switching off in doing the same, repetitive thing.”

General Carpentry Foreman

Questions COHP researchers asked the Committee during the job analysis

QUESTIONS FOR JOB ANALYSIS

Truck unloading

- What are the safest ways to unload, unpack, and sort hardware?

Laydown area

- How can we organize the work to prevent extra handling?
- How can we maintain good housekeeping?

Gang form assembly

- Could/should forms be raised up to waist level?
- Could/should forms be assembled vertically?
- What are the best/recommended tools for assembly?

Placing gang form/installing bracing

- What are the best/safest ways to place forms and install braces?
- What are the best/recommended tools for placing and bracing forms?

Building bulkheads

- What are the best/safest ways to build bulkheads?
- What are the best/recommended tools for building bulkheads?

Putting ties in

- What are the best/safest ways to put tie bolts in?
- What are the best/recommended tools for putting tie bolts in?

PHASE 2: WEEK 4 MEETING

Present: Safety Engineer, Concrete Engineer, General Carpentry Foreman, COHP Researchers

Agenda

Review list of solutions/intervention ideas from last week

Continue mapping risks and identifying interventions for formwork assembly

Review tool catalogues

Comments

- The two stewards were unable to attend this meeting.
- In debriefing on the week's toolbox meetings, COHP researchers suggested that they might be able to use information generated in the Health Trak cycle to give the Safety Engineer some ergonomics bullet points for the Contractor's worker orientation safety manual.
- COHP Researchers reviewed the list of solutions generated by the Committee in the previous week. The Committee had made it through the step of gang-form assembly.
- The Committee continued to *identify ergonomic hazards and solutions* for the following formwork assembly tasks: placing forms and bracing. (See *completed Risk Map, Summary of Hazards, and List of Solutions on pages 23-28.*)
- In discussing the task of placing forms, the Committee agreed that getting the form into its final place involves a lot of "bullwork" since one or two people need to use a lot of force with a prybar to get the form in place. The Committee discussed the possibility of improving this operation by getting a longer, lighter prybar. The Safety Engineer had seen such prybars used on other sites and said he would look into ordering one for this operation.
- The Committee reviewed the tool catalogs and noted that there were several ergonomically designed tools on the market.

WEEK 4 MEETING (CONT.)

Quotes of the week

ON DOING A TOOLBOX TALK ON BALANCING TOOL BELTS:

"At yesterday's safety meeting, we used your suggestion on equalizing the weight on tool pouches. People were receptive; they tend to do it anyways and it can bother you by the end of the day. They said that in the drywall industry, more people use suspenders to equalize the load. There's probably more going on with that subject [in my work crew] than I even thought."

General Carpentry Foreman

...LOOKING BACK TO WEEK 2 QUOTE—REASON FOR NOT SELECTING THE TOOLBOX TALK ON BALANCING TOOL BELTS:

"Any time you try to balance a tool belt, as soon as you twist or take one tool out, you're unbalanced."

Carpentry Steward

Partial listing of ergonomic hazards associated with formwork assembly

PRELIMINARY LIST OF ERGONOMIC HAZARDS ASSOCIATED WITH FORMWORK ASSEMBLY (TRUCK UNLOADING TO BRACING GANG FORMS)	
Unloading truck to laydown area	Moving forms and hardware → Awkward postures Breaking down hardware → Forceful exertions, Awkward postures
Assembling gang forms	Adjusting/prying forms → Forceful exertions, Awkward postures Bolting with speed bolts → Awkward postures, Repetition, Contact stresses
Placing gang forms	Adjusting/prying forms → Forceful exertions, Awkward postures
Bracing gang forms	Lifting and positioning braces → Forceful exertions, Awkward postures

PHASE 2: WEEK 5 MEETING

Present: Carpenter Steward, Laborer Steward, Safety Engineer, Concrete Engineer, General Carpentry Foreman, COHP Researchers

Agenda

- Catch stewards up on previous weeks' Committee meetings
- Complete mapping risks and identifying interventions for formwork assembly
- Pair up and pick one or two solutions to form assembly ergonomic risks
- Select one solution as a group

Comments

- Researchers showed the stewards the progress on the risk map from the weeks they missed. The stewards added a few items.
- The Committee completed its task of *identifying ergonomic hazards and solutions* for the final formwork assembly tasks: building bulkheads and putting ties in. This was a major turning point in the Committee, as future activities would focus on implementation of solutions.
- The Committee broke into pairs and reviewed the list of all solutions the Committee made during the mapping activity over the past weeks. The purpose of this activity was to *set priorities* for which solutions should be introduced on site.
- The pairs reported 4 solutions back to the Committee (*see list below*). Prior to the meeting, the researchers made a decision to "push" the decision-making process through by the end of the meeting; therefore, the researcher leading the activity was aggressive in taking the lead on prioritization. She used the criteria generated by the Committee in previous meetings to steer towards better access to forms:
 - Job rotation:** People on site are already doing this, and it's already been discussed in toolbox meetings.
 - Laydown areas:** Based on comments throughout risk mapping, it seems difficult to do.
 - Prybar:** We need to *get it in* before we can do anything with it.
 - Good access to forms for tying:** Probably the best bet.
- To the surprise of the researchers, the other Committee members lobbied strongly to work on laydown areas, even though they knew it would be the most challenging item to address. COHP Researchers asked the Committee to spend the next week thinking about how to introduce solutions for laydown areas on the site.
- The Committee decided it would be best to conduct a site walkthrough the following week to better understand current conditions of laydown areas on site.

WEEK 5 MEETING (CONT.)

Quotes of the week

CONVERSATION ABOUT JOB ROTATION:

General Carpentry Foreman: "We do it [automatically]—it's like 'don't hit your finger with a hammer.'"

Carpenter Steward: "But he [the foreman] said it was OK to do it."

COHP Researcher: "So it's some process people do naturally and you've reinforced it."

General Carpentry Foreman: "You've put a word on it [job rotation]."

...LOOKING BACK TO WEEK 2 QUOTE—REASON FOR NOT SELECTING THE TOOLBOX TALK ON JOB ROTATION:

"You have to balance taking it easy on a guy's job and getting it done. If I have to rotate a guy in, I'll never get it done. The crew themselves will direct themselves."

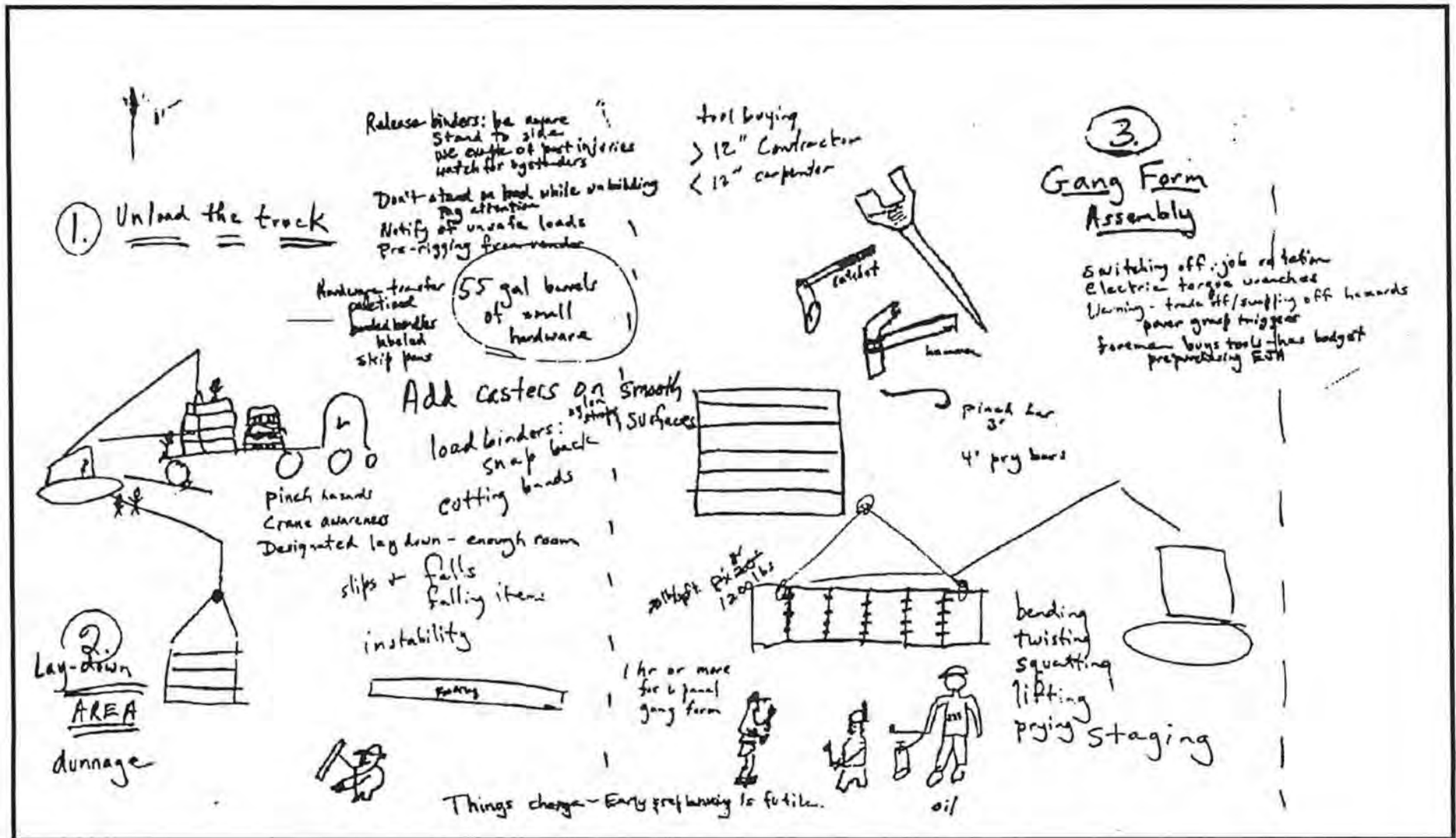
General Carpentry Foreman

Cluttered laydown area



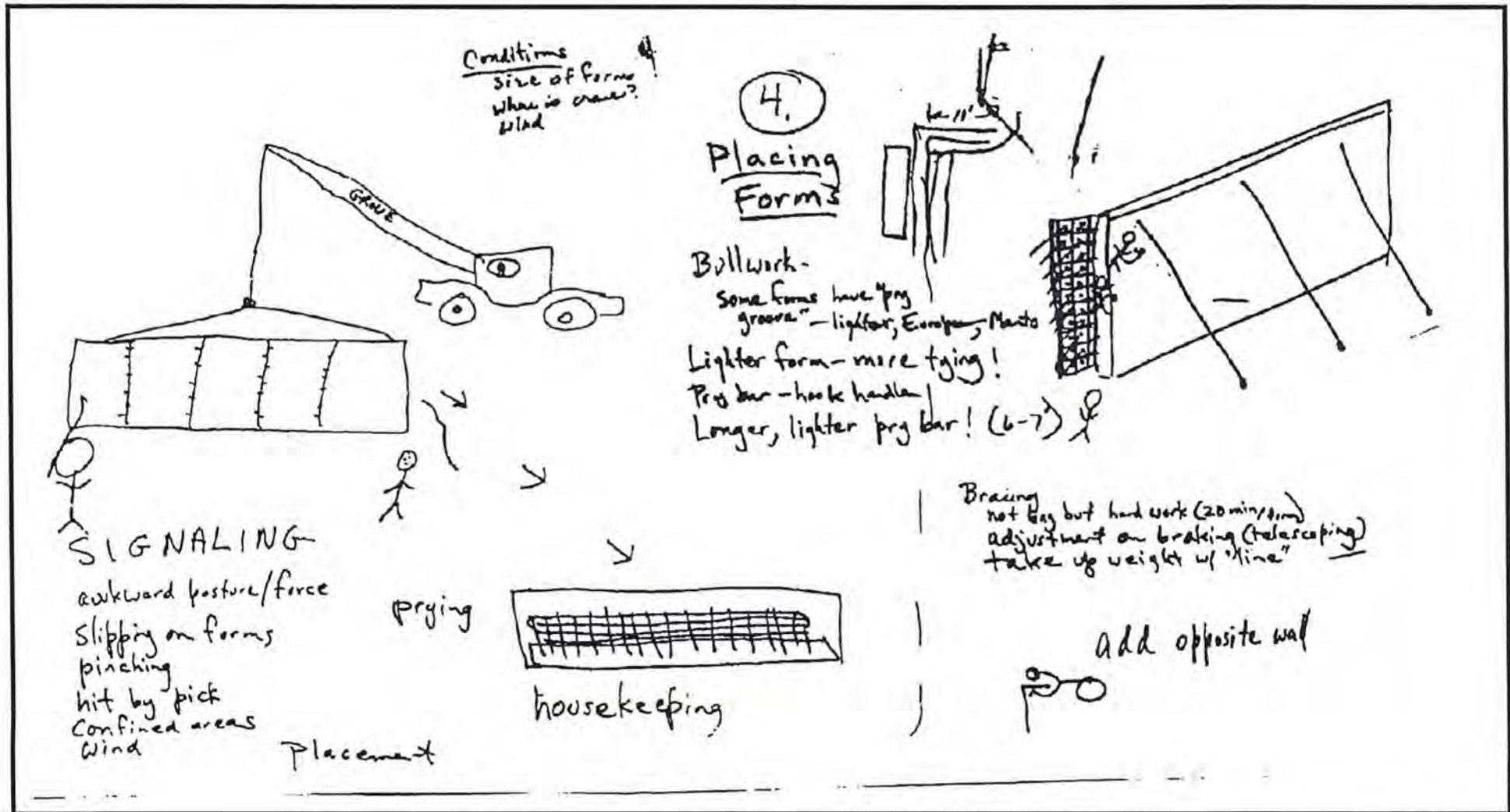
WEEK 5 MEETING (CONT.)

Risk map of form building created during Weeks 2-5



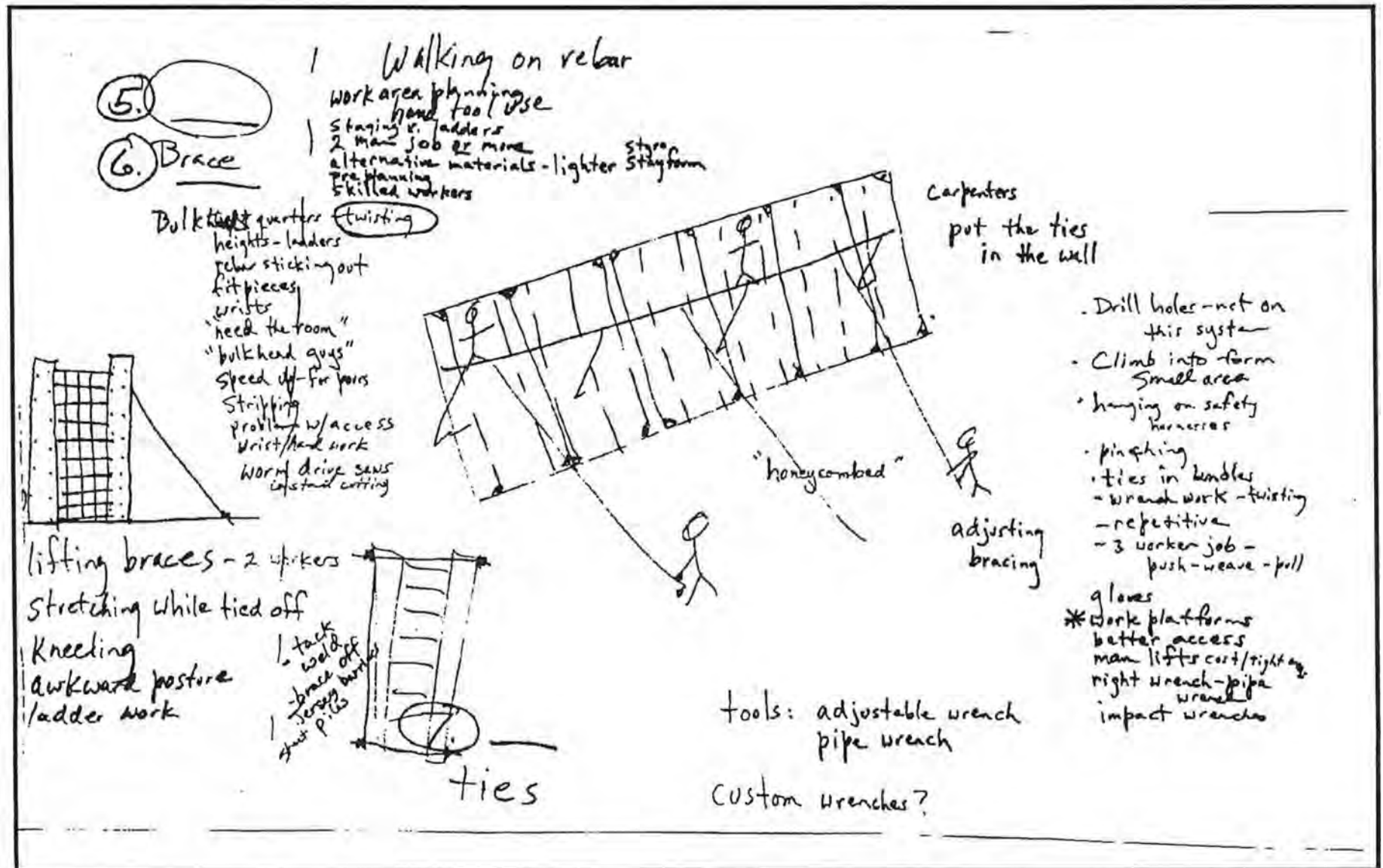
WEEK 5 MEETING (CONT.)

Risk map of form building created during Weeks 2-5 (continued)



WEEK 5 MEETING (CONT.)

Risk map of form building created during Weeks 2-5 (continued)



WEEK 5 MEETING (CONT.)

Committee members and Health Trak Advisory Board reviewing Risk Map in final meeting



WEEK 5 MEETING (CONT.)

Ergonomic hazards identified by the Committee during Weeks 2-5 and by COHP researchers during field observations

TASK	ACTIVITY	HAZARD	BODY AREA
UNLOADING TRUCK TO LAYDOWN AREA	Moving forms and hardware	Awkward postures	Back and shoulders
	Breaking down hardware	Forceful exertions	Back and shoulders
		Awkward postures	Back and shoulders
ASSEMBLING GANG FORMS	Adjusting/prying forms	Forceful exertions	Back and shoulders
		Awkward postures	Back and shoulders
	Bolting with speed bolts	Awkward postures	Back, shoulders, forearms, wrists and hands
		Repetition	Forearms and wrists
		Contact stresses	Knees and hands
PLACING GANG FORMS	Adjusting/prying forms	Forceful exertions	Back and shoulders
		Awkward postures	Back and shoulders
BRACING GANG FORMS	Lifting and positioning braces	Forceful exertions	Back and shoulders
		Awkward postures	Back and shoulders
INSERTING TIES	Bolting ties to panels	Awkward postures	Back, shoulders, forearms, wrists and hands
		Repetition	Forearms and wrists
		Contact stresses	Knees and hands
BUILDING BULKHEADS	Weaving and tying metal between rebar	Awkward postures	Back, shoulders, forearms, wrists and hands
		Repetition	Forearms and wrists
		Contact stresses	Hands

WEEK 5 MEETING (CONT.)

List of Committee solutions created during Weeks 2-5

POSSIBLE SOLUTIONS FOR REDUCING HAZARDS IN FORMWORK:

1. Truck unloading

- Unbinding and moving loads
 - Awareness of safe strapping release and band cutting methods
 - Watch for bystanders
 - Don't stand on loads when unbinding
 - Let vendor know of unsafe loads
 - Have vendor pre-rig loads
 - Watch for pinch/crushing hazards when moving loads
- Moving/handling hardware: most are in cartons on pallets and can be picked with crane

2. Laydown area

- Provide designated laydown area with enough room for panels and hardware: difficult for current formwork but will future work be different?
- Moving/handling hardware
 - Look at weights of cartons and how they are handled
 - Transfer hardware into skip pans or containers that can be picked by crane and lowered in pit
 - Provide wheels/casters on containers so they can be pushed
- Stacking forms: offset or stagger to allow easier/quicker stacking, reduce pinch points, and provide room to remove/install lifting eyes

3. Gang form assembly

- Provide designated area for panel assembly: difficult for current formwork— will future formwork be different?
- Tools
 - Use electric or pneumatic impact wrenches for speed bolting panels
 - Evaluate tools for ergonomic benefits/costs and purchase best tools
- Switch off workers doing repetitive, forceful, awkward posture jobs

4. Placing gang form (Depends on crane location, use of taglines, size of form, and wind)

- Look into longer, lighter pry bars
- Use forms with pry groove/easy access to pry point

5. Installing bracing

- Move braces to placement area with crane
- Attach braces to gang form before placing (requires adjustment of brace after placement and adjustment is high up)
- Hold up braces with rope looped through form when securing to panel

6. Building bulkheads

- Preplan to improve access (improve by excavating enough around forming area and use staging instead of ladders)
- Make two or more person job
- Use alternative, lighter materials (i.e., Styrofoam)
- Use Stayform materials (doesn't need to be removed)

7. Putting ties in

- Preplan to improve access to bolting area (improve by excavating enough around forming area and use personnel lift or staging)
- Use the right tool for the job (long enough wrench or electric or pneumatic impact wrench)

PHASE 3: WEEK 6 MEETING

Present: Laborer Steward, Safety Engineer, General Carpentry Foreman, COHP Researchers

Agenda

Discuss what the Committee observed on the laydown area walkthrough that they conducted right before the meeting

Choose what solutions to implement on site over the next two weeks

Comments

- Prior to the meeting, researchers tried to assemble the Committee for the site walkthrough they had planned during the previous week's meeting. Due to other meetings and generally busy schedules, the researchers were unable to pull the group together for an organized walkthrough. Rather, they walked around and met up with various Committee members on site as they became available.
- Afterward, the Committee convened during its regular meeting time. The Carpentry Steward and the Concrete Engineer were unable to attend the meeting.
- In the meeting, the Committee reviewed *current laydown area conditions*. The original intent was to run through this part of the activity quickly; however, because the site walkthrough was less comprehensive than originally planned, more time was needed to review current conditions in the meeting.
- The Committee then discussed improvements they would like to see and who was responsible for these improvements. The Committee generated several general suggestions, and sketched an ideal laydown area for Pit D formwork, a major upcoming formwork job on site (*see page 30*). Researchers walked the Committee through this process to provide a set of skills that could be applied to future activity planning for this operation.
- The COHP Researchers then asked the Committee *which of these solutions could be implemented* within the next two weeks. Just as the Committee began to do this, the General Carpentry Foreman was called away from the meeting. Researchers asked him to stay five more minutes to help brainstorm. The Committee quickly developed a list, but the activity was rushed. Furthermore, the Foreman had to leave before responsibilities were assigned—and many fell under his domain. (*See page 31.*)
- The researchers felt that they could have done a better job solidifying a plan for implementation of the action items generated by the Committee. They tried to reinforce the outcome of this activity by faxing the Safety Engineer a list of the action items to distribute to the Committee before the next meeting.

WEEK 6 MEETING (CONT.)

Plan for improving laydown areas

ACTION ITEMS FOR IMPROVING LAYDOWN AREAS & RESPONSIBLE PARTIES

Toolbox meeting:

1. Discuss overall plan at Monday safety meeting (*General Carpentry Foreman, Carpenter Steward*)

Planning and getting what you need:

2. Do form planning with a clean, safe area in mind (*General Carpentry Foreman*)
3. Schedule your deliveries for smooth work progress (*General Carpentry Foreman, Concrete Engineer*)

Setting up and laying out the area:

4. Provide receptacles for trash—spare skip pans or barrels (*Laborer Foreman, Carpenter Foreman*)
5. Keep motor vehicle traffic out of there—corner the area off (*Everybody*)

Maintaining the area (housekeeping):

6. Call loader operator to get bucket in area to remove waste and scrap (*General Carpentry Foreman or foremen*)
7. Have Carpenter Foreman talk to laborers to do housekeeping in spare time (*Carpenter Foreman*)

COHP researcher interviewing General Carpentry Foreman during site walkthrough



PHASE 4: WEEK 7 MEETING

Present: Carpenter Steward, Safety Engineer, Concrete Engineer, General Carpentry Foreman, Corporate Safety Director, COHP Researchers

Agenda

Evaluate how laydown area solutions are working

Discuss the "Big Picture" of Health Trak

Discuss how solutions can be spread throughout the site

Comments

- The Laborer Steward was unable to attend the meeting.
- The Committee *evaluated the introduction of solutions* to laydown areas on site. This resulted in a very rich discussion about what was and was not working. (See page 33). In particular, the description of an area with poor access to a ditch triggered a lengthy discussion among the Carpenter Steward, General Carpentry Foreman, and Safety Director that highlighted how improving communications on site can improve health and safety conditions. The Carpenter Steward thought he couldn't get someone to grade or excavate this area without being thought of as a "fanatic". The Safety Director stated it's an OSHA requirement to have access to excavations every 25 feet. The General Carpentry Foreman didn't know this was a concern and said he would correct it. The Safety Director offered to support them if necessary.
- The researchers then spent some time reviewing the Committee's progress to date. Most of the ideas for interventions were specific to formwork assembly. The researchers asked the Committee how solutions could be spread beyond the carpenters and laborers to the other trades and operations on the site. The Committee came up with these ideas and comments:
 - General picture for laydown areas is the same site wide—easy to transfer.
 - A section on laydown areas should be added to the Contractor's generic Activity Planning forms.
 - What COHP has done is bring information and put it into words—it has made everyone aware, has made a little bit of a difference.
 - Depending on the situation, priorities other than ergonomics come first.
 - It doesn't seem productive to rehash with crews each week, but seemed to have made progress over the 7-8 weeks. Carpenter crew has had a good safety record recently—is it luck or is it interventions working?
 - Attitude of foreman is important; you can learn from a crew's good example.

WEEK 7 MEETING (CONT.)

Committee evaluation of plan to improve laydown areas

EVALUATION OF IMPLEMENTATION OF ACTION ITEMS TO IMPROVE LAYDOWN AREAS

WHAT'S WORKING AND WHY?

- Setting up a waist level table to make workspace more comfortable.
- Putting a waste pan in Pit D. Active housekeeping using a magnet was being done because scrap needs to be removed from rebar before the concrete pour.
- In Pit D, kneeling on wood with kneepads. This makes work more comfortable and "saves your knees" (workers provide their own kneepads). Corporate Safety Director asked Safety Engineer to purchase kneepads and make them available.
- Roof assemblies create a covered work area.
- In Pit D, lying down to reach areas is more comfortable (Carpenter Steward stated that lying down on other sites could get you fired but on this job they permit this as long as the job gets done).
- Workers make adjustments on their own.

WHAT ISN'T WORKING AND WHY?

- Construction of a temporary roof over the pit disrupted plans for improving the laydown area. Plans for this construction had not reached the field personnel.
- Temporary roof assembly went slightly awry—(ironworkers held it up because they had to build tracks for the roof structure.)
- The plan was to build one roof structure at a time and then lift it into place.
- There was a learning curve for the roof structure—now things are set up better.
- The roof laydown area freezes and thaws and rain drains into it making the area muddy and difficult to work in.
- The I-90 Cap Beam area does not have enough room. A road runs by, it is not cleaned out, and there's a ditch with poor access.

WHAT CAN WE DO TO MAKE CONDITIONS BETTER?

- Pit D roof laydown area: Grade properly so water drains away from work area. *(Laborers and operating engineers are responsible).*
- I-90 Cap Beam area: Properly grade area. Excavate enough to get forms in. Put in access every 25 feet. Make ramp to get in and out. Maintain good access. Remove clutter. *(Foremen, crews, and stewards are responsible).*

PHASE 4: WEEK 8 MEETING

Present: Carpenter Steward, Laborer Steward, Safety Engineer, Concrete Engineer, General Carpentry Foreman, COHP Researchers

Guests: Members of the Health Trak Advisory Board—representatives from the Massachusetts Construction Safety Alliance, the Laborers Health and Safety Fund of North America, the National Institute of Occupational Safety and Health (NIOSH), and a Boston area contractor safety manager.

Agenda

Follow-up from last week

Review of accomplishments

Committee evaluation of the Health Trak process

Getting the word out

Comments

- During a pre-meeting tour of the site, COHP researchers observed level access to the cap beam formwork and another formwork area had been backfilled and cleaned up. Housekeeping could have been better because stored materials prevented clear pathways. The Safety Engineer also mentioned that the Ironworker Steward had seen the leveling work going on and had asked why this hadn't been done for the ironworkers.
- When the Committee was asked to report on progress with the laydown areas, the Carpenter Steward said not too much had been done because existing pipes/utilities prevented excavating the back side of the cap beam area. The safety engineer said that the General Carpentry Foreman had someone level off the area and clean it up.
- COHP Researchers asked the Committee what the obstacles were to improving access to work areas. They cited the following factors: existing conditions, poor access, lack of awareness that you can ask for what you need, improving access is not standard practice by most/some contractors, and that everyone is used to "terrible conditions". (See page 35.)
- The Committee's evaluation of the Health Trak process is included in the next section of this report.

WEEK 8 MEETING (CONT.)

List of Committee accomplishments and future action items

ACCOMPLISHMENTS/PLANNED WORK FROM HEALTH TRAK ON FORMWORK ASSEMBLY

I. Improved Activity Planning

- Revise existing activity plan for general formwork.
- Incorporate findings of Committee into planning for future formwork activities.

II. Improved Lay-Down Areas

- Continued progress on 7 action items for improving lay-down areas:
 1. Discuss overall plan at Monday safety meetings.
 2. Do form planning with a clean, safe area in mind.
 3. Schedule deliveries for smooth work progress.
 4. Provide receptacles for trash, such as spare skip pans or barrels.
 5. Keep motor vehicle traffic out of laydown areas by cordoning off the area.
 6. Get bucket in area to remove waste and scrap.
 7. Have carpenter foreman talk to laborers to do housekeeping in between other tasks.

III. Improved Site-Wide Ergonomics

- Revise generic activity plan form to include ergonomic hazards and lay-down area planning.
- Pursue the lighter, longer prybar.
- Give ergonomics training to incoming carpenters foremen.
- Provide ergonomics supplement to Contractor's New Worker Orientation booklet.

Obstacles to improving laydown areas identified by the Committee

OBSTACLES TO IMPROVING LAYDOWN AREAS

1. Existing conditions
2. Poor access to areas
3. Lack of awareness that you can ask for what you need
4. Improving access is not standard practice
5. Everyone is used to "terrible conditions"

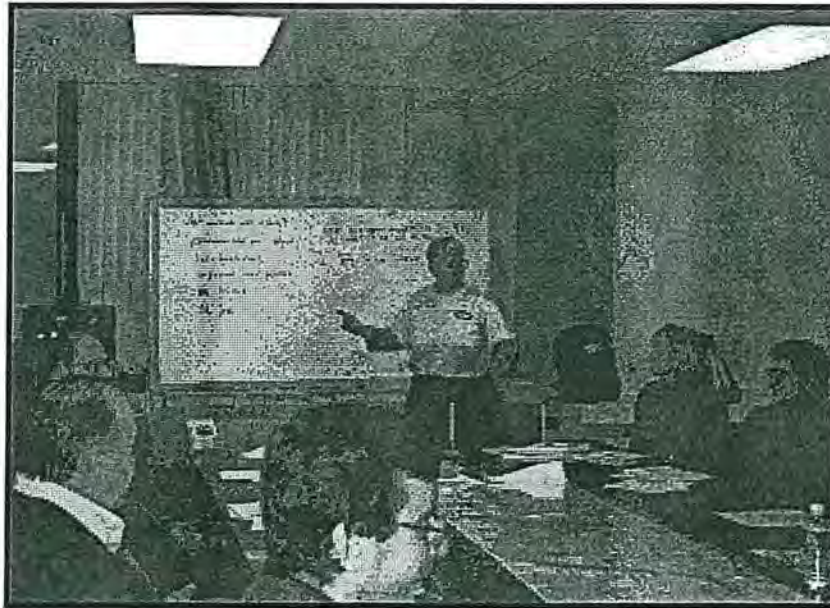
IV. COMMITTEE EVALUATION OF THE HEALTH TRAK CYCLE



Committee members evaluate risk mapping activity

IV. COMMITTEE EVALUATION OF THE HEALTH TRAK CYCLE

COHP Researcher facilitating the Committee evaluation



In the final Health Trak meeting, the Committee was asked to evaluate the eight week Health Trak cycle. Here is a synopsis of their comments.

What worked well in the Health Trak process?

- Knowledge and discussion of ergonomics increased ability to correct hazards.

"The knowledge brought forth gave us knowledge and gave us a chance to implement a program or plan to do better on the job."

Laborer Steward

- Good communication between labor and management.

"They've [management] taught us [labor] and we've taught them. You come together and things get a little better. Now I can talk to [the General Carpentry Foreman] and he won't think we're talking sky-high, fanatical."

Carpenter Steward

- Opened doors to getting management involvement in worker safety.

"In my seventeen years in construction, I haven't seen management get so involved in safety. There's usually not involvement at this level. We're getting paid to be here. You cut corners and typically you cut safety. We have a lot of good meetings—stewards meetings on Mondays with [the Safety Engineer] to go over issues on the job and we try to get it done immediately."

Laborer Steward

- Risk mapping gave an opportunity to look at the 'big picture' around operations. The goal is to have a real working document in the activity plan.

"The next time [the General Carpentry Foreman] and I write [an activity plan], I'll see the different angles from the different trades."

Safety Engineer

- Bringing common ergonomic practices to toolbox meetings was good reinforcement. Key people were identified to communicate information to workers. Continuing dialogues about ergonomics is important to making changes on site.

"There's things we've been doing as an actual practice. To take what you [researchers] have into safety meetings was good. Communication in toolbox meetings was good—repetitive tasks, switching out—those we've always allowed, but it's good to talk about it. We didn't break a lot of new ground, but we got to break the ground we've had."

General Carpentry Foreman

What are suggestions for the next time we do this?

- Superintendent involvement.
- More consistency in members present from week to week.
- More trades involved (e.g., pile drivers, iron workers, operating engineers).
- Set up time schedule consistent with timing of heavy formwork.

How can these ideas be spread though the construction industry?

- Contact corporate safety officers statewide and show them data on savings.

"You have to make a conscious effort to do it. You can't talk about what's going on here without getting your feet wet and talking to health and safety managers statewide. If you have data on cost savings, share it, find the hook."

General Carpentry Foreman

- Put findings into in print, such as COHP *Bright Ideas* or *Health Talk* series. Print on small pocket cards that can be left in trailers or distributed in union halls.
- Get everyone involved in activity planning. Have insurance company involvement (give breaks to contractor).

"You have to do something logistically...implement fines. Get insurance companies involved and give bonuses for [activity planning]. If you had politicians to push insurance companies to give contractors breaks, we'd do the right thing. That's a real way to do it."

Carpenter Steward

- Work with state and regional Labor/Management construction organizations.

V. SUMMARY AND CONCLUSIONS



COHP researcher shares findings from Health Trak cycle with Health Trak Advisory Board

TOOLBOX MEETINGS

The approach to Toolbox Meetings in this cycle differed from the previous two cycles in that COHP researchers did not take the lead in meetings, but attended these meetings as participant observers. Stewards and foreman took ownership of ergonomic topics in their meetings, resulting in natural dialogues among workers about their work environments and how to improve hazards on site. As indicated earlier in this report, workers felt that these Toolbox Meetings on ergonomics did not cover new information; but most agreed that openly discussing these topics among the crews demonstrated that it was acceptable to openly address ergonomic hazards on site.

PARTICIPANT OBSERVATION

The researchers were pleased that a previously less-successful part of the Health Trak research design, Participant Observation, was better integrated into this cycle than in past cycles. This was particularly true with respect to Committee members reporting back on toolbox meetings and Committee members participating in the site laydown area walkthrough in Week 6.

GENERAL PROCESS OBSERVATIONS

COMMUNICATION. A common thread throughout this Health Trak cycle was improved communications among Committee members as the cycle progressed. The beginning of the cycle was marked by some strained communications and posturing. As time progressed, lines of communication and exchange of information improved. In fact, in the final meeting, one Committee member noted "less posturing" as something they particularly enjoyed about the session.

RISK MAPPING. The process of risk mapping had substantial strengths and some weaknesses. As discussed above, choosing the specific operation of formwork assembly afforded the Committee the opportunity to delve deeply into the risk mapping process and arrive at an extremely comprehensive list of hazards and solutions. The workers had the opportunity to organize and articulate their knowledge in a structured process. As mentioned earlier in this report (*page 6*), the COHP has previously written two papers on ergonomic hazards associated with the formwork operation. The participatory research process greatly increased the COHP's knowledge of this operation, particularly with respect to interventions. This was the first time that the Health Trak committee members did a formal risk mapping exercise, and as can be seen in the summary graphic on page 13, more time was spent on this activity than any other during the cycle. This and the eight-week limit on the cycle resulted in the following issues: 1) some of the Committee members complained that the risk mapping activity was more for the researchers than for them since they already knew the process of formwork assembly, 2) many of the suggestions for change generated in the risk mapping exercise were not incorporated in the final implementation phase of the cycle since this was only focused on laydown areas, and 3) spending so much time on identifying hazards and solutions left less time for implementation of solutions and evaluation of the entire process.

COMMITTEE MOMENTUM. This Health Trak cycle boasted a strong Committee that developed an extensive list of potential interventions and action items. During the final Committee meeting, as Committee members reviewed the list of work remaining to be done, some participants suggested a follow-up meeting to check progress on the items. COHP researchers obliged, and with the help of the Safety Engineer, a follow-up meeting was scheduled about a month after the completion of the Health Trak cycle. On the morning of the meeting, the Safety Engineer reminded the Committee members about the meeting; however, none made it to the meeting later in the afternoon. It is the COHP's experience that without the infrastructure of a weekly Health Trak meeting, it is difficult for both researchers and Contractor participants to retain their momentum to provoke changes on site.

While the Health Trak research design is not intended to promote a Health Trak Committee that continues to meet on a regular basis after the end of a cycle, COHP researchers believe that the process of the Committee should bring some momentum for change that leaves a more permanent footprint on the Contractor's health and safety system. In the case of this Health Trak cycle, it is unclear whether the activity planning skills developed among Committee members have been used since the formal Committee meetings ended. This is an area that the COHP plans to address in the future through continued revisions to the Health Trak Committee process and improved evaluation methods.

Researcher facilitates final Committee meeting



LESSONS LEARNED

Three lessons were learned in this cycle that should be considered in future Health Trak cycles:

- 1) **EIGHT WEEKS IS TOO SHORT.** Having only eight weeks for intervention research has been an ongoing challenge to the Health Trak program. The Health Trak protocol was designed for eight weeks based on COHP researchers' experience that this is the absolute maximum amount of weeks a contractor will allow a Health Trak committee to convene. However, it is still too short for an in-depth analysis of hazards and implementation of solutions. Moreover, even when there is limited time for implementation of solutions, these tend to be "quick fix" solutions to meet time deadlines—they are not necessarily the best solutions. The COHP hopes to run another Health Trak cycle with the same contractor from this cycle; the hope is that less time will need to be spent getting participants "up to speed" and more time will be spent on developing and implementing interventions.
- 2) **RISK MAPPING IS A VALUABLE TOOL.** Although risk mapping was attempted in the two previous Health Trak cycles, this is the first time that the activity was fully integrated into the committee meetings. The Committee generated rich information on ergonomic risks and solutions for formwork assembly during the four weeks they spent on this activity. As previously discussed, there were some disadvantages to such an intensive risk mapping activity; however, these could be rectified through some modifications. A better explanation of the purpose of risk mapping as a tool for hazard identification might reduce workers' frustration that they "already know how to do their jobs" and that mapping just helps the researchers. Furthermore, "streamlining" the risk mapping activity could save time and reduce the amount of "extra" hazards and solutions generated that never make it to the implementation stage. Streamlining could be achieved by having the committee do a cursory review of the hazards for each task in an operation and then choosing one or two tasks for developing solutions. However, quickening the pace of the activity too much might water it down and render it ineffective. It will be a challenge for COHP researchers to find this delicate balance in upcoming Health Trak cycles.
- 3) **FURTHER CLARIFICATION OF RESEARCHERS' ROLE IN TOOLBOX MEETINGS.** As of this third Health Trak cycle, researchers have covered the entire spectrum of participation in weekly toolbox meetings. In the first two cycles, COHP researchers took an extremely active role in toolbox meetings; in the third cycle, researchers took a purely observational role. In the next cycle, COHP researchers hope to better integrate these two approaches to merge their strengths and help build more worker momentum for positive change in workplace safety and health programs.

APPENDIX F.

Health Trak Cycle 4 Final Report: Noise Control in Construction



Technical Report

Health-Trak Cycle 4 Final Report: Noise Control in Construction

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Reports on Health Trak Cycles 1-3 are available from
the Construction Occupational Health Program.

I. EXECUTIVE SUMMARY

The Construction Occupational Health Program (COHP) and construction joint venture Slattery, Interbeton, White and Perini (SIWP) partnered in a Health Trak research activity on noise control in construction. Health Trak involved eight stewards from six trades and five SIWP safety professionals in a five-week series of discussions, interviews, and observation during the autumn of 1999.

Discussions centered on the hierarchy of controls. This industrial hygiene principle states that hazards should first be eliminated or controlled at the source, while personal protective equipment is a last resort for cases where elimination or control are not feasible. Based on the questions, opportunities, and obstacles addressed during Health Trak, researchers developed these recommendations for feasible reduction of noise exposure at SIWP:

1. Incorporate noise reduction into activity planning.
2. Incorporate informal noise monitoring into site walk-throughs. Monitor for noise periodically, beyond the schedule and location mandated in specifications.
3. Keep an ongoing record of noise monitoring results.
4. Deliberately seek out the noisiest areas and operations on site, and monitor there.
5. Use monitoring results to identify, post, and enforce “noise perimeter zones” and maximum exposure time within high noise areas.
6. Ensure that workers receive hearing protection devices with Noise Reduction Ratings adequate for the sound levels they are exposed to.
7. Institute administrative procedures to tie PPE checkout to equipment checkout. For example, use a written policy to check out both muffs and plugs with bar locking equipment. (“Would you like muffs with that burger?”)

COHP researchers then developed a simple, user-friendly protocol for calculating noise perimeter zones and maximum allowable exposure times. This protocol is described in Appendix 1 of this report.

II. BACKGROUND

1. HEALTH TRAK

Health Trak is a form of Participatory Action Research developed by the Construction Occupational Health Program (COHP) at the University of Massachusetts Lowell. Health Trak involves researchers, workers and managers on various contracts on Boston's Central Artery/Third Harbor Tunnel Project (CA/T). Participants join in a partnership to identify worksite hazards, develop solutions to those hazards, and explore the feasibility of the solutions.

Health Trak has three pieces:

1. Health Trak Committee

The committee consists of representatives from management and labor. This process requires a majority of workers to help compensate for the imbalance of resources between labor and management. Health Trak Committee meetings are feasible for a construction sites because they last exactly one hour and end on time.

2. Toolbox and Safety Meetings

During the Health Trak cycle researchers participate in some of the site's toolbox and safety meetings. Managers and foremen can also incorporate information discussed in the Committee into toolbox and safety meetings.

3. Participant Observation

The committee uses participant observation to gather data from two sources. Researchers hold informal interviews and conversations with workers and managers on site. Labor and management Health Trak Committee members also seek information or questions agreed upon in Committee meetings.

Health Trak aims to identify, then actually institute, solutions to health hazards. The process does not seek particular numbers of solutions. Instead, participants focus on finding solutions that contractors will actually implement and that can remain in effect over time. Any solution put in place in the field is considered a success.

Participants in the Health Trak Committee identify hazards, design solutions to them, and try to implement the solutions on the job. Researchers then try to learn why solutions are or are not implemented, whether the solutions are effective, and how long they stay in place.

Researchers raise questions that help Health Trak participants see conditions on site in new ways. Participants may be able to look differently at things they see all the time, but don't actively notice or think about.

A typical Health Trak cycle lasts eight weeks. The first few weeks involve the identification and mapping of hazards, while the final several weeks are devoted to designing and attempting solutions to the hazards.

2. THE HEALTH TRAK CYCLE ON NOISE IN CONSTRUCTION

The Health Trak cycle described in this report is unusual because the contractor defined the hazard before the start of the cycle. In this case, management requested a specific focus on noise. The cycle therefore ran for only five weeks, skipping the first three weeks normally used to identify hazards.

Researchers brought two main questions to this cycle:

1. Can we reduce exposure to noise?
2. Can it stick? That is, can what we do in these weeks continue after we leave?

In the previous cycle, which focused on ergonomics in concrete form-building, participants designed several solutions to sprain and strain hazards. However, these solutions were not maintained in the field in the months following the cycle. In this cycle researchers hoped to learn how to improve the likelihood of identified solutions being implemented and continued over time.

At the first committee meeting participants decided that this cycle would focus on noise in East Bound construction. They decided that this portion of the site would be most appropriate because workers were putting up decking on that side, while on the West Bound side they were still erecting walls.

3. STUDY SITE

The joint venture of Slattery, Interbeton, White and Perini (SIWP), the general contractor on Central Artery/Tunnel site C09A4, has worked with the COHP over the past two years. In 1998 the COHP identified SIWP as a Model Contractor, a contractor with unusually good safety practices that participates in COHP research to design ways to protect worker health. Managers have explained that this contractor takes more than the required measures to keep the workplace safe, for example hiring a consultant to make sure they are covered for preventing accidents with

electricity. In other words, they pay money now to keep people safer and so save money in the long term.

Participant observation before and during this cycle has shown that most workers consider SIWP to follow unusually good safety practices. They often identified three specific factors that distinguish this contractor:

- Workers felt free to report hazards they see on site without fear of being harassed or laid off in retaliation.
- Workers were almost always able to obtain the correct equipment needed to do the job safely.
- SIWP did not emphasize the Central Artery incentive program which rewards workers on sites with low levels of reported injuries. Many workers on this site described feeling free to report injuries they experience without being pressured to continue working while injured in order to win a prize.

We have it good here. They treat us good. We have to repair something, they don't hold back, say "don't buy this." – worker on site

I don't like bonus programs, incentives. It's corrupt. They get them at [another contractor's sites] all the time.... All I want is what we're entitled to, what we bargain collectively. Let them keep the rest. – worker on site

I know of another job on the Artery where an oiler broke his foot in three places and he's still on the payroll, with no lost time. – Operating Engineer

SIWP also encourages the active participation of stewards in its safety program. Union stewards on SIWP communicate about safety issues across trades, while cross-trade communication on other sites is usually limited to jurisdictional issues.

SIWP partnered with the COHP for the Health Trak cycle previous to the one described in this report. That cycle focused on preventing sprain and strain injuries in concrete formwork (technical report available from the COHP upon request). For this cycle, SIWP specifically requested that COHP researchers lead a Health Trak cycle focused on noise. Noise is a major problem on nearly all construction sites, but SIWP is the first contractor in the COHP's experience that wants to take action to address this problem.

SIWP was recently certified for ISO 14001. Noise is a “significant aspect,” or identified hazard, for this certification. SIWP safety officers explained that this requires the contractor to develop a monitoring program to mitigate noise exposure. Specifically, the site must not expose residential areas to sound levels above 68 dB – a requirement made relatively easy by the lack of residential areas near the site.

Managers reported that Bechtel/Parsons Brinkerhoff, in charge of safety for the CA/T, looks for hearing protection during their weekly safety audits. They also send letters to contractors with high levels of recorded noise, but they may misidentify the site which is the source of the noise.

During this Health Trak cycle the committee explored SIWP’s approach to noise. According to safety officers, toolbox meetings have included discussions on noise, but actual noise reduction had not been a focus. One safety officer explained that they had entertained ideas about noise reduction.

Most noise-related safety activities on SIWP had emphasized personal protective equipment (PPE). Safety officers explained that they had tried to teach workers where PPE is found on site and how they could get it. They also stated that seeking ways to reduce noise is clearly in their job description as safety officers.

Researchers emphasized that a focus on noise reduction would fit this contractor’s interest in leading the industry in terms of safety. European countries already have higher noise prevention standards than the U.S., and one researcher predicted that noise will become a high-profile issue like lead in paint, or silica dust, within 15 years. Starting noise prevention work now provides the contractor safety staff with the opportunity to work on the cutting edge of the industry.

4. PARTICIPANTS

One basic rule of Health Trak is including a majority of representatives from labor. This requirement stems from the fact that management has more control of the worksite as well as time and resources for addressing health and safety.

Participants in this Health Trak Committee were

Labor

Dan Flynn (Carpenters Local 33 steward)
Jimmy Gaine (Laborers Local 223 steward)
Steve Gil (acting Carpenters Local 33 steward)
Mike Huxley (Ironworkers Local 7 steward)
Dominic Mazzeo (Tunnel Workers Local 88 steward)
Warren Richards (Piledrivers Local 56 Steward)
Richard Sullivan (Operating Engineers Local 4 steward)
Anthony Wall (Ironworkers Local 7 steward)

Management

Mike Adams (SIWP Safety)
Mal Flynn (SIWP Safety Engineer)
Derek Lines (SIWP Safety)
Mike Okuniewicz (Slattery Safety)
David Walbourne (SIWP Quality Control, Environmental)

UMass Lowell

Kwangseog Ahn
Lenore Azaroff
Scott Fulmer
Susan Moir

III. RESULTS OF THE HEALTH TRAK CYCLE ON NOISE

1. HEALTH EFFECTS OF NOISE

The Health Trak Committee discussed the health and safety effects of exposure to high levels of noise. Participants quickly identified health effects caused by noise exposure over the long term. All immediately named hearing loss. One steward remarked that he wished they had had noise protection 35 years ago so he would have better hearing now. The stewards had also experienced noise leading to stress, which over the long term causes circulatory problems, heart disease, high blood pressure, arteriosclerosis, and a weakened immune system. One asked whether noise kills brain cells.

Participants then discussed health problems resulting from noise in the short term. These included headaches, stress, and fatigue. A researcher told of her experience working on a particularly noisy site and going home exhausted at the end of the day although she had done nothing more physically demanding than collect data. Eventually she realized that she was exhausted by the high levels of noise.

The committee discussed noise as a safety hazard as well as a health hazard. Participants explained that loud noise reduces communication. A sudden loud noise can make people jump, disrupting their concentration or making them move equipment unsafely. One participant noted that if noise prevents workers from hearing the backup alarm on a vehicle, they can end up under the wheels. Another explained that noise can lead to anger or violence between workers: "Turn that friggin' thing off!" A researcher stated that studies have found a high association between noise and accidents, especially falls.

One steward reported that overexposure to noise can cause disorientation and vertigo both in the short and long term. He described a friend, a tank engineer who still gets vertigo from the shells he heard going off in Korea.

A researcher asked the participants about their hearing. One steward said that he has no problem hearing one person speak, but feels deaf if there is other noise going on while someone is speaking. Another reported an overall loss in hearing. A third said his hearing was still good. One manager described his hearing loss at certain frequencies.

The researcher explained that people can test their own hearing with "the radio test." She suggested that when participants get out of the car in the morning they set the volume on the radio so they can just hear it comfortably. When they get back in the car at the end of the

workday they should ask themselves whether they have to turn the volume up higher than they had it in the morning. If so, this suggests that they have a temporary threshold loss.

One of the stewards remarked that he has noticed this threshold loss from the other direction. When he gets in the car in the morning he wonders why the radio is so loud. Another has noticed that when he gets home after work he talks louder than before work, and his wife asks him why he's yelling.

2. NOISE SOURCES

This cycle used two sources to identify the most important sources of noise on site: A UMass Lowell doctoral student took sound level measurements on site during the previous summer and identified three main sources of noise: compressors, drill rigs, and bolting rebar. A researcher presented these findings to the Health Trak Committee and asked for members' thoughts on the most important sources of noise.

The committee explained to the researchers that bolting together rebar is called bar locking. Members agreed that bar locking is one of the noisiest jobs on site, especially for ironworkers. They explained that bar locking uses an impact hammer and compressed air that create great force. The metal tool impacts the metal rebar, which in turn slams on more metal. Finally, this impact noise travels down the metal.

It's horrible. There's no cheating.... The machine tells you when you're done, snaps off the head. You have to wait for that noise. – SIWP engineer on bar locking

The committee discussed alternatives to bar locking. An engineer explained that Central Artery rules control the methods for joining rebar. For example, he said that they are not allowed to cross rebar of size 14 or 18, but must bar lock them with a minimum gap in between. He added that this rule allows for no flexibility: You have to bar lock or come up with another design.

The committee agreed that piledriving creates a huge noise problem, but one that's not easy to solve. Members then identified other sources of noise in their current work areas:

heavy machinery

- 14-ton crane
- older model, non-electric road headers
- scoop trams (front end loaders)
- Brocks
- Grade-alls
- rubber tire back loaders
- trucks
- man lifts

smaller equipment

- diesel welders
- small gas generators
- compressed air machines
- power washers

hand tools

- skill saws
- power hand tools
- vibrating hammers
- sledge hammers

other

- yelling over the communications radio

Overall, members identified pile driving, bar locking, scoop trams, sledge hammers striking steel, and air-powered hand tools as the most important sources of noise in their work areas. Noise is further aggravated when it creates resonance under a metal deck. The overall level of noise in any particular space depends on what combination of machinery and tools are operating at the same time.

Managers on the committee also identified the nearby Amtrak trains as one of the most important sources of noise.

Workers corrected the researchers' terminology for the third source of noise identified by UMass Lowell: the loud machines described by the student are compressors, not generators. After discussion a researcher noted that the Health Trak Committee, unlike the COHP, did not identify compressors as a major source of noise. Workers explained that compressors are built with silencers, and that they rarely work very close to them.

During the cycle researchers examined a compressor running on site. It was not quite closed due to a broken latch. They estimated the nearby noise level at 80 dB, with noise from the compressor at high pitches.

Researchers also noted that even several stories above the location called Pit D, noise from the pit impeded communication.

3. NOISE SOLUTIONS

In the Health Trak Committee a researcher reviewed the industrial hygiene principle called the "Hierarchy of Controls."



A researcher explained that, in her experience, researchers want to follow the hierarchy, while the other members of the committee will focus on "going down the pyramid." A task of the researchers is to push other committee members to consider higher points on the pyramid or explain why they think interventions at those levels won't work. To illustrate this approach the researcher distributed an article on noise control in boats (see Appendix).

If you're taking people out in a boat Sunday, do you make them wear muffs? Do you make them stay in the bow? No. They use baffles, enclosures, retro-fitting to keep the noise down.
– COHP researcher on noise prevention in boats

Although industrial hygienists consider PPE to be a last resort, a researcher pointed out that it's often the most familiar method for many people. In the case of noise, this means ear muffs and plugs. The researcher had observed widespread use of ear plugs based on the large numbers discarded on the ground, but had seen little use of muffs. A manager explained that SIWP has started to use a new, more comfortable model of muff that has a velcro strip across the top for support.

ELIMINATING NOISE AT THE SOURCE

The Hierarchy of Controls states that the most important control is eliminating the hazard at the source. For example, managers on the Health Trak committee reported that the contractor had installed an extremely quiet ventilation system in a tunnel. The committee tried to identify other examples of elimination to reduce noise, such as substituting hand digging for pile driving or hand tools for power tools. However, they explained that these types of solutions would slow the work to an unacceptable pace.

Participant observation by the researchers raised further questions about possibilities for eliminating noise at the source. They observed that workers leave generators running when they move away to other tasks. When asked, the workers said that they did not plan to turn the generator off. This raised three specific questions:

1. Can workers turn off generators when they are not using power?
2. The way this generator is designed they have to leave the door open to use it, which increases the sound levels. Do some generators run with the door shut?
3. A yellow electrical cabinet with 14 outlets was nearby and doesn't make noise. Why do they need a generator?

Committee members answered that the electrical cabinet provides interim power only for a tower crane. It doesn't carry enough power for additional equipment. They also corrected the researchers, explaining that the piece of equipment researchers called a generator was actually a light plant not intended for use as a generator.

This new information in turn led to three further questions:

1. Why is the light plant being used as a generator?
2. Who is responsible for turning off the power source when it's not in use?
3. Is the equipment rented or owned?

The reason for the light plant being used instead of a generator remained unclear. One manager suggested he had heard of a safety problem connected with generator use in that area. The discussion revealed that no one particular person is responsible for turning off such equipment. In theory, everyone is responsible for turning it off to save fuel, but this results in no one doing so.

The committee explained that some light plants are rented, but most are now owned by contractors participating in the joint venture. A researcher suggested that they could be hard wired so equipment can plug into the outside. Another committee member added that another site down the street had Ingersoll Rand electricity sources wired with outlets on the outside. He also explained that when electricity sources are hard wired, you don't have to fire them up.

A similar discussion addressed turning down engines of heavy equipment when an operator is waiting between loads. Operators themselves are partly protected from the noise when their cab is closed, but nearby workers can be unnecessarily exposed. A researcher suggested a system for encouraging operators to lower the decibel level of their rigs when possible.

ENGINEERING CONTROLS: CONTROLLING THE HAZARD AT THE SOURCE

The second step in the hierarchy is controlling the hazard at the source. The committee identified several examples of this type of control:

- Heavy equipment comes equipped with mufflers.
- Sound barriers can block noise around piledrivers.
- Piledrivers can reduce the impact on the equipment.
- Stacks can direct the noise away from workers.

A researcher challenged the committee about improving the muffling of heavy equipment. She asked about policies and procedures for ensuring that all heavy equipment has the best muffling and that the muffling is maintained over time.

The operating engineers steward explained that the master mechanic is responsible for maintaining the heavy equipment. He depends on daily reports he gets from the operators. For example, one piece of heavy equipment recently had a bad muffler and they got rid of the machine. The steward explained that the master mechanic and safety officer share the ultimate

responsibility for ensuring that everything is properly muffled. However, the committee was not able to describe an existing inspection system for maintenance of muffling.

Participant observation by researchers on site confirmed that the master mechanic feels responsible for repairing and maintaining heavy equipment, including compressors and generators. He reports replacing any mufflers that fall off. He also explained that the smaller compressors and generators contain some insulating lining and that he has never seen the lining fall out.

ADMINISTRATIVE CONTROLS

Isolation

Administrative controls follow elimination and engineering controls in the Hierarchy of Controls. Administrative controls are systems to minimize worker exposure to hazards that cannot be controlled at the source. The committee gave the example of moving people around: if one person is working on a loud task and four people are hanging around, the four people don't need to be there. A researcher extended this idea to isolation, the practice of posting high noise areas to keep out unnecessary workers. A manager compared this to the current practice of posting a liquid nitrogen area on site.

Participants suggested that, in areas where activities change frequently, they could post keep-out notices around certain activities rather than areas. In other words, they could place signs warning non-essential workers to stay outside certain perimeters around especially noisy activities like driving sheet piles or using jackhammers.

Job Rotation

A steward recommended limiting personal exposure to noise by having a group of people work in one location for a week then move to another location. A researcher agreed, explaining that this is the industrial hygiene practice of "job rotation."

PERSONAL PROTECTIVE EQUIPMENT

Most participants in the Health Trak Committee agreed that of the solutions recommended in the discussion, improving PPE had the best chance of being implemented in the field. Managers reported that they already required hearing protection for certain jobs, such as chipping concrete.

The committee discussed ways to improve the use of PPE. These included

- making sure to use ear plugs and muffs with a high enough Noise Reduction Rating (NRR) for each situation
- requiring hearing protection for the noisiest jobs, for example piledriving and bar locking
- requiring hearing protection for certain areas, for example outside the tunnel being pipe jacked

A researcher asked the committee how workers obtain the hearing protection they need for doing particular jobs. Committee members said that the ironworkers have their own box of tools. The laborers steward explained that if a laborer gets a pavement breaker or a rivet buster, typically he will take some sort of ear plugs and respirators. The researcher recommended that the contractor institute a formal sign-up procedure for automatically signing out personal protective equipment with tools, a system like the fast food practice of asking if you would like to buy something additional: “Would you like muffs with that burger, sir?”

Managers in the committee suggested that giving workers the correct PPE should be the responsibility of the foremen. Some foremen on site are already careful to make sure their whole crew is wearing the appropriate hearing and eye protection.

During participant observation a master mechanic told researchers that he and the stewards know where they’re placing workers and give them the PPE they need, including ear muffs.

4. STEPS TO CHOOSING THE BEST CONTROLS

NOISE MONITORING

In order to use any type of control effectively, the contractor must know where noise levels exceed safe levels. Researchers emphasized that they did not plan to continue noise sampling themselves. Instead, they would work with the contractor to develop a sampling strategy.

Managers on the Health Trak Committee explained that current noise sampling is normally triggered either by CA/T rules, which require sampling at the site perimeter on a regular basis, or by ISO rules, which require them to limit the noise that affects the site's neighbors. On site, the main trigger for monitoring has been worker complaints.

Sometimes the men say, "you don't do anything until we complain." Well, that's the way it's going to be. That's why they need people out there calling their attention to the problem.

– SIWP Manager

A researcher raised the suggestion of incorporating noise measurements into site walk throughs: "What if you had a plan where one of you guys walked around one, two, three times a week, identified noisy areas, and posted them 'Hearing Protection Suggested'? ...Take people out with you, monitor the noisiest places, you'll have people with you who know what to do about the noise. Make informal noise-monitoring part of the walk-through." She recommended keeping a record of these measurements. Some committee members agreed with these suggestions.

ACTIVITY PLANNING

Managers use activity planning forms to describe upcoming jobs and plan steps to prevent environmental and safety hazards. Managers on the Health Trak Committee repeatedly emphasized the importance of activity planning as the best way to identify noise problems before they start and prevent them if possible. A researcher asked whether current activity plans address noise. Committee members were uncertain, but one thought that the plan for Pit D probably did.

The researcher also suggested that activity plans assess noise, but not solutions to noise. Managers pointed out that plans call for posting high noise areas around pile driving. They could also include more solutions, for example keeping other trades at a distance during bar locking. A steward reported use of an activity plan to negotiate connecting concrete incubators with an electrical box instead of noisy generators.

The discussion indicated that most workers on site are not familiar with activity planning, but that the employer considers it a matter for the safety department and the superintendent. Workers are not involved. Managers on the committee explained that they are still working to refine the process of activity planning.

TRAINING

Committee members agreed that workers need better understanding of hearing protection. Until workers really understand the issue, they are not likely to take it seriously. Hearing the message repeated in different forms also helps workers absorb it. Managers said that they were hoping to involve foremen in more training as part of an effort to increase the foremen's credibility. The safety officers print up what they want the foremen to present and make an effort to attend trainings to answer questions.

5. OBSTACLES TO IMPLEMENTING NOISE CONTROLS

OBSTACLES TO ELIMINATION OF NOISE SOURCES

Committee members explained that certain operations, like piledriving, cannot easily be made quieter. For these operations they had only seen engineering controls such as barriers or administrative controls such as restricting the time of day this work is performed. Piledrivers can turn down the impact, but this slows their pace of work.

Several attitudes and beliefs expressed by committee members made it hard for them to recommend methods to eliminate noise.

- Some of the managers repeated their belief that the biggest noise problem on site comes from Amtrak trains.
- Most members were primarily familiar with PPE as a form of control and had not had much experience with elimination or engineering controls.
- Stewards explained that many workers expect noise, and even hearing loss, as part of the job.

The committee discussed the reasons that many workers accept hearing loss from their work. Some feel that it's a reasonable tradeoff for the other advantages of their job: unlike white collar workers, they feel free to leave a job they don't like and get another, and they don't feel the same types of stress as office workers. Others emphasized the need to accept noise in return for having a job.

Sixty-70% of piledrivers I know have some hearing loss. That's the way it is, if you want to do this work, unless you develop new technologies – Piledrivers Steward

I don't even use ear plugs. I've just gotten used to the pain.
– Ironworkers Steward

Noise is just part of the business.
– Operating Engineers Steward

Stewards also suggested that management would hesitate to invest resources in reducing noise since they see no immediate financial gain as a result. A researcher argued that employers do indirectly see saving over the long term. She agreed that these savings are difficult to demonstrate and measure, since there is no clear way to count accidents avoided or productivity increased because of less noise.

Participant observation by researchers identified an obstacle to snubbing down the sound level of heavy equipment between loads: the operator in a closed cabin may hear much less noise than the laborers or ironworkers outside, so isn't aware of the problem. The common lack of communication among different trades can prevent him from realizing the need to change practices to protect other workers.

Researchers and other committee members agreed that inconsistent enforcement of OSHA standards, and lack of OSHA emphasis on noise reduction rather than PPE, discourage contractors from seeking ways to reduce noise.

OBSTACLES TO ENGINEERING CONTROLS: BARRIERS

The committee identified two main obstacles to placing sound barriers around noisy operations:

1. Many noisy operations on the site are mobile. For example, it would be impractical to follow ironworkers around with barriers when they are doing bar locking.
2. The operating engineers steward had seen barriers used on a site close to a residential district. The barriers blocked the operators' line of sight and they needed extra tagmen. He described this solution as a "disaster."

OBSTACLES TO ENGINEERING CONTROLS: MUFFLERS

Some equipment can't be muffled because their loudest noises result from dumping hard materials.

Committee members said that the master mechanic is responsible for maintaining the muffling installed by the manufacturer, but not for doing additional retrofitting to improve sound control. Field research with the master mechanic confirmed this belief, although, interestingly, he does retrofit the equipment for emissions scrubbers.

Noise reduction, it's whatever they come with. – a master mechanic on noise controls for heavy equipment

Stewards from other trades explained that they would not normally speak to the master mechanic about loud equipment that bothered their members, since they have no authority over him. This provided an example of lack of cross-trade communication as an obstacle to improved working conditions.

A manager suggested that muffling has a direct effect on the efficiency of the engine. He said that manufacturers limit the extra devices that can be installed on a piece of heavy equipment. Otherwise, reducing a hazard like noise might increase another hazard like emissions.

The committee also identified an obstacle to diffusing noise with stacks, in this case the position of some of the noisiest equipment in deep pits.

OBSTACLES TO ADMINISTRATIVE CONTROLS: ISOLATION

The committee identified obstacles to posting loud areas as closed to non-essential workers. Because jobs change so quickly, and many take place in such small areas close to many other jobs, management would not be able to post many jobs fast or accurately enough.

In the pits, it's really noisy with the bar locking, but once the ironworkers leave, the electricians come in. They're quiet as church mice. – SIWP Manager

OBSTACLES TO IMPROVED USE OF PERSONAL PROTECTIVE EQUIPMENT

Posting Areas as Hearing Protection Required

Posting areas “hearing protection required” does not necessarily result in the workers wearing appropriate hearing protection. The committee identified several obstacles to the use of adequate PPE:

- Workers have not received sufficient information about Noise Reduction Ratings and the selection of PPE adequate for a given job.
- Further education is needed to convince workers of the need for hearing protection.
- Jobs change rapidly, so areas are not posted if a loud activity lasts for only a short time.
- People sometimes ignore or vandalize signs.
- The workforce is too fluid to conduct a concentrated campaign to encourage hearing protection.
- Some ear muffs are heavy and uncomfortable.
- Some stewards report that not all workers know where to obtain ear plugs on site.
- Required use of hearing protection, such as for piledriving or chipping concrete, is not always enforced.
- Not all managers were able to recall the trigger sound level at which OSHA requires Hearing Conservation Programs.

Despite the obstacles, a researcher encouraged the committee to “push the envelope a little bit more” with regard to hearing protection. She reminded members that cultural change in construction is possible, and gave as an example the dramatic increase in use of hard hats and safety glasses over the past few years.

“Would you like muffs with that burger, sir?”

The committee identified these obstacles to the practice of tying PPE directly to the distribution of equipment:

- The worker in charge of distributing tools has never been responsible for worker safety or monitoring tasks.
- This same worker is usually older and “old school,” with less concern about safety.
- Heavy equipment is scattered throughout the site and not connected to PPE storage.

A safety officer argued that distributing PPE is properly the responsibility of the foreman, not the tool person. The activity plan should inform the foreman about the correct PPE required for any job. However, a researcher pointed out that the success of such a practice will require an audit system to ensure that hearing protection is always kept near the tools.

6. OBSTACLES TO CHOOSING THE BEST CONTROLS

OBSTACLES TO NOISE MONITORING

Currently the safety officers monitor for noise according to specifications set by their client, the Massachusetts Highway Department. They take a weekly 20-minute noise sample in a location selected by the client. The current location was the front gate on the site perimeter near the Massachusetts Highway Department building. As a result, the current system measures the noise that reaches the population surrounding the site, but not primarily the sound levels that affect workers. If the sound level tests high, the contractor can compensate by running the operation at night when neighboring businesses are closed, not necessarily by reducing the sound level created by the operation.

Managers on the Health Trak Committee explained that they don't look for noisy operations to monitor sound levels. They rely on activity planning to anticipate and prevent noise. Several times during the cycle, managers asked researchers if the COHP planned to implement a sound monitoring program. Researchers explained that they hoped to help SIWP develop their own, in-house program. This would require a change in practice to seek out and measure sources of noise, including brief and impact noise, directly on site, several times a week.

Workers on the committee were not familiar with contractor monitoring policy, and in fact were not aware that the contractor owns and uses a sound level meter. Participant observation by researchers in the field supported the finding that workers are not aware of noise monitoring by the contractor.

Discussions by the Health Trak Committee also revealed confusion about OSHA requirements for controlling occupational noise exposure in construction.

As a result of these issues, current monitoring practice does not seem structured to detect, document, and correct high levels of noise exposure throughout the site.

OBSTACLES TO ACTIVITY PLANNING

Most participating managers argued that activity planning is an effective system for anticipating and preventing hazards, including noise. For them, the biggest obstacle arose from their need to continue to modify and improve the process.

A researcher proposed an important need for improvement in activity planning, specifically adding noise-related items to the activity plan checklists. The current activity plan forms

included a checklist item on noise as an environmental hazard, but not as a safety hazard. Therefore, people using the form would be prompted to control noise reaching surrounding areas but not noise affecting workers on site.

Further discussion revealed an obstacle due to apparent lack of a system to soliciting worker input. Some managers agreed that worker input into activity planning would be necessary to identify hazards, but others explained that workers are not allowed to participate in the planning. In their view, activity plans completed by management should be presented to foremen, and foremen would be responsible for implementing them in the field.

Most of the committee agreed that most workers in the field are not aware of or involved in activity planning. Several workers also argued that activity planning is not effective because activity plans had not been completed before some of their jobs. These problems led several members to propose that a disconnect between theory in the office and practices in the field prevented activity planning from ensuring a safe worksite.

A further obstacle to using activity plans to prevent noise arose from some managers' belief that if a contractor's written rules for noise control exceed OSHA requirements then OSHA can cite the company for violating its own standards. The COHP agreed to write a letter to OSHA requesting clarification of this issue.

OBSTACLES TO EFFECTIVE TRAINING

Some managers expressed doubt that training alone will convince workers to wear PPE. One said that he had given trainings on noise but many workers don't remember what he told them. He argued that some workers do know about hearing protection but "just work the pain." Several participants said that training won't work until graphic videos or other methods make workers really understand the importance of the issue.

Nobody's going to see it until they believe it.
– SIWP safety officer on safety training

A major obstacle to safety training seemed to be lack of safety meetings. Managers mentioned that safety meetings were held on particular days at 7:00, but repeated on-site inquiry by researchers showed that no meetings took place over several weeks.

IV. Discussion on the Health Trak Cycle on Noise

Health Trak Committees include a majority of workers in order to compensate partly for the imbalance of researchers between workers and managers. In this cycle, only one of five committee meetings actually included more workers than managers. Two of the meetings included just one worker. Only the operating engineers steward was able to attend all five meetings. Other stewards attended only one or two meetings. In some cases stewards said they had not been informed of meetings.

However, the stewards who did attend any given meeting participated and discussed the issues seriously. A researcher observed that stewards on this site act like traditional building trades stewards who take an active role in overseeing working conditions.

Workers also had fairly limited control over the Health Trak process in this cycle. Management chose the location and the hazard of focus. Researchers chose the study design. Workers entered a process already designed by others.

On the other hand, workers influenced the selection of noise sources to examine. Although researchers repeatedly raised the question of compressors as a noise source, workers didn't see them as a major problem. Compressors were therefore dropped as a focus for further discussion.

Management representatives attended Health Trak Committee meetings regularly and participated seriously. An improvement over previous cycles was the participation of an engineer. Unfortunately he was not able to continue attending beyond the first meeting. Participants explained that he became too busy with production.

As observed in the three previous Health Trak cycles, one hour did not provide enough of a chance to design ways to avoid obstacles once identified. However, one hour is typically the maximum reasonable time that people in the construction industry can participate in the activity.

A major goal of Health Trak discussions is to work within the Hierarchy of Controls. Researchers encourage members to focus first on elimination and engineering controls, then move to administrative controls. They recommend using PPE only if other controls can't eliminate the hazard at the source. In this cycle, most of the committee argued that no elimination or engineering controls were feasible and that they could only improve PPE. This led to what a researcher called the "vicious circle of construction and research," in which researchers propose technical solutions, construction people give reasons why they can't be done, and everyone spirals back down again to PPE.

Researchers summarized this contradiction this way:

Ideal Hierarchy of Controls

1. Engineering
2. Administrative
3. Hearing protectors

Easier Hierarchy of Controls

1. Hearing protectors
2. Administrative
3. Engineering

However, after discussion participants did recommend job rotation (limiting the length of time any one worker can stay in a noisy area), which is an administrative control. Managers agreed to contact manufacturers about the possibility of adding muffling to heavy equipment in addition to what is installed.

During the last committee meeting participants shared what they liked about the process and what they would like to change. Several participants agreed that the discussions had helped them think more about hearing protection and continue the process of improving this protection on site. They appreciated researchers showing them aspects of their work they were not aware of and giving them the opportunity to see the site with new eyes.

Participants had no specific suggestions for changing the Health Trak process. They agreed that the COHP should follow up on its recommendations over time. The goal will be to learn whether SIWP is able to implement the recommendations in the long term, and the reasons that solutions are or are not put in place.

V. RECOMMENDATIONS

Based on the results described above, researchers make the following recommendations:

1. ACTIVITY PLANNING

Incorporate noise reduction into activity planning.

2. NOISE MONITORING

1. Incorporate informal noise monitoring into site walk-throughs. Monitor for noise periodically, beyond the schedule and location mandated in the specifications.
2. Keep an ongoing record of noise monitoring results.
3. Deliberately seek out the noisiest areas and operations on site, and monitor there.
4. Based on these results, identify and post high noise areas.

3. ISOLATION

Based on issues raised during Health Trak, UMass Lowell doctoral student Kwangseog Ahn developed a process for creating “noise perimeter zones” around loud equipment. Ahn demonstrated that taking sound pressure level measurements and then converting them to sound power levels allows the calculation of both a noise perimeter zone and a maximum allowable exposure time within the zone. He prepared a simple, user-friendly list of steps for calculating the noise perimeter zone and maximum exposure time.

See Appendix 1 for instructions on creating a noise perimeter zone.

4. IMPROVED USE OF PPE

1. Provide workers with hearing protection with adequate Noise Reduction Ratings (NRRs). Since hearing protection devices are tested under laboratory conditions, the National Institute for Occupational Safety and Health (NIOSH) derates them under real conditions (NIOSH criteria, 1998):

- Earmuffs: subtract 25% from the listed NRRs.
- Formable earplugs: subtract 50%
- Other earplugs: subtract 75%

2. Institute administrative procedures to tie PPE checkout to equipment checkout. For example, use a written policy to check out both muffs and plugs with bar locking equipment. (“Would you like muffs with that burger?”)

VI. SUMMARY OF HEALTH TRAK COMMITTEE PROCESS: DISCUSSIONS ON TYPES OF NOISE CONTROLS FALL, 1999

1. Elimination/Substitution

	Meeting #1	Meeting #2	Meeting #3	Meeting #4	Meeting #5
Questions	Are there ways to reduce the generation of noise in Pit D? What do you do to "mitigate" noise for influential neighbors?	Where is the noise? When is the noise especially bad? What causes it? How can it be reduced?		Why are they using a generator when they have an electrical cabinet with 14 outlets nearby? Why are they using a loud light plant as a power source? How many generators on site are not needed?	We have had success at identifying sources of noise, but limited success at making changes to prevent noise. Why?
Proposed Solutions	Decrease bar locking.		Emphasize to contractor that reducing noise will save money by reducing accidents.	Use a quiet electrical cabinet instead of a loud generator.	
Obstacles	CA/T rules require bar locking for certain sizes of rebar.	Attitude that "noise is part of the business"	High costs of substituting quieter processes for loud ones	The electrical cabinet now on site does not provide enough power to plug in additional equipment. The correct generator, which is quieter than the light plant, presents another safety hazard.	

2. Engineering Controls

	Meeting #1	Meeting #2	Meeting #3	Meeting #4	Meeting #5
Questions	Are there ways to reduce the generation of noise in Pit D? What do you do to "mitigate" noise for influential neighbors?	Where is the noise? When is the noise especially bad? What causes it? How can it be reduced? Is there an inspection system for muffling on the equipment?	Is everything muffled that can be muffled? What does P.J. do to make sure mufflers are installed and maintained? What's P.J.'s record-keeping system? Can the contractor make an administrative procedure to drop the decibels on heavy equipment between loads?	Can they turn off generators when they're not using power?	We have had success at identifying sources of noise, but limited success at making changes to prevent noise. Why? Can the contractor muffle front end loaders without reducing their power?
Proposed Solutions		Mufflers on heavy equipment Institute a system to ensure that all mufflers are installed and maintained. Sound barriers Turn down impact of hammer when driving piles.	Mufflers on heavy equipment Stacks for deflecting noise Emphasize to contractor that reducing noise will save money by reducing accidents.	Institute a system to turn off generators when not in use. Hard wire generators so they can be used with their doors closed.	Safety officers will ask manufacturers of front end loaders if it is possible to muffle them without reducing efficiency.
Obstacles to Proposed Solutions		Belief that equipment is already optimally muffled Barriers impair visibility for operating engineers. Loud operations are too brief and mobile for barriers. Turning down impact level slows piledriving. Attitude that "noise is part of the business"	Belief that muffling decreases engine efficiency Depth of pit prevents use of stacks to reduce noise. High costs of substituting quieter processes for loud ones.	Belief that all equipment is already optimally muffled Belief that muffling decreases engine efficiency Depth of pit prevents use of stacks to reduce noise. Belief that additional muffling adds cost. OSHA standards on noise are not enforced.	Activity plans only address PPE for noise protection.

3. Administrative Controls

	Meeting #1	Meeting #2	Meeting #3	Meeting #4	Meeting #5
Questions		Can the contractor post high noise areas to keep out people who don't need to be there?	Where could management post "keep-out" areas for workers who don't need to be there? What do Tom, Andrew, Bruce, and the other supervisors do to schedule work to avoid noise exposure? How can the contractor use isolation and job rotation to keep workers away from noise?		
Proposed Solutions		Limiting time of loudest operations Job rotation Keep nonessential workers away from loud operations.	Automatically post areas around certain activities to keep nonessential workers away from loud operations.		Based on monitoring results, identify and post high noise areas.
Obstacles to Proposed Solutions		No current mechanisms systematically keep nonessential workers away from loud operations.	Reluctance to post areas to keep away non-essential workers, based on belief that activity planning should make this unnecessary		

4. Personal Protective Equipment

	Meeting #1	Meeting #2	Meeting #3	Meeting #4	Meeting #5
Questions			When should workers be wearing plugs and muffs? Are muffs available? Where? What's the NRR for the plugs on site? For the muffs? Do people understand the NRR? How are the NRR and monitoring connected?		
Proposed Solutions	Use muffs with a velcro strip that helps support them.	Mandatory hearing protection for certain jobs Make plugs and muffs easily available to all workers.	Post areas "Hearing Protection Suggested."	Create an administrative system to automatically sign out appropriate hearing protection with loud tools.	Institute administrative procedures to tie PPE checkout to equipment checkout. For example, use a written policy to check out both muffs and plugs with bar locking equipment. Post signs in areas where hearing protection is recommended. Hold a campaign to promote hearing protection.
Obstacles to Solutions	Muffs are heavy.	Some workers don't use ear plugs because they "get used to the pain." Mandatory hearing protection for piledrivers is not enforced. Not all workers know how to get muffs.	Not all hearing protection is marked with the NRRs. Most workers do not receive information on NRRs. "Hearing Protection Suggested" areas change rapidly. Disagreement on management's ability to require hearing protection at certain sound levels.		Some people don't like to wear PPE. Workers don't pay attention to signs. Some people vandalize signs. Use of heavy equipment can't easily be tied to PPE sign-out because the equipment is scattered throughout the site. Workers in charge of tool sign-outs are often "old school." Safety is not the responsibility of the tool man. Holding a campaign won't work because the workforce is too fluid.

5. Activity Planning

	Meeting #1	Meeting #2	Meeting #3	Meeting #4	Meeting #5
Questions			What do the activity plans say about limiting people's exposure?		
Proposed Solutions		Activity plans should keep nonessential workers away from loud operations.			Noise is always in the activity plans because it's an "environmental aspect." Add a question to activity plans: "Can engineering controls reduce the noise more?"
Obstacles to Proposed Solutions		Current activity plans do not direct nonessential workers away from loud operations. Except for safety officers and the super, many people are not aware of activity plans. Activity planning does not currently lead to daily checks on site.	Noise is not listed in the safety checklists of current activity plan forms.		Current activity plan addresses PPE only.

6. Noise Monitoring

	Meeting #1	Meeting #2	Meeting #3	Meeting #4	Meeting #5
Questions		What monitoring is being done for mitigation?	When do safety people monitor for noise? How could they make the monitoring more effective?		
Proposed Solutions	Monitor when workers report loud noise.		Monitor in response to workers' complaints of noise.	Monitor the noisiest places. Make informal noise-monitoring part of the site walk-through.	Incorporate informal noise monitoring into site walk-throughs. Monitor for noise periodically, beyond the schedule mandated in the specifications. Keep records of noise monitoring results. Deliberately seek out the noisiest areas and operations on site, and monitor there.
Obstacles	Workers don't know that contractor has a sound meter.	Specifications require monitoring for neighbors.		Individual monitoring results can fall under the threshold for Hearing Conservation Programs. Noise might be at low levels during a sound measurement.	Reluctance to monitor loud areas due to belief that activity planning makes this unnecessary

7. Training

	Meeting #1	Meeting #2	Meeting #3	Meeting #4	Meeting #5
Questions			Has anyone talked about noise or noise reduction in toolbox meetings?	Has anyone had toolbox or safety meetings on noise?	
Solutions			Safety talks will address NRRs.		
Obstacles			Belief that training is often not effective	No one has had toolbox or safety meetings on noise. Safety meetings not held regularly as planned.	

VII. APPENDICES

1. COHP NOISE PERIMETER ZONE INSTRUCTIONS

2. "HEAR TODAY, GONE TOMORROW?"

by Richard Korman with Stephen H. Daniels and David Kohn,
from *Engineering News-Record*, March 20, 2000.

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3. "NOISE CONTROL"

by Charles Husick, from *Sail Magazine*, August, 1999.

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4. "A LABORERS' GUIDE TO PREVENT HEARING LOSS IN CONSTRUCTION"

by Scott Schneider, Laborers' Health and Safety Fund of North
America.

Calculating a Noise Perimeter Zone and Maximum Allowable Exposure Time Within the Noise Perimeter

1. Measure the sound pressure level at a distance from a noise source.

Example: You stand a few feet away from a piece of equipment. You use a sound level meter to measure the sound pressure level. Let's say it reads 86 dB.

2. Measure the distance between the noise source and measurement point.

Example: The measurement point is where you're standing to take the sound reading. The noise source is the piece of equipment. So, say you measure the distance between where you took the reading and the noisy piece of equipment. It turns out to be 15 feet.

3. Convert the sound pressure to the estimated sound power (Table #1).

Example: In step 1 you measured the sound pressure level at 86 dB. In step 2 you measured the distance from the source to be 15 feet. Find 15 feet in the list of distances across the top of Table #1. Find 86 dB in the list of sound pressure levels going down the side of the table. Find where the 15 feet column crosses the 86 dB row: 110 dB.

4. Calculate a Noise Perimeter Zone (Table #2).

Example: Let's say you don't want anyone exposed to more than 80 dB. So, you find 80 dB in the list of Target Control Levels across the top of Table #2. In step 3 you found the sound power level was 110 dB. So, you find 110 dB in the list of sound power levels going down the side of Table #2. You find where the 80 dB column crosses the 110 dB row and see 29 feet. This means that you will post a noise perimeter zone so everyone who doesn't need to be there stays at least 29 feet from the loud equipment.

5. Estimate maximum exposure time within a Noise Perimeter Zone (Table #3).

Example: People working outside the noise perimeter zone are not exposed to levels above 80 dB. People working right near the noise source are exposed to levels up to 110 dB. Table #3 tells you that they should not work at that exposure for more than 30 minutes.

The contractor can supply people inside the noise perimeter zone with hearing protection equipment that has a Noise Reduction Rating high enough to bring the noise exposure down to lower levels. Then people can work inside the zone for longer times.

Table #1. Converting Sound Pressure Measurement to Sound Power Level (dB)

Measured Sound Pressure Level (dB)	Measured Distance from Source (feet)					
	5	7	10	15	20	30
80	95	98	101	104	107	110
82	97	100	103	106	109	112
84	99	102	105	108	111	114
86	101	104	107	110	113	116
88	103	106	109	112	115	118
90	105	108	111	114	117	120
92	107	110	113	116	119	122
94	109	112	115	118	121	124
96	111	114	117	120	123	126
98	113	116	119	122	125	128
100	115	118	121	124	127	130

Table #2. Calculating Noise Perimeter Zone from Sound Power Measurement (feet)

Sound Power Level (dB)	Target Control Level (dB)		
	80	85	90
90	3	2	1
95	5	3	2
100	9	5	3
105	16	9	5
110	29	16	9
115	52	29	16
120	92	52	29
125	164	92	52
130	292	164	92

Table #3. Maximum Exposure Time Within a Noise Perimeter Zone

Sound Pressure Level (dBA)	NIOSH (85dBA & 3dB)	OSHA (90dBA & 5dB)
85	480	960
90	151	480
95	48	240
100	15	120
105	5	60
110	1	30

THE CONSTRUCTION WEEKLY

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MARCH 20, 2000

AGC will file
lawsuit to challenge 'pay-
before-paid' rule on feder-
al-aid highway work

E&C firms
build dot-com infrastructure
for a piece of the action

HEAR TODAY,

GONE TOMORROW?

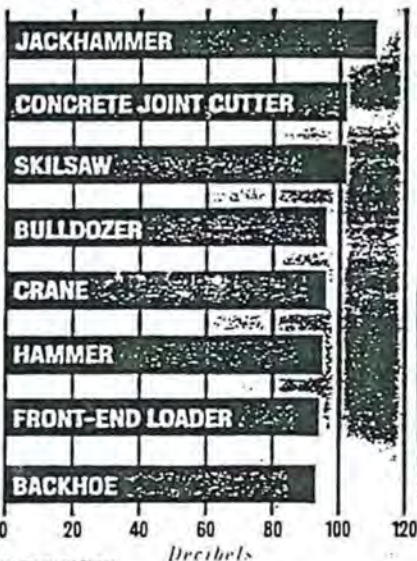
Stopping the damage from jobsite noise
before it's too late



Turning Down the Volume

New awareness of hearing loss stirs efforts to limit damage

NOISE LEVELS



John R. V. Dixon has the kind of résumé that plenty of people would admire. After serving in the Navy, he did draftsmanship and worked as an inspector of railroad lines and other heavy construction projects. Later he was a tunnel site engineer and contract change negotiator. More recently, he's been a project manager for the Washington, D.C., transportation agency, WMATA.

Dixon has another résumé—for noise endured—that is equally impressive: roaring submarine engines, rumbling front-end loaders and the brain-jarring hammer of pile drivers. He's also been in the acoustical chamber of horrors that is a tunnel where boring machines operate.

In the mid-1970s, Dixon noticed that he wasn't hearing things at meetings, but he "became an expert lip reader and bulldozed my way through." Then his wife got tired of not being heard and Dixon put on his first hearing aid in 1978 at age 36. Since then, he's become accustomed to the routine and prizes his new digitally-enhanced hearing.

There isn't any resentment when Dixon talks about his handicap and the price he paid for his career in construction. "I don't say the industry failed me personally because I might have lost my hearing anyway," he says. "But it's definitely some-

thing the industry needs to wake up to and start paying more attention to."

The wake-up call already has been arranged.

On March 30 and 31 in Washington, D.C., the Laborers' Health & Safety Fund, the U.S. Occupational Safety and Health Administration and the National Institute of Occupational Safety & Health will host a conference aimed at raising awareness about noise and hearing loss. Armed with studies showing pervasive loss among construction workers, occupational health experts and government officials are likely to call for bringing the less-stringent construction hearing protection provisions into line with the general industry rules.

NEW TRIGGERS The new rules, which are not yet even drafted, will probably require more construction employers to provide worker training, hearing tests and noise measurement. The new rules may also lower the threshold average decibel level from the 90 that now triggers the need for special action to the 85 decibel level required in general industry.

Employers have for the most part remained conspicuously absent from the hearing protection movement so far. Some of them see these rumblings for change as the beginnings of another ponderous U.S. Labor Dept. rulemaking process, sure to produce more contentiousness followed by a hard-to-com-

ply-with and harder-to-enforce health standard. "People will fight tooth and nail," says the Associated General Contractors' top safety and health official, Carl Heinlein. AGC's wariness is echoed by contractors. Employers must do everything that common sense dictates to protect their workers, but complying with the letter of some recent OSHA standards can be impossible, they say.

A new rule isn't needed, says Joe Spirito, director of loss control for EMCOR Group, the huge Norwalk, Conn.-based specialty contractor. "The problem isn't the rules," he says. "The problem is the recognition of the need to use hearing protection when the exposure exists." The fluid nature of construction makes it difficult to institute freestanding engineering controls, says Spirito, so "making hearing protection available and enforcing its use" is the single best method of control.

Others share the concern and say OSHA should stick to educating workers about the danger of noise.

"The thrust of OSHA should be to create a better-informed construction worker, not another unenforceable rule," says Mike Croyle, a project manager with contractor Stone Valley Construction Inc., Pine Grove Mills, Pa. "Education of construction workers will break down the Superman syndrome and create a safer worker."

INSTIGATOR The laborers' union is the chief instigator for hearing conservation in the building trades, and union health officials agree that education is crucial, but it is not enough. While eroded hearing is not a medical catastrophe such as falling off a scaffold, hearing loss makes a serious dent in an individual's life. The troubles often occur in later years, when retirement in theory brings freedom. "What if you can't answer the phone anymore, or have a difficult time going to restaurants because you can't hold a normal conversation?" asks Scott P. Schneider, safety and health director for the Laborers' Health & Safety Fund of North America.

The federal government needs to toughen the standard and enforce it so that employers who would not take an interest in hearing know that they risk penalties, Schneider says. As of now, OSHA only infrequently checks noise levels at jobsites. Penalties related to construction hearing protection and noise in the last year amounted to only a few thousand dollars, according to agency inspection records.

At the same time, Schneider doesn't want to wait for the slow-moving federal rule-making machinery to plod forward. A cooperative effort involving employers and manufacturers, similar to the one that led asphalt paver makers to alter their new pavers to vent fumes above the operators' heads, is preferable to waiting for new rules to be settled and published, says Schneider. Before rules change, hundreds of thousands more workers will have had their hearing permanently damaged, he claims.

"We want contractors to rent and buy quieter equipment, to do the training and give guidance on what they can do now as opposed to waiting," Schneider contends.

Employers may have more at stake than they realize. In Washington state, workers' compensation insurance claims for hearing loss in all industries soared from 653 in 1992 to 3,198 in 1996, to a total of \$40 million. Nationwide, total hearing loss claims of \$4 billion for all industries are possible, says John G. Stebbins, an industrial hygienist for Washington's Dept. of Labor and Industries.

Skeptics may say that the growing claims are only a sign that regulators, consultants and unions are beating the drum again for an over-expansive notion of employer responsibility for worker health. If workers in their off hours are listening to loud rock music or clearing lawns with leaf blowers, they are raising their total exposure. Must employers take that into account,



"I felt totally ineffective. I felt horrible. I was suddenly at a real disadvantage. I struggled to see the speaker, to watch the speaker's mouth. Women spoke more soft. A lot of them, I couldn't hear at all."

—GEORGE BAILEY, *ironworker*



SOUND EXPLOSION Supervisor Pearce must insert ear plugs before cranking up his truck.

when deciding how much protection workers need? Some health advocates say a realistic hearing conservation program should look at off-hour activity.

A more common complaint, besides the bother and discomfort still inherent in the much-improved earmuffs and earplugs, is that wearing hearing protection isolates workers from potential warnings of danger. In truth, says Eric Patton, training manager for Dalloz Safety, a maker of hearing protection devices in Reading, Pa., workers often wear protective devices that shave too many decibels of sound. Instead of over-protecting, Patton says, the goal should be getting below the hazard level. "The hearing protection needs to be suited to the environment," advises Alice H. Suter, a health consultant who studied the subject for OSHA. Uniform sound attenuation across all frequencies is preferable because cutting the decibels only in high frequencies makes it "really hard to hear backup alarms," says Suter.

DELICATE The human auditory system relies on delicate structures that convert the mechanical energy of sound into electrical impulses sent to the brain. When damage occurs over time, most people don't realize it before it's too late—and then they may be flooded with feelings of anguish.

Charles L. Bailey is a Seattle resident who first went to work as an ironworker at age 17. Now 57, he didn't become seriously concerned about his hearing loss until he took an administrative position with the local building trades council. To his horror, he couldn't hear what was said in meetings. "I felt horrible. I was suddenly at a real disadvantage. I struggled to see the speaker, to watch the speaker's mouth," Bailey says. "Women spoke more softly. A lot of them, I couldn't hear at all." This month he went to see a hearing specialist for the first time in his life.

Hearing loss also snuck up on Ken Olson, 58, an estimator for Suitt Construction Co., Greenville, S.C. He wears two hearing aids and says the damage was done mostly during summer jobs while in high school and college. On one job, he spent a day helping demolish a concrete driveway with a paying breaker. After the job, he remembers noticing a "kind of rushing noise," which he subsequently learned was a symptom of dam-

age. When he turned 40, Olson noticed how hard it was for him to hear televisions and to pick up what was being said to him in places with lots of background noise.

On numerous occasions Olson's hearing trouble translated into awkward social situations. "People become impatient with you. That's happened to me numerous times because I asked them to repeat something," he says. The flip side of the problem is when unfamiliar people see Olson's hearing aids and in a well-intentioned way try to be considerate. "Occasionally you bump into people who notice and speak louder and you don't know if they always speak that way or if they're speaking that way for you," he says.

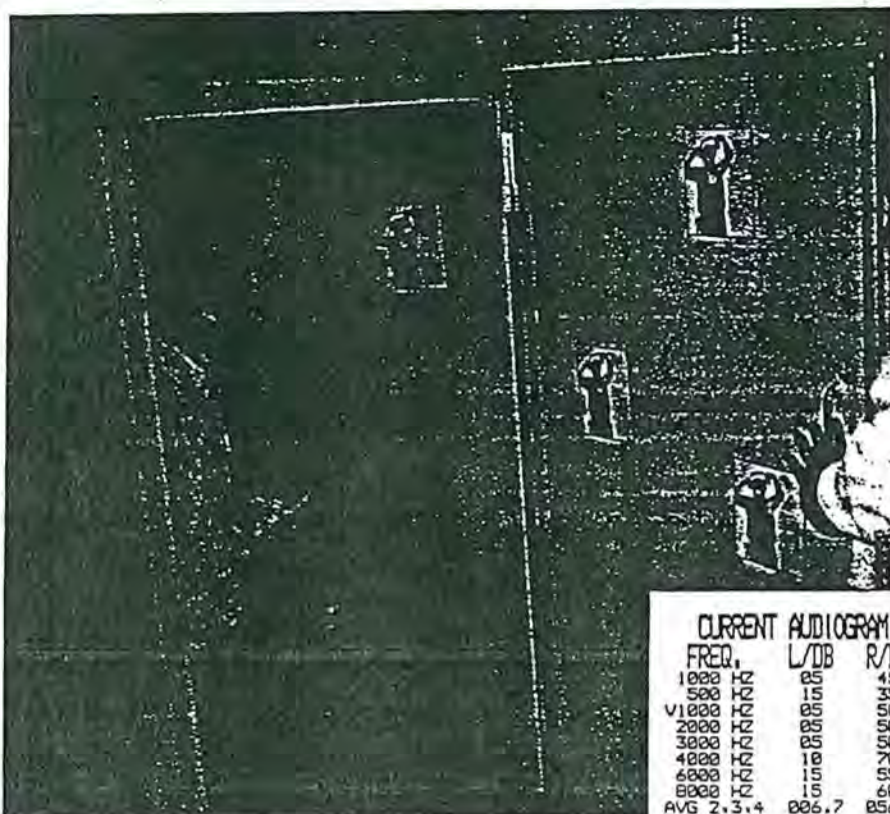
That kind of trouble is lost on many workers, especially the young. The biggest challenge is convincing people that they don't want to

have a hearing loss, says Margaret Roberts, manager of hearing loss and audiology for the Workers' Compensation Board in Vancouver, B.C., where health officials have been able to reduce the amount of hearing loss. "People can imagine not having on a hardhat and getting hit and killed," she says. "It's



METER READER Barbeau (right) measures 120 decibels.

PHOTOS BY RICHARD A. KORMAN



ONE BOOTH Earth Technology's Barbeau says audiograms establish hearing changes that could be signs of trouble.

hard to imagine what it's like to have a hearing loss because it's insidious and people don't notice it's a disability until it's too late."

There are also questions about the longterm implications of noise for the human nervous system. Some studies have shown that loud noise and vibration jack up the stress level and thus worsen stress-related illnesses.

DIFFERENT STANDARDS Federal rules on hearing protection are spread over several different standards. Under OSHA's hearing protection standard for general industry, employers must provide a hearing conservation program, hearing tests, training and hearing protection devices if the average noise exposure over an eight-hour day is 85 decibels. The standard for construction differs somewhat. Construction employers must provide protection against the effects of noise when sound levels exceed 90 decibels averaged over eight hours or 95 decibels over four hours.

Another part of the construction noise standard says that hearing protection devices must be provided when it's not feasible to reduce noise levels or the duration of exposure. Devices must be chosen by a competent person. Plain cotton wads are not acceptable. Still another standard requires employers to provide a continuing effective hearing conservation program when sound levels exceed the thresholds. "It doesn't say what the program should include and it doesn't kick in until the decibel average hits 90," says Schneider.

One challenge in conserving the hearing of craft labor is getting them to wear plugs and earmuffs. Industrial hygienist Scott Howes believes hearing protection should be put on the same level as hardhats and steel-toed boots. He acknowledges the discomfort of wearing protective devices in hot

weather, but he also says there's potential for convenience if equipment could be designed combining head, eye and ear protection. "With a package there would be no problems," Howes says.

Some employers already put hearing protection as a top priority, with good reason. One is Earth Technology LLC, a North Haven, Conn.-based environmental contractor. Joseph D. Barbeau, the firm's no-nonsense safety and health director, doesn't leave any room for slacking off.

On a warm February afternoon, Barbeau is out visiting a three-person crew. Members are vacuuming the residue of home-heating oil from the bottom of a storage tank at a sprawling tank farm in Bridgeport, Conn. Barbeau, with sound meter in hand, asks Anthony Pearce, the crew supervisor, to crank up the power in his black vacuum truck parked nearby.

Barbeau glances over at two jump-suited workers near the tank to make sure they are wearing their plugs. After Pearce inserts his plugs and Barbeau covers up, Pearce throws the switch. Soon the truck starts singing like a choir of Hoover vacuum cleaners. Bellowing at 3 ft away is futile. "It's like a jet engine," Barbeau shouts, as if anyone needed further convincing.

The safety director, who has a masters degree in public health, looks down at the simple sound meter in his hand and sees the decibel level at a dangerous 120. After the truck has been turned down, Pearce says that when one of the valves is opened, "it really screams."

Because Earth Technology's vacuum trucks are unusually noisy, the company must be careful with its workers' ears. The contractor's hearing conservation program involves hearing tests at a local hospital outpatient clinic to measure yearly changes, training in the use of hearing protection devices and the determination to keep ears protected every second that a hazard exists.

"I can tell them exactly what the rule is and why it's important to comply," says Barbeau, implying that when it comes to excuses for not wearing protection, he just can't hear them. □

By Richard Korman, with Stephen H. Daniels and David Kohn

For more information about hearing loss and the use of hearing protection devices, see the special feature on ENR's Website, enr.com.

CURRENT AUDIOGRAM		
FREQ.	L/DB	R/DB
1000 HZ	05	45
500 HZ	15	35
1000 HZ	05	50
2000 HZ	05	50
3000 HZ	05	50
4000 HZ	10	70
6000 HZ	15	55
8000 HZ	15	60
AVG 2.3.4 006.7 056.7		

TEST ID: 2591114220002181

ELAPSED TIME = 07:52

TEST TYPE = BASELINE

TEST MODE = PULSED

M = MANUALLY TESTED FREQ

TREMETRICS RA500

SERIAL NUMBER...10972181

SOFTWARE REV. 1.21-97060

CALIBRATION 02/03/00

CAL. ANSI S3.6 1989

PATIENT: RICHARD

X

EXAMINER:

X

GRAPH OF LEFT EAR



GRAPH OF RIGHT EAR



Industry Should Act Quickly on Hearing Loss

The insidious loss of hearing by workers, supervisors and managers in the industry who work close to roaring machinery is something that can be prevented. The trouble with this type of injury is that it occurs without obvious warning signs and is not life threatening. But ears that go snap, crackle and pop or do nothing at all can wreck a person's quality of life pretty quickly.

Contractors are swift to challenge any idea of mandatory requirements for construction that might be stronger than the general industry standard administered by the Occupational Safety and Health Administration. Yet they are slow to come up with alternative constructive ideas.

The difficulty in developing any sort of industry consensus to preempt formal government action is that harmful noise exposure takes many forms in construction and protection depends on the action of individuals. It is not like the asphalt paving fume exposure situation, where contractors, government, unions and equipment makers were able to quickly band together to devise and implement a voluntary solution. The engineered controls placed on

new highway-class asphalt pavers can remove 80% of the fumes from areas around workers and require no action on their part.

For any industry solution to be effective in preventing hearing loss, employers and employees must be committed to making it work every day. This means putting protective devices in the hands of people who might be exposed to harmful noise—and making sure they wear them.

The cost of hearing protective equipment is not the real barrier. Many devices cost under \$10 and are reusable and durable. It is getting people to consistently use these devices that is the difficult part. At the very least, the industry should start to crank up the issue of hearing loss and prevention through training and tool box safety talks.

Ultimately, workers are largely responsible for their own safety and health. Some big projects have been described as the commercial equivalent of going to war. We believe that each "soldier" should have the proper equipment, training, support and determination to survive in good health.



Voice of the Customer's Will Value E-Commerce

Vary a day goes by anymore without the announcement of the formation of a new e-business designed to do something that is absolutely indispensable for the construction

industry. These firms swarmed around the annual convention of the Associated General Contractors, vying to win the hearts and money of key company decision makers.

Some of the e-companies are so new that they have yet to conclude their first transaction, let alone turn a profit. Some have been better at selling themselves than their services. And yet not too many people at the convention were turned off by that. An ENR poll conducted there indicates that many contractors are not yet using the Internet to conduct their business in a big way, but expect to do so in the future. They at least want to hear about their options.

The future of e-commerce in the industry will be determined by whether these start-up companies can facilitate transactions for goods and services better, faster and cheaper than their counterparts in the old analog economy. The ticket for success for many of these firms will be to take a small slice of many transactions in return for matching buyers and sellers. The shakeout likely will be painful and messy because the careful balance needed for a winning formula and strategy may be undermined by unreasonable expectations of investors, company founders and even customers. In the end, only the customer's voice will be heard. And it may not be what some of the e-commerce firms want to hear.

DOT Should Think Again

The U.S. Dept. of Transportation and the Associated General Contractors are about to mix it up in the courts again, this time over the subject of retainage. There was plenty of warning about the feud, but no one seemed to take it seriously (see p. 12).

DOT's new retainage policy was published Feb. 2, 1999, along with new disadvantaged business enterprise rules, which we have opposed in the past. They require general contractors to pay withheld retainage to all subcontractors (not just DBEs) on federal-aid highway projects even if the general contractors have not received their retainage. DOT's apparent intent is to tighten up prompt pay en-



forcement for subs, but it leaves general contractors holding the bag. And an expensive one it is.

Last fall, AGC contractors warned DOT officials that the retainage policy would have tremendous impact on general contractors on big projects if they had not received their retainage (10/11/99 p. 12). On a \$400 million project that is 80% subbed out, 5% retainage would mean a payment of \$16 million. Sub groups claim the rules don't go far enough.

It is pretty clear that the money that has to be paid out under such conditions has to come from somewhere. At the very least, general contractors will have to build a contingency fund into their bids. While we support prompt payment to subs, we think that shifting the risk of slow payment by the government onto just the generals is equally unfair.

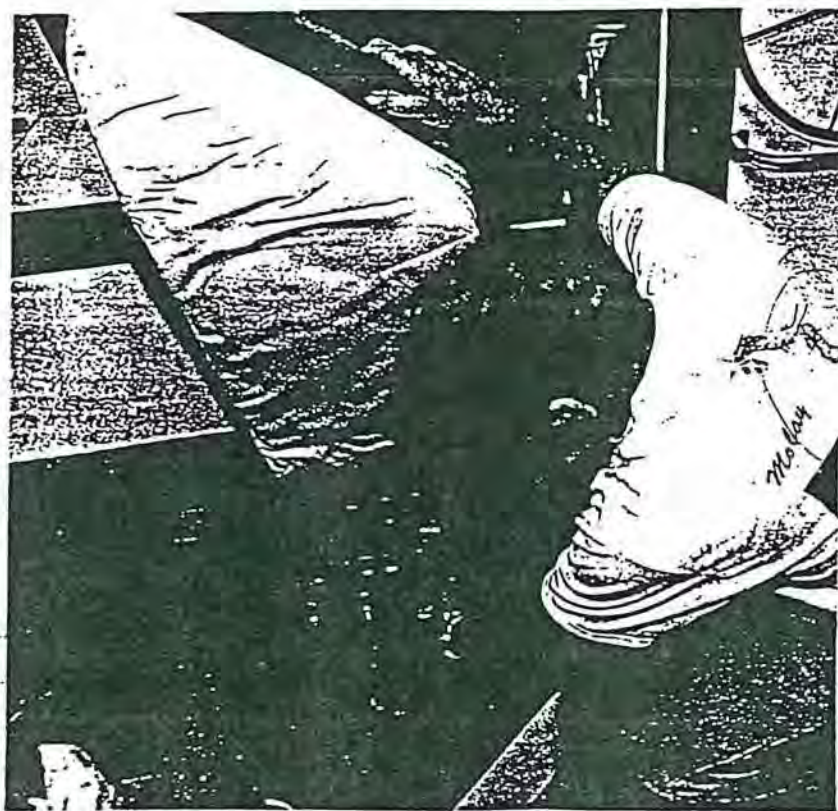
130 #5

NOISE CONTROL

Systems need to be properly insulated for noise control. Chuck Husick explains the concepts

Sound is a form of energy. The pleasant sounds of wind in the sails and water rushing past the hull are part of why we go sailing. An unpleasant sound—the roar of an engine, the hum of a genset, or even the whirl of a hydraulic winch—is called noise and should be minimized. Here's how to reduce loud noises on your boat to levels you can live with.

By Charles Husick



behind acoustic-insulation technology

Judging relative loudness is difficult, because the perception of sound energy is subjective. Quantitative measurement of a sound's loudness is done with a meter calibrated in units called decibels (dB). The sound level in a car traveling at 70 miles per hour on a smooth road measures about 68 to 70 dB, while the level of an exposed, running engine is about 100 dB. A well-insulated engine might be below 85 dB.

There are two ways in which an engine

(or anything on a boat that makes noise) transmits its sound energy—directly from the source (through the air) or indirectly, by first causing some other part of the boat to vibrate and then creating a secondary noise source. To evaluate the effectiveness of noise-control changes on your boat, you need a sound-level meter. Laboratory-grade meters are very costly, but you can buy a useful meter at Radio Shack for about \$40.

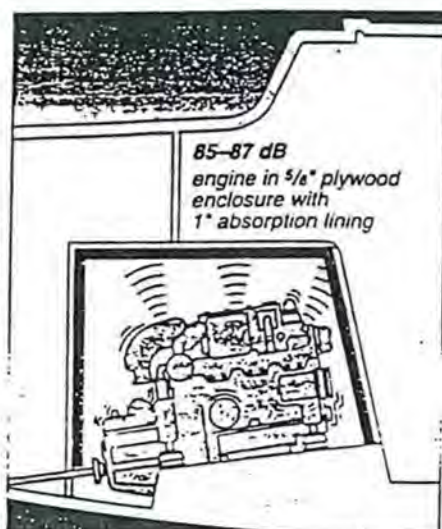
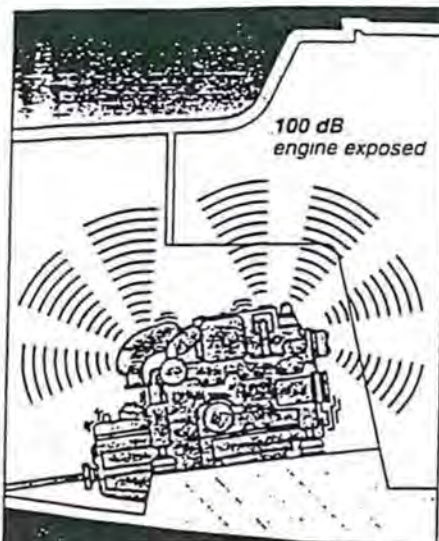
■ Pathway closure

Sound energy, like water, will pass through any available opening, regardless of how small it is. In general, the larger the opening, the greater the noise, but even a small hole will be significant.

The ultimate in pathway reduction is an airtight enclosure. The material of the enclosure is less important than the extent to which all leaks have been sealed. A fully enclosed 1/2-inch-thick plywood box will significantly reduce an engine's noise, while an insulated engine compartment that is poorly sealed won't do much at all.

The first step in quieting a noise source is to find and seal all the holes through which the sound escapes. On most boats the upper part of the engine compartment is well enclosed, although the underside is typically open to the bilge area. Sound leaking through these openings can be reduced by installing pieces of plywood that are cut to fit and glued against the hull. All access doors and panels should close tightly and have airtight seals.

If you seal the engine compartment perfectly and create an airtight compartment, things will soon be very quiet, since the engine will quit because of lack of air. Engines need air for combustion of fuel, and their spaces must be well ventilated to carry away waste heat. The challenge is to provide adequate amounts of airflow into and out of the compartment without allowing sound to escape. Air ducts built with at least one 90-degree bend and lined with sound-absorbing material will allow air but not too much noise to pass. You can also use straight ducts with internal baffles. Be careful to match your engine's ventilation



This 15 dB reduction example is typical of a noise-control project

requirements with any new enclosure or noise-control project.

■ Absorption

Sound energy trapped in an enclosure must be disposed of by conversion into another form of energy. The enclosed noise must be absorbed and converted into heat energy—otherwise, the energy will eventually escape or induce other vibrations.

The effectiveness of different materials in controlling sound is dependent on the material's density and the sound's frequency. Engines generate low-frequency noise that is best dissipated by a dense layer of material, such as lead. High-frequency noises, like the whine from an alternator, can be easily handled by a lightweight material, such as foam

Measurements and Meters

The bel, the unit of measurement for the intensity of noise, is named after Alexander Graham Bell. Measurements are usually given in units of one-tenth of a bel, the decibel (dB). The decibel is used to express the ratio between two intensity levels. The ratio between the minimum and the maximum power levels can be extremely large, so a logarithmic expression is used— $dB = 10 \log_{10} (I_1 / I_0)$ —with I_1 and I_0 being the intensity, or power, of the sounds being compared. The smallest difference in noise most people can perceive is a ratio of about 2:1, or 3 dB.

Because decibels are on a logarithmic scale, a reduction from 100 to 90 db is not a 10 percent reduction. A loss of 10 db, or 10:1, would be perceived

by the human ear as half as loud.

A sound-level meter can be invaluable when you're trying to quiet a noisy boat. It is difficult to accurately differentiate noise levels, especially as the day wears on and your ears get tired. Sound-level meters respond to the various frequencies in noise just as the human ear perceives them; this response is called "A" weighting, and the units are written as dBA. Most sound-level meters also have a "C" weighting, which gives equal weight to all of the frequencies present. For convenience where the noise energy isn't constant, meters have both a slow and a fast response-time switch. Use the A weighting and the slow setting when working on your boat.

Some acoustic insulations are composed of both a high-density layer (lead or mineral-loaded-plastic) and low-density layers (either fiberglass or foam). This composite not only blocks, or reflects, the sound energy but also absorbs the energy and converts it into heat (see "Composite Insulation," page 32).

■ Materials

Three kinds of sound-treatment materials are widely available: dense barriers, absorptive foams, and composites of the two. Although you can purchase absorptive materials and barriers separately, it's commonly accepted that composites that incorporate both are superior.

Composite materials that are suitable for a sailboat's engine box range between 0.3 and 2 inches thick and from 1 to 2 pounds per square foot. A typical 1-inch-thick engine-compartment



Absorptive foams come in a variety of thicknesses and compositions

ment insulation weighing about 1 pound per square foot provides a sound-transmission loss of 15 dB. The thicker and heavier the insulation is, the more effective they will be. Composites often have protective facings to keep out oil and water, thereby enhancing the effectiveness of the insulation.

■ Other considerations

It's desirable to prevent noise energy from reaching a surface that may cause the noise to reverberate. The cabin sole, for example, can transmit the noise energy that comes from the engine compartment. But some of this vibration can be limited if the



Vibration-absorbing mounts can be an important consideration

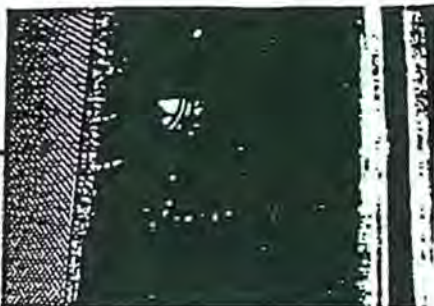
Composite Insulation

By Joseph Smullin

Acoustic insulation works on two separate principles—absorption and reflection—both of which are required for successful sound insulation of engine compartments. With different layers of materials, modern insulation can provide a complete sound barrier.

Mass is the critical element for reflecting sound energy. If you double the weight of an enclosure (a 3/8-inch plywood engine box, for example) by gluing a 1-pound-per-square-foot lead sheet or acoustic vinyl to the plywood, you'll increase the effectiveness of the panel by 6 dB. But if the same 1-pound-per-square-foot acoustic mass layer is installed as a separate barrier, independent of the 3/8-inch plywood, it will have an 11 dB effectiveness at the lower frequency range of 200 Hz, 24 dB at 1,000 Hz.

Separating the mass layer from the enclosure with a decoupler layer allows it to act as an independent barrier. The decoupler in most insulation compos-



The mass layer is centered between the absorptive and the decoupler layers

ites is a layer of foam located between the mass layer and the engine box. Sound is an energy field represented by fluctuating pressure in the air. The decoupler layer acts as a spring to isolate the sound pulsation and trap the air, much as the springs of a car's suspension isolate the road vibrations from the car. The softer the spring (the thicker the decoupler layer), the smoother the ride (the quieter the sound).

There is a minimum acceptable decoupler-layer thickness (separating the mass layer from the engine box) for a noise problem. This distance varies with the frequency of the noise to be blocked, with greater thickness required for base frequencies than for higher-pitched noises.

A layer of sound-absorbing material is required to "soak up" the sound energy reflected back into the box by the mass layer and decoupler combination. Otherwise, the noise in the box will increase because of reverberation effects. The sound-absorbing layer of an insulation composite is usually a foam material attached to the surface of the mass layer that faces the engine.

When the overall thickness of the insulation is limited to 2 inches or less, I have found that centering the mass layer in the composite with equal thicknesses of absorbing and decoupling layers on either side is best.

Joseph Smullin is an acoustician and the president of Soundown Corporation

floorboards are secured and the insulation coverage is extended as far as possible. Acoustic carpet pads can be used to reduce the noise further.

You can reduce excessive propeller noise by sticking a barrier layer to the inside of the hull above the propeller. If there's too much noise in the vicinity of the prop, you may want to consider modifying or changing the prop. Most propeller installations are a compromise between diameter, hull clearance, number of blades, and blade pitch. In general, the clearance distance between the prop tips and the hull should be at least 15 percent of the prop diameter. If the clearance is less than this,

reducing the prop diameter by 1 inch, with a compensating increase in blade pitch, may help reduce interior noise levels.

Acoustically soft materials in the cabin can absorb the noise a great deal. For example, some boats have a molded-fiberglass interior pan structure and a hard-fiberglass headliner, which together create an echo chamber. Covering the overhead with foam-backed headlining material will help quiet the din.

Noise created by engines and gensets, as well as machinery like water pumps, air conditioners, and refrigeration compressors, can be reduced with the use of vibration-

absorbing mounts. The suppliers of sound-control equipment can help you choose the right product.

Finally, think about your neighbors. In lieu of conventional mufflers, you can purchase genset-exhaust silencers that separate the exhaust gas from the cooling water; the gas is quietly exhausted into the air, and the cooling water is discharged just below the waterline.

Even after doing all you can to quiet things down, you may find that there are times when using soft-plastic ear plugs, which greatly diminish annoying and fatiguing noise, can be surprisingly helpful. Wear them, or some other hearing protection, when you're working on an operating engine or genset.

Charles Husick is a frequent SAIL contributor.

Noise-Reduction Basics

Here's a quick guide for improving the sound quality on your boat.

- Using a sound-level meter set to the dBA scale, measure the sound level of the engine when it's operating at full throttle and full load. Make a few measurements at representative points (1 foot away to port and starboard, 6 feet away, and so on) on the boat. Record the location and magnitude of the readings

- Find and seal all air leaks in the engine compartment. Make sure there's enough air entering and leaving the engine compartment.
- Line the entire compartment, including any air ducts, with a composite sound-barrier material. Seal all access-door joints.
- Repeat the measurements in the first step. You should find a 10 to 15 dBA reduction.

More Info

E-A-R Specialty Composites, tel. 317-692-3000; Greenwood Forest Products, tel. 503-670-9663; Soundcoat, tel. 516-242-2200; Soundown Corp., tel. 800-359-1036; Technicon, tel. 704-788-1131



A Laborers' Guide to Hearing Loss in Construction

Laborers' Health & Safety Fund
of North America

A LABORERS' GUIDE TO PREVENT HEARING LOSS IN CONSTRUCTION

NOISE AND HEARING LOSS IN CONSTRUCTION

HOW SERIOUS IS THE PROBLEM? Most workers who work in construction for 15-20 years can expect to lose a significant amount of their hearing. Data from the US, Canada and Sweden show that hearing loss is directly associated with how long you have worked in construction. Generally, hearing loss is gradual and you may not notice it right away, but there are tell-tale signs. If you find that your car radio is blaring in the morning, it may be because your hearing was dulled after a days work and you had to turn the radio up on the ride home yesterday. Or you may find that it is harder to hear people talking, particularly high pitch voices like women's voices. Or you may be the one turning up the television volume when everyone else thinks it is loud enough. If you find these events occurring again and again, you may have a hearing loss.

HAZARDS OF NOISE EXPOSURE - HEARING LOSS AND NON-AUDITORY EFFECTS - Hearing loss, the most common effect of noise exposure, is caused by permanent damage to the nerves in the inner ear. Noise exposure can cause more than just hearing loss. Noise can make you tired and nervous, raise your blood pressure and possibly increase your risk of heart problems. Noise exposure may also affect your sense of balance, since the organs for balance are located in your inner ear. Noise could also contribute to accidents, if, for example, it interferes with your ability to hear warning signals or communicate with your fellow workers.

EFFECTS ON DAILY LIFE - Some people don't take hearing loss seriously because hearing loss is gradual. But losing your hearing can have a dramatic effect on your life, ask any of your older co-workers. Imagine how difficult it will be to use the telephone or go to the movies. What is it like to miss 30-40% of conversations? How much pleasure do you get listening to music now, which will be harder to appreciate with a hearing loss? And what about safety questions? How much harder will it be to drive safely when, for example, you can't hear ambulances and police cars to get out of the way, or other vehicles approaching? How important is it to be able to communicate well with co-workers to ensure safety on the job? It is important to think about these now, rather than wait until hearing loss is permanent and it is too late. Unlike glasses, which can correct your vision, hearing aids can only make sounds louder. Hearing aids can't restore the quality of sound and your hearing will never be the same again. Most people with noise-induced hearing loss are not helped by hearing aids.

HOW NOISE IS MEASURED

Noise levels are measured in decibels (dB). Decibels are measured on a special mathematical scale (a logarithmic scale), like earthquakes. That means that a small change in the decibel level equals a large change in the amount of noise. For example, the sound energy doubles every time the noise level increases by 3 dB, and a 10 decibel change has 10 times more energy. So an 80 dB noise has 10X more energy than a 70 dB noise, and a 90 dB noise has 100X (not 20X) more energy than a 70 dB noise. A quiet office will usually have a noise level of about 60 decibels. Conversation is easy in that amount of noise. Levels on construction sites vary, but generally are from 80-115 decibels. The noise levels in construction are mostly produced by machinery, equipment or hand tools. The levels depend on: the power of the equipment itself and how much it has been muffled or dampened, the work it is doing (straining against a load generally produces louder noise levels), the amount of enclosure (in a closed area noise can bounce off of walls and multiply), and amount of equipment in the area (working near several other pieces of noisy equipment can add to your exposure). Common exposure levels in construction include:

COMMON NOISE LEVELS IN CONSTRUCTION

Pneumatic chipping hammer 110-113 dBA

Jackhammer 102-111 dBA

Concrete joint cutter 99-102 dBA

Skilsaw 88-102 dBA

Bulldozer 93-96 dBA

Earth Tamper 90-96 dBA

Crane 90-96 dBA

Hammer 87-95 dBA

Gradeall 87-94 dBA

Front end loader 86-94 dBA

Backhoe 84-93 dBA

Some of these exposures can be very loud and very brief, small fractions of a second, like the noise from a powder-actuated nail gun. Such short, high exposures are called impact or impulse noises, which may be even more damaging than longer lower level exposures.

Also there is new information that suggests the combined exposure to some solvents with noise can also damage your hearing.

The amount of exposure you receive depends on the noise produced by equipment or tools, how close you are to the noise, and how long you are exposed. Your exposure can be reduced by decreasing the noise produced, increasing your distance from the noise, or reducing the amount of time you are exposed. Noise exposure can also be reduced by isolating yourself from the noise with sound absorbing barriers (e.g., an insulated cab) or with hearing protectors (ear plugs or muffs).

RESEARCH ON HEARING LOSS IN CONSTRUCTION

U.S. construction workers rarely get their hearing tested. When they do, the results are seldom collected in a way that can be studied in order to draw conclusions about the risk of hearing loss by trade. But there have been lots of construction workers in Canada and Sweden who have had their hearing tested, and it is likely that their noise exposures are the same or lower than those in the US. We can use the information we have from those hearing tests to suggest how dangerous construction noise is for workers in the US.

In British Columbia, all contractors must pay into a workers compensation board fund to provide free hearing tests for construction workers each year. Results from tests of thousands of construction laborers in British Columbia in 1995 show that after 16-25 years at the trade, significant hearing loss has occurred. After 16-25 years at the trade a construction laborer has the hearing of a person about 20 years older who has had no occupational noise exposure.

In Sweden from 1974- 1990 a similar fund paid for over a million hearing tests of construction workers. The results show that in 1974 by age 41 only about 20% of construction workers had normal hearing in both ears, and 5% had severe high tone hearing loss in both ears. By age 50, only about 10% had normal hearing in both ears, and 12% had severe high tone hearing loss in both ears. (Noise induced hearing loss occurs first at the high frequencies, about 4000 Hertz (cycles per second) and makes it harder to hear high pitched sounds and understand speech).

In 1974, the Swedish construction industry began a comprehensive hearing conservation program, requiring the use of hearing protectors and providing free hearing tests for construction workers. Training on noise and hearing protection was also provided. By 1990, the percentage of construction workers with

normal hearing in both ears went up to 38%, an increase of 90%. At the same time, the percentage of Swedish construction workers at age 41 with severe high tone hearing loss in both ears went down to 3%, a drop of 40% over 1974. Some reduction in hearing loss occurred even among 50 year olds, many of who started the program after significant loss had probably already occurred.

So it is clear that hearing loss among construction workers today can be reduced with an effective hearing conservation program.

ENGINEERING CONTROL OF NOISE IN CONSTRUCTION

The best way to reduce hearing loss in construction is to reduce the amount of noise produced by construction equipment. In the 1970's EPA had a noise control office which required equipment manufacturers to make portable air compressors quieter. Now these quieter compressors are common on construction sites. They also passed requirements for quieter medium and heavy trucks. There are often quieter pieces of equipment available and employers should include noise levels as an important criterion for equipment. For example, most new heavy equipment has insulated cabs, which can dramatically reduce the noise levels to operators. They also have mufflers which can reduce the noise levels substantially to bystanders. Contractors may find it cost-effective to pay a little extra for such equipment, not only because it reduces occupational noise but also because it may help them comply with community requirements for noise abatement. This is becoming increasingly important as demands for night work increase.

EASY SOLUTIONS FOR CONTRACTORS

Even if you are not buying new equipment right away, old equipment can be economically retrofitted to significantly reduce noise levels. For example, the Bureau of Mines recently studied on how to reduce noise exposures from front-end loaders and bulldozers, two common pieces of construction equipment. They found that with about \$500- \$800 for materials and about \$1000-1300 in labor costs (total cost = \$1600- \$2100), a bulldozer could be retrofitted to reduce the noise exposure of the operator 11 decibels (The lower figures are for bulldozers with cabs, the higher figures are for those without cabs). Likewise, for front-end loaders, operator's noise exposures were reduced by 11- 12 decibels at a cost of about \$400- \$600 for materials and \$250- \$400 for labor (total cost = \$800- \$840). These Bureau of Mines reports even include

blueprints detailing exactly how to retrofit your equipment. So, retrofitting does not have to be expensive and can substantially reduce operator exposures. Many other pieces of construction equipment can also be quieted using inexpensive control measures.

OSHA NOISE CONTROL REGULATIONS - OSHA requires that exposures to noise be controlled using feasible engineering controls and/or administrative controls (e.g., reducing the noise level or the amount of time you are exposed) down to within permissible exposure limits. The National Institute for Occupational Safety and Health (NIOSH) has recommended even more conservative limits (Recommended Exposure Limits- RELs) for noise exposure. Similarly, the American Conference of Governmental Industrial Hygienists (ACGIH) has recommended exposure limits (Threshold Limit Values- TLVs) for noise exposure that are stricter than the OSHA allowable limits. While the OSHA limits are the ones enforced, it is well recognized that they ARE NOT SAFE and that the NIOSH and ACGIH recommendations should be followed to adequately protect workers from hearing loss. Below are the exposure limits and the allowable exposure times for each level.

Time	OSHA Limit	NIOSH Limit	ACGIH Limit
8 hr	90	85	85
6 hr	92		
4 hr	95	88	88
3 hr	97		
2 hr	100	91	91
1½ hr	102	92	92
1 hr	105	94	94
½ hr	110	97	97
¼ hr	115	100	100
7.5 min	115	103	103
1 min	115	112	112
.5 min	115	115	115
less than 1 sec	115	130-140	130-140

So the NIOSH and ACGIH recommendations are much lower than the levels OSHA allows (remember 100 dBA is about 10 times as loud as 90 dBA). You should also note that while OSHA reduces the allowable exposure time by half for an increase in 5 dBA (e.g., you can be exposed to 90 dBA for 8 hours but 95 dBA for only 4 hours), NIOSH and ACGIH reduce the allowable exposure time by half for an increase in only 3 dBA (8 hours at 85 dBA and 4 hours at 88 dBA). This is called the 3 dB doubling rate and is now considered the much more scientifically accepted way to manage workers' noise exposures.

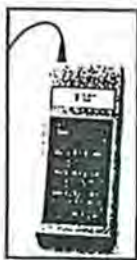
ELEMENTS OF A HEARING CONSERVATION PROGRAM IN CONSTRUCTION

OSHA has developed a comprehensive requirement for hearing conservation programs in workplaces. It requires worker training, annual hearing tests and use of hearing protection where exposures are above 85 dBA, but it currently only applies to industrial workplaces. In construction, OSHA only requires that for workers who must be exposed above the OSHA limits (i.e., where there are not feasible engineering and administrative controls to reduce their exposures), employers must provide and require the use of hearing protection, and they must have a "continuing, effective hearing conservation program" (1926.52). Plain cotton is not permitted for hearing protection (1926.101). But the details of an effective hearing conservation program in construction are not spelled out. This guide was written to help spell out how to run an effective program.

Following are seven main components of an effective hearing conservation program in construction:

- A) NOISE LEVEL DATABASE- SURVEYING THE WORK-SITE
- B) RULES ON WHEN TO WEAR HEARING PROTECTION
- C) HEARING PROTECTION SELECTION- OPTIONS
- D) TRAINING
- E) AUDIOMETRIC TESTING
- F) RECORD KEEPING-HOW TO INTERPRET IT
- G) PROGRAM EVALUATION

A) NOISE LEVEL DATABASE- SURVEYING THE WORK-SITE - While most people have a good idea on what the main noise sources are in construction, it is useful to survey your work sites periodically to check exposure levels and to demonstrate the need for hearing protection. There are sound level meters available which are relatively inexpensive and simple to operate. They can be used for on the spot measurements. Noise dosimeters, which measure noise levels over an entire day and can give you a detailed look at a person's noise exposure, are more expensive and complicated to use. But simple spot checks can help you make decisions about when to require hearing protection. If you know the length of time workers will be using noisy equipment or in a noisy area, you can compare the exposure level and the time with the NIOSH, ACGIH and OSHA limits mentioned above. Noise measurements should be made using an "A-weighted" scale which filters the sounds to mimic human hearing. Decibel levels measured with the A-weighting scale are labeled "dBA." They should be recorded in a log similar to the one in Appendix A, along with the date, time, employee's name, project name, and a description of the work, including what equipment he/she is using or is nearby. This information can easily be entered into a computerized database which will eventually give you a sound basis for making future decisions on hearing protection.



Dosimeter

Worn by worker for 8-hour shift

Gives average exposure level for entire day and is useful if working at several jobs

A-weighted measurements



Sound Level Meter

Instant sound measurements

Used for area noise measurements to determine noise levels for a specific location or task.

A-weighted measurements

B) RULES ON WHEN TO WEAR HEARING PROTECTION- Twenty years ago many construction workers did not wear hard hats. Yet now their use is almost universal. Hearing protection is another story. Many workers do not use hearing protection or, if they do, it is often used improperly. There are many excuses workers give for not wearing hearing protection. Hearing protectors can be inconvenient, uncomfortable and make it harder to communicate. Even when there are definite rules about when and where to wear hearing protection, the best way to increase their use is to eliminate the barriers. We will discuss these barriers to wearing hearing protection later.

When is hearing protection needed? Protection should be required whenever a worker is exposed to hazardous levels of noise. Currently OSHA only requires that construction workers have protection if exposures exceed certain limits (e.g., 8 hours at 90 dBA, 4 hours at 95, etc.). But since these regulations are known to be insufficient (and OSHA requires hearing protection in industry at lower levels), smart employers will follow the NIOSH/ACGIH limits for deciding when use should be required.

Often we won't have 8 hour exposure information on workers and exposures can change from day to day, depending on the phase of construction and what each worker is doing that day. For these reasons, it makes sense to tie hearing protection to: 1) use of certain equipment, 2) work in the area when certain equipment is being used, and 3) other high noise jobs, like work in enclosed areas (like tanks, boilers, etc.). To simplify the matter, hearing protection should be required for any operation or equipment use where exposure exceeds 85 dBA at any time. Hearing protectors use will then follow directly from the measurements made at the site, from the data collected on similar jobs, and can be checked easily with a basic sound level meter. A list of tasks requiring hearing protection can be developed, posted and enforced. Regulated areas can be set up

around where noisy equipment will be used based on these measurements. For example, based on noise measurements, you could determine that workers should not work within 20 feet of someone using a jackhammer without hearing protection. Then a regulated area can be set up with signs posted stating that hearing protection is required within that area. Workers will no longer be required to wear hearing protection at all times on the site, only when necessary by nature of their work. These rules on when and where to wear hearing protection should be strictly, but fairly enforced. They should apply to all personnel, including foremen and superintendents, who enter these restricted areas or use noisy equipment..

C) TYPES OF HEARING PROTECTION - There are many different models and brands of hearing protectors, but they basically fall into two categories: ear plugs and ear muffs. Ear plugs are inserted into the ear canal and ear muffs fit over the ear to block the sound. There are advantages and disadvantages to each. Ear plugs are cheap and easy to use (less than 50 cents/pair). They don't interfere with safety equipment and are good in hot weather. They are meant to be disposed of after each shift. They can be very effective, but are often used improperly, resulting in less protection than expected. They can also get dirty from handling with dirty hands and perhaps contaminate the ear canal leading to a higher potential for ear infections. Ear muffs are more expensive, but can be attached directly to a hard hat to be easily placed on and off. They also can last for a long time, so in the long run can be more cost-effective than disposable plugs.

One concern expressed by many workers is that hearing protection will prevent them from hearing warning signals, like back up alarms. Another concern is that hearing protection can also interfere with communication, particularly for workers who have already lost a significant amount of hearing. There are new types of ear plugs available now that have "flat attenuation" which don't block out as much of the high frequency sounds, like a lot of speech communication. It is also important for these workers to pick an ear plug that doesn't "overprotect" (see discussion below). In this case, bigger is not always better.

Another possible solution is to use new types of ear muffs that have a microphone which picks up sound, like conversation, and transmits it into a speaker in the ear muff. The system automatically limits the sound inside the muff to a safe level. This allows workers to carry on conversations and hear warning signals while wearing their ear muffs or without having to take them off. Some new ear muffs have new technology to "cancel" out noise as well. While these systems are fairly expensive now

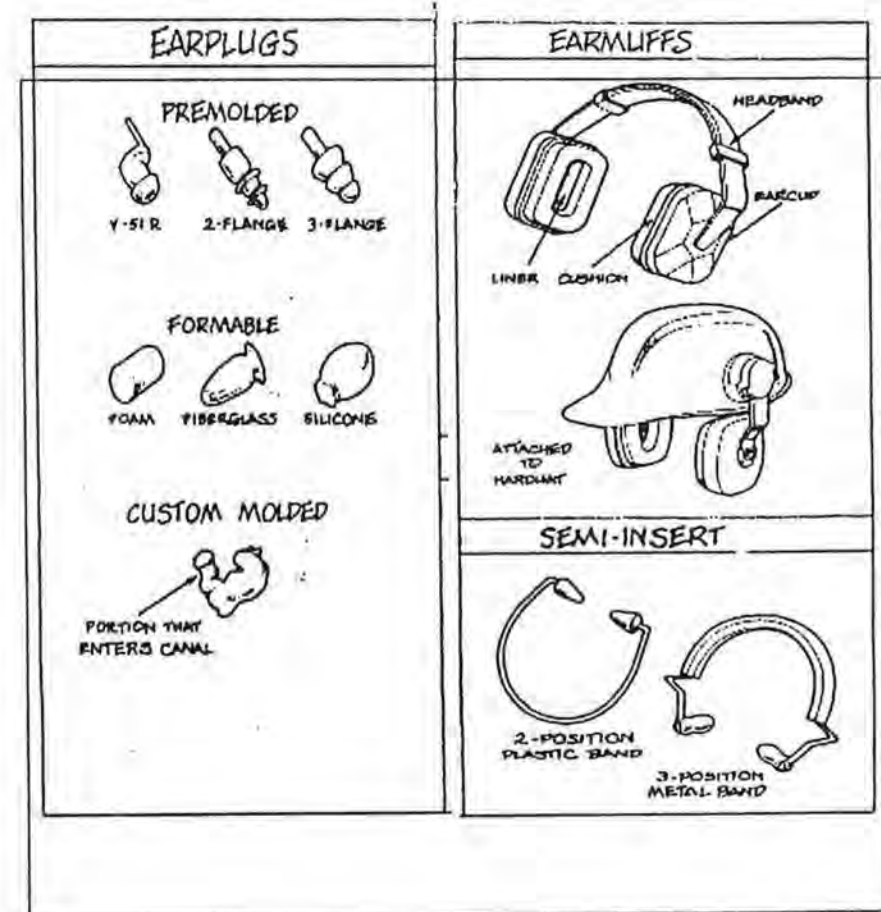
(about \$125- \$150 a pair) if they help to get workers, particularly those with some hearing loss already, to wear hearing protection more often and thereby prevent significant hearing loss, it is a good investment. It may even be considered a "reasonable accommodation" under the Americans with Disabilities Act (ADA) for hearing handicapped workers to improve their ability to continue working in construction. It also may be necessary if workers need to communicate to do their job safely.

SELECTION - How do you decide how much protection is needed? Hearing protectors have Noise Reduction Ratings (NRR). It is supposed to tell you how much the noise is reduced by proper use of the hearing protector. For example, if the noise level was 95 dBA and the NRR was 17, the sound level you hear would be 78 dBA, which is below the NIOSH/ACGIH recommendations for an 8 hour. But tests have shown that in real situations, workers generally don't get that much protection. Often earplugs are not inserted properly or not used correctly. The result is that we believe workers only get less than half the amount of protection from hearing protectors that they should. Therefore in deciding which hearing protector to use, OSHA recommends that you subtract 7 from the NRR and then divide it by 2 to determine the expected protection during actual use. So in reality this worker would be exposed to about 90 dBA ($(17-7)/2 = 5$, $95-5 = 90$), which is over the NIOSH/ACGIH limits.

One thing to avoid is overprotection. If the decibel level is 90 dBA, you only need a protector which will reduce your exposure by 5 dBA to protect yourself (one with an NRR of 17). By using more protection than needed, you may be blocking out more communication and sounds than needed. On the other hand, for very loud noises, like jack hammers, one hearing protector may not be enough. In such cases, sometimes ear plugs are used in conjunction with ear muffs to provide double protection in order to bring exposures down below 85 dBA. In either

case, the goal should be to reduce exposures down to about 85 dBA.

A variety of hearing protectors should be provided for workers to choose from. While protectors are supposed to be one-size-fits-all, different workers may find different hearing protectors more comfortable. Comfort is an important factor in determining consistent use of hearing protectors. Providing a variety of protectors (brands and types) for workers to choose from will help make sure that they can find one they like and will feel comfortable wearing.



D) TRAINING - Training is a crucial part of any effective hearing conservation program. Unfortunately many people believe that since hearing protectors are easy to use, little training is needed. Only when workers understand the nature and seriousness of the problem will they take seriously the need for hearing protection and their natural resistance to wearing it can be overcome.

Workers need training on:

- 1) the hazards of noise in construction;
- 2) sound levels produced by common equipment;
- 3) what the employer is doing to reduce noise levels using engineering and administrative controls;
- 4) how noise levels are measured and how to interpret noise level readings;
- 5) types of hearing protection and how to choose and fit them properly;
- 6) noise reduction ratings and their usefulness;
- 7) audiometric testing and how to interpret it;
- 8) signs of hearing loss; and
- 9) why workers resist hearing protection.

Training on proper fitting and wearing of hearing protectors is important. Workers need to be able to know what protectors are worn properly.

This training should take place before workers begin work and be reinforced annually. Training should incorporate demonstrations and discussion. Tape recordings of garbled speech can also be played to demonstrate what their hearing will sound like after a significant loss. Sound levels can be measured using a sound level meter. Sample audiograms can be reviewed to show noise-induced hearing loss. Discussions of workers concerns about hearing loss and use of hearing protection should be thoroughly aired.

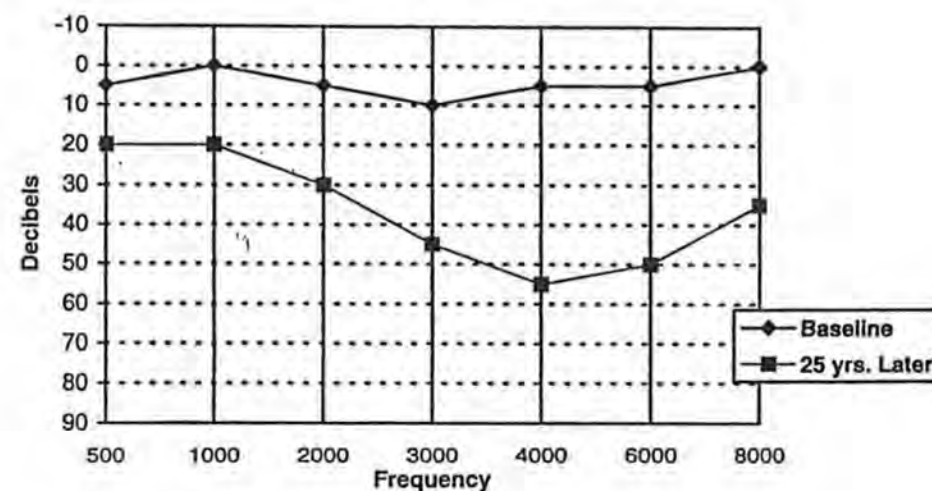
This type of training probably needs at least a 2 hour session initially. It should not be accomplished solely through watching a videotape. It is not OK to have workers reach in a box and fit hearing protectors without training. Just like respirators need to be individually fit, so must hearing protectors be individually fit. Workers should also get further reinforcement of the need for hearing protection when they go for audiometric testing. It is also critical that supervisors, foremen and superintendents are also trained, as they are going to be the ones enforcing and reinforcing the need for hearing protection. As with any other training, management commitment is critical.

E) HEARING TESTS - Hearing loss occurs gradually. So people often do not get upset about it, or realize it is happening it until it is too late. Audiometric testing is critical because it makes the hearing loss real to people. You can see exactly how much loss has occurred and even at early stages become more proactive in protecting yourself as well as demanding that more noise control measures be taken. Audiometric testing is inexpensive, non-invasive and does not take much time. It should be done at least once a year. It should be done before work or after a weekend of "quiet time" so we are not measuring temporary hearing loss from exposure during that day. Some contractors, because of liability concerns, may test workers before hiring and after completion of the job, to show no losses occurred on their job, but except when workers are exposed to unusual or extreme hearing hazards, annual hearing tests should be adequate. In some countries or provinces (Sweden, British Columbia), all contractors pay into a central fund (e.g., workers comp) to pay for free hearing tests each year for workers in construction. While we don't have such a system in the US, audiometric testing could be covered by Union Health and Welfare Funds or coordinated through the union hall. Local audiologists can often offer mobile services that can be brought to the work site. Workers can get testing done prior to work to look for long term loss. Testing could also be done after work to demonstrate the temporary effects of noise on hearing loss after a single shift. Studies have shown that by having their hearing tested each year to see how their hearing has been affected and hearing about the need for precautions from the audiologist, workers were much more motivated to wear hearing protection. The result is that the program was much more successful.

HOW TO INTERPRET IT- Hearing loss is identified by measuring how loud a sound must be to be heard. Sound levels are measured in decibels. Sound is also measured in frequencies. Higher frequency sounds mean they have more vibrations each second. The human ear can hear from about 500 vibrations

per second (or 500 Hertz) to about 8000 vibrations per second (or 8 kilohertz). The ability to hear each frequency is measured by an audiologist and recorded on an audiogram. Noise-induced hearing loss tends to occur first at around 4000 vibrations per second or 4 kHz. This is about the highest note on a piano. So in looking at an audiogram you may see a change in the chart at around 4 kHz. This means the sound had to be louder at this frequency for you to hear it. OSHA requires employers to record the hearing loss on the OSHA injury and illness log if there is an average of 25 dB loss at 2, 3 and 4 kHz. This is called a "standard threshold shift." Getting an audiogram each year lets you track any hearing loss and see if any changes are happening. If workers change employers frequently, they should try and keep copies of their audiograms so they can bring them with them each time and compare them. The audiologist should also discuss the results with employees. This has been shown to have the biggest impact in improving hearing protector use.

AUDIOGRAM



F) RECORD KEEPING - There are three major types of records that have to be kept as part of a good hearing conservation program: exposure records, audiometric records, and training records. As discussed before, by keeping records of noise levels of various jobs and tasks in a computer database, you can eventually get to where you can know in advance what type of exposures to expect and can appropriately protect individuals from expected levels as well as make appropriate rules for when hearing protection is needed.

Audiometric records must be kept like any medical records and they should be kept confidential. It is important to be able to check on changes in hearing loss from year to year and so these records need to be available to the workers, as well as giving them copies after each test.

Training records are important as training is an essential component of an effective program and only by keeping records can you see if everyone has had appropriate training and retraining.

G) PROGRAM EVALUATION - Like any other safety and health program, it is important to see if the program is really working and make it work better. The real question is what do we mean by saying it is working? There are a number of measures that can be tracked. First, you can look at number of workers trained. Workers could be given a pre and post training quiz to see if they have learned key elements of the training. Second, you can do periodic unannounced site reviews to see if areas where hearing protection is needed are properly marked, to check noise levels on the site and to see if workers are using hearing protection appropriately. Third, with a stable work crew, you can check to see if hearing loss is decreasing as a result of the program, in other words are fewer people developing hearing loss or are they developing it slower than expected? This last measure might be hard to determine, especially given the fluid nature of the construction workforce, but it may be possible in some circumstances and is really the ultimate goal. You may be able to think up other ways to measure success. It is important to measure something and use that information to review the success of the program and improve the program at least once a year.

BARRIERS TO AN EFFECTIVE PROGRAM

Nobody dies from losing their hearing, (although some may lose their lives from not being able to hear or communicate on the job site). This is one reason many people don't take noise and hearing loss seriously. It is not as dramatic as falling off a scaffold, a trench collapse, or being electrocuted by contact with power lines. It comes on gradually, creeping up on you until one day you realize it is harder to understand people in conversation or go to the movies or watch TV with your family. Construction workers accept that noise is a part of their work and often don't see much progress being made to change that fact. And while hearing protection is available, it is very important to choose the right protector to make sure it is convenient and comfortable.

HOW ABOUT CONTROLLING NOISE ON SITES MORE?

It is well known that the best way to reduce hearing loss is by engineering control of noise, by buying quieter equipment or retrofitting old noisy equipment. But this can be expensive and OSHA rarely enforces noise regulations on construction sites. Contractors that are pressed for capital are only going to spend money on things they have to. This may be seen as an unnecessary expense, especially if workers are constantly changing employers and few, if any, workers compensation cases are filed by construction workers for hearing loss. One solution to this dilemma, is to look for low cost solutions (like the front-end loader and backhoe solutions discussed earlier) and to show that workers on quieter jobs are more productive. Noise causes stress and could lead to lower quality work as well. New cab designs on heavy equipment are more comfortable and have good temperature controls as well as noise insulation and workers prefer to work in such environments. In an age when skilled labor is in short supply, this can be an important competitive advantage. A quieter work site may also make it easier to get work done since it will be easier to communicate and contrac-

tors won't have to be worrying as much about enforcing a hearing protection program. A quieter work site also makes for good neighbors when working in urban or residential areas and may provide better relations with the community which could help win projects. Heavy equipment is usually quieter when it is better maintained, another indication of a contractor who invests in the future in keeping their equipment in good shape. Also, workers are going to be more likely to use hearing protection if they see the contractor doing his/her part by trying their best to eliminate or reduce the need for wearing protection in the first place.

WHY WON'T WORKERS WEAR HEARING PROTECTION?

Have you ever worn hearing protection for 8 hours, with few breaks in 110° F weather outdoors and while trying to coordinate with co-workers? It's difficult. No one really likes wearing hearing protection or wants to wear it. They do it because they have to protect their hearing or because contractors require it. Here are some of the concerns and what can be done about them.

DISCOMFORT - Workers need to be given a variety of hearing protectors and be allowed to choose the model and brand and type that is most comfortable for them. They also need to be able to take their hearing protection off periodically for rest breaks and in non-noisy areas. Hearing protection that is easy to use and handy, like ear muffs attached to hard hats or ear plugs on a band that can be hung around the neck when not in use, encourage consistent use. Workers also need, as part of their training, to be taught how to properly use hearing protection so it fits correctly and it most comfortable as well as working best.

FEAR ABOUT NOT HEARING WARNING SIGNS - EXISTING HEARING IMPAIRMENT - Construction sites are noisy and that is one reason why vehicles have loud back up alarms to warn workers about dangers on the site. Workers who already

have lost a lot of their hearing may have a difficult time hearing and locating warning signals while wearing hearing protection. But for most workers, hearing protectors act like sun glasses which cut down the glare but allow you to see more clearly. Those who are really afraid of missing some warning signals should be encouraged to try the protectors out and see if they can hear signals with them on. For workers with significant hearing loss and for those whom communication is essential, it may be best to purchase flat attenuation plugs or ear muffs with 'active' hearing protectors which block the loud noises but will let in conversations through electronics in the muff. While more expensive, they will probably be cost-effective in the long run compared with regular plugs.

DON'T THINK IT IS NECESSARY - Some workers resist wearing hearing protectors because they are not aware of the high risk of hearing loss or feel they are getting 'used to' the noise. These workers need to talk with older trades people about what happened to them and how hearing loss has affected their lives. They need to be taught about the true risk of hearing loss in their trade and know the warning signs. Annual audiograms are also an eye-opener and help persuade workers that the risk and the problem are real. Limiting use of hearing protectors to those regulated areas or tasks where it is absolutely needed, based on noise data collected, will limit the need for constant use and help workers see it as a necessity.

ACTION PLAN FOR CONTRACTORS: WHAT YOU CAN DO TO PREVENT HEARING LOSS AMONG YOUR EMPLOYEES

OSHA is actively looking at extending the requirement for comprehensive hearing conservation programs to construction. But that requirement is probably years away. We shouldn't wait until then to work on hearing loss prevention. There are lots of things you can do right now that can make a difference. You can:

- ◇ Give a tool box talk to your employees on noise and hearing loss. (See Health Alert on Page 31)
- ◇ Provide additional training for employees on noise and hearing loss prevention. Manufacturers of hearing protection are often willing to help out with materials on proper use and fitting of hearing protectors.
- ◇ Check your worksite for noise levels from various types of equipment. Spot testing can be done with an inexpensive sound level meter from an electronics store. Make an inventory of noisy equipment and noisy jobs.
- ◇ Create restricted areas around noisy operations and require hearing protection in those areas.
- ◇ Keep your equipment in good working order. Well-maintained equipment is generally much quieter.
- ◇ Buy or rent quieter equipment. Make quieter sound levels of the equipment a condition for purchasing or renting equipment. Often the cost is comparable and it may help you get more jobs.
- ◇ Provide hearing tests for your employees and/or work with them to make sure their health benefits include an annual hearing test. Make sure workers understand the results and can compare them with results from previous tests.
- ◇ Have a variety of different hearing protectors available for use and help employees choose the ones which fit the best and are most appropriate to their work, not providing too much or too little protection. Consider providing active hearing protectors (with electronics) or flat attenuation plugs which don't cut out speech communication as much.
- ◇ Develop a strict but fair enforcement policy for use of hearing protection where required. Make sure all employees in those areas, including foremen and visitors wear them as well.

ACTION PLAN FOR EMPLOYEES:

Here are some things you and your local union can do to help prevent hearing loss among your members.

- ◇ Schedule a local union meeting to talk about hearing loss and noise. Bring in a speaker from a local hearing clinic and make sure you schedule an older member to talk about how it has affected their lives.
- ◇ Get a local health clinic to host a hearing screening for your local. Present the summary results, showing percentage of members with significant hearing loss at a future local union meeting.
- ◇ Buy an inexpensive sound level meter at a local electronics store and check out the noise levels on your work site. Write up a summary of the results and distribute it at a local union meeting or on the work site for discussion. Identify the noisiest equipment or tasks and talk with the employer about how you could reduce exposure levels or rotate workers through those jobs to reduce their time exposed.
- ◇ Contact a representative of a hearing protector manufacturer and ask them to come to a local union meeting or the site to explain to people what hearing protectors are available and teach people how to use them properly.
- ◇ Call a variety of tool/equipment manufacturers before buying new equipment and ask them about noise levels. Ask your employers to make that a condition of purchasing new equipment.
- ◇ Ask the mechanics who maintain your equipment for low cost ideas on how they could be made to run quieter.
- ◇ File a request for a consultation (or a complaint) with OSHA about noise on your worksite.

HEALTH ALERT ON NOISE

The ability to hear is one of our greatest gifts, without it the quality of our lives are significantly reduced. It's estimated that 14,000,000 workers in the U.S. are exposed to hazardous noise levels. In fact, studies have shown that after 15 years on the job laborers will experience a significant loss in hearing.

The Hazards

Hearing damage is caused by factors such as loudness, the amount of exposure to noise, and frequency. High frequency noise causes more damage than low frequency noise.

Noise may tire out the inner ear, causing a temporary hearing loss. After a period of time off, hearing is restored. But if exposure continues, the time it takes to restore gets longer. In many cases, by the time hearing is restored, it is time for another work shift. If this continues hearing never restores and the loss is permanent.

Normally, injury to the ears occur in the ability to hear higher frequency sounds. Normal speech falls into this frequency. A worker may be able to hear some sounds but speech may become unclear and distorted. Workers with hearing impairment may say "I heard you, but I don't understand what you said."

Other Hazards

It appears that noise can increase pulse rate, blood pressure, and narrows blood vessels. Workers may complain of stomach problems, nervousness, sleeplessness, and fatigue when they have been exposed to high noise levels.

Legal Limits On Noise

Under the Occupational Safety and Health Act (OSHA), every employer is responsible to provide a workplace free of excessive noise.

The details can be found in the following standards:

- 29 CFR 1910.95 - General Industry.
- 29 CFR 1926.52 - Construction.

Permissible Exposure Level

No worker is allowed to be exposed to sound levels greater than 90 dBA without the use of hearing protection. Even so, 90 dBA is not safe: 1 in 5 people exposed regularly of the levels allowed by OSHA will lose some hearing. If there are high noise levels the employer is required to reduce the noise exposure level below 90 dBA. The first step should be engineering controls, and if that fails then personal protective equipment, such as ear plugs or ear muffs, must be provided and worn.

Maximum Permissible Noise Exposure	
8 hr.	90 dBA
4 hr.	95 dBA
2 hr.	100 dBA

Normal Conversation	60 dBA
Power Saw	110 dBA
Pain Begins	125 dBA

Hearing Conservation

Whenever 85 dBA is exceeded in the general industry standard (90 dBA in construction) for an 8 hour period the employer is required to include all exposed workers into a Hearing Conservation Program. This program must include:

- Training
- Yearly Audiometric Testing Program
- Monitoring Noise Exposure
- Hearing protection must be made available.

APPENDIX G.

Health Trak Cycle 5 Final Report: Ergonomics and Contractor Activity Planning



Technical Report

HEALTH TRAK CYCLE 5: ERGONOMICS AND CONTRACTOR ACTIVITY PLANNING

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EXECUTIVE SUMMARY

A Health Trak research cycle was organized to investigate ergonomics in form construction work. The contractor's Activity Plan was assessed as a tool to incorporate ergonomics into the tasks of one of the contractor's construction stages. Modest success was achieved in reducing exposure to risk for cumulative trauma to the shoulder, neck and upper extremities of Ironworkers during concrete reinforcement bar construction. The Activity Plan helped to facilitate this intervention and many other safety measures normally taken on site. A Health Trak Committee discussed the actualities of the construction work environment, and made some observations of how the Activity Plan could be more effective: 1) more substantial support from upper management, 2) systematic inclusion of employees in implementing Activity Plan measures, 3) more consistent distribution of Activity Plan among employees.

BACKGROUND

The Research Method: Model Contractor and Health Trak

The Construction Occupational Health Program's (COHP) Model Contractor Program is a collaborative research project between the COHP and the participating Contractor that attempts to improve the health component of the Contractor's health and safety program through meaningful worker participation in identifying and abating workplace hazards. The key component of the Model Contractor Program, which has been previously described in detail¹, is a participatory research process.

Health Trak, the eight week participatory research component of the Model Contractor Program, was designed by researchers at the COHP to enhance workers' and contractors' representatives' capacity to identify and remedy health hazards on construction sites.² It uses participatory research methods that are "learner-centered," which were developed in the field of education, and which have been adapted to the field of occupational health to combine research and intervention in single studies and to transform research subjects into participants in the process.

Specifically, Health Trak participants join in a partnership to identify worksite hazards, develop and implement solutions to those hazards, and then explore the impact and feasibility of the solutions. Health Trak has three components:

1. ***The Health Trak Committee*** consists of representatives from management and labor. To compensate for the dominant influence of power and resources that favors management, the Committee is required to have a majority of participants representing labor.
2. ***Toolbox Talks, Safety Meetings, and Training*** sessions normally held by the contractor or laborers on site are opportunities for the COHP researchers and other Health Trak Committee participants to communicate information discussed within the Committee to other workers on-site.
3. ***Observations and interviews*** are conducted by COHP researchers and other Health Trak Committee participants to collect data on work methods and exposure to health hazards on the work site. This data is obtained through direct observation and by both formal and informal interviews of labor and management.

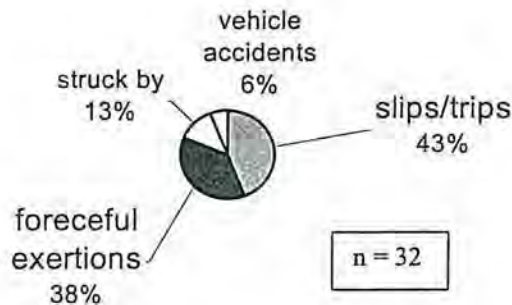
No predetermined number of hazards or solutions is defined before the Health Trak process begins. Implementation of measures to reduce exposure of any work environment risk factor identified by the committee is considered a success. Reasons for success or obstacles to risk reduction are examined by the COHP researchers aiming to understand key elements to successful intervention.

The Contractor: SIWP

In the summer of 1998, the Slattery, Interbeton, White, and Perini Joint Venture (SIWP) committed to working with the COHP as a Model Contractor. Since that time, SIWP has participated in three Health Trak cycles, including the cycle reported on here. The current cycle was conducted during the spring and summer of 2000, while SIWP was constructing the I93/I90 interchange of Massachusetts' Highway Department's Central Artery/Tunnel Project.

A review of SIWP's injury data from November 1999 to March 2000 showed that 43% of their reported injuries were slips/trips, and another 38% were generally due to forceful exertions (32 events).

FIGURE 1: Reported injuries on SIWP (November 1999 – March 2000)



Health Trak Cycle 5: Ergonomics in Concrete Slab Construction

Based on SIWP's injury data, the COHP researchers and SIWP's (Slattery) Safety Director, agreed that the goal of this cycle of Health Trak would be to develop and implement ergonomic controls to reduce workers' exposure to risk factors commonly associated with strain and sprain injuries.

To achieve this goal, two objectives were defined:

1. Recognize, evaluate, and control risk for ergonomic injury to the crews on the Ramp L stage.
2. Expand SIWP's Activity Plan to include recognition and abatement of ergonomic hazards.

The Activity Plan (AP) is one of SIWP's existing tools for anticipating and/or reacting to identified risks. Written by their safety management, the AP annotates the anticipated risks and links them with prescribed solutions. All necessary tools and equipment to complete the tasks are also listed in the AP. The safety management considers the AP to be a working document primarily used by foremen as a field guide to crew safety in a given operation.

SIWP management foresaw that the COHP insight might be most useful on a large stage that would require mostly concrete form building and concrete pouring. Therefore, COHP and SIWP agreed to focus the research on "Ramp L" (described below). In addition, SIWP management was beginning to incorporate a new project management software that could be used for this stage area, and the utility of the potential ergonomic information was viewed as an advantage that could be incorporated into the planning of this staging.

The Research Site: Ramp L

Ramp L is a large construction stage that transcends three major contracts of the CA/T, connecting northbound I-93 with eastbound I-90 to Logan International Airport (Photos 1, 2). SIWP's portion of Ramp L is a cut and cover section that also supports a viaduct superstructure. Because of this configuration and construction schedules of the superstructure, SIWP's Ramp L stage required the unusual progression of pouring a roof slab before excavation and pouring the floor and walls. An example of SIWP's "4-week Look Ahead Schedule" is included in Appendix B.

COHP has previously analyzed worker exposure to ergonomic risk factors associated with concrete formwork and pouring on other large highway construction sites.³ The work methods of the crews constructing the roof slab of Ramp L were not substantially different from what the COHP had observed at other major concrete work stages on the CA/T. Unfortunately, the COHP does not have comparable injury data, though these data would exist with the contractors.

RESULTS

Qualitative data was collected from two distinct sources: the Health Trak Committee members during committee meetings, and from on-site observations by the COHP researchers. Below, these data are grouped into five topics:

- Hazard Identification
- Intervention Development and Implementation
- Intervention Evaluation
- Activity Plan Development and Utility
- Process Evaluation

Hazard Identification

This Health Trak cycle was conceived with the goal of identifying and intervening in job tasks which exposed construction workers to ergonomic risk factors. Of particular interest were the tasks involving manual material handling. During the first three Health Trak meetings, the Committee members reviewed and discussed ergonomic risk factors.

Table 1: Summary of Health Trak Meetings

Meeting	Content
1	Introduction to Health Trak methodology; follow-up on Committee initiatives emphasized; Ironworker platform idea raised.
2, 3	Draft ideas for ergonomics in SIWP Activity Plan; "realities" of Activity Plan discussed; lifting limits discussed; plywood walkway idea raised.
4	"Risk mapping" to identify areas for ergonomic improvement; effect of economy on health and safety discussed.
5	Review of Committee progress for new members.
6	Walkway and platform maintenance roles assigned; barriers to walkway usage discussed.
7	Interventions evaluated.
8	Health Trak cycle review and evaluation.

The Committee members did not consider it feasible to address many traditionally accepted risk factors for MSDs. For example, the idea of establishing a lifting limit and/or lifting guidelines was discussed at length during Health Trak meeting #3. The Committee concluded that neither of these interventions would be possible to implement on-the-job or to incorporate into an Activity Plan.

Based on the discussions about ergonomic risk factors, the Committee focussed it's attention on a few job tasks of concern to them that they believed could be redesigned.

Table 2: Job tasks that the Committee considered for intervention

Job Tasks	Ergonomic Risk Factors	Workers Affected
Inserting rebar	Working with arms above shoulders Force	Ironworkers
Chipping concrete spills	Awkward postures due to working in cramped spaces	Laborers
Walking on rebar mats	Slips and trips	Carpenters Laborers Ironworkers

TABLE 3: Summary of ergonomic hazards observed

Task ("Jobs")	Activity	Body area	Risk
Concrete pour	Hold vibrator whip	Back	Static loading
		Ankle	Twist and sprain
	Guide hose	Back	High force Static posture
		Ankle	Twist and sprain
Build bulk-head	Fasten boards by hammering	Hand and wrist	Repetition High force
		Lower back	Awkward posture Static posture
	Cut board to length	Hand and wrist	Awkward posture High force
Insert DBS	Screw-in rebar	Back	Severe forward flexion High, static force
		Shoulder	Awkward posture—work over shoulder height High force Repetition
		Neck	Non-neutral posture—work over shoulder height
		Hand and wrist	High force Awkward posture
	Lift/carry rebar	Back	High force Awkward posture
Build rebar mat	lift/carry/place rebar	Back	High force Awkward posture
	tie rebar	Hand/wrist	High force Awkward posture
		Back	Awkward posture

In addition to the Committee's identification of hazards, observations were made by COHP researchers (several times between June and August, 2000) of four jobs within the Ramp L stage: form building (Carpenters), inserting DBSs, constructing rebar mat (Ironworkers), and concrete pouring (Laborers and Carpenters). The tasks observed were parts of concrete form and concrete pour operations as defined by COHP's taxonomic model for characterizing construction work.⁴ A summary of ergonomic hazards observed during ramp L roof construction is provided in Table 3. The observations of Table 3 are consistent with ergonomic hazards that COHP has previously observed on concrete formbuilding and pouring on other large highway construction projects.³

Intervention Development and Implementation

Of the three tasks that the Health Trak Committee members discussed, they developed and attempted to implement job-specific interventions for two: a raised platform for Ironworkers, and a plywood walkway designed to be placed over a rebar mat.

The third task of concern—chipping concrete overflows and working in tight spaces—was discussed during Health Trak Meeting 2 and put aside because the Committee members felt that no changes could be made to the way the job was done. Concrete form overflow was identified as a major ergonomic hazard for Laborers, as their task is to chip away the overflow to create a smooth edge to the slab. This must be done even if the overflow is contained within a rebar cage that is directly abutting the blown-out form. In such an instance, extreme awkward positions and forces must be used, which creates dust from the chipping and hammering of the concrete. Moving the rebar to allow the Laborer's joints to be in a biomechanically advantageous positions is not possible, so prevention of overflow is critical. Suspension of the hammer might be a consideration in certain instances, but the idea was not discussed by the committee. The hammer used was reportedly 6 lbs.

The interventions that were discussed as potential ways of alleviating worker exposure to awkward postures included job rotation and taking breaks. (In addition, COHP researchers presented the Committee with a carpenter's checklist used to ensure that the form is constructed properly to prevent the overflow.) The Committee members claimed that efforts are made to encourage job rotation when possible (limitations included production pressure, inability to plan ahead due to unforeseen work, overtime). In addition, the Committee members agreed that workers can take breaks whenever they need to. Committee members pointed to the booming economy as being primarily responsible for this "freedom." In their assessment, a surplus of work creates an environment in which workers have the freedom to leave a job when they perceive a threat to their health and safety, yet they have the security of knowing they will find another job. Indeed, during this discussion, the Committee members could identify no barriers that currently exist to a worker stopping work to stretch if he/she feels the need.

Ergonomic trainings and toolbox talks, the second component of Health Trak, were part of the strategy for implementing the interventions. COHP researchers presented a ½ hour ergonomics “training” to the foremen at their monthly safety meeting (May) to insure that foremen were aware of the HT initiative and to promote a fundamental understanding of ergonomics in construction. Also, the Ironworker steward asked the COHP to give a similar presentation for the Ironworkers who, because of their sub-contractual arrangement with SIWP, had not participated in the SIWP safety meetings. Then, for the intervention that was implemented as described below, a focused introduction to: 1) implementing ergonomics on ramp L in general and 2) implementing the specific ergonomic measures mentioned below took place during one of the ramp L foremen’s tool talk.

Ironworker Platform

Health Trak Committee members suggested building an “Ironworker platform” during the first committee meeting (Table 1). This intervention was designed to reduce the risk of strain to the shoulder of Ironworkers inserting “Dowel-By-Screw-in” (DBS) with both hands and elbows over shoulder height. The idea was simply to raise the height of the worker so he/she would not have to work overhead.

Due to the nature of the task, the Ironworker steward believed that significant risk for musculoskeletal strain could be prevented with this intervention. Inserting rebar involves lifting, holding and manipulating #11 rebar dowels. Number eleven dowel weighs 5.3 pounds per foot. The two sizes of dowels used on Ramp L panels 10e and 10w (Photos 10-12) were 11.5 and 14 feet long (Photos 3,4). The weight of the dowels being inserted were 61 or 74 pounds. Two people are required to handle this material, and therefor, two platforms were needed.

By describing this task to the Committee members, the Ironworker steward was able to work directly with the Carpenter representative to design the intervention. The Committee members agreed that the platform should essentially be a box, closed in on all sides, large enough for one worker to stand on, and tall enough to provide relief from the overhead work.

While the development of the intervention was quite simple, it’s implementation was not. Questions about who would make the platform, who had authority to have it made, when it would be used and how this information would be communicated to the foremen and workers, were raised by Committee members. After repeated discussions of these questions during Health Trak Meetings 2 and 3, a Carpenters steward agreed to “have the boxes built.” While he felt that obtaining the site supervisor’s approval would be important for building many platforms, he believed that nobody would care if the Carpenters took the time to build just two. Ultimately, the site supervisor authorized the building and use of the platforms during a Health Trak Committee meeting. Apparently, no further authorization was necessary.

As a result of the direct communication between the Ironworker and Carpenter stewards, the Carpenters built two boxes out of 2" x 12" lumber and 1" plywood and fashioned it with a rope handle (Photo 16). The platforms as built (20" x 20" x 11") raised the surface on which the Ironworkers would stand while they inserted rebar into the slurry wall by 11 inches. This reduced the distance between the lower mat, where the worker stood, and the two higher rows of DBS to 70 and 77 inches. A six foot tall worker would still be reaching overhead on the highest inserts, but would probably be able to rest the rebar on his/her shoulder while inserting into the lower DBS. (This was confirmed by the informal reports of one of the Ironworkers who used the platform.)

As far as the COHP researchers have been able to ascertain, the platforms were used during one round of rebar insertion. After that task had been completed, the platforms were not needed for an undetermined length of time. During this break in work, one platform was destroyed, but the other was "saved." Since then, the box has been used by laborers removing plywood and insulation from the threaded holes for the dowels (Photo 13, 14).

Rebar Mat Walkway

The second intervention developed by the Health Trak Committee was a plywood walkway to be placed over rebar mat. Stable footing is an issue due to the work that was required to be done while walking or standing on the rebar mat. Plywood walkways had been noted in the "Safety Equipment Needs Section" (Section 1) of the Activity Plan (AP). Because they were noted as a safety equipment need, not as a solution to an identified hazard, and because the placement and maintenance of the plywood was not specified in the "Jobsite Hazards and Solutions Section" (section 2) of the AP, we consider it a Health Trak intervention. The Committee's intent was that the plywood walkway be used by the Carpenters and Laborers during form construction to prevent ankle sprains and leg and groin contusion that result from falls through the rebar mat.

The Health Trak Committee struggled to clarify and delineate the methods and use of the plywood walkway, and thus to facilitate and standardize its usage. After lengthy discussions, the Committee decided to make the walkway from 2' x 8' lengths of plywood painted to identify their purpose. These dimensions had not previously been noted in SIWP's Action Plan. It was the Committee's contention that the 2-foot wide dimension would be easier to handle than 4-foot wide materials, while still being wide enough to walk on.

The plywood walkway was never cut or marked as designed by the Committee, nor was it successfully implemented as an intervention for Carpenters and Laborers during form construction. Uncut and unmarked 4' x 8' sheets were observed in use as walkways over rebar mat, but not in the immediate areas where the Carpenters and Laborers needed to access their work.

The Health Trak's proposed plywood walkway was not accepted because it was seen as an obstruction to the Ironworkers' task of completing the rebar mat. Although

Committee members claimed that walkways were “used all the time”, it was believed that “Ironworkers don’t want a walkway.” However, the Ironworkers did not view the plywood as an obstruction when it was kept at the edge of the pit away from their job tasks. Though Ironworkers often work on and around rebar, and certainly this conditioning increases their ability to avoid falls, anecdotal report from a labor foreman indicates that Ironworkers voiced appreciation for the plywood walkways, if only to a restricted extent. This is particularly true on rainy or misty days when the rebar is very slippery, and the bursts of heavy rain require them to move some material quickly on and off the mat.

A second barrier to the successful design of a walkway was the Committee's inability to develop a plan for its easy use during concrete pours. One of the Laborers' operations is the concrete pour. The Health Trak participants discussed the pros and cons of using the plywood walkway during the pour. There was consensus that a walkway would not be feasible during a pour. Clearly there is increased risk for ankle sprains and contusions during the concrete pour operation, and a modified boot may help. One concrete pour on Ramp L was directly observed by COHP researchers, and a slipping event occurred. After he fell up to his crotch, the Laborer continued working, as interrupting his task would have had an effect on the completion of the pour.

The final, and most important, barrier to the implementation of this intervention was the Ironworker foreman's resistance to the idea, insisting that the walkway was an obstruction to the Ironworkers' tasks during the concrete reinforcement operation (Photos 5 - 8). While the Committee members had discussed this specific issue--that the walkway may hinder the Ironworkers--the Ironworker steward on the Committee felt that it would be easy enough to move out of the way, and that the benefits to the other trades outweighed the inconvenience to the Ironworkers. However, the final decision about the use of the intervention fell to the foreman, who was not a member of the Committee.

Intervention Evaluation

COHP researchers collected data to evaluate the ergonomic interventions. These data were gathered to try to answer the following questions:

- Was the intervention used?
- Did its use reduce or eliminate workers' exposure to the risk factor of concern?
- Did the workers who used the intervention "like" it and would they use it again?
- If the intervention was used and "liked," why was the intervention a success?

Ironworker Platform

The Ironworker platforms were used at Ramp L at a time when neither the Health Trak participants nor COHP researchers were present to observe their use.

The COHP researchers had developed a questionnaire to be used to gather information from the specific workers who used the intervention (Appendix E). This questionnaire had been reviewed and accepted by the Committee members. Unfortunately, the COHP researchers could not administer the questionnaire immediately after the use of the platforms since they were not present when they were used. The COHP researchers made repeated unsuccessful attempts to contact the specific Ironworkers who used the platforms, but the two workers had been transferred to other sites.

However, some data on the platform was gathered by informal interview and direct observation. One COHP researcher talked to one of the Ironworkers a week after he used the box. The Ironworker reported that at least three people used the box, including himself. The box enabled them to rest the rebar dowel on their shoulder instead of having to hold over the bar over head. This information supports the idea that exposure to the awkward shoulder posture was reduced. He said that they all seemed to like using the box, and that they had had some input into its design. He did not elaborate on what the input was. When asked, he felt that it did not introduce an additional fall hazard. However, a 20" square would not allow much space for the Ironworker to adjust his footing.

During the final Health Trak Committee meeting, the Committee members reviewed the use and utility of the Ironworker platforms. They agreed that the platform was a good intervention because "It's a practical solution that makes sense".

When asked to identify the most important factors that made implementing the intervention successful, the Committee members cited the following items, in addition to the fact that the platform was "practical":

- particular efforts of the Ironworker steward,
- communication between trades at the Health Trak meetings, and
- cooperation between trades.

Of these factors, the Committee overwhelmingly believed that the efforts of the Ironworker steward were the most important in developing and implementing the Ironworker platform intervention.

COHP researchers also asked the Committee members to reflect on what actions would be necessary to ensure that the platforms continue to be used. In the subsequent discussion, the Committee members identified two factors. First, the platforms must be available; this means that the platforms must be treated as any other tool and be stored and maintained for workers to use. Second, the workers must know that the platforms are available, and how and why to use them; the Committee suggested reviewing the use of the platforms at safety talks.

While the Committee members apparently believed that the platforms should continue to be used, they did raise and discuss one significant barrier to introducing ergonomic interventions on-the-job: "negative consequences for health and safety activism."

Rebar Mat Walkway

Evaluation was not possible because the intervention was never implemented.

Ergonomics and Intervention "Training" Sessions

"Training" sessions were used to disseminate information about ergonomic hazards in general, and to advance the acceptance and utility of specific ergonomic interventions. A session was held to specifically discuss the two interventions described above with the foremen on Ramp L. Unfortunately, COHP researchers did not evaluate the impact of this session, so we do not really know if they had an impact on the acceptance and use of the interventions. Interestingly, the Ironworker foremen does not normally attend foremen toolbox talks, as the Ironworkers are subcontracted and have their own process for handling safety and toolbox talks. Certainly, had the Ironworker foremen been present, there would have been a discussion about the use of the walkway and its apparent obstruction of the Ironworkers' process.

Activity Plan Development and Utility

The Committee members reviewed and approved new items for SIWP's Activity Plan (Appendix C3). These items described the use of the two interventions the Committee had developed. These items were passed on to the SIWP Safety officers for inclusion in the AP.

Repeated discussions about the use of the AP on-the-job kept coming to the same conclusions: the AP's should be shared with the workers and enforced by the foremen and safety officers. However, the members of the Committee had not received copies of the AP, and they felt that for large crews, there was no good way to review its contents with the workers.

Members of the Committee gave the following answers (A) when asked to evaluate the impact of the Activity Plan.

Q: *"What was the impact of the Activity Plan?"*

- A:
- They're not used.
 - Staff changes; safety officers leave because they are not supported by managers
 - Activity Plan hasn't gotten to folks
 - Activity Plan needs to go to foremen; super tells foremen to use it
 - Post Activity Plan so workers can see it
 - Make the Activity Plan simple, but complete
 - Make the Activity Plan specific to each trade

Though the Activity Plan seems to be the only tool for diffusion of health and safety ideas on site, if it creates more time and paperwork, it is not viewed as practical.

Process Evaluation

The Health Trak was viewed as positive, with limited success. The stewards hold that management do not consider Health Trak to be more than "window dressing." They made several suggestions to improve the Health Trak process.

Members of the Committee gave answers (A) to the following questions (Q).

Q: *"What did you like about Health Trak process and meetings?"*

- A:
- focus on helping workers
 - intention to make construction safe
 - learn/get ideas and help
 - cooperation between the trades

Q: *"What would you change about the Health Trak process and meetings?"*

- A:
- different location – hold meetings in the offices, as trailer has too many distractions
 - can't change basic barrier of resistance to increasing costs
 - need mandatory safety rules
 - need management to really participate
 - responses from management to way what they will and won't do
 - agreement between labor/management to take action]
 - need powerful people on the committee: general super, general foreman
 - set goals on a monthly basis to focus on one issue each month
 - OE didn't feel tied into the issues
 - Talk with C. Rountree about problems of enforcing changes
 - More focus needed on crane use; site personnel don't know how to utilize cranes well or plan for their use
 - HT issues don't get down to laborers; ideas don't get beyond management

DISCUSSION

Selecting Ergonomic Hazards to Abate

Committee talked about many ergonomic hazards and, in the end, chose to focus on three. The three they chose (overhead work, walking on rebar, and chipping concrete overflows) are all tasks that have been associated with injuries at SIWP:

- Tunnel Worker registered a hand/wrist injury with SIWP after chipping away concrete overflow at another stage of the SIWP site.
- Recent shoulder strain from overhead work with rebar – the Ironworkers had to reinsert dowels into the slurry wall at a lower level after the mat had been constructed at the second level. Consequently, one Ironworker strained his shoulder while lifting a dowel (in concert with two other individuals) while in a squatting position under the second level mat.
- Injury due to slip on rebar mat (observed by COHP researcher) – during a concrete pour, a Laborer slipped and one leg fell through the rebar up to his groin.

While these reports support the Committee's decision to focus on these specific tasks, it is also interesting to review the specific hazardous tasks that the Committee discussed but chose not to address: general lifting and manual material handling.

The association between ergonomic hazards and health effects is demonstrated by the SIWP (Figure 1). One of the reported injuries of a lower back strain was reportedly causally associated with lifting rebar. This particular lift required a 60 ft. dowel of #11 rebar to be lifted by the injured person and two other people when the strain occurred. The average weight handled for each of the three workers would have been 79.5 lbs., but easily could have been more at any given moment due to weight shifts during handling. In addition, two other reported health events (elbow injuries) were recorded as consequences of lifting rebar. An ergonomic assessment of concrete form building in Washington state showed similar health effects as those noted in Figure 1 of SIWP's injury data.⁵

However, in spite of the evidence that these tasks result in worker injury, the Committee chose not to address them. Their reasons for avoiding these ergonomically hazardous tasks are discussed below.

Lifting and Lifting Limits

Lifting limits is a primary concern of ergonomics. Several interesting discussions with the participants regarded the use and practicality of a lifting limit on a construction site. None of the participants supported a 50lb. lifting limit. Several reasons were given, such as tradition, industry packaging often above 50 lbs., productivity. Though the participants did recognize every individual has his/her limits of strength, none of them felt that an objective limit could be defined. Logically, then, the group could not describe

a standard policy that would prevent individuals from exceeding their limits on site during the normal course of a task.

An unwritten rule seemed to exist that this would be done as necessary, but this approach certainly has more to do with personalities and even the strength of the labor market than with an overriding, consistent, and protective respect for health. Workers tend to be assigned tasks in pairs, with the older worker usually bearing the lesser load among the two. Assigning pairs and recognizing skills and strengths is generally the job of the foremen. A foreman may or may not be sensitive to ergonomics. Production is a higher priority, and only an immediate risk to safety, not cumulative trauma, is reportedly a typical concern of the foremen. The burden of recognizing and "asking" for a control, such as job rotation, then, falls to the individual worker who is exposed. And, as one Health Trak participant explained, "Health and safety activism can have negative consequences for the workers."

A lifting limit, therefore, may be more important in that it removes the social and political burden from a worker to recognize his/her own lifting limit. Malcontents notwithstanding, the fact that human beings are prone to underestimate their own level of musculoskeletal strain is well documented. Clearly, too, everyone's lifting capability is limited at some level. In our meetings, none of the Health Trak participants denied these facts.

Further research attention should be given to resolving an acceptable lifting limit in construction. The National Institute for Occupational Safety and Health (NIOSH)'s formula for a Recommended Weight Limit (RWL) includes several factors in defining a lifting limit. Understanding these factors is critical in intervening with some control. For example, consider the Ironworker task of lifting 7' dowels of #11 rebar from the mud mat of the roof slab pit to the lowest row of threaded holes in the slurry wall of Ramp L (see photo). The destination of the dowel is roughly 3" above the mud mat. For the purpose of illustration, say the bar is lifted from the mat then inserted in one motion at a rate of 1 bar every two minutes for a duration of 2 hrs. NIOSH's lifting guideline equation would recommend that the material being lifted in this manner (the dowel in this case) be limited to 36.6 lbs. The actual weight of the dowel is 37.1 lbs., or 101% of the recommended limit. If the dowel were placed on a cradle 25" above the mud mat, and all other conditions were not changed, then the RWL would be 40.5 lbs., or 8% more than the actual weight. The factor being improved upon would be the severity of the forward flexion at the origin of the lift. A lifting limit, then, does not have to be a specific weight in that adjusting for relevant factors of material handling would effectively reduce musculoskeletal strain. A specific weight might be enumerated as a hazard in the AP hazard checklist (e.g., "repetitive lifts of >35 lbs.", "single lift of >50lbs.", etc.), and then suitable task specific solutions could be described in the jobsite hazard and solution section.

Manual Material Handling

Manual materials handling is also a great concern for ergonomics. This should certainly be on every Activity Plan, beginning with "manual materials handling" being enumerated

in the Hazard Checklist in section 1 of the AP. Many tools and construction materials contribute to the overall strain on the musculoskeletal system of construction workers. Some of them, like the tool belt, are universally accepted. At the least, the Activity Plan should establish a protocol for communication between the Operating Engineers and the other trades regarding the timing and need for the mechanical of a crane. The communication would help in the pre-planning and site lay-out necessary to increase work flow and reduce superfluous motions. A crew of Laborers could be dedicated to actively maintain the site lay-out and general housekeeping.

The Operating Engineer steward who was only peripherally involved in this Health Trak Committee, voiced the view that management on the site did not fully understand how to best use the cranes to assist with manual material handling. He believed that the cranes are underutilized due to a lack of understanding and planning.

Barriers to Intervention Implementation

The Committee was successful in designing and implementing one intervention. The Ironworker platform by all accounts succeeded because it was simple, needed, easy to use, and it worked. Unstated reasons for its success would also include its cost (cheap!) and that it did not interfere (in a negative way) with productivity, but, indeed, seemed to aid productivity. While this intervention may well provide a good model for how and when ergonomic interventions will be successful in the construction industry, a closer look at the other proposed and/or unselected interventions may provide useful insight into the significant barriers to intervention implementation.

How is knowledge/information shared: role of AP and training

The Committee discussed the importance of getting information to the workers, both to ensure that interventions are tried and to ensure that good interventions continue to be used. The AP could fulfill this role, but, as currently used, doesn't. The Activity Plan needs to be shared better with workers and foremen, be made trade specific, and enforced.

Another way to get information to workers is to use training. Cross-trade education was suggested as a good way to get communication and cooperation happening--this may have helped in the implementation of the walkways. Also, Committee suggested worker training as a key element in ensuring the continued use of successful interventions.

Who has the power to enforce interventions?

This was a question that came up repeatedly.

Management has the power, but is perceived not to have bought into the process. Committee members questioned management's will to really change the way the jobs are done. There is a general perception that safety and health concerns come second

to production, and so any interventions that labor cannot do "on the side" or "on their own time" (as the Ironworker platforms were) would not be supported by management.

Field Safety Officers have the mandate to enforce the Activity Plan, but do not always have either the full support of upper management or the foremen. As they are also mandated to ensure compliance with OSHA safety regulations, they would give higher priority to ergonomics if OSHA included ergonomics in its construction regulations.

Labor stewards gave some conflicting messages about the power to enforce interventions. On one hand, they agree that the booming economy creates a certain power and freedom for labor, as it allows individuals the security of leaving an unsafe job to find work at a safer site. On the other hand, they also agreed that making gains in health and safety on a worksite has political consequences. If someone makes demands for an intervention that in some way is perceived to burden the production process by a supervisor, he/she might be less likely to receive the same cooperation in the future, or worse, may be moved to another crew on site. Healthy conditions, then, can become political bargaining points for labor, rather than inalienable rights.

Foremen have some power to enforce interventions, but they must balance the demands of management and labor, and they have direct contact with the workers. The Committee felt that they should enforce intervention use, and enforce use of the AP. A foremen's role in implementation of interventions (and other safety measures) is a key link. Foremen often allow production pressure to supercede health and safety measures, though no clear measure of the positive or negative impact of health and safety measures on production has been made. The stewards on the Committee held high regards for the safety manager, and agreed with the safety officer that a weak point in the implementation of safety measures was at the foremen level. The reasons for this weak point were not agreed upon, though a preference to production over health and safety is clearly involved.

CONCLUSIONS

Dissemination of interventions

Ironworker platform: The platform is easy to make and use, as long as people understand what it's for and how to maintain it properly. The version observed in this study, however, had some problems. The rope handle broke, and the platform itself seemed heavy and difficult for one person to transport.

Walkway: despite our failure, there probably is a way to use this necessary intervention. Other versions of idea worth pursuing are: snowshoes, kneeling platform (Photo 19).

However, another intervention idea raised was a modified boot that worked like a snowshoe. This is an idea that deserves more consideration. The modified boot should not increase the degree of ankle rolling if it should fail in its purpose.

An idea not raised or discussed by the Committee is a kneeling platform developed and used for work on wet concrete. The kneeling platform can be carried across then set down on the rebar mat. Some exposure to the unstable footing would occur, but this exposure would be less than without a control.

Activity Plan: limitations and potential

The Activity Plan is recognized as being one acceptable means for addressing safety and health hazards. For it to succeed, the Health Trak participants agreed that it should be accessible to the foremen and even the workers. The committee never agreed on whether this was actually happening or not. The stewards did agree that the Activity Plan has been used more effectively on other stages of SIWP. Other ideas discussed for the Activity Plan included manual materials handling, lifting limits, lifting aids, crane usage, and concrete overflow prevention checklist.

Lasting change is certainly effected by a better economy, as the Health Trak participants pointed out, yet risks and need for ergonomic-type abatement are likely to exist (perhaps more in slow economy) regardless of the times. As ergonomic hazards are more fully recognized, better solutions can be and are generated and accepted among management and labor. Ideally, the contract engineers and business managers will recognize and include health and safety as a cost of business and bid contracts accordingly. Then, rank and file workers should be able to see the contractors commitment to his/her health and safety. Labor participants of Health Trak firmly held that good ideas about health and safety, originating from Health Trak or spontaneously from labor or safety management, must be enforced and supported from upper levels of management.

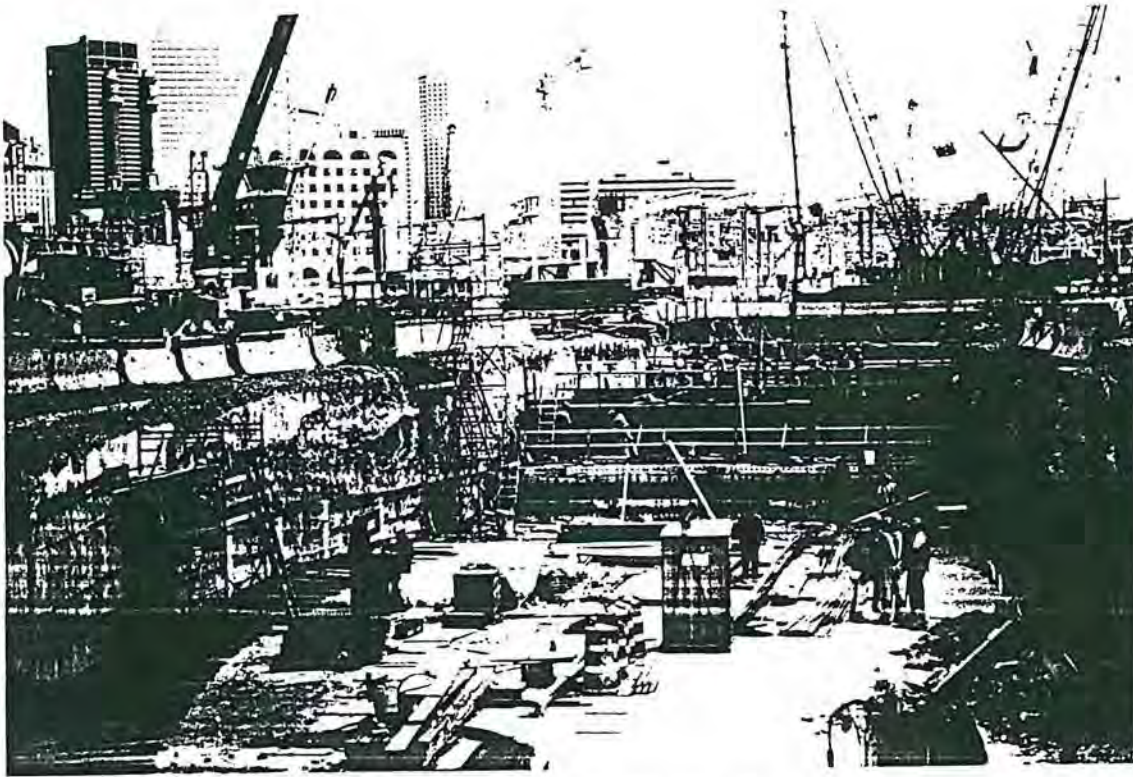
REFERENCES

- 1 Noll, Hanson, Moir, Azaroff. Health Trak Cycle 3 Final Report: Reducing Ergonomic Hazards in Concrete Formwork Assembly Through Worker Participation. Technical Report from the Construction Occupational Health Program, Department of Work Environment, UMass-Lowell. (March, 2000).
- 2 Moir, Buchholz. Emerging Participatory Approaches to Ergonomic Interventions in the Construction Industry. *American Journal of Industrial Medicine*. 29: 425-430 (1996).
- 3 DesMarais, McDonald. Ergonomic Job Analysis: Laborers Constructing Concrete Base Structures. Technical Report from the Construction Occupational Health Program, Department of Work Environment, UMass-Lowell. (April, 1998).
- 4 Paquet, Punnett, Buchholz. An Evaluation of Manual Materials Handling in Highway Construction Work. Technical Report from the Construction Occupational Health Program, Department of Work Environment, UMass-Lowell. (1996).
- 5 Spielholz, Wiker, Silverstein. An Ergonomic Characterization of Work in Concrete Form Construction. *American Industrial Hygiene Association Journal*. 59:629-635 (1998).

APPENDICES

- A Photos
- B 4-wk look ahead
- C Activity Plan
 - C1 Blank Activity Plan
 - C2 Activity Plan for Ramp L
 - C3 Draft activity plan inserts (2)
- D New hire ergo training insert
- E Ironworker platform questionnaire (blank)
- F Training materials from foreman training session

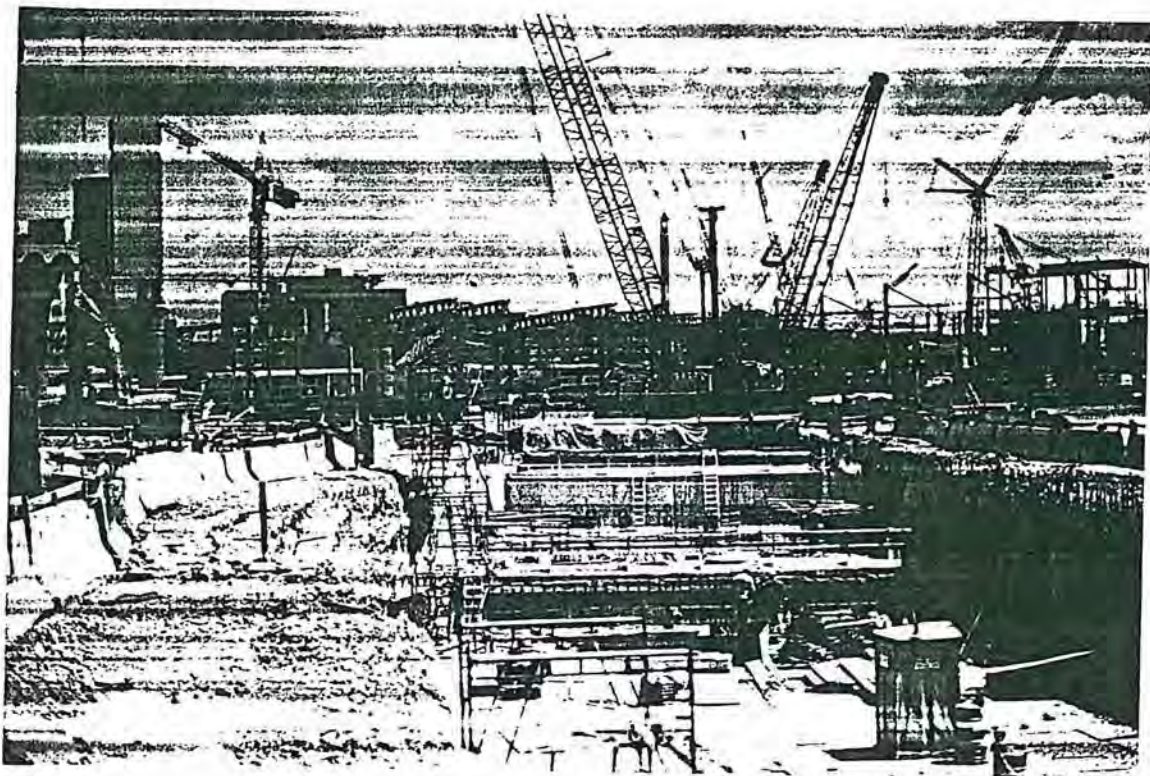
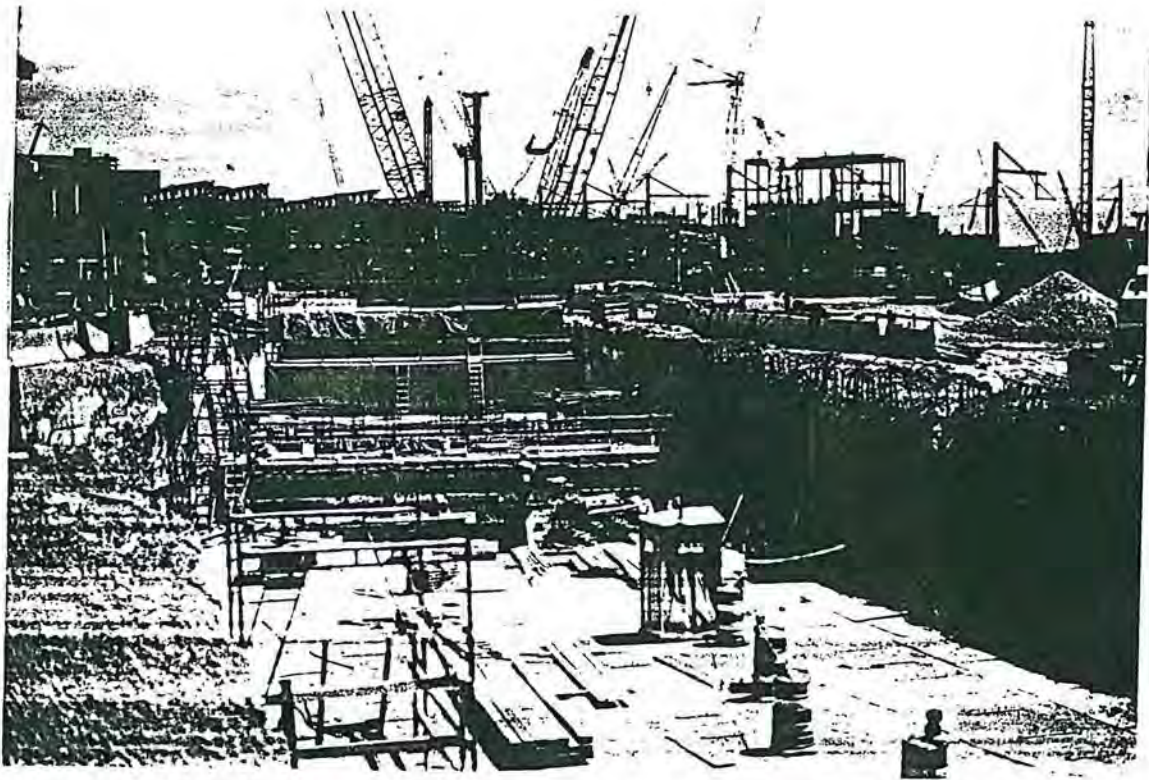
APPENDIX A: Photos



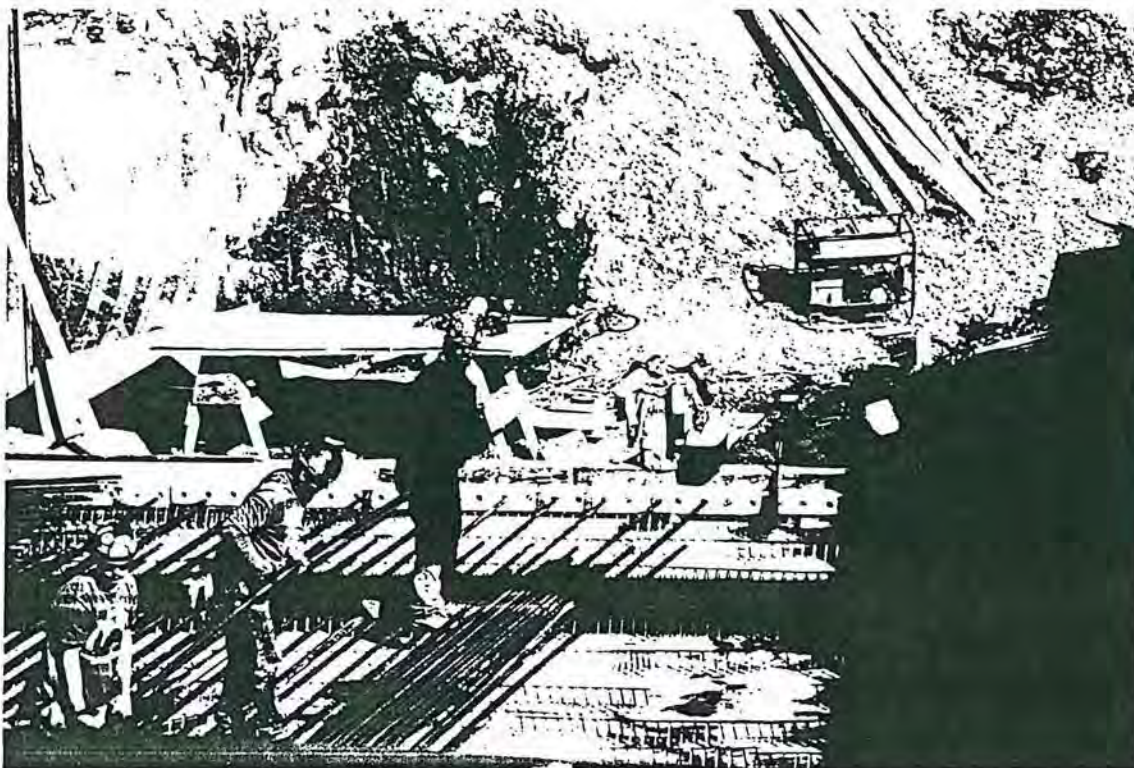
1: View north over Ramp L roof slab construction, with Mass Highway Dept. building in background



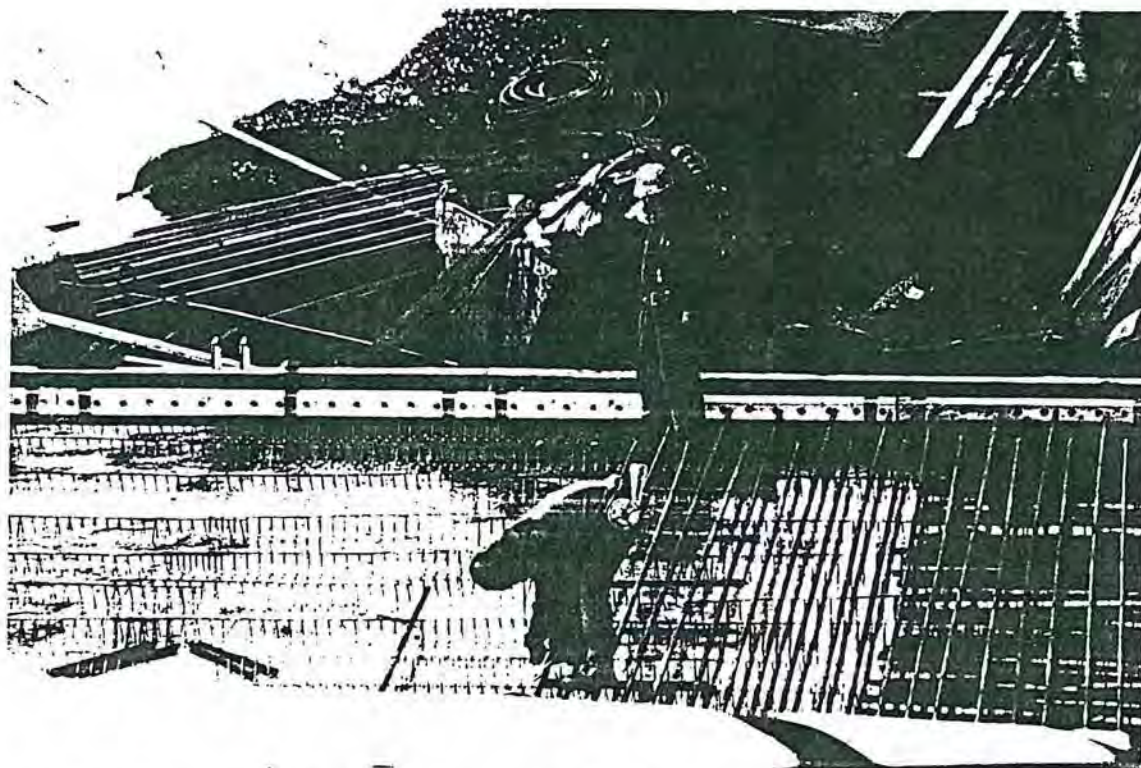
2: View south from Mass Highway Dept. building at Ramp L construction area, Amtrak rails in foreground



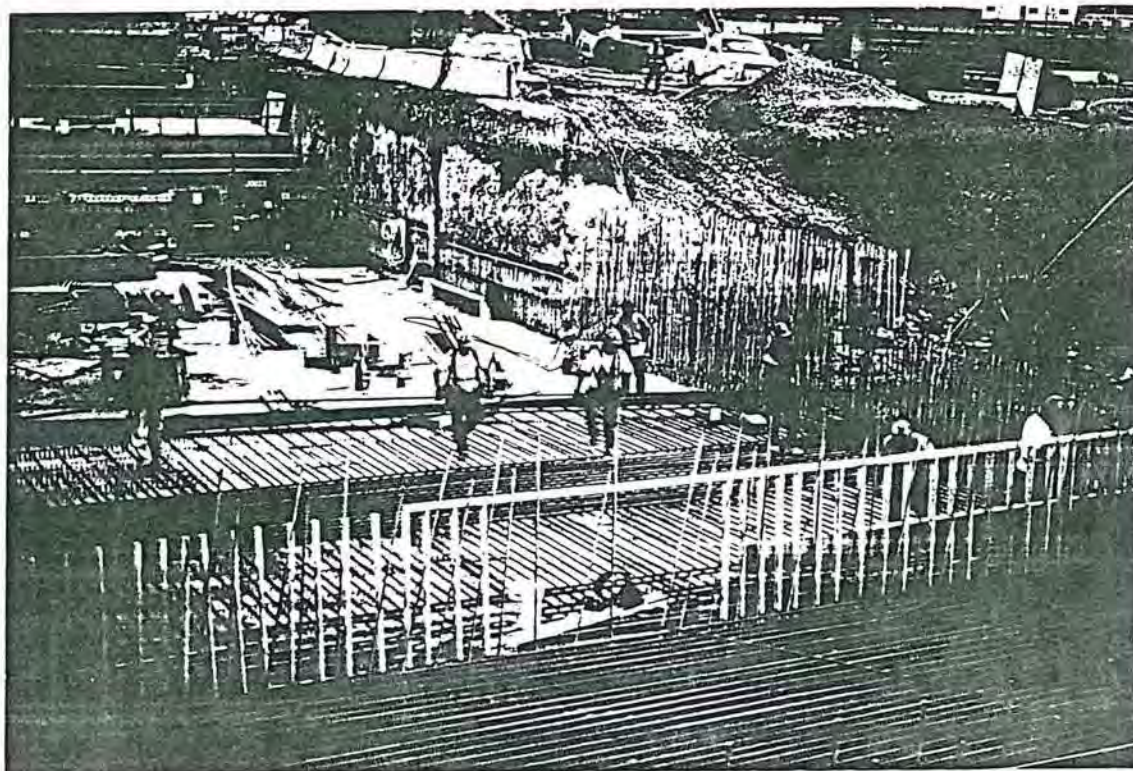
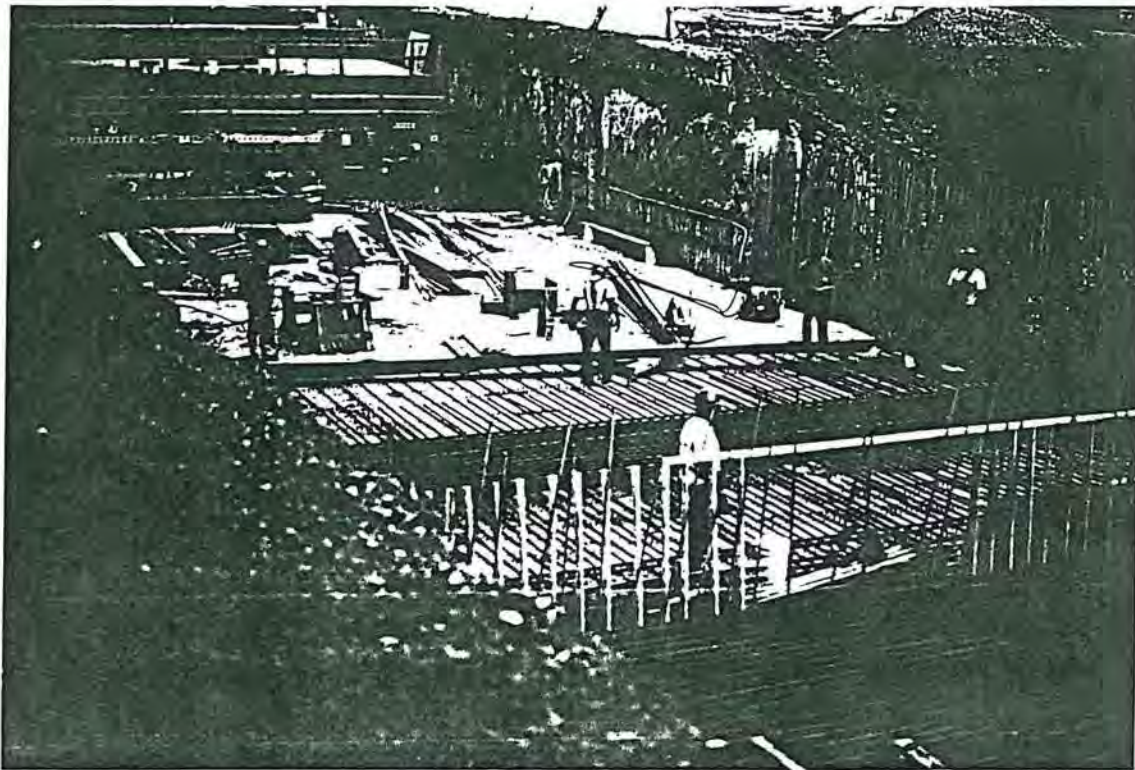
3, 4: Two views of Ironworkers - on top of recently poured roof slab - inserting 14' dowel into slurry wall, with carpenters at base slab, (Mass Hiway Dept. building at top left)



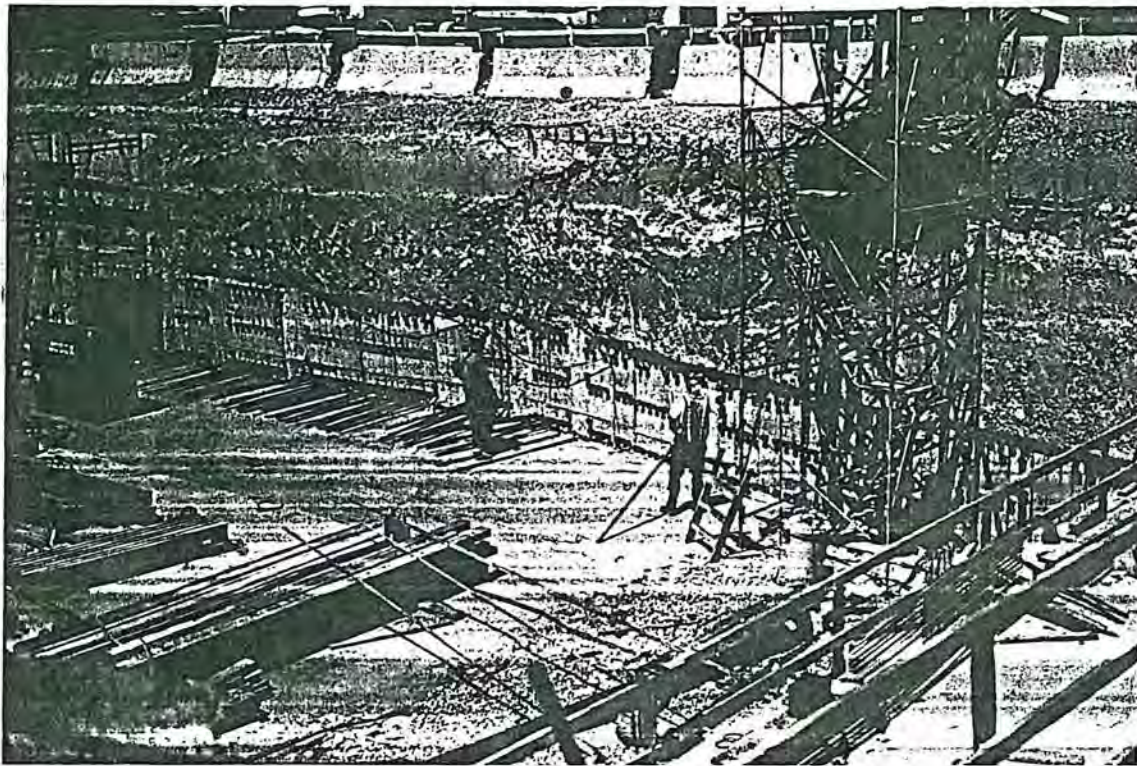
5: Ironworkers carrying long dowels to place in construction of lower rebar mat



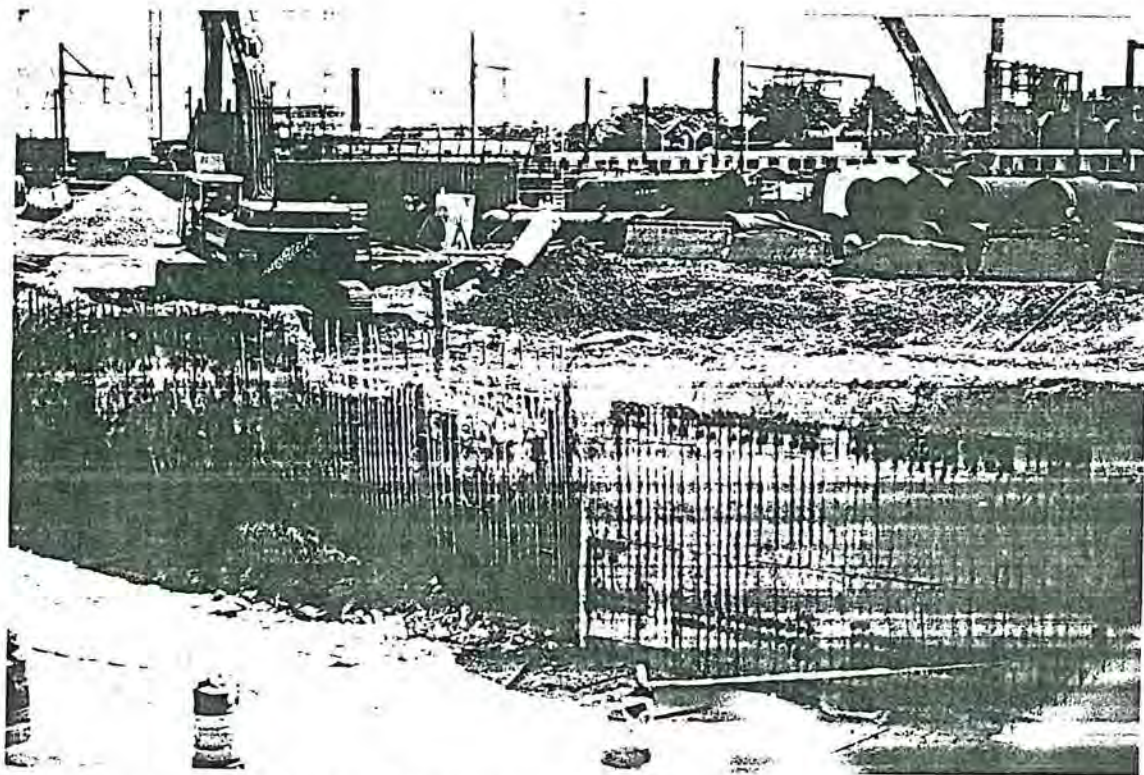
6: After carrying and placing, Ironworker ties long dowel; dowel inserts support mat at right



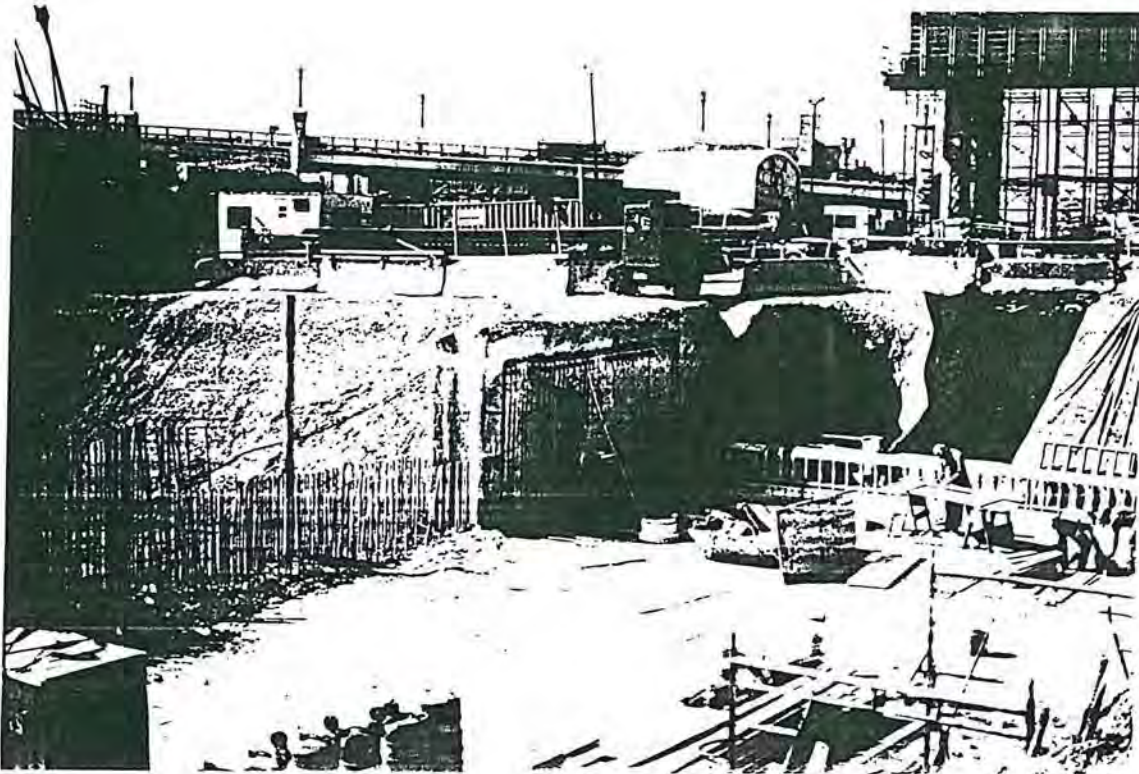
7, 8: Two views of Ironworkers before and during the lift and carry of a long rebar dowel; carpenters constructing form wall in foreground are working on top of rebar mat without plywood walkway support



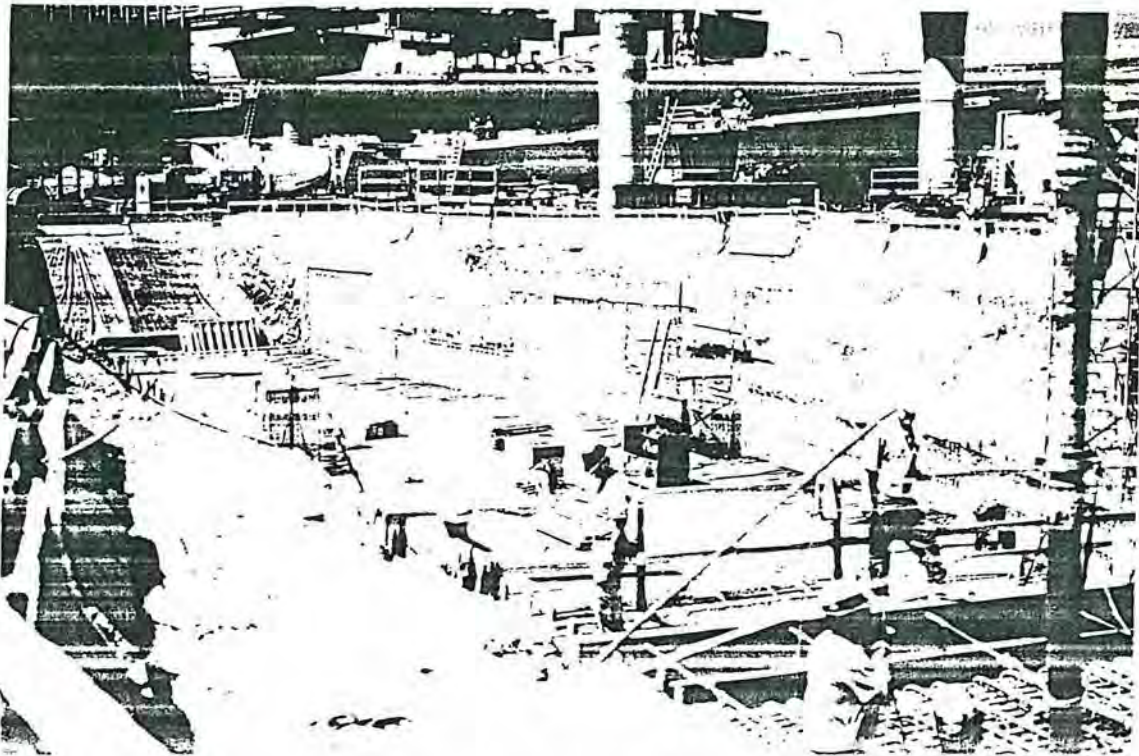
9: Ironworkers inserting dowels into slurry wall at lowest level



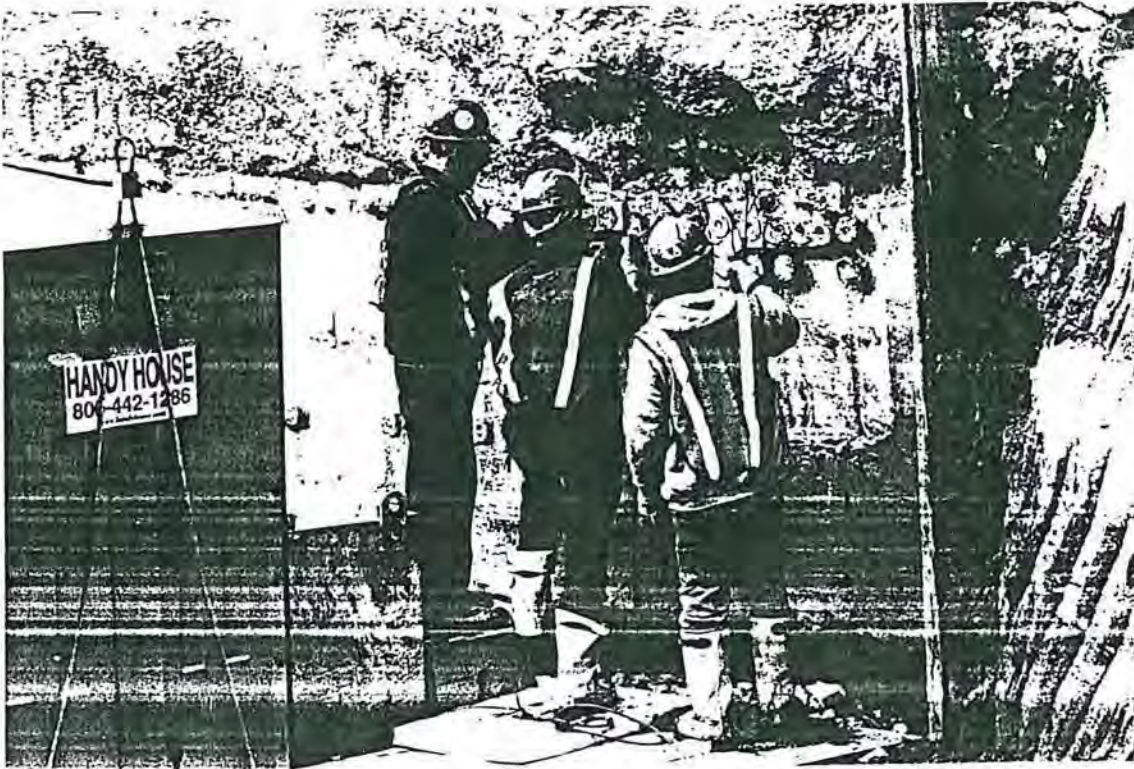
10: Insert panel 10e where Ironworker platform was used



11: Another view of panel 10e with carpenter standing on middle DBS level and reaching overhead to run electrical cord in between threaded holes in slurry wall



12: Panel 10w at far end of roof slab pit area; lower level dowels already inserted into slurry wall



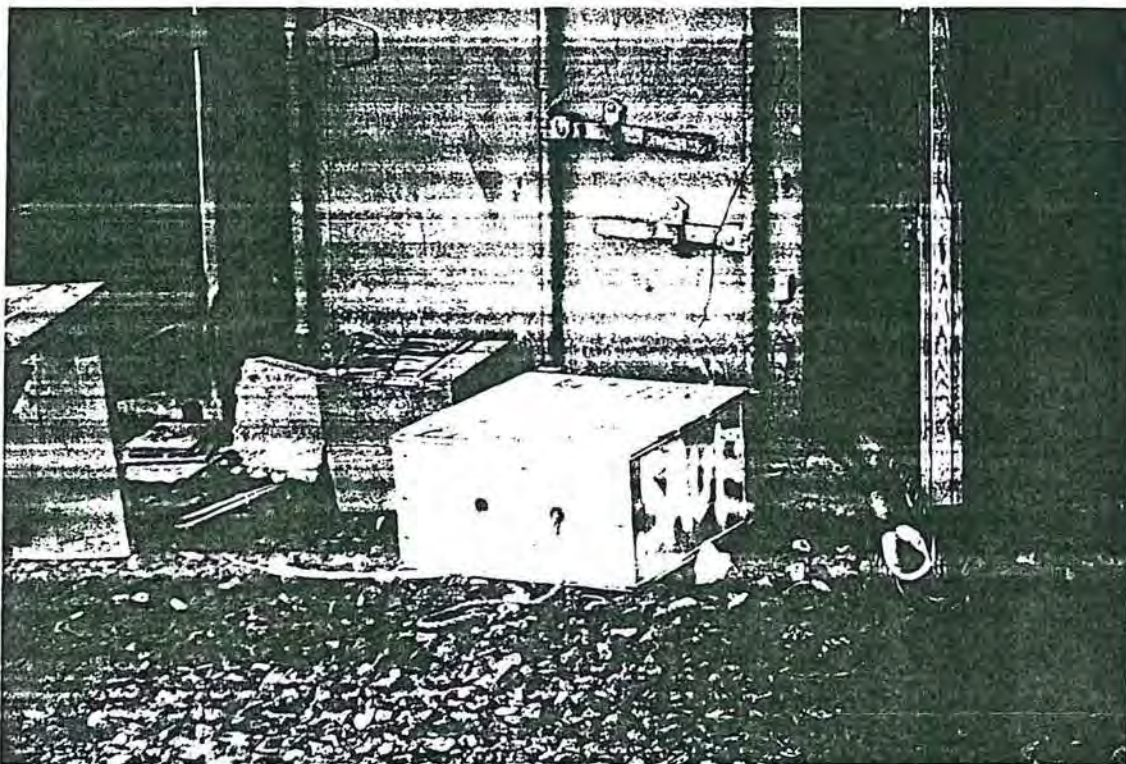
13, 14: Two views of Ironworker platform in use by Laborers removing plywood from around threaded holes in slurry wall

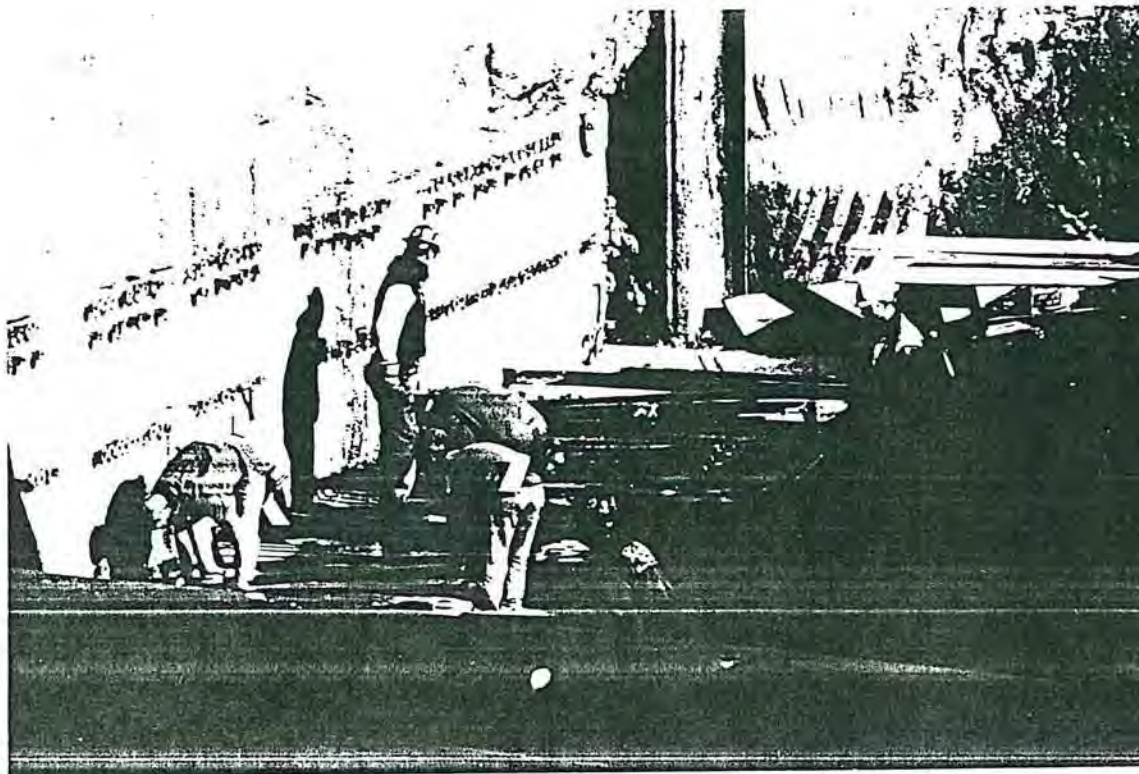


15: Right: Ironworker platform
after use by Ironworkers
but before demarcation

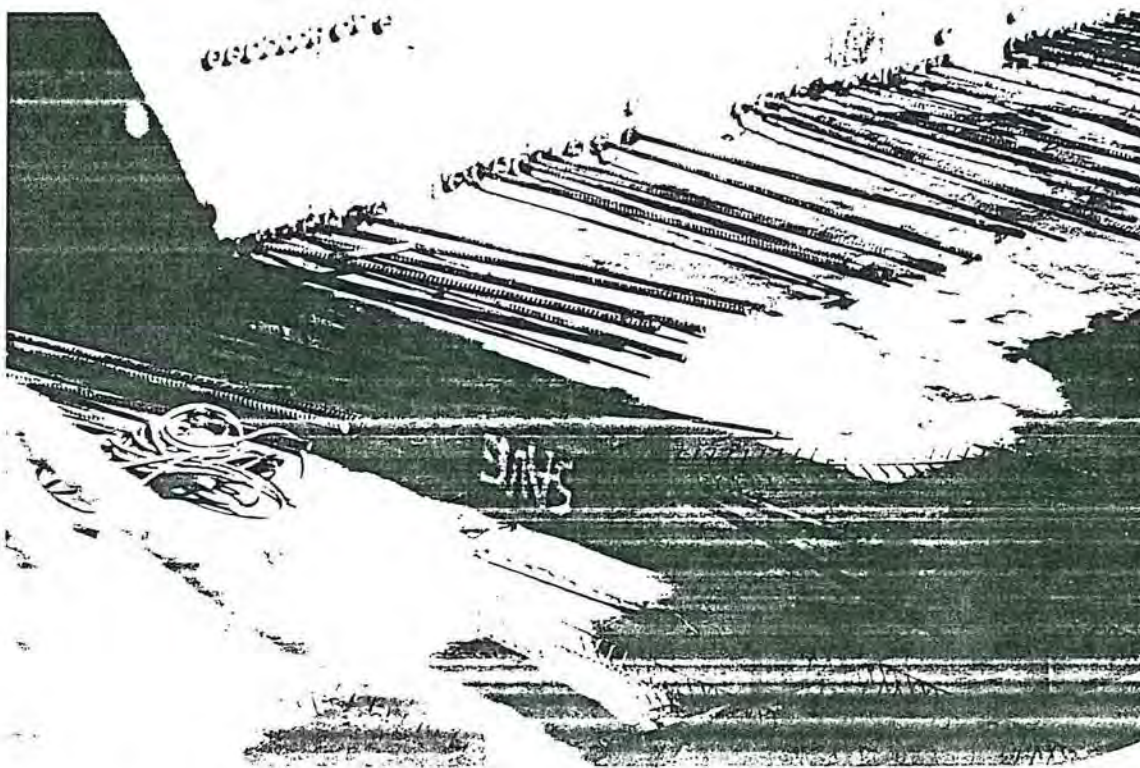


16: Below: Ironworker platform
with "SAVE" painted on it
and stored near Ironworkers'
trailer; rope handle broken

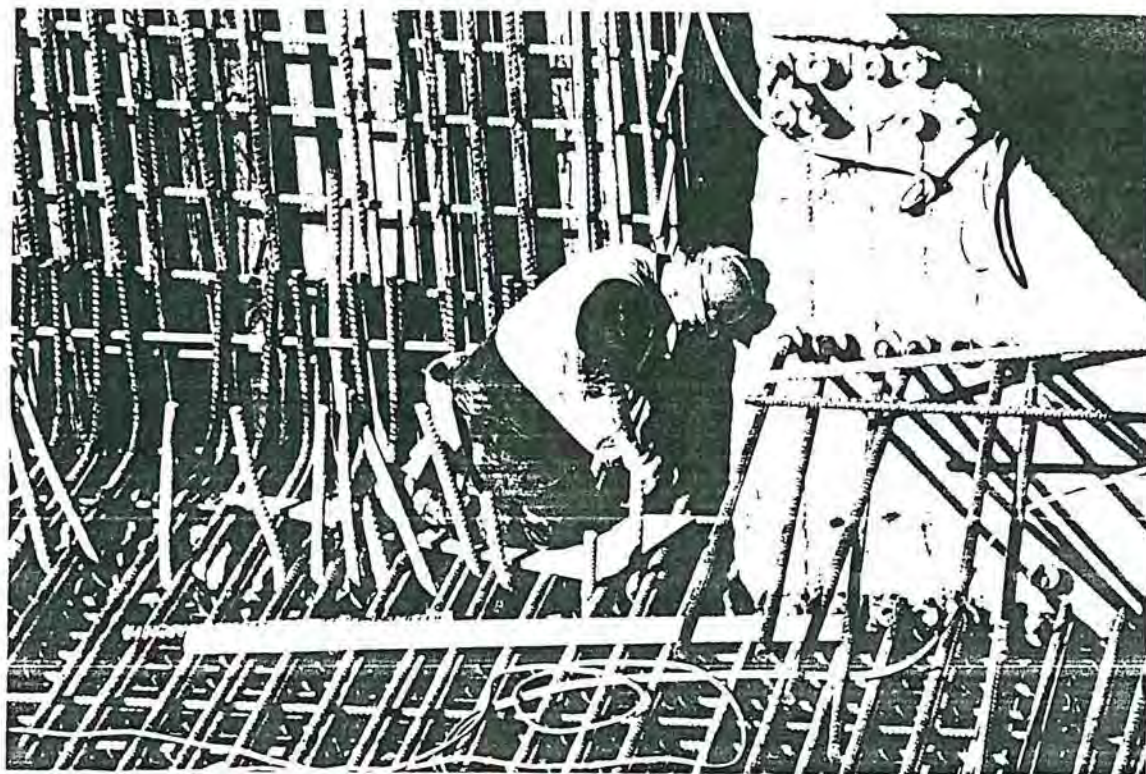




17: Ironworkers correcting insert angle of several dowels on lower level



18: Ironworker platform, with demarcation, in roof pit construction area having been used as a tool to assist Ironworkers in correcting insert angles (15)



19: Example of non-Ironworker (Laborer) task being done over rebar mat; scrap plywood and scrap 2x6 being used as working platform and walkway

APPENDIX B: 4-wk look ahead

SIWP - 4 Week Look Ahead Schedule

06-May-08																													
SUPERSE SAFETY	FE	Structure	Activity	Act. Plan	5/8	5/9	5/10	5/11	5/12	5/13	5/14	5/15	5/16	5/17	5/18	5/19	5/20	5/21	5/22	5/23	5/24	5/25	5/26	5/27	5/28				
JK/LS DH	ROB C.	Viaduct Superstructure	Install Starter Segments 25NB E/W	03/20/00																									
			Instat Starter Segments 26NB E/W	03/20/00																									
			Falsework HOV East	03/20/00																									
			Erection Hoveb East girder	03/20/00																									
			Fixed Pier 30x																										
			Midspan @27/28																										
			Stress 27/28																										
			Launch to SB 29XXE																										
			Ered span 29XXE																										
			Midspan @28/29																										
			Stress 28/29																										
			Launch to SB 30XXE																										
			Ered span 30XXE																										
JM/BN DH	ASHRAF A.	Ramp L	Removal pier 16																										
			Excavate for roof Area B																										
			Install gravel, mud mat																										
			Preproofing																										
			Install rebar																										
			Install side forms																										
			Egress J shafts																										
JM/JS MA	EMIDIO M.	JF White Utility 72" CS/ Forcemains	Install 72" pipe over Ramp L	x																									
			Pile Cap Forcemain																										
			Instat 48", 18", 12" pipes																										
			Testpits Drainage/Traveler str																										
			Traveler str Drainage S3-10, S3-11																										
JM/SL MA	JONI / JIM J.	Wye Conn	Excavate @ South Cofferdam																										
			Prep caissons Cap 2 / Install friction collars	04/20/00																									
			Rebar Cap 2	04/20/00																									
			Pour Cap 2	04/20/00																									
			Start Cap 4	04/20/00																									
		Structure 501	Reroute Road																										
			Design & Fabrication of struts																										
			Excavation / Demo M.H.																										
			Install slots/wales/struts																										
JM/LS DH	JIM J.	FRN 3	Case installs mini piles (nites)																										
JM/SL MA	AMY B.S. JIM J.	Yard	Resteel Fabricate Columns / Caissons																										
					5/8	5/9	5/10	5/11	5/12	5/13	5/14	5/15	5/16	5/17	5/18	5/19	5/20	5/21	5/22	5/23	5/24	5/25	5/26	5/27	5/28				

chedule

Activity	Act. Plan	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN	MON	TUE	WED	THU	FRI	SAT	SUN
Roofs	02/29/00																																			
is DMC7-83 (Intermittent operation)	X																																			
Slabs	04/12/00																																			
Walls	04/12/00																																			
Upperwalls	04/13/00																																			
Plasters																																				
Walls	X																																			
Slab 1 Infill																																				
Slab 4 + 5	03/20/00																																			
Wall 1 + 5	03/20/00																																			
Wall 4 + 6																																				
Wall 7 + 8																																				
Slab 6 + 7 Egress stairs																																				
Roof R1 + R2 Shoring																																				
Mudslab / O.S. Removal																																				
ab S3,S4,S11,S12,S17,S18																																				
hist (Final clean-up + unstruts)																																				
Lifting WB Jacked Tunnel	03/13/00																																			
Headwall Demo	03/13/00																																			
Jacking Westbound																																				
Production jacking (3/5/day)	02/23/00																																			
for jacking equipment EB to WB																																				
EB	05/01/00																																			
WB headwall	05/01/00																																			
Obstructions known EB	05/01/00																																			
Delivery of EB-Phase II Material	n/a																																			
1/4" Steel Plate Installation	05/01/00																																			
Base Slab Edge Forms	05/01/00																																			
Slab Reinforcing Steel Installation	05/01/00																																			
Relocate Freeze Manifolds																																				
Remove Overburden																																				
Channel Drill																																				
Cashman Excavation pier 5																		</																		

APPENDIX C1: Blank Activity Plan

- ACTIVITY PLAN -
INSERT ACTIVITY TITLE
GENERAL INFORMATION & DESCRIPTION OF ACTIVITY

DATE: _____ PRINTED: _____

JOB NUMBER: _____ COMPANY: _____

JOB LOCATION: _____

SECTION ENGINEER: _____

FIELD ENGINEER: _____

SUPERINTENDENT: _____

FOREMAN: _____

QC ENGINEER: _____

SAFETY ENGINEER: _____

ACTIVITY SCOPE OF WORK:

BUDGETED MAN-HOURS:

WORK SCHEDULE:

- ACTIVITY PLAN -
INSERT ACTIVITY TITLE
GENERAL INFORMATION & DESCRIPTION OF ACTIVITY

QUALITY CONTROL

ENVIRONMENTAL MANAGEMENT PROGRAM

EQUIPMENT NEEDS:

MATERIAL NEEDS:

SMALL TOOL NEEDS:

- ACTIVITY PLAN -
INSERT ACTIVITY TITLE
GENERAL INFORMATION & DESCRIPTION OF ACTIVITY

SAFETY EQUIPMENT NEEDS:

HAZARD CHECKLIST

Safety Aspects

1. Emergency plan -
2. Hazardous waste
3. HazCom Requirements
4. Fall Protection -
5. Respiratory Protection -
6. Hearing Protection -
7. Lead Exposure
8. Silica Exposure -
9. Asbestos Exposure
10. Electrical -
11. Housekeeping -
12. Ladders -
13. Scaffolds
14. Machinery, Equipment, Tools -
15. Hoisting Equipment -
16. Manlifts -
17. Excavation and Trucking -
18. Employee Facilities -
19. Proper Barricading of Floor/Wall openings -
20. Fire Protection -
21. Proper Installation of Fall Blocks, Ratlines Handrails -
22. Orientations (Employee, Subcontractor) -
23. Safety Meetings/Training -
24. Protection of Public (Pedestrian, Motorist, Etc.)
25. Confined Space Entry
26. Cold/Heat Protection -
27. Special Eye Protection
28. Special Hand, Arm, Leg Protection
29. Lock out Procedure -
30. Chain Saw Protection
31. Concrete/Steel Demolition -
32. Fire Watch
33. Rigging Inspection -
34. Sandblasting/ Painting
35. Subcontractor Considerations
36. Railroad Work
37. Pedestrian Traffic -

Environmental Significant Aspects

38. Hazardous Materials -
39. Hazardous Byproducts and waste materials -
40. Fuel and Petroleum Products Storage -
41. Transportation (fuel consumption, emissions, etc.) -
42. Erosion/ Sedimentation/ Dust/ Dewatering -
43. Noise -
44. Demolition -

- ACTIVITY PLAN -

JOBSITE HAZARDS & SOLUTIONS

HAZARD:
SOLUTION:

HAZARD:
SOLUTION:

HAZARD:
SOLUTION:

HAZARD:
SOLUTION:

HAZARD:
SOLUTION:

HAZARD:
SOLUTION:

NOTE: Use additional copies of this page as needed to address all known hazards.

- ACTIVITY PLAN -

JOBSITE ENVIRONMENTAL ASPECTS

ASPECT:
OBJECTIVES & TARGETS:

ASPECT:
OBJECTIVES & TARGETS:

ASPECT:
OBJECTIVES & TARGETS:

ASPECT:
OBJECTIVES & TARGETS:

ASPECT:
OBJECTIVES & TARGETS:

ASPECT:
OBJECTIVES & TARGETS:

NOTE: Use additional copies of this page as needed to address all known aspects.

- ACTIVITY PLAN -
HAZARD AWARENESS – CREW SIGNOFF SHEET

DATE: _____ JOB NUMBER: _____

PREPARED BY: _____

CREW SIGN OFF:

[illegible]

NOTE: When developing hazard solutions please remember to:

1. Be creative - Eliminate hazardous conditions FIRST.
2. Provide Personal Protective Equipment SECOND.

APPENDIX C2: Activity Plan for Ramp L

- ACTIVITY PLAN -

Ramp L Roof Slab

GENERAL INFORMATION & DESCRIPTION OF ACTIVITY

DATE: 5/6/00 PRINTED: 5/11/00
JOB NUMBER: 118 COMPANY: SIWP
JOB LOCATION: Boston, Ma

SECTION ENGINEER: Boaz Neugebauer
FIELD ENGINEER: Ashraf Aly
SUPERINTENDENT: Joe Massakowski, Andrew Morog
FOREMAN: Bill Torny
QC ENGINEER: Dave Walbourn
SAFETY ENGINEER: Darren Harlan
COMPETENT PERSON(S): Ladders: Tony Besada Rigging: Bill Torney

ACTIVITY SCOPE OF WORK:

This activity involves pouring slab on grade mud mat and structural reinforced slab using concrete bucket and pump. Concrete placement is against forms and slurry walls. Roof slab thicknesses range from five feet to 13 feet. The largest quantity approaches 1000 cubic yards.

Mud mats require a finished surface because bottom of roof slab will be exposed and require a finished appearance.

BUDGETED MAN-HOURS:

See budget info

WORK SCHEDULE:

7:00 A.M. to 3:00 P.M.

Overtime as necessary

- ACTIVITY PLAN -

Ramp L Roof Slab

GENERAL INFORMATION & DESCRIPTION OF ACTIVITY

QUALITY CONTROL

ENVIRONMENTAL MANAGEMENT PROGRAM

EQUIPMENT NEEDS:
Concrete Bucket Pump Truck Crane

MATERIAL NEEDS:
Concrete Form Oil Ladders Plywood

SMALL TOOL NEEDS:
Vibrators Extension Cords

- ACTIVITY PLAN -

Ramp L Roof Slab

GENERAL INFORMATION & DESCRIPTION OF ACTIVITY

SAFETY EQUIPMENT NEEDS:
Hardhat, vest, safety glasses, rubber gloves, rubber gloves, eyewash, vinegar/water solution, barrier cream, plywood walkways on top of rebar mats.

- ACTIVITY PLAN -

JOBSITE HAZARDS & SOLUTIONS

HAZARD: Concrete Burns

SOLUTION: Protect skin from exposure by use of: rubber gloves, rubber boots, rain pants, tyvek suits, and/or barrier cream. If concrete contacts skin it can be neutralized by applying a dilute vinegar solution on skin. Never wear concrete soaked clothing until it has been washed. It can still burn you, even after it has set up. Protect your eyes by using additional eye/face protection as needed. At a minimum, you must wear safety glasses.

HAZARD: 911 Emergency/ Site Evacuation

SOLUTION: Follow company 911 and evacuation procedures. Identify first aid/CPR qualified personnel in area: Andrew Morag, Bill Torney, or Darren Harlan

HAZARD: Exposure to form oil

SOLUTION: Use standard PPE. Be cautious of wind direction when applying oil to forms. Review MSDS

HAZARD: Fall hazards from top of form work on the differing roof levels.

SOLUTION: Install standard handrail along the width of form work in areas where level is 6' or greater. Top rail at 42" +/- 3" and a midrail with standard toeboard of at least 3"

HAZARD: Electrical Shock

SOLUTION: Ensure cords on all vibrators and other electrical equipment are checked and assured grounding program is implemented. Current color is green and will change to red in July

- ACTIVITY PLAN -

JOBSITE HAZARDS & SOLUTIONS

HAZARD: Ladder failure

SOLUTION: Ensure ladders in use are secured at top and bottom and are inspected by a competent person. Have a 3' extension or other acceptable means to provide a hand grab when employee reaches top of ladder.

HAZARD: Rigging Failure

SOLUTION: Competent person inspect all rigging hardware daily before use as well as knowledge of load weights ie: concrete bucket, skip pans, wood bundles, plywood, etc.

HAZARD: Concrete Trucks/ Pump Trucks

SOLUTION: Ensure back-up alarms are operational and pump trucks are washed out in designated areas

HAZARD:

SOLUTION:

HAZARD:

SOLUTION:

NOTE: Use additional copies of this page as needed to address all known hazards.

- ACTIVITY PLAN -

JOBSITE ENVIRONMENTAL ASPECTS

ASPECT:
OBJECTIVES & TARGETS:

ASPECT:
OBJECTIVES & TARGETS:

ASPECT:
OBJECTIVES & TARGETS:

ASPECT:
OBJECTIVES & TARGETS:

ASPECT:
OBJECTIVES & TARGETS:

ASPECT:
OBJECTIVES & TARGETS:

NOTE: Use additional copies of this page as needed to address all known aspects.

DATE: _____ JOB NUMBER: _____
PREPARED BY: _____

This image shows a single page of white paper with horizontal black lines, resembling notebook paper. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

SECTION: 4 – PAGE: 1

APPENDIX C3: Draft activity plan inserts (2)

D/W # 1

ERGONOMIC RISK FACTORS AND INTERVENTIONS TO ADD TO SIWP'S ACTIVITY PLAN FOR RAMP L

JOB	Cut and cover for ceiling—Inserting and tying rebar
HAZARD	Ergonomic Risk Factor—Working over-head
SOLUTION	“Huxley” box—When work with rebar requires prolonged over-head work, build Huxley box. Box should be used so all rebar work is done between waist and shoulder height. Huxley boxes should be built for ironworkers supporting 14' rebar overhead, and for any other ironworkers working with rebar overhead.

JOB	Cut and cover for ceiling—Working on top on rebar mat
HAZARD	Ergonomic Risk Factor—Walking over rebar mat (slips, trips, sprains, strains?)
SOLUTION	Safety planks—Safety planks should be built and laid over rebar mat. Planks are ½ sheets of plywood, painted orange. Planks are not attached to rebar. Planks must be on-hand for creation of safe walkways and can be moved by workers as needed.

GENERIC ERGONOMIC RISK FACTORS AND “SOLUTIONS” TO ADD TO SIWP'S ACTIVITY PLANS

JOB	General construction
HAZARD	Ergonomic Risk Factor—Awkward postures
SOLUTION	Redesign job to reduce the following: ☐ Twisting or bending body to the side ☐ Holding arms at or above shoulders ☐ Bending or twisting neck ☐ Leaning over or kneeling ☐ Using tools in difficult positions ☐ Working in small tight spaces

JOB	General construction
HAZARD	Ergonomic Risk Factor—Static postures
SOLUTION	Redesign job to reduce the following: ☐ Working in one position for long periods

JOB	General construction
HAZARD	Ergonomic Risk Factor—Repetition
SOLUTION	Redesign job to reduce the following: ☐ Using the same motion repeatedly for over an hour a day ☐ Frequent forceful or awkward motions

JOB	General construction
HAZARD	Ergonomic Risk Factor—Force
SOLUTION	Redesign job to reduce the following: ☐ Lifting or moving more than 50 lbs without help ☐ Lifting or moving more than 20 lbs repeatedly ☐ Lifting more than 6 lbs with one hand ☐ Carrying big materials (for example, 4 X 8 sheets) ☐ Using poorly maintained or the wrong tools for the job ☐ Using heavy or poorly balanced tools ☐ Contact stress: tools, equipment or materials pressing on the body

JOB	General construction
HAZARD	Ergonomic Risk Factor—Vibration
SOLUTION	Redesign job to reduce the following: ☐ Using vibrating tools ☐ Sitting or standing on vibrating surfaces

JOB	General construction
HAZARD	Ergonomic Risk Factor—Extreme temperatures
SOLUTION	Redesign job to reduce the following: ☐ Working with excessive exposure to cold or heat

JOB	General construction
HAZARD	Ergonomic Risk Factor—Work stress
SOLUTION	Redesign job to reduce the following: ☐ Excessive production pressures ☐ Excessive overtime ☐ Not enough rest breaks

APPENDIX D: New hire ergo training insert

ERGONOMICS IN CONSTRUCTION

All jobs should be designed to fit the size, strengths, skills, and capabilities of any person who might be doing them. Jobs that are not well designed result in musculoskeletal disorders (MSDs) such as tendonitis, tenosynovitis, bursitis, epycondylitis, carpal tunnel syndrome, thoracic outlet syndrome, and back injury. MSDs account for almost half of all injuries in construction.

THESE INJURIES ARE PREVENTABLE IF WORK IS PROPERLY DESIGNED.

ERGONOMIC RISK FACTORS: The goal of ergonomics is to eliminate unnecessary demands on the body. To evaluate a job for ergonomic design, look for the following “risk factors:”

1. Excessive force or weight greater than 50 lbs.
2. Highly repetitive motions
3. Awkward body postures, especially overhead work or work below the knees
4. Prolonged work in cold temperatures
5. Vibration from tools or machinery
6. Mental stress resulting in tense muscles

ERGONOMIC DESIGN: Proper ergonomic design begins with eliminating or reducing the “risk factors” that lead to injury. The following steps can aid in reducing exposure to ergonomic risk factors:

1. Look for and reduce ergonomic risk factors when planning the work.
2. Lay out work and materials to reduce workload and unnecessary exposure to risk factors.
3. Locate tools and materials close to the point of use.
4. Use mechanical assists in materials handling wherever possible.
5. Never lift more than 50 lbs. alone.
6. Keep work as close to waist level as possible.
7. Keep tools sharp and in good repair.
8. Always have good lighting.
9. Reduce noise to eliminate damage to the ear, to improve communication and to reduce stress.
10. Include regular short rest breaks and/or worker rotation when planning heavy work.

APPENDIX E: Ironworker platform questionnaire (blank)

1. Did you use it? (If not, skip to Q2)

Did you like it? Why?

If liked, was it because you felt/understood that it was reducing your muscle strain, or because it helped made the job easier, or both?

Did anyone tell you why it was being used?

Did you talk to anyone about how it should be used?

Did you have any input into the size and shape of the platform?

What was your input, and was it put into use?

How long did it take you to feel comfortable using the platform?

Did you feel stable, or were there any instances when the platform became unstable?

Did you feel the platform was heavy or hard to move?

How could the platform been better or easier to use, if at all?

Would you use a similar platform or other kind of support for inserting dowels into the DBS in the slurry wall for locations where the insert is not as high as it was when you did use the platform?

Have you ever used anything like it in the past?

2. Do you know how the platform was built? (If not, skip to Q3)

What were the dimensions?

Why were these particular dimensions used?

How long did it take to make the platform?

Was it a burden on the builder's workload to make the platform?

Did you feel that management supported the construction and use of the platform?

3. Did you observe the platform being used? (If not, no more Qs – unless they know job or worker specs, below)

Do you think it achieved it's goal of reducing exposure to working with elbows over the shoulder height? How could it have been better?

Were the iron dowels stored near the platform?

Was the platform in the way of other work happening nearby?

Were there any unforeseen reasons why the platform should not have been used?

4. Specifications:

Heights of DBS

Size and weight of rebar dowels

Number of reiterations

Duration of task

Weather conditions on day platform was used

Dimensions of platform

Type of handle

Weight of platform

Platform material

Worker anthropometrics

Weight

Height

Age

Years rebar experience

APPENDIX F: Training materials from foreman training session

Introduction to ergonomics in construction

- Define ergonomics
- Review musculoskeletal injuries
- Discuss risk factors for injury
- Explore solutions

Ergonomics

Redesigning jobs to prevent or
reduce exposure to risk factors for
musculoskeletal injuries

3 Facts About *Musculoskeletal Disorders*

- ✓ They affect your **musculoskeletal system**—your muscles, nerves, tendons, ligaments, joints, cartilage or spinal discs.
- ✓ They are **cumulative**—That means they happen gradually.
- ✓ They are **chronic**—as opposed to accidents or “acute” events.

Common MSDs



SIWP injuries (32) since November



Types of risks

- Awkward postures
- Static postures
- Repetition
- Force
- Vibration
- Extreme temperatures
- Work stress

Awkward postures

- Twisting or bending body to the side
- holding arms at or above shoulders
- Bending or twisting neck
- Leaning over or kneeling
- Using tools in difficult positions
- Working in small tight spaces

Static posture

- Working in one position for long periods

Repetition

- Using the same motion repeatedly for long periods
- Frequent forceful or awkward motions

Force

- Lifting or moving more than 50 lbs. without help
- Lifting or moving more than 20 lbs. repeatedly
- Lifting more than 6 lbs. with one hand
- Carrying big materials (ex, 4 x 8 sheet)
- Using poorly maintained or the wrong tools for the job
- Using heavy or poorly balanced tools
- Contact stress: tools, equipment or materials pressing on the body

Vibration

- Using vibrating tools
- Sitting or standing on vibrating surfaces

Extreme temperatures

- Working with excessive exposure to cold affects soft tissues
- Working with excessive exposure to heat affects entire body

Work Stress

- Excessive production pressures
- Excessive overtime
- Not enough rest breaks

Solutions

Planning to reduce exposure to cumulative musculoskeletal trauma (examples in formwork):

- Offset or stagger forms when stacking to allow easier access, reduce pinch points
- Designate laydown area with room for panels and hardware to reduce materials handling

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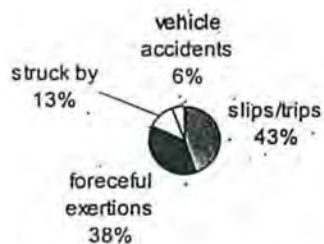
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