NATIONAL OCCUPATIONAL RESEARCH AGENDA (NORA)

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NATIONAL CONSTRUCTION AGENDA

FOR OCCUPATIONAL SAFETY AND HEALTH RESEARCH AND PRACTICE IN THE U.S. CONSTRUCTION SECTOR

Developed by the NORA Construction Sector Council

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A short description of activities to follow for the NORA Construction Sector Council and implementation of the NORA National Construction Agenda.

INTRODUCTION

What is NORA and the NORA Construction Sector Council?

The National Occupational Research Agenda (NORA) is a partnership program to stimulate innovative research and improved workplace practices. Unveiled in 1996, NORA has become a research framework for NIOSH and the nation. Diverse parties collaborate to identify the most critical issues in workplace safety and health. Partners then work together to develop goals and objectives for addressing these needs.

The program entered its second decade in 2006 with a new sector-based structure to better move research to practice within workplaces. There are eight separate sectors involved in NORA[1]. NIOSH is the steward of NORA and facilitates the work of the multi-stakeholder NORA Sector Councils, which will develop and implement research agendas for the occupational safety and health community over the decade (2006-2016). The NORA Construction Sector Council is the group that has been working to develop the draft agenda for construction.

What does the National Construction Agenda represent?
Who is the target audience?

This is the first national effort to create an agenda for the construction industry. It is intended to address the question: “What information do we need to be more effective in preventing injuries and illnesses in construction?” The agenda consists of 14 strategic goals designed to address 10 “top problems” in construction safety and health. The agenda foundation is based on research needs and information gaps that need to be filled in order to make progress on important construction issues. But it is intended to go beyond research to address how the research findings can be used by various construction stakeholders to bring about needed changes in the industry. Including “research to practice” or R2P goals is thus critical to making the link between research and workplace impact. While not every stakeholder group is involved with research, most every construction organization is involved somehow with converting knowledge into practice for use by either contractors or construction workers. Developing the National Construction Agenda provides a vehicle for construction industry stakeholders to describe what they believe are the most relevant issues, gaps, and safety and health needs in the industry.

The National Construction Agenda is important because it will provide guidance for construction industry stakeholders (e.g., industry, labor, professionals, and

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[1] The 8 sectors are: Agriculture, Forestry & Fishing, Construction, Healthcare & Social Assistance, Manufacturing, Mining, Services, Transportation, Warehousing & Utilities, and Wholesale and Retail Trade

academics) to prioritize their work among the many safety and health issues of interest. It is intended to inspire decision makers to include these topics in their top priorities. It is intended to steer researchers to cohesive topic areas for research proposals. Lastly, it is intended to encourage dialog and partnering among stakeholders on a subset of key issues ---thus increasing our collective ability to make an impact in reducing injuries and illnesses among construction workers. In sum, the agenda has been designed with a wide construction target audience in mind. See Table 1 for examples.

Table 1 – NORA National Construction Agenda – Potential Target Audiences
Research funding sources -Federal research agencies -Research Foundations -State supported sources -Workers Compensation Insurance research organizations -Industry research organizations -Trade associations -Building owner associations
Public and private researchers -Government researchers -Academic researchers -Association and Organization researchers
Construction industry organizations -Trade Associations -Labor Organizations -Apprenticeship training organizations -Regulatory agencies involved with construction at federal, state, and local levels -Non-profit organizations and community-based construction groups -Engineers and architects -Tool, equipment, and material manufacturers and distributors -Construction management firms
Safety and health practitioners -Professional associations (e.g. ASSE, AIHA, NSC, ASCE) -Individual Safety, industrial hygiene and engineering practitioners -Consensus standards groups -Other professionals with safety and health interest (economists, physicians)

The Agenda is broad and reflects the diversity of the construction industry. However, it is not intended to be an inventory of all issues - so not every possible issue of interest is included on the agenda. The agenda should not be viewed as suggesting that other topics are unimportant. We arbitrarily restricted ourselves to ten topics in order to preserve the ability to focus resources on a manageable set of goals. If every topic is included as a priority then no topic truly is a priority. However, once a topic was selected, we have tried to develop sufficient intermediate goals to address key gaps and needs. We have not tried to limit the resulting goal proposals to any specific budget or anticipated activity level.

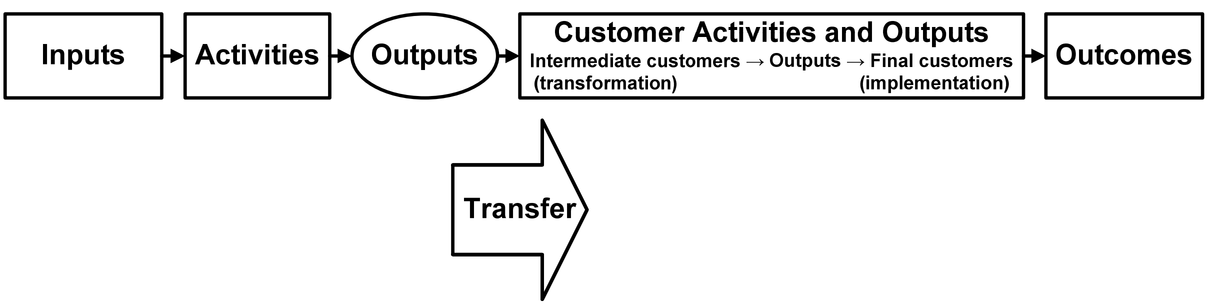
What process has been used to develop the goals?

A variety of information sources have been used to develop these draft goals. NORA was launched with a series of town hall meetings around the country, and the construction sector meeting was held on December 19, 2005 in Chicago, Illinois. Construction-related comments were submitted by others at town hall meetings around the country. Additional written comments were submitted by stakeholders to a NORA sector docket. The resulting comments have been organized by subject and are accessible at http://www2a.cdc.gov/niosh-comments/nora-comments/commentsrch.asp. Additional input was solicited via breakout sessions at the NORA Symposium held in April of 2006.

An initial NORA Sector Council was assembled from a cross section of groups and individuals representing various construction perspectives. The group held a kickoff meeting on March 23, 2006. The group recommended adding additional members and the first full meeting of the Council was held on September 26 and 27, 2006. Council members were briefed on the NORA comments along with information on current available surveillance findings on construction injuries and illnesses. Group members also contributed their opinions on three top problems in construction. The group considered a variety of criteria in looking at top problem candidates. For example:

1. What evidence supports this as a top problem?
2. Who is affected?
3. Why does the problem persist?
4. What would be the ideal situation?
5. What stage are we at in our knowledge and understanding of this construction problem?
    - -Do we understand the hazard?
    - -Do we understand the solutions?
    - -Do we understand the implementation of solutions?
6. Can the problem be described using common priority-setting criteria?
    - -Severity, Incidence or Prevalence,
    - -Size of exposed population,
    - -Need to improve current performance,
    - -Likelihood that research will make a difference for addressing this problem?
    - -How much change is needed for near-term improvement?
7. From a construction practice perspective, what stage is the problem at?
    - -For Construction Safety and Health Practitioners?
    - -For Contractors and Workers?

NIOSH provided the council with a “logic model” to provide a diagram and shared understanding of the path by which the research process leads to impacts on reducing injury and illness. The process begins with **inputs** such as planning inputs, stakeholder inputs, and production inputs such as funding and infrastructure, supporting **activities** using the inputs. Activities are the various types of research via internal or externally funded investigators performed in partnership with stakeholders to accomplish objectives. A variety of **outputs** result from research activities. They include scientific reports such as peer-reviewed journal articles, technical reports, meeting presentations, book chapters, and review articles. Other types include recommendations, guidance, market ready inventions, patents, measurement tools, and new training techniques. **Transfer** of outputs is a critical step to disseminate findings. Transfer can target either **intermediate customers** (the term used to describe trade associations, labor organizations, government agencies, etc) or **final end customers** (construction workers, contractors, subcontractors, owners). Researchers and research agencies generally have fewer direct links to workers and contractors in comparison with regulatory agencies, and must rely more heavily on effective transfer to intermediate groups such as construction trade associations and unions. The term **intermediate outcome** is used to describe the further use or response to research outputs by intermediate customers. For example, an organization might include research-derived recommendations in training materials provided to members. These construction trade associations and labor organizations have closer links to workers and contractors, and their dissemination can then influence workers and contractors to utilize the information and recommendations. It is the use of the information by workers and contractors to change worksite practices that ultimately leads to **end outcomes** such as a reduction in injuries.



The logic model helps to provide a common terminology and understanding of the pathway between research activity and making an impact in construction workplaces[2]. It helps to reinforce the need for researchers and construction stakeholders to build partnerships to support effective collaboration. It helps to reinforce the need to build in "research to practice" (R2P) and transfer and diffusion steps in planning. Lastly, it provides a way to think about structuring goals, since strategic goals should reflect improved end outcomes, and intermediate goals should reflect approaches to transform research outputs into

[2] The NIOSH Construction Program developed a more detailed construction-specific logic model which is included on page 35 of the Program Review package provided to the National Academies at http://www.cdc.gov/niosh/nas/construction/pdfs/chap2.pdf

products and activities that workers and contractors can then use toward improving safety and health performance.

Discussions led to selection of a list of “top ten” construction topics. Workgroups, co-chaired by NORA Construction Sector Council members, began work to convert the top problems into strategic and intermediate goals. Workgroups included other interested individuals who participated as “corresponding” members to the NORA Construction Council. The resulting workgroup products, while varying somewhat on length and detail, all include the same basic goal and performance measure elements. The draft goals are not yet complete, but have been developed enough at this stage to begin receiving invaluable feedback – thus we are making these preliminary draft goals available for public comment. We believe that the ten areas represent important construction topics where research and combined industry efforts are needed over the decade. A listing of NORA Construction Sector Council members is available at http://www.cdc.gov/niosh/nora/councils/const/planpart.html and a listing of corresponding members will be added shortly and updated on a regular basis.

Organization of the report and definition of common terms

The Draft National Construction Agenda consists of ten topics and fourteen strategic goals. Three topics address outcomes and the other seven topics address contributing factors that cut across and affect progress on the outcomes. Because two of the topics (traumatic injury and health hazards) are both broad and important, three specific focus areas (e.g. falls) were selected for each for strategic goal development. The six strategic goals from these two topics combined with one strategic goal for each of the other eight topics resulted in fourteen strategic goals.

Each strategic goal includes a performance measure designed to help gauge progress, and intermediate goals to describe the smaller steps needed to achieve the strategic goal. Intermediate goals have been placed in text boxes to make them easier to find. Each goal includes an introductory narrative to provide background and context for the topic and goals. Some of the goals include tables, additional narrative and reference sections as well.

Here are definitions of some of the common terms used in this report.

Outcomes – The end results - the actual reduction in injuries, fatalities, exposures, illnesses and disorders in construction workers.

Contributing factors– Factors that represent important influences impacting the likelihood that prevention and control measures and actions are taken on a construction job.

Strategic Goal - A goal related to improving performance on end outcomes.

Performance Measure – A metric that allows tracking of progress toward a strategic or intermediate goal

Intermediate Goal – A goal secondary to a strategic goal that reflects an intermediate step and intermediate outcome necessary to move towards a strategic goal.

Research Goal – For this report, a subsidiary research goal below an intermediate goal that reflects filling an information gap via research to move towards an intermediate goal.

Research to Practice Goal – For this report, a subsidiary goal below an intermediate goal that describes activities to utilize existing or newly generated research for products that can be used by construction stakeholders in support of achieving an intermediate goal.

NORA Construction Sector Council Core member – The Council includes about 36 core members (12 from NIOSH and 24 from external stakeholder groups) who participate in twice yearly face to face meetings and help co-chair workgroups. The Council is led by two co-chairs, one selected by NIOSH, and one selected by the external core members. Most core members will rotate off the Council after two years of service and be replaced by other interested candidates.

NORA Construction Sector Council Corresponding member – interested construction stakeholders may participate in particular workgroup conference calls and emails via corresponding membership.

National Construction Agenda – This term describes the ten national strategic goals for the construction sector.

Implementation Plan – Several considerations need to be considered to implement the National Construction Agenda. These include: 1) extent of interest from construction organizations in participating on a particular goal and/or R2P activity via partnerships; 2) availability of research funding; 3) availability of researchers with needed expertise. A plan to be developed at a later date will describe some of these issues related to implementing the National Construction Agenda goals.

What is the process going forward? How can you be involved with the National Construction Agenda?

To provide comments
We are looking for input in the form of recommended additions, expressions of support, or modifications or deletions from the draft list of goals and goal topics.

There are two ways to comment:

1) Use the Online form at:
http://www.cdc.gov/niosh/NORA/comment/public/ConstDraftDec2007/comments.html

2) Send an email with the subject line "**ConstDraftDec2007:Comments"** to noracoordinator@cdc.gov

You can also attend a February 14 workshop to discuss the draft NORA Construction Agenda. Please contact the http://www.buildsafe.org website for registration information and additional details.

Comments received by January 31, 2008, will be considered by the council in February. Comments will be accepted through April 30, 2008.

To become a "corresponding member"
If you are interested in participating with the existing workgroups to continue to develop these draft goals, please provide the following information and send to Either the NORA Coordinator noracoordinator@cdc.gov or the NIOSH Construction Co-chair at mgillen@cdc.gov

-Your Organization
-Email address
-Phone number
-Mailing address
-Workgroup(s) interested in

To join the effort as a potential partner
If you or your organization is interested in partnering on a particular strategic or intermediate goal, please contact the NIOSH Construction Co-chair at mgillen@cdc.gov. Partnering opportunities can cover a wide range of activities such as participating in research, helping to develop information products from research, or disseminating information.

The National Construction Agenda is a living document that will benefit from free exchange of ideas, opinions, and data; we look forward to hearing from you.

SECTION 1 – OUTCOME GOALS

The seven goals in this section address the three major outcome categories for occupational safety and health. These are: 1) injuries arising out of a traumatic event; 2) occupational illnesses arising out of workplace exposures; and 3) musculoskeletal disorders arising out of acute or chronic overloading to the musculoskeletal system. The goals that follow address events and exposures of concern associated with these outcomes. They may address specific events associated with an outcome, improvements in understanding underlying risk factors, or development of interventions or solutions to prevent and control them.

TOPIC: TRAUMATIC INJURY/EVENTS

Traumatic injury is the most well-known outcomes of concern for construction. National data systems allow a partial statistical picture for traumatic injury including information on twelve types of injury events. These data were used to guide workgroup discussions and several resulting summary tables of interest are included in the Appendix at the end of this Section write-up.

Construction workers have high rates of work-related injuries and deaths in comparison with other U.S. industry sectors. Construction experiences the largest number of fatalities of any sector and while construction represents about 8% of the American workforce, construction workers experience about 21% of fatal injuries nationwide. Construction consistently loses more workers to traumatic injury death than any other major sector – there were 1192 deaths in 2005. The fatality rate for construction is 11.0 deaths per 100,000 workers, which is fourth highest behind agriculture, mining, and transportation. Leading causes of construction fatalities include falls to a lower level, electrocutions, struck-by events, and caught-in or crushed-by events.

Regarding nonfatal injuries, these data are also available from the Bureau of Labor Statistics (BLS). In 2005, BLS reported that the construction industry experienced a total of 157,070 nonfatal serious injuries. The BLS defines a serious injury as an incident involving a day away from work beyond the day the incident occurred. Construction-related cases involving days away from work had a lost-time rate of 2.4 per 100 full-time workers, which is the second highest rate among all U.S. industry sectors, after Transportation and Warehousing with a rate of 2.9 per 100 full-time workers.

For the NORA Construction Research Agenda, three traumatic injury events were identified as focus areas *that* affect large numbers of construction workers. These are: **Falls**, **Electrical hazards**, and **Struck-by injuries.**

These three causes represent about 65% of fatal injuries[3] and 43% of nonfatal injuries with days away from work. They represent 4 out of the top 5 events. A separate strategic goal is proposed for each of these three focus areas.

Note that construction fatalities among vehicle operators from highway accidents rank second after falls as a top cause of fatal injuries in construction. However, this topic was not selected as a construction focus area since there is a NORA transportation sector and we expect that group to be in a better position to take the lead on deaths and injuries associated with vehicle operation.

In developing draft intermediate goals for the three focus areas, the workgroup recognized that some issues of potential interest might overlap with other broad NORA Construction Sector contributing factor goal topics and workgroups. For example, (1) addressing the importance of managerial support and worker buy-in through behavior changes to maintain a safe workplace; (2) developing better surveillance techniques related to traumatic events; (3) providing a research focus on non-English-speaking workers; (4) developing procurement practices for estimators and schedulers to address the importance of the role of the owner and controlling contractor to address all traumatic incidents. The workgroup expects that draft goals related to these goals will also support improved construction industry performance related to traumatic injuries and events.

The workgroup took a perspective that the first five years of NORA (2006-2010) could be used to identify, develop, and pilot safety-related intervention devices, methods, or systems in construction; and, the second five years (2011-2016) could focus on implementing solutions via partnerships with organizations and companies that will actively support and utilize intervention devices, methods, or systems during normal construction activities. The focus is to increase the use of commercially available safety products, and to use research and other applied techniques to reduce hazards and prevent traumatic events from occurring to construction workers while doing their job. A well-designed and facilitated approach can increase the likelihood that risks faced daily by construction workers can be reduced.

FOCUS AREA : FALLS

STRATEGIC GOAL 1.0 - Reduce Construction Worker fatalities and serious injuries caused by falls to a lower level

[3] Top fatal injury events and exposures in construction include: falls to lower level (32.2% of fatal construction injuries); struck-by objects (10.9%); contact with electric current (9.0%); pedestrian struck by vehicle (8.1%); and caught in or crushed by collapsing materials (4.4%) for a total of 64.6% [BLS, 2005a].

Performance Measure: Address technical solution gaps, increase implementation of effective fall prevention measures, and utilize design approaches and social marketing campaigns to support a 33% reduction in the rate of fatal falls among construction workers over the decade.

Falls are the largest single source of fatal injuries for construction workers, accounting for 33% of total construction fatalities in 2005. Construction experiences a disproportionate share of fall fatalities. While construction represents about 8% of all workers, construction workers experienced 51% (394) of the 770 fall fatalities that occurred across all industries in 2005 [BLS, 2005b]. Occupations with high frequencies of fatal falls include ironworkers, roofers, and laborers (approximately 68, 26, and 10 deaths per 100,0000 FTEs per year respectively) in comparison with the fall rate for all construction occupations of about 4 per 100,000 FTEs [CPWR 2002].

Much research has been performed to evaluate the risk factors associated with falls and to develop interventions to address them. For example, work has been done on roofs, scaffolds, ladders, aerial lifts, telecommunication towers, and fall protection harnesses. Substantial regulations, guidance materials, and training materials also exist for falls. As a result, some stakeholders view most falls as preventable by following and implementing existing fall prevention approaches. From this perspective, the question of how to overcome implementation obstacles and expand use of existing solutions is the crux of the problem. However, some fall-related exposures are viewed as lacking feasible engineering solutions and options for contractors, so additional development of fall prevention practices and techniques is also recognized. The following intermediate goals address both of these gap questions.

Intermediate Goal 1.1 - Partner with construction stakeholders and safety professionals to identify the top three fall-related problems requiring technical engineering solutions and develop and evaluate options to fill these gaps.

Performance Measure: Within 2 years, identify 3 important engineering solution gaps and within 6 years develop, evaluate, and disseminate solutions to fill them.

<u>Research Goal 1.1.1</u> – Inventory existing fall protection technologies and identify three gaps where technical engineering guidance needs to be developed or modified further for fall protection.

Examples might include systems for anchorage points, residential construction fall protection systems, or improved systems for elevated work platforms**.**

Research Goal 1.1.2 – Develop and evaluate engineering interventions and guidelines to address the three fall protection gaps.

Research to Practice Goal 1.1.3 – Disseminate these solutions and guidelines throughout the industry

Intermediate Goal 1.2 - Partner with Construction stakeholders to expand awareness and use of existing effective fall prevention and protection solutions by construction employers and workers

Performance Measure: Within 4 years, identify small contractor obstacles to implementing fall protection measures and develop additional solutions. Within 6 years, develop and disseminate pre-job planning tools and trade-specific materials to facilitate greater implementation of fall prevention and protection measures.

Research Goal 1.2.1 – Work with insurance companies and consultation organizations to identify small contractor implementation obstacles associated with existing fall prevention and protection measures.

Research Goal 1.2.2 – Develop additional protective and cost effective solutions

Research to Practice Goal 1.2.3 – Develop simple pre-job planning tools for use by small and medium size contractors to improve identification of the most common fall hazards and solutions.

Research to Practice Goal 1.2.4 – Partner with construction stakeholders to disseminate widely.

Research to Practice Goal 1.2.5 – Utilize existing information about fall prevention and protection solutions to develop and disseminate trade-specific materials for the major categories of falls from heights associated with fatal and serious injuries to include awareness materials, implementation guidance, business case studies, and training materials in paper and electronic media.

Intermediate Goal 1.3 - Partner with architects, engineers, and construction organizations to expand the use of "safe-by-design"[4] practices for fall prevention via demonstration projects and guidance.

Performance Measure - Within 7 years, develop, disseminate, and document effectiveness for at least six "safe by design" practices related to prevention of falls to lower levels**.**

Research Goal 1.3.1 – Identify and evaluate 3 existing "safe by design" practices that address falls to lower levels and develop case study materials.

For example, these might include built-in safety anchors in building beams or use of non-breakthrough skylights.

Research Goal 1.3.2 – Identify and evaluate 3 new "safe by design" practices that address falls to lower levels and develop case study materials.

Research to Practice Goal 1.3.3 – Partner with OSHA, international construction groups, professional societies, trade associations and unions, architect-engineer-and-designer firms, and insurance companies to disseminate case study materials and to expand the use of safe by design approaches

Research *to Practice* Goal 1.3.4 – Within 6 years, document effectiveness of implementation of these safe-by-design practices.

Intermediate Goal 1.4 - Work with construction partners to develop and implement a national campaign to reduce fatal and serious injuries associated with construction falls to a lower level.

Performance Measure: Within 3 years, evaluate options and prepare a proposal for a "National Construction Fall Prevention Campaign". Within 5 years, convene construction stakeholders to decide on pursuing a national campaign, and if support is provided, begin implementation.

Given that**:** (1) falls are the top cause of fatal injuries in construction, (2) the nonfatal injuries from falls are typically severe and costly, and (3) many falls could be prevented by using currently available approaches, falls are a compelling topic for the construction industry to work together on. Countries such as the United Kingdom have successfully used national social marketing campaigns to raise awareness about specific construction hazards. Consideration of a similar approach tailored to U.S. conditions offers promise. This approach might be most successful if it built upon some

[4] The term being used for the NORA Construction Sector Goal topic on Design is "Construction Hazard Prevention through Design" or CHPtD.

of the work described in earlier intermediate goals to address engineering and implementation gaps.

Research Goal 1.4.1 – Evaluate the potential for a "National Construction Fall Prevention Campaign" by assessing: 1) the components and effectiveness of U.S. campaigns on related public health injury topics; and 2) the components and effectiveness of internationally based campaigns on construction injury topics. Prepare a proposal for a U.S. campaign.

Research to Practice Goal 1.4.2 – Convene a meeting of construction stakeholders and industry leaders to discuss a proposal for a U.S. "National Construction Fall Prevention Campaign". If support is provided, develop an action plan for implementation.

Research to Practice Goal 1.4.3 – If support is provided, implement the action plan in conjunction with construction industry stakeholders and evaluate the resulting impact.

FOCUS AREA : Electrical Hazards

STRATEGIC GOAL 2.0 - Reduce fatal and nonfatal injuries from contact with electricity among construction workers.

Performance Measure: Address technical solution gaps, and increase dissemination and use of interventions to reduce construction-related electrical injuries to support a 20% reduction in the rate of electrocutions among construction workers over the decade.

During the ten-year period from 1992-2002 the overall total of deaths associated with contact with electricity was nearly 3,400, with 47% of these occurring in the construction industry [Cawley 2006]. About 1 in 8 construction industry deaths involved electricity versus 1 in 20 for all industry. Deaths and injuries due to contact with electricity are not just a problem for electricians – surveillance data show that it is an important injury risk for many construction trades such as roofers, painters, laborers, operating engineers, and carpenters. Existing studies have examined risk factors associated with electrical hazards. The most common electrical injury event is contact with overhead power lines (OHPL) (740 cases - 47%). Contact with OHPL occurs most often to construction laborers (20% of 740 cases), electricians (13%), electrical power installers and repairers (8%), painters (7%), and roofers and carpenters (each with 6%). The second most common fatal electrical event is contact with wiring, transformers, or other electrical components (487 cases - 31%). The intermediate goals address these top two causes.

Intermediate Goal 2.1 - Investigate ways to improve the performance of power line proximity warning alarms to protect operators of mobile vehicles and nearby construction workers.

Performance Measure - Within 3 years, evaluate studies associated with current systems and develop alternative options. Within 7 years, design, construct, and test at least one proposed means of protection, and field test within 10 years.

<u>Research Goal 2.1.1</u> – Evaluate perceived limitations in current proximity warning alarms for protecting mobile vehicle operators and nearby workers and develop alternative technology options.

<u>Research Goal 2.1.2</u> – Design, construct, and field test at least one proposed proximity warning system for mobile vehicles and work with equipment manufacturers to disseminate

Intermediate Goal 2.2 - Investigate ways to protect construction workers from electrocution hazards involving power line contact through hand-carried metallic objects and vehicle-related contacts.

Performance Measure - Within 6 years, identify interventions to address workers, tasks, and risk factors associated with power line contacts via hand carried metallic objects or contacts with vehicles. Within 10 years, evaluate the interventions and disseminate throughout the industry.

Research Goal 2.2.1 – Identify workers, tasks, and risk factors associated with the greatest risk for electrocution involving contact with power lines while hand-carrying metallic objects or via vehicle-related contacts.

Research Goal 2.2.2 – Identify and evaluate interventions to address risk factors associated with groups and tasks most at risk.

For example, these mitigation approaches might include improved work practices, training, and/or engineering controls

Research to Practice Goal 2.2.3 – Promote and disseminate successful strategies via industry and labor construction organizations.

Intermediate Goal 2.3 - Investigate ways to protect construction workers from contact with live electrical wiring and components by studying electrical installation, maintenance, and repair tasks and recommending ways to improve work practices, techniques, and tools. Special emphasis will be given to lockout and tagout procedures for troubleshooting tasks, which may involve using certain work practices, tools, techniques, and personal protective equipment (PPE), that may be conducted when the circuit is live (such as under NFPA 70E[5]).

Performance Measure - Within 6 years, identify interventions to address workers, tasks, and risk factors associated with contact with live electrical wiring and components during installation, maintenance, and repair. Within 10 years, evaluate the interventions and disseminate throughout the industry.

Research Goal 2.3.1 – Identify workers, tasks, and risk factors associated with the greatest risk for electrocution involving common electrical and non-electrical installation, maintenance, and repair tasks.

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[5] National Fire Protection Association Standard 70E – *Standard for Electrical Safety Requirements for Employee Workplaces -2004* supplements the National Electrical Code (NFPA 70) with important electrical safety information for those who work on or around electrical equipment or systems, including establishing an electrically safe work condition using electrical lock out and tag out procedures, maintenance safety, and arc flash safety recommendations.

Research Goal 2.3.2 – Identify and evaluate interventions to address risk factors associated with the groups and tasks most at risk.

For example, these mitigation approaches might include improved work practices such as lockout and tagout, tool techniques, training, engineering controls, or use of PPE

Research to Practice Goal 2.3.3 – Promote and disseminate successful strategies via industry and labor construction organizations.

Intermediate Goal 2.4 - Forge new partnerships with small employers and companies with substantial Hispanic employment to determine how electrical safety information may be more effectively disseminated.

Performance Measure - Within 2 years, characterize construction related electrocutions among Hispanic construction workers and within 5 years disseminate tailored materials meeting their needs.

Research Goal 2.4.1 – Characterize the number and rate of construction related electrocution fatalities among Hispanic construction workers and identify higher risk tasks.

Research to Practice Goal 2.4.2 – Partner with diverse construction stakeholders to tailor and disseminate construction electrical safety information

Examples might include suppliers, equipment rental firms, churches, social organizations

FOCUS AREA: Struck-by injuries involving objects, vehicles, and collapsing materials and structures.

STRATEGIC GOAL 3.0 - Reduce fatal and serious injuries associated with struck-by incidents associated with objects, vehicles, and collapsing materials and structures.

Performance Measure: Address risk factor gaps, develop new interventions, and increase dissemination and use of interventions to reduce construction-related struck-by injuries associated with objects, vehicles, and collapsing materials and structures by 33% over the decade.

In comparison to falls and electrical hazards, struck-by hazards address a number of diverse construction settings and less information is available about known risk factors. The resulting intermediate goals address three different struck-by settings.

Intermediate Goal 3.1 – Objects: Improve understanding of risk factors associated with struck-by fatalities and serious injuries associated with falling, flying, swinging, and rolling objects; and compare findings to existing regulations and guidance.

Performance Measure: Within 3 years, elucidate the risk factors associated with struck-by events and compare to existing guidance and regulatory language to identify any key gaps.

<u>Research Goal 3.1.1</u> – Characterize fatal struck-by injury data involving falling, flying, swinging, and rolling objects to elucidate tasks and risk factors associated with these events. Identify commonalities and differences among the four types of object-related struck-by events

For example, studies could include detailed analysis of Census of Fatal Occupational Injuries, Annual Survey data, and fatality investigations.

<u>Research to Practice Goal 3.1.2</u> – Inventory existing regulations and consensus standards and compare to risk factors so as to identify gaps where guidance and regulations might be needed to address these types of struck-by injuries

Intermediate Goal 3.2 – Objects: Use risk factor and gap information to develop and evaluate interventions and guidance for preventing struck-by injuries involving falling, flying, swinging, and rolling objects. Partner with construction stakeholders to disseminate resulting interventions.

Performance Measure: Within 6 years, develop, evaluate, and disseminate at least 5 interventions and associated guidance to address struck-by object risk factors.

Research Goal 3.2.1 – Develop and evaluate intervention options and guidance to address major struck-by object risk factors

Research to Practice Goal 3.2.2 – Disseminate trade specific interventions and guidance that address struck-by object risk factors throughout the construction industry

Intermediate Goal 3.3 – Vehicles: Evaluate strategies to reduce worker exposure to being run over by heavy construction vehicles and equipment.

Performance Measure - Within 5 years, complete evaluation of existing control strategies and complete the evaluation of emerging technologies within 10 years.

Research Goal 3.3.1 – Evaluate existing engineering control strategies (Internal Traffic Control Plans and off-the-shelf Proximity Warning Systems).

Research Goal 3.3.2 – Develop and evaluate emerging technologies (HASARD – Hazardous Area Signaling And Ranging Device and RFID – Radio Frequency Identification Device)

Intermediate Goal 3.4 – Vehicles: Promote the availability and use of operator visibility limit information for road construction equipment.

Performance Measure - Within 3 years, blind area diagrams for 50 pieces of construction equipment will be made available. Within 8 years, 40% of construction companies surveyed will use blind areas for training truck drivers, equipment operators, and workers who work around operating construction equipment.

Research to Practice Goal 3.4.1 – Make available blind area diagrams for selected heavy construction vehicles equipment used in the construction industry.

Research to Practice Goal 3.4.2 – Disseminate and promote the use of blind area diagrams for training truck drivers, equipment operators, and workers on foot who work around operating construction equipment.

Intermediate Goal 3.5 – Vehicles: Evaluate worker injury risks associated with the expanded use of night work in the road construction industry.

Performance Measure - Within 3 years, survey the industry and convene a workshop to address nighttime road construction risk factors. Within 7 years, quantify risks and develop 3 intervention options to address them

Research Goal 3.5.1 – Survey the industry on night work-related injuries.

Research Goal 3.5.2 – Convene a workshop addressing safety of nighttime road construction to improve understanding of injury patterns and risk factors associated with night work, along with potential impacts on daytime interventions (e.g. operator visibility limits).

Research Goal 3.5.3 – Develop methods to quantify injury risk due to hazards specific to night work.

Research Goal 3.5.4 – Develop and evaluate intervention options to reduce night work risk factors and prepare guidance for night work.

Intermediate Goal 3.6 – Vehicles: Gain widespread usage of effective prevention measures in the road construction industry

Performance Measure - Within 2 years, a baseline survey will be performed on industry use of practices for reducing vehicle struck-by injuries. The industry will be re-surveyed after 8 years and effective measures will be incorporated into road construction contracts, regulatory and consensus standards, guidelines, and best practices and 40% of firms will be using the measures.

Research to Practice Goal 3.6.1 – Partner with road construction industry stakeholders to widely disseminate effective practices for reducing injuries associated with struck by vehicle events in road building.

Research Goal 3.6.2 – Develop a strategy to use industry surveys to develop a baseline and follow up measures to track usage of prevention measures over the decade.

Intermediate Goal 3.7 – Collapsing Materials/Structures: Characterize circumstances associated with collapsing structures (e.g. scaffolding, demolition work, partially built structures)

Performance Measure - Within 5 years, evaluate and identify risks and gaps associated with collapses of structures under construction, and within 10 years develop and disseminate appropriate guidance to address these risks and gaps.

Research Goal 3.7.1 – Partner with OSHA, NIST, civil engineers, and other construction stakeholders to evaluate root causes, risk factors, and the existence of any regulatory or guidance gaps associated with collapses of structures under construction.

Research Goal 3.7.2 – Based on findings, develop and evaluate interventions and provide guidance to address these types of collapses.

Research to Practice Goal 3.7.3 – Disseminate guidance and interventions throughout the construction industry.

Intermediate Goal 3.8 – Collapsing Materials/Structures: Partner with construction stakeholders to greatly increase the diffusion of existing effective practices for preventing fatalities and serious injuries associated with trench collapses.

Performance Measure - Within 4 years, pilot-test at least three new approaches for improving the implementation of trenching practices by small employers and evaluate the current competent persons training curricula for excavation within 5 years.

Research Goal 3.8.1 – Explore and pilot at least three approaches for improving implementation of effective trench practices by small and medium sized employers including approaches such as working with local and state construction permitting offices, local emergency rescue forces, or local equipment rental facilities.

Research to Practice Goal 3.8.2 – Disseminate information on effective pilot approaches for improving implementation of effective trench practices throughout the industry

Research to Practice Goal 3.8.3 – Evaluate the current curricula used for training competent persons for excavation and examine the need to further standardize competent person skills. Share results with industry partners

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APPENDIX – Key Construction Injury Data Tables used by the NORA Construction Sector Traumatic Injuries Workgroup

Tables 1 through 4 provide current BLS data that assisted the Traumatic Events Work Group to focus on the most hazardous sectors of construction.

Table 1 presents the number and percent breakdown of fatal occupational injuries for all U.S. (this includes private industry, all government agencies, and self-employed contractors) and for the private sector of the Construction Industry (excludes government agencies and self-employed) for the years 2003 thru 2005. These data were retrieved from the BLS public website for fatal occupational injuries (the Census of Fatal Occupational Injuries [CFOI]) from www.bls.gov. Overall totals can be obtained for all U.S. industries according to private industry, government, and self-employed (Table A-3 of the CFOI data). More detailed information, such as source of injury by industry sector (Table A-4) or type of injury event or exposure by industry sector (Table A-9), is available only for the private sector. Other data searches are required to obtain the breakdown of injury sources or events for government and self-employed workers. CFOI is the most reliable count of occupational fatalities that occurred.

Table1. Comparison of all U.S. and Construction-related fatalities, 2003-2005. (*Source is BLS CFOI*)

Event or Exposure	2003, Total All U.S.[1]		Fatal Injuries Construction[2]		2004, Total All U.S.[1]		Fatal Injuries Construction[2]		2005, Total All U.S.[1]		Fatal Injuries Construction[2]	
	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)	No.	(%)
Totals	5575	(100)	1131	(100)	5764	(100)	1234	(100)	5734	(100)	1192	(100)
Falls	696	(12.5)	364	(32.2)	822	(14.3)	445	(36.1)	770	(13.4)	394	(33.0)
Fall to lower level	*604*		*354*		*738*		*437*		*664*		*384*	
Transportation	2364	(42.4)	290	(25.6)	2490	(43.2)	287	(23.3)	2493	(43.5)	318	(26.7)
Highway Incident	*1353*		*145*		*1398*		*148*		*1437*		*154*	
Non-highway Incident	*347*		*48*		*338*		*45*		*340*		*53*	
Worker struck by vehicle or equip	*337*		*84*		*378*		*78*		*391*		97	
Contact w/ Object & Equipment	913	(16.4)	231	(20.4)	1009	(17.5)	267	(21.6)	1005	(17.5)	244	(20.5)
Struck-by object	*531*		*111*		*602*		*150*		*607*		*130*	
Worker caught in, compressed by equip or objects	*238*		*41*		*269*		*38*		*278*		*52*	
Trenching, excavation	*48*		*44*		*41*		*39*		*44*		*39*	
Exposure to harmful materials & environments	486	(8.7)	179	(15.8)	464	(8.0)	170	(13.8)	501	(8.7)	164	(13.8)
Contact w/ electric current	*246*		*132*		*254*		*122*		*251*		*107*	
Fires & Explosions	198	(3.6)	29	(2.6)	159	(2.8)	34	(2.8)	159	(2.8)	40	(3.4)
Assaults; Violent Acts	902	(16.2)	37	(3.3)	809	(14.0)	31	(2.5)	792	(13.8)	31	(2.6)
Bodily Reaction	12	(0.2)	--	--	8	(0.1)	--	--	11	(0.2)	--	--
Other (nonclassifiable)	4	(0.1)	--	--	3	(0.0)	--	--	3	(0.0)	--	--

[1] "All U.S." includes data from private industry, government agencies, and self-employed.
[2] "Construction" includes data for private industry only.

The data in Table 2 have been compiled and presented to provide an indication of which construction areas should be focused on for developing future goals for research and intervention development related to fatal incidents. Specific traumatic-related construction topics have been identified that are considered to be priority – falls, electrocutions, work zone activities, and the combination of struck-by / caught-between event types were selected as categories to be focused on. The struck-by events were further separated into struck-by falling objects and struck-by collapsing materials in trenching and excavation cave-ins.

Table 2. Comparison of construction-related fatal injuries for key "event" categories, with frequency and percent increase or decrease, 2003-2005.

Event or Exposure	Construction fatalities, 2003		Construction fatalities, 2004		Construction fatalities, 2005		3-yr Total		Net Change '03 to '05	Pct Change '03 to '05
Total Fatalities	***1131***		***1234***		***1192***		***3557***		***+ 61***	***+ 5.4%***
Fall to lower level	**(364)***	**354**	**(445)***	**437**	**(394)***	**384**	**1175**	**#1**	**+ 30**	**+ 8.5%**
Highway incident	**(290)***	**145**	**(287)***	**148**	**(318)***	**154**	**447**	**#2**	**+ 9**	**+ 6.2%**
Non-highway incident		**48**		**45**		**53**	**146**		**+ 5**	**+10.4%**
Worker struck by vehicle or equip		**84**		**78**		**97**	**259**	**#5**	**+ 13**	**+15.5%**
Struck-by object	**(231)***	**111**	**(267)***	**150**	**(244)***	**130**	**391**	**#3**	**+ 19**	**+17.1%**
Caught in, compressed by		**41**		**38**		**52**	**131**		**+ 11**	**+26.8%**
Trench/excavation cave-in		**44**		**39**		**39**	**122**		**- 5**	**- 11.4%**
Contact electric current	**(179)***	**132**	**(170)***	**122**	**(164)***	**107**	**361**	**#4**	**- 25**	**- 18.9%**

***Numbers in parentheses ( ) are totals for that event category; also shown in Table 1.**

The data for the years 2003, 2004, and 2005 provide support for some of those topics, but more importantly, the data highlight the need to direct research and intervention activities toward the transportation sector, specifically events involving highway incidents. The total number of highway incidents for the three years is second behind deaths from falling to a lower level. The BLS database also separates highway incidents into "workers being struck by a vehicle or a piece of equipment." However, a detailed review of the narratives is needed to determine how many of those 259 incidents (over the 3-year period) involved work associated with an active work zone or a construction site.

Table 3 presents the number and percent breakdown of nonfatal serious injuries for U.S. private industries and for the construction industry for the years 2003 through 2005. The nonfatal data were also retrieved from the BLS public website – www.bls.gov. However, for the nonfatal injuries, the Survey of Occupational Injury and Illness data sets (also know as the Annual Survey) are used. As opposed to a census, the Annual Survey is an estimate of injuries based on a very precise sampling of more than 180,000 workplaces (known as sampling units) throughout the U.S. For a nonfatal serious incident, BLS defines serious as an incident involving a day away from work beyond the day the incident occurred.

Table 4 lists 12 event categories. A natural break occurs with the top five nonfatal events (struck-by object, fall to lower level, overexertion from lifting, fall on same level, and struck against an object) having 3-year totals greater than 38,000 incidents and the other seven categories having 3-year totals less than 18,000 incidents. These data will help focus on the most serious injury events.

Table 3. U.S. & Construction Nonfatal Serious Injuries, 2003-2005

Event or Exposure	2003 Nonfatal Serious Injuries US Priv Industry/ Construction		2004, Nonfatal Serious Injuries US Priv Industry/ Construction		2005 Nonfatal Serious Injur's US Priv Industry/ Construct'n	
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
Totals	1,315,920 (100%)	155,420 (100%)	1,259,320 (100%)	153,200 (100)	1,234,680 (100%)	157,070 (100%)
Contact w/ obj & equipment	341,750 (26.0%)	54,230 (34.9%)	335,160 (26.6%)	51,830 (33.8%)	338,080 (27.4%)	55,590 (35.4%)
Str-by object	166,440	28,890	170,080	27,950	167,730	30,640
Str-against obj	91,440	13,570	83,330	12,720	85,500	12,600
Caught-in eq.	57,030	5,640	55,160	5,170	54,600	5,990
Fall, lower level	82,670 (6.3)	20,280 (13.0)	79,800 (6.3)	20,950 (13.7)	79,310 (6.4)	21,750 (13.8)
Fall, same level	174,570 (13.3)	14,050 (9.0)	167,010 (13.3)	12,700 (8.3)	167,180 (13.5)	12,360 (7.9)
Slip/trip w/o fall	41,870 (3.2)	4,720 (3.0)	37,500 (3.0)	4,490 (2.9)	36,150 (2.9)	4,900 (3.1)
Overexertion	339,140 (25.8)	30,390 (19.6)	316,670 (25.1)	30,460 (19.9)	298,130 (24.1)	28,520 (18.2)
Ovrex'n, lifting	5,060	17,470	173,400	16,860	159,970	15,720
Repetitive motion	57,420 (4.4)	2,670 (1.7)	48,710 (3.9)	3,240 (2.1)	43,790 (3.5)	2,490 (1.6)
Exposure to Harmful Mat'ls	55,780 (4.2)	5,660 (3.6)	52,830 (4.2)	5,220 (3.4)	51,860 (4.2)	5,520 (3.5)
Transportation	57,670 (4.4)	5,980 (3.8)	62,860 (5.0)	5,670 (3.7)	61,170 (5.0)	6,190 (3.9)
Fires & Explosions	2,330 (0.2)	310 (0.2)	2,420 (0.2)	470 (0.3)	2,600 (0.2)	380 (0.2)
Assault & Violence	16,560 (1.3)	110 (0.1)	17,670 (1.4)	240 (0.2)	14,560 (1.2)	180 (0.1)

Table 4. Comparison of construction-related nonfatal injuries for key "event" categories, with frequency and percent increase or decrease, 2003-2005

Event or Exposure	Construction 2003	Construction 2004	Construction 2005	Three-year Total	Net Change, '03 to '05	Pct. Change, '03 to '05
Struck-by object	28,890	27,950	30,640	87,480 *#1*	+1750	+6.1 %
Struck-against obj	13,570	12,720	12,600	38,890 *#5*	- 970	-7.1 %
Caught-in equip't	5,640	5,170	5,990	16,800	+350	+6.2 %
Fall, lower level	20,280	20,950	21,750	62,980 *#2*	+1470	+7.2 %
Fall, same level	14,050	12,700	12,360	39,110 *#4*	-1690	-12.0 %
Slip/trip, w/o fall	4,720	4,490	4,900	14,110	+180	+3.8 %
Overexertion, lifting	17,470	16,860	15,720	50,050 *#3*	-1750	-10.0 %
Repetitive motion	2,670	3,240	2,490	8,400	-180	-6.7 %
Exp harmful mat'l	5,660	5,220	5,520	16,400	-140	-2.5 %
Transportation	5,980	5,670	6,190	17,840	+210	+3.5 %
Fire & Explosions	310	470	380	1,160	+70	+22.6 %
Assault / Violence	110	240	180	530	+70	+63.6 %

TOPIC: HEALTH HAZARDS

Health hazards and resulting occupational illnesses are an important concern for construction. Meaningful national statistics are not available to describe the true numbers and incidence of occupational illnesses in construction workers, because longer term illnesses tend not to be recognized and reported[6]. National estimates suggest that the total burden from deaths due to occupational illness is likely to exceed that for deaths from occupational injury by a factor ranging from 4 to 11 [Steenland et al. 2003].

Awareness about health hazards is more likely to be lower than for injury hazard awareness among construction employers and employees. Some substances have few warning properties upon exposure. Some hazards such as lead paint or silica are "in place" in structures and surfaces undergoing construction and are not immediately recognizable to workers or contractors without testing or awareness training. In addition, most chronic occupational illnesses resulting from exposures have a delayed onset. Resulting illnesses are spread over time and over various worksites making it more difficult for employees and employers to make the link between exposure and illness.

Three health hazards were identified as important focus areas affecting large numbers of construction workers for the NORA Construction Research Agenda. These are: **Noise**, **Silica**, and **Welding fumes**. Research exists on all three but more is needed and efforts are also needed to convert existing information into practical tools and guidance for construction employers and groups. Short write-ups are provided for each focus area in the following sections.

A separate strategic goal is proposed for each of the three health hazards, but a common template is being proposed for each of the three goals:

- Raising awareness, since this is a prerequisite for interest in pursuing solutions;
- Applying approaches commonly used for preventing construction injuries to health hazards (e.g. use of training, competent persons, and pre-job planning);
- Targeting a unique health hazard issue - portability of employee health testing across employers – meaning that testing could be transferable from one employer to another in a way that preserves worker privacy.
- Increasing availability and use of engineering controls;
- Increasing the availability and use of model practices and programs.

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[6] The Bureau of Labor Statistics (BLS) states that:" *Some conditions (for example, long-term latent illnesses caused by exposure to carcinogens) often are difficult to relate to the workplace and are not adequately recognized and reported. These long-term latent illnesses are believed to be understated in the survey's illness measures.*" (BLS, Page 6, "Workplace Injuries and Illnesses in 2006" 10/16/07 http://stats.bls.gov/news.release/pdf/osh.pdf

In addition, the goals for silica and welding fume include goals to address gaps in hazard and exposure information that are relevant for construction.

The lack of national statistics for chronic occupational illnesses makes it more challenging to develop meaningful performance measures for health hazards. Thus a surveillance step is suggested to help develop a baseline for each of the three hazards. The baseline can utilize existing information and research about prevailing exposure levels and occupational illness incidence levels. This available information will be supplemented via survey research to gather information about relevant leading indicators – such as awareness of the hazards, availability and use of controls, and current use of model programs.

Experience from applying these approaches on these three hazards will provide insights into further development of a common approach that can be applied to other health hazards of concern in construction.

FOCUS AREA – NOISE AND HEARING LOSS

STRATEGIC GOAL 4.0 – Reduce hearing loss among construction workers by increased use of noise reduction solutions, practices, and hearing conservation programs by the construction community

Performance Measure – A performance measure cannot be set for this strategic goal until better baseline information can be obtained and analyzed. Intermediate goal 1 will address this need and is expected to support a performance measure such as "Increase use of noise reduction solutions, practices, and hearing conservation programs by the construction community by 33% over baseline in ten years."

Construction work involves extensive use of heavy equipment and power tools and harmful noise exposures are common. All construction workers are at some risk for exposure to harmful levels of noise and one study found that the probability of developing hearing loss after a lifetime of construction work averaged 60 % among all trades and up to 80 % in some trades [Dement et al. 2005]. Another study determined that hearing loss among construction trade workers was significantly elevated, as much as three and one-half times that of workers in other industries [Waitzman and Smith, 1998]. Hearing loss is important because it is preventable, irreversible, and even the best available hearing aids cannot restore the hearing loss in the higher decibel ranges that are caused by noise. Tinnitus--a persistent ringing in the ears—can also be a problem for noise exposed workers. Hearing loss is an impairment that interferes with every day communication with co-workers and family members. Extensive noise exposure can lead to earlier onset of hearing loss. In fact, by age 25, the average carpenter has been shown to have "50-year old ears", and by age 55, two out of three are past the point where hearing aids are typically needed [Sweeney et al. 2000].

Much is known about hearing loss. For example, the link between excessive noise and hearing loss is generally well understood. NIOSH-supported research has helped characterize noise sources for many construction tasks and trades. Researchers have systematically characterized field-based noise exposure data for various construction trades using task-based exposure assessment. Noise exposure profiles for many individual construction tasks have been collected and published. [Neitzel et al, 2001; Suter 2002] These include: cutting, jack-hammering, drilling, blasting, spraying, paving, chipping, earth moving, grinding, spraying, and pile driving among other tasks. Other noise exposure data have been collected during evaluations of residential construction [Methner 2000; Methner et al, 2000]. Given the important contribution made by powered hand tools to construction noise exposures, additional work has focused on characterizing sound power levels for common powered tools [Hayden et al, 2005]

Demonstration projects have examined issues related to worker training, hearing conservation, practical engineering noise controls, impulsive noise, and effective use of hearing protection. Model approaches that reduce noise sources and rely on training, hearing protection, and audiometric testing interventions to protect workers have been available and have been shown to be effective [Pell 1973]. In 2007, ANSI A10.46- 2007, titled: “Hearing Loss Prevention in Construction and Demolition Workers” was issued. It is a voluntary standard that aims to help employers develop a hearing conservation program in order to prevent hearing loss among construction workers. The standard identifies seven components of a hearing conservation program: 1) Identification of Hazardous Exposure; 2) Controlling the Hazard; 3) Hearing Protection Devices; 4) Audiometry; 5) Training; 6) Recordkeeping; and 7) Evaluation. There are no current regulatory requirements for construction employers to provide hearing conservation programs and they are reported to be relatively rare [Neitzel and Seixas, 2005]. No actual estimates of use of hearing tests or noise reduction efforts among construction employers are available. The primary construction strategy for noise has been provision of hearing protection devices (HPD’s) as opposed to noise reduction strategies. However, studies show that usage of HPDs among construction workers varies related to a variety of factors from inadequate awareness and training to concerns about effectiveness and barriers to use [Lusk, Kerr and Kaufman 1998, Neitzel and Seixas 2005]. The intermediate goals proposed for noise are intended to raise awareness, increase the use of noise reduction approaches, and to develop and disseminate tailored practices and programs for construction.

Intermediate Goal 4.1 - Use existing information supplemented by survey research to develop a baseline on current noise control and hearing loss practices in construction.

Performance Measure – Within 3 years, develop a noise control and hearing loss practice baseline using existing information and survey results.

Examples of information to be considered for the baseline include: available information on prevailing noise exposure data for construction tasks and trades, estimates of current hearing loss incidence in construction workers, and estimates of hearing protection device usage from existing studies. These can be supplemented by surveys with construction workers, apprenticeship training providers, contractors, owners and suppliers to collect information such as current noise awareness and use of precautions, current use of hearing conservation programs, current availability of quieter tools and audiometric testing options; and use of model programs by best practice employers. The survey can be repeated 5 and 9 years after the baseline effort to track changes in industry performance.

Intermediate Goal 4.2 – Increase awareness about noise hazards and solutions among construction workers, contractors, owners, and suppliers.

Performance Measure – Increase awareness of noise hazards and solutions among the target audience by 33% over baseline in 10 years.

In one construction study, noise levels from screw guns, hammer drills, routers and jigsaws were high enough that exposure without hearing protection for just 45 minutes would expose the carpenters to enough noise to exceed the recommended noise dose for an entire 8 hour day. However, the researchers reported that carpenters and trade representatives did not identify these tools as noisy or thought they were just borderline [Kerr, Brosseau and Johnson, 2002]. Perceptions of noise can be important in motivating workers and employers to take action to reduce noise or to use hearing protection. So increasing awareness is an important prerequisite for making progress to reduce hearing loss in construction workers.

<u>Research Goal 4.2.1</u> – Evaluate innovative training or other methods that could raise noise awareness and influence contractor and worker use of noise precautions and hearing protection.

Examples might include approaches such as: 1) providing audiometric testing for apprentices, 2) simulating future hearing loss for a day in apprentice training, 3) developing a training certification requirement for operation of tools louder than 100dbA, or 4) incorporating trade-specific top 10 noise sources into training, etc)

Research to Practice Goal 4.2.2 – Develop, evaluate, and disseminate awareness materials derived from existing studies on construction noise issues. Produce in various languages and in various media.

Examples might include materials describing noise levels associated with construction tasks and tools, health impacts of noise, effective construction solutions for reducing noise, and importance of hearing protection.

Research to Practice Goal 4.2.3 - Develop and promote the use of trade-specific noise and hearing loss course materials for apprentice training, competent person training, and 10 hour training elective training modules.

Intermediate Goal 4.3 – Increase the availability and adoption of quieter tools and equipment in the construction industry via research and implementation of a "Buy Quiet" campaign.

Performance Measure – Increase the availability and use of quieter construction tools and techniques by 33% over baseline in 10 years.

The replacement of construction tools and equipment as they reach the end of their service life represents an opportunity to reduce noise sources via purchase or rental of quieter models. For example, quieter compressors are now available. "Buy Quiet" initiatives have been used in Australia as an approach for construction noise [DOCEP, 2007] and the European Noise Emission of Outdoor Equipment Directive (2000/14/EC) calls for noise limits and labeling for more than 20 types of construction equipment. These initiatives address both occupational and environmental (e.g. public) noise issues. Expanding engineering knowledge on noise reduction, combined with practical methods for making it easier for contractors and workers to make buy quiet decisions, hold promise as an approach to reduce construction noise exposures.

Research Goal 4.3.1 – Develop a researcher/tool manufacturer partnership to improve engineering knowledge of noise reduction options for construction power tools and equipment -- leading to an increase in the number of commercially available tools and equipment with noise reduction features.

Research Goal 4.3.2 – Support research to develop methods to improve the measurement and understanding of impact noise in construction. Partner with field researchers and safety and health professionals to use these improved methods to further characterize impact noise in construction settings.

Research Goal 4.3.3 – Develop, evaluate, maintain, and promote methods to collect tool and equipment manufacturing data by quiet technology characteristics to facilitate "Buy Quiet" efforts by construction tool users.

Research to Practice Goal 4.3.4 – Analyze market barriers and opportunities and develop, evaluate, and publicize a “Buy Quiet” Construction Campaign using social marketing techniques to increase the availability and use of quieter construction tools and techniques.

Intermediate Goal 4.4 – Develop and promote the use of model programs and practices by construction owners, governmental groups, professional groups, and best practice employers.

Performance Measure – Increase the use of model hearing loss programs by best practice employers and organizations by 33% over baseline in 10 years.

Research on specific hearing loss program components is needed to effectively tailor existing practices to construction. These components need to be packaged together into programs, and the use of programs by best practice employers, professionals, and owners needs to be promoted.

Research Goal 4.4.1 – Audiometric testing program component - Develop, evaluate, and promote “portable” (that is, transferable from one employer to another) audiometric testing options that can be maintained for workers as part of a hearing conservation program across multiple employers.

Research Goal 4.4.2 – Pre-job planning component - Develop, evaluate, and promote a straightforward 3-5 step pre-job hazard review/plan that can be used by competent persons to estimate and plan for project -specific noise hazards.

Research Goal 4.4.3 – Hearing Protection component – Develop, evaluate and promote approaches to increase the use of hearing protection on construction sites and to address perceived obstacles to use.

Research Goal 4.4.4 – Policy driver component - Improve understanding of the economic and policy factors that support or discourage the use of model programs and practices for noise and hearing loss prevention in construction.

Examples of drivers might include uncertainty about business case factors, impacts from competitive bidding, increasing public concerns about community and residential noise, or similar factors.

Research to Practice Goal 4.4.5 – Develop guidance on model practices and programs based on research findings to target needs of key construction stakeholders.

Examples of key stakeholders might include small employers, apprenticeship training programs, owners, state consultation groups, governmental organizations, professional associations, and trade associations. Guidance could include development of business case studies for model noise reduction and hearing protection programs for small and medium sized construction employers.

Research to Practice Goal 4.4.6 – Partner with construction stakeholders and policy driving groups to promote the use of model programs by construction owners and best practice employers of all sizes throughout the industry.

FOCUS AREA – SILICA EXPOSURES AND ILLNESSES

STRATEGIC GOAL 5.0 – Reduce silica exposures and future silicosis risks among construction workers by increasing the availability and use of silica dust controls and practices for tasks associated with important exposures.

Performance Measure – A performance measure cannot be set for this strategic goal until better baseline information can be obtained and analyzed. Intermediate goal 1 will address this need and is expected to support a performance measure such as "Increase use of silica control solutions and exposure reduction practices by the construction community by 33% over baseline in ten years."

Silicosis is a debilitating and sometimes fatal lung disease resulting from breathing microscopic particles of crystalline silica. Respirable crystalline silica (RCS) exposure occurs in a wide variety of industries and occupations, including the construction industry and construction related occupations, and is associated with silicosis, lung cancer, and other diseases. In the construction sector the most common exposures involve the disruption of materials containing crystalline silica including:

- Chipping, hammering, and drilling of rock,
- Crushing, loading, hauling, and dumping of rock,
- Abrasive blasting using silica sand as the abrasive,
- Abrasive blasting of concrete regardless of the abrasive used,
- Sawing, hammering, drilling, grinding, and chipping of concrete or masonry,
- Demolition of concrete and masonry structures,
- Dry sweeping or pressurized air blowing of concrete, rock, or sand dust.

Studies of construction exposures have reported excessive exposures associated with certain tasks. For example, exposures ranging as high as 100 times in excess of the NIOSH Recommended exposure limit of .05 mg/m3 have been reported [Shields, 1999]. Surveillance systems currently capture approximately 200 silicosis-related deaths annually in U.S. workers with an unknown number going unreported or undiagnosed. Surveillance findings for the years 1985-1990 indicate that the construction industry was the industrial sector most frequently recorded on death certificates (10.8%) documenting deaths related to silicosis [NIOSH, 1994].

Existing research has examined health hazard and risk assessment issues associated with silica exposure and the exposure profiles associated with many construction tasks. Work on control measures has produced prototypes for controls using local exhaust ventilation and wet methods for reducing exposures. Methods for measuring silica levels have been improved. There are no current regulations or consensus standards to describe construction programs for controlling and managing silica exposures. The strategic goals proposed for silica are intended to raise awareness, increase the use of silica exposure reduction approaches, and to develop and disseminate tailored practices and programs for construction.

Intermediate Goal 5.1 - Use existing information supplemented by survey research to develop a baseline on current silica control practices and programs in construction.

Performance Measure – Within 3 years, develop a silica control and silicosis baseline using existing information and survey results.

Examples of information to be considered for the baseline include available information on current silica exposure levels, estimates of silicosis incidence in construction workers, and estimates of use of controls and respiratory protection from existing studies. This can be supplemented by surveys with construction workers, apprenticeship training providers, contractors, owners and suppliers to collect information such as silica hazard awareness and current use of practices and controls, current availability of guidance and control options, and use of model programs by best practice employers. The survey can be repeated 5 and 9 years after the baseline effort.

Intermediate Goal 5.2 – Increase awareness about silica hazards and known solutions among construction workers, contractors, owners, and suppliers

Performance Measure – Increase awareness of silica hazards and solutions among the target audience by 33% over 10 years.

Awareness is a key issue for silica because it is present in many common construction products and is easy to overlook. Dust created from disturbing silica containing materials is noticeable but is not highly irritating, and silicosis is a chronic disease that occurs years after exposure begins. Increased industry awareness is a prerequisite for broader use of control measures. An awareness campaign for silica was launched by OSHA, NIOSH, MSHA and others in 1997 but these materials and messages need to be updated.

<u>Research Goal 5.2.1</u> – Use communication science and best practices to test and update silica awareness materials. Develop materials in multiple languages and media to communicate exposure risks associated with the ten most common high exposure tasks.

<u>Research to Practice goal 5.2.2</u> – Partner with professional and construction organizations to inventory those common construction tasks where

exposures are already understood and where effective, inexpensive controls have already been identified. Develop worker and contractor-tested "how to" materials in multiple languages and media to facilitate implementation, and promote or standardize the use of those controls.

Research to Practice Goal 5.2.3 – Partner with construction training entities to develop and promote the use of trade-specific silica awareness and control course materials in multiple languages and media for apprentice training, competent person training, and 10 hour training elective modules.

Research to Practice goal 5.2.4 – Partner with state organizations, professional associations, and construction stakeholders to disseminate awareness and control information into construction practice.

Intermediate Goal 5.3 – Increase the availability of engineering and work practice options for reducing silica exposures

Performance Measure: Increase the availability of engineering and work practice guidance and tool options by 33% over baseline over 10 years

Research goal 5.3.1 – Develop a researcher/tool manufacturer partnership to develop and improve ventilation and wet method engineering control power tool designs for dust control and usability --- leading to an increase in the number of new and improved commercially available tools/ equipment/work practices available for reducing silica exposures

Research to Practice goal 5.3.2 - Explore innovative demonstration projects to partner with tool manufacturers, tool rental and suppliers, and other groups to increase the availability of silica control tools and supplies.

Intermediate Goal 5.4 – Develop model practices and programs and promote their use by construction owners, governmental groups, professional groups, and best practice employers.

Performance Measure – Increase the use of model silica dust control programs by best practice stakeholders by 33% over baseline in 10 years.

There is a need for research on certain program components to tailor approaches to maximize their fit for construction settings. Components need to be packaged together into programs, and the use of programs by best practice employers, professionals, and owners needs to be promoted.

Research Goal 5.4.1 – Portable health testing program component - Develop, evaluate, and promote "portable" (that is, transferable from one employer to another) options for respirator fit testing to include key information such as fit-certified respirator models, respirator training records, respirator medical evaluations, and silica related medical testing that can be maintained for workers as part of a health surveillance program across multiple employers.

Research Goal 5.4.2 – Field screening method component - Explore the feasibility of developing a silica exposure screening approach to provide a dust monitoring instrument and strategy that could be used by contractors and workers on dusty jobs.

> Examples of issues to consider might include a package approach that considers the following: 1) training to use the screening method (via competent person training), 2) the use of bulk and air testing, 3) the use of health protective assumptions to address uncertainty, 4) a trigger to let contractors know whether more sophisticated industrial hygiene measurements are needed.

Research Goal 5.4.3 –Silica exposure database component - Develop and promote the use of a silica exposure task database that can be used by safety and health professionals, contractors, and competent persons for pre-job exposure estimation and for planning the use of controls.

> Examples of information to consider include the need to establish minimum data quality standards for data to be submitted (e.g. need specific data for the task and tool sampled to accompany the measurement), and use of existing control banding concepts to categorize exposure levels into bands for development of control guidance.

Research Goal 5.4.4 – Pre-job planning component – Develop, evaluate, and promote a straightforward 3-5 step pre-job silica hazard review/plan that can be used by competent persons to estimate and plan for project –specific silica exposure hazards.

> This component can be linked to the use of the field screening method component and/or the silica exposure database component to provide contractor-friendly methods for identifying and planning controls for operations likely to result in worker silica exposures.

Research Goal 5.4.5 – Policy driver component - Improve understanding of the economic and policy factors that support or discourage the use of model programs and practices for silica control in construction.

> Examples of drivers might include uncertainty about business case factors, impacts from competitive bidding, the potential for certain owners and clients (such as schools or hospitals) to be more receptive to requesting low dust renovation practices.

Research to Practice Goal 5.4.6 – Develop demonstration projects to evaluate the effectiveness of program components and practices to address needs of key construction stakeholders. Incorporate results into guidance on model practices and programs.

Examples of key stakeholders might include small employers, apprenticeship training programs, owners, state consultation groups, governmental organizations, professional associations, and trade associations. Include development of business case studies for model silica practices for small and medium sized construction employers.

Research to Practice Goal 5.4.7 – Partner with construction stakeholders and groups to promote the use of model programs by construction owners and best practice employers of all sizes throughout the industry.

Intermediate Goal 5.5 – Evaluate hazard and exposure assessment research gaps associated with silica in construction

Performance Measure – Support at least 3 research projects to address hazard and exposure gaps and provide findings to construction researchers and stakeholders

Construction researchers and stakeholders need to support basic research to fill information gaps that are highly relevant for construction. The NIOSH Construction Program can assist the NORA sector in coordinating efforts with other NIOSH research programs that focus on these types of cross-cutting studies.

Research Goal 5.5.1 – Reactive species hazard component - Support research to improve understanding of health effects and field exposures associated with mixed exposures to silica particulates co-generated with metal exposures

Existing lab studies [Castronova et al, 1997] suggest that certain construction operations (e.g. abrasive blasting, certain sawing operations) generate metal exposures in addition to silica, and that the resulting reactive species may be more toxic than either the silica or metal alone. There are a number of alternative abrasive blasting agents but studies are needed to clarify the toxic properties associated with these substitutes.

Research Goal 5.5.2 – Exposure assessment component – Support research to improve sampling methods to support the ability to reliably and accurately measure respirable crystalline silica levels at concentrations below the current NIOSH REL of 0.05 mg/m3.

Basic research to improve current sampling methods is needed given limitations in current methods.

FOCUS AREA – WELDING FUMES AND ASSOCIATED ILLNESSES

STRATEGIC GOAL 6.0 – Reduce welding fume exposures and future related health risks among construction workers by increasing the availability and use of welding fume controls and practices for welding tasks

Performance Measure – A performance measure cannot be set for this strategic goal until better baseline information can be obtained and analyzed. Intermediate goal 1 will address this need and is expected to support a performance measure such as "Increase use of welding fume exposure reduction solutions and practices by the construction community by 33% over baseline in ten years".

Welding is performed by a variety of construction trades such as pipefitters, sheet metal workers, ironworkers, and boilermakers. Welding presents a complex exposure picture. The process creates noise, heat, ultraviolet radiation, gases, electromagnetic radiation, and fumes. The type and amount of contaminants generated vary based on factors such as the type of welding being performed, the base metal being worked on, the presence of any coatings, and the work setting conditions. Metal fume characteristics (e.g., particle size distribution, distribution of metals, fume surface area) will also vary depending on a number of factors. No current estimates are available on the number of construction workers who perform welding or the most common welding methods used in construction welding.

Health effect studies on welders have reported respiratory and other organ system effects including elevated cancer risk. Epidemiology studies have shown that a large number of welders experience some type of respiratory illness. Key health effects seen in full-time welders include airway irritation, bronchitis, chemical pneumonitis, lung function changes, asthma, and a possible increase in the incidence of lung cancer [NIOSH 2003]. Pulmonary susceptibility to infections is also increased in welders [Antonini 2003]. In addition, adverse skin reactions and potential reductions in neurological function have been reported. The International Agency for Research on Cancer (IARC) reviewed the health effects literature for welding in 1990 and found that welding fumes are "possibly carcinogenic."

Concerns about welding health effects have increased among construction employers and workers based on increasing awareness about two important welding-related contaminants: Chromium (CrVI) and manganese. Cr(VI) is primarily a concern when welding on stainless steel but may also be present in small amounts in mild steel. It has been associated with lung cancer and occupational asthma and was recently regulated by OSHA. The OSHA health standard lowered the Permissible Exposure Limit (PEL) for Cr(VI) to 5 ug/m^3 and requires training, exposure monitoring, and other protective measures.

Manganese is found in steels, filler metals and electrodes and has been associated in some studies with neurological conditions similar to Parkinson's disease.

In comparison with the other two focus areas, welding is somewhat more complex. The variety of welding methods means that exposures can vary more and this adds to the need for studies to understand health effects and for studies to characterize exposure potential. The strategic goals proposed for welding fume hazards are intended to raise awareness, fill hazard and exposure gaps, increase the use of silica exposure reduction approaches, and to develop and disseminate tailored practices and programs for construction.

Intermediate Goal 6.1 - Use existing information supplemented by survey research to develop a baseline on current welding control practices and programs in construction.

Performance Measure – Within 3 years, develop a welding control and welding health effects baseline using existing information and survey results.

Examples of information to be considered for the baseline include available information on current welding exposure levels, estimates of incidence of welding related occupational illnesses in construction workers, and estimates of use of controls and respiratory protection from existing studies. This can be supplemented by surveys with construction workers, apprenticeship training providers, contractors, owners and suppliers to collect information such as welding hazard awareness and current use of practices and controls, current availability of guidance and control options, and use of model programs by best practice employers. The survey can be repeated 5 and 9 years after the baseline effort.

Intermediate Goal 6.2 – Increase awareness about welding fume hazards and known solutions among construction workers, contractors, owners, and suppliers

Performance Measure – Increase awareness of welding fume hazards and solutions among the target audience by 33% over 10 years.

Awareness is a key issue for welding hazards because it is a prerequisite for use of control measures. Awareness is complicated by the range of methods, base metals, and exposures possible from the various methods.

Research Goal 6.2.1 - Use communication science and best practices to develop welding fume hazard awareness materials. Develop materials in multiple languages and media to communicate exposure risks and availability of controls associated with welding fume.

Research to Practice goal 6.2.2 – Evaluate innovative training or other methods that could raise awareness and influence contractor and worker use of local exhaust ventilation (LEV) and related welding fume precautions.

Examples might include approaches such as: 1) video feedback on positioning of Local Exhaust Ventilation (LEV) by welders, 2) including health and safety skill tests in welder certification, or 3) incorporating trade-specific top 10 welding emission lists, etc).

Research to Practice Goal 6.2.3 – Partner with construction training entities to develop and promote the use of trade-specific welding fume awareness and control course materials in multiple languages and media for apprentice training, competent person training, and 10 hour training elective modules.

Research to Practice goal 6.2.4 – Partner with state organizations, professional associations, welding associations and construction stakeholders to disseminate awareness and control information into construction practice.

Intermediate Goal 6.3 – Increase the availability of engineering and work practice options for reducing welding exposures.

Performance Measure: Increase the availability of engineering and work practice guidance and control options by 33% over baseline over 10 years.

Research goal 6.3.1 – Develop a researcher/welding equipment manufacturer partnership to develop and improve local exhaust ventilation and other control designs that reduce exposures and maximize usability -- leading to an increase in the number of new and improved commercially available tools/equipment/work practices available for reducing welding exposures.

Research to Practice goal 6.3.2 - Explore innovative demonstration projects to partner with equipment manufacturers and suppliers and tool rental firms and other groups to increase the availability and use of welding fume control tools and supplies.

Intermediate Goal 6.4 – Develop model practices and programs and promote their use by construction owners, governmental groups, professional groups, and best practice employers.

Performance Measure – Increase the use of model welding fume control/ protection practices and programs by best practice stakeholders by 33% over baseline in 10 years.

Research Goal 6.4.1 – Portable health testing program component - Develop, evaluate, and promote "portable" (that is, transferable from one employer to another) options for respirator fit testing to include key information such as fit-certified respirator models, respirator training records, respirator medical evaluations, and welding fume related medical testing that can be maintained for workers as part of a health surveillance program across multiple employers. Develop and disseminate guidance on suitable welding medical surveillance approaches.

Research Goal 6.4.2 – Emission factor and field screening component - Evaluate the feasibility and use of 1) welding "emission factor" data and 2) available direct reading field instruments, for use in a construction-user friendly system to provide pre-job exposure estimates for safe job planning.

Examples of issues to consider might include a package approach that considers the following: 1) training to use the screening method and emission factor data (via competent person training), 2) the use of information on expected arc time, consumption of welding materials, and degree of air circulation, 3) the use of health protective assumptions to address uncertainty, 4) a trigger to let contractors know whether more sophisticated industrial hygiene measurements are needed.

Research Goal 6.4.3 – Welding fume exposure database component - Develop and promote the use of a welding fume exposure task database that can be used by safety and health professionals, contractors and competent persons for pre-job exposure estimation and for planning the use of controls.

Examples of information to consider include the need to establish minimum data quality standards for data to be submitted and use of existing control banding concepts to categorize exposure levels into bands for development of control guidance.

Research Goal 6.4.4 – Pre-job planning component – Develop, evaluate, and promote a straightforward 3-5 step pre-job welding fume hazard review/plan that can be used by competent persons to estimate and plan for project-specific welding exposure hazards.

This component can be linked to the use of the field screening method component and/or the welding fume exposure database component to provide contractor-friendly methods for identifying and planning controls for operations likely to result in worker welding exposures.

Research Goal 6.4.5 – Policy driver component - Improve understanding of the economic and policy factors that support or discourage the use of model programs and practices for welding fume control in construction.

Examples of drivers might include uncertainty about business case factors, impacts from competitive bidding, usability of local exhaust controls, predicted shortages of sufficient skilled welders, and similar factors.

Research to Practice Goal 6.4.6 – Develop demonstration projects to evaluate the effectiveness of program components and practices in addressing needs of key construction stakeholders. Incorporate results into guidance on model practices and programs.

Examples of key stakeholders might include small employers, apprenticeship training programs, owners, state consultation groups, governmental organizations, professional associations, and trade associations. Include development of business case studies for model welding practices for small and medium sized construction employers.

Research to Practice Goal 6.4.7 – Partner with construction stakeholders and groups to promote the use of model programs and practices by construction owners and best practice employers of all sizes throughout the industry.

Intermediate Goal 6.5 – Evaluate hazard and exposure assessment research gaps associated with welding fume in construction

Performance Measure – Support at least 3 research projects to address hazard and exposure gaps and provide findings to construction researchers and stakeholders

Construction researchers and stakeholders need to support basic research to fill information gaps that are highly relevant for construction. The NIOSH Construction Program can assist the NORA sector in coordinating efforts with other NIOSH research programs that focus on these types of cross-cutting studies.

Research Goal 6.5.1 – Health hazard testing component - Support research to improve understanding of health effects and field exposures to welding fumes – both for special contaminants of concern and for contaminant mixtures associated with the ten most common types of welding combinations.

Basic research is needed on the health effects associated with the mixed exposures resulting from welding operations.

Research Goal 6.5.2 – Exposure characterization component - Inventory existing welding fume exposure characterization data to identify data gaps where additional exposure data are needed and fill these data gaps.

Given the many welding combinations possible given the different methods and base metals, there are some welding operations where exposure data is lacking.

Research Goal 6.5.3 – Exposure assessment component – Support research to improve capability, reliability and accuracy of welding fume sampling methods on construction sites. Currently separate samples must be collected for different metals (Cr+6) and samplers are large and bulky for construction site use.

Welding exposures involve mixtures and current methods are limited in their ability to identify different components. Basic research on methods can improve the tools available for exposure assessment.

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TOPIC: MUSCULOSKELETAL DISORDERS

STRATEGIC GOAL 7.0 - Reduce the incidence and severity of work-related musculoskeletal disorders among construction workers in the U.S.

Performance measure: Increase the number of effective interventions (i.e., technologies and 'best practices') to reduce construction workers' exposures to WMSD risk factors and develop effective methods to improve and expand intervention adoption and diffusion in the construction industry

Introduction

Work-related musculoskeletal disorders (WMSD) are injuries or illnesses of the muscles, tendons, joints, and nerves caused or aggravated by work. Examples of WMSDs are: inflamed tendons or joints, elbow muscle and tissue inflammation (tennis or golfer's elbow), herniated disc, rotator cuff syndrome, carpal tunnel syndrome (CTS), and back or neck strain. Workers in all construction sectors and occupations are exposed to multiple physical risk factors associated with WMSDs, such as high physical exertions (e.g., manual material handling), prolonged static physical exertions (e.g., working with arms/shoulders raised or working in kneeling position), repetitive physical exertions (e.g., use of manual and power tools), awkward working postures (e.g., stooping to work at floor level, working inside confined spaces such as duct work and crawl spaces), working in cold conditions, and whole-body or segmental vibration (e.g. tool vibration and mounted equipment vibration). (NIOSH 1997; NRC/IOM 2001)

WMSD incidence and prevalence rates are widely believed to be underreported in the national U.S. injury and illness statistics (Lipscomb et al 1997; NRC/IOM, 2001; Schneider, 2001; Morse et al, 2005; Fan et al, 2006). Despite underreporting, WMSDs are recognized as a major problem by many industry stakeholders, because they result in significant hardship for workers and increased costs for contractors and building owners. The U.S. Bureau of Labor Statistics (BLS) uses a probability sample of contractors' reports of injuries and illnesses to estimate the incidence of WMSDs and other injuries and illnesses. In 2005, the BLS estimated 35,900 construction workers developed a WMSD. According to the BLS, 42% of the construction workers with WMSDs were laborers and carpenters. The median number of days away from work (DAW) for a WMSD was 10 days (BLS 2006).

Data indicate that WMSD costs are disproportionate to their occurrence (Hashemi et al, 1998). CNA Insurance reported that WMSDs accounted for 29% of workers' compensation claims and 36% of claims dollars during 1999-2001. Electricians' WMSD claims during the same period also showed a disproportionate claim-to-cost ratio. (Albers et al, 2006).

These problems are expected to increase in the near future. As the construction workforce ages, many of the physical demands associated with construction tasks, such as manual material handling and sustained overhead work, may be incompatible with the physical capabilities of older workers (de Zwart et al 1996; NRC 2004; NCCI 2005).

For the NORA Construction Agenda, three general areas were identified for development of goals. These are: 1) improving information and tools for evaluating risk factors; 2) expanding available interventions; and 3) diffusing information on solutions to promote wider adoption in the construction industry.

Intermediate Goal 7.1 - Develop and evaluate practical field exposure assessment methods for use by contractors to prioritize the effectiveness of workplace interventions.

Performance Measure: Within 3 years, identify and prioritize the risk factors leading to WMSDs in Construction, including their interrelationships.

There is a need to expand current knowledge regarding the association between construction workers' exposures to WMSD risk factors and the development of WMSDs, particularly for less understood disorders including vibration related disorders of the extremities. Risk factors are not well understood with regard to the dose response relationship of WMSDs. There is a plausible mechanism for correlating musculoskeletal disorders and the physical exposure to work conditions. The influence of psychosocial factors on the development, and progression of WMSDs also need to be investigated. Individual vulnerability assessments may be considered for typical at risk conditions but will not be considered as a critical goal of this measure due to the complexity of the issue. The assessment method should use information collected as part of Intermediate Goal 7.2 to focus this measure.

<u>Research goal 7.1.1</u> – Conduct review of current in use and proposed field assessment methods used to identify WMSDs in the workplace including non-construction activities.

This may include current and proposed state plan tools, EU and Canadian assessment tools, and select contractor and union developed programs. These tools will be classified for applicability to construction activities and the components of the assessments will be tallied and compared to applicable and expected WMSD risk factors.

<u>Research goal 7.1.2</u> - Evaluate the tallied assessment components and determine if measurable goals or metrics would be able to determine effectiveness of a workplace intervention for reducing WMSDs using the assessment components.

Metrics should consider the measure of true occurrence, severity and costs of WMSDs and goals may consider psychological and psychosocial objectives and worker perception finding developed in Performance measure 1.1b.

Research to Practice goal 7.1.3 – Disseminate information regarding risk factors to stakeholders.

Intermediate goal 7.2: Conduct studies, including short-term prospective studies, to characterize the effects of work activities on the musculoskeletal systems among workers in different trades and construction divisions and help identify high-risk activities/trades.

Performance Measure: Develop one practical field assessment method for effectively and simply identifying high risk tasks in construction within 5 years and widely disseminate it and encourage its use by contractors.

Construction work is highly variable in type of activities performed, duration of task, length of work day, and tools and equipment used by different trades. In many cases environmental factors such as weather, co-exposure to job hazards not associated with task being performed, and scheduling and management pressures for job completion all impact the risk of WMSD. There are a number of possible variables both independent and co-dependent that can impact the occurrence and severity of a WMSD. While case controlled studies are not very feasible in construction, prospective cross sectional analysis can be used to correlate identified risk factors to either reported (as compensable work injuries) or self reported as pain or discomfort level. Initial studies should be short duration in order to permit identification of significant and null factors related to specific tasks associated with type of construction activities, trade skills, and tool/equipment use.

Research goal 7.2.1 – Develop a field assessment tool that allows collection of a construction-specific risk factor assessment along with additional job condition information that could impact the potential risk of WMSDs. The tool should consider physical conditions as well as psychosocial conditions of the workplace. A beta test of the tool will be conducted with at least one each of a small, medium, and large contractor both union and merit shop.

Research goal 7.2.2 - Evaluate assessment tool considering contractors work force size as small, medium, and large. (numbers TBD by NORA Construction Committee). Selected sites will have conducted Job Hazard Analysis of at risk tasks and identified specific WMSD corrective actions to be applied to the tasks. Cross sectional analysis should include multiple trades on a single job site. Assessment should be conducted at job start, and quarterly over task duration. Work conditions will be captured on assessment tool data set for correlation to progress towards goals through parametric analysis.

Research to Practice goal 7.2.3 – Develop and disseminate model assessment tools to stakeholders.

Intermediate goal 7.3 – Expand the availability of effective interventions to prevent WMSDs in Construction.

Performance Measure: Within 3 years identify, catalogue and evaluate existing interventions and identify gaps (high risk tasks where no effective interventions currently exist). Within 7 years develop and evaluate effective interventions for high risk tasks which currently do not have effective interventions. Within 10 years, disseminate and make widely available information about these interventions.

There is a need to identify, develop and evaluate interventions (i.e., tools, equipment and programmatic interventions, such as MSD injury prevention plans; participatory intervention programs, worker training, design processes, site planning/scheduling/coordination; and owner requirements for MSD injury prevention plans) for reducing workers' risk of WMSDs.

Factors that contribute to WMSDs extend beyond the specific etiologic risk factors (awkward postures, forceful exertion, vibration, etc.) to include the organizational and project delivery systems that influence/determine the work environments that construction workers encounter while preparing to accomplish their tasks. Examples of these factors are: design processes (communicated through construction drawings and specifications), project schedule development, site logistics (including material lay down areas and paths for material flow), project communications, contractual expectations by owners and general contractors, availability and appropriateness of equipment and tools for tasks. Targeted interventions to address systems which influence/determine the work environment should be implemented and evaluated as well as more narrow interventions focused on specific tools, work methods or worker training.

Research goal 7.3.1 – Evaluate interventions that are currently available to reduce or eliminate task-based physical exposures to WMSDs. A wide range of interventions (from tool interventions to programmatic ones) should be evaluated each year.

Research goal 7.3.2 - Develop and evaluate (in collaboration with industry stakeholders) interventions for high risk tasks for which no existing interventions exist.

Research goal 7.3.3 – Evaluate physical and psychosocial risk factors associated with work organization and project delivery and propose strategies to modify or replace these systems.

Research goal 7.3.4– Develop and evaluate the use of construction sector appropriate "Model MSD Programs" by insurance companies, best practice employers, and professional groups

Research to Practice goal 7.3.5 – Develop and disseminate information regarding interventions (i.e., best practices) to stakeholders.

Intermediate Goal 7.4 – Improve the acceptance, diffusion, and adoption of MSD interventions and solutions by contractors, owners, and workers.

Performance Measure: Within 3 years, identify barriers to dissemination and adoption of these interventions. Within 5 years, develop implementation plans to address these barriers and pilot test with 3 interventions. Within 7 years, develop an industry-wide dissemination and diffusion plan to encourage adoption of effective interventions. Within 10 years implement this diffusion plan and increase adoption of interventions such that every construction site has implemented at least one intervention to reduce the risk of WMSDs.

There are many interventions available to reduce WMSD in construction yet many are not widely disseminated or adopted. Figuring out why this is the case will help improve dissemination and reduce the risk of injuries. A three part strategy is suggested: 1) look at adopted interventions and see what influenced adoption, 2) perform pilot dissemination projects for a small number of interventions, and 3) then use those results to implement a much larger dissemination strategy for many more interventions.

Research goal 7.4.1 – Evaluate previously implemented contractor/owner/worker work method or work practice innovations to determine factors that facilitated or inhibited acceptability of innovations.

Research goal 7.4.2 - Conduct pilot studies that will develop and implement dissemination strategies for interventions to evaluate the factors that facilitate and inhibit intervention adoption and diffusion among contractors, owners or workers.

Research to Practice goal 7.4.3 – Disseminate model intervention adoption and diffusion programs (i.e., strategies and tactics) and evaluate their use by stakeholders and affect on stakeholders.

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SECTION 2 – CONTRIBUTING FACTOR GOALS

The seven goals in this section may or may not directly address a specific outcome such as fatalities from falls. However, they represent important influences that affect the likelihood that prevention and control measures and actions are taken on a construction job. Contributing factors cut across all types of outcomes, and provide an alternative perspective on how to improve safety and health conditions. These topics are relevant because they are linked to the likelihood that outcome-related goal measures are implemented and sustained. It is this combination of attention to outcomes and contributing factors that is viewed as most likely to result in reductions in injury rates and improvements in workplace conditions.

TOPIC: CONSTRUCTION SAFETY AND HEALTH CULTURE

STRATEGIC GOAL 8.0 - Increase understanding of factors that comprise both positive and negative construction safety and health cultures; and, expand the availability and use of effective interventions to maintain safe work practices 100% of the time in the construction industry.

Performance Measure: This goal will be successfully achieved if by 2016, NIOSH, its stakeholders, and the construction industry as a whole increases its recognition and understanding of the complexity of safety and health culture and strives to use successful measurement and intervention tools to create a positive culture at the worksite.

Background

"Safety Culture" is recognized as an important contributing factor for safety and health performance that has attracted much attention across a broad spectrum of industries [Choudry et al, 2006]. It is increasingly mentioned in relation to the intrinsic culture of an employer or organization, or the culture of an occupation or trade, or some other group of interest. Safety and health culture is an important concept for construction. It can be a positive factor, such as a culture that reinforces and supports safety considerations at all levels of an organization. Alternatively, it can be a negative factor, such as a culture that tolerates safety hazards and injuries as just an inevitable part of construction.

There is no recognized definition of culture used for construction safety and health considerations. Discussions about construction safety and health culture among stakeholders can involve differing concepts about what it should mean. Some view culture as a construction safety and health management issue, and others suggest that not enough is known about measuring or changing culture for it to be reliably managed. There are few known studies focusing on construction culture. There is no apparent consensus on how to describe the culture of an organization. A review of general studies on safety culture and safety climate reported 18 definitions [Guldenmund 2000].

For the purposes of this draft report, a preliminary description of construction safety and health culture may be summarized as the attitudes, values, priorities, and behaviors of management and employees and understanding its impact on the development, implementation, performance, oversight, and enforcement of safety and health in the workplace. Construction safety and health culture arises from social and psychological relations in the workplace. It encompasses a variety of elements such as management commitment to safety and health, and management's visibility and support of that culture, how management communicates to workers about safety and health, whether there is support for safety and health on the jobsite or the belief that an accident "will not happen to me," and whether a function exists that has management and employee accountability and that management and employees are empowered to correct problems and effect change.

The common presence of safety and health hazards in construction and the large number of injuries each year can, in part, be attributed to the atmosphere on many construction sites that does not encourage people to speak up about hazards or correct them; and, in many cases, discourages them or terminates them for doing so. This atmosphere can be changed to positively impact safety and health in construction, but to do so it must first be operationally defined, measured, and successful interventions identified and diffused.

The proposed intermediate goals are intended to provide a common framework for construction safety and health culture that will improve understanding of what it means, how to measure it, and how to reliably develop it on construction worksites.

Intermediate Goal 8.1- Develop an understanding of factors that contribute to a positive or negative safety and health culture in the construction industry and a working definition and framework.

Performance Measure: Within 4 years, identify, evaluate, and inventory research into factors creating positive or negative construction cultures.

The social and cultural work environment in construction is diverse, ever-changing, complicated, and multi-faceted in its design criteria, workforce, and management styles. There is a need to understand the factors that can contribute to positive or negative culture as an initial step.

Research Goal 8.1.1 - Identify and evaluate factors affecting construction safety and health cultures across differing sites accounting for dynamics such as, but not limited to:

- Inherent construction attributes such as productivity pressure (“time is money”) and low bid practice
- Management involvement in safety
- Employee involvement in safety
- Size of the project/site
- Complexity of the project;
- Union or non-union jobsite
- Residential or non-residential structure
- Highway work
- Prime contractor or subcontractor
- Differences between trades
- Educational levels
- Ethnic and cultural values of a diverse multinational workforce
- Geographical area
- Shift work
- Night work
- Construction management vs. Direct hire
- Owners involvement

Research Goal 8.1.2 - Evaluate how safety and health cultures influence construction industry subgroups such as:

- New workers
- Young/Older workers
- Apprentices
- Female workers
- Immigrant workers

Research Goal 8.1.3 **-** Conduct interviews of some companies identified in the literature review that exhibit a strong safety and health culture to determine what works for them.

Research Goal 8.1.4 - Forge new partnerships with construction unions, small and large employers, trade associations, and others to evaluate factors and subgroups identified in RG 8.1.1 and 8.1.2.

Research Goal 8.1.5 - Conduct research on the impact of risk communication on safety and health culture.

Research Goal 8.1.6 - Investigate the monetary relationship (e.g. business case) between positive and negative construction health and safety cultures.

Research to Practice Goal 8.1.7 - Create a repository of existing and new research on factors influencing positive and negative safety cultures in construction.

Research to Practice Goal 8.1.8 - Disseminate results of this research to the construction industry through publications to stakeholders, labor unions, and industry associations so contractors can improve their safety and health culture.

Intermediate Goal 8.2 - Develop a set of validated measurement methods of safety culture in the construction industry.

Performance Measure: Within 7 years, using information gathered on factors contributing to positive or negative construction cultures, develop and inventory construction culture measurement methods.

There is a need to develop effective construction-relevant methods to assess safety culture. Resulting research results can be transformed into products for use by construction stakeholders to reliably measure safety culture.

Research Goal 8.2.1 - Survey and inventory the existing literature to determine the available methods that measure safety culture.

Research Goal 8.2.2 - Evaluate the existing measurement methods to determine the key conceptual elements of the existing measures; identify similarities between methods and conceptual gaps in the existing measures.

Research Goal 8.2.3 -Develop a baseline metric against with which progress can be measured.

Research Goal 8.2.4 - Develop a multi-method set of cross-validated measures of construction safety and health culture; including simple methods contractors can use in the field to determine the impact of their company culture on safety and health.

Research Goal 8.2.5 - Validate measurement methods that consistently identify the positive and negative aspects of construction safety and health culture.

Research Goal 8.2.6 **-** Use partnerships established in RG 8.1.4 to validate and utilize existing and newly developed construction culture measurement methods.

Research to Practice Goal 8.2.7- Create a repository of existing and newly developed measurement methods for positive and negative safety cultures in construction.

Research to Practice Goal 8.2.8 - Disseminate construction culture measurement methods through various publications to construction industry associations, labor unions, and government entities.

Intermediate Goal 8.3 - Develop effective intervention measures that result in an improved safety and health culture in the construction industry.

Performance Measure: By 2016, in coordination with IG 8.1 and 8.2, develop and implement three interventions designed to improve construction culture.

There is a need for interventions that can be used to reliably improve construction culture. This will position culture to be more effectively managed to improve safety and health outcomes.

Research Goal 8.3.1 - Identify and validate interventions that are effective in improving construction safety and health cultures.

Research Goal 8.3.2: Determine best available avenues to transfer and diffuse effective health and safety culture interventions in the construction industry.

Research Goal 8.3.3: Use partnerships established in RG 8.1.4 to validate and utilize interventions identified in RG 8.3.1.

Research Goal 8.3.4: Identify and validate an attainable goal for improvement of construction safety and health culture from the baseline established in IG8.2, RG 8.2.3 - e.g. 20% improvement.

Research to Practice Goal 8.3.5: Provide this information to the construction industry through presentations at conferences and seminars.

Research to Practice Goal 8.3.6: Produce pamphlets and brochures to distribute to the construction industry stakeholders.

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TOPIC: CONSTRUCTION SAFETY AND HEALTH MANAGEMENT

STRATEGIC GOAL 9.0 - Improve the effectiveness of safety and health management programs in construction and increase their use in the industry.

Performance Measure – Form partnerships with successful companies, unions, and associations to learn which management practices promote job safety and health. Then build products (training and promotion materials in a variety of media), hold conferences, and reach 25% of the construction industry with these messages by 2012**.**

Management is fundamental to the effective operation of an organization or enterprise. Management typically includes the people responsible for defining the direction of a business or organization; policies, procedures, and practices to guide direction; and networks and systems to enable and support implementation of the procedures and practices. Management practices can have a profound impact on the job safety and health of employees, and management of safety and health has developed into a specific component of an overall management program. Safety and health program management criteria have been described by many sources, such as the general OSHA Safety and Health Program Management Guidelines [OSHA, 1989] and Voluntary Protection Program (VPP) Guidelines [OSHA, 2000], and six states have safety and heath program requirements. Construction-specific guidelines include examples such as the American National Standards Institute Safety and Health Program Requirements for Demolition Operations (ANSI A10.6-2006); and the ANSI Construction and Demolition Standard for Safety and Health Program Requirements for Multi-Employer Projects (ANSI A10.33- 2004). Programs have further evolved into management "systems", such as the International Labor Organization 2001 Occupational Safety and Health Management Systems Guidelines; the ANSI Occupational Health and Safety Management Systems Standard Z10-2005; and the 2007 Occupational Safety and Health Assessment Series 18001 and 18002 Guidelines.

Safety and health management programs typically include four basic components: 1) management leadership and employee involvement; 2) work-site analysis; 3) hazard prevention and control; and 4) safety and health training [Garner, 2004]. Construction programs and systems must address industry attributes such as: managing multiple work locations, managing relationships with other construction firms and subcontractors, planning for and managing intermittent and continuously changing hazards, and managing inherently high risk tasks and various weather related conditions. These are addressed by defining and implementing new organizational structures appropriate to each site or project via job safety analyses, planning, and specific program elements and procedures. Examples of such elements include: pre-project planning, hazard anticipation and identification, selection of work methods, tools, and control options, and deployment of competent persons including safety and health personnel.

It is valuable to understand the effectiveness of the various program elements or combinations of elements for reducing injury and illness rates. It is also important to examine how existing programs are adapting over time to address emerging construction issues. While preventing injury is a longstanding construction concern that represents a substantial focus of most construction safety and health management programs, there appears to be less experience managing and preventing musculoskeletal disorders or health effects such as hearing loss. Other safety and health management challenges include the increasingly multilingual nature of construction sites, increasingly complicated matrices of subcontractors, vendors and pre-fabricators, and increasing demands to manage information over the structure lifetime from design to demolition. There is a need to develop and evaluate the effectiveness of program elements and management system approaches that address these topics.

Another critical area for construction is small employers. Construction employers under 10 employees constitute approximately one quarter of the construction workforce, but suffer nearly half of the fatal injuries. Are management programs and systems guidelines developed for larger employers relevant? What activities, such as daily short-interval safety planning, are most important for reducing injuries in small employers, and what business case information or model contract language is available to help encourage them to adopt relevant aspects of safety and health management systems?

Lastly, construction employer programs do not function in isolation. Construction is a multi-employer activity and “managing” relationships with owners, architects, other contractors, and subcontractors and their programs is also an important topic for consideration. However, these topics are currently addressed by the very next NORA Construction Sector Goal – *Construction Industry and Work Organization*, and so will not be the focus for this section. Please let us know if you believe that this issue is better addressed by including it instead within this goal or whether some overlap is appropriate given the importance of the issue.

The purpose of this strategic goal is to promote research and stakeholder activities that increase our understanding of how safety and health management practices can influence safety and health performance. Given the importance and broad scope of safety and health management, it overlaps many of the other NORA Construction topics (e.g. training, construction culture, construction industry organization, design).

Intermediate Goal 9.1 – Develop a baseline to describe and understand the current use of safety and health management programs in construction

Performance Measure: Within 1 year, establish a frame of target construction firms that will share information on safety and health management practices. By 3 years, gather data through surveys, focus groups describing the distribution and characteristics of such programs in construction. Within 4 years develop a white paper characterizing the state of safety and health management programs in the construction industry and any gaps that exist.

Research Goal 9.1.1 Determine the extent to which construction firms currently use safety and health management programs and systems in the U.S. (and to the extent possible in Canada and the European Union).

Research Goal 9.1.2 Characterize the extent to which safety and health management programs extend down – what is the lowest working group accountability for program implementation and what are the program elements at this level?

Research Goal 9.1.3 Characterize the variation in current construction safety and health management program elements. What content or elements are viewed as most critical to effective OSH management systems in construction? What resources are available? Where is the accountability for the program in the organization? How do program elements vary by employment size?

For example, how often do existing programs address only required regulatory elements, and how often to they go beyond this with additional elements or higher performance standards? What is the extent of management involvement?

Research Goal 9.1.4 Characterize the drivers that affect construction firms to either establish and support, or to decline to establish, safety and health programs/ management systems.

Intermediate Goal 9.2 - Improve understanding of the effectiveness of best practice construction safety and health management programs and program elements

Performance Measure: Within 5 years identify the key elements of successful safety and health management programs in construction and characterize the impact of these programs on businesses.

Research Goal 9.2.1 Evaluate best practice programs and their effectiveness as used by small, and large construction firms in targeted construction sub-sectors such as small and large industrial, commercial, highway, and single family residential projects.

Research Goal 9.2.2 Evaluate the current use of key performance indicators and/or leading indicators by small, medium, and large construction safety and health management programs and how well these indicators predict future injury and illness rates.

Research Goal 9.2.3 Evaluate the extent to which safety and health management program requirements are effectively passed down multiple tiers of sub-contractors via mechanisms such as contractor bid qualification requirements, and what information is collected to track effective conformance.

Research Goal 9.2.4 Determine how contractors incorporate non-regulatory consensus standards and best practices into programs

Research Goal 9.2.5 Develop business case estimates of OSH management costs and benefits in construction for small, medium, and large firms. Where relevant, include consideration of common forms of cost shifting and define who pays the costs and who receives the benefits.

Intermediate Goal 9.3 – Partner with best practice contractors, on best practice sites or projects, to develop and expand safety and health management program elements that address important emerging issues

Performance Measure: Within 3 years, collect a sample of 20 high-performance projects with low injury incidence rates, facing emerging issues and willing to share their experience via surveys and focus groups. Within 7 years, identify key elements of successful safety and health programs that address the most difficult safety and health problems in construction, e.g. health issues, vulnerable workers, injury reporting.

Research Goal 9.3.1 Develop program elements that address needs of vulnerable workers (e.g. immigrant workers, young workers, aging workers, women workers)

Research Goal 9.3.2 Develop program elements that improve injury reporting and address potential underreporting of injuries, including the need to tailor incentive programs to preserve reward aspects without biasing injury reporting.

Research Goal 9.3.3 Develop program elements that improve prevention and management of musculoskeletal disorders

Research Goal 9.3.4 Develop program elements that improve prevention and management of occupational exposures (e.g. noise, silica, welding fumes) to reduce health effects and occupational illnesses

Research Goal 9.3.5 Develop program elements that incorporate measures to build, measure, and improve construction safety culture

Research Goal 9.3.6 Develop program elements to increase the use of effective leading indicators to measure success of safety and health management programs

Research Goal 9.3.7 Develop program elements to support and expand the Incorporation of health and safety performance metrics in corporate annual reports used by medium and large construction firms.

Intermediate Goal 9.4 – Partner with best practice small employers to identify the most important safety and health management elements and increase the use of programs tailored to small construction employers.

Performance Measure: Within 4 years, characterize and validate the successful approaches of small employers and contractors. This effort should include building a knowledge base of methods used by small employers that have anecdotal or other evidence of effectiveness. Within 7 years develop practical and effective best practices for safety and health management systems for small contractors.

Research Goal 9.4.1 Identify obstacles and challenges that prevent small contractors from developing, implementing, and managing relevant components of safety and health management programs.

These might include topics such as: Pass-through of extra costs; limits of available technical safety support; Absence of formal management structure in very small employers; uninformed clients who may be ignorant of construction practices; time pressures on short-term projects; access to workers and worker knowledge and trainability issues; or language and other cultural barriers

Research Goal 9.4.2 Create several template options for use by small contractors for managing safety and health.

Content items to consider might include: Specific tasks for implementing an effective program in checklist form; Planning tool for defining OSH responsibility on a job; Lexicon of common contract terms for safety performance; List of resources for free or low cost assistance; Top 10 warning signs that OSH program is in trouble; Effective methods to motivate worker buy-in; key considerations in pre-project planning for safety; daily pre-task planning guides that address control options for common hazards

Research to Practice Goal 9.4.3 Assist small contractor managers to become effective implementers of OSH programs.

Approaches might include: development of checklists/Written safety and health plans; Simple tools for tracking and measuring progress; Improved small contractor training methods; Contractor/owner training on cost-benefits of improved OSH programs; and Mentoring programs with larger best practice construction firms

Intermediate Goal 9.5 – Partner with trade associations, management associations, and other construction stakeholders to disseminate new information and practices and to expand the use of effective safety and health management programs.

Performance Measure: Within 5 years, develop checklists, videos, CDs/DVDs, and success stories that can be disseminated to the construction industry. Within 10 years, reach every contractor in the US with information about best practices for safety and health management systems and practical approaches to implementing them. Increase the use of safety and health management systems by construction contractors in the US by 50% and among small contractors by 100%.

Research to Practice Goal 9.5.1 Develop a web-based resource center to provide a one-stop location for construction safety and health management information.

Research to Practice Goal 9.5.2 Develop specific marketing plans to guide efforts to disseminate and diffuse safety and health management information to target groups in construction such as small and medium sized employers.

Research to Practice Goal 9.5.3 Disseminate information on safety and health programs widely throughout the construction industry.

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TOPIC: CONSTRUCTION INDUSTRY AND WORK ORGANIZATION

STRATEGIC GOAL 10.0 - Improve understanding of how construction industry organization factors relate to injury and illness outcomes; and increase the sharing and use of industry-wide practices, policies, and partnerships that improve safety and health performance.

Performance Measure – Increase the recognition of the external and internal characteristics of the organization of the industry that may impact (i.e., reduce or contribute to) injury and illness outcomes, and increase the availability and use of best practices in the construction industry to improve health and safety performance.

Introduction
One major difference between construction and other industry sectors is the higher degree of organizational complexity at the worksite. While a manufacturing workplace most likely involves one primary employer, a construction workplace involves multiple employers and employees, and these groups change over time as the project progresses. Moreover, the safety of one firm's employees are often affected by the actions of individuals employed by a different firm. Construction worksites can range from small residential housing jobs involving a few employers to large projects such as the construction of the Denver International Airport, a $2.8 billion project that involved 2,843 individual contracts spread over 769 contractors and subcontractors during a five year period [Glazner et al, 1998]. Ever greater proportions of onsite construction tasks and functions are completed not by the prime contractor, but by smaller independent specialty subcontractors. Production techniques are continually evolving to increase efficiency, reduce waste and promote schedule and workforce flexibility. Organizational complexity can contribute to scheduling challenges resulting in rushed deadlines and impacts on safety.

The traditional safety and health focus is on individual employer programs and practices. While this is important[7] it may not be sufficient as a sole approach for construction. There is increasing interest in taking a broader perspective to look at how the many organizations and disciplines involved in a construction project interact as a system, and how this interaction or lack of interaction can impact safety and health.

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[7]The Construction Safety and Health Management goal (see page X) addresses these important research and practice issues related to individual employer internal management programs

The purpose of this strategic goal is to promote research and stakeholder activities that increase our understanding of how construction industry organization and structure can influence safety and health performance. This information can then be used to identify and evaluate improved system level interventions to promote increased safety and health for construction workers. Effective practices can then be disseminated throughout the industry.

Roles, relationships, responsibilities, and mechanisms

The construction industry is a complex system and relationships between construction organizations are affected by many influences, including legal tort liability, labor law, regulatory requirements and professional association policies (Toole 200A). Recently, a Review Commission decision in the Summit Construction case (April 27, 2007), called into question OSHA's multi-employer workplace policy that allows it, in some cases, to cite the general contractor for violations of the subcontractors. This was rejected by the Review Commission (under appeal) and may lead to laws explicitly assigning responsibility for subcontractor safety to the prime contractor. Such laws could have a substantial effect on how safety is managed at multiemployer worksites. Research is needed to improve understanding of the roles played by various construction organizations and how either fragmentation or enhanced coordination can affect project safety. It can also look at professional roles and responsibilities of key disciplines involved with construction (e.g., architects, engineers, safety and health professionals).

The traditional and still most common project delivery method is design-bid-build (DBB), in which the design of a project is completed before the entities performing the construction are identified. This *disjointedness* of the design-construction process prevents needed communication between designers and constructors.

Many general conditions explicitly allow value engineering, which is when the General Contractor proposes changes to the design to reduce the cost of construction. (The resulting savings are split between the owner and the General Contractor). Value engineering is an important part of contracting for two reasons. First, it is recognized that contractors often have a better understanding of materials and methods that are inherently more cost effective than do design professionals. Second, it is recognized that the DBB process prevents the GC from communicating value-engineering and other constructability-related information to the designer during the design process. Current construction custom and practice does not allow a value engineering-like process to occur for safety, because there is no mechanism for contractors to propose changes to the design based on their better understanding of material and methods that are inherently safer. Consequently, designers perform their design essentially oblivious to the safety aspects of their design decisions and contractors are forced to do their best to *manage in* safety, despite the well known safety principle that it is inherently more effective when safety is *designed into* a product or process.

The negative effects on safety of the disjointedness of the DBB process is compounded by the fact that the process is highly *fragmented*, that is, both the design and construction is performed by many specialized entities. Building design, for example, is typically completed by a design team that includes an architect, a civil/site engineer, a geotechnical engineer, a structural engineer, a mechanical engineer, a fire protection engineer, and a lighting engineer. Building construction is typically accomplished by a team of 25-50 subcontractors and material vendors. Communication between these entities during construction planning and execution—which is critical to safety management because many firms are typically working simultaneously on the site—is hampered by the sheer number and self-interest of these entities.

In addition to those features of the construction industry's organization described above, many other features of the current industry suggest research topics that merit investigation. Two main research themes were identified as important for further research and construction stakeholder involvement. These involve evaluating roles, relationships, and responsibilities across organizations; and understanding and improving construction industry mechanisms for defining and influencing these relationships.

Intermediate Goal 10.1 - Characterize the connections between construction industry organization and safety and health performance and identify changes that might improve performance.

Performance Measure: Within 4 years, evaluate current industry roles and practices and develop and disseminate 3 white papers that characterize current and suggested model practices.

Industry organization relates to fundamental roles and responsibilities for worksite communication and control of safety and health. Even with the existence of legal and regulatory definitions, safety and health roles and responsibilities between and among contractors and subcontractors can wind up being ambiguous during construction (Toole 2002B). Owner involvement is an increasing trend but there is considerable variation in current practice. Owners that take an active role in the safety of their sites (through bid specifications and oversight) have reported large reductions in injuries (e.g., CURT, Army Corps of Engineers). Interdisciplinary practice is a related issue since it is the engineers, architects and others working for construction firms that are involved with these relationships. Involvement of architects and engineers is important for making progress on promising areas such as "Prevention through Design".

Research Goal 10.1.1 – Construction entities - Evaluate roles, relationships and responsibilities among construction project entities to identify problem areas (e.g., gaps and ambiguities) and opportunities (e.g., model practices). Develop a white paper describing current variations in construction practice and suggesting model practices.

Construction entities include, for example, owners, contractors, subcontractors, unions, equipment vendors and suppliers and other key groups. Roles and relationships include concepts such as "host employer" or "controlling contractor" both used by OSHA.

Research Goal 10.1.2 – Construction Professionals - Evaluate current roles, relationships and responsibilities among professional disciplines involved in construction projects (such as architects, engineers, safety engineers, industrial hygienists, attorneys, and risk-management specialists) to identify problem areas and opportunities. Develop a white paper describing current variations in construction practice and suggesting model practices.

Research Goal 10.1.3 – Key groups - Evaluate the effects of owner involvement, union involvement, small business involvement and vendor and supplier involvement on job safety. Develop a white paper describing current variations in construction practice and suggesting model practices.

Examples of issues might questions such as how to measure the impact of owner involvement? What impact does unionization have on safety on the job? What role can equipment rental businesses play in ensuring that their equipment is used safely?

Research to Practice Goal 10.1.4 – Identify and evaluate promising model practices and procedures for improved coordinating system safety planning among construction entities and professional disciplines. Partner with construction stakeholders to disseminate across the industry.

Intermediate Goal 10.2 – Evaluate and improve current construction system mechanisms used to define and influence safety and health roles.

Performance Measure: Increase the use of construction system mechanisms that reduce the risk of occupational injury and illness**.**
Within 4 years, evaluate current construction system mechanisms and develop and disseminate a white paper that characterizes current and suggested model practices. Within 7 years, pilot test 3 enhancements or new practices and disseminate to the industry.

The construction industry uses a variety of mechanisms to define and communicate various roles and responsibilities. Some can detract from safety efforts. For example, state and federal procurement regulations requiring awards to the "lowest bidder," have been cited by OSHA as a factor that encourages firms to cut corners on safety. Alternative practices such as "best value contracting" or using the "lowest responsible bidder", support safety by including it as criterion for bidders. Many public (e.g., Connecticut, Los Angeles School District, U.S. Army Core of Engineers) and some larger private sector (e.g., Intel) building and construction project 'owners' utilize safety and health contract specifications. Some owners screen which contractors can bid on projects based on their safety records, including the safety records of the subcontractors they intend to work with. The effect of these safety prequalifications has not yet been rigorously established, nor have strategies been designed to ensure that safety records are properly recorded. Similarly, contracting specifications that explicitly push responsibility for safety to subcontractors or independent contractors may create situations in which responsibility for safety is sufficiently diffused that it is neglected (Johnstone, Mayhew and Quinlan, 2001). Optimizing the use of these existing mechanisms is an important way to improve construction system safety.

Research Goal 10.2.1 – Characterize construction mechanisms used to define construction industry roles, relationships and organization. These include examples such as project delivery systems, procurement practices, bidding arrangements, contract specifications and language, and health and safety management systems. Develop a white paper describing variation in current application of these mechanisms, the impact on safety and health, metrics for measuring these impacts, and suggestions for model practices.

For example, what impact do bidding arrangements have on job safety (e.g., low bid, lowest responsible bidder, best value contracting, etc.)? How do contract specifications on safety affect overall jobsite safety (e.g., does it improve conditions by making them more enforceable by the owner?)

Research Goal 10.2.2 – Identify and evaluate the effectiveness of options for improving current mechanisms and collaborate with construction stakeholders to pilot test most promising options.

Research to Practice Goal 10.2.3 – Identify and evaluate promising enhancements to existing mechanisms (e.g., new procurement or model specifications) and partner with construction stakeholders to disseminate materials and increase adoption of improved practices across the industry.

Intermediate Goal 10.3 - Study how subcontractors and small construction employers affect construction system safety and health performance. Develop and disseminate model practices for improving subcontractor and small employer safety performance on multi-employer construction projects.

Performance Measure: Within 4 years, evaluate subcontractor and small contractor issues and develop and disseminate a white paper to describe current conditions. Within 7 years, evaluate and disseminate model practices to improve small employer safety performance on multi-employer projects.

Recent decades have brought an increase in the typical number of subcontractors involved in construction projects, apparently because construction project costs are reduced. Subcontractors are increasingly specialized and therefore more efficient at performing their individual tasks than are generalist contractors. Also, subcontractors are increasingly worker-owners who are willing to work for lower wages because they have very limited company overhead. They therefore often lack formal safety programs, management sophistication and the insurance of larger subcontractors, but they are very cost competitive. Theoretically, increasingly specialized subcontractors could improve site safety, because specialty firms should be particularly knowledgeable about the risks of their trade. However, construction safety requires coordination among firms because construction often occurs on small sites with many firms working in close proximity to one another. In addition, smaller firms have fewer personnel and resources to invest in safety and health activities. The increase in the number and specialization of firms has therefore made it more difficult to perform coordinated safety planning and execution.

Research Goal 10.3.1 – Subcontractors - Evaluate current subcontracting trends and their potential impacts on injury reporting and occupational health and safety performance.

For example, how has the large rise in “independent contractors” impacted construction safety? What effect does subcontracting out more dangerous tasks have on overall safety for the subcontractor and for the overall project? How can these effects be mitigated or reduced?

Research Goal 10.3.2 - Study small employer interactions on small construction projects to address three questions: 1) How well are safety roles and responsibilities handled by small contractors, subcontractors, and self-employed contractors? 2) What safety and health information sources and mechanisms are relied upon by these small employers? and 3) What best practices exist for small construction projects?

Research Goal 10.3.3 – Study the interaction and impact of small employers on medium and larger size construction projects to address three interrelated questions: 1) Do small employers adversely impact project safety performance of other employers?; 2) Can small employers successfully apply flow down safety requirements on large projects or is customization needed to accommodate special needs?; and 3) How influential are well run projects for transferring safety skills and practices to small employers? Are safety gains specific only to that project or are they maintained on other jobs?

Research to Practice goal 10.3.4 – Use results from three previous intermediate goals to develop a white paper to describe small employer practice issues. Identify and evaluate promising best practices or new enhancements and accommodations for improving subcontractor and small employer safety and health performance and partner with construction stakeholders to disseminate and support their use.

Intermediate Goal 10.4. Study and improve the effect of various workers compensation arrangements and mechanisms on construction injury and illness at the system level.

Performance Measure: Within 4 years, identify and evaluate the impact of workers compensation arrangements on injury and illness reduction. Within 5 years, evaluate potential best practices and develop and disseminate a white paper to describe the issues and provide recommendations to improve impact at the system level.

Workers Compensation arrangements represent an important financial incentive for safety and health. Workers Compensation providers range from private insurance firms to state run programs and represent an important source of construction safety and health expertise. Whether workers compensation "experience ratings" create potent incentives for firms to improve their safety records is not yet well established. Providers utilize a variety of interventions, from loss control consulting services to safety grants to discounts for use of certain safety program features. Findings of construction injury underreporting [Glazner et al. 1997; Welch et al. 2007]. raise similar questions about self-reported injury experience used for setting rates. This is also important given the increasing use of experience modification rates for other purposes such as a metric for prequalification reviews. New insurance arrangements like large deductible policies, insurance groups, self-insurance, project "wrap up" policies and collectively bargained workers compensation agreements, may be helpful in reducing the risk of injuries. Research on these and other questions is needed.

Research goal 10.4.1. - Identify and evaluate Workers' Compensation insurers' practices for reducing fatalities and serious (i.e., compensable) injuries and illnesses at the single employer level.

For example, how much of an incentive does the workers compensation system present for injury reduction? Are "Experience Modification Ratings" effective for small and large employers? Are workers compensation services and incentives effective for addressing musculoskeletal disorders or health outcomes? Do workers' compensation systems provide incentives that result in shifting injury costs to the health care system or workers (through underreporting) thus decreasing the preventive impact on jobsite safety and health?

Research goal 10.4.2 – Identify and evaluate Workers' Compensation insurers' project-wide safety and health practices, such as Owner Controlled Insurance Programs (OCIPs) in improving coordination and performance at the multiple construction employer level.

Research goal 10.4.3 - Identify and evaluate small contractors' beliefs and attitudes concerning WC incentives for preventing fatalities, injuries and illnesses. Collaborate with 2-3 WC insurers to pilot injury and prevention incentive programs for small contractors.

For example, how effective are economic incentives such as end of year rate rebates for good experience records or discounts for safety program features in improving safety?

Research to Practice goal 10.4.4 – Develop model Workers' Compensation insurers' 'best practices'. Combine with information from the three previous intermediate goals into a white paper and disseminate to insurance companies, state authorities, and other construction stakeholders.

Intermediate Goal 10.5 - Study and enhance the role of regulatory, consultative, consensus and other organizations and policies for improving construction safety and health at the industry level.

Performance Measure: Within 4 years, evaluate the role of regulatory, consultative, consensus, and other organizations and policies for improving construction industry safety and health and develop and disseminate 2 white papers describing improvements that can be made at the industry level.

This goal addresses federal and state regulatory agencies (e.g., OSHA), consultative groups (e.g., State OSHA Consultation programs), and consensus groups (e.g., ANSI, ACGIH) since they influence construction safety and health and represent important system components. How do these groups identify construction firms, projects, and topics for interventions? How well do their products meet the needs of construction stakeholders? For example, OSHA makes thousands of inspections on construction sites each year, yet many of the likely worst sites escape inspection, operating below the radar due to limitations in existing information available to OSHA for targeting. Alternative methods for targeting sites have been suggested, such as: targeting on the project level (rather than the contractor), risk-based targeting (e.g., targeting certain high risk projects or contractors with a history of violations of high risk standards), efficacy-based targeting (where change is expected to have the most effect), and targeting certain high risk sectors or stages or by project size (e.g., residential housing, small projects). Another system consideration relates to the potential for collaboration between federal and state programs and local programs. Although local programs such as county building permitting offices do not typically address safety and health, they collect important information about where, when and what type of building is getting done. They also could act as an important point of contact for information dissemination and as a check on the building process, particularly for small projects which are not often inspected or impacted by OSHA.

Research goal 10.5.1 Evaluate the effectiveness of regulations, consultations, and consensus standards in improving safety and health at the construction industry level and develop a white paper describing current practices, limitations and opportunities, and suggested options for improvement.

Research goal 10.5.2 Evaluate policies and methods and options for identifying construction firms and projects for regulatory and consultation interventions and develop a white paper describing options for improvement.

Research goal 10.5.3 Explore and evaluate options for how federal and state safety regulatory and consultation programs could enhance collaboration with local regulatory and consultation programs.

For example, county building permit offices could provide information on trenching and excavation where building permits address these operations.

Intermediate Goal 10.6. Evaluate the nature of construction work and the inherent work organization factors that can influence the risk of injuries and illnesses. Develop recommendations and solutions to address impacts.

Performance Measure: Decrease the use of work organization systems that result in increased risk of occupational injury or illness by 20% over baseline via increased awareness and availability of solutions.

The nature of construction work is temporary and subject to deadlines. Work organization factors such as extended shifts, seasonal employment, job insecurity, and schedule pressures may impact injury experience in construction. These issues cut across employer, project, and industry-wide levels and additional information is needed to understand their contribution to safety and health performance.

Research goal 10.6.1 – Survey the construction industry to estimate the current prevalence of work organization risk factors, such as: night work, long duration extended shift work, and production pressures such as incentives for early completion which might lead to increased risk of injury or illness.

Research goal 10.6.2 - Evaluate the impact of the work organization factors most likely to affect safety and health.

Research goal 10.6.3 – Develop and evaluate interventions and accommodations that address the work organization and disseminate throughout the industry to increase the adoption of these methods/alternative work organization systems.

For example, if night work is shown to increase risk, then how can night work be minimized or the impact mitigated? Can production pressures be decreased through better planning of the work?

Intermediate Goal 10.7 - Integrate the findings from the previous intermediate goals to provide an overarching safety and health framework, logic model, and management system for the construction industry.

Performance Measure: Within 8 years, integrate previous findings and develop and disseminate products to raise awareness and help explain the importance of industry organization issues to construction safety and health, and to increase industry wide activities to address these issues.

The findings from the preceding intermediate goals can be used to
to map key relationships and mechanisms in construction both as they exist along with how they could be changed via model practices. This in turn can lead to products that help construction stakeholders to understand how changes in one part of the system might affect other parts of the system and overall safety and health performance.

Research to Practice goal 10.7.1 – Develop products such as logic models to visualize and explain construction sector interrelationships at the system level. Disseminate to the industry.

Research to Practice goal 10.7.2 – Use resulting information to make recommendations for system wide interventions such as industry-wide campaigns and enhancements to existing employer safety and health management systems.

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TOPIC: TRAINING ISSUES

STRATEGIC GOAL 11.0 – Increase the recognition and awareness of construction hazards and the means for controlling them through broad dissemination of quality training for construction workers, including non-English speaking workers.

Performance Measure: Demonstrate a minimum set of safety and health competencies required for all workers on construction sites to recognize hazards and the methods to control or avoid them through access to quality training and educational materials.

The mission of the NORA Construction Sector Council workgroup on Training Issues for Construction Safety and Health is to assess training needs, resources, and tools to address occupational safety and health hazards in the construction industry. The training issues workgroup is charged to provide leadership in the development of goals and priorities which identify gaps in current training and the resources which can best be applied to address them. The training issues workgroup will seek to identify barriers as well as best practices and strategies for developing and delivering effective training and guidance to address construction-related hazards and prevent illness and injury for construction workers.

Training is recognized as a key factor for addressing and preventing hazards in construction; yet, to be meaningful, it must be considered in the context of a comprehensive safety and health program that includes management commitment, employee participation, hazard identification and control, and program evaluation as well as the training program itself.

Challenges related to training include quality of training available, frequency of training, audience specific training materials (Hispanic resources, trade or activity specific training), and evaluation of effectiveness (e.g., ability to evaluate the influence of training on safety behavior and culture versus teaching knowledge and skills). Training effectiveness research has shown that training can improve levels of knowledge and skills for workers, which can be a contributing factor in increasing awareness of hazards and recommended safe work practices in construction. However, additional research (including behavioral observation and evaluation) is needed to determine whether these precautions are exercised and to validate the true effectiveness of training as a contributing factor to avoiding hazards by utilizing recommended controls and taking appropriate precautions. Further evaluation is required to characterize the effectiveness of training, targeting outcomes such as increased use of recommended controls, personal protective equipment, and improved work practices. By addressing these challenges related to training, and by conducting additional research and evaluation, these measures can translate into fewer injuries and fatalities by eliminating or mitigating hazards.

A reduction in the occurrence of accidents and injuries will not only save lives and improve the quality of life for workers, it can also result in lower workers' compensation claims and other financial expenditures for contractors and owners of construction projects.

Obstacles to use of training include time management issues, language barriers, failure to perceive hazards or a need for training, and additional costs. The persistence of hazards and associated injuries and fatalities could indicate that training is not the appropriate solution in some situations, or that training is ineffective, not frequent enough, not understood, or not consistent with expected practices on worksites. There exists a need for better characterization of the role that safety and health training plays in the construction industry, and how training is developed, delivered, and assimilated into construction practices.

Significant Factors

Employment in the construction industry is expected to grow at ~1.2% over the period from 2000 to 2010, creating 825,000 new wage and salary jobs [Berman 2001; CPWR 2002]. Growth is projected to be higher in residential construction trades over that period (~9%), while growth in heavy construction employment (highway, bridge, and street construction) and special trades will be consistent with the industry average. Given the anticipated growth, demand for training for new construction workers is also expected to rise. Consequently, identification of relevant training materials and methods, appropriate delivery to target audiences, and evaluation of training effectiveness are several of the key issues facing the construction industry.

Among those groups and individuals likely to be impacted either as providers or users (intermediate customers) of training methods and materials are the following:

Banking, mortgage, lending, insurance, and financing organizations
Construction owners, users, and developers
Architecture, engineering, and design firms
Construction managers, supervisors, and workers
Contractor, industry, and trade associations
Training organizations and universities
Federal, State, and local government
Trade unions and organized labor groups
Immigrant workers and worker centers
Equipment rental, supply, and repair contractors.

Intermediate Goal 11.1 – Perform a construction training needs analysis.

Performance measure - Assess current state of training needs for at least 3-5 major construction trades within 3 years, and expand to include 3-5 more additional trades every year after over 10 years.

Research Goal 11.1.1 – Identify existing and potential surveillance tools for tracking the use of training and its impact in construction trades. Use and organize existing databases, surveillance systems, and other information.

Research Goal 11.1.2 – Harmonize training needs analysis to include intermediate and supporting goals from other NORA Construction Sector Council workgroups. Communicate with other NORA Construction Sector workgroups to identify, assess, and coordinate training needs and solutions as they relate to those workgroups' goals.

Intermediate Goal 11.2 – Survey current training programs, models, materials and best practices to identify the scope of training resources available.

Performance measure – Create an inventory or clearinghouse repository (e.g., electronic Library of Construction Occupational Safety and Health, or eLCOSH) of model programs within 3 years that could serve as resources to other industry sectors for effective identification of training needs, and developing sector specific resources to address those needs. Maintain the repository by updating it at least annually.

Research Goal 11.2.1 – Identify programs used to provide training on safety and health core competencies (e.g., Susan Harwood programs, SmartMark program). Develop and define a description of safety and health core competencies required for construction workers, construction trainers, and construction employers, and encourage identification or development of programs which meet these requirements (e.g., NIEHS Minimum requirements document).

Research Goal 11.2.2 – Identify existing quality training materials (e.g., toolbox talks, simple solutions, industry and trade materials).

Research Goal 11.2.3 – Compile resources from peer-reviewed literature on construction safety and health training.

Research Goal 11.2.4 – Identify methods used to provide training for construction safety and health (e.g., Each one teach one approaches, coaching worker-trainers).

Research Goal 11.2.5 – Identify methods of analysis and measures for effectiveness evaluation of training.

Intermediate Goal 11.3 – Develop new or improved training programs, models, materials, and methods.

Performance measures – Conduct baseline survey of construction safety and health toolbox talks available via electronic libraries initially within 3 years and conduct surveys periodically thereafter to determine availability of new materials. Demonstrate an increase in publication of peer reviewed literature on construction safety and health training.

Research Goal 11.3.1 – Develop, evaluate, and implement new materials and methods for delivering effective training on safety and health core competencies.

Research Goal 11.3.2 – Identify best methods of analysis and appropriate measures and indicators for effectiveness of training. Promote funding for training intervention effectiveness research.

Intermediate Goal 11.4 – Promote the dissemination and use of construction training best practices, materials, and methods.

Performance measure – Increase the number of construction workers provided with the core competencies for understanding construction hazards and their prevention.

Research/Research to Practice Goal 11.4.1 – Plan a national state-of-the-science conference on construction training issues, resources, and needs. (Options could include convening a dedicated national conference, participation in sister safety and health conferences, and piggy-backing onto existing safety and health conferences to focus on discussion of construction safety and health training issues.)

Research Goal 11.4.2 - Research and develop or refine approaches to institutionalize change. Examples might include: funding research and assisting with dissemination and use of results; publicizing practitioner success stories; using awards and other social marketing approaches.

Research to Practice Goal 11.4.3 - Improve training delivery and transfer of knowledge to small and self-employed construction contractors. Utilize or develop better surveillance tools to improve delivery systems for reaching smaller construction contractors (the majority of the industry).

Research to Practice Goal 11.4.4 - Increase communication with other construction safety and health researchers to integrate research findings into training programs. Encourage diffusion of research findings through multiple venues including web-based information sources, peer-reviewed literature, professional organizations, construction user groups, contractor associations, and construction worker unions.

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TOPIC: VULNERABLE WORKERS

STRATEGIC GOAL 12.0 - Increase understanding of how vulnerable worker groups experience disproportionate risks in construction work and expand the availability and use of effective interventions to reduce injuries and illnesses among these groups.

Performance Measure: This goal will be successfully achieved if by 2016, there is improvement in the understanding of what constitutes worker vulnerability; expansion of the existing knowledge base of injury, illness, and exposure of vulnerable worker populations; and increased distribution of effective interventions.

Background

Available evidence suggests that certain working populations are at disproportionate risk for work related health problems within the construction sector. For example, data on fatal occupational injuries suggest that Hispanic construction workers as well as younger construction workers may be at increased risk. The cause of these population's increased vulnerability is multifactorial including differential employment rates in more dangerous job assignments, limited prior work experience, inadequate training --which is compounded by language and cultural barriers, and job insecurity especially for workers employed in nonstandard work arrangements such as day laborers.

Vulnerable working populations in the construction sector also include those who continue to be under-represented in the sector, such as African American workers and women. This paper focuses on the factors directly related to disparities in traumatic injuries, while recognizing the importance of discriminatory hiring and contracting practices and adverse working climate as social determinants of health that may have equally important adverse effects.

Immigrant Workers

Hispanic construction workers, particularly those foreign-born workers who have immigrated recently, experience a variety of adverse working conditions that support their classification as vulnerable workers. Hispanic construction workers have experienced higher occupational fatality rates for every year from 1992, when the Census of Fatal Occupational Injuries (CFOI) was introduced; through 2005 (the most recent for which data is available). The largest contributor to this disparity is fatal injuries resulting from falls. Meanwhile the fraction of the construction workforce classified as Hispanic has grown rapidly, fueled primarily by enormous increases in foreign-born Hispanic workers, with the majority of Mexican origin. Hispanic construction workers also have lower rates of health insurance coverage, lower rates of unionization, lower average hourly wages, lower average educational levels, fewer years of construction experience, and are concentrated in lower skilled and more hazardous occupations such as helpers, laborers, and roofers. Although underreporting of nonfatal injuries is a concern in this population, based on the Medical Panel Expenditure Survey (MEPS) they also experience higher rates of nonfatal lost-work-time injuries. Because of their economically precarious circumstances, these workers may be less likely to refuse or to walk away from unsafe working conditions and more likely to accept poorer work conditions. Intervention and dissemination research must explicitly address this vulnerable population to understand potential barriers to change.

The vulnerability of Hispanic construction workers is evident, in part, because of the growing Hispanic workforce in the U.S. construction industry; other immigrant workers likely face similar conditions and challenges that may go unrecognized. The role of immigration status, language skills, inexperience and age and other personal attributes in contributing to vulnerability may or may not be compounded by specific discriminatory activity related to ethnicity, or specific strategies of economic exploitation.

Young Workers
Young workers, inexperienced workers, and those new to a specific job or worksite, have increased rates of fatal traumatic injuries compared to the workforce as a whole. This form of vulnerability is not completely understood, but evidence suggests that a desire to perform well coupled with lack of experience and with a strongly perceived power differential, all may contribute.

Contingent Workers
The construction industry hires, and has become increasingly dependent upon, immigrants including undocumented workers, non-English speakers, inexperienced workers, and day laborers or contingent workers to meet construction demands. Much of the industry is dependent on cheap labor as a response to the pressure to cut costs. Diffusion of responsibility occurs as many subcontractors contribute to the hazards. The very nature of construction work characterized by “constantly working yourself out of a job” as projects are completed, is likely a more vulnerable situation for some than others, including those who are most economically deprived.

Older and Disabled Workers
The aging construction workforce is of concern on the worksite and because cumulative injuries and disability may lead to transfers to employment, often in other sectors, which is less physically demanding. Early “retirement,” low retention of older skilled workers, and the contribution of work-related injuries, should be better characterized with longitudinal data sets.

Research and Surveillances Needs
There is a need to understand, and to work to remedy, factors that systematically increase vulnerability and disparities in health and safety of construction workers. Simple inclusion of vulnerable populations in research

projects will not accomplish aims of reducing disparities in health and safety. Vulnerability is often created through inequitable power structures (access, benefits, resources) making many vulnerable workers difficult to identify by any personal characteristics. The focus of these investigations must reach beyond personal characteristics of the workers to thoughtful examinations of formal and informal policies, work norms, subcontracting practices, and social influences on health disparities in construction.

Research must be designed and conducted in a manner that supports equity in resources, benefits, and opportunities and should include evaluation of public policies. For example, there are poorly understood influences of timely documentation of work-relatedness on modified work opportunities, paid time away from work, appropriate and timely treatment and outcomes. But for conditions to be recognized they have to be reported and conditions that keep workers from reporting work-related injuries or illnesses have the potential to contribute to disparities. On some projects, many construction employers are small businesses that do not fall under fair labor standards, workers' compensation, or OSHA regulations. In other situations, workers are inappropriately treated as independent contractors slipping through OSHA regulations as self-employed.

Surveillance methods inadequately capture illness and injury experience of vulnerable workers. Some of the conditions that contribute to vulnerability and potential exploitation are the very conditions that make these workers more difficult to identify through existing surveillance approaches and to engage in research efforts. In addition to the likelihood that the most vulnerable workers are less likely to report or have their illnesses or injuries recorded as such, the most widely cited surveillance systems are not designed to capture information necessary to document disparities. For example, basic information about race and ethnicity is not well documented by either SOII or workers' compensation records. Likewise, information about potential risk factors that may contribute to disparities e.g. language spoken, is not routinely captured in surveillance data sources. Examination of such disparities in injury rates also requires careful evaluation of sampling strategies used for enumerating the overall scope of these vulnerable populations used as rate-denominators.

As surveillance improves, the recognized vulnerability of these groups will increase. Because we do not have accurate longitudinal data, existing data are not adequate to support evaluation of interventions' impact on health effects directly.

Intermediate Goal 12.1: Improve surveillance of work-related injuries, illnesses, hazards and related costs among vulnerable workers in construction in order to set intervention priorities, guide future research, and evaluate progress in reaching prevention goals.

Performance Measure: Within 2 years, review, inventory, and recommend improvements or upgrades to existing datasets to increase the knowledge base of injury, illness, and exposure of vulnerable worker populations. Within 5 years, trial at least 3 innovative programs designed to improve our understanding of risks and injury experiences of vulnerable workers.

Research Goal 12.1.1 - Review current occupational illnesses and injury data surveillance data sets and standard reports (e.g. CFOI, SOII, IMIS) to identify and recommend modifications to improve surveillance of vulnerable construction workers and identify gaps to be addresses through new surveillance initiatives.

Research Goal 12.1.2 - Explore and implement use of other existing state and national surveillance systems (e.g. BRFSS, NHANES/MEPS, others) and databases to address gaps information about occupational injuries, illnesses and risks factor among vulnerable workers in construction. This should include exploration of construction-targeted government surveys similar to the National Agricultural Workers Survey.

Research Goal 12.1.3 - Strengthen capacity of states and community-based organizations to track work-related injuries and illnesses among vulnerable construction workers, using innovative community-based approaches to data collection such as through community clinics and other community organizations serving vulnerable worker populations employed in construction.

Research Goal 12.1.4 - Support efforts to improve collection of improved race, country of origin, gender, and detailed ethnicity information in health and employment data sets.

Research Goal 12.1.5 - Expand surveillance research to explore systematic underreporting of vulnerable construction workers in existing occupational health surveillance systems.

Intermediate Goal 12.2 - Improve our understanding of conditions and risk factors that contribute to the vulnerability of workers and the mechanisms though which vulnerability places workers at increased risk for work-related injury (or illness) in the construction trades, and their longitudinal effects.

Performance Measure: By 2014, identify and evaluate factors contributing to worker vulnerability; inventory these findings for future research and intervention development; and develop and implement interventions designed to improve working conditions and reduce injuries and illness among vulnerable workers.

Research Goal 12.2.1 - Evaluate formal and informal policies and workplace norms and conditions that may systematically increase vulnerability and disparities in health in the construction trades. This should include workplace norms and policies along with construction industry level practices such as informal sector employment and cost shifting practices.

Research Goal 12.2.2 - Improve understanding of how individual worker characteristics contribute to vulnerable worker injury and illness. This should include exploration of social and cultural factors and safety attitudes, as well as more commonly recognized language barriers. Exploration should also focus on improved understanding of conditions that may contribute to precarious employment such as informal work arrangements, immigration status, economic conditions and alternative employment.

Research Goal 12.2.3 - Identify current interventions and practices used to address vulnerable worker risks. Evaluate how existing construction mechanisms such as the use of competent persons, 10 and 30 hour safety training, apprenticeship skills training, and contractor prequalification programs can be modified to more effectively address vulnerable worker risks.

Research Goal 12.2.4 - Explore and evaluate the effectiveness of new types of construction-tailored interventions to address vulnerable worker risks. These might include creative mechanisms involving community-based organizations, peer-to-peer networks, family-based measures, or similar efforts as well as policy initiatives.

Intermediate Goal 12.3 - Develop and disseminate materials on effective interventions so as to increase the utilization of these methods by construction stakeholders and influence policy-makers. Based on existing information, Hispanic workers should be an important target group, but efforts should not neglect other vulnerable groups including other immigrant groups and inexperienced workers.

Performance Measure: By 2016, develop and disseminate five intervention materials/methods found to be effective from implementation according to IG 12.2.

Research Goal 12.3.1 - Explore the delivery and evaluation of new types of creative mechanisms for reaching immigrant construction workers that target contractors, workers, community groups, advocacy groups, local unions, schools, etc. Pilot and evaluate the effectiveness of promising dissemination methods.

Research to Practice Goal 12.3.2 - Increase dissemination of safety, workers rights, and resource information to immigrant/vulnerable workers.

Research to Practice Goal 12.3.3 - Establish partnerships with construction organizations and groups who represent vulnerable workers to develop and disseminate materials.

Research to Practice Goal 12.3.4 - Forge new mechanisms for outreach to small employers and companies with considerable vulnerable worker populations to evaluate intervention effectiveness and disseminate important safety and health information.

TOPIC: CONSTRUCTION HAZARDS PREVENTION THROUGH DESIGN *(CHPtD)*

STRATEGIC GOAL 13.0 – Increase the use of "prevention through design (PtD)" approaches to prevent or reduce safety and health hazards in construction.

Performance Measure: Increase the use of CHPtD by 33% over the next 10 years.

The National Institute for Occupational Safety and Health (NIOSH) is promoting a broad concept of Prevention through Design (PtD) which is defined as:

> *Addressing occupational safety and health needs in the design process to prevent or minimize the work-related hazards and risks associated with the construction, manufacture, use, maintenance, and disposal of facilities, materials, and equipment.*

In applying this concept to the construction industry, the NORA Construction CHPtD workgroup is charged to provide leadership in the development of goals and priorities which explore and promote the identification and use of effective engineering strategies. The workgroup also seeks to advance CHPtD concepts and tools to prevent illness and injury for construction workers through formation of partnerships, coordination of efforts, and effective utilization of networks (capacity building) among the construction industry and affiliated groups.

Background and Problem Statement:
The construction industry employs seven percent of the workforce, yet accounts for 22.6% of all work-related fatalities in the United States (Bureau of Labor Statistics, 2004; NIOSH, 2004). Because of the ongoing prevalence of safety problems in the construction industry, one breakthrough idea to reduce site hazards is to involve architects and design engineers in considering construction safety during the design process (Korman, 2001). The intervention—referred to as construction hazards prevention through design (CHPtD) or designing for construction safety (DfCS)—seeks to incorporate preparations for construction worker safety upstream of the construction site into the design phase of a project's life cycle. This intervention does not abdicate the role of construction firms and their employees, but rather seeks to provide a greater opportunity for them to work safer and healthier. Graphically, the ability to influence construction safety and health in terms of project phases is shown in Figure 1 (Szymberski, 1997). A significant portion of the ability to influence construction safety is lost when site safety is not considered until the construction phase.

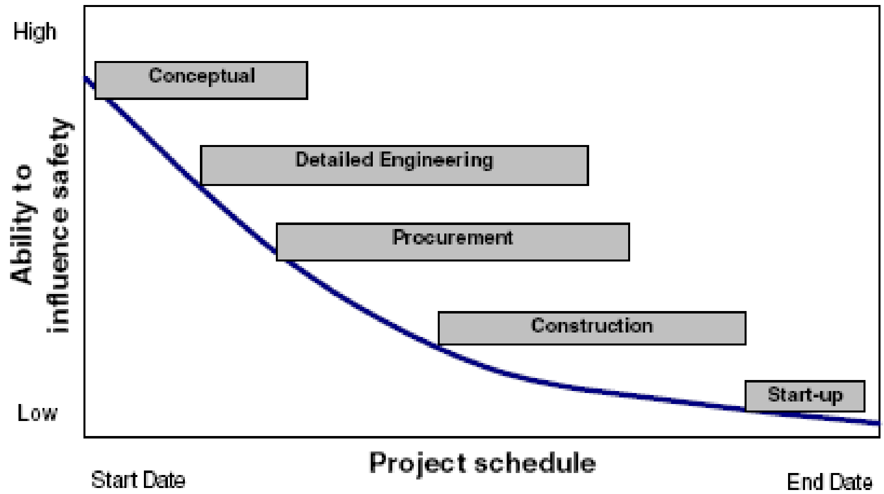

Fig. 1. Time/safety influence curve (Szymberski, 1997).

Actions and inactions by architects and design engineers made in a project's design phase can positively and negatively influence construction worker safety and health (Gambatese et al, 2005; Trewethy and Atkinson, 2003; Smallwood, 1996). Various studies have demonstrated injury surveillance (Hinze and Wiegand, 1992; Jeffrey and Douglas, 1996) and prioritized safety through design as a method to improve construction safety and health. Further studies identified its lack of incorporation as a causal influence in construction fatalities and injuries (Behm, 2005; Gibb et al, 2004). Specifically, Behm (2005) found that 42% of construction fatalities were causally linked to design process, while Gibb et al (2004) found that the causes in 50% of construction accidents were due to decisions made upstream of the construction site in the design process.

Accident causality is complex and multifaceted; CHPtD of its own accord is not a panacea. Consider that in 2001, falls to lower level accounted for the greatest number of fatal occupational injuries among construction workers – 410 fatalities or 4.3 per 100,000 full-time workers (NIOSH, 2004). Previous intervention research to reduce the incidence of falls to a lower level has focused on enhanced harness design, training in harness use, and behavior modification. These interventions are focused at on-site activities of construction workers; for complete intervention effectiveness, previous research assumes that there will always be an appropriate anchorage point to attach the harness and lifeline. This design aspect is the missing piece in a holistic approach to enhance construction worker safety. In this example, the CHPtD intervention seeks to ensure that there are appropriate anchorage points designed into the structure at appropriate locations for the construction workers to utilize. Therefore, previous intervention research can become more effective and realized in practice by incorporating prevention through design.

Previous European research (ILO, 1985; European Foundation for the Improvement of Living and Working Conditions, 1991) in this area has led many European countries to adopt legislation requiring architects and design engineers to implement and employ design for construction safety and health practices. Most notable is the United Kingdom's Construction Design and Management (CDM) regulations (HMSO, 1994). In the United States, however, construction worker safety is solely the responsibility of the construction firms (the employer); this is reinforced in OSHA regulations and supported by standard construction contracts. Design suggestions (Gambatese et al. 1997) and design tools (WorkCover, 2001) are available for implementation and evaluation.

Additional resources describing the background, concerns, and challenges include:

- *Designing for Safety and Health in Construction* (Hecker, Gambatese, Weinstein [2004]).
- *Inherently Safer Design Principles for Construction* (MacCollum [2005]).
- *NIOSH Prevention Through Design Initiative* [2006-2007]
- *National Safety Council Programs*
- *Construction Safety Engineering Principles (MacCollum, 2007)*

Based on this characterization of relevant issues, the ultimate goal for this priority topic area is to focus CHPtD efforts to increase the knowledge, dissemination, and implementation of PtD for reducing injuries and illnesses among construction workers. The mission of the NORA Construction Sector Council workgroup on CHPtD is to reduce hazards and improve safety and health in the construction industry through decisions made and communicated as they relate specifically to design processes at the project planning stages.

One of the best ways to prevent and control occupational injuries, illnesses, and fatalities is to "design out" or minimize hazards and risks early in the design process. A growing number of business leaders are recognizing PtD as a cost-effective means to enhance occupational safety and health. Many U.S. companies openly support PtD concepts and have developed management practices to implement them. Other countries are actively promoting PtD concepts as well. The broad approach that will be used to develop and implement the PtD National Initiative will be framed by industry sector and include four functional areas: *Research, Education, Practice, and Policy*. As described in the previous section, there is already a brief history and a growing body of literature to describe concepts of PtD within the construction industry sector. The objective of the PtD initiative is to prevent or reduce occupational injuries, illnesses, and fatalities through the inclusion of prevention considerations into all designs that impact workers. Consistent with the objectives of the National Occupational Research Agenda (NORA), partners and stakeholders must actively participate in addressing shared goals to make PtD business as usual in the 21st century.

Intermediate Goal 13.1 – Characterize the current use of CHPtD and coordinate efforts to promote its use.

Performance Measures: Provide a baseline report within 2 years describing key measures of current national use of CHPtD within construction, along with a repository of currently available materials, current construction organization activities and contacts, and current training. Use findings to inform and begin at least three promotion activities. Collect data from at least eight (8) design/construction firms and other organizations actively involved in this process. Compile cost comparison assessments and business case models to characterize costs of CHPtD approaches. Develop a repository for large and medium size AE firms which deal with electrical, mechanical, civil, and commercial projects. For target audiences (i.e., engineers, architects, construction managers, and safety and health professionals), develop the following training programs to disseminate the principles and benefits of CHPtD:

- Full semester undergraduate course
- One week modules which can be incorporated into existing college courses
- 8-hour continuing education course

Surveillance Research Goal 13.1.1 Establish a baseline on the current use of CHPtD.

Research to Practice Goal 13.1.2 - Identify other groups working on these issues and coordinate efforts to facilitate understanding of challenges and possible solutions.

Research Goal 13.1.3 - Collect basic materials, case studies, and business case models needed for effective demonstrations of concepts and strategies. Evaluate materials and identify gaps where additional information products are needed.

Research to Practice Goal 13.1.4 – Create a repository of existing programs, checklists, best practices, etc. which can be adapted according to type of construction and firm size.

Research to Practice Goal 13.1.5 – Promote the use of CHPtD.

Intermediate Goal 13.2 – Confirm the most prevalent obstacles to acceptance and implementation of CHPtD:
- **fear of liability;**
- **lack of expertise in safety and in designing for safety; and,**
- **increased costs associated with CHPtD.**

Performance Measures: Conduct a survey or other quantitative research method of owners, AEs and professional liability insurance carriers to empirically confirm the factors hindering their adoption of PtD processes

Research Goal 13.2.1 - Explore and characterize the issue of liability concerns for designers. Develop potential solutions such as model contract language, design specifications, and legal protection that allow designers to incorporate CHPtD concepts without exposing themselves to inappropriate liability.

Research Goal 13.2.2 - Develop a recommended/suggested minimum level of adequate safety and health training for design students and determine the number schools that provide an acceptable baseline level of safety training.

Research Goal 13.2.3 – Characterize economic consequences of implementing CHPtD concepts.
- Will inclusion of safe design concepts increase direct costs for designers?
- Will there be costs associated with higher insurance premiums and associated legal defense with potential changes in liability?
- Will increased design fees associated with CHPtD be offset by reduced construction cost, potential lawsuits, and costly injuries in the total design and construction of the project?

Intermediate Goal 13.3 - Develop tangible products and methods to address identified CHPtD obstacles and challenges.

Performance Measures: Develop tools, policies, sources of information, training courses and other formal mechanisms to circumvent barriers to the acceptance and implementation of CHPtD. See performance measures below.

The diffusion of CHPtD can be expedited by developing tools to facilitate the implementation of CHPtD by four (4) specific groups - design professionals, engineering and architectural professionals, educators, and owners. The tangible products and methods needed to enable implementation should be customized for each group.

Performance Measure 13.3.1: Within 2 years, develop a website repository to house tangible CHPtD products and methods.

Performance Measure 13.3.2: Within 2 years, develop a targeted white paper for engineering and architectural professionals, educators, and owners that describe the PtD process.

Performance Measure 13.3.3: Within 2 years, develop presentation materials tailored for engineering and architectural designers, educators, and owners for use at professional conferences, such as ASCE, ASSE, AIA, CII, CURT, AOD, DOT, National Safety Congress, etc.

Performance Measure 13.3.4: Within 2 years, develop model contracts and general conditions text to allow designers to perform CHPtD without shifting responsibility for means, methods and site safety from contractors.

Performance Measure 13.3.5: Within 3 years, develop and provide associations such as ASCE, AIA, ASME, IEEE and ASSE with model language they can use for policy statements that support implementation of CHPtD.

Performance Measure 13.3.6: Within 3 years, develop a customized CHPtD "OSHA 10-hour" course for design professionals and educators.

Performance Measure 13.3.7: Within 5 years, develop tools such as educational documents, checklists, databases and interactive software to enable designers to perform CHPtD.

Performance Measure 13.3.8: Within 5 years, develop three general and discipline-specific case studies of design professionals or design builders implementing CHPtD, emphasizing the business case for CHPtD.

Performance Measure 13.3.9: Within 5 years, develop modules for engineering and architectural courses that include specific CHPtD applications.

Performance Measure 13.3.10: Within 5 years, develop CHPtD training modules for practicing design professionals that could earn them continuing education credits.

Performance Measure 13.3.11: Within 5 years, develop 2 business case studies of owner organizations who have implemented CHPtD.

Intermediate Goal 13.4 - Expand the use and evaluation of CHPtD practices.

Performance Measure: Increase the use of CHPtD by 33% over the next 10 years.

Not only can diffusion of CHPtD can be expedited by raising awareness of CHPtD within the four (4) groups identified in IG13.3, but also by raising awareness throughout the industry.

Research Goal 13.4.1: Develop CHPtD demonstration projects.

Research to practice Goal 13.4.2: Dissemination of results from IG13.3 through outreach to partners.

Research to practice Goal 13.4.3: Publicize practitioner success stories and use to make larger policy, institutional, and organizational changes.

Research to practice Goal 13.4.4: Implement social marketing approaches, awards, and other campaigns to increase awareness of CHPtD concepts.

Research to practice 13.4.5: Within 4-6 years, develop method to utilize the U.S. Green Building Council's (USGBC) Leadership in Energy and Environmental Design (LEED) rating system and the sustainability movement to implement CHPtD.

Intermediate Goal 13.5 - Develop incentives for architects and engineers to include the following in facility design plans and specifications:

- **Methods for safer project erection**
- **Methods for safe operation**
- **Methods for safe service and maintenance**
- **Methods for safety of the public**

Performance Measure: Create and promote multiple mechanisms for encouraging inclusion of CHPtD design concepts including: design competitions; CHPtD design criteria and certification procedures; and CHPtD requirements in project bidding specification.

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TOPIC: IMPROVING SURVEILLANCE OF HAZARDS AND OUTCOMES

STRATEGIC GOAL 14.0 - Improve surveillance at the Federal, State, and private level to support the identification of hazards and associated illnesses and injuries; the evaluation of intervention and organizational program effectiveness; and the identification of emerging health and safety priorities in construction.

Performance Measure – Increase available surveillance resources, construction information products, strategies for improving surveillance, and use of surveillance resources by construction stakeholders to meet the intermediate goal performance measures listed in the following sections.

Surveillance is the public health term used to describe the ongoing systematic collection, analysis, and interpretation of data (from national, state, industry, or organization sources) for purposes of improving safety and health. Surveillance provides an important foundation for all national safety and health efforts. It provides a starting point for identifying emerging problems and research needs. It provides the means for taking stock and monitoring performance over time. Surveillance findings serve to raise awareness among construction stakeholders and to guide intervention researchers toward the most important risks. The reverse is also true – outcomes or causes not adequately addressed by current surveillance systems can be obscured from view making them more difficult to understand and improve. Thus research to understand limitations in current systems is also an important component of surveillance.

Surveillance information for construction is mostly based on national and state systems such as the U.S. Department of Labor Bureau of Labor Statistics (BLS) and the U.S. Department of Commerce. A list of key occupational safety and health surveillance resources is provided in Table 1. Construction researchers and stakeholders need to partner with these organizations to discuss and implement improvements in surveillance systems. National systems are large and changes can involve significant costs. Pilot and demonstration projects to evaluate smaller scale modifications can provide important insights on the value and cost of system-wide improvements.

Construction related surveillance research supported by NIOSH and others since 1990 has greatly expanded information available for construction. For example, a Construction "Chart Book" is available (http://www.cpwr.com/rp-chartbook.html) which pulls together construction data from many sources into one convenient product. Researchers have evaluated injury, mortality, and illness patterns for many construction trades.

TABLE 1 – Key Surveillance Resources relevant for safety and health
(Table still under development)

Name of system	System owner	Brief description	Link
CFOI (Census of Fatal Occupational Injuries)	DOL BLS	Data on all reported fatal injuries	http://stats.bls.gov/iif/oshcfoi1.htm
SOII (Survey of Occupational Injuries and Illnesses)	DOL BLS	Survey of employers to estimate total injuries and rates	http://stats.bls.gov/iif/oshsum.htm
CPS (Current Population Survey)	DOL BLS	Household survey that provides data on the labor force, employment and unemployment	http://stats.bls.gov/cps/home.htm#overview
FACE (Fatality Assessment and Control Evaluation)	NIOSH	Investigations of targeted types of fatal injury cases	http://www.cdc.gov/niosh/face/
ABLES (Adult Blood Lead Epidemiology and Surveillance)	NIOSH	State based reports of elevated blood lead levels	http://www.cdc.gov/niosh/topics/ABLES/ables.html
NEISS (National Electronic Injury Surveillance System)	CPSC	National sample of hospitals on every emergency visit involving an injury associated with consumer products	http://www.cpsc.gov/library/neiss.html
Multiple Cause of Death Data	NCHS	Death certificate data	http://www.nber.org/data/vital-statistics-mortality-data-multiple-cause-of-death.html
National Health Interview Survey	NCHS	Annual household survey	www.cdc.gov/nchs/nhis.htm
National Hospital Discharge Survey	NCHS	Annual survey of short-stay non-Federal hospitals	www.cdc.gov/nchs/about/major/hdasd/nhdsdes.htm
Occupational and Environmental Disease Surveillance Database	AOEC	Association of Occupational and Environmental Clinics data from 24 AOEC member clinics	www.aoec.org
Population Data Estimates	BoC	US Bureau of Census population data	www.census.gov/prod/www/abs/decenial.html
SENSOR Sentinel Event Notification Systems for Occupational Risks	NIOSH/CDC	State-based surveillance of specific conditions and intervention	

Researchers have examined construction worker injury experiences using alternatives to traditional surveillance data such as workers' compensation data sets [Dement and Lipscomb 1999], hospital emergency department data [Hunting et al. 1999], owner controlled insurance data [Lowery et al. 2000], and emergency room data collected by the Consumer Product Safety Commission (CPSC) [Marsh, Derk, and Jackson 2006]. These studies provide important risk factor findings and have improved understanding of the value of these types of data for enhancing construction surveillance.

Studies have also begun to examine limitations in our current system. The most important findings are 1) the failure of national surveillance systems to capture illness data and 2) the substantial and growing underreporting of injury data throughout the industry, particularly in the BLS data. [Glazner et al. 1998; Welch et al. 2007]. Other limitations involve the ability to use the data to track performance within construction. For example, while the number of fatalities in an industry is a good indicator of total burden, the number of fatalities can increase or decrease related to rises and declines in construction activity. Fatality rates are a better indicator of performance since they account for year to year differences in construction activity. While the fatality rate for the construction sector as a whole is made available each year, fatality rates for industry subsectors are not provided. The structure of the construction industry is by trade (e.g. electricians, sheet metal, etc) and unions and trade associations reflect this organization. Progress on improving safety and health is most likely to occur at this subsector and industry level. These groups do not currently have access to fatality rates to track whether or not their performance is improving or deteriorating.

Thus additional work is needed to understand the reliability of current traditional systems and to support incremental upgrades. Exploration of alternative mechanisms to supplement these systems is also important, along with long term planning to describe key information needs for meaningful tracking of construction industry performance, and how they might be obtained.

Another important surveillance area is the use of case-based information for targeted interventions. Our national surveillance systems cannot collect detailed risk factor information for all hazards given the prohibitive costs that would be associated with such an approach. Case-based surveillance, where investigators collect more detailed information on a subset of hazards and cases, provides invaluable detail about risk factors. NIOSH's FACE (Fatality Assessment and Control Evaluation) is an example of a case-based program that relies on state and national investigators to complement national population statistics. Evaluation of FACE reports allows recognition of common risk factors and newly emerging problems leading to development of targeted state and national hazard alerts and interventions. In sum, it is important to include case-based approaches in broadly defining national surveillance needs for construction.

The following intermediate goals address three topic areas. The first goal addresses improving traditional surveillance systems, which focus on collecting information on outcomes such as fatal and non-fatal injuries and illnesses. The second goal acknowledges that while traditional surveillance provides crucial information critical for understanding impact, it is also “lagging” information that represents failures to prevent injury and illness. Goal 2 addresses the increasing interest in developing “leading indicators” such as information on exposure or the existence of programs and practices that correlate with safety and health performance. For example, given known limitations in the ability to capture occupational illnesses, capturing information on national sector exposure trends is an important surveillance enhancement to consider. This emerging surveillance concept represents opportunities for new surveillance partnerships with construction industry trade associations, labor unions, and interested safety and health professionals. The third goal addresses improving surveillance practice at the enterprise and project level. This recognizes that surveillance is not just a national or state or sector level activity. It is also a model practice for construction employers and projects to support continuous improvement of safety and health performance. There are new opportunities for merging surveillance concepts with management benchmarking practices to improve surveillance approaches at the enterprise and project level.

NOTE: THE FOLLOWING INTERIM INTERMEDIATE GOAL IS TO BE DELETED FROM FINAL SURVEILLANCE GOALS. IT IS INCLUDED FOR INTERNAL NORA CONSTRUCTION SECTOR COUNCIL COORDINATION DISCUSSIONS PRIOR TO FINALIZING DRAFT GOALS.

Intermediate Goal - Assist NORA Construction Sector workgroups to develop appropriate baselines, performance measures, and progress reports related to the National Construction Agenda

Performance Measure*: Assure that the workgroups working on the other nine NORA Construction Sector goals can generate meaningful baseline performance measures and can track performance over the decade.*

Surveillance issues cut across all of the other NORA Construction Sector Strategic goals because each requires development of performance measures, and follow-on performance tracking over the decade. Some of the other construction goals rely upon existing surveillance information and some plan to develop new baseline measures using survey research. There is a need to coordinate these efforts to minimize overlap, preserve surveillance resources and to maximize effort. Thus these coordination goals are listed first to address the need to insure coordination across the NORA Construction sector on surveillance issues.

Coordination goal 1 – Support and assist with coordination of sector-wide efforts to develop performance baselines.

For example, the NORA Construction Sector council co-chairs, advised by the Construction Sector Surveillance workgroup representatives, can convene a meeting to include NIOSH Surveillance representatives, NORA Construction Sector workgroup representatives, and surveillance experts to discuss specific surveillance and survey needs and to provide suggestions for coordinated efforts among workgroups. Additional coordination can be provided to develop Healthy People 2020 objectives for construction.

Coordination goal 2 – Develop a Sector-wide plan to support generation of progress reports on NORA Construction Sector performance measures for 5 years and 9 years after baseline information is collected.

For example, the NORA Construction Sector council co-chairs, advised by the Construction Sector Surveillance workgroup representatives, can develop an implementation plan for generating progress reports over the course of the second decade of NORA.

Intermediate Goal 14.1 – Partner with surveillance researchers and federal and state surveillance programs to support, enhance, and expand collection of traditional surveillance information relevant for the construction sector

Performance Measure: This goal will be met by accomplishing the following outputs: two workshops, one white paper, at least three new information products, and development and piloting of at least five upgrades or enhancements to currently available surveillance resources.

Research Goal 14.1.1 – Convene a workshop to systematically review existing national outcome surveillance systems to identify key shortcomings relevant to construction and to develop and implement three proposals for enhancement or expansion of current systems.

For example, this effort could address the need for denominator data sources to support development of rates at the subsector (e.g. Building Construction; Heavy and Civil Engineering Construction; and Specialty Trade Contractors) and specific industry (e.g. residential construction) level, and needs such as collection of more complete information on contractors and contingent workers. Discussion with surveillance experts and construction stakeholders could include ideas for enhancement pilot studies.

Research to Practice Goal 14.1.2 – Convene a workshop to explore improving the organization and use of currently collected surveillance information via creation of new types of information products. Develop and disseminate additional construction surveillance information products identified from the workshop.

For example, stakeholder and surveillance expert discussions might include discussions of information products that rank specific construction industry injury rates, or which list the top causes for each specific construction industry.

Research Goal 14.1.3 - Expand surveillance research to improve understanding of reliability and sources of bias in existing national outcome surveillance systems.

For example, research might address key issues relevant for construction such as underreporting of injuries among construction workers (especially vulnerable workers) and the potentially disparate impact of the healthy worker effect in construction.

Research Goal 14.1.4 – Explore and pilot approaches for enhancing the collection and use of construction sector information at the state and local level including innovative community-based approaches to documenting work-related injuries and illnesses among vulnerable worker groups in construction.

Research Goal 14.1.5 - Explore and pilot the concept of a regular (e.g. every five years) "National Construction Survey" as a mechanism to collect information not currently collected by our traditional national systems.

For example, current systems provide limited information on health outcomes. The current Health Hazard strategic goals include surveys to collect information for performance measure baselines, and this could serve as a pilot effort.

Research Goal 14.1.6 – Develop a "White Paper" to identify the core data elements needed to meaningfully track 1) construction sector performance for injury, illness, and musculoskeletal disorder outcomes and 2) to identify future health and safety priorities in construction. Identify surveillance and survey research options and a long term roadmap for implementation.

Research to Practice Goal 14.1.7 –Explore developing a communications product such as a "Construction Surveillance Index" or a "Construction Sector Dashboard" to describe key surveillance needs in construction in comparison with currently available information. Update over time to reflect improvements and upgrades resulting from the NORA construction sector research.

For example, such a product might reflect the "White Paper" data elements described in 1.6 so as to describe information gaps in terms of the basic information needed (e.g. the ability to track and rank fatality rates for specific construction industries) to help communicate the importance of surveillance and current gaps to the wider audience of construction and policy decision makers above and beyond surveillance experts. [*NOTE: the NORA Construction Surveillance Workgroup will develop a prototype for discussion to help decide on the potential value of this goal]*

Intermediate Goal 14.2 – Partner with professional associations, surveillance experts, insurance companies, regulatory and consultation organizations to explore, develop, and implement new types of construction-sector hazard, exposure, and performance indicators to supplement current surveillance approaches.

Performance Measure: This goal will be met by developing one white paper describing a model set of construction leading indicators; at least two national databases for construction health hazard exposures; and development and dissemination of guidance on these topics.

<u>Research Goal 14.2.1</u> – Develop a set of "leading" indicators tailored to construction to provide additional sector metrics for evaluating and guiding construction industry safety and health performance. Research should include evaluation of the measures to determine if they correlate with outcome measures. Indicators should be described in a "White Paper" report.

While traditional surveillance measures are important and are directly related to serious injury, fatality and illness outcomes, they are retrospective or "lagging" indicators that quantify events that have already occurred. The value of leading indicators is that they address precursor measures that can be tracked and used to prevent injuries and fatalities. Examples might include metrics such as: numbers of workers with 10 hour training; numbers of jobs where pre-job planning for specific hazards is done; reported use of hazardous materials (e.g., lead or silica sand abrasive); or use of specific health interventions or controls. Resulting indicators might be used as input for developing a National Construction Survey.

<u>Research Goal 14.2.2</u> – Develop, evaluate, and implement national construction sector exposure databases for important construction health hazards such as noise, silica, and welding fumes.

These qualitative and quantitative databases could be designed via partnerships with professional associations, governmental organizations, and construction stakeholders. Design considerations could include providing exposure assessment benefits for individual employers and organizations contributing and sharing data, and the ability to aggregate and structure data to allow development and tracking of sector exposure trends.

<u>Research Goal 14.2.3</u> – Explore the value and interest in developing additional data sharing templates for collection and sharing of other types of data (besides industrial hygiene exposure data).

For example, sharing of information on topics such as: subcontractor prequalification evaluations; job safety analyses; or other model practices depending on interest and perceived value for improving sector safety and health performance over time.

Research to Practice Goal 14.2.4 – Develop and disseminate construction sector guidance on leading indicator metrics, exposure databases, and information sharing practices throughout the industry.

Intermediate Goal 14.3 – Partner with best practice employers, labor organizations, and project owners to explore, develop and implement model safety and health surveillance measures to support improved safety and health performance at the enterprise and project level

Performance Measure: This goal will be met by developing one white paper describing model surveillance practices at the employer and project level and dissemination of information to expand the use of these practices.

Research Goal 14.3.1 – Develop and expand the use of model surveillance practices at the employer and project level. The intent of this goal is to develop and evaluate approaches that employers and others can use to optimize the collection and active use of both leading and lagging indicators. Successful approaches should be described in a “White Paper” report.

For example, research topics might include systems for collecting and using so-called “near miss” information; for owner tracking and use of project-wide injury and leading indicator metrics; evaluation of leading indicators for correlation to outcome data, or business case studies of the value of such model practices.

Research to Practice Goal 14.3.2 – Partner with insurance carriers, governmental organizations, best practice employers, and others to disseminate information on model employer and project surveillance practices and benefits. Expand the use of model practices among best practice employers and owners.

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NORA – A PLAN FOR THE DECADE AHEAD (2006-2016)

The purpose of this section is to describe what lies ahead for the NORA effort. The initial phase (2006-2007) has focused on developing these draft goals. We plan to incorporate comments and finalize the goals in the middle of 2008. What will happen next? What other activities will NORA involve? Here is our current thinking on the decade ahead.

Developing an implementation plan

NORA is intended to provide an agenda for the nation, and we strongly encourage construction stakeholders to participate and partner on specific strategic and intermediate goals. An implementation plan will be developed to address start-up and coordination efforts for the agenda. Stakeholder interest in specific goals, along with factors such as anticipated funding levels and availability and interest from researchers, will be considered to select priorities and schedule initiation of the NORA National Construction Agenda efforts. Stakeholders interested in participating can provide input and help shape the implementation plan to accompany the national agenda.

Partnerships

Partnerships are key to the success of NORA, and NIOSH will encourage "NORA Construction Partnerships" to facilitate implementation of the National Construction Agenda. There are a variety of ways to participate. For example, a construction firm might be interested in participating in research; trade associations and labor unions might be interested in working to generate tailored products for their members derived from research findings; and professional associations might partner to survey members or disseminate findings and products via meetings and publications. We also encourage organizations that fund construction research to partner by adopting these goals for funding. Some partnerships can be formalized using memorandums of understanding where appropriate. Other partnerships may be more informal or be arranged between groups with minimal NIOSH involvement.

Using NORA to guide new research

The NORA goals will be incorporated into research funding mechanisms such as "Requests for Applications" (RFAs) to drive the direction of construction research towards these strategic goals. Efforts will be made to incorporate these goals beginning later in 2008.

Tracking progress on performance measures and industry outcomes

All of the goals include performance measures. These will be tracked over the decade starting from initial baselines (some baselines need to be created as early intermediate goals). A mid-decade status report will be prepared to describe progress. A final report will be generated at the end of the decade (2016) to report on the progress made by the construction sector in meeting these goals.

Research to Practice (R2P)

R2P is a critical component for NORA to be a success, and it will be a major focus of the NORA Construction Sector Council once the goals have been finalized. Here are some examples of potential R2P activities:

- Linking researchers and construction partners for new NORA National Construction Agenda projects.
- Hearing from researchers finishing up projects about their results – and discussing how best to disseminate results and create additional information products for the industry.
- Developing new types of products tailored to construction – such as products for small employers, business case studies, materials for immigrant workers, etc.
- Increasing opportunities for researchers and stakeholders to interact at meetings.
- Improving targeted dissemination of materials – including more effective use of the construction trade press and getting solutions to more of the industry via new diffusion methods.
- Trying new types of activities – such as coordinated efforts like a "National Falls Campaign" to use social marketing methods to improve awareness and implementation.

Communicating to partners and stakeholders

An electronic newsletter titled ***"NORA Construction Sector News"*** will be issued four times a year to inform Construction stakeholders about NORA developments. As goals lead to activities and activities to products, this will provide a mechanism to get the word out on research results, new R2P products, meetings, and partner activities. It will also provide a vehicle for sharing reports on how NORA outputs are being used to improve safety and health conditions for construction workers. The inaugural December 2007 issue reports on the availability of the draft goals for comment. To view or sign-up for the NORA Construction Sector electronic newsletter go to the NORA Construction Sector page http://www.cdc.gov/niosh/nora/councils/const/ and click on products.

Ultimate goal – making an impact

The National Construction Agenda provides a way for construction sector stakeholders to work together on shared priorities to make a difference for employee safety and health. Please join us.