All Hands Safety Meeting

May 10, 2017

ARCHITECTURE, ENGINEERING
AND CONSTRUCTION
UNIVERSITY OF MICHIGAN

Agenda

SAFETY FIRST

Welcome

Marina Roelofs, University of Michigan, AEC

U-M Construction Safety Update

Mike Marenghi, Project Director and Matt Kettman, Construction Safety Specialist

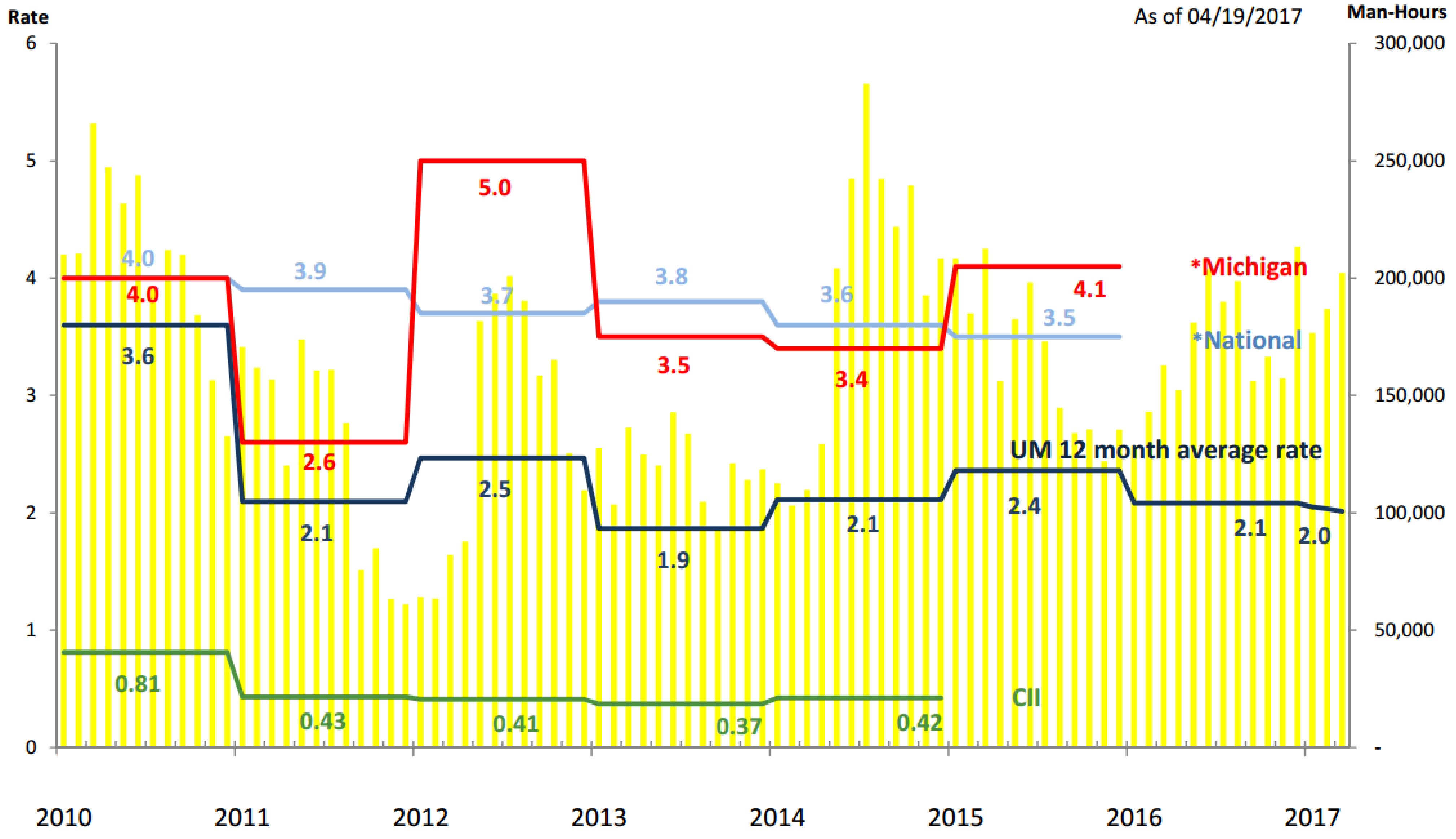
Occupational Health Standard, Part 690 – Silica in Construction

Eric Allen, Construction Safety & Health Division Manager, MIOSHA

Emergent Technologies & Studies in Worker Safety and Employee Performance

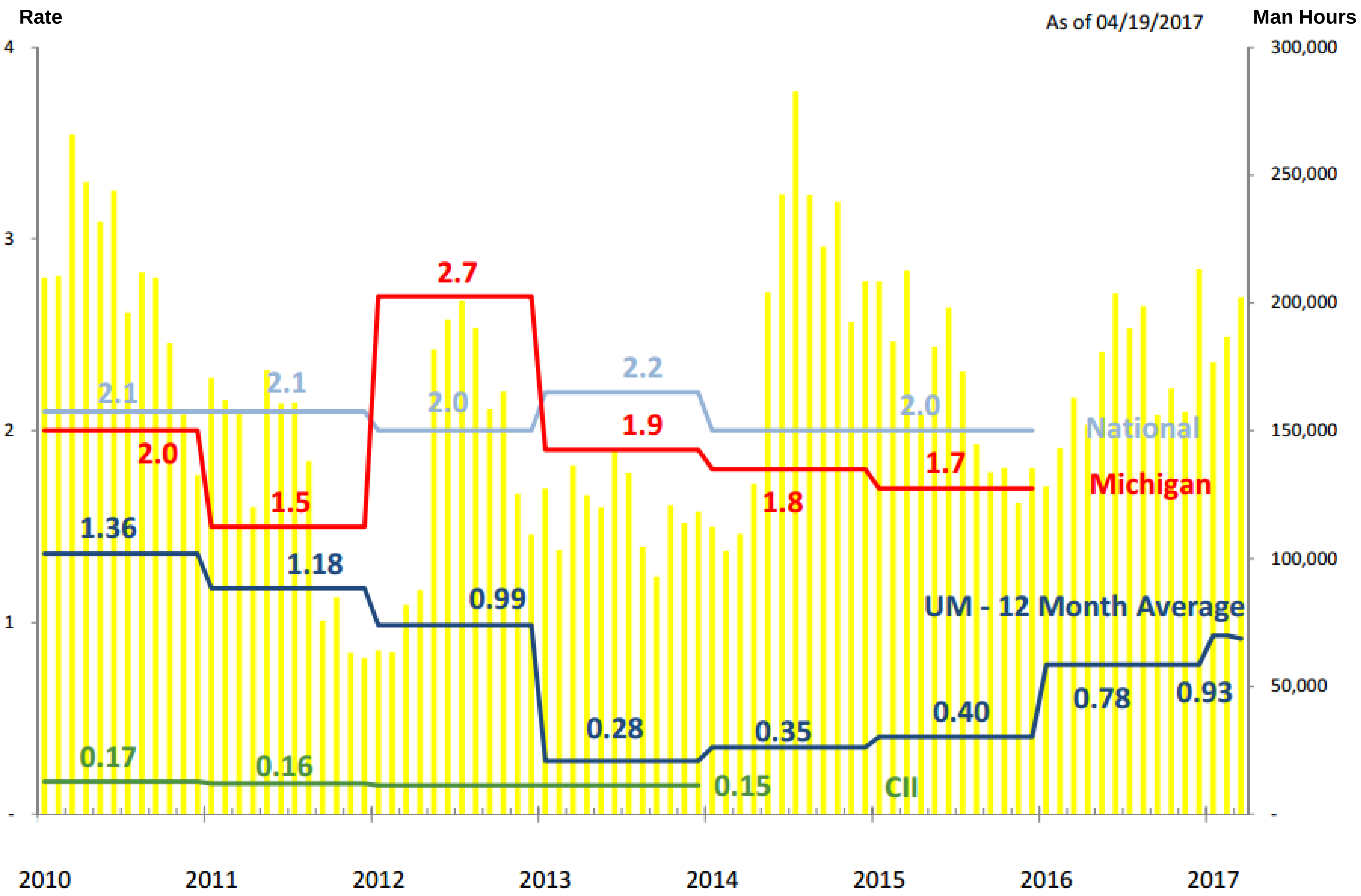
Dr. SangHyun Lee, Associate Professor, University of Michigan/Civil & Environmental Engineering

Annual OSHA Recordable Incidents Rate



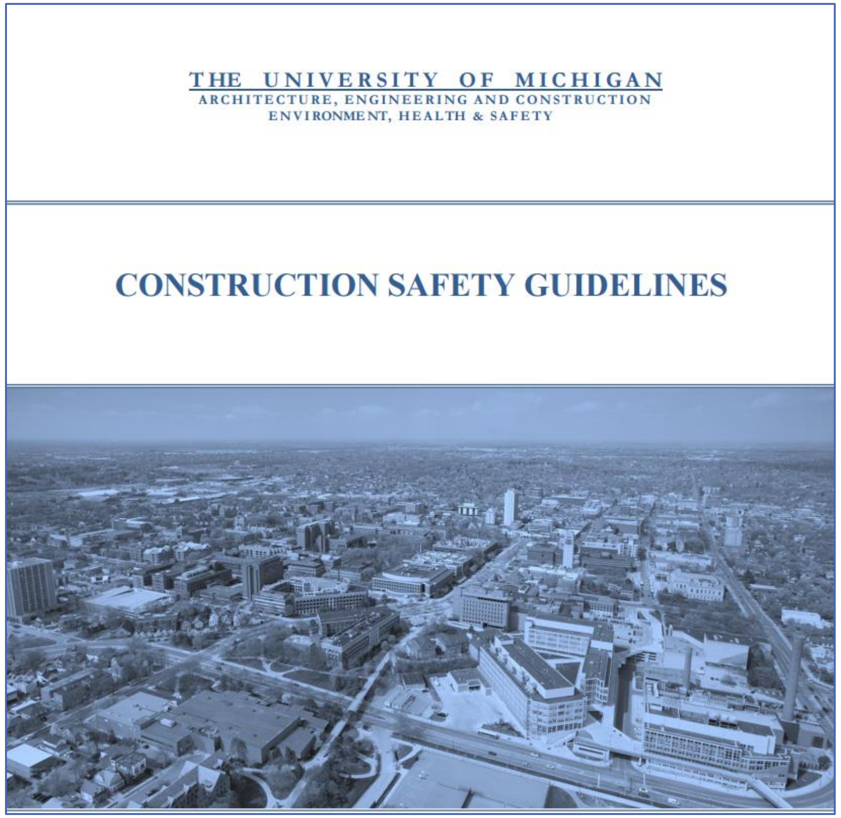
*OSHA Annual Recordable Incident Rate as reported by the U.S. Bureau of Labor Statistics

Annual DART Recordable Incidents Rate



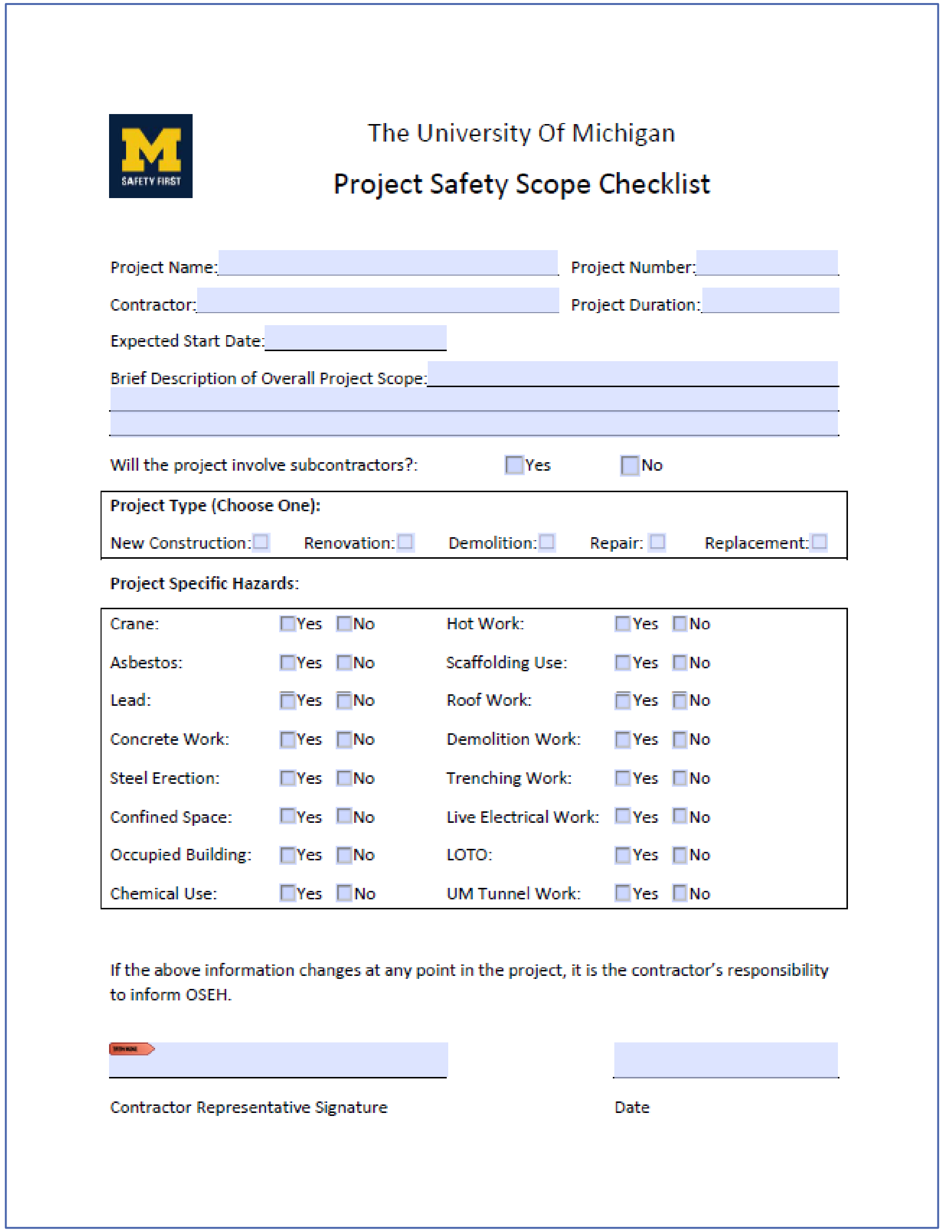
Changes to the Safety Guidelines

- New Project Safety Scope Checklist
- Post-assembly inspections
  - Must be performed whenever a crane is assembled or altered onsite
- Change to near miss reporting
- Temporary Elevator Policy
  - No more separation of doors!
  - Simplified
    - Car is to left with doors open and a barricade placed across the opening



Project Safety Scope Checklist

- New Form that should be submitted with all safety plans
- Assist EHS in prompt and accurate review
- Located on the EHS website under “Contractor Safety”
- Please start using immediately!



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Project Safety Scope Checklist

Project Name: ______ Project Number: ______

Contractor: ______ Project Duration: ______

Expected Start Date: ______

Brief Description of Overall Project Scope: ______

Will the project involve subcontractors?: ☐Yes ☐No

Project Type (Choose One):

New Construction: ☐ Renovation: ☐ Demolition: ☐ Repair: ☐ Replacement: ☐

Project Specific Hazards:

Crane:	☐Yes ☐No	Hot Work:	☐Yes ☐No
Asbestos:	☐Yes ☐No	Scaffolding Use:	☐Yes ☐No
Lead:	☐Yes ☐No	Roof Work:	☐Yes ☐No
Concrete Work:	☐Yes ☐No	Demolition Work:	☐Yes ☐No
Steel Erection:	☐Yes ☐No	Trenching Work:	☐Yes ☐No
Confined Space:	☐Yes ☐No	Live Electrical Work:	☐Yes ☐No
Occupied Building:	☐Yes ☐No	LOTO:	☐Yes ☐No
Chemical Use:	☐Yes ☐No	UM Tunnel Work:	☐Yes ☐No

If the above information changes at any point in the project, it is the contractor’s responsibility to inform OSEH.

______ ______

Contractor Representative Signature Date

Monthly Safety Report

- Please use the current version.
- Revised 12/22/16.

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Monthly Safety Report

(Submit by the 7th of next month)

Project Name: ____________ UM Project Number: ____________

Construction Start Date: ____________ Construction End Date: ____________

Data for Month of: ____________ Date Submitted: ____________

☐ Check here if in the construction phase but not yet mobilized or if substantially complete with no activity on site. Data is not required; Project Manager may submit on behalf of contractor.

INCIDENT TYPES	Number of Cases			U-M Project Goal	Rates		
	Current Month	Year to Date	Project to Date		National Average	Year to Date	Total Project
OSHA Recordable Incidents				0	3.5		
DART Incidents				0	2.0		
Lost Work Incidents				0	1.3		
Non-recordables, near misses, etc.				0	2015 BLS Construction Data		

OSHA RECORDABLE INCIDENTS: *Please classify **Incident type** below and also complete page 2 with details:*	Current Month	Year to Date	Project to Date
Fall (e.g., floors, platforms, roofs)			
Struck by/against(e.g., falling objects, vehicles)			
Caught in/between (e.g., cave-ins, unguarded machinery, equipment)			
Electrical (e.g., overhead power lines, power tools/cords, outlets, wiring)			
Overexertion			
Inhalation			
Heat			
Other (other items not covered above)			
EMPLOYMENT INFORMATION *(includes contract workers)*			
Average Daily Number of Employees (FTE's)			
Total Hours Worked by Employees			

SAFETY FIRST

Crane Lifts Over Occupied Buildings

- Registered structural engineer shall review
- Must determine capability of building to withstand dropped load
- Coordinate with UM project manager

Respirable Crystalline Silica

MIOSHA Part 690

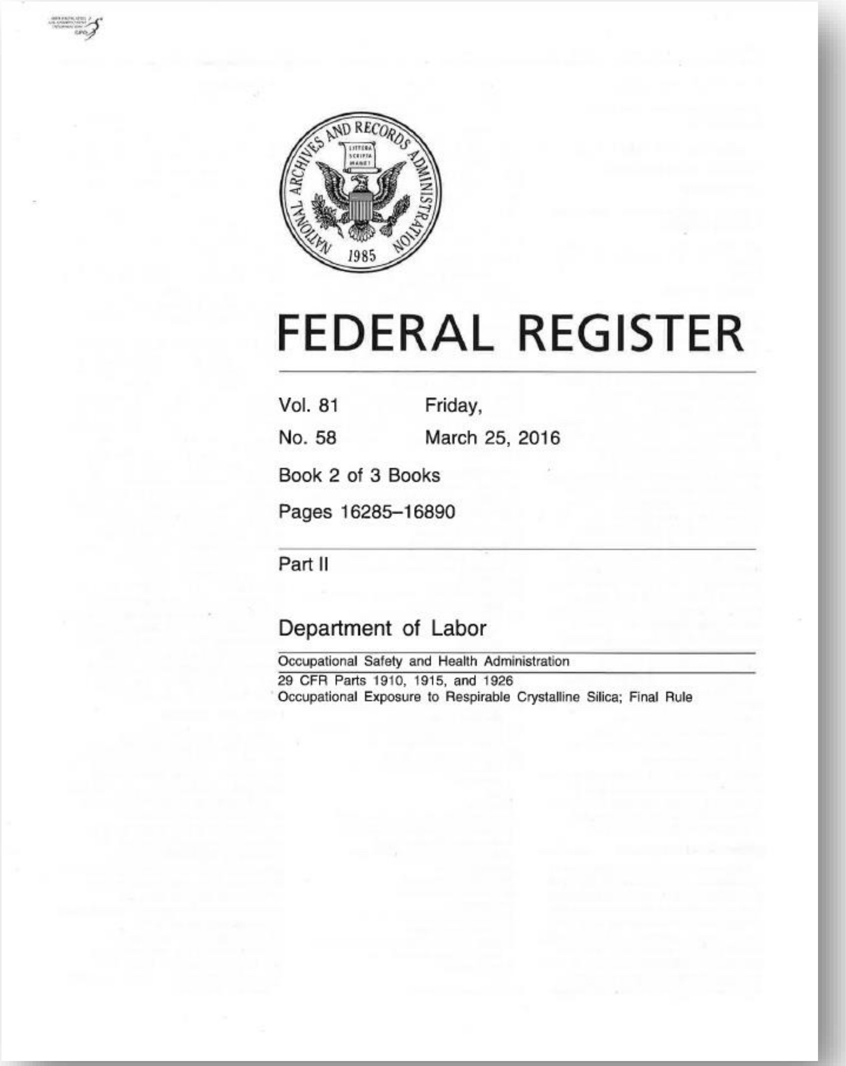
University of Michigan

May 10, 2017

Presented by Eric Allen

Adopts Federal OSHA Standard

- Published on March 25, 2016.
- Addresses employee exposures to respirable crystalline silica.
- Impacts both Construction and General Industry activities (maritime is protected by federal OSHA).
- Reasons for the new standard:
  - Current PELs do not adequately protect construction and general industry employees.
  - Extensive epidemiologic evidence that lung cancer and silicosis occur at exposure levels below 100 $\mu g/m^3$.



NATIONAL ARCHIVES AND RECORDS ADMINISTRATION 1985

FEDERAL REGISTER

Vol. 81 No. 58

Friday, March 25, 2016

Book 2 of 3 Books

Pages 16285–16890

Part II

Department of Labor

Occupational Safety and Health Administration

29 CFR Parts 1910, 1915, and 1926

Occupational Exposure to Respirable Crystalline Silica; Final Rule

MIOSHA
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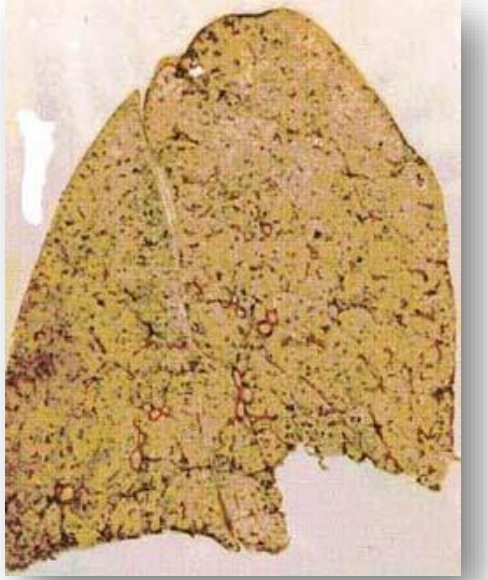
Exposure and Health Risks

Exposure to respirable crystalline silica has been linked to:

- Silicosis,
- Lung cancer,
- Chronic obstructive pulmonary disease, and
- Kidney disease.



Healthy Lung

Silicotic Lung

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Respirable Crystalline Silica Standards

- Two standards in Michigan:
  - MIOSHA Part 590 for general industry (maritime is addressed by federal OSHA).
  - MIOSHA Part 690 for construction.
- Adopts the federal OSHA requirements by reference.

Scope (a)

Construction Standard (MIOSHA Part 690)

- ***Applies to all occupational exposures to respirable crystalline silica*** *in construction work,*
- *Except where employee exposure will remain below 25 micrograms per cubic meter of air (25 $\mu g/m^3$) as an 8-hour time weighted average (TWA) under any foreseeable conditions.*
- Foreseeable exposures must remain below the action level.

Objective Data

- Information, such as air monitoring data from industry-wide surveys or calculations based on the composition of a substance, demonstrating employee exposure to respirable crystalline silica associated with a particular product or material or a specific process, task, or activity.
- The data must reflect workplace conditions closely resembling or with a higher exposure potential than the processes, types of material, control methods, work practices, and environmental conditions in the employer's current operations.

Objective data must include…

The crystalline silica material in question.

The source of the objective data.

The testing protocol and results of the testing.

Description of the process, task, or activity on which the objective data were based.

Other data relevant to the process, task, activity, material, or exposures on which the objective data is based.

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Specified Exposure Control Methods (c)

Construction Standard (MIOSHA Part 690)

- **Option 1**: If an employee is engaged in a task is identified in Table 1, fully and properly implement the engineering controls, work practices, and respiratory protection specified by Table 1; **UNLESS**
- **OPTION 2**: Assess and limit employee exposure to respirable crystalline silica in accordance with paragraph (d) of this section.

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Specified Exposure Control Methods

MIOSHA Part 690, Table 1 Equipment/Tasks

1. Stationary masonry saws
2. Handheld power saws
3. Handheld power saws for cutting fiber-cement board
4. Walk-behind saws
5. Drivable saws
6. Rig-mounted core saws or drills
7. Handheld and stand-mounted drills
8. Dowel drilling for concrete
9. Vehicle-mounted drilling rigs for rock and concrete
10. Jackhammers and handheld powered chipping tools
11. Handheld grinders for mortar removal (i.e., tuckpointing)
12. Handheld grinders for uses other than mortar removal
13. Walk-behind milling machines and floor grinders
14. Small drivable milling machines
15. Large drivable milling machines
16. Crushing machines
17. Heavy equipment and utility vehicles used to abrade or fracture silica-containing materials
18. Heavy equipment and utility vehicles for tasks such as grading and excavating

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Example of Table 1 Entry

Handheld Power Saws (any blade diameter)

Equipment / Task	Engineering and Work Practice Control Methods	Required Respiratory Protection and Minimum APF	
		≤ 4 hr/shift	> 4 hr/shift
Handheld power saws (any blade diameter)	Use saw equipped with integrated water delivery system that continuously feeds water to the blade. Operate and maintain tool in accordance with manufacturers' instruction to minimize dust. - When used outdoors - When used indoors or in an enclosed area	None APF 10	APF 10 APF 10

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For tasks performed indoors or in enclosed areas…

Provide a means of exhaust as needed to minimize the accumulation of visible airborne dust.

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For tasks performed using wet methods…

Apply water at flow rates sufficient to minimize release of visible dust.

For measures implemented that include an enclosed cab or booth …

Ensure that the enclosed cab or booth:

A. Is maintained as free as practicable from settled dust;
B. Has door seals and closing mechanisms that work properly;
C. Has gaskets and seals that are in good condition and working properly;
D. Is under positive pressure maintained through continuous delivery of fresh air;
E. Has intake air that is filtered through a filter that is 95% efficient in the 0.3-10.0 µm range (e.g., MERV-16 or better); and
F. Has heating and cooling capabilities.

When implementing Table 1 control measures… (continued)

- Where an employee **performs more than one task on Table 1 during the course of a shift, and the total duration of all tasks combined is more than four hours**, the required respiratory protection for each task is the respiratory protection specified for more than four hours per shift.
- If the **total duration of all tasks on Table 1 combined is less than four hours**, the required respiratory protection for each task is the respiratory protection specified for less than four hours per shift.

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Employees Engaged in Table 1 Tasks

- Employees are “engaged in the task” when operating the listed equipment, assisting with the task, or have some responsibility for the completion of the task.
- Employees are not “engaged in the task” if they are only in the vicinity of a task.

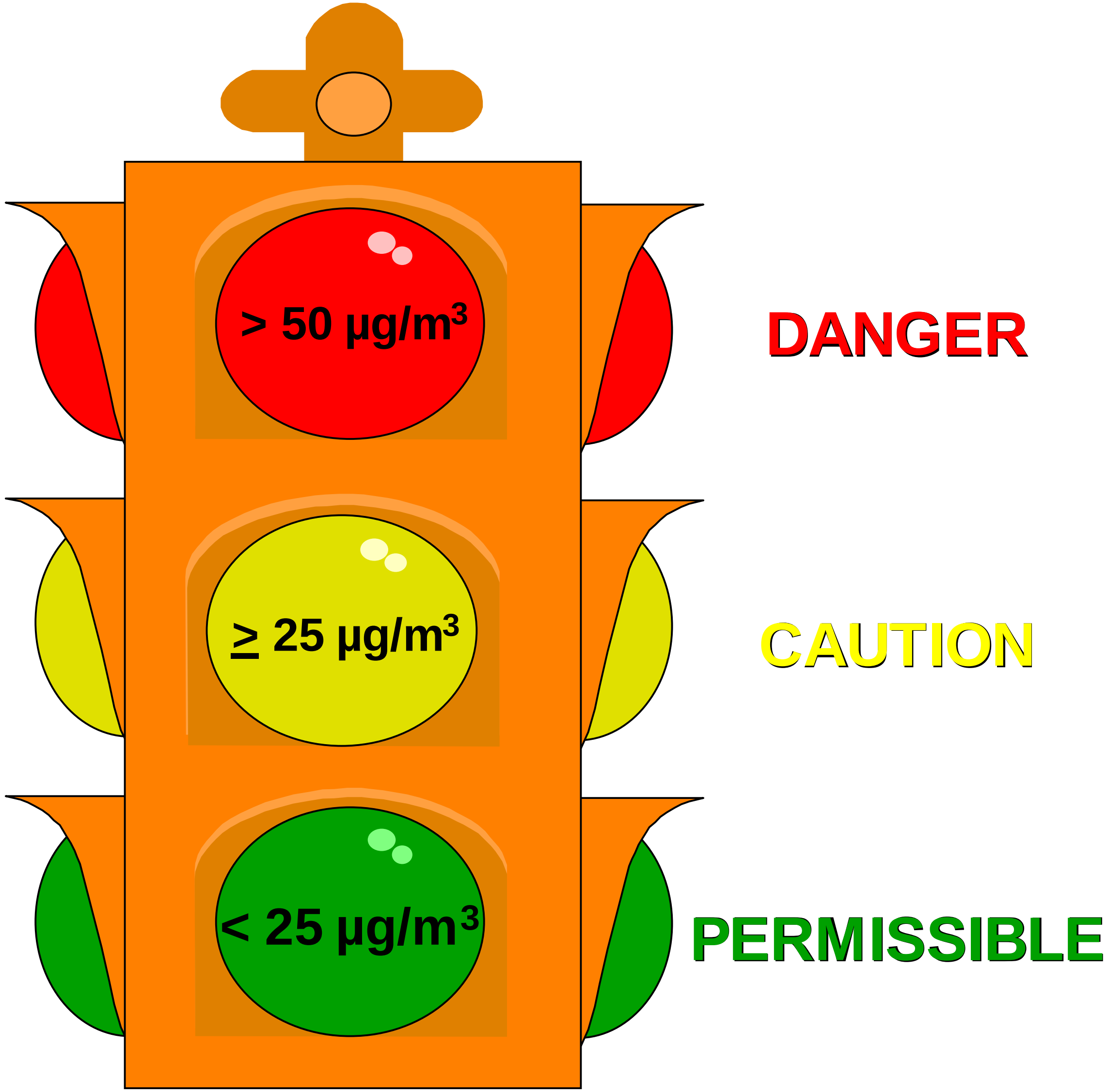
Silica Exposure Limits

- **PEL**: 50 µg/m³, 8-hr TWA

- AL: 25 µg/m³, 8-hr TWA

PEL: permissible exposure limit

AL: action level



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Frequency of Monitoring

- Initial results < AL: No additional monitoring
- Most recent result ≥ AL Repeat again within 6 months
- Most recent result > PEL Repeat again within 3 months
- When two consecutive non-initial results, taken 7 or more days apart, but less than 6 months, are < AL Can discontinue monitoring

If/when conditions change... **REASSESS**

Reassessment of Exposures

- Reassess exposures **whenever a change in the production, process, control equipment, personnel, or work practices** may reasonably be expected to result in new or additional exposures at or above the action level, **OR**
- When the employer has any reason to believe that **new or additional exposures** at or above the action level have occurred.

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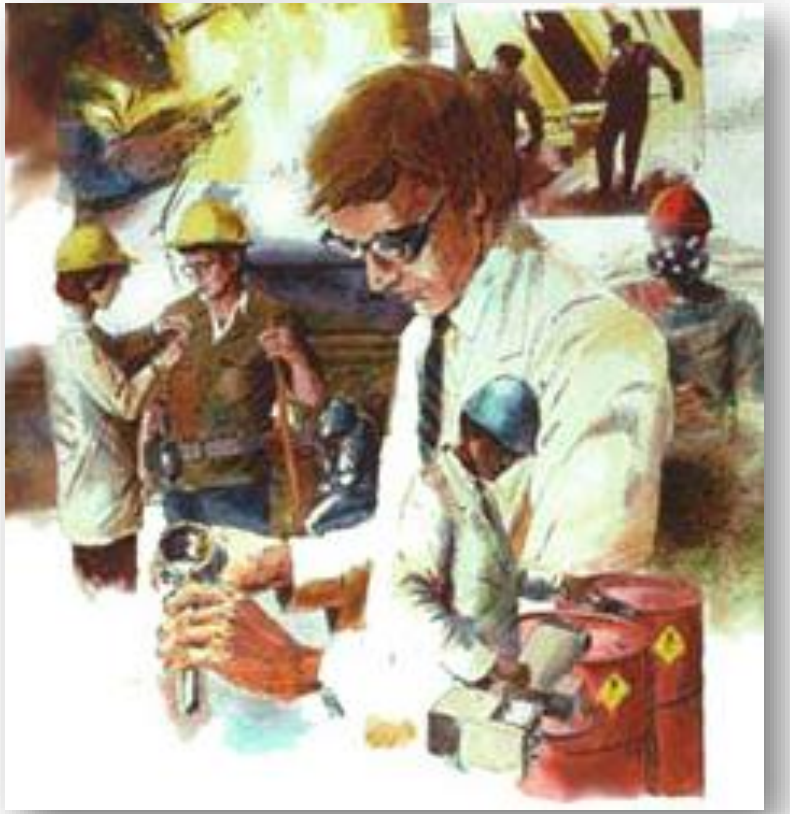
Methods of Sample Analysis

Use of Appendix A



- Employers must ensure that samples are analyzed by a laboratory that follows the procedures in Appendix A.
- Appendix A specifies methods of sample analysis:
  - Allows for use of OSHA, NIOSH, or MSHA methods.
  - Analysis must be conducted by accredited laboratories that follow specified quality control procedures.

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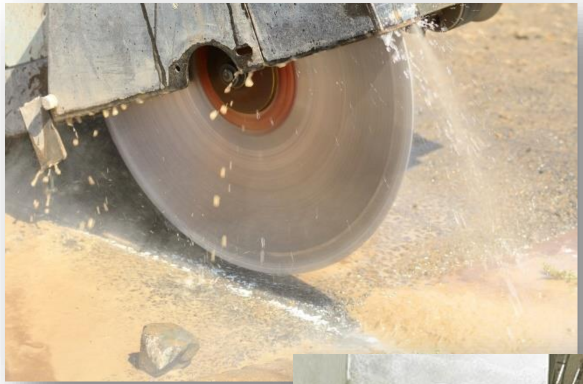
Methods of Compliance

Engineering and Work Practices Controls

- Employers shall **use engineering and work practice controls** to limit exposures to or below the PEL unless they are demonstrated to be not feasible.
- Use such controls even if they do not reduce exposures to or below the PEL.
- **Respirators permitted where PEL cannot be achieved** with engineering and work practice controls



Wet methods

HEPA vacuum

HEPA-filtered respiratory protection

MIOSHA Michigan Occupational Safety and Health Administration

Written Exposure Control Plan

The plan must describe:

- Tasks involving exposure to respirable crystalline silica.
- Engineering controls, work practices, and respiratory protection for each task.
- Housekeeping measures used to limit exposure.
- Procedures used to restrict access to work areas, when necessary (minimize exposed employees).

- Review the plan annually; update as necessary.
- Make the plan readily available.

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Medical Surveillance

- Employers must offer medical examinations to **workers required to wear a respirator under Part 690 for 30 or more days a year**.
- Employers must **offer examinations every three years** to workers who continue to be exposed above the trigger.
- Exam includes medical and work history, physical exam, chest X-ray, and pulmonary function test (TB test on initial exam only).

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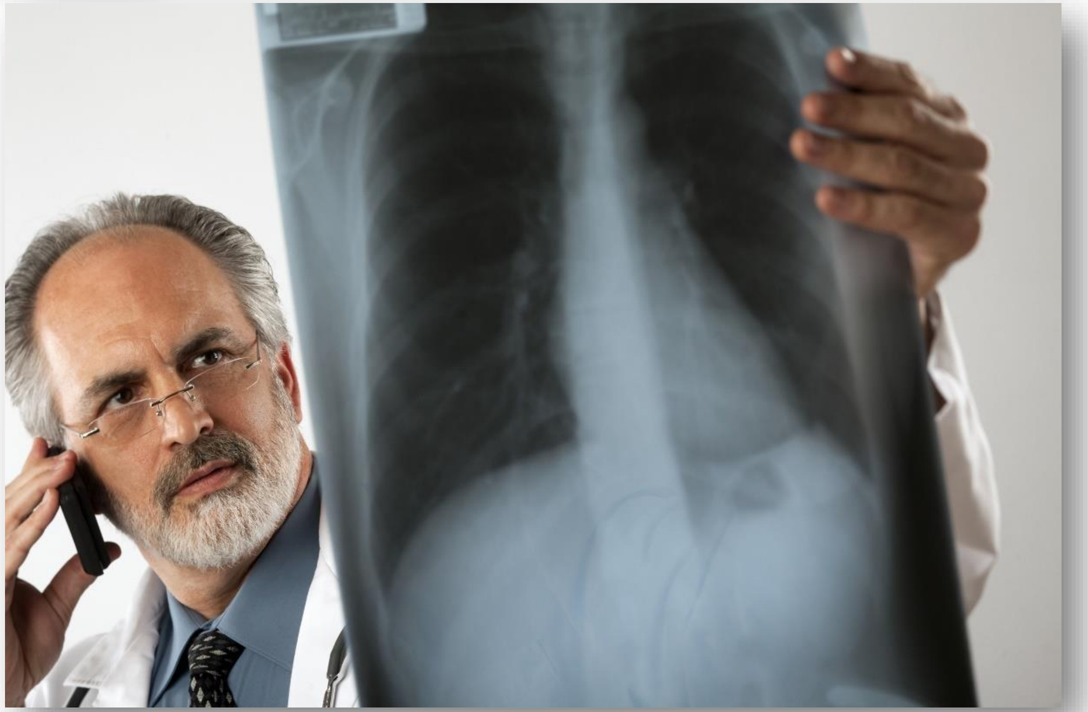
Medical Opinion



- Worker receives report with detailed medical findings.
- Employer receives an opinion that only describes limitations on respirator use, and if the worker gives written consent, recommendations on:
  - Limitations on exposure to respirable crystalline silica, and/or
  - Examination by a specialist.

Compliance Dates

U.S. Department of Labor

Occupational Safety and Health Administration
Washington, D.C. 20210

Reply to the attention of:

APR 0 6 2017

MEMORANDUM FOR THE REGIONAL ADMINISTRATORS

FROM: for DOROTHY DOUGHERTY
Deputy Assistant Secretary

SUBJECT: Delay of Enforcement of the Crystalline Silica Standard for Construction under 29 CFR 1926.1153

The final rule on Occupational Exposure to Crystalline Silica in Construction, published on March 25, 2016, established a new Permissible Exposure Limit and contained several other ancillary provisions that apply to the construction industry. This rule was codified at 29 CFR §1926.1153 and became effective on June 23, 2016. Under the standard, all obligations were to commence on June 23, 2017, except for requirements for sample analysis in paragraph (d)(2)(v), which commence on June 23, 2018.

The construction standard for crystalline silica has a number of unique features warranting development of additional guidance materials. In order to provide the opportunity to conduct additional outreach to the regulated community and to provide additional time to train compliance officers, we have decided to delay enforcement of this standard until September 23, 2017. We are currently developing educational materials for employers and enforcement guidance for your staff that will be made available shortly. Please instruct your staff to provide these materials to employers that are subject to the requirements under § 1926.1153 and to provide guidance on what steps the employers can take to ensure that they are in compliance with the new provisions when enforcement begins on September 23, 2017.

The rule will go into effect on:

September 23, 2017

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Appendix A

- Specifies procedures for analyzing air samples for respirable crystalline silica and quality control procedures employers must ensure laboratories use when performing an analysis.
- The employer must ensure the laboratory:
  - Evaluates all samples using one of six analytical methods;
  - Is accredited with respect to crystalline silica analyses;
  - Uses the most current traceable standards for instrument calibration or instrument calibration verification;
  - Implements an internal quality control (QC) program;
  - Characterizes the sample material; **AND**
  - Analyzes quantitatively for crystalline silica and performs specified instrument calibration checks.

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The End!

Any Questions?

Emergent Technologies for Construction Safety and Health

SangHyun Lee, PhD

Associate Professor & John Tishman Faculty Scholar
Department of Civil & Environmental Engineering
University of Michigan

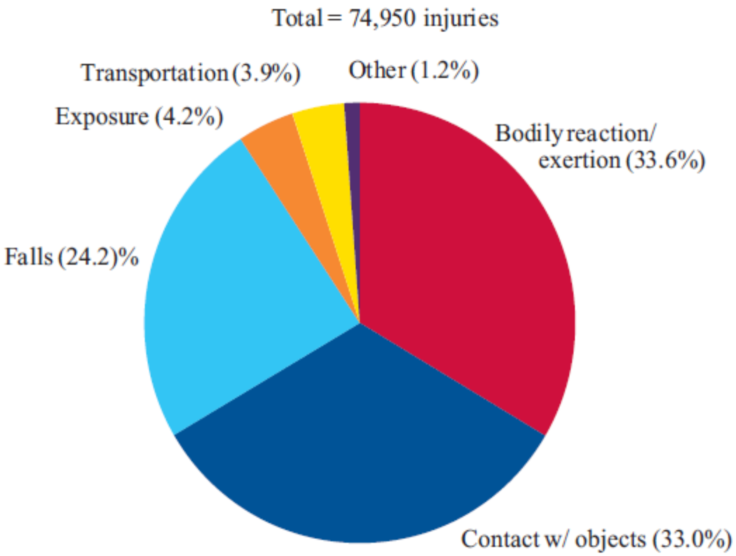
UM Dynamic Project Management Group

- http://dpm.engin.umich.edu
- 1 Post doctoral fellow, 5 PhD students, 2 MSc student, 5 undergraduate students
- Construction safety and health
  - Sensing technologies, human behavior, social influence

Work-related Musculoskeletal Disorder

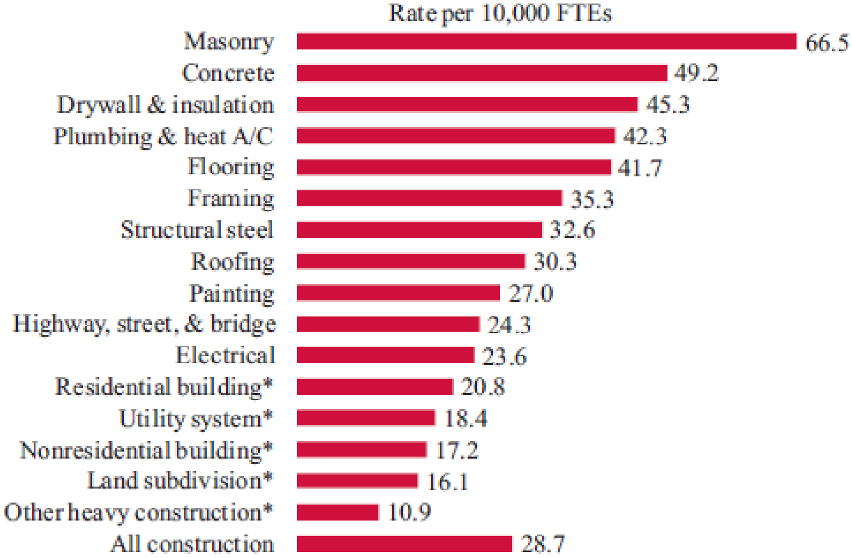
- High risks of WMSDs during construction tasks
- Account for 33.6% of non-fatal injuries in construction
- Could be more severe due to underreporting (30-40%)

43b. Distribution of leading causes of nonfatal injuries resulting in days away from work in construction, 2010 (Private wage-and-salary workers)



(CPWR 2013)

47e. Rate of overexertion injuries resulting in days away from work, selected construction subsectors, 2010

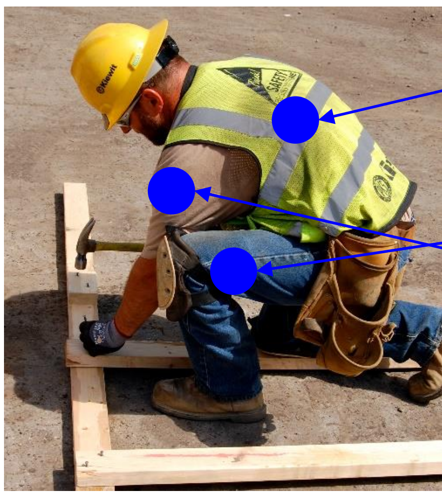


Source: NIOSH Construction Safety & Health Initiatives

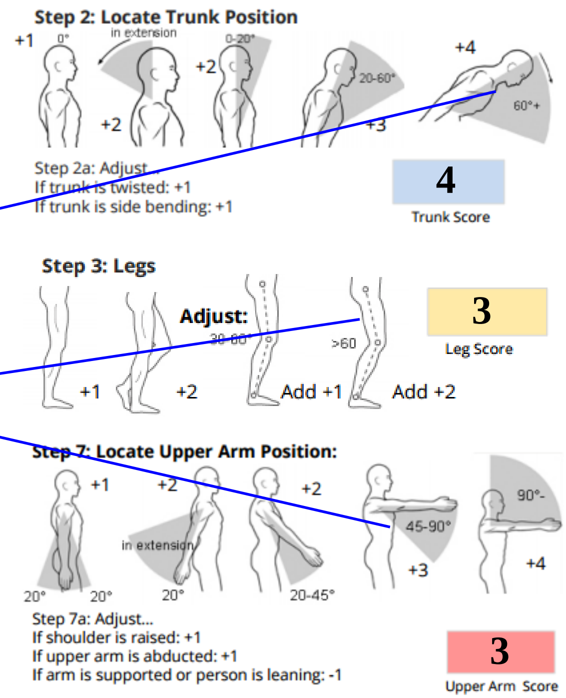
This is What Automotive Industry Does

- NIOSH Lifting Equations, OWAS, RULA, REBA, etc.

Posture A



REBA
(selected postures)

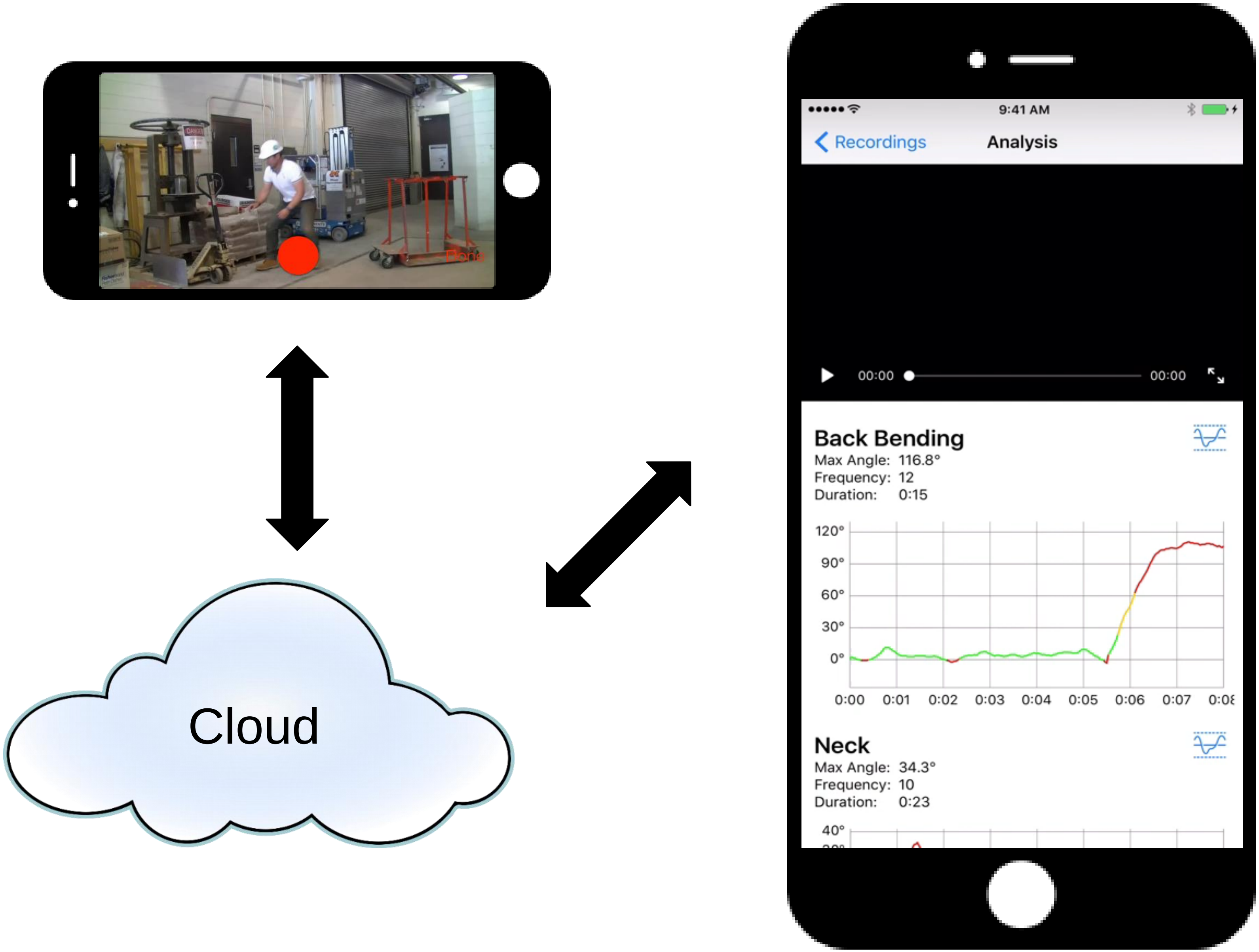


Scoring
1 = Negligible Risk
2-3 = Low Risk. Change may be needed.
4-7 = Medium Risk. Further Investigate. Change Soon.
8-10 = High Risk. Investigate and Implement Change
11+ = Very High Risk. Implement Change

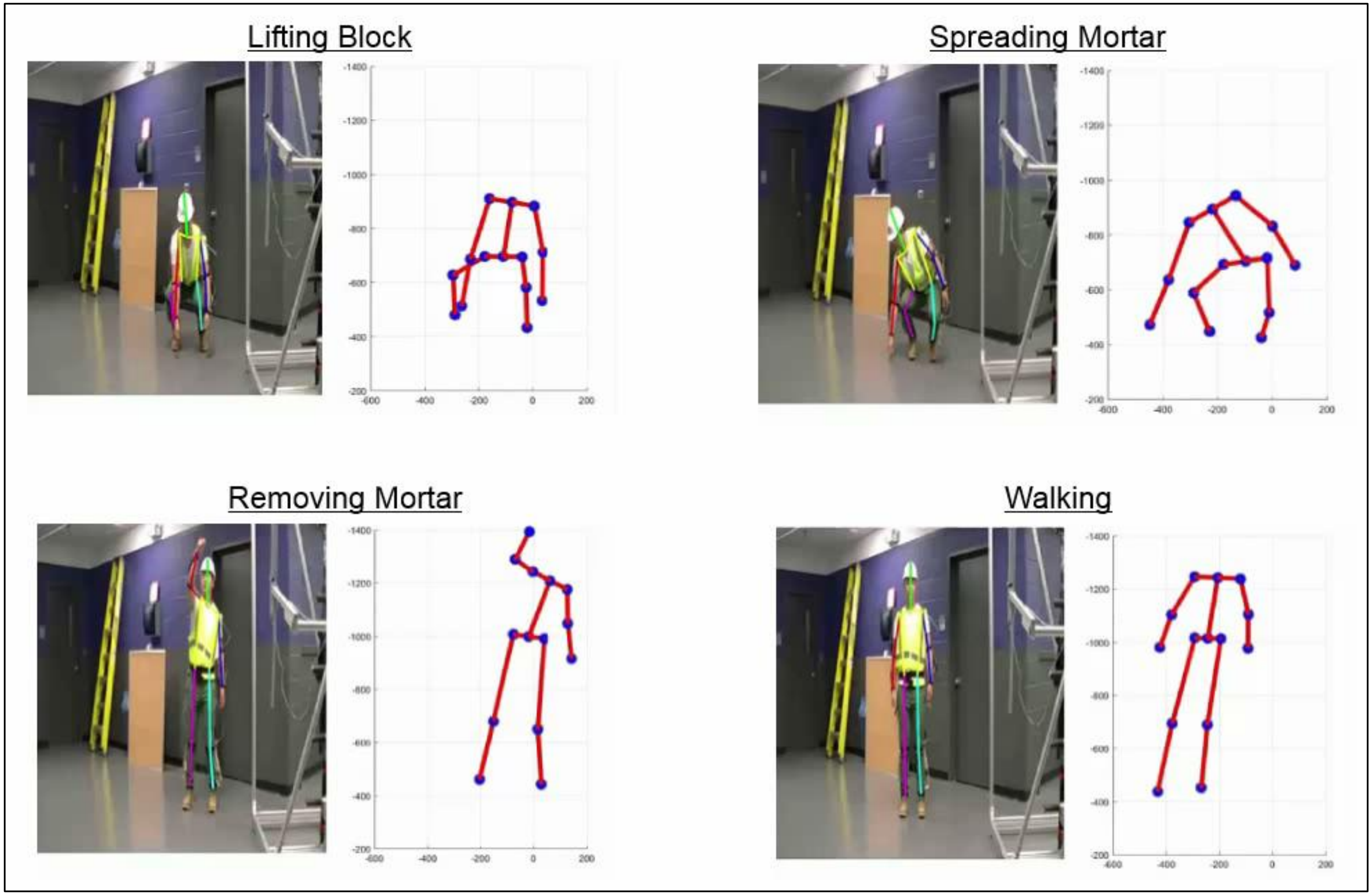
- **Posture Classification**
- **Frequency**
- **Duration**
- **Severity (body angles)**

Smartphone-based Ergonomic Risk Assessment

Mobile System: Ergo-Ray



3D Skeleton with Dual-Lens Phone



Field Tool for Biomechanical Analysis

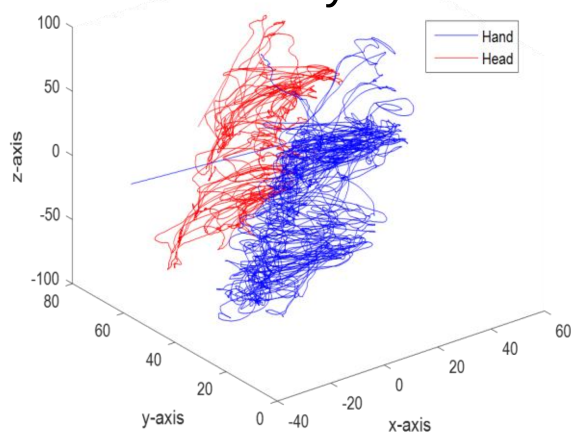
Dynamic Project Management Group

Biomechanical Analysis for Masons

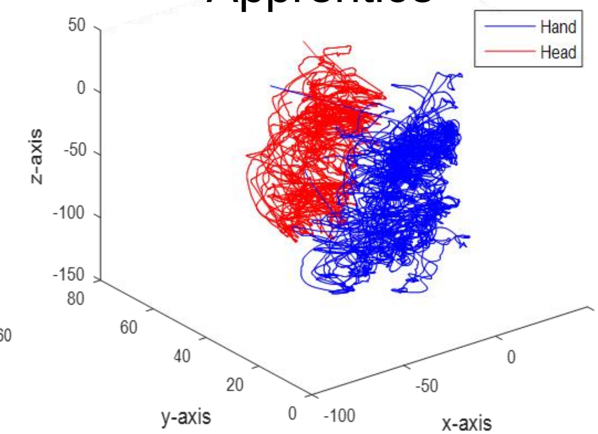
- 21 Subjects, 45 Concrete Blocks (12*6)

Number of participants	Experience (years)	Height (SD)	Weight (SD)	Skill
5	0	176.6 (8.41)	83.8 (7.6)	Novice
4	1	174.7 (8.73)	80.75 (15)	Apprentice
7	3	179.7 (4.7)	93.4 (4.75)	Apprentice
5	>5	176.8 (8.84)	85.6 (10.5)	Journeymen
—	Average	177.3 (7.17)	86.85 (9.98)	—

Journeyman



Apprentice



Duration	34min		47min	
Distance per block (m)	Head	Dominant Hand	Head	Dominant Hand
	21.75	45.88	29.16	48.18

Biomechanical Analysis for Masons

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5	0	176.6 (8.41)	83.8 (7.6)	Novice
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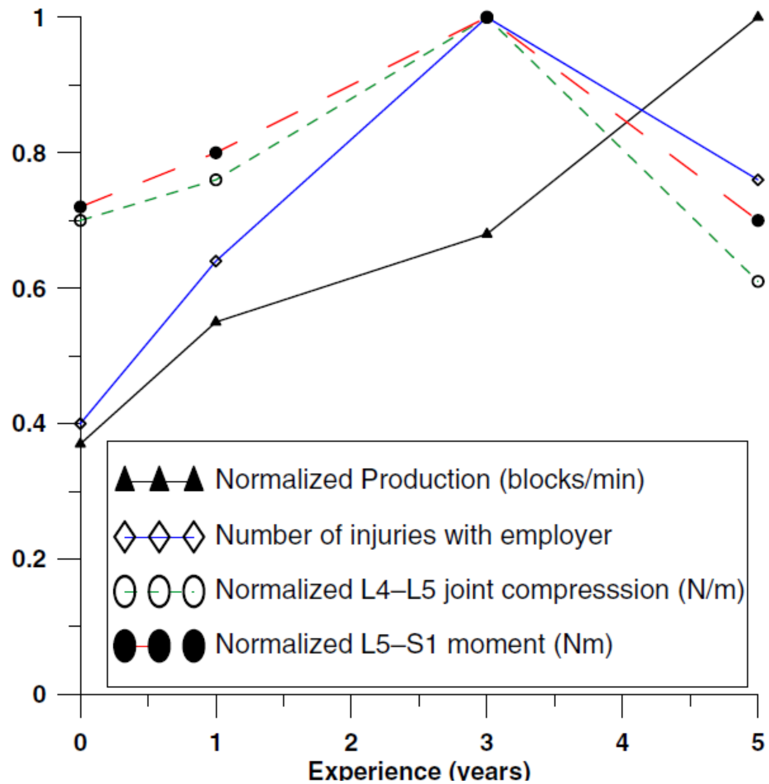
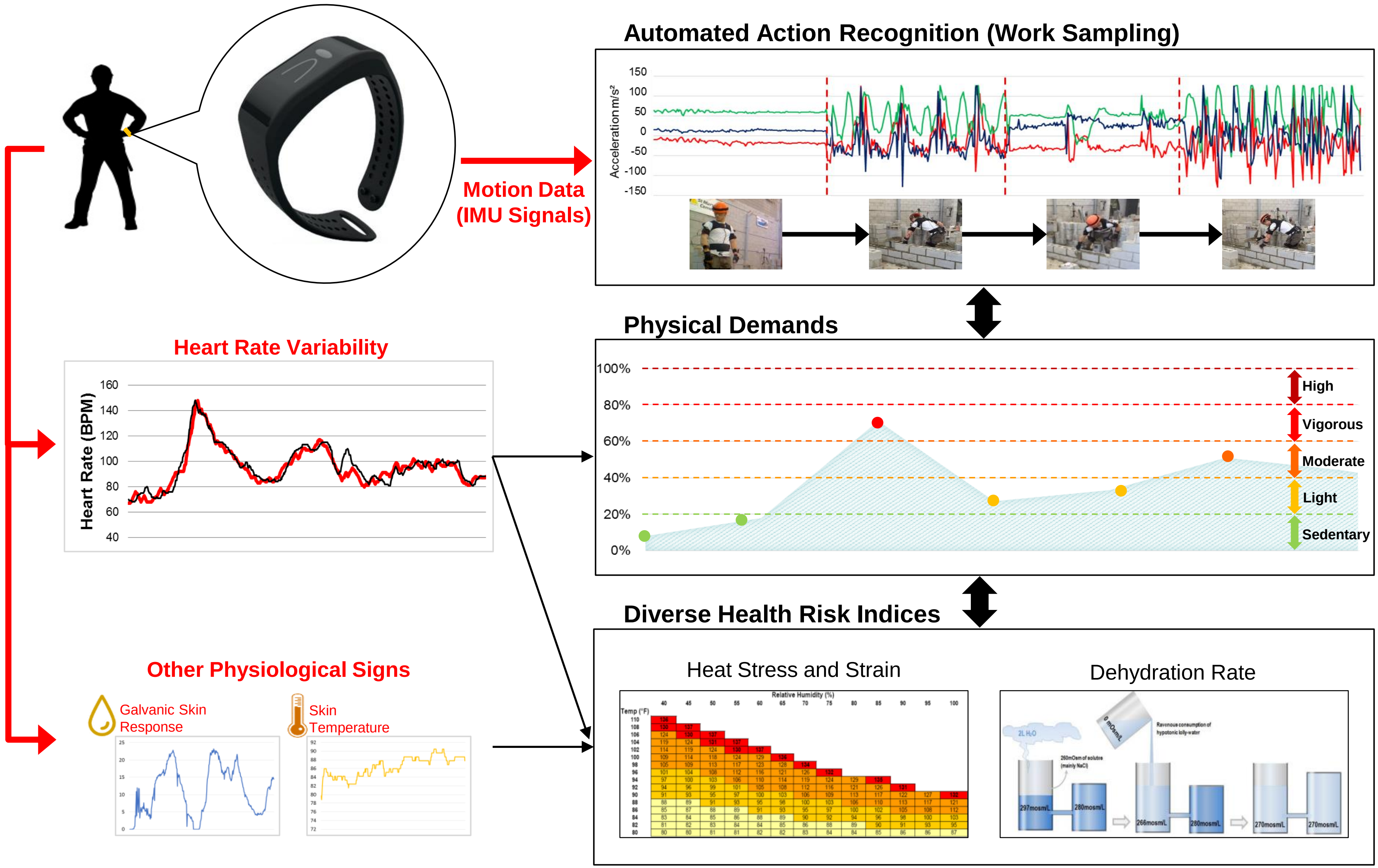


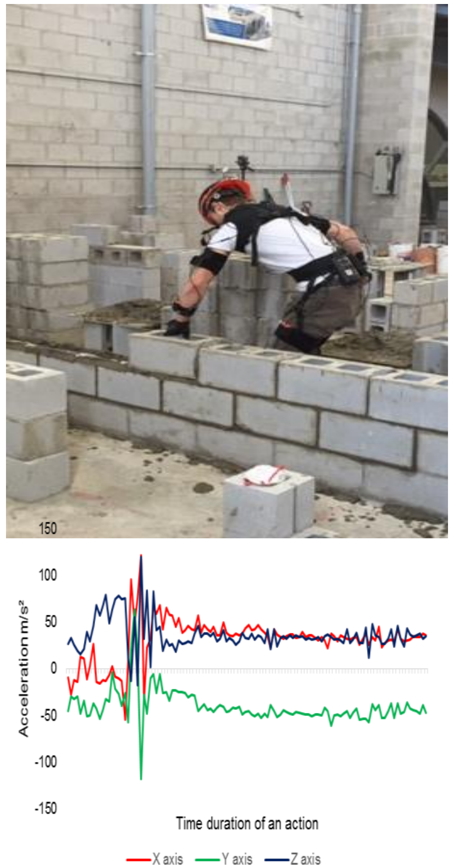
Wristband for Workers' Safety & Health



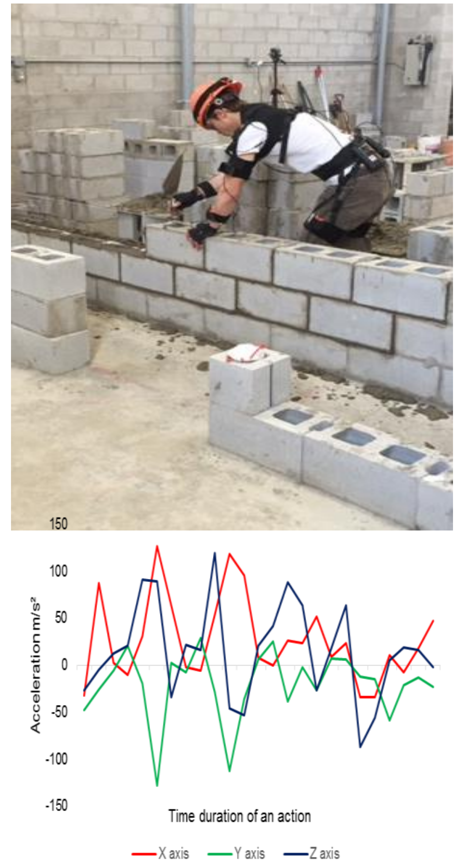
Action Recognition: Masonry Work

Spreading Mortar

Laying Brock



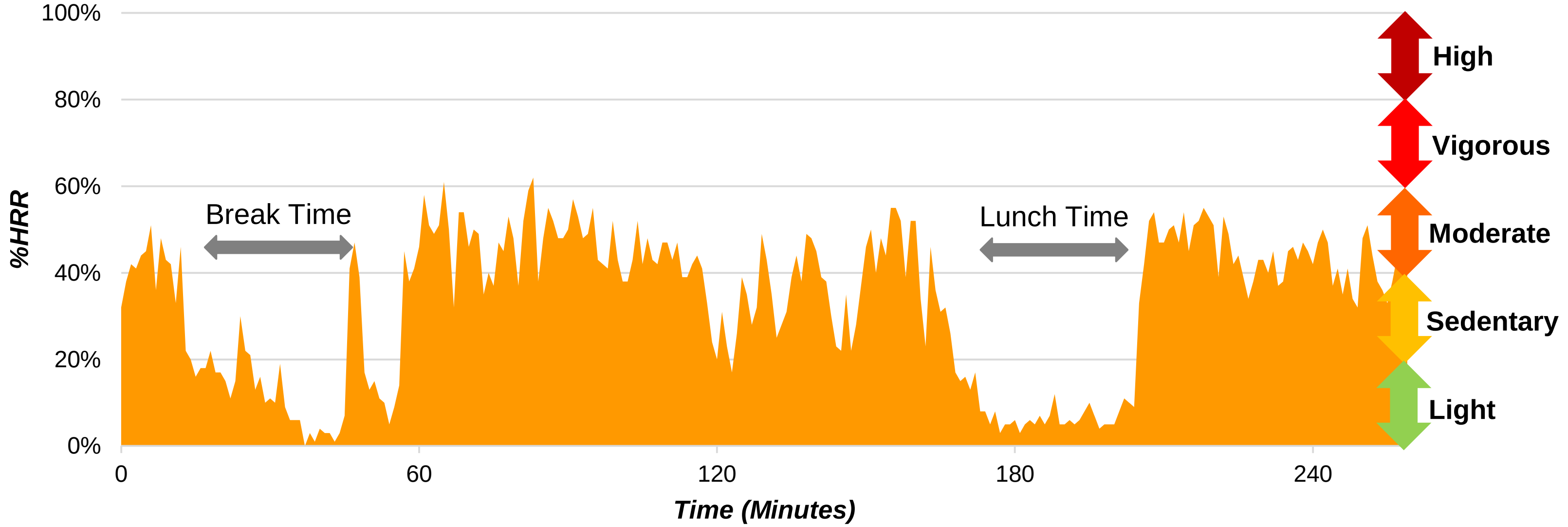
Adjusting



Removing Mortar

Physical Demand Measurement

- %HR Reserve (%HRR) for Physical Demand Analysis



$$\%HRR = \frac{HR_{Working} - HR_{Resting}}{HR_{Maximum} - HR_{Resting}} \times 100\%$$

where

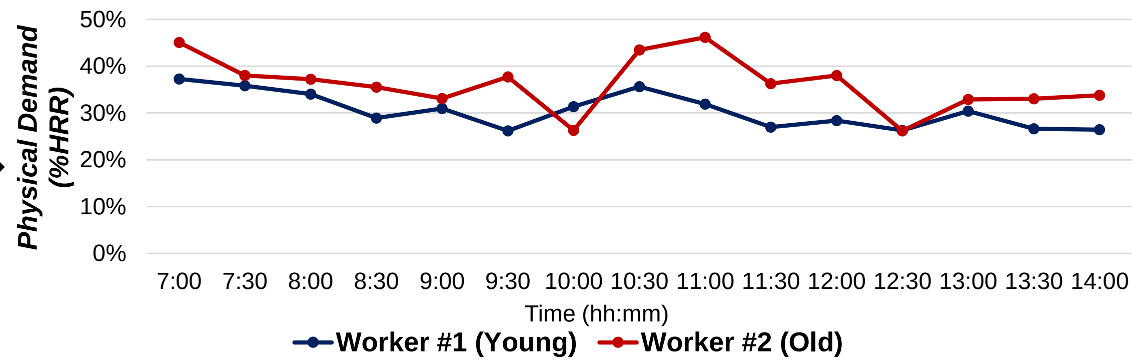
$HR_{Working}$ = average working heart rate [bpm]; $HR_{Resting}$ = resting heart rate [bpm];

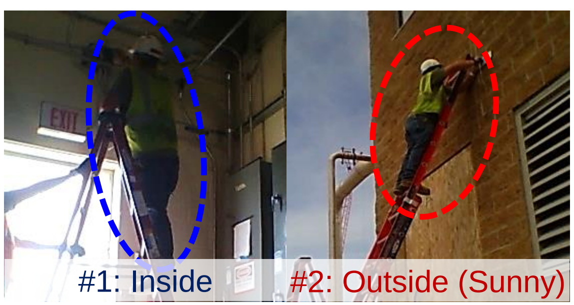
$HR_{Maximum}$ = the maximum heart rate estimated by the equation of age: $208 - 0.7 \times$ age [bpm] (Tanaka et al. 2001)

Physical Demand Comparison

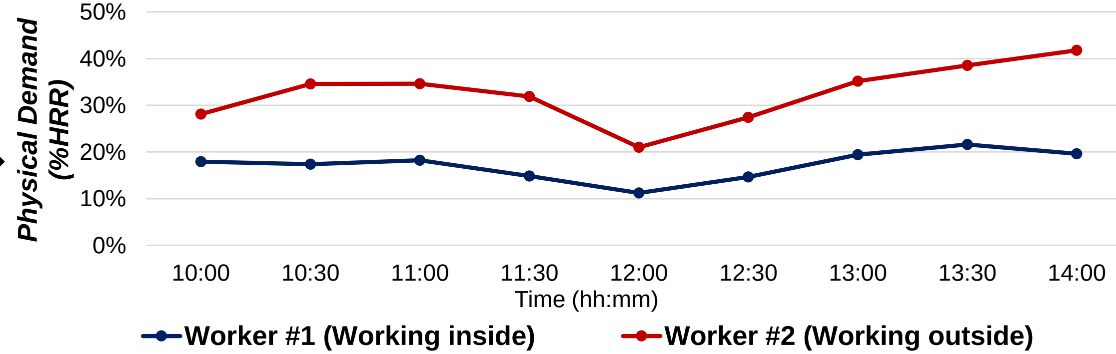
- Aging Workforce
- Different Working Conditions

Workers with different ages



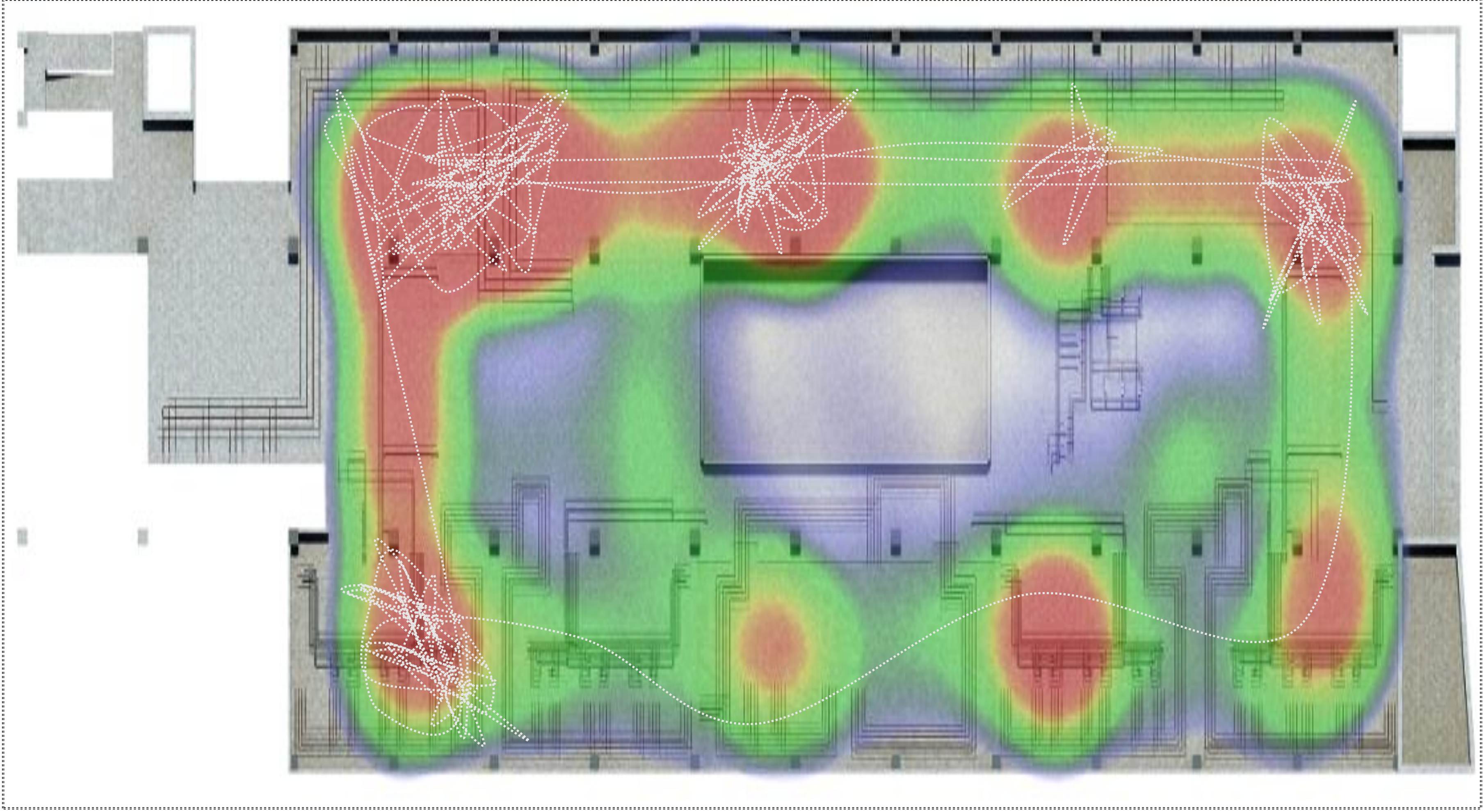


Workers in different locations



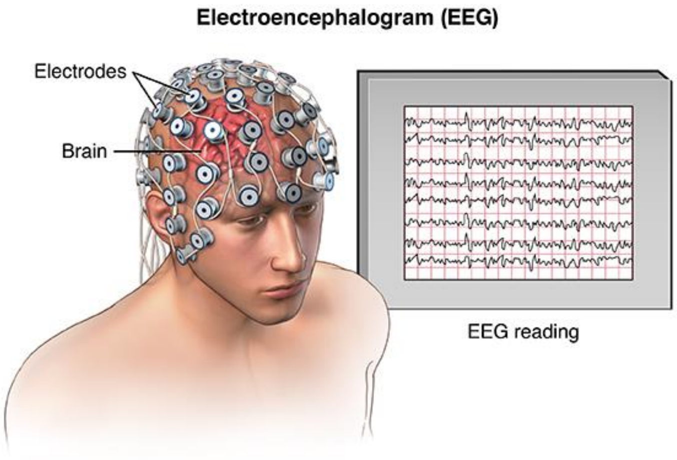
Heatmap w/ BIM

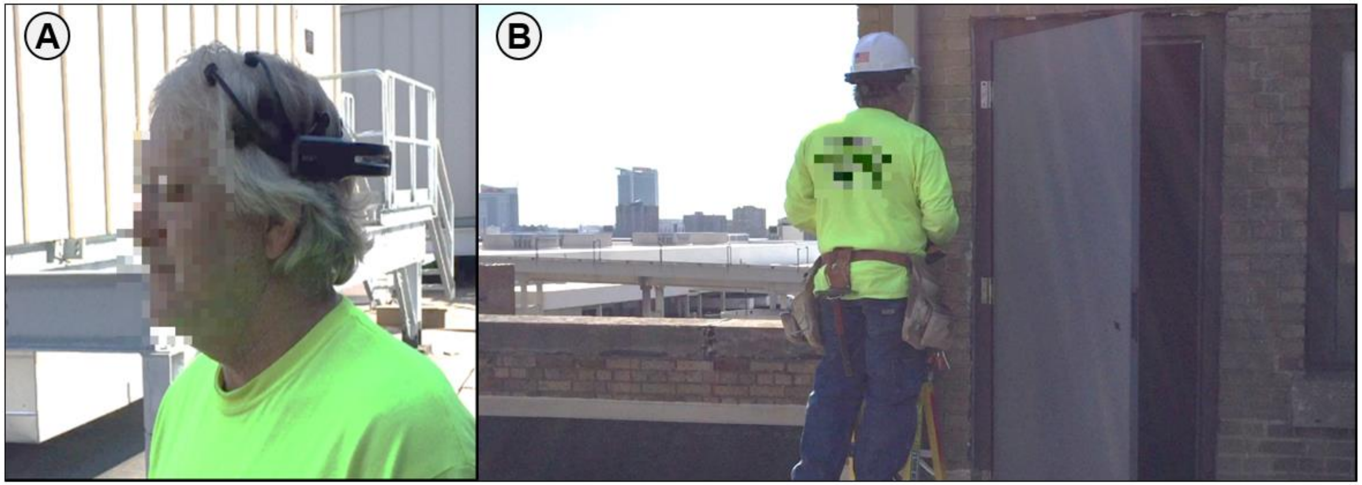
- Location, Actions, Physical Demands, Attention, etc.



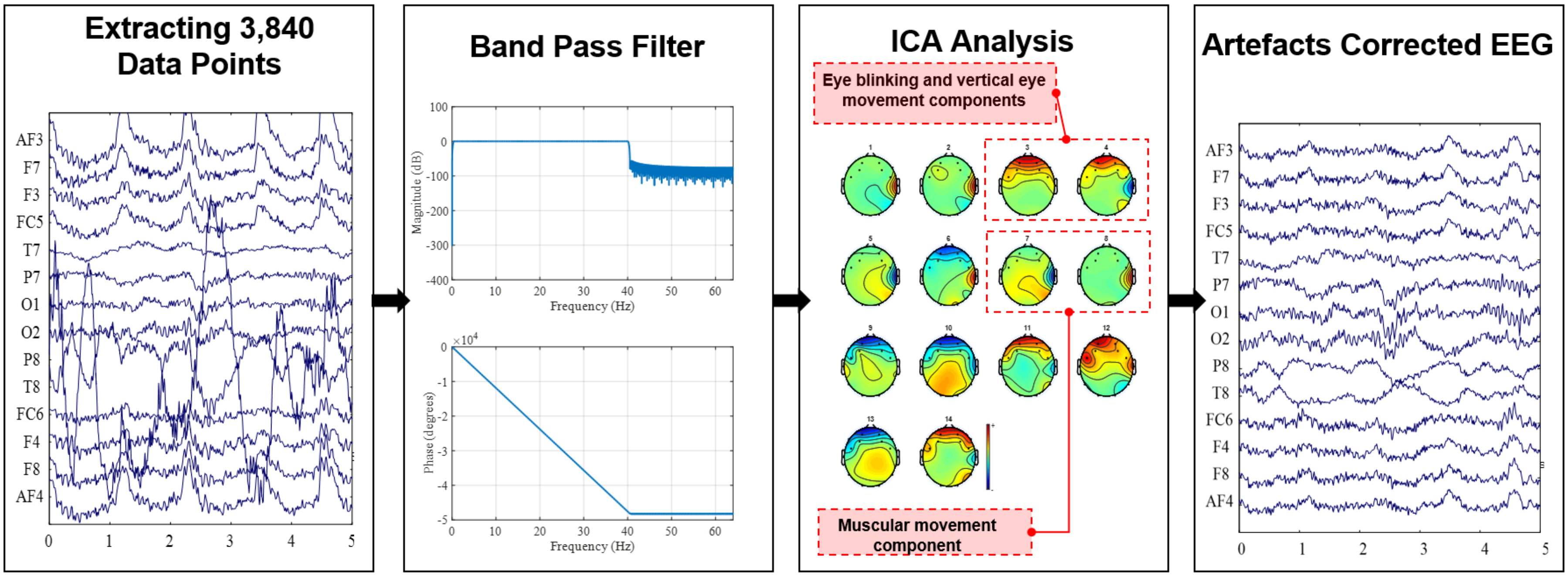
Field Stress Measurement

- Electroencephalogram (EEG)





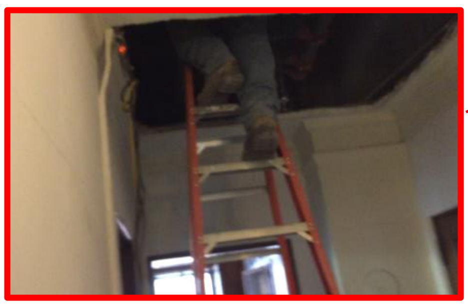
Signal Processing Framework



Stress in Hazardous Work Conditions

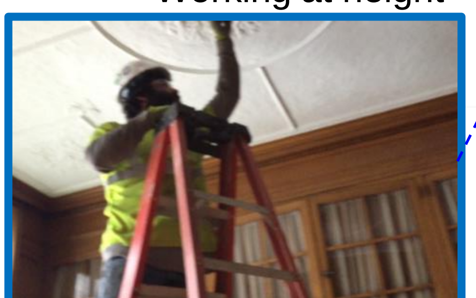
- Frontal EEG Asymmetry (FEA)

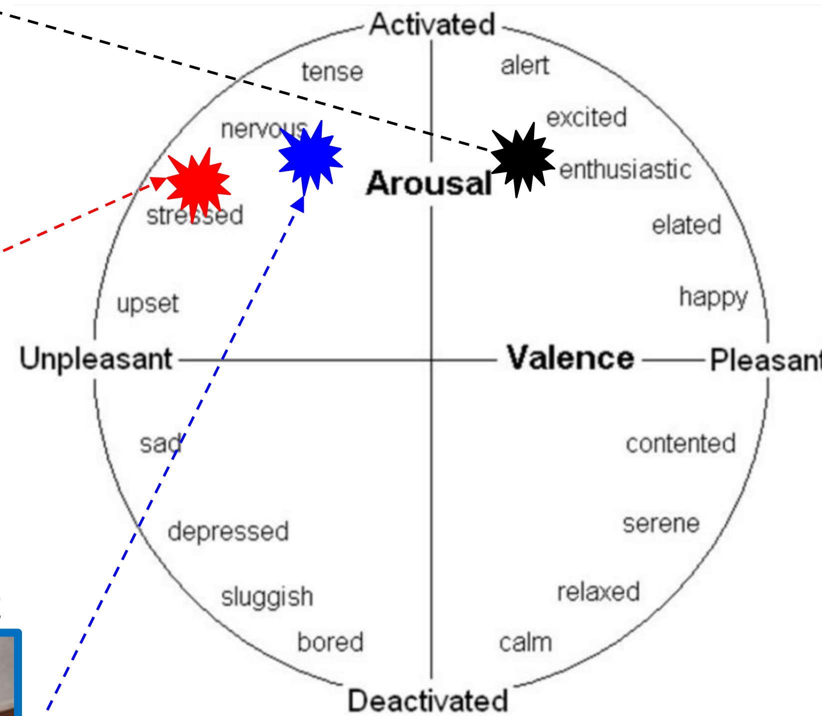
Ground Work



Working at height in confined space

Working at height

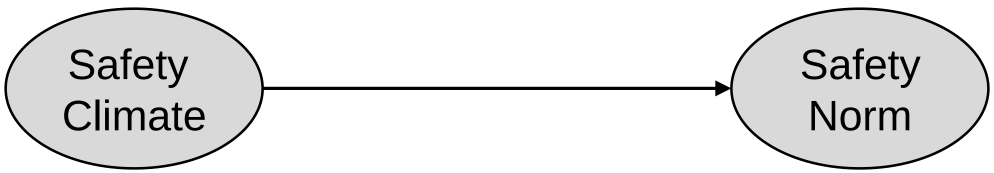




Russell's Affective Space Model in Understanding Emotions (Russell 1980)

Social Influence on Workers' Safety Behavior

- 80-90% of accidents are cased by unsafe behavior
- Safety culture/climate and safety norm
  - Workers' safety behaviors are under the influence of the group level informal controls (i.e., safety norm, safety climate) (Zohar 1980; Neal et al. 2000; Mohamed 2002; Choudhry et al. 2007; Nahrgang et al. 2011).



Employees' shared perceptions of organizational safety policies, procedures, and practices (Zohar 1980)

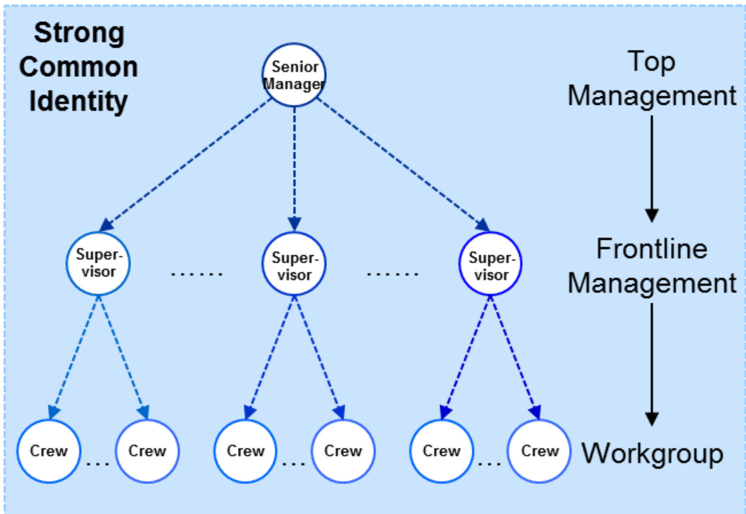
Individual's shared perception of the accepted behavior in a particular group, community or culture (Jon1989)

  - Social norms can account for varied and situational behaviors
  - More cost effective and durable than regulating by formal rules

Social Norm and Social Identity Theory

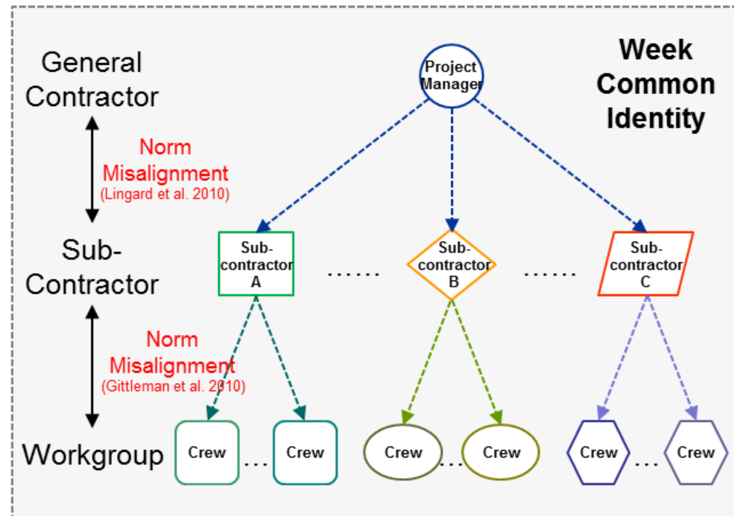
- Social Identity Theory
  - Self-image derived from the social categories to which he/she perceives himself/herself as belonging (Tajfel and Turner 1979).

<Permanent Organization>



- Company as a common identity
- Long-term relationship

<Construction Project>

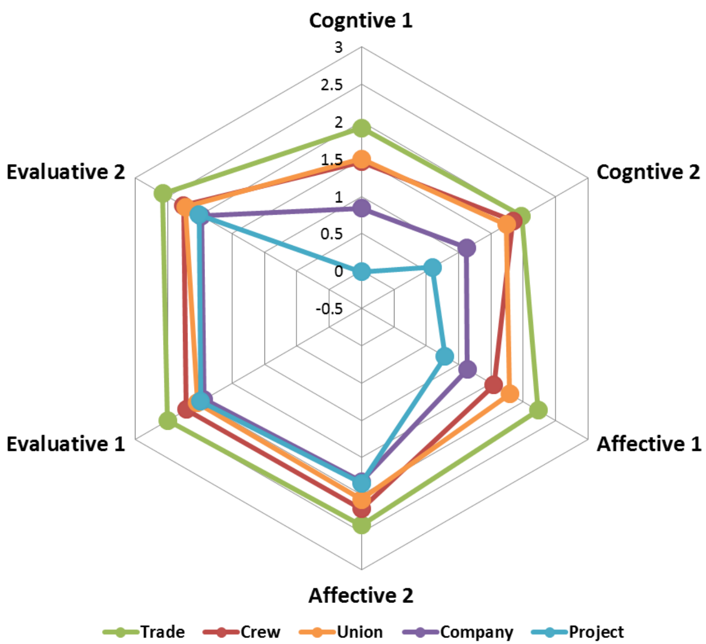


- Mix of multiple identities
- Temporary relationship

Mix of social norms and social identities makes the effect of social norms more complex

Current Status of Workers' Social Identities

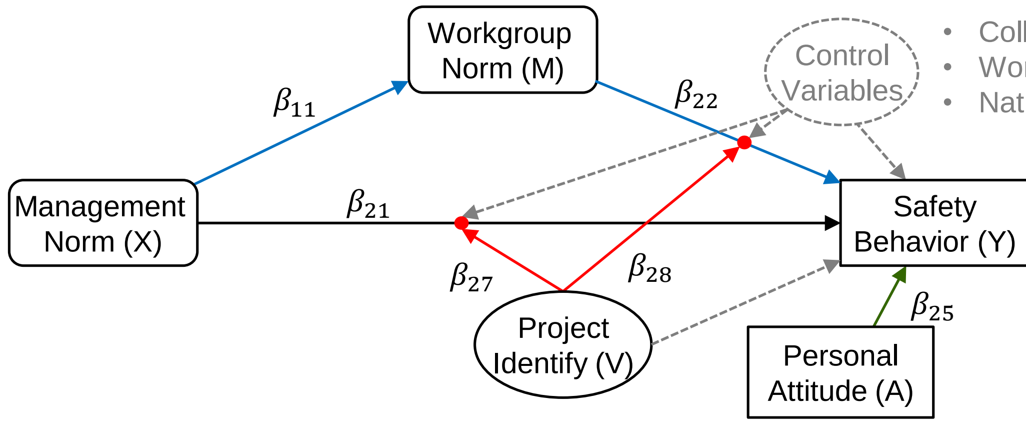
- What is the level of workers' social identification with each group in their jobsite?



Pair	Mean Difference	SD	T
Crew – Company	.45	1.00	4.04**
Crew – Project	.71	.96	6.70**
Crew – Trade	-.35	.81	-3.92**
Crew – Union	.02	1.28	.17
Company – Project	.27	1.04	2.33
Company – Trade	-.80	1.22	-5.89**
Company – Union	-.42	1.51	-2.52
Project – Trade	-1.06	1.04	-9.25**
Project – Union	-.69	1.45	-4.32**
Trade – Union	.37	1.02	3.33*

Note: N=82, *p < .05, ** p < .01

Moderator: Project Identity



- Collective self-concept (Q)
- Work experience (C)
- Nationality (U, K)

Prediction of workgroup norm (M) = $\beta_{10} + \beta_{11}\boldsymbol{X} + \varepsilon_1$

Variable	b	β	S.E	R^2	F
Management Norm (X) - β_{11}	**.770****	**.689****	**.048**	.475	255.44

Prediction of safety behavior (Y)= $\beta_{20} + \beta_{21}\boldsymbol{X} + \beta_{22}\boldsymbol{M} + \beta_{23}\boldsymbol{V} + \beta_{24}\boldsymbol{Q} + \beta_{25}\boldsymbol{A} + \beta_{26}\boldsymbol{C} + \beta_{27}\boldsymbol{XV} + \beta_{28}\boldsymbol{MV} + \beta_{29}\boldsymbol{XQ} + \beta_{30}\boldsymbol{MQ} + \beta_{31}\boldsymbol{U} + \beta_{32}\boldsymbol{K} + \varepsilon_2$

Variable	b	β	S.E	R^2	F
Management Norm (X) - β_{21}	.117	.123	.070		
Workgroup Norm (M) - β_{22}	**.200****	**.236****	**.057**		
Project Identity (V) - β_{23}	.054	.050	.069		
Collective Self (Q) - β_{24}	.257**	.220**	.072		
Attitude (A) - β_{25}	**.157****	**.143****	**.055**		
Experience (C) - β_{26}	-.011	-.076	.007		
Management Norm x Project Identity (XV) - β_{27}	**.133***	**.202***	**.069**	.477	20.65
Workgroup Norm x Project Identity (MV) - β_{28}	**-.239****	**-.350****	**.064**		
Management Norm x Collective Self (XQ) - β_{29}	-.143*	-.214*	.067		
Workgroup Norm x Collective Self (MQ) - β_{30}	.082	.107	.066		
U.S. (U) - β_{31}	-.015	-.006	.168		
Korea (K) - β_{32}	.068	.028	.138		

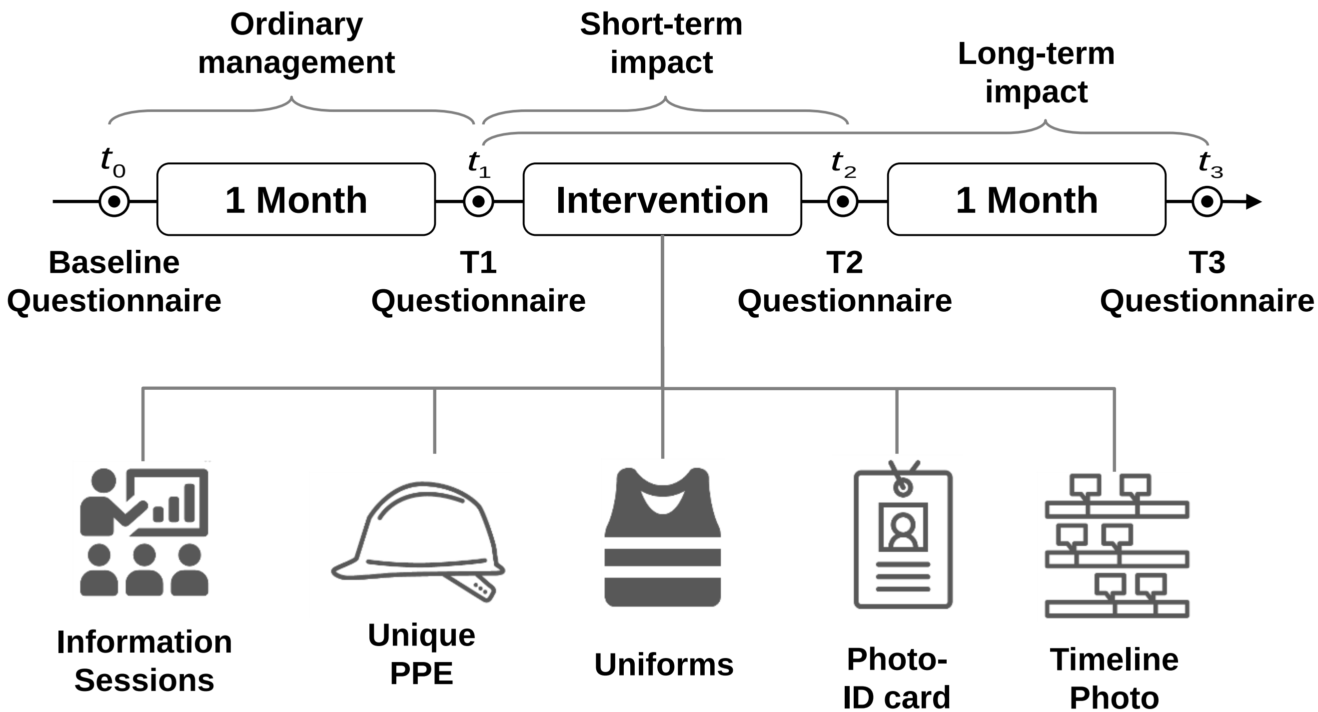
Note: N = 284, *p < .05, **p < .01

Project identity positively moderates relationship between management norm and safety behavior

Project identity negatively moderates relationship between workgroup norm and safety behavior

Can We Improve Project Identity?

- Research Objective
  - To identify effective management interventions to promote workers' social identification with project
- Field Experiment Design



Ongoing Work

- How to improve project identity and its impact on worker behavior
- Wearable technology (e.g., wristband) + Social influence (e.g., peer pressure)
- Other techs