2012 ASCE 142ND ANNUAL CIVIL ENGINEERING CONFERENCE
MONTREAL, QUEBEC, CANADA OCT. 18-20, 2012

THE GLOBAL GROWTH OF PREVENTION THROUGH DESIGN

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"Safety Considerations in Design"

How it Started

Content started in “Constructability” reviews by Project Management Teams working with engineering.

We knew there were issues that could be improved through review and planning based on safety.

- Part of our continuous improvement program
- Requests from clients
- Involvement in Design Build activities with our own employees increased the awareness

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Project Responsibility for Environmental Safety & Health

		PROJECT										BUSINESS GROUP(BG)				DIVISION					
	SCOPE OF WORK	Project Mgr.	Project ESH Mgr.	Project Controls Mgr.	Project HR Mgr.	Engineer Mgr.	Start-up Mgr.	Project Superintendent	Site Mgr.	Maintenance Mgr.	Business Mgr.	Industrial Hygienest	President	ESH Director	Estimators	Quality Assurance	President	ESH Vice President	ESH Training Director	ESH Director	Workers Compensation	Security Director
OVERSIGHT	Provide guidance and services to management and ESH Busines Groups												●	●		●	●	●	●	●		●
	Provide oversight through formal audits of projects and facilities													●		●		●	●	●		
	Lead the development/implementation of ESH management system improvements													●				●	●	●		
	Assist in WC claims management and cost reductions		●											●				●			●	
	Lead professional development of ESH personnel	●	●										●	●			●	●	●	●		
	Track and report ESH metrics		●											●				●	●	●	●	
	Provide services and support to Division and BG ESH													●			●	●	●	●	●	●
	Troubleshoot/Problem solve	●	●											●				●	●	●		●
	Serves as a focal point for project/facility ESH issues and activities													●				●	●	●		●
PROPOSAL STAGE	Assign technical safety manager													○				○				
	Proposal and contract review	○	○										○	○	○	○						○
	Review Technical Scope of Work	○	○			○	○	○	○	○	○	○	○	○								
	Identify potential safety and health hazards	○	○	○	○	○	○	○	○	○	○	○		○								
	Propose hazard controls		○									○										
	List training required by contract	○	○																			
	List training required by regulation		○											○								
	List training required by PEPs/SAF procedures		○											○								
	Identify safety deliverables for contract	○	○																			
	Establish milestones to meet deliverables and training	○	○																			
	Identify required licenses and permits for work		○			○		○								○						
	Develop milestone for license and permit applications	○	○													○						
	Assign technical leads for specialized requirements	○																				
ESTIMATE/ BUDGET	Determine safety requirements for each task		●			●		●				●										
	Prepare safety equipment list		●									●										
	Determine required medical monitoring		●									●										
	Outline resources required for meeting training requirements		●									●										
	Identify instruments and supplies required for monitoring including calibration and repairs											●										
	Estimate laboratory services for sample analysis										●	●										
	Estimate use rate of PPE		●								●	●										
	Estimate disposal costs for contraminated and used PPE		●								●	●			●							
	Provide budget for support equipment	●						●			●				●							
	Develop budget and milestones for safety awards/program	●	●								●		●	●								
SAFETY REVIEW	Review client supplied documents	●	●	●										●								
	Verify that regulations and codes are current and applicable		●									●				●						
	Review current training and medical quals of proposed personnel		●									●		●								
	Set project safety goals and awards in accordance with BG and Division goals	●	●	●	●	●	●	●	●	●	●	●		●			●	●	●	●		
	Verify that estimated safety and security support is adequate	●	●		●									●								●
	Verify that safety statistics used in proposal are accurate	●	●											●				●				
	Safety in Design Review					●	●							●	●				●	●		
EXECUTION	Assign safety personnel and staff		●											●				●				
	Establish contact with WC insurance carrier		●																		●	
	Identify resources training		●									●							●			
	Set up and contact support medical services		●																	●		
	Establish emergency services		●																			●
	Identify technical specialists required for execution	●	●									●		●								
	Acquire project start up materials		●				●															
	Establish effective communication for project goals and performance	●	●																			
	Provide oversight of the project/facility ESH professionals		●											●				●	●	●		
	Manages Vehicle Safety Program		●		●			●						●				●				
	Manages Division Substance Abuse Prevention Program		●		●													●				
	Assess and monitors site/facility compliance with company requirements		●											●								●
	Provides guidance and direction to management		●											●								●
	Serves as a focal point for project/facility ESH issues and activities		●											●								
	Troubleshoot/problem solve project ESH issues		●									●		●					●	●		
	Assists management during investigation by outside agencies	●	●									●		●				●		●		●
	Assists with Alternative Work assignments for WC claims		●		●																●	
	Manages project WC claims		●											●							●	

Utilizing Proactive Programs

Employees:	VPP
	Behavior Based Safety
Supervisors/ Managers:	Safety Trained Supervisor (STS)
Executives:	Leading Indicators
	Employee Contacts

Barriers to implementing this program?

- Engineers did not have formal knowledge of construction safety standards and best practices.
- Engineering curriculums do not include industrial safety.
- Engineers/architects avoidance of liability potentials and do not include safety considerations..
- Perceived increase costs for engineering.
- Engineers do not identify means and methods.
- Contracts, procurement and scheduling do not include safety reviews.

Presented to:

- Engineers
- Designers
- Estimators
- Contract Administrators
- Procurement Professionals

Over 2,500 Over the Last 6 Years

Training Outline

1. Safer Design Principles for Construction is a 4 hour class that identifies the potential hazards involved with Design in Construction.
2. It includes many examples where we could have done a better job in the design phase.
3. A matrix that allows the engineering staff to identify the hazards and implement methods to engineer the hazards from the design.
4. Attendees are given a number of resources that allow them to have immediate answers to the types of hazards and the means of eliminating them.

Safety Qualified Supervisor

Two Day Training

- 10-Hour OSHA Construction Safety
- Economics of Safety
- Supervisor Responsibilities and Accountability
- Work Planning/Job Hazard Analysis
- Control of Hazardous Energy
- “Safety Consideration in Design”

STS Safety Trained Supervisor Certification

How did we integrate as a company philosophy?

- Formal program initiated with engineering discipline leads.
- Standardized the process through the development of a Project Execution Plan (PEP) for implementation and operation.
- Development of a 4-hour training module.
- Participation with OSHA Alliance work group on Safety in Design.
- Training activities initiated in 2006.

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DESIGN FOR SAFETY

Pre-Project Planning & Project Initiation

Training – Incorporating Safety into Design

Review Project Scope of Services/Facilities and conceptual design documents

Design for Safety Guidelines (EG-00-002, 003)

Other Regulatory Inputs, e.g. OSHA

Integrate Plan into Engineering Execution Plan (PEP 203)

Develop Plan for the incorporation of Safety in Construction, Operation and Maintenance into the Design approach including baseline D4S design features

Project Execution

Verify within Scope of Work. Address Change Management per PEP 314

Integrate D4S into Design Reviews, Constructability Reviews and Start-up Reviews

Design for Safety Guidelines (EG-00-002, 003)

Constructability Reviews (PEP 365)

Present summary of features to Construction Management and Client/Owner

Develop specific design features to support Safety

Other Regulatory Inputs, e.g. OSHA

Design Reviews

Start-up Reviews

Incorporate into Design Deliverables, Purchase Orders and Subcontracts as applicable

Project Closeout

Provide Feedback on Project Measures in Project Completion Report (PEP 601)

PROJECT EXECUTION PLAN

Request for Proposal

RFP Scope of Work Document PEP 201

Review Company Lessons PEP 206

RFP Project Execution Plan Preliminary/ Abbreviated

Submit Proposal to Client PEP 101

Authorization to Proceed/Notice to Proceed Received from Client PEP 200

Letter of Instructions Issued (if applicable) PEP 200

Company Lessons Learned PEP 206

Engineering Execution Plan PEP 203

CAE/CAD Execution Plan PEP 204

Procurement Execution Plan PEP 205

Construction Execution Plan

Preparation of Project Execution Plan

Update Scope of Work PEP 201

Project Controls

Safety

Quality

Commissioning and Start-up Execution Plan

Approval

Distribution

Project Team Training

ENVIRONMENTAL, SAFETY AND HEALTH

BG ES&H Director

Client Data and Requirements

Project Manager Request that BG Prepare Health and Safety Plan

Project Information

as required

Task Team

Regulatory Requirements

BG Director Assigns Safety Manager or Representative

Task Specific Hazard Analysis

Audits and Inspections

Record Keeping and Incident Reports

Site Specific Rules

Training

Industrial Hygiene and MSDS program

Orientation

Substance Abuse Prevention

HazCom

Task Specific

Safety Awards/ Incentive Programs

Competent or Qualified person

Medical Monitoring Required

yes

OcMed Clinic

PEPs

202	207	208	212	314	315	363	364	365	368
Project Execution Plan	Licenses, Permitting, Codes and Hazard Requirments	Environmental, Safety and Health	Preparation of Project Risk Management Plans	Change Control	Project Quality Control	Project Hazard Review	Regulatory Compliance Plan and Compliance Review	Constuctability Review	Design for Safety

Client Health, Safety and Environment Design Checklist

Stage 1 Appraise

Construction Safety

				Design Issue?		Installation or Startup Issue		
TOPIC	Reference(s) Cited	Note No. (At end of table)	Applies? Yes or No	Yes or No	Complete? Yes or No	Yes or No	Complete? Yes or No	Engineer's Initials
Safe constructability has been reviewed for the various options.	29 CFR 1926.20							

Stage 2 Optimize

Construction Safety

Environmental/seasonal considerations have been made for construction	Best Practice							
Adequate site access and egress, including impacts to existing traffic patterns, lay down area, emergency vehicles, etc., have been addressed.								

Stage 3 Define

Construction Safety

TOPIC	Reference(s) Cited	Note No. (At end of table)	Applies? Yes or No	Design Issue? Yes or No	Design Issue? Complete? Yes or No	Installation or Startup Issue Yes or No	Installation or Startup Issue Complete? Yes or No	Engineer's Initials
Hot tap/tie-in locations have been reviewed and justified.	SPC-PT-NS-80001							
Energy isolation has been considered for all tie in locations.	29 CFR 1910.147							
Environmental/seasonal considerations for construction have been finalized	Best Practice							
Preliminary lift plans for critical lifts have been completed.	Best Practice							
Adequate site access and egress, including impacts to existing traffic patterns, lay down area, emergency vehicles, etc., has been addressed.	Best Practice							
Early installation and operation of permanent fire detection and suppression systems has been designed into the project.	29 CFR 1926 Subpart F							
Any pre-existing utilities where civil work or VSM/caiasson installation must take place has been identified in the drawings.	Alaska Safety Handbook Area Civil Work Request							

Stage 4 Execute

Construction Safety

				Design Issue?		Installation or Startup Issue		
TOPIC	Reference(s) Cited	Note No. (At end of table)	Applies? Yes or No	Yes or No	Complete? Yes or No	Yes or No	Complete? Yes or No	Engineer's Initials
Radiation and egress studies have been completed for construction work near flares.	Best Practice							
Lift plans for critical lifts are completed.	Best Practice							
Spool size and weight have been considered for construction handling.	Best Practice							
Field weld locations have been reviewed and confirmed.	Best Practice							

Order of Precedence for Addressing Safety Hazards

1. Design to eliminate or avoid the hazard
2. Design to reduce the hazard
3. Incorporate safety devices after the fact
4. Provide warning devices
5. Institute training and operating procedures

Personal Risk Manager / The 3C Approach

- The 3C card is a tool you can personally use to measure risk.
- Risk is a personal perception. That's why some people sky dive while others won't.
- Whether we take the "risk" or not is based upon our perception of the risk level, our control of the variables, and the potential outcome of the event.
- This tool gives you the ability to "qualify" if the risk of a job task is extreme or low and it provides a checklist for assessing and correcting risk factors.

Personal Risk Management: Basic Components

Personal safety comes down to basically three components:

1. Recognizing the hazard and conditions that could lead to an incident.
2. Assessing the potential consequences of an activity.
3. Controlling the hazard and thus eliminating or reduce the risk.

Safety in Design Examples

- Install temporary power to permanent lighting fixtures.
- Procure structural steel pre-drilled for fall protection cables.
- Procure structural steel pre-painted to avoid indoor air issue.
- Install stairwells early for vertical access.
- Segregating foot traffic from vehicular traffic.
- Scheduling/contracting work to minimize scaffold erection.
- Design windows to meet fall protection requirement.

Risk Assessment

- Client Case

Risk Assessment indicates that the highest fatal rate within the company is with the employee / heavy equipment interface.

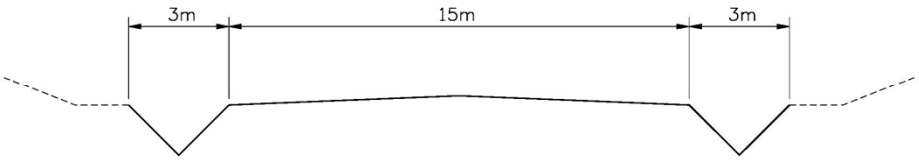
Drawings for a new facility show 3 separate and distinct roadways.

Designers used wider roadways to remedy the hazard of the employee / heavy equipment interface.

After review and discussion, the design was revised to eliminate most of the employee / heavy equipment interface.

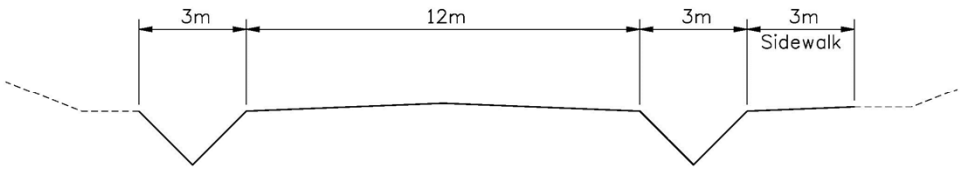
Original Road Design

- 15 Meter Wide Roads to prevent employees from being contacted by equipment.



Revised Road Design

- New design allows employees a clear and unobstructed walkway and the ditch provides a barrier to prevent the employee and equipment interface.



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The “Get Bent” approach to impalements – Preventing through Design

One example

16' X 4" - 2 rows of 24 (48) Vertical impalements	Candy-Cane	Carnie Cap	Wood Trough	Rebar Cap
Device or fasteners	$0.51	$12.04	$1.00	$60.00
Lumber needed		$13.04	$42.16	
Labor (55/hr.) Unload or fab/Stage/install/Remove/Store	$0.35	$21.84	$15.90	$25.48
Total Cost	$41.28	$46.92	$59.06	$85.48
Cost per impalement protected (initial cost)	**$0.86**	**$0.97**	**$1.23**	**$1.78**
	0.00%	12.70%	47.60%	106.90%

Labor Estimates:	Time:	Materials:	
Carnie Cap - 4 devices w/2-2x4x16	24 min.	Carnie	$3.01
Rebar Caps - 48 caps	28 min.	Rebar-Cap	$1.25
Build troughs - 1-2x6x16 2-2x8x16	20 min.	Add rod length.	$0.35
Bending at fabricator		Candy Cane	$0.86

CONSIDERATIONS: "Get Bent" Approach

Candy-Cane

Impalement hazards eliminated

No labor (or hazards to labor) during installation, no removal, no repair, no maintaining or storing

Must be oriented in order to comply with design provisions

Candy-Canes would eliminate horizontal struck-by hazards

Handling may be complicated by the hooks snagging other stock when sorting

Carnie-Cap

Lumber available for scavenging from other trades

Hazards including lifting, stooping, carrying lengths

Storage of Carnies easier than conventional caps but materials staging needed

Require consistent rebar heights

Impalement hazard remains when uncovered during pour

Solid covering impacts access to workers along runs

Requires straight runs of rebar

Wood-trough

Extensive field fabrications hazards including saws, scrap (trips) electricity, hammering, lifting, carrying lengths

Requires consistent rebar heights

Significant handling (use) and storage concerns

Staging area for immediate use and storing when removed requires planning

Hazard remains when uncovered during pour

Solid covering impacts access to workers along runs

Brings a fire hazard onto a project when used and then stored

If distance between rows excessive (12") the cost indicated is doubled (one cover per row)

Requires straight runs of impalements

Rebar caps

Easily available and contractor may already own

Require consistent maintenance due to other trades knocking off or scavenging

Hazard not protected during pour

Need for storage containers (and that handling) for staging, installation, removal and storage

Caps are trip hazards when knocked off

One size does not fit all

Ergonomic hazards for each - must be installed by stooping and hand twist

Conventional tray support system (all supports are hand assembled in the field.

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Cable tray bundle being lifted into cable tray spread area by ironworks (installation was late – notice overhead steel in place)

Tray bundles staged in cable tray spread area

Cable tray bundle being lifted into Absorber building Unit 1 by electricians and ironworks (timing correct – no overhead steel)

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Cost category	Preassembly	Stick build	Savings
Craft hours	1,300	7,910	6,610
Craft related costs	$79,812	$477,391	$397,579
Material and assembly costs	$142,408	$132,389	($10,019)
Engineering hours	743 (required to develop design of modules)	0 (original design based on typical details from previous project)	(743)
Engineering costs	$92,291	0	($92,291)
Total costs	**$314,511**	**$609,780**	**$295,269**

The above represents a 48% total savings and a 83% installation savings. Opportunities for future savings will be by the elimination of the added engineering costs by standardizing this method of supporting cable tray in long runs of vertically stacked tray and stacked tray in concentrated areas.
The constructability approach is being applied to 75% of project applications, duct work, cable trays, piping, handrail, stairwells, etc. The project has worked since August 2008 1.8 million safe work hours without a days away case.

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