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
## Project Responsibility for Environmental Safety & Health

### SCOPE OF WORK

**Oversight**
- Provide guidance and services to management and ESH business groups
- Provide oversight through formal audits of projects and facilities
- Lead the development/implementation of ESH management system improvements
- Assist in VSC claims management and cost reductions
- Lead professional development of ESH personnel
- Track and report ESH metrics
- Provide services and support to clients and ESH
- Troubleshoot/Problem solve

**Proposal stage**
- Design technical safety manager
- Physical 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 PPE/procedures
- Identify safety deliverables for contract
- Establish milestones to meet deliverables and training
- Identify required licenses and permits for work
- Develop criteria for license and permit applications
- Assist technical leads for specialized requirements

**Estimate/budget**
- Determine safety requirements for each task
- Prepare safety alignment list
- Overview required financial monitoring
- Outline major tasks for upcoming and next year
- Identify instruments and supplies required for monitoring, including calibration and repairs
- Identify laboratory services for sample analysis
- Estimate use of PPE
- Estimate disposal costs for contaminated and used PPE
- Provide budget for support equipment
- Develop budget and milestones for safety activities/program

**Safety review**
- Review client supplied documents
- Verify that regulations and codes are current and applicable
- Review current training and medical status of proposed personnel
- Set project safety goals and awards in accordance with VSC and Division goals
- Verify that estimated safety and security support is adequate
- Verify that safety training used in proposal are accurate
- Safety in Design Review

**Design**
- Ensure safety personnel and staff
- Establish regular contact with VSC, insurance carrier
- Identify resources required
- Set up and contact support medical services
- Establish emergency services
- Identify technical specifications required for execution
- Acquire project start-up materials
- Establish effective communication for project goals and performance
- Provide oversight of the project/functional safety professional
- Manage VSC safety programs
- Manage Division safety programs
- Assist and monitor all safety compliance with company requirements
- Provide guidance and direction to management
- Serve as a local point for project safety/functional issues and activities
- Troubleshoot/Problem solve project ESH issues
- Assist senior management in investigations by outside agencies
- Assist with Alternative Work arrangements for VSC claims
- Manage project ESH services
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.
## Client Health, Safety and Environment Design Checklist

### Stage 1 Appraise

#### Construction Safety

<table>
<thead>
<tr>
<th>TOPIC</th>
<th>Reference(s) Cited</th>
<th>Note No. (At end of table)</th>
<th>Applies? Yes or No</th>
<th>Design Issue?</th>
<th>Installation or Startup Issue</th>
<th>Complete? Yes or No</th>
<th>Complete? Yes or No</th>
<th>Engineer’s Initials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe constructability has been reviewed for the various options.</td>
<td>29 CFR 1926.20</td>
<td></td>
<td>Y</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</table>

### Stage 2 Optimize

#### Construction Safety

<table>
<thead>
<tr>
<th>TOPIC</th>
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<th>Applies? Yes or No</th>
<th>Design Issue?</th>
<th>Installation or Startup Issue</th>
<th>Complete? Yes or No</th>
<th>Complete? Yes or No</th>
<th>Engineer’s Initials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental/seasonal considerations have been made for construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adequate site access and egress, including impacts to existing traffic patterns, lay down area, emergency vehicles, etc., have been addressed.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
# Stage 3 Define

## Construction Safety

<table>
<thead>
<tr>
<th>TOPIC</th>
<th>Reference(s) Cited</th>
<th>Note No. (At end of table)</th>
<th>Design Issue?</th>
<th>Installation or Startup Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot tap/tie-in locations have been reviewed and justified.</td>
<td>SPC-PT-NS-80001</td>
<td></td>
<td>Yes or No</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Energy isolation has been considered for all tie in locations.</td>
<td>29 CFR 1910.147</td>
<td></td>
<td>Yes or No</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Environmental/seasonal considerations for construction have been finalized</td>
<td>Best Practice</td>
<td></td>
<td>Yes or No</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Preliminary lift plans for critical lifts have been completed.</td>
<td>Best Practice</td>
<td></td>
<td>Yes or No</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Adequate site access and egress, including impacts to existing traffic patterns, lay down area, emergency vehicles, etc., has been addressed.</td>
<td>Best Practice</td>
<td></td>
<td>Yes or No</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Early installation and operation of permanent fire detection and suppression systems has been designed into the project.</td>
<td>29 CFR 1926 Subpart F</td>
<td></td>
<td>Yes or No</td>
<td>Yes or No</td>
</tr>
<tr>
<td>Any pre-existing utilities where civil work or VSM/caisson installation must take place has been identified in the drawings.</td>
<td>Alaska Safety Handbook Area Civil Work Request</td>
<td></td>
<td>Yes or No</td>
<td>Yes or No</td>
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### Stage 4 Execute

#### Construction Safety

<table>
<thead>
<tr>
<th>TOPIC</th>
<th>Reference(s) Cited</th>
<th>Note No. (At end of table)</th>
<th>Applies?</th>
<th>Installation or Startup Issue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiation and egress studies have been completed for construction work near flares.</td>
<td>Best Practice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lift plans for critical lifts are completed.</td>
<td>Best Practice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spool size and weight have been considered for construction handling.</td>
<td>Best Practice</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Field weld locations have been reviewed and confirmed.</td>
<td>Best Practice</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Design Issue?**
  - Yes or No
- **Complete?**
  - Yes or No

- **Engineer’s Initials**
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.
The “Get Bent” approach to impalements – Preventing through Design
## One example

<table>
<thead>
<tr>
<th>16' X 4&quot; - 2 rows of 24 (48) Vertical impalements</th>
<th>Candy-Cane</th>
<th>Carnie Cap</th>
<th>Wood Trough</th>
<th>Rebar Cap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device or fasteners</td>
<td>$0.51</td>
<td>$12.04</td>
<td>$1.00</td>
<td>$60.00</td>
</tr>
<tr>
<td>Lumber needed</td>
<td></td>
<td>$13.04</td>
<td>$42.16</td>
<td></td>
</tr>
<tr>
<td>Labor (55/hr.) Unload or fab/Stage/install/Remove/Store</td>
<td>$0.35</td>
<td>$21.84</td>
<td>$15.90</td>
<td>$25.48</td>
</tr>
<tr>
<td>Total Cost</td>
<td>$41.28</td>
<td>$46.92</td>
<td>$59.06</td>
<td>$85.48</td>
</tr>
<tr>
<td>Cost per impalement protected (initial cost)</td>
<td>$0.86</td>
<td>$0.97</td>
<td>$1.23</td>
<td>$1.78</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Materials:</th>
<th>Time:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Candy-Cane</td>
<td>24 min.</td>
<td>Carnie</td>
</tr>
<tr>
<td>Rebar-Cap</td>
<td>28 min.</td>
<td>$1.25</td>
</tr>
<tr>
<td>Add rod length.</td>
<td>20 min.</td>
<td>$0.35</td>
</tr>
<tr>
<td>Candy Cane</td>
<td></td>
<td>$0.86</td>
</tr>
</tbody>
</table>
CONSIDERATIONS: “Get Bent” Approach

**Candy-Can**:e
- 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.)
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)
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.