Abating Fall Hazards Before They Are Created

Although it may be easier to see the hazards in an existing structure, it is safer and more cost-effective to implement fall protection before structures or processes are built. This article focuses specifically on the benefits and process of abating fall hazards before they are created. This is possible when safety measures are evaluated and implemented during the programming and design phases of a project.

This approach to safety has been promoted and applied in different ways. The concept of safety through design was introduced in the 1940s, but the design and construction industries did not begin adopting the process until the 1980s. Then, in early 2012, a new consensus standard related to this concept, *Prevention Through Design: Guidelines for Addressing Occupational Hazards & Risks in Design & Redesign Processes (ANSI/ASSE Z590.3-2011)*, was made effective by the American National Standards Institute. No matter what the concept is called, evaluating and implementing safety measures during the programming and design phases of construction ensures optimal safety for workers—from construction to operations and throughout ongoing maintenance. Besides the obvious enhanced safety benefits, addressing safety concerns early in the design process will significantly reduce the cost of addressing fall protection issues.

In this article, a sample case study helps explain the basic benefits of incorporating fall protection measures into the design process. While the nuances of every project are different, the basic elements involved in moving these discussions earlier in the project timeline will provide safety, productivity and cost benefits. To address all factors, it is essential to gather the right team, including engineering, operations and maintenance personnel.

**Figure 1 Hierarchy of Controls, Moving Down From Most to Least Acceptable**
The impact to bottom line cost can be dramatic. When considering whether to evaluate fall protection during design, the question should not be “How much will it cost if we wait until the end?” Instead, the question is “How much can be saved if the hazards are abated now?” This is no different from any other engineering discipline, where it is more cost-effective to engineer a solution during the design of a project, rather than arrive at a solution and retrofit during operations.

**Benefits**

The primary benefits of abating fall hazards during the design phase of a project relate to inherent safety and cost benefit. This proactive approach helps organizations focus on these two critical aspects that help reduce overall safety and financial risk.

**Safety**

When fall protection is implemented during the design phase, safety can be incorporated at an appropriate stage during the design process. The hierarchy of control (Figure 1) can be optimized by evaluating each potential solution’s effectiveness and defeatability. More effective and safer solutions, such as hazard elimination, engineering control strategies and the general principle to stay toward the top of the hierarchy of control, can be incorporated into the original design.

If fall protection measures are not incorporated during design, abatement options are often limited. Essentially, the ability to apply the hierarchy of control is compromised due to lack of preplanning. Although it can still be considered by evaluating a solution’s effectiveness and defeatability, field conditions often dictate how a hazard is abated. In certain cases, the only possible means of protecting employees is through the use of PPE, which is in the lowest position in the hierarchy of control. PPE is often required due to existing interferences and inability to access the area with appropriate engineering controls unless significant, costly modifications are made. In addition, all interferences, connection details, layout issues and required clearances must be field-verified, and details must be developed and designed to match existing conditions. Additional framing may also be required to work around existing equipment, requiring costly physical modifications to the structure.

Another concern is that fall protection solutions developed in the field are often handled by inexperienced personnel working under pressure. In these cases, inadequate solutions may be adopted, with overreliance on PPE.

**Cost**

A study conducted by an international consumer goods manufacturer showed that implementing safety measures during the conceptual design phases of a project resulted in substantially lower costs than implementing systems during or after construction.

Table 1 (p. 20) summarizes the relative cost required to achieve the same level of safety for a given hazard based on when the hazard is identified and abated during the design and construction process. Incorporating safety during the design stage saves money because designers need not erase lines on their drawings—the safety aspects are simply programmed into the design. Implementing the same solution during operations would be far more costly. Using the optimal solution may not be possible since it cannot be fitted in the field, forcing an inferior alternative to be adopted. In the example portrayed in Table 1, implementing safety during conceptual design represents a base cost ($1) to abate the hazard.

If fall protection measures are implemented after a project is completed, the cost to abate the hazard increases due to the following elements:

- design costs;
- production of additional drawings for hazard abatement;
- mobilization of the contractor;
- potentially significant field modifications;
- potentially significant rework of interferences;
- long-term costs of not using the ideal abatement method;
- costs associated with using a potentially riskier (more easily defeated) means of hazard abatement, such as PPE.

Short-term and recurring costs, as well as productivity gains and losses, should also be thoroughly considered prior to selecting abatement solutions. A simple example is evaluating engineering controls (such as platforms with guardrails with a fixed ladder) versus a personal fall arrest system. With an engineering controls solution, short-term costs include design, procurement and basic employee training. On the other hand, a PPE-based system requires these same costs, plus recurring costs related to time for equipment inspections or modifications, advanced employee training, periodic retraining of personnel, equipment replacement purchases, rescue considerations and productivity losses. Engineering controls typically allow workers to perform their tasks more quickly, efficiently and safely, while PPE solutions require preplanning, inspection, donning, doffing and storage.

**Case Study: Process**

When companies plan large building projects, many factors must be considered. Even within the safety category, so many different issues must be considered that fall protection is often overlooked. When a petrochemical organization planned the...
construction of a new offshore platform, they decided to incorporate fall protection considerations into the front-end engineering design and detailed design stages of the project. From previous experience, the organization’s leadership understood the ramifications of incorporating fall protection measures after a platform was operational.

To improve safety for workers and to minimize the impact to operations, the project management team invited a fall protection consultant to assist the design team by providing fall protection expertise. The design team and fall protection consultant worked through the following process to incorporate fall protection.

**Kickoff Meeting with Design Team.** The initial step was a kickoff meeting with the design team so that every team member could better understand the fall protection issues that could be considered during the design process for the project.

Having a fall protection consultant involved helped the entire team better understand the importance of proactive safety approaches and how employees could be best protected from potentially dangerous or fatal situations. At the start of the project, specific concerns related to fall protection emerged through a survey given to operators and members of the design team.

**Virtual Fall Hazard Risk Assessment.** With a baseline of information about the project and the specific fall protection issues, the team moved into hazard identification and risk assessment. Using a 3D model of the project, the fall protection consultant conducted a “virtual” fall hazard risk assessment of the platform. Essentially, safety professionals who are experienced in fall hazard assessments for petrochemical facilities used the model to identify potential fall hazards. Then, they documented these hazards along with possible abatement solutions.

**Design Team Workshops.** The virtual fall hazard assessment was followed by a workshop for both the topsides and the hull. During the workshops, the team used the 3D model to “walk through” the structure to review the preidentified fall hazards. Because the fall protection consultant performed the fall hazard assessment independently, the workshops provided the opportunity to complete the assessment with the input of the stakeholders, who provided additional context to the specific tasks and locations.

In addition, the fall hazards identified during the assessment were validated or rejected. Then, the team determined whether the hazard could be eliminated. For the hazards that could not be eliminated, the team evaluated and selected a fall hazard abatement solution. From this input, the team developed specific action items for each identified hazard (i.e., what are the next steps, who was responsible for the next steps, action required and due date). Through an iterative process, the team was able to account for all identified hazards and to provide a solution for each.

The workshops involved members of the design team, operations personnel, inspectors and others who have an interest in the project. Each individual stakeholder provided input from their unique perspective, while the fall protection consultant provided an impartial perspective on the overall project. Again, this collaboration helped ensure that safety, productivity and cost were all considered.

**Specification Binder for Hazard Abatements.** The goal of this process was to eliminate hazards or to control them with passive fall protection solutions. Some hazards that could not be abated using engineering controls needed further consideration, and the team determined that some hazards would best be controlled with PPE solutions. One example is areas where guardrails must be removed to accomplish the desired task. Another example is ladders in the elevator shaft that exceed length and clearance limitations, which prohibit the installation of a ladder cage and landings.

For these circumstances, a performance specification was provided to allow the construction team to install the required fall restraint or fall arrest systems. The operations team will also use this information to help com-

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### Table 1 Costs of Implementing Fall Protection at Different Project Stages

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<thead>
<tr>
<th>Project Phase</th>
<th>Cost Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conceptual Design</td>
<td>$1</td>
</tr>
<tr>
<td>Final Drawings</td>
<td>$10</td>
</tr>
<tr>
<td>Field Modifications</td>
<td>$100</td>
</tr>
<tr>
<td>Startup &amp; Debugging</td>
<td>$1,000</td>
</tr>
<tr>
<td>Post Completion</td>
<td>$10,000</td>
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</tbody>
</table>
complete the process required for training and certification of these systems.

Follow-Through During Construction Process. As construction proceeds, the fall protection consultant will provide review of the constructed platform to ensure that the identified hazards have been abated as planned and that any hazards not identified during the design phase are subjected to the same rigorous assessment process.

Using this process allowed team members to contribute their expertise and specialized knowledge. This collaboration helped account for the needs of all perspectives and stakeholders.

**Case Study: Results**

Companies that have incorporated safety into the design process have shown that costs are lowered, task performance is improved and life-threatening work hazards are reduced. Learning the critical skill of foreseeing safety hazards before they are created will benefit the organization in the long term.

On this project, the following items were the primary results of incorporating fall protection during design.

Hazards eliminated:
- valves and actuators relocated from near the edge of an elevated platform;
- equipment related to lifeboat and fast-rescue craft relocated to a safer location;
- flame sensors and deluge nozzles relocated to areas that provide safe access, while not compromising the level of protection required for these items.

Hazards abated with engineering controls, rather than PPE:
- floor opening covered with grating;
- ladders and platforms provided for access insideballast tanks and voids;
- processes/products changed to reduce risk;
- flare boom stair guardrail posts strengthened to allow them to be used as anchorage points;
- light bulbs changed to long-life bulbs to decrease the frequency required for changing bulbs;
- fall protection system developed and incorporated for maintenance requirements on top of crane boom.

Some may wonder if incorporating safety into design is cost-effective. On this project, project leadership noted that the fees paid to the fall protection consultant would have been spent on a few days’ worth of erecting scaffolding to gain access to solve issues after project completion. This is a significant cost savings, not to mention the improvements to worker safety and productivity.

When fall hazards are eliminated or managed through engineering control solutions, there are fewer fall protection issues to contend with through the life of a facility. This translates to less equipment purchases, less training and fewer elements to manage. While it may be difficult to attach a direct cost savings to this, it reduces overall operating costs.

**Conclusion**

When workers are faced with fall hazards in an existing structure, potential solutions are limited. Many times, equipment-based solutions are the only choice due to existing operations and interferences. But, when fall hazards are identified and evaluated before facilities are built, fall hazards can be eliminated or controlled in the best possible manner, often with a solution at the high end of the hierarchy of control.

Based on the example case study presented in this article, it is clear that safety can be drastically improved without a major impact on the existing design process. And, it was well worth the cost. As this company found, engaging in the process of thinking through fall hazards results in practical, cost-effective safety solutions.

When considering whether to evaluate fall protection during design, the question should not be “How much will it cost if we wait until the end?” Instead, ask, “How much can be saved if the hazards are abated now?”

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