

MINIMIZING SEVERE INJURY & FATALITY RISK IN WAREHOUSE OPERATIONS

By Steven J. Schwartz

Severe injuries and fatalities are caused by personal exposure to hazardous energy, and warehouse operations continue to present employees and contractors with a high probability of exposure to sources of motion (forklift to human or forklift to forklift) and gravitational (dropped objects) energy.

The hierarchy of controls provides warehouse operations and safety professionals with a technology-based approach to reducing these exposures. Each plan of action must be considered under the dual premises of impact (i.e., how much the probability or severity is reduced) and the ease of implementation (in terms of time, money, people). There are many “quick wins” that pair substantial risk reduction with minimal requests for resources.

The hierarchy of controls is often referenced in safety management; however, it is not always followed as intended. Often, leaders or safety professionals immediately dispel engineering projects (technology) because they perceive massive strains on their budget, their ability to manage projects, or all of the above. Many of these approaches can be implemented with modest financial investments while providing significant rates of return due to the efficacy of their design. The hierarchy of controls includes:

1. elimination (remove the hazard from the workplace),

2. substitution (replace a high-risk situation with a low-risk situation),
3. engineering controls (use technology to prevent an exposure),
4. administrative controls (use programs or policies to prevent an exposure) and
5. PPE (as a final layer of protection).

Eliminate Warehouse Hazards

At first glance, it is easy to assume that this top level of control is not feasible in a warehouse environment. A warehouse requires people to operate the equipment and move materials in the name of logistics. Furthermore, the forklifts are necessary to make heavy lifts and facilitate material handling. Elimination is not easy, but it can be an option. An automated storage and retrieval system (ASRS; Photos 1 and 2) delivers an environment free of people and powered industrial vehicles. Since the ASRS is fully guarded and automated, the likelihood of exposure to gravitational energy (e.g., falling pallets or loads) and forklift collision is zero during operations, as is the probability of any human error. The ASRS

is designed with tight-space tolerances and precise pallet dimensions inside an enclosed area. Cranes, automated palletizers, barcoding systems and engineered conveyor systems eliminate the need for both manual- and material-handling systems. Sophisticated engineering controls are used to prevent entry, and the safety control systems can be designed to the highest levels (ISO 13849-1) to avert any machine movement while persons are authorized to be inside for cleaning, service or maintenance. The ASRS eliminates the confluence of people, industrial vehicles and loaded pallets, directly reducing the risk of personal exposure to collisions and dropped goods. An ASRS is a substantial investment in capital (think millions) with the opportunity to receive a return on investment in addition to the positive safety impact.

Another method of eliminating risk is to restrict specific groups of people from accessing the warehouse floor. Often the warehouse is used as a path for nonwarehouse workers to get from point A to point B. Warehouses can be managed with individual identification badge access so that only warehouse workers are within the perimeter. Purely reducing the number of people in a defined area with forklift traffic directly reduces the probability of a collision between a forklift and a pedestrian. Some warehouses have constructed catwalks that provide a safety pedestrian path over forklift operations. The second option for elimination includes nonforklift vehicles. Eliminating any bicycle traffic, maintenance cart traffic, golf cart traffic or other non-material-handling-equipment traffic will also directly reduce the probability of vehicle-to-person and vehicle-to-vehicle collisions. Both nonessential pedestrian and vehicle traffic must be provided a safe route around the warehouse to make this approach effective. Furthermore, nonessential people and vehicles may be admitted into the warehouse with a comprehensive and consistent permit process, with authorization at the highest level. In these situations, other precautions must be taken to reduce risk and meet the conditions of the permit.



Photos 1 (left) and 2 (right): Automated storage and retrieval systems (ASRS) deliver an environment free of people and powered industrial vehicles, eliminating the likelihood of exposure to gravitational energy (e.g., falling pallets or loads) and forklift collision during operations.



A painted pedestrian crosswalk that has been made indistinct due to road traffic (Photo 3, top) can be substituted with a projected pedestrian crosswalk (Photo 4, bottom).



Photos 5 (left) and 6 (right): Automated/automatic guided vehicles (AGVs) are typically fitted with many controls such as lasers, cameras and other sensor devices to identify and mitigate collision exposures. They can also be programmed to maintain a specified path and reduce speed or stop if specific parameters are not maintained.

Substitution

Substitution of one risk element with a lower risk element requires thinking outside the box. Unlike chemistry where a hazardous chemical may be replaced with a less hazardous chemical in a reaction process, it is not easy to find suitable replacements for warehouse risks. One example that is easy to replicate is substitution of personal clothing or dull-colored uniforms with high-visibility uniforms. Neon-yellow shirts, jackets and vests provide a vivid contrast in sight for forklift operators. In Europe, the high-visibility clothing is considered PPE, however, standardizing high-visibility clothing for all warehouse occupants provides an alternate approach to identifying people on the shop floor and provisioning safety bubbles around people or forklift operators.

Decay of floor signs, either painted or stickered, can be substituted with high-definition projection imagery. For example, a pedestrian crosswalk that has been made indistinct due to road traffic can be substituted like-for-like with a crystal-clear projected image (Photos 3 and 4).

Projectors can be designed to illuminate crosswalks, stop signs, yield signs and other important messages that are difficult to see on the warehouse floor. In addition, these projectors can be installed to operate full time, or they can be triggered from a motion sensor or other presence-sensing device.

Automated/automatic guided vehicles (AGVs; Photos 5 and 6) have become more prevalent in warehouse operations that strive for increased accuracy and productivity. Safety is also a significant

benefit as the AGV is typically fitted with many controls to identify and mitigate collision exposures. If the AGV is considered the substitute for human-powered forklifts, then the combination of lasers, cameras and other sensor devices takes the place of human eyes and ears. Furthermore, AGVs can be programmed to maintain a specified path and reduce their speed or immediately stop if specific parameters are not maintained. AGVs have been proven to operate in extreme temperatures (e.g., in freezers) where people are exposed to additional risks to their well-being, such as reduced circulation. AGVs can operate as safely as they are programmed, with no risk of rushing, complacency, fatigue or frustration.

Engineering Controls

An entire book can be written about the various types of engineering controls used to reduce exposure potential in the warehouse. There are two main types of possible energy exposure: motion (struck by a forklift) and gravity (struck by a dropped object). Anticollision technology is available on most forklift platforms offering both radio frequency and ultrawide band mechanisms for identifying pedestrians or other forklift traffic. Antennae are installed on forklifts and tags are worn by pedestrians such that an inner and outer band are designated as a bubble. A cautionary alert (visual, audible) can be transmitted at the outer band, and a red or danger alert (also visual and audible) is sent to both parties if the inner band is breached. The anticollision technology can also be utilized to define geofencing, specifically to prevent fork-

lifts from leaving or entering designated areas of the warehouse.

One area of significant concern is the threshold between a warehouse dock and the back edge of a parked trailer. Forklifts are required to load or unload pallets to and from the trailer, often relying on procedures or key control to prevent a premature drive-off. Dock restraints and integrated wheel lock systems are commercially available to provide the dock employee with ultimate control over the trailer's motion. Trailers back into docks with green lights and initiate the process of controlled process steps that lock the trailer in place, allow the dock door to be open and give way for a dock-leveling device to span the threshold from dock to trailer. The outdoor light changes to red, communicating to the driver that they cannot leave. An indoor light turns green, communicating to the forklift driver that it is safe to load or unload the trailer. The forklift or dock operator is the only person who can release the trailer, changing the outdoor light back to green and communicating to the driver that they may pull away.

Another example of an engineering control is a vehicle presence sensor. Specific sensors are designed to identify the presence of an approaching vehicle (but not pedestrians or vehicles moving away from the sensor). These sensors can be mounted on walls or from the ceiling. Once the sensor registers the oncoming vehicle, it can send a signal to an audible alert (including a computerized stop tone), a visual alert (e.g., a strobe), or to a projected sign or image as described earlier.

The use of high-visibility bollards and rails to separate pedestrian traffic from



Photo 7: While PPE is the lowest layer of protection, it is a crucial to preventing mishaps with material handling devices. This steel-toe shoe was struck by powered pallet jack.

forklift traffic is an efficient way to respect areas designated for one or the other. Bollards and rails should be designed and installed to prevent total failure if struck by a forklift. These systems are commonly available in industry.

High visibility can also be applied to the forklifts and other powered industrial vehicles in the warehouse. Blue LED spotlights are becoming more commonplace on warehouse vehicles to increase their visibility to pedestrians and other forklift operators. The LED spotlights are placed on the front end and back end of the forklift to cast an intense blue beam of light in the oncoming path, regardless of whether the vehicle is driven forward or in reverse.

Administrative Controls

The use of policies, procedures and rules constitutes administrative controls, and it is no secret that these are only as strong as the culture and compliance dictates. These controls are as strong as the weakest link, which means that any deviation or omission constitutes a precursor, which can lead to an increased probability of exposure to hazards. All it takes is one person to deviate from an administrative control to put themselves or others in harm's way. A spaghetti diagram or plot is a method of viewing the flow of pedestrians, forklift traffic and potential intersections. A simple administrative control is to designate pathways for pedestrians and pathways for forklifts and other vehicles. Typically, these pathways would be separated by bollards or rails. A weaker mechanism is to provide floor markings or lines of separation for both groups. The lowest approach to risk

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reduction is to use procedures or rules to designate who can move through which areas. Administrative controls are inexpensive to implement; however, they provide a very low impact to the risk-reduction process, especially in organizations with a high injury rate or immature safety culture.

PPE

PPE is the lowest layer of protection available to warehouse employees, although it is crucial to preventing mishaps with material handling devices such as pallet jacks. Safety shoes, or shoes with steel toes that meet the local standards, are designed to provide a barrier from dropped objects and from objects in motion, including powered pallet jacks (as shown in Photo 7).

Another common type of PPE used more frequently in warehouses is the yellow high-visibility vest. In areas where employees are free to wear personal clothing to work (rather than company provided uniforms) or where visitors or other functional support personnel must be present on the warehouse floor, these high-visibility vests provide a valuable layer of protection for the forklift operator. The use of both steel-toed shoes and high-visibility vests is also embedded into local administrative controls, as it must be required in local procedures or rules that this protective gear must always be used.

Conclusion

Serious injury and fatality prevention has placed more rigor on areas of high exposure, including warehouse and dock operations. The hierarchy of controls is a time-tested approach to mitigating exposure risk to motion (collisions) and gravity (dropped objects). Whereas it is easy (and therefore common) to rally around inexpensive and quick fixes, greater risk reduction can be achieved through more deliberate approaches such as elimination, substitution and engineering controls. These top-tier approaches have less reliance on company culture, employee behaviors and common states that lead to workplace injuries. The availability of technology to reduce exposure risk in the warehouse environment is as robust as ever, and high-level controls are a fundamental building block to protecting employees and contractors within a company's facilities. **PSJ**



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