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Get To The Root Of Accidents

Systems thinking can provide insights on underlying issues not just their symptoms

By Nancy Leveson, Massachusetts Institute of Technology, and Sidney Dekker, Griffith University

AN OFTEN-CLAIMED "fact" is that operators or maintenance workers cause 70–90% of accidents. It is certainly true that operators *are blamed* for 70–90%. Are we limiting what we learn from accident investigations by limiting the scope of the inquiry? By applying systems thinking to process safety, we may enhance what we learn from accidents and incidents and, in the long run, prevent more of them.

Systems thinking is an approach to problem solving that suggests the behavior of a system's components only can be understood by examining the context in which that behavior occurs. Viewing operator behavior in isolation from the surrounding system prevents full understanding of why an accident occurred — and thus the opportunity to learn from it.

We do not want to depend upon simply learning from the past to improve safety. Yet learning as much as possible from adverse events is an important tool in the safety engineering tool kit. Unfortunately, too narrow a perspective in accident and incident investigation often destroys the opportunity to improve and learn. At times, some causes are identified but not recorded because of filtering and subjectivity in accident reports, frequently for reasons involving organizational politics. In other cases, the fault lies in our approach to pinpointing causes, including root cause seduction and oversimplification, focusing on blame, and hindsight bias.

ROOT CAUSE SEDUCTION AND OVERSIMPLIFICATION

Assuming that accidents have a root cause gives us an illusion of control. Usually the investigation focuses on operator error or technical failures, while ignoring flawed management decision-making, safety culture problems, regulatory deficiencies, and so on. In most major accidents, all these factors contribute; so to prevent accidents in the future requires all to be identified and addressed. Management and systemic causal factors, for example, pressures to increase productivity, are perhaps the most important to fix in terms of preventing future accidents — but these are also the most likely to be left out of accident reports.

As a result, many companies find themselves playing a sophisticated "whack-a-mole" game: They fix symptoms without fixing the process that led to those symptoms. For example, an accident report might identify a bad valve design as the cause, and, so, might suggest replacing that valve and perhaps all the others with a similar design. However, there is no investigation of what flaws in the engineering or acquisition process led to the bad design getting through the design and review processes. Without fixing the process flaws, it is simply a matter of time before those process flaws lead to another incident. Because the symptoms differ and the accident investigation never went beyond the obvious symptoms of the deeper problems, no real improvement is made. The plant then finds itself in continual fire-fighting mode.

A similar argument can be made for the common label of "operator error." Traditionally operator error is viewed as the primary cause of accidents. The obvious solution then is to do something about the operator(s) involved: admonish, fire or retrain them. Alternatively, something may be done about operators in general, perhaps by rigidifying their work (in ways that are bound to be impractical and thus not followed) or marginalizing them further from the process they are controlling by putting in more automation. This approach usually does not have long-lasting results and often just changes the errors made rather than eliminating or reducing errors in general.

Systems thinking considers human error to be a symptom, not a cause. All human behavior is affected by the context in which it occurs. To understand and do something about such error, we must look at the system in which people work, for example, the design of the equipment, the usefulness of procedures, and the existence of goal conflicts and production pressures. In fact, one could claim that human error is a symptom of a system that needs to be redesigned. However, instead of changing the system, we try to change the people — an approach doomed to failure.

For example, accidents often have precursors that are not adequately reported in the official error-reporting system. After the loss, the investigation report recommends that operators get additional training in using the reporting system and that the need to always report problems be emphasized. Nobody looks at why the operators did not use the system. Often, it is because the system is difficult to use, the reports go into a black hole and seemingly are ignored (or at least the person writing the report gets no feedback it even has been read, let alone acted upon), and the fastest and easiest way to handle a detected potential problem is to try to deal with it directly or to ignore it, assuming it was a one-time occurrence. Without

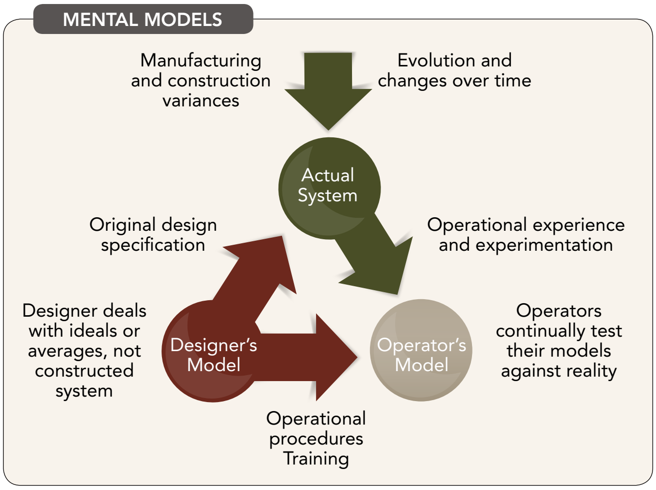

Figure 1. Designers and operators necessarily view systems differently.

fixing the error-reporting system itself, not much headway is made by retraining the operators in how to use it, particularly where they know how to use it but ignored it for other reasons.

Another common human error cited in investigation reports is that the operators did not follow the written procedures. Operators often do not follow procedures for very good reasons. An effective type of industrial action for operators who are not allowed to strike, like air traffic controllers in the U.S., is to follow the procedures to the letter. This type of job action can bring the system down to its knees.

Figure 1 shows the relationship between the mental models of the designers and those of the operators. Designers deal with ideals or averages, not with the actual constructed system. The system may differ from the designer's original specification either through manufacturing and construction variances or through evolution and changes over time. The designer also provides the original operational procedures as well as information for basic operator training based on the original design specification. These procedures may be incomplete, e.g., missing some remote but possible conditions or assuming that certain conditions cannot occur. For example, the procedures and simulator training for the operators at Three Mile Island nuclear power plant omitted the conditions that actually occurred in the well-known incident because the designers assumed that those conditions were impossible.

In contrast, operators must deal with the actual constructed system and the conditions that occur, whether anticipated or not. They use operational experience and experimentation to continually test their mental models of the system against reality and to adjust the procedures as they deem appropriate. They also must cope with production and other pressures such as the desire for efficiency and "lean operations." These concerns may not have been accounted for in the original design.

Procedures, of course, periodically are updated to reflect changing conditions or knowledge. But between updates operators must balance between:

1. Adapting procedures in the face of unanticipated conditions, which may lead to unsafe outcomes if the operators do not have complete knowledge of the existing conditions in the plant or lack knowledge (as at Three Mile Island) of the implications of the plant design. If, in hindsight, they are wrong, operators will be blamed for not following the procedures.
2. Sticking to procedures rigidly when feedback suggests they should be adapted, which may lead to incidents when the procedures are wrong for the particular existing conditions. If, in hindsight, the procedures turn out to be wrong, the operators will be blamed for rigidly following them.

In general, procedures cannot assure safety. No procedures are perfect for all conditions, including unanticipated ones. Safety comes from operators being skillful in judging when and how they apply. Safety does not come from organizations forcing operators to follow procedures but instead from organizations monitoring and understanding the gap between procedures and practice. Examining the reasons why operators may not be following procedures can lead to better procedures and safer systems.

Designers also must provide the feedback necessary for the operators to correctly update their mental models. At BP's Texas City refinery, there were no sensors above the maximum allowed height of the hydrocarbons in the distillation tower. The operators were blamed for not responding in time although they had no way of knowing what was occurring in the tower due to inadequate engineering design.

FOCUSING ON BLAME

Blame is the enemy of safety. "Operator error" is a useless finding in an accident report because it does not provide any information about why that error occurred, which is necessary to avoid a repetition. There are three levels of analysis for an incident or accident:

- What — the events that occurred, for example, a valve failure or an explosion;
- Who and how — the conditions that spurred the events, for example, bad valve design or an operator not noticing something was out of normal bounds; and
- Why — the systemic factors that led to the who and how, for example, production pressures, cost concerns, flaws in the design process, flaws in the reporting process, and so on.

Most accident investigations focus on finding someone or something to blame. The result is a lot of non-learning and a lot of finger pointing because nobody wants to be the focus of the blame process. Usually the person at the lowest rung of the organizational structure (the operator) ends up shouldering the blame. The factors that explain why the operators acted the way they did never are addressed.

The biggest problem with blame, besides deflecting attention from the most important factors in an accident, is that it creates a culture where people are afraid to report mistakes, hampering accident investigators' ability to get the true story about what happened.

One of the reasons commercial aviation is so safe

is that blame-free reporting systems have been established that find potential problems before a loss occurs. A safety culture that focuses on blame will never be very effective in preventing accidents.

HINDSIGHT BIAS

Hindsight bias permeates almost all accident reports. After an accident, it is easy to see where people went wrong and what they should have done or avoided or to judge them for missing a piece of information that turned out (after the fact) to be critical. It is almost impossible for us to go back and understand how the world appeared to someone who did not already have knowledge of the outcome of the actions or inaction. Hindsight is always twenty-twenty.

For example, in an accident report about a tank overflow of a toxic chemical, the investigators concluded "the available evidence *should have* been sufficient to give the board operator a clear indication that the tank was indeed filling and required immediate attention." One way to evaluate such statements is to examine exactly what information the operator actually had. In this case, the operator had issued a command to close the control valve, the associated feedback on the control board indicated the control valve was closed, and the flow meter showed no flow. In addition, the high-level alarm was off. This alarm had been out of order for several months but the operators involved did not know this and the maintenance department had not fixed it. The alarm that would have detected the presence of the toxic chemical in the air also had not sounded. All the evidence the operators actually had at the time indicated conditions were normal. When questioned about this, the investigators said that the operator "could have trended the data on the console and detected the problem." However, that would have required calling up a special tool. The operator had no reason to do that, especially as he was very busy at the time dealing with and distracted by a potentially dangerous alarm in another part of the plant. Only in hindsight, when the overflow was known, was it reasonable for the investigators to conclude that the operators should have suspected a problem. At the time, the operators acted appropriately.

In the same report, the operators are blamed for not taking prompt enough action when the toxic chemical alarm detected the chemical in the air and finally sounded. The report concluded that "interviews with personnel did not produce a clear reason why the response to the … alarm took 31 minutes. The only explanation was that there was not a sense of urgency since, in their experience, previous … alarms were attributed to minor releases that did not require a unit evacuation." The surprise here is that the first sentence claims there was no clear reason while the very next sentence provides a very good one. Apparently, the investigators did not like that reason and discarded it. In fact, the alarm went off about once a month and, in the past, had never indicated a real emergency. Instead of issuing an immediate evacuation order (which, if done every month, probably

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would have resulted in at least a reprimand), the operators went to inspect the area to determine if this was yet another false alarm. Such behavior is normal and, if it had not been a real emergency that time, would have been praised by management.

Hindsight bias is difficult to overcome. However, it is possible to avoid it (and therefore learn more from events) with some conscious effort. The first step is to start the investigation of an incident with the assumption that nobody comes to work with the intention of doing a bad job and causing an accident. The person explaining what happened and why it happened needs to assume that the people involved were doing reasonable things (or at least what they thought was reasonable) given the complexities, dilemmas, tradeoffs and uncertainty surrounding the events. Simply highlighting their mistakes provides no useful information for preventing future accidents.

Hindsight bias can be detected easily in accident reports (and avoided) by looking for judgmental statements such as "they *should have* …," "if they *would only have* …", "they *could have* …" or similar. Note all the instances of these phrases in the examples above from the refinery accident report. Such statements do not explain *why* the people involved did what they did and, therefore, provide no useful information about causation. They only serve to judge people for what, in hindsight, appear to be mistakes but at the time may have been reasonable.

Only when we understand why people behaved the way they did will we start on the road to greatly improving process safety.

ESCAPING THE WHACK-A-MOLE TRAP

Systems are becoming more complex. This complexity is changing the nature of the accidents and losses we are experiencing. This complexity, possible because of the introduction of new technology such as computers, is pushing the limits that human minds and current engineering tools can handle. We are building systems whose behavior cannot be completely anticipated and guarded against by the designers or easily understood by the operators.

Systems thinking is a way to stretch our intellectual limits and make significant improvement in process safety. By simply blaming operators for accidents and not looking at the role played by the encompassing system in why those mistakes occurred, we cannot make significant progress in process safety and will continue playing a never-ending game of whack-a-mole.

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ALWAYS LOOKING AHEAD

Weigh In Process Safety

A properly designed weigh model can optimize safety and improve efficiency

By Michael Sutton, Mettler Toledo

PROCESS DESIGN and process safety are critical considerations in chemical production and processing. With design and safety paramount at the outset of any new development or equipment retrofit, firms can minimize risk exposure, maximize productivity and position themselves to remain compliant and competitive. Advanced automation technologies continue to drive productivity improvements.

In addition, automating certain industrial tasks reduces people's exposure to workplace hazards. One area that has experienced technological advancements in safety is industrial weighing. Today's weigh modules, which can be used to convert most tanks, hoppers or other vessels into a scale, have been designed to maximize safety without sacrificing accuracy or reliability.

Regulatory scrutiny and employer liability increase the need to evaluate every part of a production facility. The current generation of weigh modules has been designed to improve performance, safety, ease of selection, installation and commissioning. To maximize the value of these safety features and design enhancements, these products were also designed to allow for installation by someone without advanced scale knowledge.

Older or poorly designed weigh modules can compromise the manufacturing process in various ways. Weight data —used in batching, filling, inventory control or other applications — are entirely dependent on the accuracy of the weigh module. A poorly designed weigh module can negatively impact product quality and production yields and diminish organization efficiency.

In addition, an outdated or poorly designed weigh module can cause safety hazards and possible compliance violations. Without extensive experience and expertise, designing a weighing system that takes advantage of today's advanced features can be challenging. Organizations should consider design integrity, load-cell quality, safety requirements and shipping and installation features to make sure they are meeting all requirements.

DESIGN SAFETY

Not all weigh modules are created equal. Some weigh modules have been carefully designed and tested to maximize safety, accuracy and efficiency. Other weigh modules only appear to have these features. It is important to recognize the difference. While the weigh module does weigh the scale, it is also an integral component of the overall support structure.

The weigh module obtains weight as a measurement of vertical force applied by the vessel and contents. This means it is often the only connection between the vessel and the ground. The weigh module

LOAD CELL WITH ROCKER-PIN SUSPENSION

Figure 1. A self-aligning rocker-pin suspension design allows some degree of movement to occur without causing damage to the load cell or changes to its accuracy.

and application must be matched so the vertical force does not exceed the maximum capacity of the load cell. But as the primary connection to the ground, the weigh module must also provide resistance to lateral forces to prevent tipping. So, while the design is important to accuracy, it is critical to safety as well.

Organizations should seek weigh modules that offer anti-lift protection as a standard option. As a field-installed option, anti-lift protection is often overlooked on site. This can be a critical safety feature in windy outdoor conditions or any installation where vehicle traffic can impact the scale. The anti-lift feature protects the scale from tipping. For maximum safety, the anti-lift feature should function without a load cell installed. Seek weigh modules with vertical down-stops to prevent tipping in the event of any suspension hardware failure for added security.

Organizations also should conduct Finite Element Analysis (FEA), a computer-based structural analysis method, in the design of any weigh module. With satisfactory results from computer modeling, the process moves to the production of prototypes.

Prototype testing should first establish that the design can meet the desired specification for both vertical and lateral forces. If the requirements are met, conduct additional testing to identify upper limits of the design capabilities and the failure point. Pursuing design to this level ensures that safety and performance requirements are fully met. The last step is to create drawings, load ratings and installation documentation so the weigh module can be safely and easily integrated into the overall scale design.

In hazardous areas, load cells and weigh modules must also achieve correct certifications to satisfy the requirements of the appropriate governing bodies (FM, ATEX, etc.).

EVALUATING LOAD CELLS

There are several "types" of load cells that are marketed as appropriate load cells for a weigh-module system. But load-cell selection must include a variety of factors. First, make sure the load cells have NTEP, OIML, NEMA and IP ratings to match the application in which they will be used (Figure 2). Beyond basic certifications, there are a variety of other factors that impact the system that should be considered.

Thermal expansion/contraction can create a push/pull force on the vessel supports. In high-traffic production areas, vessels are susceptible to accidental side impacts. Wind forces on exterior tanks or even vibrations from a mixing agitator can reduce load-cell accuracy. Look for a design that takes these and other factors into consideration to achieve the best result. There are load cells available that contain safety or compensation features to deal with those factors.

An example is a self-aligning rocker-pin suspension. This design allows some degree of movement to occur without causing damage to the load cell or changes to its accuracy. In addition, this feature and similar options always return the scale to the ideal weighing position, ensuring repeatability and the highest level of accuracy.

This rocker-pin type suspension in its simplest form allows only limited movement — generally

bidirectional only. A more robust design would typically provide a 360° range of motion to allow expansion/contraction in all directions. This type of design needs to include 360° checking with sufficient strength to stop the scales' movement in all directions to prevent load-cell damage or even tipping.

SHIPPING AND INSTALLATION

In addition to advancements in performance and safety, the modern weigh module design may improve the installation process, resulting in a more robust installation that may be easier to achieve than previous generations. Engineers and product designers have considered every element of the weigh module, including the logistics between production and installation. Look for a weigh module that can be delivered to a site in a shipping/installation "mode." In this mode, the various components are locked in the manufacturer's ideal initial positions in a way that isolates the load cell until installation is complete. In addition to preventing accidental damage to the load cell, this feature also helps to ensure load introduction and equal top-plate travel in all directions upon commissioning (transfer of weight to the cell).

Some products offer alignment and rigidity that is independent of the load cell. In this scenario, the load cell can be installed after rest of the process is complete. This feature has also been designed to allow for quick and easy replacement of a load cell in the event of a failure.

Weigh modules that offer a "shipping/installation" mode also have been designed to provide greater flexibility in the overall design and construction process. With the safeguards that prevent forces to be transferred to the load cell in place, they can fixed to the foundation before the tank is lowered into place or they can be installed to the tank legs at any time before it is lowered to the foundation, even before the tank is shipped to the site.

Following installation, it should be easy to convert the weigh modules from shipping/installation mode to weighing mode in preparation for calibration.

FACTORS TO CONSIDER

Figure 2. When selecting load cells, make sure they have NTEP, OIML, NEMA and IP ratings to match the application in which they will be used.

SUMMARY

Weigh modules are an important component of a weighing system. When selecting one, opt for the modern features discussed here to ensure long equipment life and the best performance. Versatile and feature-rich weigh modules can simplify installation and ensure safety throughout their lifetime.

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METTLER TOLEDO

Design Blast-Resistant Petrochemical Facilities

Building a blast-resistant structure goes beyond just keeping personnel safe

By Ali Sari, Ph.D., PE, Structural Analysis Manager, Genesis Oil and Gas Consultants

BLAST-RESISTANT BUILDING design is a relatively unexplored frontier. For one thing, very little research has been done on the actual effects of blasts on various types of structures. Then there are aesthetic and psychological considerations; in addition to making a building safe, it's important to create interior spaces that are functional and provide appropriate levels of comfort for personnel.

RedGuard of Wichita, Kan., hired my team to help design blast-resistant buildings because we're one of the few engineering teams in the world with actual blast experience. We were called in to investigate the Texas City, Texas, refinery disaster in 2005, which provided us with data that's ordinarily very difficult to come by, and which informed our efforts to design new and safer structures for personnel in blast zones.

STRUCTURAL CONSIDERATIONS

When we design a blast-resistant building, we start with a framework similar to that of the human rib cage. You can appreciate the strength of this natural construct if you have ever seen slow-motion video of a boxer taking a punch to the side of the body. His ribs compress in a way that dissipates the energy of the punch over a large surface area, protecting the vital organs inside. The same is true of the steel stiffeners we place at 11- to 12-inch intervals in the frame of a blast-resistant building. When we weld steel walls around these "ribs," we have a structure more redundant and reliable than a traditional building.

The interior walls are often made from oriented strand board, which minimizes the likelihood of wall shrapnel breaking free and injuring personnel.

PRACTICAL CONSIDERATIONS

We equip every blast-resistant building with battery powered emergency lights, smoke detectors and a fire extinguisher.

Broken glass is a huge danger in a blast, so we use tamper-proof fluorescent light fixtures, which are designed for correctional facilities. They have hard plastic diffuser housings with shielded fluorescent tubes inside. If a tube breaks, the glass is safely contained inside these two protective layers.

Electrical and communication wiring conduits are deliberately left exposed so any damage incurred in a blast will be visible, and personnel will know not to turn power on until it's repaired.

MAKING IT COMFORTABLE

Many of the blast-resistant buildings we've helped design are placed in the field with very few frills, and they work well in a variety of applications, from guard shacks to tool cribs. They can be

PORTABLE CONTAINER

Figure 1. Blast-resistant buildings can be transported like shipping containers, and this portability allows petrochemical facilities to move them quickly and easily as needs and work flows change.

transported like shipping containers (see figure above), and this portability allows petrochemical facilities to move them quickly and easily as needs and work flows change.

But some applications call for foundation-mounted facilities with office-like interiors and amenities. These feel less like a warehouse and more like an executive office on the inside.

In addition to being more elegant and somewhat more permanent (usually foundation-mounted), such facilities offer a psychological advantage: many people are accustomed to seeing finished interior walls in permanent structures, so they feel safer in this type of environment.

MAKING SURE IT WORKS

Various engineers performed analysis on our design, trying to predict how it would behave in a blast, and some said it would slide significantly or roll across the ground. My analysis indicated that it would not do so, but with all our analysis and real-world observation, we were not really sure what would happen until we tested it.

We detonated 1,250 pounds of high explosive ANFO charge at a standoff distance of 110 feet from the building, which created a blast load far in excess of the ratings required to meet ASCE medium response standards. The building suffered no structural damage, it did not roll and slid less than an inch. The furnishings, equipment and test dummy inside also sustained no damage.

Although blast-resistant building design is still a comparatively new discipline with very little information available to the safety engineers who are tasked with protecting employees, we are making progress at last.

ALI SARI, PH.D., PE, is a structural analysis manager for Genesis Oil and Gas Consultants .

RedGuard, formerly A Box 4 U, designs and creates blast-resistant buildings and uses third-party blast tests to ensure reliability. Learn more at redguard.com or call 855.REDGUARD.

Find New Solutions to Old Challenges

Modern barrier safety systems can protect both plant personnel and equipment

By Andy Olson, Rite-Hite

TRANSPORTING GOODS FROM one place to another is nothing new. As long as there have been products to move, there have been people who have made their living doing it. Today, as people and businesses worldwide are more connected than ever before, the quick, safe movement of goods and materials is critical. Facilities managers need to be ready to meet modern demand without putting their employees, equipment or products at risk.

Workplace accidents are costly for your operation and more importantly, your employees. According to the Occupational Safety and Health Administration (OSHA), forklift accidents account for nearly 100 fatalities in the United States annually.[1] In 2006, the cost of workplace injuries was $164.7 billion, which exceeded the combined profits reported by the 11 largest Fortune 500 companies that year.[2] Unfortunately, some of the dangers in the workplace go unnoticed until after an accident occurs.

Reducing the risk of accidents is important for the health of your employees and your company. Start by evaluating your current barrier systems and procedures at the loading dock as well as inside your facility.

CHALLENGES AT THE LOADING DOCK

The loading dock provides the connection between the materials entering and leaving your facility. It's a busy hub of activity — and it's where 20% of all industrial accidents take place. [3]

Vacant loading docks present one potential hazard in the facility. At sites that lack proper barriers or gates, materials handlers and forklift operators are at risk of falling off the dock. And in many facilities, loading dock doors are left open to allow fresh air into the building, making the situation even more dangerous. The four-foot drop is enough to cause serious injury to workers and damage to equipment.

CHALLENGES IN THE FACILITY

Inside the facility there are additional challenges. People and vehicles are moving around the floor, and it's up to facilities managers to ensure they are doing so safely. Creating spaces and managing the flow of movement is one solution, but separating and defining work areas within a large space such as a plant or warehouse can be a complex undertaking.

Yellow painted lines on the floor are a cost-effective and movable solution. However, they may not always be visible and, what's more, provide no protection to people, materials or equipment.

Fixed steel guard barriers do provide some protection. But, they don't allow for easy access to areas and reconfiguring them can be costly. For facilities that need to be more flexible with space and how it is used, steel barriers are not always an adequate solution.

KEYS TO SAFETY

There are three key factors to creating full-time safety at a loading dock opening. First, you need a highly visible barrier to alert material handlers. Second, the barrier needs to be impact resistant. And finally, the barrier needs to be removable so it doesn't impede the loading and unloading of materials.

To meet all these requirements, consider a 4-ft-high safety barrier (Figure 1) that stretches across the door opening and is easy visible to plant personnel. It can stop up to 10,000 lb traveling at 4 mph and can be interlocked with a vehicle restraint to create a sequence of operation, which prohibits the barrier from being removed until a vehicle restraint is fully engaged. This high-impact, easy-to-remove barrier is well-suited for loading dock environments.

In addition to dock safety, other application-specific barrier solutions exist for inside a facility. These include barriers that offer protection and flexibility for organizations that need to reconfigure work areas, workspaces or walkways quickly and efficiently. When used with corner posts, these barriers are easy to reconfigure to suit the needs of the facility as it changes. They provide unobstructed access to work areas and the flexibility to relocate barriers at minimal cost.

Other barriers exist for larger work areas and spaces that require protection against potential impacts from forklifts (Figure 2). Visible and strong, these barriers offer serious impact protection, which keeps both employees and equipment safe.

Straps that span up to 60 ft between permanently mounted steel posts and can be removed easily for unobstructed access to a work area provide an effective visual and physical barrier to help keep people and material handling equipment out of harm's way. Straps are available that can withstand 10,000 lb traveling at up to 4 mph.

Other barriers are designed to stop a fork truck with little or no deflection. Such systems can be used as a stand-alone barrier or it can be incorporated into custom installation with other barrier systems in your facility.

Figure 1. This 4-ft-high safety barrier stretches across the door opening and is easy visible to plant personnel.

Figure 2. Flexible barriers, designed for larger work areas and spaces, protect against potential impacts from forklifts.

For elevated applications, a mezzanine safety gate offers protection to personnel working on elevated work platforms and mezzanines. A dual reciprocating barrier (Figure 3) can make elevated platform loading and unloading safer. It creates a controlled access area in which the inner gate and outer gate cannot be opened at the same time. The exclusive link bar design ensures that both gates always work in unison.

When the outer gate opens to allow pallets to enter the mezzanine, the inner gate automatically closes to keep workers out. After the pallet is received, mezzanine-level workers open the inner gate to remove material from the work zone while the outer gate closes to secure the leading edge of the platform. To prevent the outer gate from being raised by a worker inside the work zone, a special latch is integrated that can only be accessed when standing outside the work zone.

Look for a safety gate constructed from heavy-duty steel and aluminum, and features a raised toe board to help prevent materials from accidently being pushed off the elevated edge. Another useful feature is having the link bars, which control the gate opening and closing, run along protected, 3-in. tracks with nylon rollers, making gate operation smooth and easy for workers.

In environments where workspaces are elevated, or use multi-level pick modules, you can install safety gates that provide fall protection within a racking system.

WORKING TOGETHER IN THE WORKPLACE

A system of barriers, working together, help to create a safer, more productive work environment. Working with a trained loading dock equipment representative can help facilities managers understand the challenges specific to their operations and implement the system that best meets their needs. If your company is ready for a systematic approach to workplace protection, and needs the flexibility modern barrier systems can provide, consider components engineered for safety and efficiency.

Safety equipment specialists should conduct an on-site visit to analyze all aspects of your operation, including:

- Drive approach
- Loading dock dimensions
- Loading dock door configuration
- Workspace configuration
- Current barrier system
- Mezzanine safety system
- Security and safety risks.

PERSONNEL PROTECTION

Figure 3. This dual reciprocating barrier makes elevated platform loading and unloading safer.

SOURCES

1. OSHA
2. National Safety Council, "Injury Facts," 2008
3. OSHA

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