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The Layered Approach to Hazard Recognition

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Even within organizations with the best safety and health management systems, both the line organization and safety, health and environmental (SH&E) professionals can overlook hazards. Therefore, effective techniques must be used to recognize potential hazards so that controls can be implemented to prevent unwanted events such as injury, illness, and property damage. Many hazard recognition techniques exist, and almost all organizations need to use a variety of techniques in order to be more assured that hazards are recognized. Table 1 lists the most common and most effective hazard recognition techniques.

Every organization needs techniques that are effective for different personnel in the organization. There should be techniques for SH&E professionals (such as Risk Mapping), supervisors and managers (such as walk-through audits), and the individual employee performing the task (such as the Final Safety Checks). Many techniques can be used by all members of an organization (such as Job Safety Analysis and behavioral observations), but others will require a higher level of trained and equipped personnel to use (such as Process Hazard Analysis and testing circuits with electrical test equipment). Your challenge is to identify every task that occurs in your work place and assure that there is a layer of hazard recognition techniques to identify the hazards.

When Can Hazards Be Recognized?

There are three opportunities to recognize hazards.

1. Before Exposure: Some hazards can be recognized in the planning, design and preparation phase of a task or project. This is the best time to recognize potential hazards because at this point, no one has been exposed to any hazards. There should be adequate time allowed to review the upcoming job and determine what hazards may be present. Examples commonly used during this phase would include Blueprint Reviews, Job Hazard Analysis, Turnaround and Outage Planning, Prevention through Design and The Final Safety Checks.

2. During Exposure: After the job, task, or operation has started, hazards can still be found, preferably before an unwanted event occurs. Examples commonly used during this phase include Process Hazard Analysis after a process is already in operation, walk-through audits, and review of job procedures.

3. After Exposure: After exposure has occurred, recognition may be the result of an incident such as an injury or illness, or could be the result of a critique or review of the task or job just performed. This phase also includes review of work permits,

policies and procedures, and debriefing of the individuals that took part in the job. Examples commonly used during this phase include Root Cause Analysis, Demolition Audits, and Job Cessation Reviews.

To be effective, multiple techniques may be required to be used simultaneously or back-to-back to find hazards. Many hazard recognition techniques are useful when applied at all three of these opportunities. The key objective for every organization is to implement enough techniques at all phases of the operation to find and control hazards.

The Layered Approach to Hazard Recognition

Hazard recognition is a multi-layered approach. Figure 1 indicates the three layers useful to identify hazards before exposure. More layers in the pyramid can be added to find hazards after the task has started, and should an unwanted event occur, even another layer can be added.

The first layer of hazard recognition before someone is exposed, at the bottom of the pyramid, is the initial planning for the project, job or task. The normal technique is a meeting of interested parties to discuss the task and what is needed to complete it. This meeting typically occurs in an office, conference room, control room or perhaps a morning meeting at the job site. These planning sessions can be as simple as a tool box meeting or more complex such as a group of engineers, SH&E professionals, maintenance and operations managers, and other advisors. This layer may also involve sending a planner to the jobsite to assess the procedures, tools, equipment and personnel that will be needed.

For example, ZZZ Construction is planning to replace a 5-ton air conditioning unit on the roof of a building with a larger air conditioner. The customer and contractor meet in the office to discuss how the job will proceed. They examine blueprints to understand roof load capacities, discuss expected weather conditions, evaluate the skill of the personnel needed and plan on the types of cranes, aerial lifts, helicopters, tools and other equipment needed. A planner will most likely be sent to the jobsite to note visually what tools, equipment, personnel and documents will be needed.

During this layer, general hazards, such as roof capacities, land topography, overhead power lines and building height will be noted and evaluated. Therefore, the hazard recognition techniques that might be used in this phase include blueprint review, risk mapping, management of change and new equipment reviews. Ideally, SH&E professionals will be included during this phase, but they often are not. It is also common for generic checklists and standard operating procedures to be used during this phase to help identify hazards.

The second layer of hazard recognition includes the formal written techniques commonly used to identify, evaluate and control hazards. The broad plans, equipment, personnel and environment have been considered and evaluated in the first phase. The second layer is the opportunity to prepare formal SH&E plans.

Various options are available. For example, ZZZ Construction can prepare a series of job safety analyses for the various job steps. ZZZ may prepare a lift plan for using the crane or helicopter. With the assistance of SH&E professionals, the company may prepare a complete SH&E review. Permits for overhead work, hot work and barricading may be used. These methods are useful for the planners of the task to review written documents that guide them and remind them of issues that must be considered.

The third layer of hazard recognition is useful for the field employee who performs the job or task. After the first two layers are concluded, the field employee may find that conditions have changed: the weather has changed, the planners overlooked hazards or did not estimate correctly how the job could be performed, new people have been introduced to the job, or hazards were overlooked during the first two phases.

Additional layers of hazard recognition may also be necessary to protect individuals who are exposed to the job during and after completion. These techniques might include safety audits during the job, start-of-shift hazard assessments, behavioral observations and updating permits. Once the job is completed a job review should be conducted to ensure that hazards were not left behind (for example, impaling hazards, floor holes, and electrical hazards). Studs that held the original air conditioner in place or an aesthetics barrier that was removed may leave impaling or tripping hazards for those who will service the air conditioner in the future.

Effective Hazard Recognition Techniques during the Second Layer

During the past 36 years as a safety professional, I have used a variety of techniques in many different locations and many different types of entities, including manufacturing, service organizations, construction sites, migrant labor camps, shipyards, public sector agencies, aviation and maritime. The following paragraphs list some of the most common hazard recognition techniques that are useful during the second layer, and examples of how the technique can be used. This list is not in any particular order.

1. Pre-Use Analyses: This technique is also called New Equipment Reviews and New Chemical Reviews. Pre-use analyses can be applied to new personal protective equipment, a new industrial hygiene sampling device, a new tool or piece of equipment. For example, a pre-use analysis has helped an organization discover that the new Plano safety glasses for visitors did not have an ANSI Z87 approval. In another case, a company learned that a new environmental sampling device was not intrinsically safe. In a third example, a manufacturing plant learned during the pre-use analysis that the purchasing folks had bought rolling ladder stands that did not have adequate guardrails. Before any new equipment, device, protective equipment, etc., is put into use, someone or a team that is qualified should conduct a pre-use analysis.

2. Blueprint Reviews: This technique is intended to be used before construction starts and during construction as well. How many times have you seen retrofits or remodeling needed on structures and buildings because they were designed wrong! Examples include inadequate numbers of exits or the exits are not placed remote from one another, the location where the maintenance folks must be located to work on equipment puts them at the edge of the roof and no guard rails are installed, and the eyewash is installed several hundred feet from where the hazardous chemicals are used. With virtual computer-design plans, this process has even gotten to be more effective. The safety and health staff should review the drawings before the construction starts.

3. Work Permitting: Issuing a written permit or approval document to perform all but the most routine tasks will require the workers to go through a checklist to ensure that hazards have not been overlooked. Some organizations have multiple work permits for different activities but it is also quite effective to have a single work permit that will

cover hot work, vessel entry, excavations, overhead work, working alone, lockout/tagout, etc. A technique for finding hazards after the exposure occurs is for permits to be reviewed periodically to look for additional missed hazards, oversights, and procedural errors.

4. Equipment Inspections: This technique is effective before equipment is used on a particular work shift. OSHA has nearly 400 inspection requirements for items such as slings, cranes, respirators, forklifts, machines, grinding stones, etc. There are many more equipment inspections that OSHA does not specifically address that should also be performed such as for eyewashes, machine emergency stops, hand tools, etc. To do these inspections, the inspections must be planned and organized and those who do the inspections must be adequately trained. These inspections and training increase hazard awareness as well as find potential hazards before the equipment is used.

5. Risk Mapping: This technique can be used anytime, but should be used before a task or operation begins. Risk Mapping involves drawing out a map of the entire work site, and including surrounding areas if necessary, the operations that are occurring and the hazards that each generate. Then, synergistic or causal effects of one operation impacting another operation are considered. For example, arc welding in an area where flammable vapors can be carried by prevailing winds into the welding area can produce deadly fires and explosions. The placement of administrative staff adjacent to areas that have vibration and excessive noise is another example. Unless the impact of one operation on an adjacent operation is studied, these hazards can be overlooked.

6. Hazard Operability Studies: Sometimes, these studies or reviews are called HAZOP's, What-If Reviews, process hazard analyses [PHA's], and other names. OSHA and EPA require these studies for some chemical processes, but every chemical process would benefit from this type of review. The purpose of this review is to prevent or minimize the consequences of catastrophic releases of toxic, reactive, flammable and explosive chemicals by identifying improper procedures, equipment, employee training, management systems, and maintenance. For example, during the study, one may find that galvanized piping has been used for a chemical that is highly reactive to galvanized piping.

7. Perception Surveys: Every organization has three safety and health management systems: 1. The first management system is the one you have written in your safety manual. Many of you have very detailed policies and procedures for safety and health. 2. The second management system is the one you think you have in the field. You know that not every single item in the safety and health policies manual is being done or followed to the letter, but you have a good idea of how well the activities follow the prescribed systems. And, 3. The third management system is the one you really have in the field – what is really going on. Perception surveys will tell you what employees really think about safety, work practices, risk acceptance, management leadership and more. You learn about hazards that are occurring through ignorance, shortcuts, miscommunication, and nonchalance. Conduct a survey every two years for a while and see if there is improvement. The goal is to get all three safety and health systems the same!

8. Management of Change: This technique is most useful after a process, piece of equipment, or machine has been placed in service and changes need to be made. Whenever any changes are made, with the usual exception of "changes in kind," a new

hazard can be introduced: the wrong valve, the wrong type of metal in the piping, the wrong circuit breaker, the wrong training, the wrong gloves, or the wrong ladder. Analyze each change for what could happen.

9. Job Hazard Analysis: This technique is also called job safety analysis, job safety and health analysis, and other names. The most common approach is a three-column spreadsheet. The auditor lists each major step required to perform a particular task. Beside each step, the auditor lists the hazards that are present when performing that step in the task. Then, in the third column, the auditor lists the potential control measures for each hazard noted. You will find very thorough guidance for using this technique in the National Safety Council's Accident Prevention Manual, Administration and Programs, 12th Edition, pages 173 through 179, and OSHA Publication 3071 – 2002 Job Hazard Analysis.

Effective Hazard Recognition Techniques during the Third Layer

The best laid plans can go awry. For this reason, the third layer is needed at the job site to find and control hazards that may have been overlooked or that developed after the initial planning. New personnel, changes in the weather or working conditions, unfamiliar equipment and tools and mistakes during the planning process can cause hazards.

The following five techniques have a long history of being used effectively by the field employee just before the start of the job. Collectively, they are known as Final Safety Checks. But each has a distinct value and purpose.

1. Last Minute Safety Check or Simple Multi-Step Planning Process: Every task, every job, and every activity needs to be rechecked after the planning and organizing phases. To do the job, task or activity safely, a simple, short multi-step question process will cause the employee to stop and consider the hazards and controls. Some employers even put these processes on a wallet card, the back of the employee's ID, or on a sticker for the toolbox or hardhat (If you want to put a sticker on a hardhat, follow the hardhat manufacturer's requirements for applying adhesives to a hardhat.). There are many variations of the Last Minute Safety Check, but most are based on four simple questions. The questions should be similar to:
   - What am I about to do?
   - What do I need to do this job and how will I do it?
   - How could I or someone else get hurt?
   - What am I going to do to prevent injury?

   Examples of this process include SCAN, used by ExxonMobil. First, Survey your surroundings for potential hazards. Next, consider how your actions could create an additional hazard. Third, analyze what could go wrong and hurt someone. And, fourth, correct the situation or if you are not able, notify your supervisor to control the hazard.

   Another example is SLAM, used by Marathon Petroleum. First, stop, plant your feet and prepare to look around at your surroundings. Next, look for potential hazards. Third, analyze what could go wrong and hurt someone. And, fourth, Mitigate the hazards either yourself if trained and authorized, or report the hazard, if not.

A third example is called First Things First. The developers of this Last Minute Safety Check require that their employees recheck four key issues before starting any job or task. 1. Assure that any hazardous energy is controlled. 2. Assure that housekeeping is in order. 3. Assure that the correct personal protective equipment is available, in good condition and is used. And, 4. Assure that all potentially needed emergency equipment and procedures are accessible, in good condition and understood how to use.

And, a fourth example is the 3C Personal Risk Manager developed and used by URS Washington Division. First, step back 2 yards for 2 minutes and ask: Are there any unsafe Conditions? Next, determine the Consequences of your actions. And third, Control the hazards.

The beauty of these techniques is that no paperwork is necessary, employees learn a simple and quick method to identify hazards that may have just developed or were overlooked, and employees take further responsibility for their own safety.

For example, ZZZ has removed the old air conditioner and the new air conditioner has been set in place. Now, the crew needs to anchor the new equipment and attach it to the utilities. This crew would use the last minute safety check before starting the job to assure that they aren't too close to the edge of the roof without fall protection, that the weather has not changed, that they have an escape route, and that their tools and personal protective equipment are in good shape.

2. The Ten-Second Drill: Other names for this technique include 360 Degrees, The Circle of Safety and The Ten Foot Circle. This technique encourages the employee to take ten seconds before the start of the task to review surroundings. Why? Because the employee will be concentrating on his or her task and not necessarily nearby conditions. During movement around the task, or if there is a need to evacuate the area, potential hazards should be identified and controlled before starting. During this ten seconds, the employee would assure that a primary and a secondary means of egress is known and is accessible, that there are no impaling hazards nearby such as an OS&Y valve stem or piece of rebar, that there are no holes or floor openings, and no drain covers missing, and that there are no hoses or electrical cords in the immediate vicinity that could create a tripping hazard.

   For example, the ZZZ crew preparing to install the new air conditioning unit would take about ten seconds and assure that there are no impaling hazards, no tripping hazards, no stumbling hazards and that no unauthorized personnel are in the area.

3. Out-of-Plain-View Observations: It is fairly easy to walk through a work area and take a quick look at the obvious, in-plain-view items and find potential hazards. However, many hazards are behind closed closet or electrical panel doors, in drawers and toolboxes, behind and under desks and cabinets, above us and below us, inside of a pipe and otherwise just not in plain sight. Working surfaces may not be structurally sound, guard rails and walls (particularly glass walls) may not support the intended load, other people may walk under a grating or pipe chaise and be exposed to dropped objects, a weather pattern may be developing on the other side of the tanks or towers, and an exit door may hide a restricted means of egress on the other side of that door. I asked a contractor foreman of a work crew installing new machinery at a plant several years ago how his crew would escape if there was an emergency. I noticed before I asked him that there was a marked exit about 10 feet away but it had a piece of red barricade tape across

the door with a cardboard sign that stated "Keep Door Shut." The foreman replied that his crew would go through that door, that the red tape wouldn't stop them. I asked the foreman if he had checked what was on the other side of that door before starting the installation of equipment. The foreman laughed and answered that he had not. I said, "Let's check it." We walked over and opened the door and found that the stair tower had been removed and there was a 15 foot drop to the ground.

In our example of installing the new air conditioner, ZZZ workers should check roof openings such as skylights and ventilators for out of view hazards, for wasp nests and other hiding vermin in the new equipment, weak places in the roof, and roof holes where sparks could enter the building.

In addition, some hazards that are not in plain view require testing devices to identify hazards. Ground fault detectors, current sensors, receptacle tension testers and air gauges may be necessary to identify hazards not in plain view. For example, an electrical receptacle looks innocent enough, but it may have no ground, reversed polarity, an open neutral or other hazard. Normally, employees in the field do not carry receptacle testers, electrical current testers and other testing equipment, but these employees can be advised to look for damage, missing parts, and modified parts as clues that further tests may be needed to identify hidden hazards.

4. Looking for Differences: One does not need to be a SH&E professional to find hazards. One simple technique is to teach employees to look for differences. Look for differences based on their education, their life experiences and what they would normally expect to find in the workplace. When one sees something that is different or out of place, chances are good that a hazard exists. If someone sees something that is different and knows that a hazard exists, that person should correct the hazard if trained and authorized, or report the hazard if not. If someone sees something different and does not know if the difference is a hazard, then someone who would know should be consulted before the start of the task. For example, the use of duct tape and cardboard is usually a difference and many times is a clue that a hazard exists. Machine parts leaning against the wall or on the floor should be a difference. Electrical covers lying about should be a difference. If one machine is covered and a similar machine is not, that is a difference.

   For example, the ZZZ crew installing the air conditioner might notice that the concentric rings guarding the fans have different width openings. They may notice different gauges of sheet metal in the units themselves, or different sizes of electrical wiring. These are differences that may be just fine, or they may indicate a hazard.

5. Pre-Use Equipment Inspections: As I assist clients on job sites, I find many examples of damaged and modified tools, ladders, slings, hoists, fork trucks, machine guards, and a host of other pieces of equipment that present hazards. The reasons for these findings include a belief by the employee that it is OK to use damaged equipment, an understanding by the employee that there is no hazard, failure on the part of management to teach the employee how to safely use the equipment, poor leadership among management and the first line supervisor in allowing the damaged equipment to be used and an inadequate inspection of the tool or equipment before use. Before an employee can conduct an adequate inspection, the employee must understand what is unsafe equipment, what is an acceptable and unacceptable risk, how to inspect the equipment, and must be given the time to inspect the piece of equipment.

OSHA has numerous requirements to inspect equipment before use such as for hoists and cranes [1910.179(j)], slings [1910.184(d)], respirators [1926.103(h)(2)], and aerial lifts [1910.67(c)(2)(i) and 1926.453(b)(2)]. Many other pieces of equipment should be inspected before use such as grinders, hand tools, ladders, and personal protective equipment.

For example, the crew installing the air conditioning unit should inspect their tools, lifting devices, ladders, aerial lifts, PPE, electrical cord sets, etc. before starting the job. Any defective equipment would be discarded or repaired.

Summary

There are numerous hazard recognition techniques available. Every organization needs a variety of techniques to be able to find the different hazards that are present to be able to evaluate the severity and probability of an unwanted event occurring. The hazard recognition system must be properly managed through planning, organization, leadership and control. This system must be periodically audited to recognize deficiencies and needed improvements.

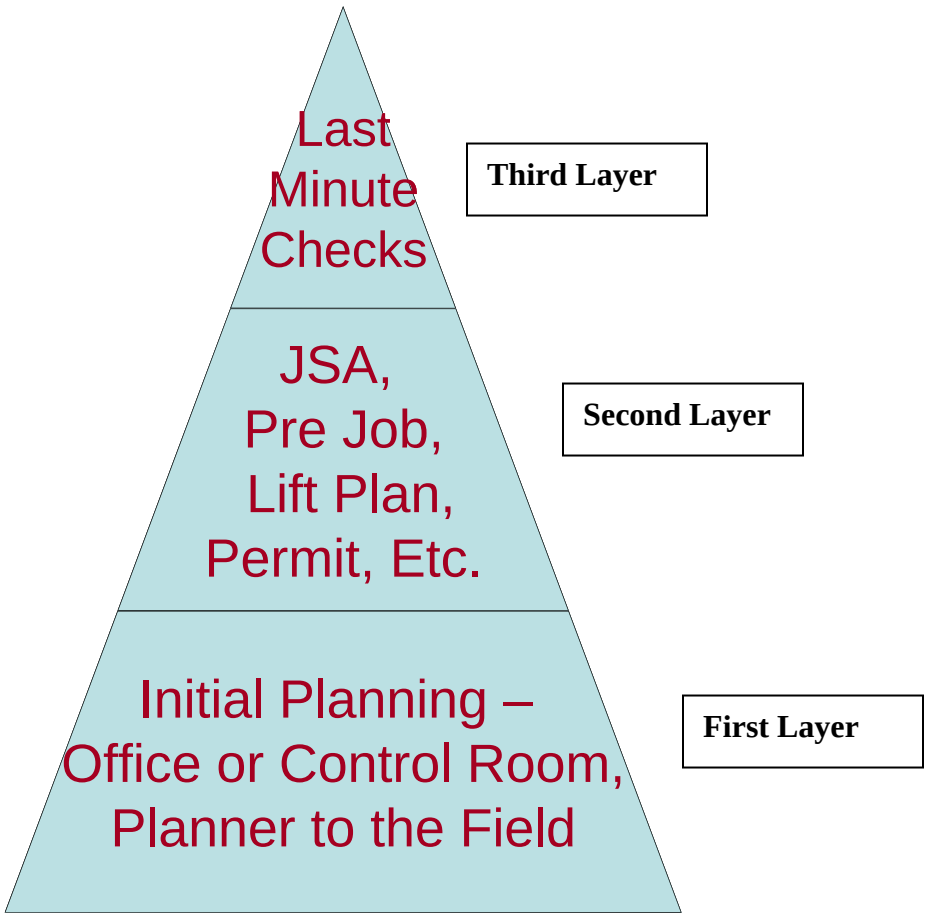
How bad can someone be injured at your work site? They could die, couldn't they? Your employees deserve the best hazard recognition management system that you can provide.

Table 1. The Most Common Hazard Recognition Techniques.

- Action Critiques
- Activity Safety Analysis
- Behavioral Observations
- Blueprint Reviews
- Demolition Audits
- Documentation Reviews
- Employee Suggestion Systems
- Final Safety Checks – Last Minute Safety Check, The Ten Second Drill, Out of View Observations, Looking for Differences and Pre Use Equipment Inspections
- Hazard Operability Studies
- Incident Investigation/Analysis
- Inspections and Audits
- Job Safety Analysis, Job Hazard Analysis, Job Safety and Health Analysis
- Job Cessation Reviews
- Management of Change
- New Equipment Reviews
- New Chemical Purchases
- New Chemical Equipment Reviews
- Operational Readiness Reviews
- OSHA-Required PPE Hazard Assessment [1910.132(d)(1)]
- OSHA-Required Demolition Plan [1926.850(a)]
- Perception Surveys
- Permitting (Confined Space Entry, Hot Work, Lift Plans, Hot Taps, Barricading, Scaffold Tagging, Working Alone, Excavations and Working Overhead are examples)
- Pre Job Safety Analysis and Pre Job Task Analysis
- Risk Mapping

- S/H/E Project Reviews
- Safety by Design
- Safety Policy Reviews
- Start-of-Shift Hazard Assessment
- Training and Education
- Turnaround, Overhaul and Outage Planning
- What If?
- Work Orders

Figure 1. The Layered Approach to Hazard Recognition.



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