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Spot the Hazard! A Cultural Extension of Hazard Identification Training

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Hazard identification training (HIT) programs have been used in the chemical processing industry to raise awareness with employees on what constitutes a process hazard and techniques for identifying these hazards. Quite often these HIT programs will deliver the course material to the participants as classroom instruction, computer-based training, organized field reviews, or a combination of these formats. These presentations tend to be one-time efforts or cyclic programs that reach the target audience on some periodic basis (e.g., triennially). Although the content of the course material may be educational, these programs often have limited success because of their inability to make a lasting impression with the participants. Organizational and personnel changes, employee turnover, vanishing corporate memory, and shifting priorities can all have an undermining effect on the well-intended efforts of traditional HIT programs. The challenge thus becomes finding ways to keep the knowledge both relevant and current, to effect lasting cultural change in a dynamic environment.

This article presents a unique HIT program known as "Spot the Hazard," which uses the facility's intranet to reinforce the concepts taught in the classroom. Spot the Hazard blends photographic examples and technical knowledge with aspects of behavior modification. The photographs that are presented have not been staged and thus are germane to the employees. The inherent on-going nature of the program ensures the knowledge remains current, while at the same time it provides a platform for making a positive cultural change.

The concepts of Spot the Hazard are explained in greater detail in the current article, along with a representative number of actual examples. © 2008 American Institute of Chemical Engineers Process Saf Prog 28: 200–206, 2009

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INTRODUCTION

This article presents a creative and unique cultural extension to hazard identification training (HIT) known as "Spot the Hazard!" The Spot the Hazard! Program (hereafter also referred to simply as the "Program") is a web-based monthly contest that is operated on the facility's intranet.

The Program began following a 2-year HIT initiative to educate operating, maintenance and technical staff on hazard awareness and identification [1]. This initiative covered 12 operating facilities within the Corporation. Senior process safety and loss prevention professionals delivered the course material in an interactive session lasting 6–7 h. The curriculum included subject matter on fire science: sources of flammables and combustibles; sources of ignition; principles of toxic releases; and principles of prevention and protection. Employees were taught the science of combustion and technical concepts that influence the combustion process (e.g., flash point temperature, auto-ignition temperature, inert atmospheres, etc.). In addition, photographs were taken at each operating facility and incorporated into the curriculum to illustrate where combustibles are found, where ignition sources may be found, and examples of prevention and protection facilities.

CONCEPTS AND APPROACH

The focus of the aforementioned HIT initiative was oriented towards fire science and preventing uncontrolled process fires in the operating facilities. How-

ever, the fundamental objective of the course was common to any other HIT program used in similar industries: to modify the thought processes and behavior of the course participants.

It is necessary to comment on the difference between education and training. The name "Hazard identification training" is actually a misnomer, yet it is routinely used in the chemical processing industries to describe this type of initiative. Training aims "to impart a set of established facts and skills and to obtain a uniform predictable behavior from the trainees without the necessity of their understanding why they should act in the prescribed manner" [2]. Education, on the other hand, "seeks to have the student learn skills and to understand why actions are taken or not," [2] and to "observe, analyze and question, to formulate hypotheses and make conclusions and then to act, live and modify their actions according to these conclusions" [2].

The significant difference between the two terms, therefore, lies in the concept of understanding. Understanding the principles presented in any educational program is absolutely necessary for application of the knowledge. In particular with hazard recognition, it is not sufficient to simply train employees to recognize the same hazards in the field as those presented in the classroom. Employees must understand the principles being presented, and then be able to translate that knowledge to the field to identify hazards in new and unique situations based on the learned principles. It is only when employees understand the fundamental principles that they can begin to apply the knowledge to different situations [3]. In turn, the behaviors and thought processes of the employees begin to change. When the collective organization inherits this knowledge and consistently applies it to identifying and evaluating hazards, true cultural change can occur.

SAFETY CULTURE

Two sources frequently cited for definitions of "safety culture" are the UK Health and Safety Executive and the Center for Chemical Process Safety (CCPS). The UK Health and Safety Executive definition is "... the product of the individual and group values, attitudes, competencies and patterns of behavior that determine the commitment to, and the style and proficiency of, an organization's health and safety programs" [4]. The CCPS suggests a direct and more succinct definition: "Safety culture is how the organization behaves when no one is watching" [5]. These definitions are specific to safety culture, and while they are somewhat different, they share the common notion that organizational culture is a reflection of the shared common values that drive organizational performance [6]. In effect, the process safety performance of an organization is a function of the degree to which the collective organization embraces the process safety policies and programs.

Leadership is an essential component of managing culture, and plays a significant role in influencing cultural change. The CCPS [5] recognizes that leadership cannot effect cultural change with mandates and edicts. Rather, positive movement comes from leadership by example, where the desired values and behaviors are advanced from being vision and set into action when leaders model the vision. Successful leaders inspire, enable and challenge the organization towards improvement. It is no coincidence that the model for transformational leadership [6] includes these concepts in its four dimensions: charisma, inspiration, individual attention, and intellectual challenge. Transformational leadership applies these characteristics consistently and frequently to gradually move the values of the collective whole in a positive direction.

The key contributors to successful transformational leadership lie in consistency and frequency. The vision and the message must be consistent. The communication and positive reinforcement must be frequent. This combination yields change. In the context of HIT, this framework translates to a curriculum of hazard identification principles and techniques that are consistently communicated, and reinforced on a frequent basis with employees. However, this is often where traditional HIT programs fall short in their ability to effect cultural change. HIT tends to be either a one-time initiative, or one of many required training courses that is scheduled on a periodic basis (e.g., triennially) for employees. The course material is normally delivered too infrequently to keep the organization focused. Furthermore, the effectiveness of HIT programs can be compromised by organizational and personnel changes, employee turnover, vanishing corporate memory and shifting business priorities. These factors create significant challenges for process safety professionals, and often limit the success of HIT programs in terms of shifting the culture of the organization.

PROGRAM DESCRIPTION

Spot the Hazard! places photographs of actual hazardous conditions found in the process on a web page of the intranet (Figure 1). Employees are given the opportunity to spot the hazard in the photograph, and submit their answers electronically through the integrated e-mail system. At the end of the contest period, one winner is randomly selected from among the correct responses to receive a reward. The winner is announced to the entire facility through e-mail, along with a detailed explanation of the process hazard, the reason why it is a hazard, and recommended actions to correct the concern. Every employee that submitted a correct response is also recognized in a positive manner in the winning e-mail announcement.

The previously discussed HIT initiative forms the foundation for the Spot the Hazard! Program. The photographs generally aim to capture potential sources of combustible materials, ignition, hazardous exposures and the like. The e-mail communications are used to announce the contest winner, but more importantly reiterate the technical principles and knowledge that support the identification and evaluation of process hazards.

With each new contest, there is an opportunity to consistently demonstrate how the knowledge has been applied to yet another unique and different situation. Furthermore, the key principles and relevant

Figure 1. Example screen shot of Spot the Hazard! Web page. [Color figure can be viewed in the online issue, which is available at **www.interscience.wiley.com**.]

knowledge are frequently reinforced with employees, to maintain a collective focus on hazard identification and risk assessment (HIRA).

Core Components

The core elements of the Spot the Hazard! Program include:

1. *Hazard Identification:* Photographs of process hazards identified at the facility form the foundation of the Program. The photographs are never "staged" or simulated. Actual conditions are photographed as they are found. Generally the site process safety engineer will identify these conditions during planned general inspections (PGI) or *ad-hoc* surveys. However, all employees are encouraged to submit findings for future contests, and the submitted findings must be from the site.
2. *Risk Assessment:* Once a hazardous condition has been identified, OPERATION is consulted for a simple risk assessment. This serves two purposes. First, the risk assessment determines if the concern is legitimate and acceptable or unacceptable. Second, it ensures buy-in from the asset owner and key stakeholders before the photograph is used on the intranet.
3. *Problem Solving:* The risk assessment discussion will, quite often, prompt recommendations to correct the deficiency. The asset owner is responsible for implementing corrective action(s), and given enough time to do so before the photograph is used on the intranet.
4. *Employee Participation:* Employee Participation is one of the fundamental elements of any process safety program, and the Spot the Hazard! web page provides an additional means to accomplishing this. The web page is accessible to all site employees, and everyone is encouraged to submit a response through the integrated e-mail system. A simple risk matrix can also be easily attached with the picture and distributed to the employees. In addition to spotting the hazard in the picture, employees could also be requested to rank the risk associated with the identified hazard.

5. *Process Safety Education:* At the end of each monthly contest, the winner is announced in a site-wide e-mail. This communication is the vehicle for continuing education. Here, details are provided to employees regarding what the process hazard is, why it is a hazard, and how the hazard can be eliminated or how the risk can be mitigated. This stage provides the educational component to the Program, to consistently and frequently connect with employees.

Leadership and Cultural Parallels

Aside from the obvious benefits, such as gains in employee participation and education on hazard identification, the Program has progressively demonstrated a number of soft benefits. These less tangible, but equally important, benefits include an increase in social capital, new leadership platforms, and positive cultural shift.

1. *Social Capital:* The term "social capital" refers to a core concept in organizational behavior, and may be described as the existence of a specific set of informal values or norms shared among members of a group that permits cooperation among them. Social capital is indicated by consensus, collective action, and the amount of trust demonstrated in a community or among individuals. Unlike other forms of capital that are depleted by use, social capital is depleted by nonuse. Harvard political scientist Putnam [7] describes two types of social capital: "bonding social capital" and "bridging social capital." Bonding social capital refers to the value of social networks within homogenous groups, whereas bridging social capital refers to that value between socially heterogeneous groups. Bonding social capital explains why some groups become isolated and disenfranchised from the rest of society (or an organization). Bridging social capital, on the other hand, works across horizontal networks of individuals and groups to enhance productivity and consensus, and thus is seen as a positive asset. The Spot the Hazard! Program fosters development of these horizontal networks by communicating with teams across the organization and allowing process safety professionals the opportunity to become engaged with the rest of the facility in a meaningful fashion.
2. *Leadership Platforms*: Seven definable leadership practices have been connected to the development and support of high-performing cultures [6]: vision, credibility, collaboration, feedback and recognition, accountability, communication, and action-orientation. The Spot the Hazard! Program applies each of these practices in the following ways:
   a. Vision: For every hazardous condition shown, employees are provided with recommendations to correct the deficiency or mitigate the risk. In other words, a vision is provided for the desired state of operation.
   b. Credibility and Collaboration: These two practices work in tandem, and are accomplished by discussing the hazards with the asset owners. Buy-in from the asset owners ensures credibility with the various stakeholders, and satisfies the need for collaboration.
   c. Feedback and Recognition: Participants who submit a correct response to the monthly contest are recognized in the winning e-mail announcement and given positive feedback for their accomplishment. Furthermore, the contest winner is recognized with a reward.
   d. Accountability: The Program uses photographs taken from all areas of the facility. No single operating area is either excluded from being used in the Program or specifically selected for use. This has the effect of reminding employees that process safety is the responsibility of every employee at each level of the organization.
   e. Communication and Action Orientation: The Program intends to be proactive, by identifying hazardous conditions before they result in undesirable consequences. These conditions are communicated to the asset owners and resolved in a timely manner. By its very nature, the process is tuned towards timely communication and results-oriented action.
3. *Cultural Shift:* A positive shift in the process safety culture is clearly one of the desired outcomes of the Program. Technical principles are orchestrated with concepts of leadership and education to produce the desired step change. The e-mail communications consistently reinforce the technical aspects and connect them to principles of process safety and loss prevention engineering.

ANALYSIS

At the time this document was prepared, the Spot the Hazard! Program had been in operation for ~1 year. The following subjects have been featured in the Program thus far:

- Photo contest #1: Energized abandoned conduit.
- Photo contest #2: Impaired fire protection system.
- Photo contest #3: Free standing compressed gas cylinder.
- Photo contest #4: Disabled pressure/vacuum vent.
- Photo contest #5: Unsupported abandoned piping.
- Photo contest #6: Unsafe venting of pressure relief valve.
- Photo contest #7: Dangerous hose connections.
- Photo contest #8: Hydrochloric acid piping dead-leg.
- Photo contest #9: Unrestricted access to electrical substation.
- Photo contest #10: Unprotected combustible trash receptacles.
- Photo contest #11: Uncontained acid piping drains.
- Photo contest #12: Open-ended piping system.
- Photo contest #13: Horizontal hookup on flexible hose.
- Photo contest #14: Abandoned wood pipe support.
- Photo contest #15: Unsafe pipe and hose supports.

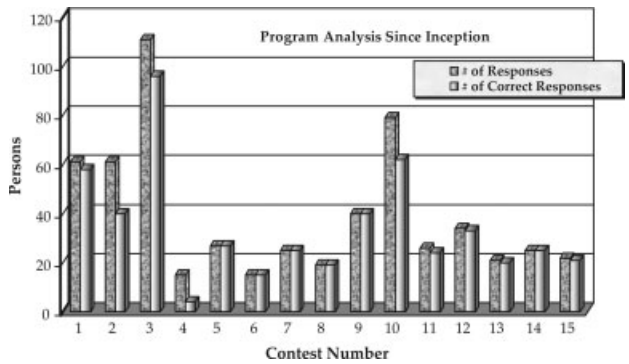

Figure 2. Program analysis: total responses received and number of correct responses.

Figure 2 illustrates the total number of responses received to each contest, and the corresponding number of correct entries. (Note: the total number of employees at the facility is ~200 persons.)

CASE EXAMPLES

Several examples have been selected from the Program for presentation in the current section. These examples are representative of the typical content included in the e-mail communications to the facility following each contest.

Contest #7: Dangerous Hose Connections

The Photo

Photo #7 featured a simple hose station with two capped connections. This particular hose station is located near the site's barge unloading dock, and used for liquid water-treatment chemicals.

[Color figure can be viewed in the online issue, which is available at **www.interscience.wiley.com**.]

The Process Hazard

This photograph showed several hazards, including a manual block valve in the open position immediately upstream of the hose connection. In addition, the locking mechanisms (sometimes referred to as "dog ears") on the caps were not secured in place. Several other employees further noted the deteriorated condition of the pipe support and the absence of line labels.

The Reason this is Hazardous

The potential for both loss of process containment and personnel exposure exists in this situation. With the block valve in the open position, it is possible that liquid inventory is trapped behind the cap, and may be under substantial pressure. This places employees at risk of being exposed when it comes time to remove the cap and use the hose connection. Furthermore, because the locking mechanisms are not secured with wire or a band, they could unexpectedly come off, especially if pressure builds behind the cap.

What Should be Done

The manual block valves on this, and all hose stations, should be closed when they are not in use. The locking mechanisms on the caps should also be secured in place with Velcro bands, wire ties, or a similar method. Quite often drain valves will also be installed between the block valve and end cap, so the line can be checked for inventory and pressure before the cap is removed.

Contest #13: Horizontal Hookup on Flexible Hose

The Photo

Contest #13 featured a photograph of a black flexible hose on the third floor of the Screening Building.

[Color figure can be viewed in the online issue, which is available at **www.interscience.wiley.com**.]

The Process Hazard

The hose in the photograph was connected to the piping on the horizontal, and the weight of the coiled hose had caused the hose to kink (partially collapse)

at the connection point. This condition is indicative of flexure beyond the minimum bend radius of the hose assembly.

The Reason this is Hazardous

Hoses and flexible connections are often the least considered, least regulated component in both utility and process applications. Yet they are expected to function under a wider variety of physical and chemical stresses than any other mechanical component. As a result, hose assemblies and flexible connectors are highly susceptible to failure.

In this particular instance, the horizontal hookup of the hose has resulted in severe bending at the pipe connection, which may contribute to premature failure of the hose assembly. In addition, the hose clamps do not meet specification, and the piping transition is not an engineered design.

What Should be Done

Piping systems installed for hose connections should have the pipe outlet directed downward, so the hose is connected in the vertical plane. This will protect employees from exposure in case of accidental rupture, slow the aging process of the hose by "straightening" the flow path, and reduce bend stresses at the end of the hose assembly. Also, proper engineering designs should be used to connect hoses to piping systems, making use of the correct hose clamps.

CONCLUSIONS

In some respects the field of process safety management has taken a step change in new directions over the last few years. NASA's experiences with the shuttles Challenger [8] and Columbia [9] have prompted our industry to re-examine tragic events, such as the explosion at Longford [10], the Piper Alpha oil platform accident [11], and most recently the BP Texas City refinery explosion [12] for contributing cultural causes. Similarly, CCPS has devoted an entire chapter to the subject of safety culture in its Guidelines for Risk Based Process Safety [13], indicating the necessity of a strong safety culture for strong process safety performance.

CCPS and others [14] have developed guidance for creating and fostering a strong process safety culture. This guidance typically includes the development of strategic plans, tools and communication devices to sustain the culture, once it has been developed. The Spot the Hazard! Program is an illustration of how the process safety professional can extend a traditional instrument (i.e., HIT) to a new format for sustainability.

The Spot the Hazard! Program has been in operation for ~1 year, yet indications of its success are already evident. For example, it's quite common for participants to raise attention to hazards and concerns beyond the main focus of the photograph. In fact, individual entries have often contained several responses, speaking to both the acceptance and commitment of the employees to the Program.

Another indication of the success of the Program has been seen in the number of ideas submitted by employees, as they look forward to the continuation and expansion of the Program. Initially, the author photographed various conditions around the facility to kickoff the Program and build momentum. Over the course of the past year, however, specific suggestions have come from all levels of the organization, including plant management. This type of participation is particularly interesting, in that it demonstrates an elevated level of hazard recognition among the plant population.

Perhaps the most noteworthy indication of success is in the fact that the Program is still in operation, even after the author's departure from the facility. After moving on to another role in the company, the Spot the Hazard! Program was voluntarily adopted by a production supervisor who has committed to provide the leadership necessary to maintain the Program. This is testament to the value that plant supervision sees in the Program.

RECOMMENDATIONS

The future of the Spot the Hazard! Program lies in integration. This begins when the Program is spread to the other manufacturing locations throughout the company. By having the Program in place at all facilities, the benefits can be compounded many times over, as knowledge is transferred among all facilities.

Furthermore, there is substantial opportunity to collect and analyze data from the Program. For example, it would be beneficial to understand the types and number of process hazards that are being identified. Hazards could potentially be categorized by type (e.g., fire/explosion, toxicity, electrical shock, etc.) and compared across the organization and within a facility. In addition, participation rates and incident trends may be relevant measures to assess the effectiveness of the Program on influencing process safety culture.

The key measure of success, however, will be integrating the Program on a much larger scale, in such a way that the impact to the organization is greatest. The maximum program benefit will only be realized when all stakeholders are involved. The greatest yield will be when process improvement becomes the product of shared input by operations, maintenance, engineering, training and management. When this occurs, integration has blossomed and the benefits are magnified.

On a broader scale, the Spot the Hazard! Program can be readily adapted to similar industries, and tailored to the types of hazards present in that particular industry, while still achieving the same desired results. A better-educated workforce with a mindset of hazard awareness and recognition is, after all, in the common interest of all of us.

LITERATURE CITED

1. K.G. Phillips, N. Nibber, and M.R. McPhail, "Hazard awareness training in managing operational risks," 51st Canadian Chemical Engineering Conference, Process Safety and Loss Management Symposium, Halifax, Nova Scotia, October 2001.
2. A.L. Carney, "Factors in instructional design: Training versus education," Instructional Technology

Lab Seminar, University of Illinois, Chicago, March 2003.
3. J. Louvar and D. Hendershot, Education materials for universities and industry" Process Saf Progr 26 (2007), 85–89.
4. UK Health and Safety Executive, Safety Culture: A Review of the Literature, HSL/2002/25, 2002.
5. Building Process Safety Culture: Tools to Enhance Process Safety Performance, New York, Center for Chemical Process Safety of the American Institute of Chemical Engineers, 2005.
6. P. Killimett, Organizational factors that influence safety, Process Saf Progr 25 (2006), 94–97.
7. R. Putnam, Bowling Alone: The Collapse and Revival of American Community, Simon and Shuster, 2000.
8. Report of the Presidential Commission on the Space Shuttle Challenger Accident, National Aeronautics and Space Administration, Washington, DC, 1986.
9. Columbia Accident Investigation Board, Report volume 1, United States Government Printing Office, Washington, DC, 2003.
10. A. Hopkins, Lessons From Longford—The Esso Gas Plant Explosion, CCH Australia Limited, 2000.
11. UK Department of Energy, The Public Inquiry into the Piper Alpha Disaster, London: HMSO, 1990.
12. The Report of the BP U.S. Refineries Independent Safety Panel, 2007, Available at: **www.bp.com/bakerpanelreport** (Accessed circa Feb. 2008).
13. Center for Chemical Process Safety, Guidelines for Risk Based Process Safety, Wiley, Hoboken, 2007.
14. S.H. Kadri and D.W. Jones, Nurturing a strong process safety culture, Process Saf Progr 25 (2006), 16–20.