Managing Risk Perceptions

Safety Program Support Outcomes

By Vladimir Ivensky

IN BRIEF
- **Misjudging risks posed by specific hazards may lead to incidents.**
- **Correctly assessing and evaluating risks is one goal of OSH.**
- **This article reviews perceptions of hazards and controls to illustrate the management of risk perception.**

When applied to safety, errors in risk perceptions posed by a specific hazard may lead to disagreements among project team members, misallocation of resources and, in worst cases, incidents. In OSH, one goal is to achieve the proper recognition and evaluation of safety hazards and the risks they pose. To illustrate risk perception management in safety, this article reviews perceptions of hazards and associated controls based on the principle: risk = hazard/control.

The four basic expected scenarios and reactions are:

1) Low hazard/high control: Annoyance, low support of safety program;

2) Low hazard/low control: Compliance/neutral;

3) High hazard/low control: Fear, outrage with a lack of safety support;

4) High hazard/high control: Support of safety program.

The article discusses achieving a correct, shared vision of project hazards and required controls within project teams as a necessary condition of an effective OSH program.

Vladimir Ivensky, CSP, CIH, has more than 25 years' experience in OSH. He is a corporate vice president of safety, health and environment for a global multidisciplinary consulting and construction management firm. Ivensky holds a master's degree and doctorate (equivalents) in Occupational Safety and Health and Environmental Protection from the Rostov Civil Engineering Institute in the former Soviet Union. He is a professional member of the Philadelphia Chapter.

Differences in Risk Perceptions

Risk perception is related to conceptions of knowledge that stress the limits of science (Sjöberg, Moen & Rundmo, 2004). Recognition and evaluation (perception) of hazards as well as evaluation (perception) of controls have elements of subjectivity. People respond to hazards according to their perceptions of the risks those hazards pose. What they perceive, why they perceive it that way and how they will subsequently behave are matters of great importance to industries and governments trying to assess and implement new technologies (Peters & Slovic, 1996).

People's perceptions of risks posed by a specific hazard vary based on their personalities, experience, knowledge and many other criteria, and these perceptions vary among individuals and groups as well.

Subjective risk perceptions are analyzed and studied with a classification strategy: psychometric paradigm. Surveys, for example, may be asking responders to provide a numerical value (e.g., from 1 to 7) to characterize a risk posed by some specified elements of a particular hazard (Fischhoff, Slovic, Lichtenstein, et al., 1978) such as:

- voluntary versus nonvoluntary exposure (e.g., smoking vs. nuclear power station exposure);
- chronic versus catastrophic outcome (e.g., exposure to X-rays vs. fall from height);
- common versus dread (e.g., caffeine vs. nuclear power plant incident or fall from height);

•certain nonfatal versus certainly fatal (e.g., exposure to lead paint vs. nerve gas);

•known to exposed person versus not known to exposed person (can be any hazard; people who are typically exposed to a hazard give it a lower score than laypersons);

•known to science versus not known to science (e.g., lead vs. genetically modified food);

•controllable versus not controllable (can be any hazard, depending on its control perception).

The responses vary among the groups based on their awareness of a particular hazard (professionals vs. laypeople), personal and cultural differences, and hazard characteristics. The psychometric paradigm studies have demonstrated that perceived risk is quantifiable and predictable (Slovic, Fischhoff & Lichtenstein, 1981).

For example, in studies by Slovic, Fischhoff and Lichtenstein (1981), four different groups of people were asked to rate 30 activities (e.g., smoking, firefighting), substances (e.g., food coloring) and technologies (e.g., railroads, aviation) according to the present risk of death from each. Three groups from Eugene, OR, including 30 college students, 40 members of the League of Women Voters (LWV), and 25 business and professional members of the active club. The fourth group was composed of 15 persons selected nationwide for their professional involvement in risk assessment. This expert group included a geographer, an environmental policy analyst, an economist, a lawyer, a biologist, a biochemist and a government regulator.

These people were asked to rate each of the 30 items, "to consider the risk of dying as a consequence of this activity or technology." Respondents were told to first study the items individually, thinking of all the possible ways someone might die from each. Next, they were to order the items from least to most risky and, finally, to assign numerical risk values by giving a rating of 10 to the least risky item and making the other ratings accordingly.

Table 1 shows how each group ranked some of these 30 activities and technologies according to riskiness. Many similarities exist between the three groups of laypeople. For example, each group ranked motorcycles, motor vehicles and handguns as highly risky, while they ranked vaccinations, home appliances, power movers and football as posing relatively little risk. However, strong differences exist as well. Experts' judgments of risk differs markedly from the judgments of laypeople. The experts ranked electric power, surgery, swimming and X-rays as more risky than did the other groups, and they judged nuclear power, police work and mountain climbing to be much less risky (Slovic, et al., 1981).

In public risk management, when the public's perception of risk is higher than professionals' perception of risk, the task is typically to work toward matching the risk perceptions of the two. The targeted outcome would be to reduce the public risk perception and to increase risk tolerance via awareness and education campaigns.

Table 1

Ordering of Perceived Risk

	Group 1: LWV	Group 2: College students	Group 3: Active club members	Group 4: Experts
Nuclear power	1	1	8	20
Motor vehicles	2	5	3	1
Handguns	3	2	1	4
Smoking	4	3	4	2
Motorcycles	5	4	2	6
Alcoholic beverages	6	7	5	3
Private aviation	7	13	11	12
Police works	8	9	7	17
Pesticides	9	4	13	8
Surgery	10	11	9	5
Firefighting	11	10	6	18
Electric power	18	19	19	9
Swimming	19	30	17	10
X-rays	21	17	24	7
Vaccinations	30	29	29	23

Note. *Ordering of perceived risk for 30 activities and technologies, based on the geometric mean risk rating within each group. Rank 1 represents the most risky activity of technology. Data from "Facts and Fears: Societal Perception of Risk," by P. Slovic, B. Fischhoff and S. Lichtenstein, 1981,* Advances in Consumer Research, 8, *pp. 497-502.*

Table 2

Application of Psychometric Paradigm to Example Hazard Analysis

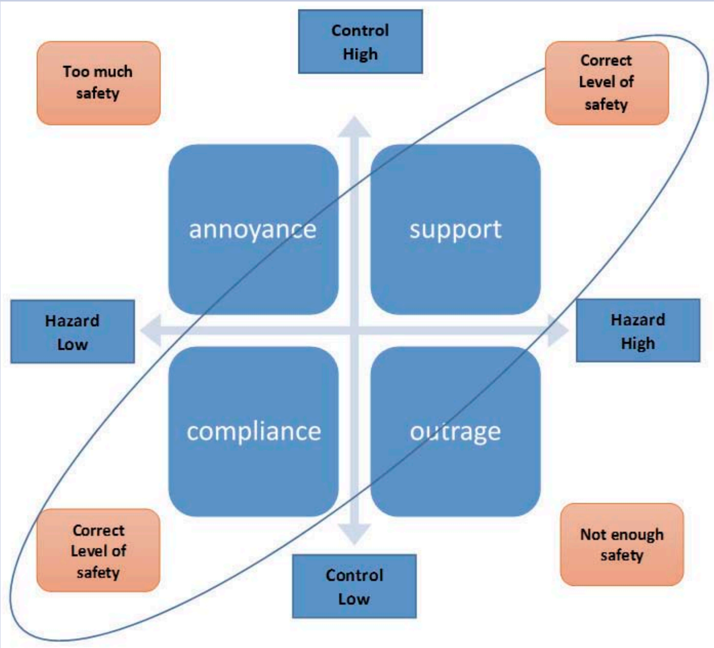
Example task: Confined space entry		
Rate = 1	**Rate**	**Rate = 7**
Voluntary	7	Not voluntary
Chronic	7	Catastrophic
Common	7	Dread
Nonfatal	7	Fatal
Known to exposed	7	Not known to exposed
Known to science	1	Not known to science
Controllable	1	Not controllable
Usual, typical task	7	Unusual task

In occupational safety, however, the typical task (with some exceptions) is to reduce the employees' risk tolerance in situations where employees' risk perception of a hazard is lower than that of the experts (e.g., X-rays and electric power in Table 1). The issue of bringing risk perceptions of various individuals and groups involved in the same project to a common denominator (defined by professionals) is the main topic of this article.

In a discussion of risk tolerance and its management in occupational safety, applying the principles of psychometric paradigm may be beneficial. For example, emphasizing the items on the right

Figure 1

Potential Responses to Combinations of Various Safety Hazards & Controls



column of Table 2 (p. 45) while discussing permit-required confined spaces, describing the invisible deadly threat of hazardous atmospheres to untrained entrants and past catastrophic and dreadful outcomes, may result in increased risk perceptions and reduced risk tolerances.

Of course, basic general awareness of the existence of confined-space-related hazards is necessary. Trainees in those circumstances should be reminded that their work-related activities are not voluntary; workers are asked by a company to act in a specific safe fashion, are not expected to act on their own, and that acts of valor are not expected, required or tolerated by a company. This would achieve the dual purpose of reducing uncontrolled or at-risk activities and increasing the perceived risk level with the expectation of and request for effective safety controls.

At the same time, emphasizing that all confined space hazards are well known to science and absolutely controllable would balance the high hazard perception with adequate controls and emphasize a need to study and understand hazards, implement controls and involve experts.

The "Report of the Presidential Commission on the Space Shuttle *Challenger* Accident" provides a thought-provoking illustration of different risk perceptions among project parties or between various levels within an organization, and the potentially grave implications of a lack of risk communication. Following are quotes from the report's introduction (first quote) and the report's conclusion (Feynman, 1986):

> It appears that there are enormous differences of opinion as to the probability of a failure with loss of vehicle and of human life. The estimates range from roughly 1 in 100 to 1 in 100,000. The higher figures come from the working engineers, and the very low figures from management. What are the causes and consequences of this lack of agreement? Since 1 part in 100,000 would imply that one could put a Shuttle up each day for 300 years expecting to lose only one, we could properly ask "What is the cause of management's fantastic faith in the machinery?"

> If a reasonable launch schedule is to be maintained, engineering often cannot be done fast enough to keep up with the expectations of originally conservative certification criteria designed to guarantee a very safe vehicle. In these situations, subtly, and often with apparently logical arguments, the criteria are altered so that flights may still be certified in time. They therefore fly in a relatively unsafe condition, with a chance of failure of the order of a percent (it is difficult to be more accurate).
>
> Official management, on the other hand, claims to believe the probability of failure is a thousand times less. One reason for this may be an attempt to assure the government of NASA perfection and success in order to ensure the supply of funds. The other may be that they sincerely believed it to be true, demonstrating an almost incredible lack of communication between themselves and their working engineers.
>
> In any event this has had very unfortunate consequences, the most serious of which is to encourage ordinary citizens [a school teacher] to fly in such a dangerous machine, as if it had attained the safety of an ordinary airliner.
>
> Let us make recommendations to ensure that NASA officials deal in a world of reality in understanding technological weaknesses and imperfections well enough to be actively trying to eliminate them. They must live in reality in comparing the costs and utility of the Shuttle to other methods of entering space. And they must be realistic in making contracts, in estimating costs, and the difficulty of the projects. Only realistic flight schedules should be proposed, schedules that have a reasonable chance of being met. If in this way the government would not support them, then so be it. NASA owes it to the citizens from whom it asks support to be frank, honest, and informative, so that these citizens can make the wisest decisions for the use of their limited resources.
>
> For a successful technology, reality must take precedence over public relations, for nature cannot be fooled.

Open communication channels between all levels of an organization and among the organizations at multiemployer projects are critical for ensuring the effective exchange of risk-related information. While in many instances it might be difficult to quantify the risk, it is critical that management has complete data and is able to "deal in a world of reality in understanding technological weaknesses and imperfections well enough to be actively trying to eliminate them" (Feynman, 1986). In addition to technological difficulties, management should be aware of and prepared to deal with human factor limitations. Risk perceptions by various groups should be communicated and discussed until a common vision is achieved on the existing hazards and required controls, based on all available information and professional analysis.

Risk as Hazard Divided By Control

To simplify evaluation and illustration of risk perceptions in safety, this article reviews perceptions of hazards and associated controls separately. Similar to Sandman's (1999) famous formula, dealing with risk perceptions by the public:

risk = hazard + outrage

The following illustration of employees' perception of OSH hazards, controls, risks and their associated responses to a safety program is based on:

risk = hazard/control

Further:

•actual risk = actual hazard/actual control;

•perceived risk = perceived hazard/perceived control (i.e., perceived by any party: employer, project manager, safety manager; perceived risks would differ from person to person);

•perceived hazard = actual hazard x perception of hazard;

•perceived control = actual control x perception of control.

Potential perceptions of a hazard can be:

•correct = 1;

•increased > 1 (fear);

•decreased < 1 (detachment, ignorance).

Potential perception of control can be:

•correct = 1;

•increased > 1 (annoyance);

•Decreased < 1 (outrage).

Potential responses to combinations of actual or perceived hazards and controls are illustrated in Figure 1. The vertical line represents control; it can be high or low. The horizontal line represents hazard; it also can be high and low. Four basic scenarios/combinations and expected reactions to associated safety programs are:

1) Low hazard/high control: Annoyance;

2) Low hazard/low control: Compliance/neutral;

3) High hazard/low control: Fear, outrage;

4) High hazard/high control: Support.

It is presumed that people will support the safety program when they think that a hazard is reasonably matched by a control, and that the higher the hazard (or perceived hazard), the higher the safety program support will be. When the hazard is reasonably low, the support for the program would wane; if the program is supported by strong controls that are perceived as unnecessary and bothersome, people may become annoyed with the unnecessarily controlling safety program (whether actual or perceived) and compliance with the program would suffer.

Figure 2

Opinion Spectrum for Perceived "Adequate Control" Safety Program

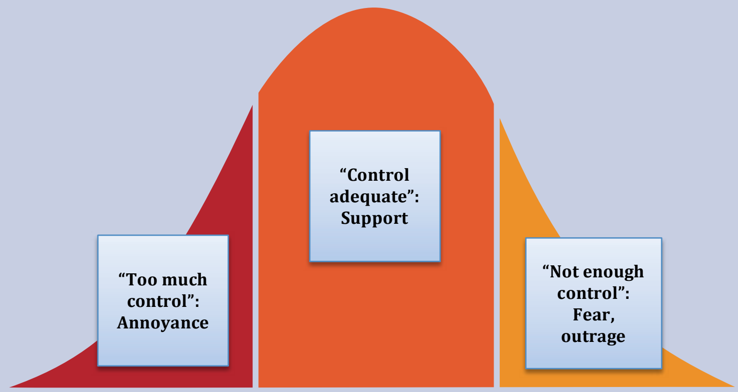


Figure 3

Opinion Spectrum for Perceived "Too Much Control" Safety Program

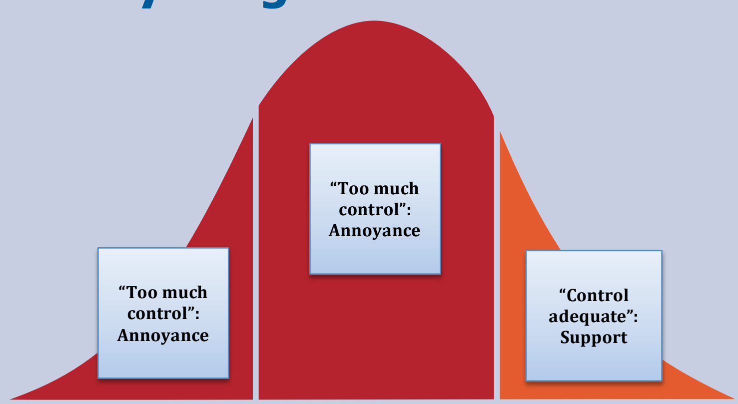


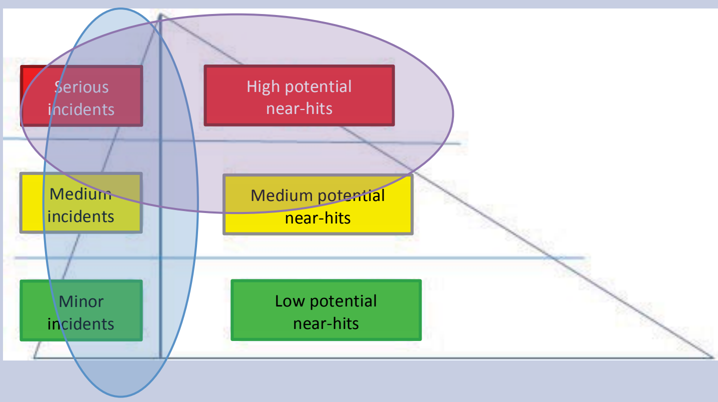
Figure 4

Opinion Spectrum for Perceived "Not Enough Control" Safety Program

It also is essential that the control not only match the hazard in magnitude, but also be correctly selected and properly applied (otherwise it would become bothersome, irrelevant and impossible to comply with, increasing the risks instead of controlling them).

Figure 5

Actual & Potential Incident Triangle



When people deal with actual or perceived high potential hazards and with safety programs that actually do not, or are perceived to not, provide sufficient controls, the expected reaction would be fear and outrage with the safety program (i.e., people would expect more safety).

Therefore, this suggests that noncompliance with the safety program may signal a disagreement with the project risk assessment and with project safety controls selected and applied; individual employees may consciously or subconsciously characterize hazards, controls and risks differently than management, the safety department or their colleagues. Every individual involved in a project would have his/her own perception of involved hazards, required controls, required defensive behavior, residual risks and their acceptability. People would also have differing opinions on the definitions of acceptable and unacceptable incidents (and also different from the employer, typically invoking OSHA's recordkeeping system and defining an unacceptable event as either OSHA-recordable, restricted or lost-time injury case).

Employees' individual behavior would be a function of their own risk perception and may involve annoyance/detachment, compliance, support of the safety program, or fear and outrage because of lack of sufficient safety program support. The fol-

Figure 6

Perceptions of Hazards/Controls/Risks & Resulting Attitudes Toward Safety Program

Actual hazard	Perceived hazard	Actual control	Perceived control	Actual risk	Perceived risk	Comments		Perceived risk-based reaction	Actual risk-based reaction
10	10	10	10	1	1	No errors		Support	Support
1	1	1	1	1	1	No errors		Support	Support
10	1	1	1	10	1	Error evaluating hazard	Danger. Evaluate hazard, improve control	Support	Outrage
1	10	1	1	1	10	Error evaluating hazard	No danger. Evaluate hazard.	Outrage	Support
10	10	1	10	10	1	Error evaluating control	Danger. Evaluate control, improve control.	Support	Outrage
10	10	10	1	1	10	Error evaluating control	No danger. Evaluate control.	Outrage	Support
1	1	1	10	1	0.1	Error evaluating control	No danger.	Annoyance	Support
1	1	10	1	0.1	1	Error evaluating control	No danger. Wasting an effort on control. Evaluate control.	Support	Annoyance
10	1	1	10	10	0.1	Errors evaluating both hazard and control	Danger. Reevaluate hazard and control.	Annoyance	Outrage
1	10	10	1	0.1	10	Errors evaluating both hazard and control	No danger. Reevaluate hazard and control. Wasting an effort on control.	Outrage	Annoyance
1	10	1	10	1	1	Errors evaluating both hazard and control	No danger. Reevaluate hazard and control.	Support	Support
10	1	10	1	1	1	Errors evaluating both hazard and control	Warning. High hazard is mischaracterized. Reevaluate hazard and control.	Support	Support
10	1	10	10	1	0.1	Errors evaluating hazard	Warning. High hazard is mischaracterized. Reevaluate hazard.	Annoyance	Support

Table 3

Bringing Safety Risk Perceptions to a Common Denominator

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Actual risk	1	1	1	1
Employee's risk perception	1	10	0.1	1
Manager's risk perception	1	1	1	0.1
Safety manager's risk perception	10	1	1	1
Situation description	Company-wide annoyance with the excessively controlling safety program	Employee is outraged with the perceived deficiencies of the safety program	Employee is annoyed with the perceived excessive safety controls	Dissatisfaction with poor safety leadership by the management
Suggested action	Correct safety manager's risk perception (reduce)	Correct employee's risk perception (reduce)	Correct employee's risk perception (increase)	Correct manager's risk perception (increase)

lowing provides several illustrations on these points.

High Hazard/High Control: Support

•Example: Biosafety level 4 is required for work with dangerous and exotic agents that pose a high individual risk of aerosol-transmitted infections and life-threatening disease that is frequently fatal.

•Level of safety professional qualification required: very high (limited number of specialized OSH professionals available).

•Prevalent opinion for perceived "adequate control" safety program results in employee support (Figure 2, p. 47).

It is presumed that the opinion spectrum on any OSH program will always include fringe opinions (e.g., too much control on one end; not enough control on another). The purpose of a good OSH program is to minimize the fringes and bring the opinions of all project participants to a common correct denominator. Normal distribution is illustrated in Figure 2. In reality, the distribution of opinions would vary, depending on a situation.

Moderate Hazard/Moderate Control: Compliance/Neutral

•Example: When working in the field, wear proper PPE, plan for the heat and wildlife exposures, have emergency preparedness and action plan ready, conduct task hazard analysis and pay continuous attention to surroundings.

•Level of safety professional qualification required: low to moderate (significant number of safety advisors is available).

Low Hazard/High Control: Annoyance

•Example: When walking the stairs, hold the rail. Cameras record cases of noncompliance.

•Level of safety professional qualification required: none (excessive number of advisors is available).

•Prevalent opinion for perceived too much safety control results in annoyance (Figure 3, p. 47).

High Hazard/Low Control: Fear, Outrage

•Example: An office contains some toxic mold, but the company does nothing about it.

•Level of safety professional qualification required: high (limited number of specialized OSH professionals/public risk communicators).

•Prevalent opinion for perceived "not enough safety control" results in fear and outrage (Figure 4, p. 47).

Concentrating on Higher Potential Hazards

Consider a project with a mix of 90% low potential hazards and 10% high potential hazards. Ideally, the safety program should be balanced as follows:

•10% of the total effort to the 90% low potential hazards;

•90% of the total effort to the 10% high potential hazards.

As in the earlier examples, it would be wrong to dwell on managing handrail usage while biosafety level 4 is required in a facility, or where people are dissatisfied with actual or perceived hazards of toxic mold. In reality, however, many safety programs, especially those with well-developed behavior-based elements, distribute their efforts proportionately to the flow of incident reports, including minor cases:

•90% of the total effort to the 90% low potential hazards;

•10% of the total effort to the 10% high potential hazards.

Ten percent of the high potential hazards may be the source of 90% of losses. The author studied one global company's workers' compensation losses in which the top 2.5% of workers' compensation insurance claims resulted in 85% of losses. Prevention of those 2.5% of cases would have made a serious difference for the health and well-being of several people. It would be logical to direct a significant portion of the available safety resources to prevent the 2.5% most serious cases.

Some companies, sensitive to their OSHA recordkeeping standard-defined safety performance indicators, may not distinguish between high potential and low potential hazards and incidents. Many safety programs try to prevent all actual incidents (Figure 5), minor and major, but especially incidents deemed recordable by OSHA (29 CFR 1904) (the vertical oval), while high potential hazards and near-hits might be underrecognized.

The focus of those safety programs might become skewed, and may miss the critical pieces of the puzzle: preventing serious incidents. These programs also risk losing employee support if they are perceived as creating unnecessary burden and controls for the situations that are perceived (correctly or not) to pose only minor risks, or the opposite, providing insufficient support or control of critical, high potential hazards.

The recommended strategy is to focus efforts on moderate to serious risks (incidents and near-hits) (the horizontal oval).

Bringing Risk Perceptions to a Common Denominator

As noted, risk is defined as hazard/control. Under this definition, OSH risk would be mischaracterized when a mistake is made in a hazard characterization, in a control characterization or in both. Some errors may not result in increased danger to a person exposed to the hazard, but may affect that person's perception of the safety program applied and his/her attitude toward the safety program (Figure 6, p. 48).

Misevaluating hazards, controls and resulting risks by any member of the team (or several members of the team with different perceptions of risks) can cause disagreement and conflict, which damages the effectiveness of an OSH program and can increase the probability of incidents. Multiple scenarios are possible (four example scenarios and corrective actions are shown in Table 3, p. 49).

Conclusion

Open communication channels between all levels of an organization and between organizations of multiemployer projects are critical for ensuring an effective exchange of risk-related information. While it may be difficult to quantify the risk, management must have complete data and must "deal in a world of reality in understanding technological weaknesses and imperfections well enough to be actively trying to eliminate them" (Feynman, 1986). In addition to technological difficulties, management should be aware of and prepared to deal with human factor limitations. Risk perceptions by various groups should be communicated and discussed until a common vision is achieved on the existing hazards and required controls, based on all available information and professional analysis.

When applied to safety, errors in perception of risks posed by a specific hazard may lead to disagreements among the members of project teams, misallocation of resources and, in worst cases, incidents. One goal of OSH is to achieve the proper recognition and evaluation of safety hazards and the risks they pose. To illustrate risk perception management in safety, this article reviewed perception of hazards and associated controls, based on the principle: risk = hazard/control.

Achieving a correct and shared vision of each hazard and required control within the project team is a necessary condition of an effective OSH program:

•While conducting an activity hazard analysis, make sure that all members of the team, including management, safety, employees and subcontractors, share the perception of hazards, controls and residual risks that matches those of experts.

•The support of a safety program depends on the team's agreement that the level of controls provided adequately addresses the hazards. The four basic expected scenarios and reactions are:

1) Low hazard/high control: annoyance, low support of safety program;
2) Low hazard/low control: compliance/neutral;
3) High hazard/low control: fear, outrage with lack of safety support;
4) High hazard/high control: support of safety program.

•It is presumed that people will support the safety program when they agree that an occupational hazard is reasonably matched by a control, and the higher the hazard (or perceived hazard), the higher would be the support of safety program's efforts to control the hazard.

Applying the principles of the psychometric paradigm to safety awareness programs may help modify employees' risk perceptions, improving the support of safety program.

•Typical application of the psychometric paradigm is in managing public risk perceptions from higher to lower. In the case of occupational safety, a reverse application is suggested where risk uncertainties and potential dreadful outcome scenarios are emphasized to move the perceived hazard from lower to higher, which would result in increased risk perceptions and increased support of controls provided by the safety program.

Focusing on high- to medium-potential hazards versus all hazards may help reduce the probability of serious incidents.

•Focusing safety efforts on the lower end of the hazard spectrum (low hazard/high control) and emphasizing postincident case management of minor cases may result in employee annoyance with the safety program and decreased overall support and compliance. **PS**

References

Feynman, R.P. (1986). Vol. 2: Appendix F—Personal observations on reliability of shuttle. Report of the Presidential Commission on the Space Shuttle *Challenger* accident. Retrieved from http://history.nasa.gov/rogersrep/v2appf.htm

Fischhoff, B., Slovic, P., Lichtenstein, S., et al. (1978). How safe is safe enough? A psychometric study of attitudes towards technological risks and benefits. *Policy Sciences*, *9*(2), 127-152. doi:10.1007/bf00143739

Peters, E. & Slovic, P. (1996, Aug.). The role of affect and worldviews as orienting dispositions in the perception and acceptance of nuclear power. *Journal of Applied Social Psychology*, *26*(16), 1427-1453.

Sandman, P.M. (1999, Oct. 4). Risk = Hazard + outrage: Coping with controversy about utility risks. *Engineering News-Record*, A19-A23.

Sjöberg, L., Moen, B.-E. & Rundmo, T. (2004). Explaining risk perception: An evaluation of the psychometric paradigm in risk perception research (Report No. 84). Trondheim, Norway: Rotunde publikasjoner. Retrieved from www.svt.ntnu.no/psy/torbjorn.rundmo/psychometric_paradigm.pdf

Slovic, P., Fischhoff, B. & Lichtenstein, S. (1981). Facts and fears: Societal perception of risk. *Advances in Consumer Research*, *8*, 497-502.