# 위험저감을 위한 인적오류의 동적관리 방법

조영도, 박교식
한국가스안전공사, 가스안전시험연구원 시설연구실

# Dynamic management of human error to reduce total risk

Young-Do Jo, Kyo-Shik Park
Institute of Gas Safety Technology, Korea Gas Safety Corporation, 332-1, Daeya-dong, Shihung-shi, Kyunggi-do, 429-712, Korea

## Introduction

The present dynamic society has very aggressive and competitive environment. Companies tend to focus on short-term financial criteria rather than long-term criteria concerning safety to adapt to a dynamic environment of the modern society. It means that an optimal management of risk in process industries to maximize profit of its activity implies the risk of crossing the limit of safe practices[1].

The classical risk management or assessment in process industries focused on reliability of mechanical component and consequence of accident, while human factors are not deeply considered. Human activities continue to play a critical role in protecting the safety in many different fields. In spite of recent advances in automated control and in process integration, human decision making must still be explicitly considered within the safety-cases that support many complex production processes. The causes of industrial accidents indicate that human errors are determining factors in 50 ~ 80% of cases[2].

Human error analysis has undergone significant development since its inception as a technology in the 1960s. The well-known technique for human reliability prediction(THERP) has been applied successfully to the problem of nuclear weapons assembly at the end of the decade. Subsequently the same approach was applied to nuclear power risk assessment. The deficiencies in this approach, which emphasized the impact of latent and time unconstrained failures. The characteristic of latent errors is that they do not immediately degrade function of the system, but in combination with other events, which may be active human error or other random events in the environment, they give together raise to a catastrophic failure. The first time dependent human reliability models characterized by time reliability correlations(TRCs) have been applied used throughout the decade of the 80s into early 90s in the probabilistic safety assessment performed in the USA and in Europe. In the mid-80s the principle of the TRC was extended by combining it with a popular information processing model, often referred to as the skill-based, rule-based, knowledge-based(SRK) framework. The resulting human cognitive reliability(HCR) approach advanced the TRC by providing a simple reliability model based on SRK framework. Most of major accidents indicate that the observed coincidence of multiple errors cannot be explained by a stochastic coincidence of independent events. This justifies the conclusion that in industrial systems operating in aggressive and competitive environment, the erroneous relations between actors with in organization may result in behavior of individuals and teams, such that they in certain circumstances are not able to prevent and cope with an accident. Lots of results of study have been published recently about the human error depending on a context[3].

Most of major accidents have several root causes including human errors and mechanical component failures[1]. But number of researches have been studied about human error and mechanical failure independently or not cross each other. This paper is focused on coincidence of human error and mechanical failure to develop a concept of dynamic management of human error. The safety of process industry may be improved without additional investments by reducing the intersection of human error and mechanical failure.

**Dynamic risk management**

The risk in process is function of probability of unwanted top event and consequence of the event in terms of possible damage to property, environment, and people. The most of major accidents occurs with coupling of human error and mechanical fail as discussed above. Only a single human error is seldom a cause of major accident in process industries because safety equipments were adapted generally at design stage. But if the safety equipment is unavailable during very short time, such as testing time and repairing time, the probability of top event may increase temporarily because human error is related directly to the top event. The top event is major accident such as hazardous gas release or reactor explosion.

The ratio of the recognized period for unavailable state to the total period of interesting is very small but the large part of total unavailability may be focused on the recognized period. Therefore, an appropriate management of human error taking attention to the required task during the recognized period may reduce the probability of unwanted top event. However, the quantifying of the appropriate management is difficult, since the task can change from situation to situation along with the quantification of temporary personal factors. A person's effectiveness can not be sustained during plant-life-time. It declines very rapidly under vigilance tasks, such as the night-lookout on a ship or an inspector visually inspecting large numbers of uniform items, almost all of which are good. In situations where failure of detection may have serious consequence, the person engaged in the vigilance task should be relieved at the end of 30 minutes of the continuous watch[3]. The decrease in effectiveness on the tasks may be attributed to a decline in the persons level of arousal, caused by insufficient stimulation. Therefore, an appropriate dynamic management of human error during a short period of recognizing the unavailability of mechanical component may be able to prevent the most of unwanted consequences arising from slips of action as well as mistakes by means of temporarily improving the performance shaping factors.

The dynamic management of human activity, as similar to the situation awareness in the field of aviation, is an active management method for human error when the system is in more hazardous state by failure of safety equipment or of redundancy component[4]. The method starts from FTA or failure mode and effect analysis(FMEA) as shown in Fig. 1.

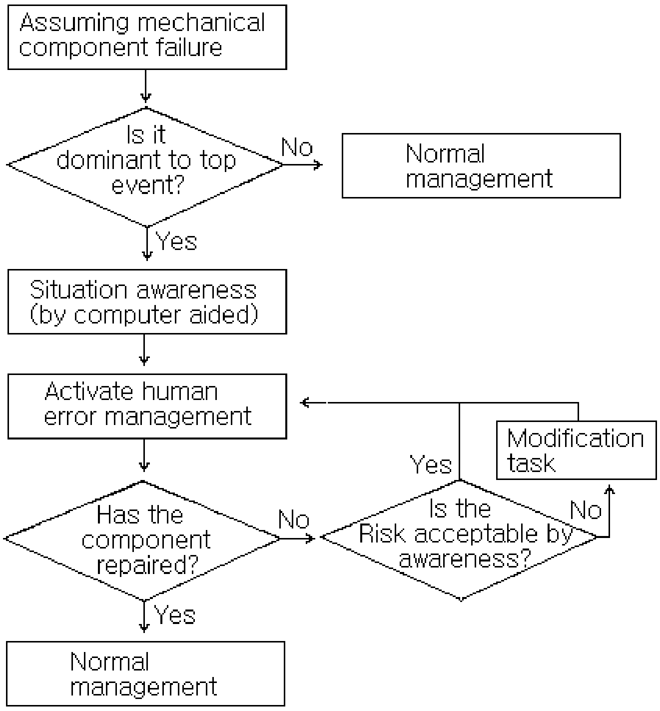


Figure 1. A systematic diagram of dynamic management of human error according to situation associated with mechanical failure.

If a failure of mechanical component contributes dominantly to the probability of the hazardous top event, the situation awareness to operator is important to take attention to his task and reduce human error such as slip. Some cases cannot reduce the risk to be acceptable by simple awareness of the situation, such as high stress induction situation. In that case, the task has to be modified in order to reduce the human error conducting to unwanted top event associated with the mechanical failure by using human redundancy or some other method.

By dynamic management to reduce the conditional probability of human error, the total risk may be reduced significantly without any further investment on system safety. Because the probability of major accident is very low, operators may not feel the effect of the dynamic management of human error, while it obviously increase the system safety as discussed above.

## Conclusions

Safety management in companies is compelled to do at the limit of risk criteria to survive in very aggressive and competitive environment of modern society. It implies that the risk in process industries is crossing the limit of safe practices.

Most of major accidents consists of human errors and mechanical component failures, and cannot be explained by a stochastic coincidence of independent events. By active management human error during a short period when a mechanical component is temporarily unavailable during periodic test or maintenance time, the probability of major accident may be reduced significantly without additional investment for improving safety. The dynamic management of human error may be useful method to prevent loss effectively in process industries.

References

1. Svedung, I & Rasmussen, J., (2002). Graphic representation of accident scenarios: mapping system structure and the causation of accidents, *Safety Science*, 40, 397.
2. Hollnagel, E., (1998). Cognitive reliability and error analysis method, Elsevier Science Ltd.
3. Swain, A.D. & Guttmann, H.E., (1983) Handbook of human reliability analysis with emphasis on nuclear power plant applications, NUREG/CR-1278, Sandia National Laboratories for the U.S. Nuclear Regulatory Commission, Washington, DC(supercedes 1980 edition)
4. Endsley, M.R., (1995). Measurement of SA in dynamic systems, Human Factors, 37(1), PP. 65-84.