

Crew resource management training adapted to nuclear power plant operators for enhancing safety attitude

ISHIBASHI Akira¹, KITAMURA Masaharu², and TAKAHASHI Makoto³

1. Safety Management Lab. Co. Ltd., Yokohama, Japan (Tel: +81-45-784-7862, E-mail:captishi@safepnrch.com)

2. Research Institute for Technology Management Strategy Co. Ltd., Sendai, Japan (Tel: +81-22-393-4884, E-mail: kitamura@temst.jp)

3. Graduate School of Engineering, Tohoku University, Sendai, Japan (Tel: +81-22-795-7920, E-mail: makoto.takahashi@qse.tohoku.ac.jp)

Abstract: A conventional training program for nuclear power plant operators mainly focuses on the improvement of knowledge and skills of individual operators. Although it has certainly contributed to safety operation of nuclear power plants, some recent incidents have indicated the necessity of an additional training program aiming at the improvement of team performance. In the aviation domain, crew resource management (CRM) training has demonstrated the effectiveness in resolving team management issues of flight crews, aircraft maintenance crews, and so on. In the present research, we attempt to introduce the CRM concept into operator training in nuclear power plant for the training of conceptual skill (that is, non-technical skill). In this paper an adapted CRM training for nuclear power plant operators is proposed. The proposed training method has been practically utilized in the training course of the managers of nuclear power plants

Keyword: CRM training; conceptual skill; attitude; situation awareness; communication

1 Introduction

Since the first use of nuclear power in 1966 in Japan, it had been gradually accepted by neighboring community based on the record of safety operations. However, Fukushima Daiichi Nuclear Power Plant has been damaged by the tsunami caused by the Great East Japan Earthquake on March 11, 2011, which resulted in the loss of core cooling function and in the release of radioactive materials. Number of people had to evacuate from their hometown and some of them still cannot return to their home. It has become common understanding among experts in nuclear fields that the pioneering introduction of safety culture is still on the way and further elaboration of ethical code is also required.

Nuclear safety requires global perspectives and cooperation among neighboring countries as the influence of possible accident may expand beyond the national border. In order to enhance the recognition for higher level of safety, the attitude for quality assurance and promotion of safety is needed to be considered in addition to the technical skills directly required to perform system operation tasks. As the method for training of non-technical skills, Crew Resource Management (CRM) training has

been successfully applied to the aviation domain since 1980's. In this paper, the adaptation of CRM training method to the nuclear fields is discussed.

2 CRM training

2.1 Background of CRM training

In the middle of 1970's, the cause of aircraft accidents had shifted from the technical troubles of hardware to the human factors. The importance of the researches on human factors had been recognized extensively in the aviation domain along with the progress of aviation engineering. For example, the major aviation accidents had been re-examined from the viewpoint of human factors. Based on the results of the analysis of Eastern Air Lines Flight 401 accident in 1972 and the Tenerife disaster in 1977, the problem of team performance among cockpit crews drew considerable attention. Focus has been set on the task performance as team as well as human factors of individual pilot. The issues such as crew communication, situation awareness, decision-making and team performance for the execution of the decided action are taken into consideration in CRM training. TAG: Trans-cockpit Authority Gradient is one of the factors identified as important in the course of CRM development. Steep TAG may result in the atmosphere in which expressing concerns, questioning decisions, or even

Received date: October 21, 2015

(Revised date: November 5, 2015)

simply clarifying instructions will require considerable determination of subordinates. These problems had not been considered in the flight skill training required for maintaining license. As the additional training process for non-technical skill to the conventional flight skill training, the CRM training has been developed. The CRM training has also been intended to correct the behavior of authoritarian pilots making decision based on their own and refusing any type of feedback from co-pilot. The results of full mission simulation of a civil air transport scenarios also suggested the necessity of the similar type of training process focusing on the crew cooperation. As the result of the extensive research activities by aviation society, the Cockpit Resource Management training has been completed on early 1980's and has spread all over the world. The concept of Cockpit Resource Management training has been extended to cover activities related to overall flight operations and has been re-defined as Crew Resource Management. Furthermore, it has been re-defined recently as Corporate Resource Management, covering all the activities in the corporate organization^[1].

2.2 Outcome of CRM training

The modules constituting CRM training is shown in Fig.1. Although there may be some variations according to airlines, the five elements such as "Communication", "Situation awareness", "Decision making", "Team building" and "Workload management" are major modules in CRM training.

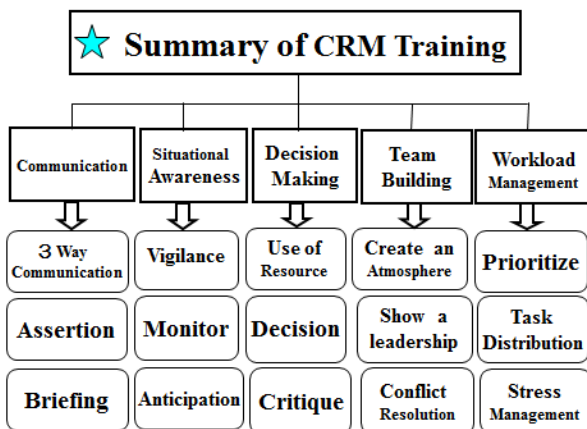


Fig.1 Five elements of CRM skill.

As it is very important to recognize the tendency of change in the environments precisely up to the stage of "Decision making", human-human communication and human-machine communication play significant roles. Thus, the skill for decision-making, situation awareness and communication should be considered simultaneously. For the stage of execution of decided action, skills for team building, role sharing and workload management become important factors. The CRM training has been designed so that it covers all of the factors necessary for enhancing team strength.

The successful outcomes of introducing CRM training have been shown in number of incidents in which cockpit crew faced critical situations. In the accident of United Airlines Flight 232 DC-10 in 1989, the aircraft losing all hydraulic system for flight control could land by using engine power control based on the cooperative work of cockpit crews and grand crews and many passengers survived otherwise all lost. The captain of this aircraft told that Crew Resource Management was the one of the factors that saved many lives.

The survival of US Airways Flight 1549 after multiple bird strikes causing both engines to fail, so called "Miracle on the Hudson", is another example of the successful outcome of CRM training.

The successful landing of ANA1603 with nose gear unable to down at Kochi airport is another case in which cooperative work of cockpit crews and corporate crews resulted in the survival of all passengers on board.

All these cases are characterize by the excellent cooperation and communication among cockpit crews, grand crews, ATCs and airport stuffs, in which all available resources have been utilized to make optimal decision. The widespread use of CRM training has contributed to the success of these outstanding cases and also to the enhancement of superior safety record of commercial aviation.

3 Needs of CRM training in nuclear domain

It can be considered that CRM training is effective as a training program for operators and maintenance personnel in the nuclear domain. The nuclear domain has well-developed training programs as to technical skills. However, for enhancing the safety of nuclear plants, not only the training of technical skills but also that of non-technical skills is indispensable. Even in the training curriculum to enhance the operators' ability of responding emergency situations, only the technical aspects of plant operations such as the appropriate use of manuals and accurate operations following procedures tend to be emphasized ^[2].

CRM training places high importance on the acquisitions of non-technical skills for appropriate and resilient decision-making in any situation. Along with the training purpose, the core methods of CRM training are workshop and group discussion by training participants. In the workshop and group discussion, the participants are required to think for themselves and to take part in deep discussions. Needless to say, technical skills are also essential for safe plant operation. The sufficient level of technical skills is a prerequisite for CRM training.

In the operation of large-scale complex systems such as nuclear power plants, one of key requirements for appropriate decision making is obviously good teamwork. The analysis of the accident investigation report of Fukushima Daiichi Nuclear Power Plant from CRM perspective performed by the authors reveals that the team performance not only of the crew members in the central control room but also among the all staffs of the countermeasures office in the power station were strongly required in any situation right after the huge earthquake occurred. Prominent team performance can be a significant contributing factor for overcoming emergency situations in nuclear power plants. Enhancing team performance is the main objectives of CRM training ^{[3][4]}.

4 Adaptation of CRM training to nuclear domain

CRM training was originally developed for improving crew performance in a flight deck. Thus, in introducing CRM training into the nuclear domain, adaptation in response to the training needs of the nuclear domain is definitely required. In other words, both identifying the needed non-technical skills in the nuclear domain and establishing training contents corresponding to the identified skills are the indispensable process of the introduction of CRM training. Facts and figures obtained from detailed field observation should be carefully referred and taken into consideration for appropriate adaptation.

5 Introduction of CRM training

It takes several days to train all elements of CRM skill listed in Fig. 1. One of the critical issues faced in the introduction of CRM training to non-aviation industries is the limitation of available time for the training. The reduction of the minimum training time can be a key point for the widespread use of CRM training in various industrial domains.

For addressing the issue, this paper proposes 2- step training method of CRM. The first step is the training of the process of decision-making. The second step focuses on the implementation of the decision. The 2-step approach of CRM training makes it possible to complete the training in shorter time frame. It is desired that CRM training is taken by as many staffs as possible within a short period, which can contribute to promote the organizational understanding of the basic concept of CRM training.

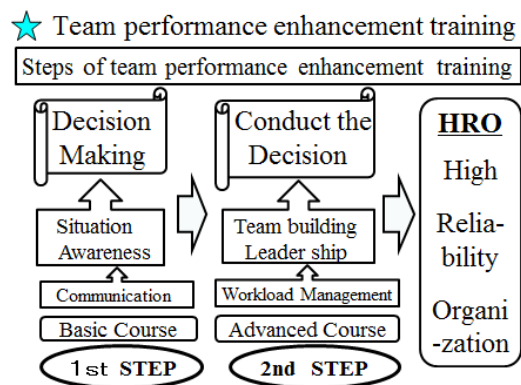


Fig.2 2-Step training method.

CRM training should be started with the review of the basic concepts of human factors such as mechanisms and countermeasures of/for human errors, because the knowledge is the foundation for understanding 5 elements of CRM skills.

The training session of each element of CRM skills consists of approximately 15 minutes lecture of the element and group discussion by 5 or 6 training participants. The purpose of the group discussion is to let the participants notice the importance of the CRM skill through the exchange of participants' success and failure experiences relating to the CRM skill. For the active exchange of opinions among participants, small group activities called ice-breaking before starting group discussion can be helpful. Self-introduction, naming a group and role sharing in a group are the typical examples of ice-breaking. In the end of the training sessions of respective CRM skills, the outcomes of group discussion are presented and shared among all participants. The training sessions described above can be followed by integrated training of multiple CRM skills using training scenarios, case studies, and so on. After completing all training sessions described above, it is strongly recommended that the participants have an additional discussion for exchanging the ideas of the practical application of trained CRM skills in their daily work.

In CRM training, short (typically, 15 minutes) lectures of respective CRM skills are given by a facilitator. The facilitator also supports active group discussion. Having active group discussion itself might be a kind of training of CRM skills because it requires the active listening and clear explanations of participants. As noted above, since the facilitator plays the important role in managing training sessions, trained and experienced facilitator is desired for effective CRM training.

6 Fostering safety culture

After the accident of Fukushima Daiichi Nuclear Power Plant, the nuclear domain has been continuously making efforts to enhance the safety. The authors believe that CRM training aiming to improve the non-technical skills of operators and maintenance personnel can contribute to the safety efforts. However,

as the foundation of the effective CRM skills, safety culture, which is a concept proposed through the analyses of the Chernobyl disaster, is definitely required. For the purpose of achieving a higher level of safety, the highest priority issue in the nuclear and other industrial domains is the appropriate fostering of safety culture in organizations through repetitive education and training of the fundamental concepts of human factors^[5].

Acknowledgement

The authors are deeply grateful to all the members of the CRM project of Japan Nuclear Fuel Ltd. and Tohoku Electric Power Co., Inc. for their invaluable comments and suggestions on this research.

References

- [1] ISHIBASHI, A., KARIKAWA, D., TAKAHASHI, M., WAKABAYASHI, T., and KITAMURA, M.: Training Method for Enhancement of Safety Attitude in Nuclear Power Plant based on Crew Resource Management, *Journal of the Atomic Energy Society of Japan* (in Japanese), 2010, 9(4): 384-395.
- [2] YAMAZAKI, S., TAKAHASHI, M., ISHIBASHI, A., KITAMURA M., KARIKAWA, D., WAKABAYASHI, T., and NAKANOWATARI, H.: A Study of the Crew Resource Management Training of Rokkasyo Reprocessing Plant From Resilience Engineering Prospective. In: *Proceedings of International Symposium on Socially and Technically Symbiotic Systems (STSS) 2012*, Okayama, 2012.
- [3] HOLLNAGEL, WOODS, D. D., and LEVESON, N. (ed.): *Resilience Engineering: Concepts and Precepts*, Ashgate Publishing, 2006.
- [4] HOLLNAGEL, E., PARIÈS, J. WOODS, D. D., WREATHALL, J. (ed.): *Resilience Engineering in Practice: A Guidebook*, Ashgate Publishing, 2010.
- [5] ISHIBASHI, A, KARIKAWA, D., TAKAHASHI, M., WAKABAYASHI, T., and KITAMURA, M.: Adaptation of Crew Resource Management Training to Nuclear Industry. In: *Proceedings of 2011: Spring Meeting of the Atomic Energy Society of Japan* (in Japanese), 2011.
- [6] ISHIBASHI, A., and GOFUKU, A.: Analysis and Lessons of the Accident of Fukushima Daiichi Nuclear Power Plant from Human Factors Perspective – Consideration of Accident Responses from Viewpoint of Crew Recourse Management, In: *Proceedings of 2013: Fall Meeting of the Atomic Energy Society of Japan (The Session of Human-Machine System Study Group)* (in Japanese), 2013.