Innovative Modelling Approach of Safety Culture Assessment in Nuclear Power Plant

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A culture is commonly defined as the shared set of norms and values that govern appropriate individual behavior. Safety culture is the subset of organizational culture that reflects the general attitude and approaches to safety and risk management. While safety is sometimes narrowly defined in terms of human death and injury, we use a more inclusive definition that also considers mission loss as a safety problem and is thus applicable to nuclear power plants and missions. The recent accident reports and investigations of the nuclear power plant mission failures (i.e., TMI, Chernobyl, and Fukushima) point to safety cultural problems in nuclear power plants. Many assessment approaches have been developed by organizations such as IAEA and INPO based on the assessment of parameters at separate levels — individuals, groups, and organizations.

However, recent reports from the Korean nuclear industry show that there is a need to understand multi-level interactions that are more complex and dynamic. One such example is the workload of employees, which is one of the main factors that deteriorate safety culture in nuclear power plants. This is due to the organizational complexity that results from poor management of institutional complexity such as export and new power plant construction. The individual complexity arises from not being able to cope with this. Excess workload occurs due to poor resource allocation policy and conflicting goals of performance versus safety. Excess workload increases the stress of employees in power plants, leading to more corner-cutting in their work, which ultimately increases the likelihood of accidents. In management science, interruption theory is known to explain this relationship between performance and productivity of employees in terms of work stress. According to this theory, employees in organization can maintain their productivity up to a certain point, from which the productivity deteriorates and causes accidents in power plants. I incorporate this theory into a dynamic modeling approach to assess the safety culture in nuclear power plants.

Based on the interruption theory of stress, the System Dynamics modeling approach that I use rests on a new way of thinking about accidents. It integrates all aspects of risk, not only individual-level risk but also organizational and social aspects. Systems are viewed from a new perspective as interrelated components that are kept in a state of dynamic equilibrium by feedback loops of information and control. A socio-technical system is not treated as a static design, but as a dynamic process that continually adapts to achieve its ends and reacts to changes in itself and its environment. Accidents then are viewed as the result of flawed processes involving interactions among people, societal and organizational structures, engineering activities, and physical system components.

I argue that safety culture can be modeled, analyzed and engineered just like physical systems. The models will be useful in designing and validating improvements to the risk management and safety culture, evaluating the potential impact of changes and policy

decisions, assessing risk, detecting when risk is escalated to unacceptable levels, and in performing root cause analysis. Prescriptions for preventing accidents include designing a control structure encompassing the entire socio-technical system, which will enforce the necessary requirements to mitigate accidents from occurring in the system.