Application of the Technical Safety Requirements for the Fuel Cycle Facility

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1. Introduction

Korea Atomic Energy Research Institute (KAERI) has been developing a pyroprocessing technology to reduce the waste volume and recycle some elements in a spent nuclear fuel. Because the operation with some fissionable materials such as pyroprocessing operations may cause very high risks of accidents resulting in high radiation doses for the public, facility worker, and collocated worker, the safety analysis is prerequisite to fuel cycle facility design. However, regulation guides in Korea are not prepared and are insufficient as compared with commercial nuclear power plants. With such situation in mind, KAERI performed Integrated Safety Analysis (ISA) for large-scale pyroprocessing facility, as suggested in NUREG-1520 rev.2, and radiological and chemical hazards are identified for accident analysis using ISA as required by 10 Code of Federal Regulation (CFR) 70.61 (Performance requirements)[1]. For the safe operation of the facility, the safety analysis report, which is the result of the ISA, provides the limiting conditions for the operation and administrative control throughout the facility operation. 10CFR 830.205 requires responsibility for nuclear facilities to develop Technical Safety Requirements (TSRs)[2]. In this summary, an example of derived TSRs applicable to nuclear fuel cycle facilities, consisting of safety limits, limiting condition, administrative controls, and other requirements is proposed. The guides and requirements for the TSR are also introduced.

2. Technical Safety Requirements

2.1 Regulations and Requirements

In Korea, there are no regulations and requirements for the nuclear facility including the fuel cycle facilities. However, 10CFR 50.36 of the Technical Specifications, regulated by the US Nuclear Regulatory Commission (NRC), requires applicants for a license authorizing to include proposed technical specifications in their application. Technical Specifications will include items in the following categories: (1) Safety limits, limiting safety system settings, and limiting control settings (2) Limiting conditions for operation (3) Surveillance requirements (4) Design feature (5) Administrative controls (6) Decommissioning (7) Initial notification. 10CFR 830.205 of the Nuclear Safety Management Rule requires Department of Energy (DOE) contractors responsible for Hazard Category 1, 2, and 3 DOE nuclear facilities to develop TSRs. International Atomic Energy Agency (IAEA) also proposes the preparation of operational limits and conditions for the nuclear fuel cycle facilities in safety requirements No. NS-R-5.

2.2 Guides for TSRs Development

TSRs define the performance requirements of Structures systems and components (SSCs) and identify the safety management programs used by personnel to ensure safety. TSRs are aimed at confirming the ability of the SSCs and personnel to perform their intended safety functions under normal, abnormal, and accident conditions.

Through analysis of the encompassing bounding accidents, the necessary safety systems and accident mitigating system are identified and their characteristics are defined. Flowing from the analysis is information that provides the bases for controls, limits, and conditions for operation, known as TSRs.

2.3 TSR elements

As mentioned previously, Safety analysis identifies some parameters that must be controlled to ensure the safety requirements for the facility are met. There are several components for TSRs, but the important TSR components are as follows[2]: Safety Limits (SL) are limits on important process variables

needed for the facility function that, if exceeded, could directly cause the failure of one or more of the passive barriers that prevent the uncontrolled release of radioactive materials, with the potential of high consequences to the public. Limiting Control Settings (LCS) define the settings on safety systems that control process variables to prevent exceeding and SL. Limiting Conditions for Operation (LCO) defines the limits that represent the lowest functional capability or performance level of safety SSCs required to perform an activity safely. Action statements should describe the actions to be taken if an operating limit is not met and establish the steps and time limits to correct the conditions that are beyond the TSR limits. Surveillance Requirements (SRs) are used to ensure operability or availability of the safety SSCs identified in the operating limits. SRs are most often used with LCOs to periodically validate the operability and availability.

3. TSR examples

The small transfer lock system is one of the components of the hot cell boundary that is most important to prevent the leakage of radioactive materials to public in nuclear fuel cycle facilities. Thus, small transfer lock system shall be operated safely and ensured the reliability. Applicable LCO for small transfer lock system is shown below as an example.

[Example]

KRS LCO 1 − Small Transfer Lock System

The Small Transfer Lock System shall be operable.

Mode applicability − Operation mode

Actions

Condition	Required action	Completion time
One Small Transfer Lock System door is inoperable	Ensure the Small Transfer Lock System companion door is closed.	Immediately
Both Small Transfer Lock System doors are inoperable	Place main hot cell in the standby mode.	Immediately

Surveillance for compliance with KRS LCO 1	Frequency
Visually verify the Small Transfer Lock System doors are closed	Quarterly and following maintenance
Verify that the Small Transfer Lock System leak rate is lower than 0.05 m^3/hr	Quarterly and following maintenance

4. Conclusion

Safety analysis is required for the safe operation of nuclear fuel cycle facilities. Through conducting the safety analysis for the facility and operation, continuous management or operational guidelines are naturally derived so that safety SSCs and administrative control perform their intended safety functions.

The TSRs consisting of several limitations must be prepared before the operation of the facility, and any changes to the process or facility will require the TSRs to be revised.

Regulatory requirements for establishing TSRs will be needed for nuclear fuel cycle facility, although the legal requirements are not currently available in Korea.

Acknowledgements

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REFERENCES

[1] U.S. NRC, “Standard Technical Specification”, NUREG-2194, Vol. 1 (2016).

[2] U.S. DOE, “Implementation guide for use in developing technical safety requirements”, DOE G 423.1-1A (2010).