*Transactions of the Korean Nuclear Society Spring Meeting*
*Jeju, Korea, May 19-20, 2022*

# Monitoring Methodology for Limiting Conditions for Operation of Technical Specification

Nokyu Seong*, Jaehee Lee, Jongbeom Lee
*KHNP Central Research Institute, 70, 1312 beon-gil, Yuseong-daero, Yuseong-gu, Daejeon*
**Corresponding author: nokyuseong@khnp.co.kr*

## 1. Introduction

Technical Specification (TS) is a document that establishes requirements for the prevention of accidents and minimization of damage caused by the operation of nuclear power plants. It consists of safety limits, surveillance requirement, design features, Limiting Conditions for Operation (LCO) and etc. [1, 2]. For the safe operation of nuclear power plant, operators must continuously monitor whether the LCO which specifies minimum requirements for ensuring safe operation of the unit is met. If LCO is not met then required actions must be taken within completion time of satisfaction condition.

In order to comply with the technical specification, we suggest a two-step monitoring methodology to support the operator's determination on operability of LCO. The suggested the two-step monitoring methodology is divided into a detection logic and an evaluation logic, and the detection logic detects abnormal conditions based logic diagram using parameters that can be measured in real time. In the evaluation logic, it helps the operator to determine the operability of the LCO by evaluating the items derived through analysis of its safety function to check whether its specified safety function can be performed.

## 2. Analysis of Limiting Conditions for Operation

LCO can be divided into those that can be automatically monitored and those that cannot be automatically monitored. Types that can be monitored automatically are conditions that require the plant parameters to be within specified ranges, such as LCO 3.4.1 'RCS Pressure, Temperature, and Flow Limits'(Pressurizer pressure ≥ 154.7kg/cm$^2$A and ≤ 161.6kg/cm$^2$A) [3]. This type can be easily monitored, and if it is out of the range, there is no difficulty in entering into the LCO because the LCO can be applied without the operator's additional judgment. However, this type is few compared to the number of LCOs to be monitored, and since they are the key plant parameters, they can be checked through another channel such as a plant alarm system.

Types that cannot be automatically monitored are cases where real-time monitoring is not possible, such as LCO 3.4.17 'Steam Generator Tube Integrity'. Since such an LCO can be checked according to the relevant program and whether LCO is met or is not met can be judged according to the result, there is no difficulty for the operator to enter into the LCO. Another type that cannot be automatically monitored is when the operability is included in LCO. The definition of operability is as follows.

*'Operable-Operability: A system, subsystem, train, component, or device shall be OPERABLE or have OPERABILITY when it is capable of performing its specified safety function(s) and when all necessary attendant instrumentation, controls, normal or emergency electrical power, cooling and seal water, lubrication, and other auxiliary equipment that are required for the system, subsystem, train, component, or device to perform its specified safety function(s) are also capable of performing their related support function(s)] [2].'*

In order for the operator to determine the operability, it is necessary to understand the mechanism inside the equipment as well as the prior operator's knowledge of the plant system. In addition, the longer the determination for operability, the shorter the allowable time to take the required actions when the LCO is not met. For example, if the time of discovery of situation when the operator detects the abnormal condition of LCO is $t_1$, and the declaration time of the entry into LCO at which the operator finally determines that LCO is not met is $t_2$ and the completion time of LCO is ($t_3$-$t_1$) then the allowable time to take required actions is ($t_2$-$t_1$). Fig. 1. shows the example of allowable time.

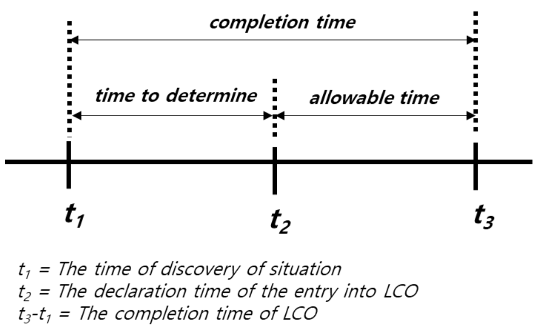


Fig. 1. The example of allowable time

In order to maximize this allowable time, therefore, the evaluation logic is needed to quickly determine whether LCO is met or not met.

The results of the pre-site survey conducted for the development of Technical specification Operator Support System (TOSS) also confirmed that the main goal is to solve the difficulties in determining the operability of LCO [4].

## 3. Monitoring Methodology

If the LCO is met as a result of surveillance test, LCO keep in the presumption of operability status unless other abnormal conditions are detected. Fig. 2. shows the overall LCO monitoring flow.

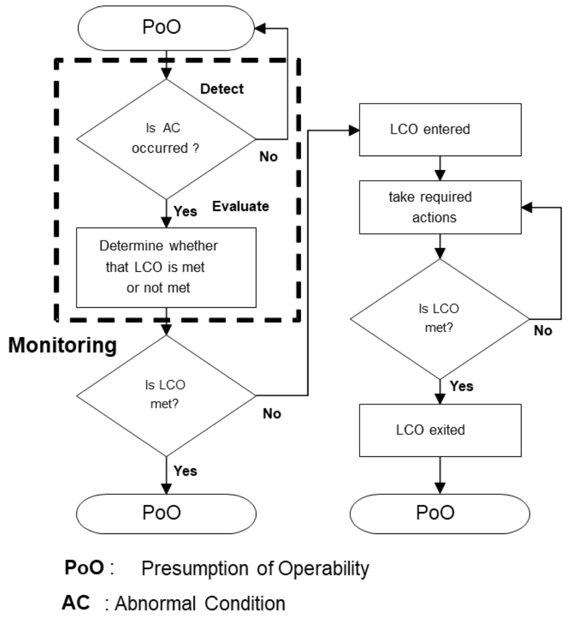


Fig. 2. LCO monitoring flow

As shown in Fig. 2., the suggested monitoring methodology provides an evaluation logic that allows the operator to determine whether LCO is met or not met after detecting an abnormal situation.

### *3.1 Detection*

The detection logic for LCO is composed of plant mode calculation logic including additional condition of applicability and the logic to detect abnormal conditions for LCO. The LCO abnormal condition is detected using the plant information received from the PI system, and the operator enters the evaluation stage after checking the abnormal situation of LCO properly.

### *32 Evaluation*

To evaluate operability of the operator, the operators check the its specified safety functions of the TS Structure, Systems and Components (SSC). Next, the operators check conditions of TS SSC that can perform their own safety functions. Finally, it is determined whether the LCO is met or not met by comparing the plant status with the predefined conditions that can perform its specified safety function. The predefined conditions were selected by reflecting the surveillance test procedure, the operator's experience of experts and plant practices. In order to overcome the limitations of the evaluation logic, the 'Not applicable' that can confirm the inaccuracy of the monitoring logic and the 'others' are added to secure the completeness of the items to be evaluated.

## 3. Conclusions

Currently, the technical specification operator support system (TOSS) is being developed reflecting the suggested methodology. It is expected that the safety and utilization rate of the plant will be improved by using the TOSS to support determination on whether LOC is met or not met. In addition, it is expected that the accuracy of the monitoring logic (detection and evaluation) will be further improved as data is accumulated after the application of the TOSS.

## REFERENCES

[1] NRC glossary, Last Reviewed/Updated March 9, 2021, accessed March 3, 2022, https://www.nrc.gov/reading-rm/basic-ref/glossary/technical-specifications.html
[2] NUREG-1432. Vol. 1, Rev. 2. Standard Technical Specifications. Combustion Engineering Plants. U.S. Nuclear Regulatory Commission.
[3] APR1400-K-X-FS-14002-NP. Rev. 3. APR1400 Design Control Document Tier 2, Chapter 16 Technical Specifications.
[4] Yu et al., Conceptual Design of Operator Support System for Limiting Conditions for Operation. KNS Spring Meeting, 2019.
[5] NRC INSPECTION MANAUAL CHAPTER 0326 "Operability Determinations"
[6] NEI 18-03, DRAFT "Operability Determination"