

Design of Not Applicable Action on APR1400 Computerized Procedure System

Nokyu Seong*, Yeonsub Jung

Nuclear System Safety Laboratory, KHNP Central Research Institute, 70, 1312 beon-gil, Yuseong-daero, Yuseong-gu, Daejeon

*Corresponding author: nokyuseong@khnp.co.kr

1. Introduction

The Computerized Procedure System (CPS) of Advanced Power Reactor 1400(APR1400) had applied at Shin-Kori unit 3 in 2012 and CPS is being improved continuously [1]. CPS provides the operators with navigating between procedure elements, automatic evaluating on instructions, calling step support display, etc. [2-4].

Not Applicable (N/A) action is the necessary operator action performing the procedures depending on the plant status but the reference CPS does not have this N/A action. Therefore, the procedure writers have to add the Boolean input in task group of computerized procedure and the operators need to click two times when entering the N/A action. This paper introduces the design of N/A action to reduce the operator's burden and to enhance the convenience of operators.









2. Design of Not Applicable Action

In this section detailed design features of N/A action are described.

2.1 Display of N/A action

APR1400 CPS has the strength in recording the place keeping and performance records compared to the paper based procedure. The operators perform the procedure by evaluating 'True' or 'False' on the instructions such as 'Verify that the reactor power is decreasing', 'At least one of the SG level is within 25% ~ 80%'. In Shin-Kori 5&6 CPS the N/A action is added to the instruction status. The below table I shows the display depending the instruction status [3].

Table I: Evaluation Status on Instruction

Status	Null	True	False	NA
Interactive Instruction				
Executed but Non Interactive				

The input method of N/A action is the same as the 'cancel' using can be entered by right mouse button on evaluation cap and selecting N/A on context sensitive menu.

2.2 Token of N/A action

Instructions can be interactive when it has the token. If the instruction has token, the upper elements such as Step, GrossStep and Procedure states are 'under execution'. If the evaluation result of the instruction is 'True', token is duplicated to next instruction and the next instruction is interactive. When the operator input the N/A action on the instruction which has no child instructions, token is duplicated to the next instruction. The below figure shows the token interaction between the instructions.

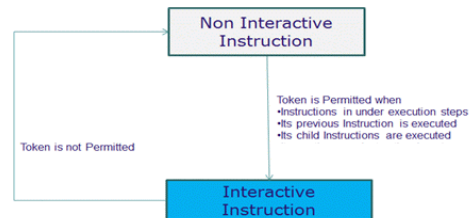


Fig. 1. Token between instructions

2.3 Casting true

The result of N/A action on instructions which have the child instructions is casting true. It means that the result of N/A is not affected to the result of parent instruction until the result of parent instruction is evaluated using the combination of other results of instructions [5].

2.3.1 Case 1: No N/A action in child instructions

The result of the parent instruction is the same as the result of reference CPS. For example, if one of child instructions is true in 'OR' logic, the result of parent instruction is true.

2.3.2 Case 2: One or more N/A action(s) in child instructions

The result of the parent instruction is evaluated using other child instructions except the N/A action on instruction. The below figure shows the example of case 2. In 'AND' logic the combination result of other instructions is false therefore the result of parent instructions is false.

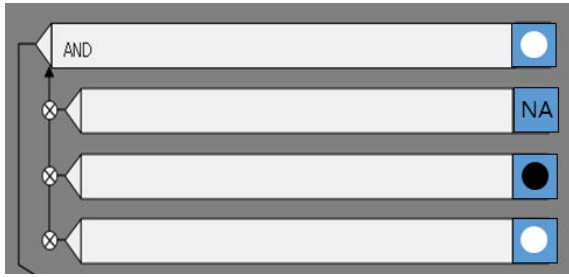


Fig. 2. Example of the result of one or more N/A action(s) in child instructions

2.3.3 Case 3: All N/A actions in child instructions

The result of the parent instruction is true and the token is duplicated to the next instruction or the step is possible to complete. This design can make operators keep performing the procedures. This design conforms the practices of operation using paper based procedure. In paper based procedure the operator can navigate to other instructions. The below figure shows the example of case 3. The result of parent instructions is N/A and the token is duplicated to the next instruction or the step is possible to complete.

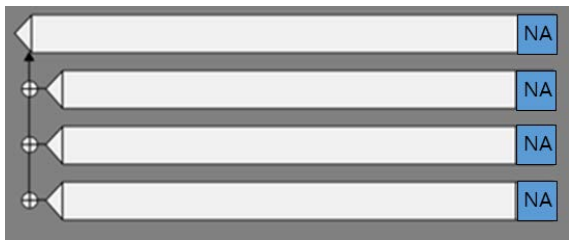


Fig. 3. Example of the result of all N/A actions in child instructions

2.4 Limitation on the use of N/A

CPS has the five types of instructions to support the executing the procedures [2,3]. The provided instructions are as follows:

- Unitary Instruction: the number of target flow is one.
- Binary Instruction: the number of target flows is two.
- Case Instruction: the number of target flows is two or more.
- Caution Instruction: no target flow
- Note Instruction: no target flow

N/A action is only applied to the unitary instruction because the basic operation of binary and case instruction is related to the choice not the decision.

2.5 Override function to the result of parent instruction

The operators were not allowed to override the result of parent instruction in the reference CPS. Therefore token can be occasionally stuck in the specific case. For

example the operators try to achieve the goal of instruction using the all success paths but the operators cannot achieve the goal. Therefore the token is stuck and the operator cannot move to the next instruction. In Shin Kori 5&6 CPS the operator can override the result of the parent instruction. This function makes the operators keep going the procedure as his or her decision.

3. Conclusions

This paper describes the features of N/A action in APR1400 CPS. The design of N/A action is being improved through the result of human factors engineering verification and validation. The guideline for the use of N/A action is being made by central research institute. N/A action effectively reduces the operator's burden and enhances the convenience of procedure execution.

REFERENCES

- [1] Nokyu Seong, Yeonsub Jung "Improvement on Procedure Directory of APR1400 Computerized Procedure System" Transactions of the Korean Nuclear Society Spring Meeting Jeju, Korea, May 17-18, 2018.
- [2] System Specification for Computerized Procedure System in Shin-Kori 3&4 (DDS1), Korea Hydro & Nuclear Power, 2009
- [3] System Specification for Computerized Procedure System in Shin-Kori 5&6 (DDS1), Korea Hydro & Nuclear Power, 2015
- [4] Nokyu Seong, Yeonsub Jung, Chanho Sung, "Features of Computerized Procedure System of Shin-Kori 5&6 unit", Transactions of the Korean Nuclear Society Autumn Meeting Gyeongju, Korea, October 27-28, 2016.
- [5] Technical Correspondence, 2018-50003339-전-TC "Design Basis of N/A action of Computerized Procedure System Specification"