

Review of the Assessment Items for the NPP Stress Test

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1. Introduction

Through the stress tests, KHNP has established a plan for implementation by assessing the capability of the all nuclear power plants to respond to natural hazards exceeding the design basis, and has been deriving safety enhancement by itself. There are 6 fields in the NPP Stress test, but in this paper, 6-1(Adequacy of Accident Response Strategy), 6-2(Adequacy of major operator actions), and 6-3(Adequacy of major resources) are reviewed in the sixth field which is operational technical capability evaluation, and the assessment result of 6-4(Human factors engineering validation) is described.

2. Methods and Results

NPP Stress test consists of 6 fields such as the characteristics of extreme natural hazards beyond the design basis (field 1), robustness of structures, systems, and equipment for extreme natural hazards (field 2), response capability for loss of safety functions like power systems (field 3), severe accident management capability (field 4), disaster prevention and emergency response capability (field 5), and operational technical capability (field 6).



Fig. 1. NPP Stress test evaluation flow chart.

Especially, the evaluation items of field 6 (operational technical capability) require verifying the following sub assessment items for the purpose of enhancing accident response and operating capability in case of actual accidents:

- (6-1) Adequacy of accident response strategy
- (6-2) Adequacy of major operator actions
- (6-3) Adequacy of major resources
- (6-4) Human factors engineering validation
- (6-5) Ability to respond to multiple simultaneous accidents.

In the paper, we would like to review the sub assessment items such as (6-1) accident response

strategy, (6-2) major operator actions and (6-3) evaluation of the adequacy of the major resources, and also to describe the result of (6-4) human factors engineering validation. The results of (6-4) were found out through real plant evaluation including (6-1) to (6-3).

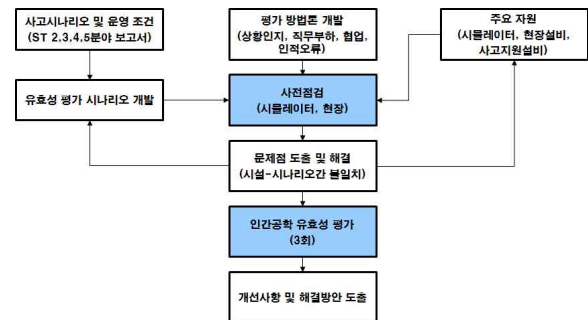


Fig. 2. Evaluation procedure of field 6

2.1 Adequacy of major operator actions

The accident response strategy verifies the adequacy of the accident response strategy for the scenarios established to respond to loss of safety functions like the power system, and to manage severe accidents. To evaluate the adequacy of the accident response strategy, the 10 scenarios having representativeness are reviewed.

The following considerations were taken to assess the adequacy of the accident response strategy.

- Evaluation whether the established accident scenario takes into account the loss of each essential function and the strategy for recovering it is properly established

- Evaluation for the feasibility of implementing a strategy to maintain and restore essential functions in response to established accident scenarios

- Evaluation for the adequacy of the associated items, such as facilities-facilities, facilities-procedures, procedures-procedures (instructions), facilities-organizations/manpower, in order to implement the strategies for responding to established accident scenarios

The essential functions for nuclear power plants in the event of extreme natural disasters are those for ensuring safety of nuclear power plants and ensuring safety of workers and the general public. To ensure safety, the following three safety functions shall be reviewed for ensuring the necessary alternative functions:

- Reactor shutdown and subcritical maintenance
- Core cooling and inventory retention

- Maintaining integrity of containment

2.2 Adequacy of major operator actions

The adequacy evaluation of the major operator actions is to evaluate the adequacy of the accident response strategy, the ability to respond to loss of safety functions, such as the power system, and the adequacy and feasibility of the major operator actions derived from severe accidents.

The following considerations were taken to assess the adequacy of the major operator actions:

- the adequacy of the major operator actions required to perform the defined tasks in the scenario.
- the feasibility of major operator actions for the tasks required to carry out the response strategy in extreme situations (earthquakes, fires, etc.) including accident scenarios
- the available time for carrying out the major operator actions analyzed and sufficiently secured, and alternative implementation measures established assuming that the major operator actions fail due to human error.
- Identifying human errors or decision errors that can occur when using facilities, procedures, etc. while performing accident sequences, and established measures to minimize the errors and to secure response capabilities.

The scope of the adequacy test for the major operator actions is as follows:

- Evaluation for appropriateness of major operator actions derived from analysis of accident scenarios
- Evaluation for the possibility of implementation of major operator actions in extreme situations
- Identification and evaluation of human error or decision error in the process of successfully implementing the established accident response strategy

The adequacy test for the major operator actions is an assessment of the possibility of operator actions and performance of the procedure according to the optimal operation path.

- a. Actions after reactor trip and accident diagnosis
- b. 1MW Mobile generator connection
- c. Non-required direct current load shedding
- d. Open the bulkhead door
- e. Isolation of safety injection tank
- f. 3.2MW Mobile generator connection
- g. Transfer type high flow pump connection
- h. Reduction of the cooling pressure of the reactor coolant system
- i. Start the filling pump
- j. Small portable generator connection

2.3 Adequacy of main resources

The adequacy of the major operator actions is to evaluate the adequacy of the main resources(including fixed facilities, mobile facilities, procedures/instructions, personnel (including in and out of plant organizations), education and training programs) for performing the major operator actions derived from the adequacy of the accident response strategy and the appropriateness of the major operator actions, and the availability of the main resources in the event of extreme hazards exceeding the design basis.

The considerations for assessing the adequacy of major resources are as follows:

- Human-system interface facilities for carrying out major operator actions shall be available in extreme situations (earthquakes, fires, etc.) including postulated accident scenarios, and alternative measures shall be proposed if they are not available.
- Procedures for carrying out major operator actions shall be clearly established and the interface between the procedures and the instructions shall be ensured.
- Ensure sufficient organization and manpower to carry out major operator actions
- The ability to perform accident characteristics, response strategies, facilities and procedures, including the ability of operators and in/out of the plant emergency response members, is verified through periodic training and training programs (including structured scenarios, cycles, methods, results, etc.)corresponding to the responsibilities and authorities of the members.
- The adequacy, responsibilities and authority of the organization and personnel required for decision making, and the analysis and procedures for performance are established.
- In extreme situations, strategies for resource utilization not only on-site but also off-site should be established to ensure suitability, and the ability to implement on-site and off-site response strategies is secured.

The scope of the evaluation of appropriateness of major resources is as follows:

- Evaluation for the adequacy of human-system interface facilities, procedures, organizations and manpower, and tools for carrying out major operator actions
- Evaluation for the adequacy of training and training to ensure the validity of major operator actions
- In-out of plant resource utilization strategies and evaluation of the ability to execute them

2.4 Improvements to safety enhancement based on assessment results.

There were several items to be supplemented for safety enhancement from the human factors engineering validation. Among the items, the education and training supplement is to be described as a representative. It seems because personnel of the plant met the situation that is exceeding the design basis for the first time, so they need to be trained continually to cope with such extreme natural disasters. In addition, there needs some supplement for improving simulator functions like severe accident modules.

3. Conclusions

In a part of activities to enhance the safety of nuclear power plants(NPPs), KHNP has been conducting an evaluation of the capability of operating power plants to cope with extreme disasters (including human disasters) that exceed the design basis. In this paper, 6-1 (the adequacy of accident response strategies), 6-2 (the adequacy of major operator actions), and 6-3 (the adequacy of major resources) were reviewed in the operational technical capability evaluation. Also through the human factors engineering validation, items to be enhanced were found out and the items are being supplemented gradually. Therefore the safety of NPPs for extreme disasters exceeding the design basis will be more reinforced

REFERENCES

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