Utilization of risk information at Hamaoka Nuclear Power Station

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Abstract:
After the Fukushima-Daiichi accident, the utilization of risk information such as PRA (Probabilistic Risk Assessment) has been enhanced at the Hamaoka Nuclear Power Station operated by Chubu Electric Power Company. At present, the main features of the plant status are 1) the station has been in a long-term shutdown since 2011, and 2) there are many scaffolding and temporary items present due to extensive constructions. We have focused on earthquakes, fire and adverse effect by workers as major risks during plant shutdowns, and we are implementing measures to reduce these risks. And, as the standby status of safety-related systems changes daily, we evaluate the Fuel Damage Frequency (FDF) and manage operation and maintenance schedule not to exceed the threshold. Furthermore, to promote the utilization of risk information, we have established an inter-departmental working group whose members are selected from engineering, maintenance, work control, and operations within the station. This working group engages in comprehensive discussions about utilizing risk information, for further enhancement of RIDM (Risk Informed Decision-Making) at the plant.

Keywords: RIDM, PRA, Hamaoka

1. INTRODUCTION

Chubu Electric Power Company has committed to prevent severe accidents like Fukushima-Daiichi accident in 2011. With this commitment, we have developed a roadmap for voluntary and continuous improvement of nuclear safety. As part of our efforts to improve safety, we are strengthening our risk management. While risk management is being implemented at all organizational levels, this paper focuses on on-site activities such as operations and maintenances.

This paper introduces various initiatives that utilize risk information at the field level. Risk management for individual field works is introduced in Section 2. Work control and risk management for the entire plant is introduced in Section 3. Activities to promote the use of risk information is introduced in Section 4.

The station has been in long-term shutdown since 2011, so these efforts are intended for activities during shutdown. However, some of these efforts are expected to be effective after re-start.

2. RISK MANAGEMENT FOR INDIVIDUAL FIELD WORKS

We have prioritized earthquakes, fires and unexpected worker contact with safety-related components as the major adverse events that could occur during plant shutdowns. For individual field works, we execute Risk Management Actions to address these hazards(Table 1).

Table 1. Risk Management Action

Hazard	Risk management
Earthquakes	・Scaffolding Management
Fires	・Temporary Placement of Combustible Materials Management
Adverse Effects By Workers	・Display of the standby system at the site ・Establishment of exclusion zones with fences for critical equipment ・Implementation of risk reduction measures during on-site work

2.1 Earthquakes

Currently, there is a lot of scaffolding in the station due to extensive construction and inspections. Before the new risk management was implemented, when scaffolding was installed near critical equipment with functional requirements, the maintenance supervisor was required to prepare a scaffolding installation plan that included safety measures and conduct on-site inspections. In addition, the use of metal anchors was recommended to prevent scaffolding collapse due to earthquakes.

In addition to these measures, we have strengthened risk management to mitigate the risk of fuel damage. Specifically, we maintain the plant configuration to ensure that even if all equipment within 1 meter of the scaffolding were assumed to be damaged, the water injection or heat removal function through permanent equipment could still be maintained, additionally, our station has portable equipment such as pumps for those function.

2.2 Fires

As a management of combustible materials, we have managed "what", "where" and "how much" are temporarily stored. This is a legal requirement. Under the new risk management program, based on information such as PRA, we select equipment that is considered important for safety (as follows), and we prohibit the temporary placement of combustible materials near the selected equipment (either in the entire room or within 1 meter).

・Equipment related to LCO (Limiting Condition for Operation).

・Important Equipment (that triggers initiating events etc.) in a shutdown PRA.

・Equipment related to the loss of external power.

2.3 Adverse Effects by Workers

Adverse effects caused by workers include errors in the equipment to being inspected, unexpected contact while transporting materials and so on. Traditionally, we mitigate these risks by using Human Performance Tools and installing fences in front of safety-related control panels and I&C components.

Under the new risk management program, standby systems are displayed in a specific color at the entrance of the building, and additional fences are installed around important systems (as described in 2.2) to indicate no entry area. From the perspective of PRA, systems such as the makeup water system have been included as targets.

In addition, we classify work according to the nature of the work. Work around important equipment, some crane operations, etc. are classified as high-risk tasks, of which the work supervisor is required to identify potential risks and consider risk management actions. The risk management actions are also reviewed by Safety and Systems Engineering Department. The results of these measures are communicated to the field worker.

Figure 1. Display of No Entry Area

3. RISK MANAGEMENT FOR WORK CONTROL

To understand the risk of the entire plant, we check the status of each system and evaluate the Fuel Damage Frequency (FDF). In a plant during shutdown, the status of systems changes daily. To avoid inappropriate maintenance schedule, we manage our operation and maintenance schedule for the FDF not to exceed the threshold. When the FDF exceeds the threshold or remains high over an extended period without exceeding the threshold, risk management actions are implemented.

Such risk information is shared within the station. The main information is “State of systems”, ”FDF”, ”Special risk mitigation measures”, ”Critical systems in the event of earthquake”, “Systems that triggers initiating events in a shutdown PRA”, “Area of scaffolding”. The information is expected to contribute to initial response in case of an accident. (Figure.2,3)

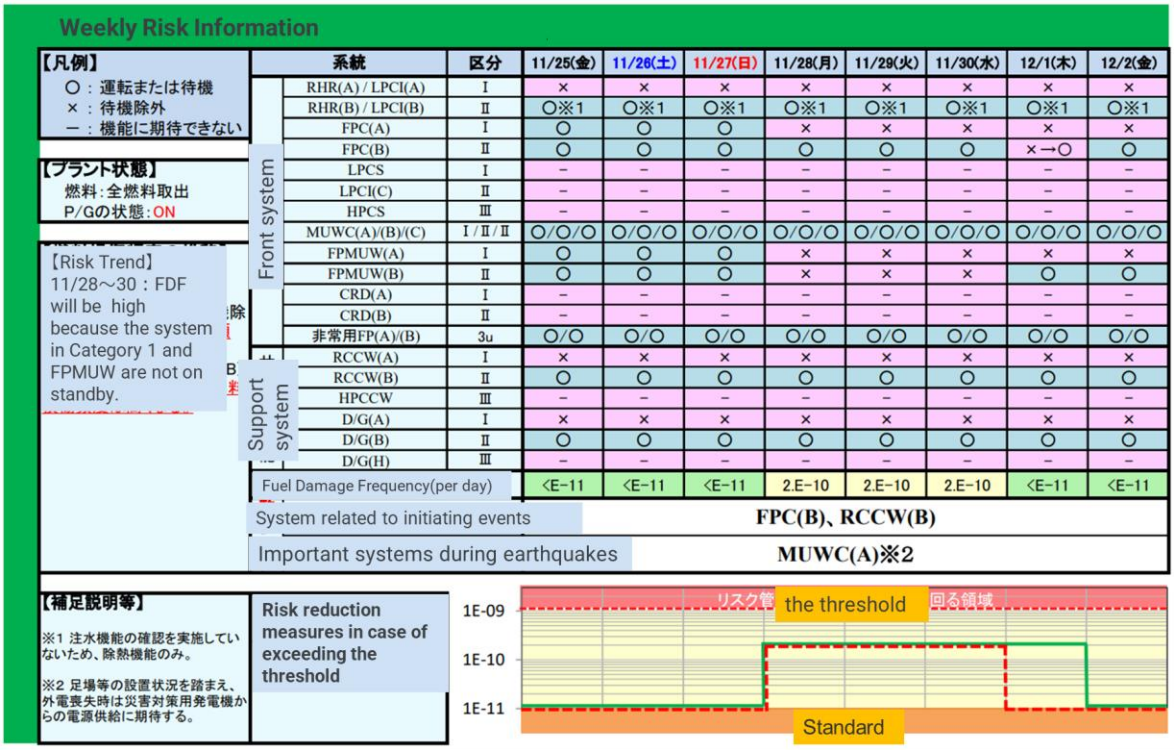

Figure 2.Weeky risk information

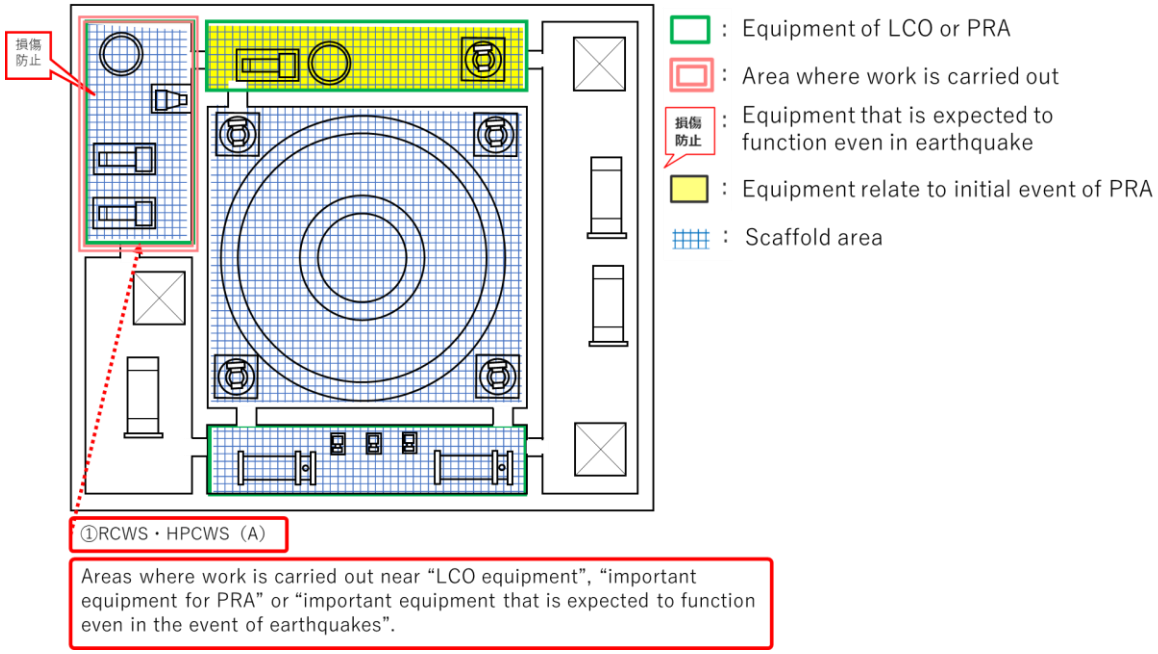

Figure 3. Risk Map

3.1 Example of Work Control

The following examples illustrate the concept of work control.

【Example 1】

Situation

From June to December 2023, the Reactor Cooling Water System (RCWS)(A) vortex strainer swivel valve will be out of service for inspection. As a result, Reactor Component Cooling Water (RCCW)(A) and Diesel Generator (D/G)(A) will also be out of service.

Evaluation and Consideration

The FDF is 5.6E-11(/day), which is below the established threshold(1E-09/day). Additionally, the incremental core damage probability (ICDP) is 9.9E-9 (5.61E-11/d×177day), which is below the provisional threshold(5E-08) that set with reference to U.S. maintenance regulations. Moreover, risk management actions such as power interchange from other units are being implemented. However, for this inspection, risk management strategies are considered due to the extended out-of-service period(at least six months), the potential for an extended factory inspection period due to damage to parts, and the elevated risk of LCO deviation.

Table 2. Risk consideration

Risk	Risk Management Actions
Problems that may lead to loss of functionality of RCCW(B), RCWS(B) and D/G(B) are progressing.	Although there is information on concerns related to the system, we have confirmed that it is not an issue that will lead to loss of functionality.
Perform work that affects RCCW(B), RCWS(B) and D/G(B) adversely during the inspection period.	We confirmed that no work was scheduled that would affect these systems during the inspection period. In addition, we shared that work that would affect these systems should not be carried out during the inspection period.
Due to the extension of inspection period for RCWS(A), the risk of loss of functionality of	In order to ensure work control, the department responsible for inspection management maintains close communication with the contractor. Additionally, if

RCCW(B), RCWS(B) and D/G(B) will increase.	inspection results that lead to schedule changes are confirmed, the information will be promptly shared with related parties.
In cases the RCCW(B), RCWS(B) or D/G(B) loses functionality without a determined response policy, the time for loss of functionality is prolonged.	The response policy was considered as follows. ＜Response Policy＞ ・Promptly restore suspended RCCW(A), RCWS(A) and D/G(A). ・RCWS (A) has the vortex strainer swivel valve drive part removed and automatic cleaning is not possible, so the strainer will be operated by bypass.

【Example 2】

Situation

During the period of example 1 (RCWS(A), RCCW(A), D/G(A) are out of service), an inspection was planned in which the emergency fire extinguishing pump(A) and (B) would be out of service.

Evaluation and Consideration

The FDF was 8.1E-8(/d), which exceeds the threshold(1E-9/d). This is because the emergency fire extinguishing system that does not depend on the reactor component cooling system is of particular importance in a situation where only one reactor component cooling system is on standby. Consequently, the inspection plan for the emergency fire extinguishing system has been changed and will be conducted subsequent to the restoration RCWS(A).

4. PROMOTION OF RISK INFORMATION UTILIZATION

In order to facilitate the utilization of risk information at the station, we are implementing a series of initiatives. As part of these efforts, a Risk Information Utilization Working Group is being established. The Working members are selected from engineering, maintenance, work management, and operations within the station. The specific activities are as follows.

- Sharing and discussion about finding from daily risk management by initiatives in each field. (design/equipment maintenance, work management, operation, work area control)
- Discussion about risk assessment and actions when trouble occurs (equipment malfunction, etc.).
- Planning activities to promote awareness/prevalence of risk information utilization within the station.

5. CONCLUSION

Some risk information utilization practices have been enhanced at the Hamaoka Nuclear Power Station. These utilizations are expected to contribute to mitigation the risk. Additionally, it is believed that an understanding of the significance of risk information utilization is becoming more prevalent among station employees through working groups and educational initiatives.

On the other hand, we think that there are areas that can be improved, such as optimization of maintenance methods/intervals using risk severity and so on. We also upgrade PRA models, which is extremely important information for further implementation of RIDM.

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