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TEPCO's Work Management Initiatives

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ABSTRACT

In order to pursue safety and efficiently manage resources, we are improving our maintenance business process by using information technology (IT) and introducing a work management process (WM process). These efforts have resulted in improvements in managing the duration of safety-equipment unavailability and in addressing non-conformance backlogs.

KEYWORDS

Information technology, Work management process, Performance indicator, Corrective action program

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1. Introduction

Tokyo Electric Power Company Holdings, Inc. (TEPCO) has been reforming its maintenance business process by using improved IT and by introducing WM process referring to the Nuclear Energy Institute (NEI) Standard Nuclear Performance Model (SNPM) [1] and the Institute of Nuclear Power Operations' Action Program (INPO's AP) guidelines such as AP-928 [2] that describe best practices in the United States Nuclear Industry.

In April, 2017, the WM process was applied to maintenance work at Kashiwazaki Kariwa Nuclear Power Plant (KK) Units 1～5, which are in long-term shutdown.The purpose of introducing WM process by referring to the SNPM and INPO's AP guidelines is as follows:

・To pursue safety by developing and adhering to plans that minimize nuclear safety risk and equipment protection risk of maintenance activities.
・To efficiently manage human and material resources, and enhance productivity.

2. TEPCO's Work Management

2.1. Reform of TEPCO's maintenance business process

We have changed our maintenance business process based on WM process that refers the SNPM and INPO's AP guidelines. For each core process of the SNPM, such as work management, operate plant, equipment reliability and configuration management, TEPCO has conducted gap analysis by comparing its existing maintenance business processes with the INPO's AP guidelines together with a supporting process called Corrective Action Program (CAP). Based on the results gained from this analysis, TEPCO has introduced a new business process which the company is continuously improving.

This paper explains about the changes we made to the WM process, one of the core processes mentioned above. Key points of the updated WM process are described below.

1. 7 phases and Milestone
2. Function Equipment Group(FEG)

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3. Work Window(WW)
4. Performance Indicator(PI)

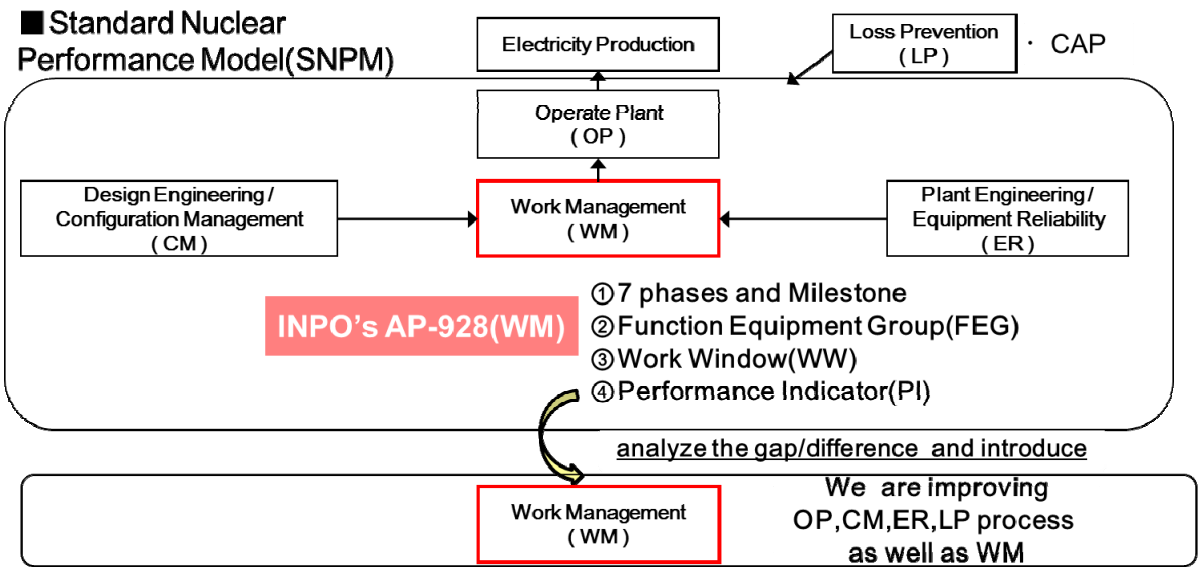

Fig. 1. Gap/difference Analysis with SNPM and INPO's AP-928

2.2. Milestones and Activities in WM Process

WM process is divided into 7 phases and Milestones set up. Milestones are set for each month up to the Execution phase. Figure 2 shows the contents of implementation at each phase of WM.

Equipment maintenance activities are managed by Work Order (WO) utilizing IT system. WO is issued for preventive maintenance, design change request, non-conformance / equipment failure and OE information.

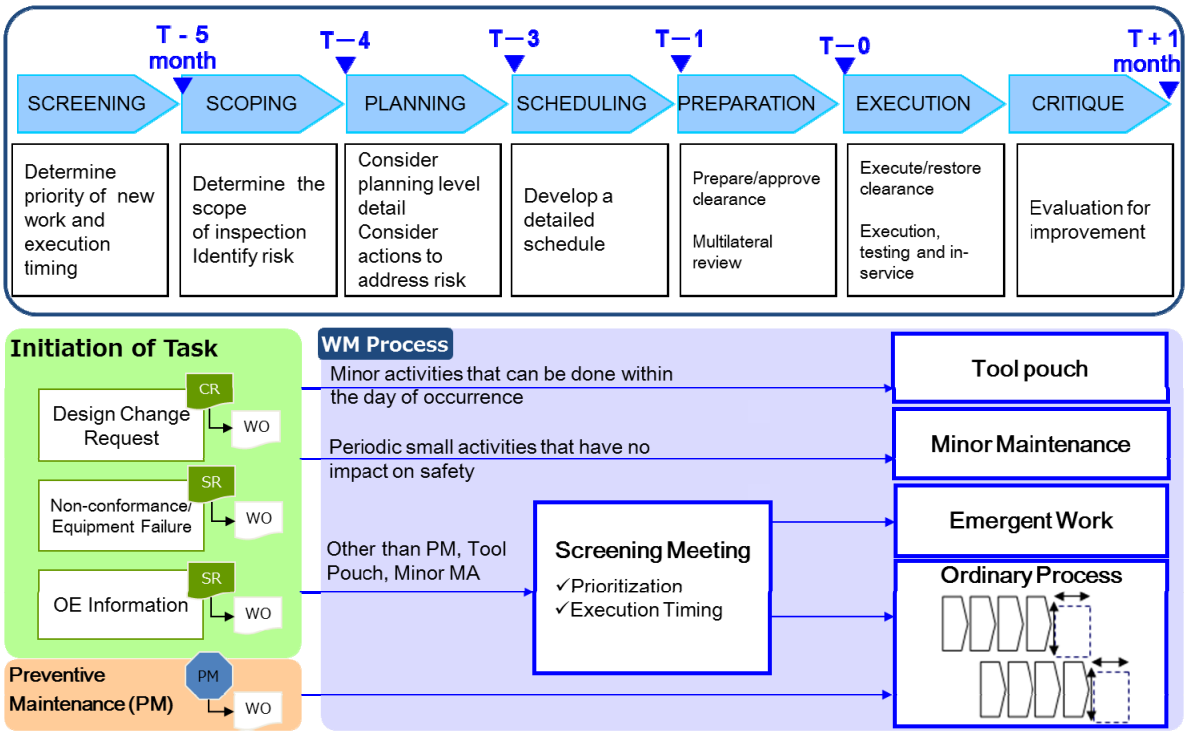

Fig. 2. WM process Model

Figure 3 shows Prioritization Matrix used in Screening phase, which is based on INPO's AP-928. Depending on the Significance and Type of Work, equipment is classified into four priority categories, and target work completion dates set.

Equipment classification Significance of work		Work Type					
		A. Failures/significant deficiencies impacting system function	B. Failures/significant deficiencies not impacting system function	C. Minor equipment deficiencies other than those on the left	D. Functional enhancement/improvement relating to the equipment other than that on the right.	E. Restructuring, functional enhancement/improvement relating to hoisting, measurement and testing equipment.	F. Improvement of structures, support structures, land and tools.
	Weight	10	8	6	5.5	4	3
1) Matters involving functional significance level 1	10	100	80	60	55	40	-
2) Events requiring operator's accident response or enhanced monitoring.	9	90	72	54	50	36	27
3) Matters involving functional significance level 2	8	80	64	48	44	32	24
4) Events causing no changes to loads, but requiring operator's response such to water leak and alarms.	7	70	56	42	39	28	21
5) Matters involving functional significance level 3	6	60	48	36	33	24	18
6) Matters involving functional significance level 4	4	40	32	24	22	16	12
7) Matters outside the scope of maintenance (Events relating to ITV, FEI, admin building facilities, land and tools)	2	-	16	12	11	8	6

Item/Priority	
Corrective Maintenance	CC : 1A,3A CN : 5A CL : 6A
Deficient Maintenance	DC : 1B, 1C,3B,3C DN : 5B,5C DW : 6B,6C

Priority	Target work completion date
1	(100-90) = Immediate response
2	(89-70) = Complete within 1 month
3	(69-42) = Complete within 3 month
4	(41-1) = Complete within 6 month

Fig. 3. Prioritization Matrix

2.3. WM Process and IT Support

An EAM software was introduced in 2014 to provide IT support for WM, Facility and Corrective Action Program (CAP). An EAM software uses Work Order (WO) to manage status of maintenance work plan by each equipment, and is also used to accumulate Operating Experiences and work records.

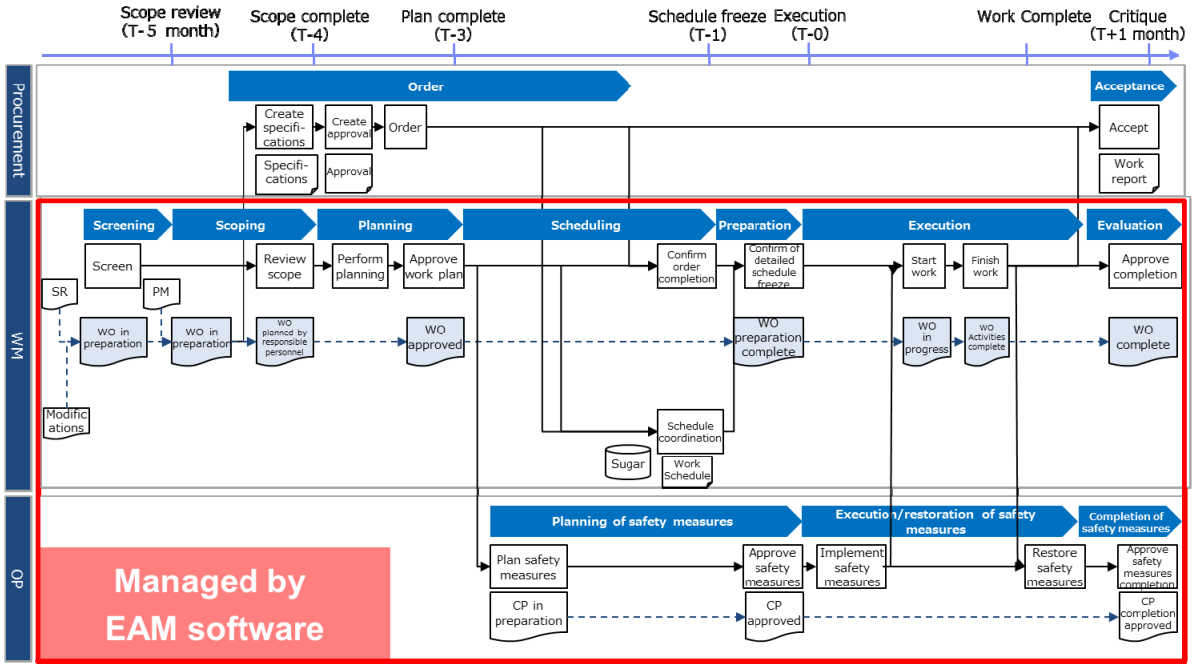

Fig. 4. WM process and IT Support

2.4. Development of Functional Equipment Group（FEG）

A functional equipment group (FEG) is defined as "a group consisting of a main component and subcomponents, within shared isolation boundary or fixed position". Isolation boundary is defined by work duration, target, function, content of work, etc. with all activities performed within the defined boundary. Equipment in FEG is maintained at once during the execution phase.

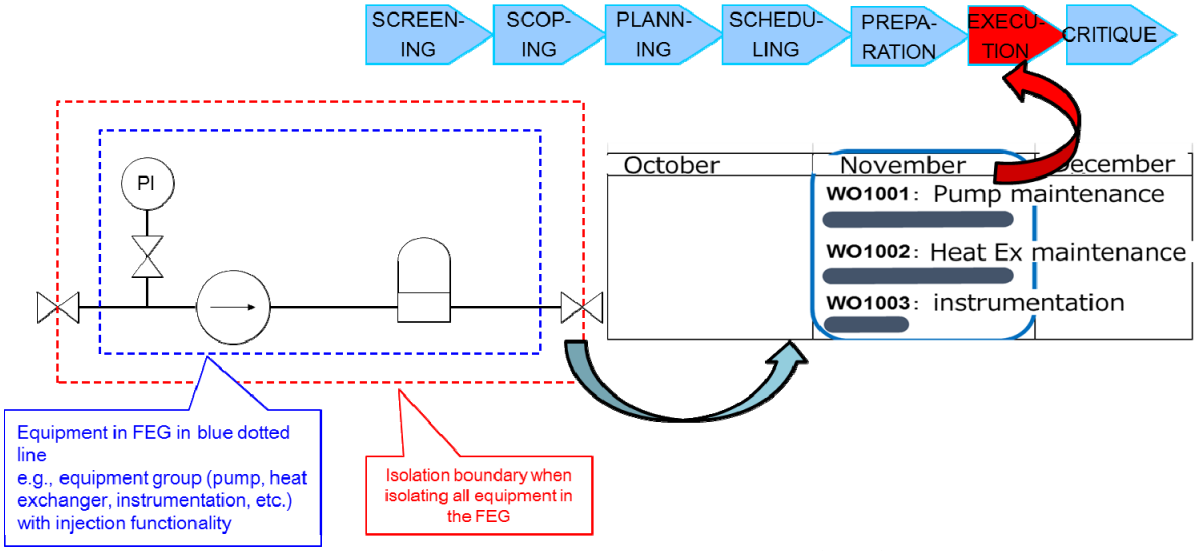

Fig. 5. Functional Equipment Group（FEG）

2.5. Work Window（WW）Establishment

WW is a work period. Equipment is allocated to WW by FEG. Duration of a WW is one month and One WW cycle is one year. The time frame during which safety systems and power supply facilities are set out-of-service is assigned to WWs.

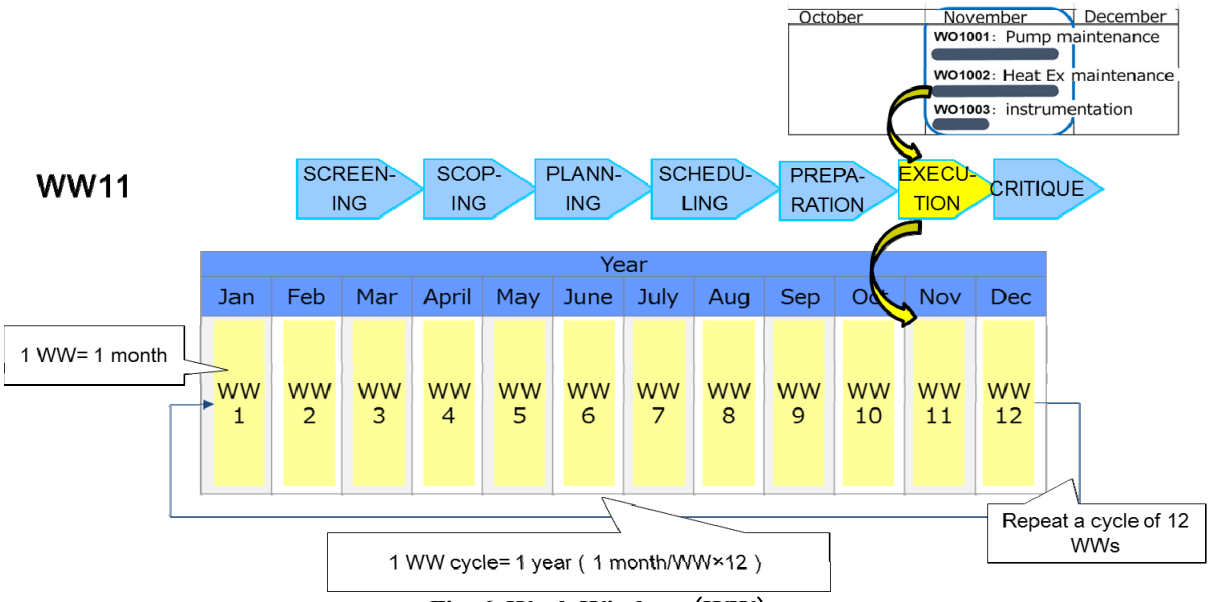

Fig. 6. Work Window（WW）

2.5.1. Safety Systems taken out of service at KK unit 1-5

Figure 7 shows safety systems A/B at KK units 1-5 assigned to WW to minimize D/G unavailability. When assigning to WW, following two points are carefully considered.

Point1 : Systems A/B are not removed from service at the same time to avoid loss of loading function. To prevent systems A/B being out of service simultaneously, an interval is secured in case the out-of-service duration is extended.
Point2 : System B of other unit is not assigned to a WW following a WW during which system B of a given unit is out of service. By that, we avoid four D/Gs being out of service in case the out-of-service duration is extended.

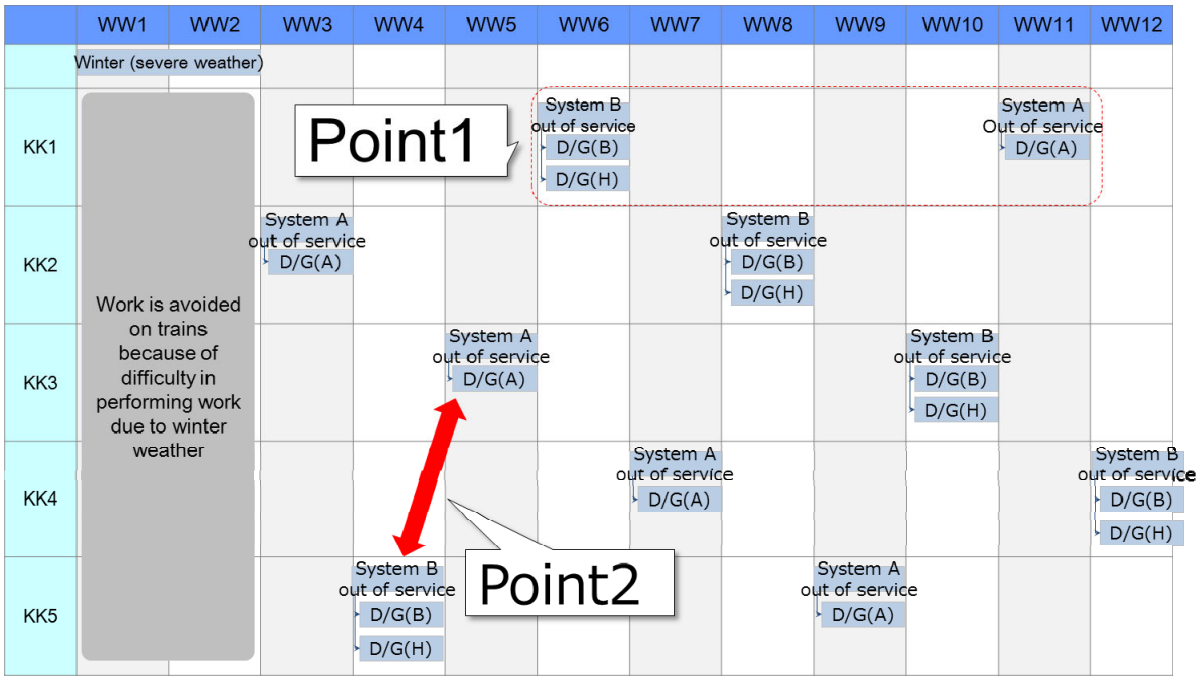

Fig. 7. KK units 1-5 safety systems A/B are assigned to WW to minimize D/G unavailability

2.6 Evaluation by Performance Indicator

During critique phase, we evaluate responses to safety risks, effectiveness of the process, and lessons learned, in order to utilize the results in our next planning. Effectiveness of the process is evaluated by following Performance Indicators (PIs). These PIs are counted up using IT system.

Table 1 Example of Performance Indicator (PI) for KK Units 1-5

PI for managing the duration of safety-equipment unavailability
Unavailability rate of HP/LP systems and emergency power supply during plant shut-down
PI for schedule adherence
Schedule completion rate (% of work completed by the end of WW duration)
Percentage of emergent work (% of additional work after the schedule freeze)
Scope/Schedule stability (% of Scope/Schedule change after the scope freeze)
PI for managing non-conformance backlogs
Average of days from the occurrence of CM/DM to the completion of action
Average of CM/DM backlogs to be implemented during long-term shutdown

2.6.1. Evaluation of Past Performance

Figure 8 shows PI: Unavailability rate of HP/LP systems and emergency power supply during plant shut-down. In 2017 when we launched WM, the PI was exceeding target. However in 2018 WM process was established at KK site, and the PI showed improvement.

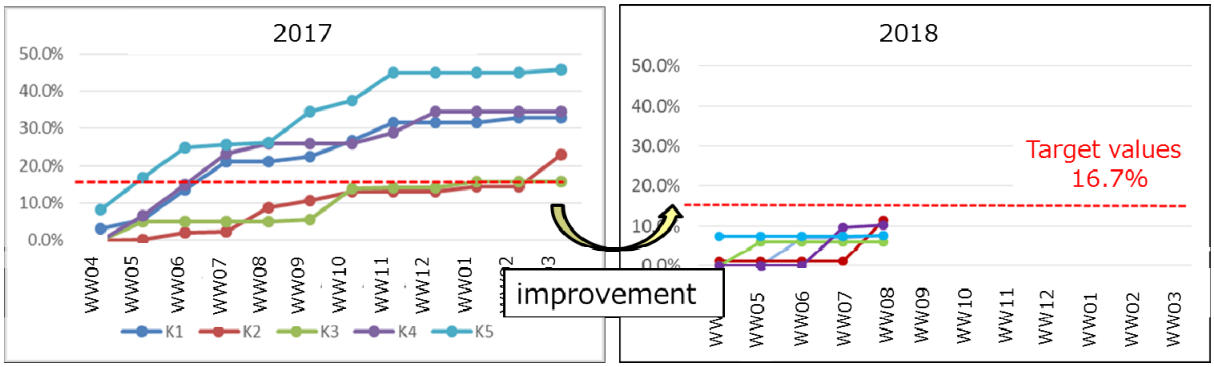

Fig. 8. PI：Unavailability rate of HP/LP systems and emergency power supply during plant shut-down

3. Conclusion

TEPCO has conducted gap analysis by comparing its existing maintenance business processes with the INPO's AP guidelines and has arranged WM process flow, PI, duration of a WW etc. to fit our business processes.

Efforts we placed on work management have resulted in improvements in setting and managing the duration of safety-equipment unavailability and in addressing non-conformance backlogs, which we believe to have contributed to enhanced safety. TEPCO is determined to continuously make improvements to minimize safety risks and to improve efficiency by managing risks.

References

[1] Electric Utility Cost Group: EUCG Standard Nuclear Performance Model (2007).
[2] Institute of Nuclear Power Operations: Online Work Management Process Description, INPO's AP-928 (2016).