Development and Utilization of RIDM Guide

Nuclear Risk Research Center
Manabu WATANABE

© CRIEPI 2026

CRIEPI Central Research Institute of Electric Power Industry

Contents

1. Risk-Informed Decision-Making Overview
2. Risk-Informed Decision-Making Background and Gaps
3. Efforts to Overcome the Gaps
4. Research Results
   (1): Establishing On-line Maintenance Methods
   (2): Trial Evaluation of Extended Containment Vessel Leak Rate Test Interval
5. Current Achievements & Future Actions

[Appendix] Progress in Overcoming Gaps

[Appendix] Status of Initiatives

© CRIEPI 2026

1. Risk-informed Decision-Making Overview

- **In the preceding presentations**, NRRC's efforts and achievements in developing PRA technologies have been presented.
- In this presentation, I would like to address NRRC's efforts to establish methods for making decisions about safety management activities at nuclear power plants using utilizing risk information, which are insights gained from PRA. MW1

Current Achievement MW2

✓ Support for Improving the Quality of Internal PRA Models
✓ Seismic PRA Methodology Development and Plant Applications
✓ Tsunami PRA Methodology Development and Plant Applications
✓ Development of Methodologies for Internal Fire and Flooding PRAs and Plant Applications
✓ Level2 PRA Methodology Development and Plant Applications
✓ **Development and Utilization of RIDM* Guide**

* RIDM: Risk-Informed Decision Making

© CRIEPI 2026

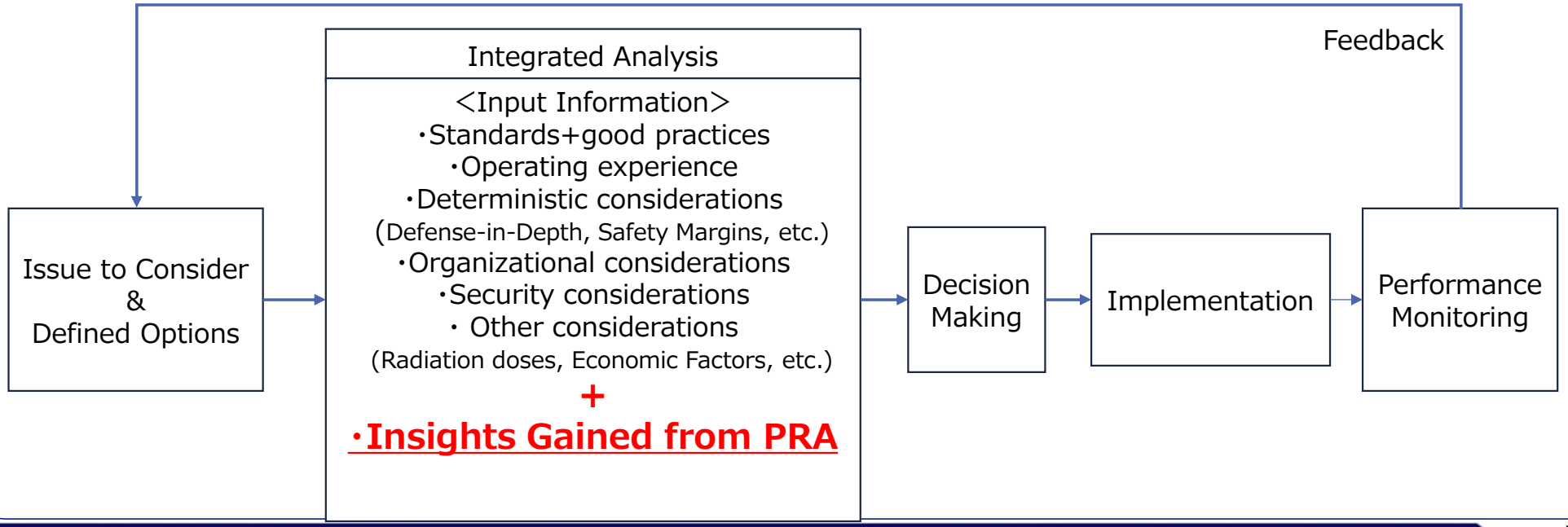
スライド 3

MW1 メモ）
保安活動
NPP maintenance→safety management activities at NPPsに変更
Manabu Watanabe (渡邊 学),

MW2 PRA about risk→PRA
と修正
Manabu Watanabe (渡邊 学),

1. Risk-informed Decision-Making Overview

- **RIDM: Risk-Informed Decision-Making :**
  Approach to decision-making that integrates insights gained from PRA with those derived from conventional deterministic analyses. RIDM enables organizations to focus on safety-significant issues, thus promoting more effective and appropriate safety management.
- **Key Benefits of Utilizing PRA Insights**
  - ✓ Comprehensively and realistically identifying how accidents may progress reveals plant vulnerabilities.
  - ✓ Quantitative results enable effective prioritization of resources and safety improvements.



1. Risk-informed Decision-Making Overview

- Risk-informed decision-making is broadly applied in the United State.

Work Control: Maintenance planning, shutdown safety

Operation: Changes to technical specifications (allowed outage time, surveillance frequency)

Regulatory assurance: Regulatory inspections (significance determination process, license amendment requests)

Maintenance programs: In-service inspections, maintenance management (including on-line maintenance)

Engineering: Changes to SSC categorization, extended power uprate, license renewals

© CRIEPI 2026

2. Risk-Informed Decision-Making Background & Gaps

■Background

- In the United States, risk-informed approaches have been established for modifying plant operations and designs. These have been broadly applied, including to cases where licenses have required amendment, and demonstrated to contribute to improved safety and operational performance.
- Based on lessons learned from the accident at Tokyo Electric Power Company's Fukushima Daiichi Nuclear Power Plant, Japanese operators decided to introduce risk-informed decision-making as a means for furthering safety beyond mere regulatory compliance.

■Gaps to Overcome

- Little experience in Japan in making and implementing decisions based on risk information about plant operation and design modifications, and such specific methods have been hardly established.

MW1

© CRIEPI 2026

スライド 6

MW1 No ～methods have been established
→such specific methods have been hardly established.
と修正。全くないわけではないので。
Manabu Watanabe (渡邊 学),

3. Efforts to Overcome Gaps

■Establishing Methods for Risk-Informed Decision-Making

- NRRC discussed priorities with operators and started developing the following implementation methods with reference to practices in the United States where risk-informed approaches are broadly.
  - Establishing for on-line maintenance methods
    ⇒ [Research Result (1)]
  - Trial Evaluation of extended containment leak rate tests intervals
    ⇒ [Research Result (2)]
  - Trial Evaluation of risk-informed in-service inspections of piping and resolution of related issues
  - Development of practical guidance for integrated risk assessments

MW1

■Training Personnel in Risk-Informed Decision-Making

- Training program on risk-informed decision-making led by U.S. expert instructors with extensive practical experience

スライド 7

MW1 全体的に修正
Manabu Watanabe (渡邊 学),

4. Research Result (1) : Establishing On-Line Maintenance Methods

■ Background

- On-line maintenance (OLM) refers to the maintenance of equipment while a plant is operating.
- Japan's current regulations do not permit preventive maintenance on safety-related equipment during plant operation.
  → Concentrating maintenance work during plant shutdowns poses certain drawbacks.
- OLM provides the following benefits so it is expected to improve the quality of maintenance work:
  - Work is performed year-round, making it easier to secure a permanent workforce.
  - Work congestion is avoided, skilled workers optimally utilized, etc.

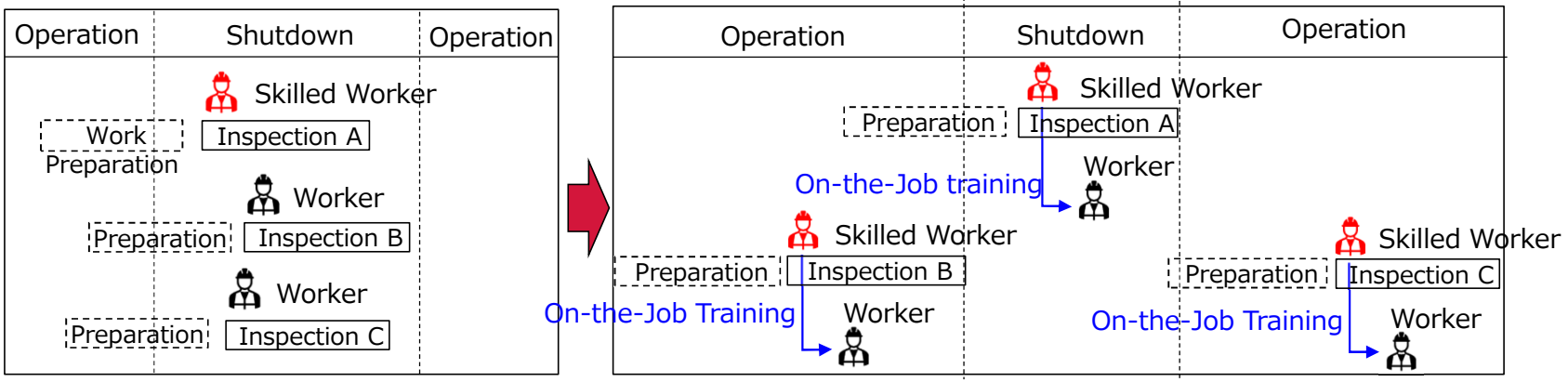


Illustration of How OLM Levels Work

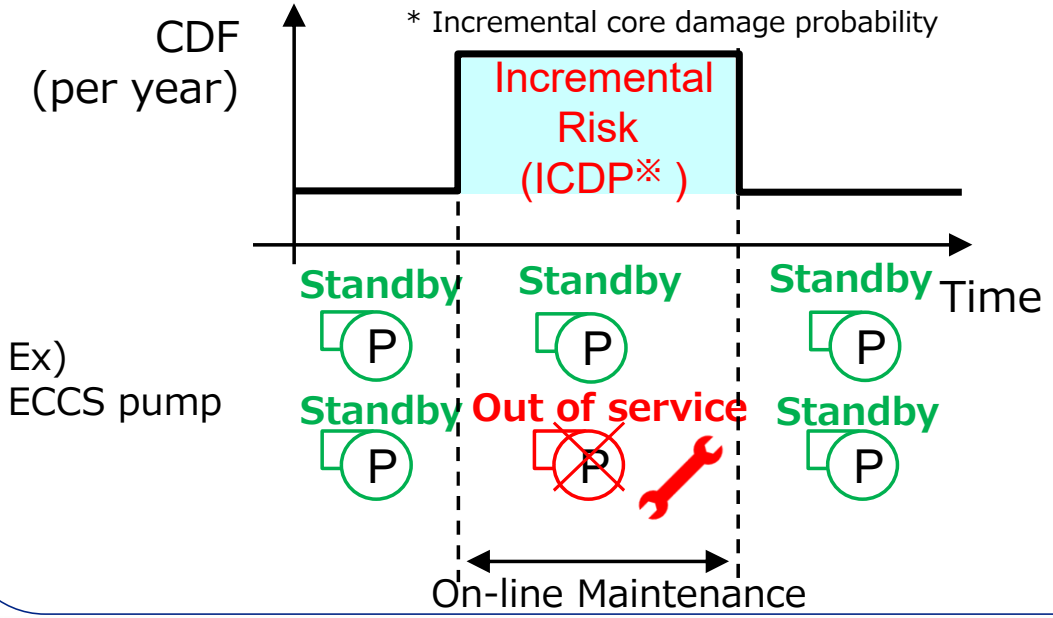
4. Research Result (1) : Establishing On-line Maintenance Methods

■ Summary of Results

- NRRC developed guidelines that include assessing risks associated with maintenance work (equipment becoming inoperable, etc.) and establishing risk management measures commensurate with the risk level with reference to U.S. practices, where OLM is widely implemented.

MW1

□ Risk Assessment



□ Risk Management Measures

Risk Level	ICDP	Definition of Risk Levels and Examples of Measures
Red	$>10^{-5}$	Level at which no on-line maintenance is performed
Yellow	$\leq 10^{-5}$	Level at which on-line maintenance is performed subject to **risk compensatory measures to assure functional integrity** Ex) Pre-staging deployment of mobile water injection trucks
White	$\leq 5\times10^{-6}$	Level at which on-line maintenance is performed in conjunction with **risk management measures** Ex) Restricting access to areas around risk-significant equipment
Green	$\leq 10^{-6}$	Level requiring risk management in accordance with **standard work procedures**

MW

スライド 9

MW1 全体的に表現を見直し。
Manabu Watanabe (渡邊 学),

MW2 見直し
Manabu Watanabe (渡邊 学),

4. Research Result (1) : Establishing On-line Maintenance Methods

■Application of Research Results

- In FY2023, industry proposed introducing on-line maintenance (and provided an explanation of on-line maintenance guidelines).
- In FY2025, in the presence of Nuclear Regulation Authority inspectors, the guidelines were applied and demonstrated on-site.
- In March 2026, the Nuclear Regulation Authority approved the introduction of on-line maintenance.
- On-line maintenance is expected to be implemented according to NRRC's guidelines after relevant internal regulations are amended MW1

MW2



Replacing lubricating oil

Scene of on-site demonstration at Ohi Power Plant Unit 3 [1]

スライド 10

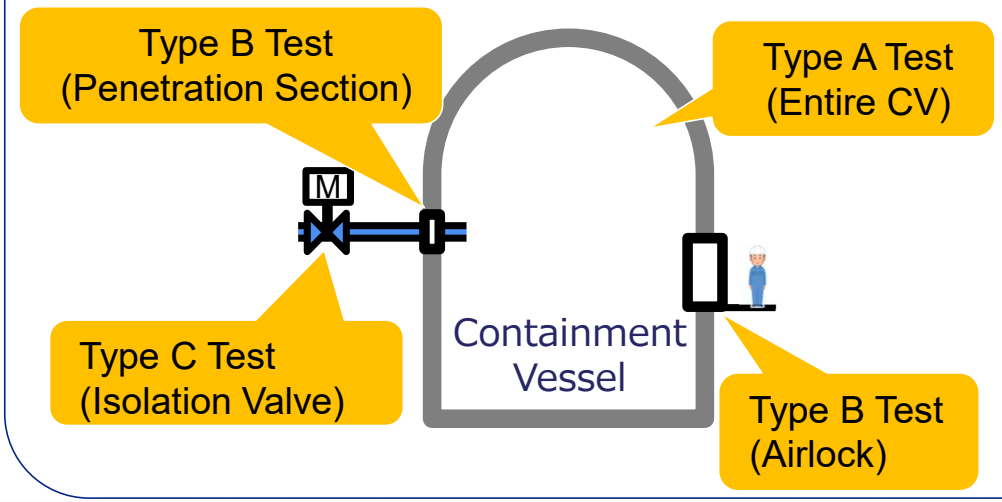
MW1 These→NRRC’s
に変更。明確化。
Manabu Watanabe (渡邊 学),

MW2 この後ろにあった余計な文を削除。
Manabu Watanabe (渡邊 学),

5. Research Result (2): Establishing Methods for Extending Containment Leak Rate Test Intervals

■ Background

- Containment vessel leakage rate test is a test where the entire or a portion of the containment vessel is pressurized to confirm that the leak rate is below a specified limit.
- In Japan, Type A tests, which measure overall containment leakage, are conducted every outage or once every three outages in accordance with the Japan Electric Association testing code (JEAC4203).
- Optimizing the testing interval is expected to reduce the risks associated with the tests (see below) and improve plant safety.



Risks Associated with Type A Tests

Following changes in plant configuration for testing

- ✓ Isolation of instrument air system
- ✓ Disconnection of fire detectors
- ✓ Protective covering over equipment

Risks such as equipment damage or failure to restore systems due to human error

スライド 11

MW1 追加
Manabu Watanabe (渡邊 学),

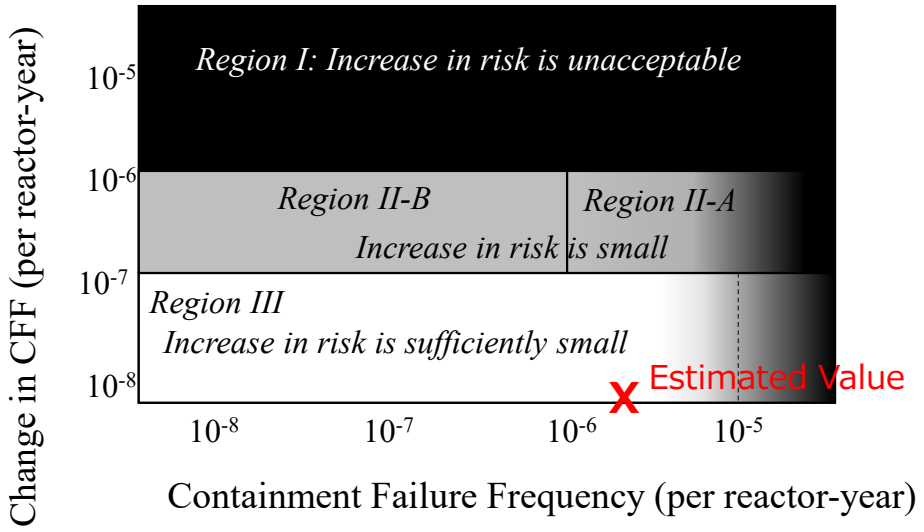
5. Research Result (2): Establishing Methods for Extending Containment Leak Rate Test Interval

■ Summary of Results

- NRRC referenced U.S. practices where test intervals are extended up to a maximum of once every 15 years and presented a method for determining whether test intervals may be extended. We demonstrated that extending the test interval is acceptable based on trial evaluation results for a representative domestic plant.
- Our study demonstrated that an increase in containment failure frequency (CFF) resulting from extending the test interval is acceptable from the standpoint of risk assessment.

[Risk Assessment Process]

Consolidate Type A Test Results for 34 Reactors in Japan
(376 total tests, with 0 leakage incidents)
↓
Estimate frequency of containment leaks
↓
Evaluate changes in the containment leak probability
when Type A test interval is extended
(Figure at right shows interval extended from once in 3 outages to once every 15 years)
↓
Evaluate change in Containment Failure Frequency (ΔCFF)



Sourced from Reference [2], with additional values added

Risk Assessment Results from a representative Domestic Plant

スライド 12

MW1 Typical plants→ a representative plant
に変更。
Manabu Watanabe (渡邊 学),

MW2 Feasible→acceptable
に変更。物理的に実施可能ということでなく、リスクが許容されるというニュアンス。
Manabu Watanabe (渡邊 学),

MW3 representativeに変更
Manabu Watanabe (渡邊 学),

5. Research Result (2): Establishing Methods for Extending Containment Leak Rate Test intervals

■Application of Research Results

- Public review has been completed of the revised Containment Leak Rate Test Code (JEAC4203), which allows the Type A test interval to be extended from the current “once every three scheduled outages” to “once every 10 years,” based on actual test results. The JEAC4203 is currently being prepared for publication.
- Our MW1earch findings are cited in the JEAC4203 annotated notes as results detailing risk impact assessments for extending the test interval.

© CRIEPI 2026

スライド 13

MW1 追加
Manabu Watanabe (渡邊 学),

6. Current Status & Future Actions

■ Current Achievements

- NRRC established a method for implementing on-line maintenance. Its introduction has been approved by the Nuclear Regulation Authority, and expected to be implemented following revision of relevant internal regulations.
- NRRC presented a method for using a risk-informed approach to determine whether to extend the containment leak rate test interval. A trial evaluation based on this method demonstrated the acceptability of extending the interval.
- A revised Containment Leakage Rate Test code (JEAC4203), incorporating the risk impact assessment annotating NRRC findings, is expected to get reviewed by the Nuclear Regulation Authority. MW1

■ Future Actions

- Pilot evaluations of risk-informed in-service pipe inspections will be conducted at representative plants, and efforts will be made to resolve issues faced in domestic implementation.
- Furthermore, operators' plans for risk-informed applications will be collected, and specific methods and guidelines for those applications will be developed as necessary. MW2

© CRIEPI 2026

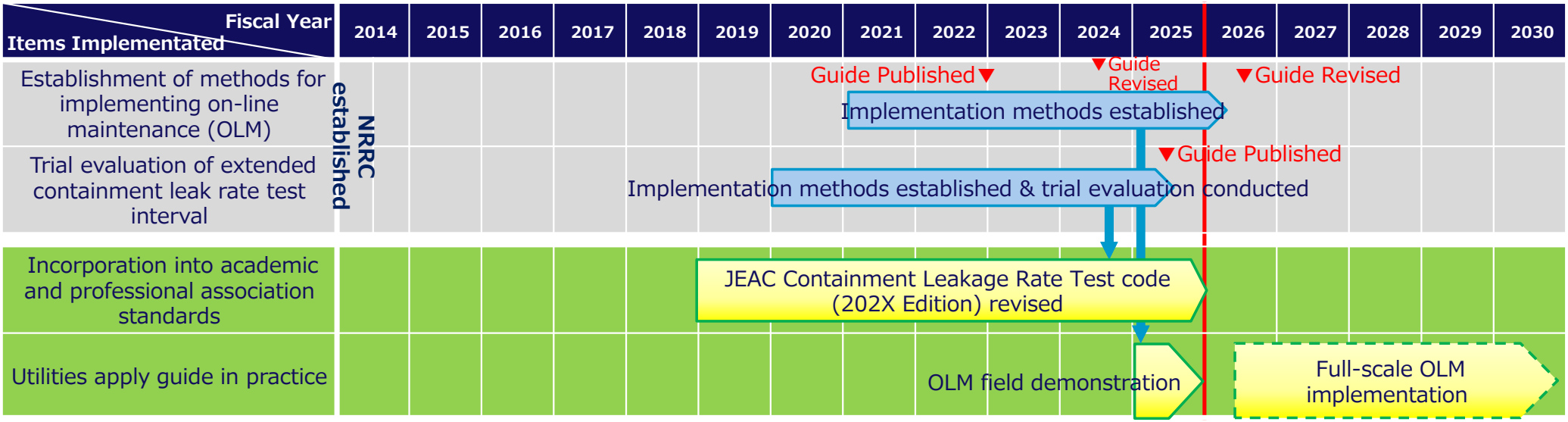
スライド 14

MW1 Feasiblity→acceptability
Manabu Watanabe (渡邊 学),

MW2 全体的に見直し。
Manabu Watanabe (渡邊 学),

[Appendix] Progress in Overcoming Gaps

- Risk-informed decision-making methods for On-line maintenance and extension of containment leak rate test interval have been established. MW1



スライド 15

MW1 見直し。
Manabu Watanabe (渡邊 学),

[Appendix] Status of Initiatives

Gaps to overcome	Description	Progress
Establishing Method for Risk-Informed Decision-Making	Establishing methods for implementing on-line maintenance (OLM)	Completed in FY2023
	Establishing methods for extending containment leak rate test intervals	Completed in FY 2025
	Development of practical guidance for integrated risk assessment	To be implemented by FY 2026
	Pilot evaluation of risk-informed in-service inspections of piping, and proposals for resolving issues to facilitate implementation	To be implemented through FY 2028
Training Personnel in Risk-Informed Decision-Making	Implementation of training program on risk-informed decision-making led by U.S. expert instructors with extensive practical experience	Ongoing

© CRIEPI 2026

[Appendix] References

[1] Kansai Electric Power Co., Inc., “Report on the Third On-Site Demonstration of OLM at Kansai Electric Power’s Ohi Power Plant Unit 3” (February 24, 2026, meeting with the Nuclear Regulation Authority; Document 1-1)

[2] The Atomic Energy Society of Japan, “Implementation Standard Concerning Integrated Risk-Informed Decision-Making for the Continuous Safety Improvement in Nuclear Power Plants: 2019” (AESJ-SC-S012)

© CRIEPI 2026