Lessons Learned through Regulatory Activities associated with Longer Life Operation of Japanese LWRs beyond 30 year

Regulatory Information Conference 2010
Session : License Renewal Program Improvements
March 10, 2010

TORU OSAKI
Aging and Material Reliability Evaluation Group
Japan Nuclear Energy Safety Organization（JNES)

Contents

- JNES in Japanese regulatory framework
- Regulatory system for operation beyond 30 year
  - LWRs operating beyond 30 year
  - Long-Term Maintenance Management Policy
  - Role of JNES - Technical Review by JNES
- Lessons Learned
  - Metallic Component - Electrical Equipment
  - Concrete Structure - Seismic Safety
  - 1ST PDCA of Tsuruga#1
- Summary

JNES in Japanese Regulatory Framework

Regulatory Authorities

Nuclear Safety Commission (NSC)
Oversight of regulatory activities,
Examination guides,
Regulatory investigation, etc.

Nuclear and Industrial Safety Agency (NISA) in METI
Nuclear Power Plants,
Nuclear fuel cycle facilities,
Radioactive wastes

MEXT
Research Reactors,
Radiation applications
Nuclear material safeguards

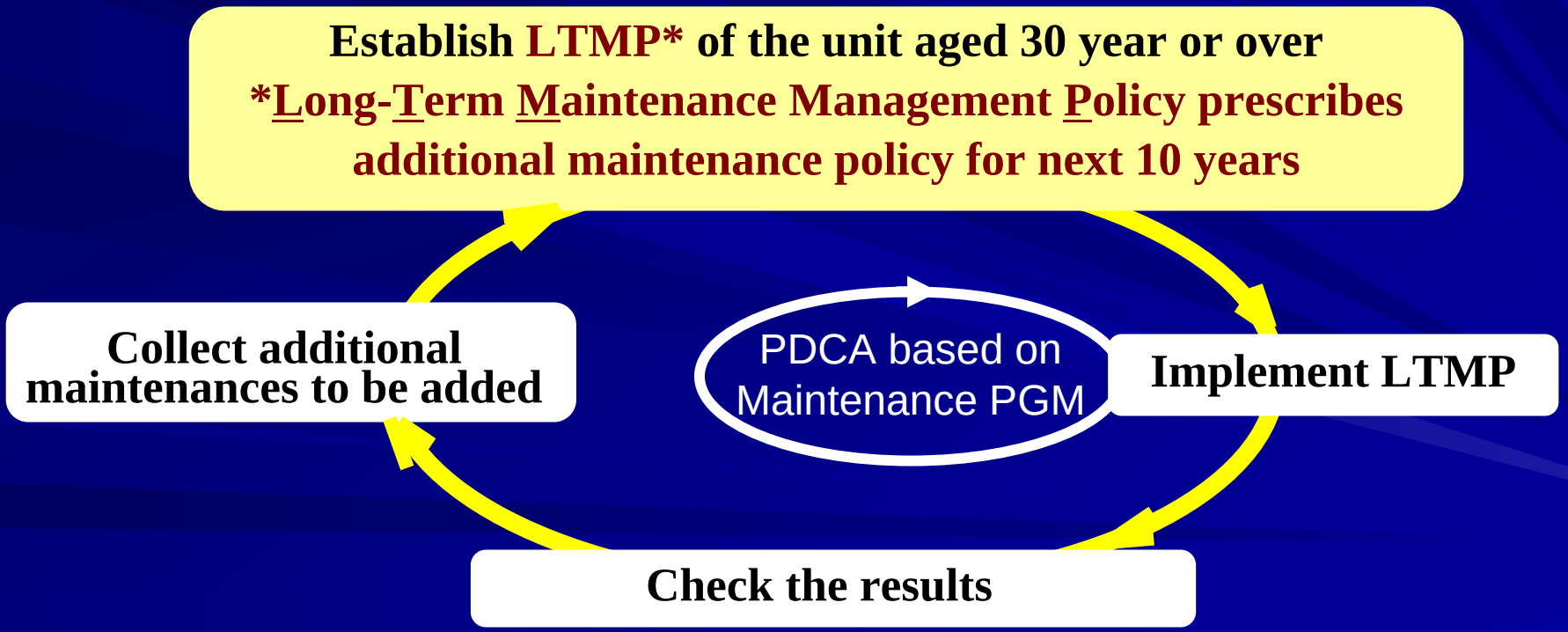
Technical Support Organization (TSO)

Incorporated Administrative Agency

JNES
(460 staffs)
Inspection, Safety analysis,
Safety research, Seismic safety,
Emergency preparedness, etc.

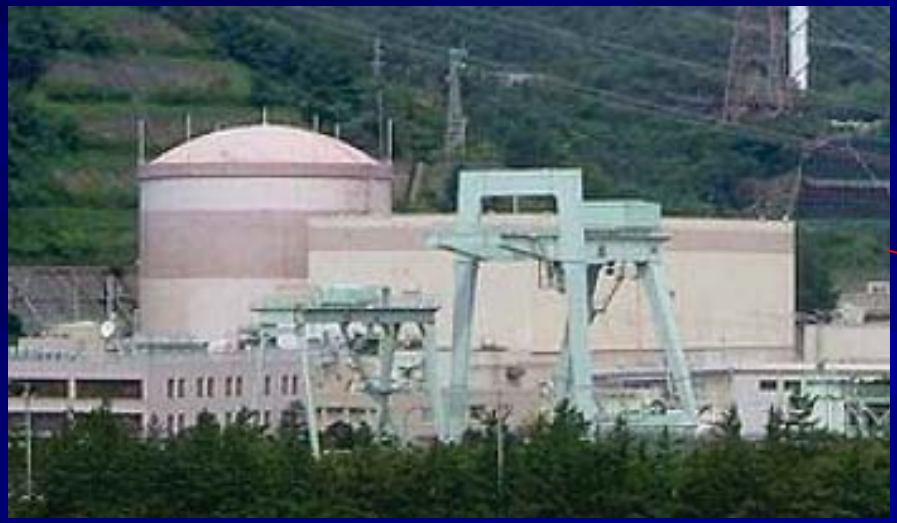
Regulatory system for operation beyond 30 year

For operating a LWR beyond 30 year, licensee is required to run PDCA cycle based on LTMP* , additional to the that based on the maintenance program for every fuel cycle.
Some lessons learned identified through the technical review of the activities based on LTMP are presented.



LWRs operating beyond 30 year

Tsuruga#1 operated about 40 years since 1970, and is about to start 2nd PDCA cycle based on the revised LTMP.
17 LWRs are on the way of the 1st PDCA cycle based on LTMPs.

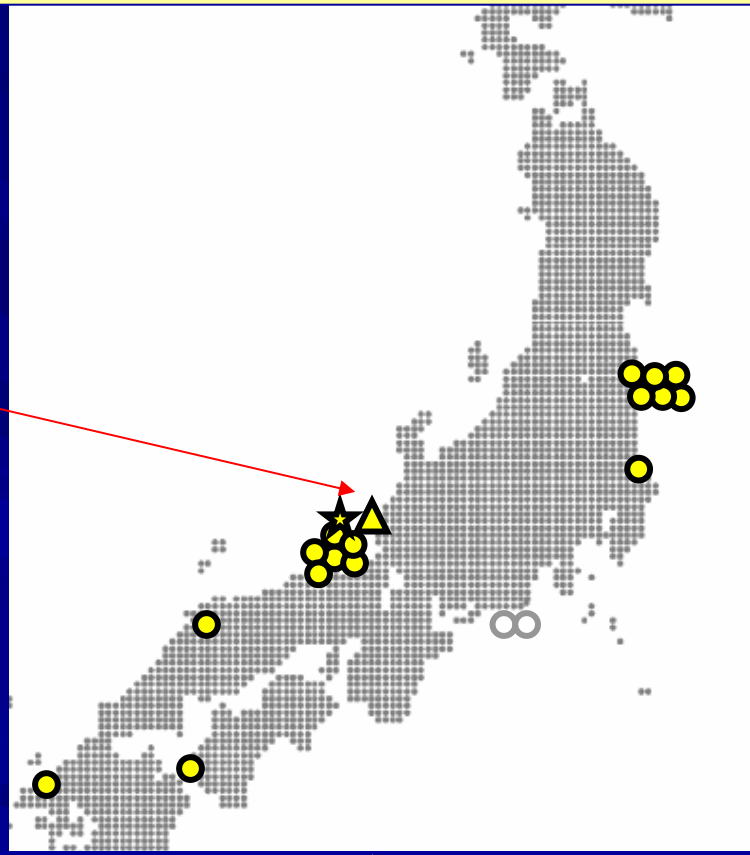


Tsuruga#1

Reactor Type : BWR

Electric output : 357 MW

Commercial operation since 1970/3



LTMP(40y-50y) BWR△, PWR☆ under revie
LTMP(30y-40y) BWR/PWR ☆○

Long-Term Maintenance Management Policy

LTMP is added in the operational safety program of LWRs which is operated beyond 30 year.

Samples identified in LTMP

- ×× type electrical penetrations to be replaced within ×× years
- Maintenance reflecting the expected results of the ongoing ×× research to be introduced within 10 years

Role of JNES

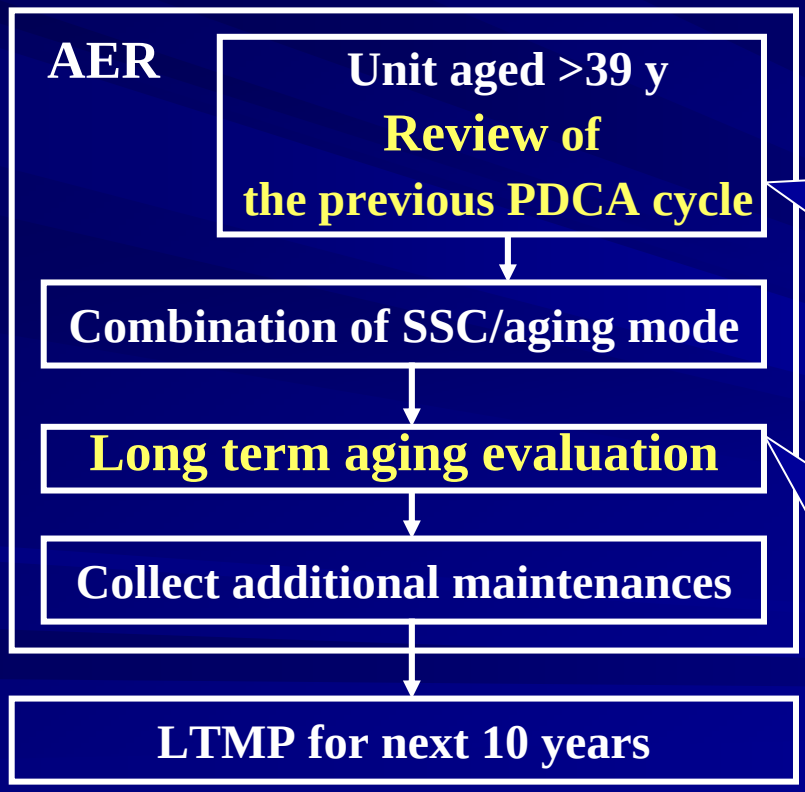
JNES carries out technical review of LTMP submitted for NISA's approval, through the examination of Aging Evaluation Report (AER) , which is the attached technical base of LTMP.
JNES follows up the implementation of LTMP.

Licensee	**Submit the revised operational safety program to NISA, which contains the new or revised LTMP attached by AER**
N I S A	**Examine / Approve LTMP, Check its implementation**
	Request technical review of LTMP/AER to JNES based on NISA's guide and Standard Review Plan
J N E S	**- Technical review of LTMP/AER using JNES review manuals** **- Follow up the implementation of LTMP** **- Research on material degradation, structural integrity, etc.**

Technical Review by JNES

Review the adequacy of LTMP for the continued operation beyond 30 year of LWRs for next 10 year, based on the TLAA results and the operational/maintenance performance.

TLAA: Time Limiting Aging Analysis (targeting 60 year)



major review points

New data of the unit in the past 10years

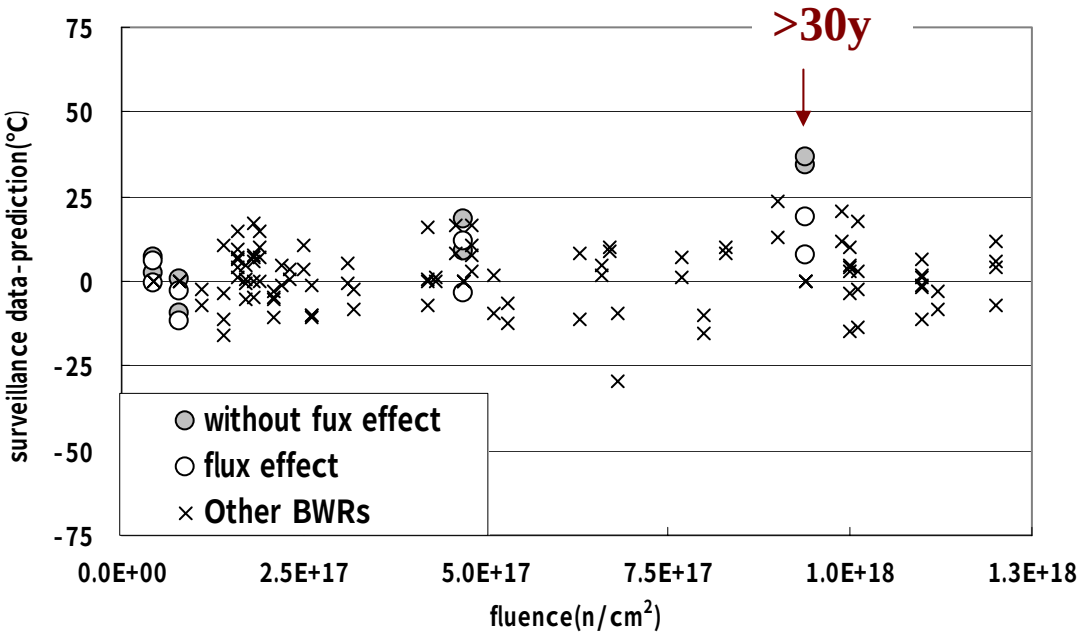
- **aging related events**
- **Inspection/monitoring data**

Long term prospect of structural integrity or functional performance

- **TLAA targeting 60 years**
- **Extrapolation of operational and maintenance performance**

Lessons learned : metallic component

TLAA is required for low cycle fatigue in water environment, irradiation embrittlement of RPV, irradiation assisted stress corrosion cracking, and thermal aging of cast stainless steel. The surveillance test data of RPV was found to be beyond the prediction at 30 years. The knowledge to date explained the reason, and the prediction was revised appropriately



●×prediction at 30 year without flux effect

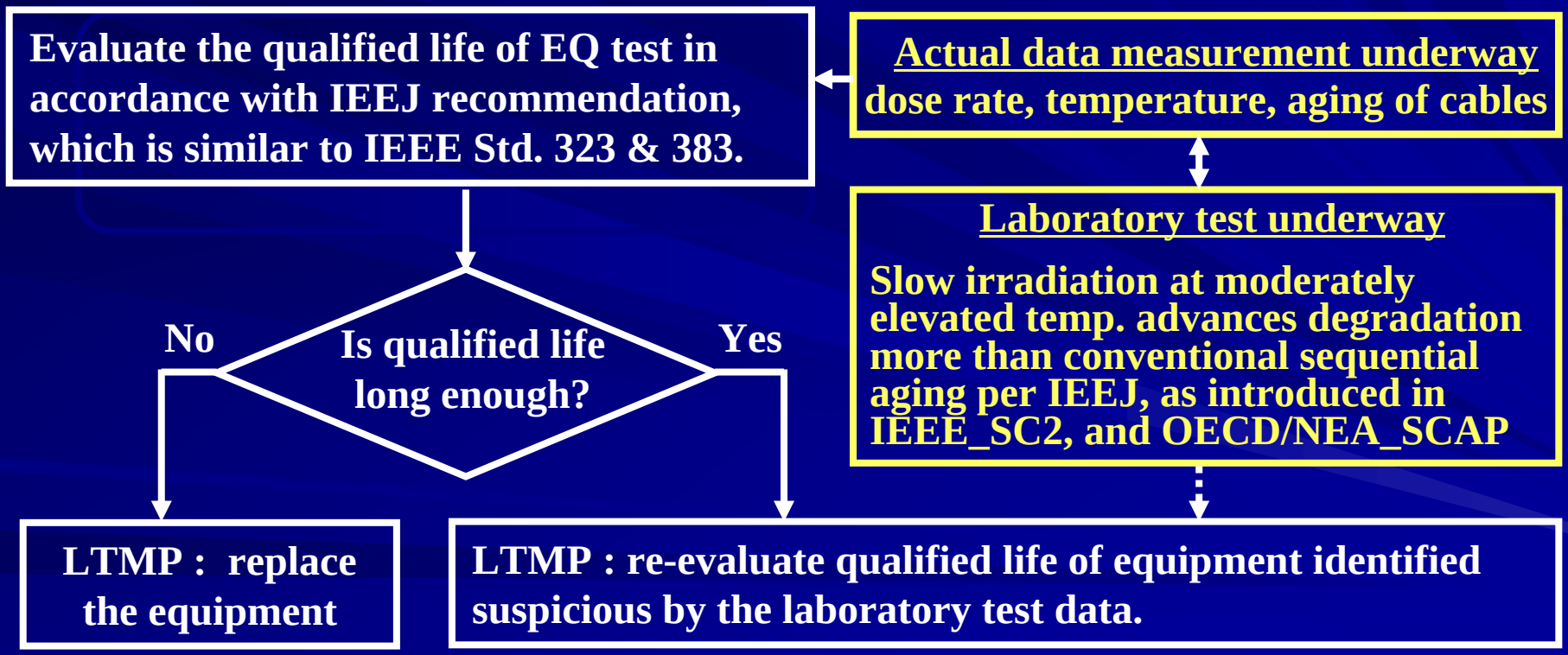
↓

○ with flux effect

Transition temperature shift of surveillance test deta of BWRs

Lessons learned : electrical equipment

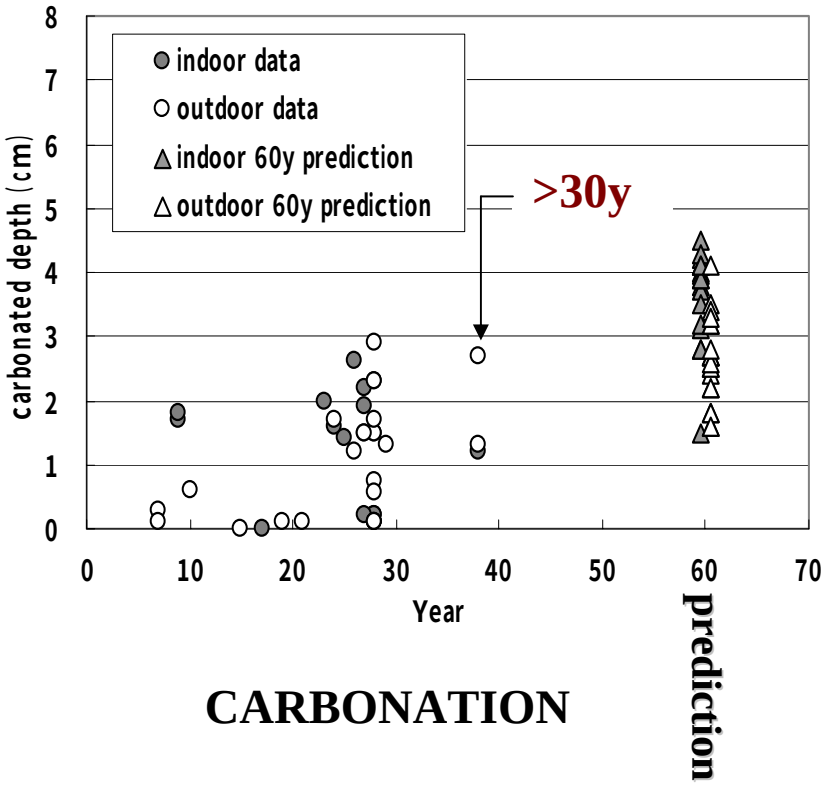
Qualified life of cables and electrical equipment by EQ test is evaluated based on the IEEJ recommendation.
Even if evaluated life is long, it is to be re-evaluated reflecting the ongoing laboratory test, which are indicating insufficient aging simulation of IEEJ recommendation.



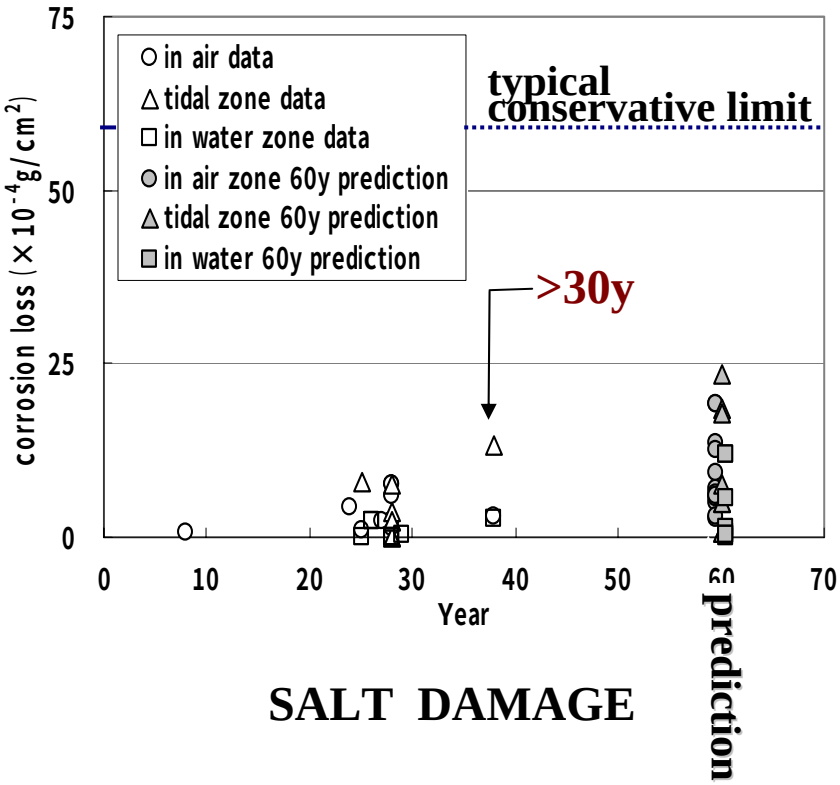
Lessons learned : concrete structure

Major factors of concrete aging are irradiation, high temperature, carbonation, and salt damage.

Cracking due to rebar corrosion by carbonation and/or salt damage is not likely based on the actual data even at 60 year.



CARBONATION

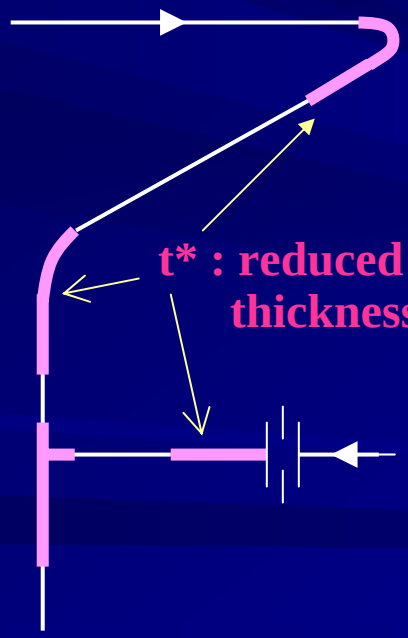


SALT DAMAGE

Lessons learned : Seismic Safety

Seismic safety of the components and structures with assumed degradation at targeting 60 years is evaluated.
Some pipes sensitive to wall thinning are to be operated not being reinforced by supports, but under the more frequent wall thickness measurement based on LTMP.

piping subject to wall thinning



Seismic stress analysis (1)
$t^* = t_{sr}$: minimum required thickness against pressure

OK → Continue current thickness measure-ment to keep $t \geqq t_{sr}$

overstress →

Seismic stress analysis (2)
$t^* = t_m$: thickness after ×× years at the max. measured thinning rate of the line

OK → LTMP : Measure wall thickness more frequently to confirm $t \geqq t_m$.

overstress →

Add supports

* Region sensitive to wall thinning is such as within 3D downstream of elbow, tee.

Lessons learned : 1st PDCA of Tsuruga#1

(1) Were the previous predictions reliable enough comparing with the actual data and research results obtained after 30 year?

Some data deviated from the prediction at 30 year, but not so serious to affect the structural integrity of SSC in the past 10 years. Predictions were revised reflecting new knowledge.

phenomena to TLAA	new data / new research results in the past 10 yars
Low cycle fatigue	Frequency of transients / Effect of water environment
Embrittlement of RPV	Surveillance data / Low flux effect on high Cu steel
Irradiation assisted SCC	Dose change due to CI replacement / －
Cast SS thermal aging	－ / Predictive method of aging
Degradation of electrical insulation & performance.	Actual dose rate and temperature / Degradation of insulation under actual environment
Degradation of concrete	Core boring data / －

Lessons learned : 1st PDCA of Tsuruga#1

(2) There are some aging related events recorded in the unit after 30 year. Was the previous LTMP/AER insufficient?

No. All recorded events were INES level 0 or less.
Lessons were obtained through the root cause analyses of these trivial events.

(3) Did LTMP give adequate additional maintenance measure for continuous operation in the past 10 years?

Probably yes, since additional maintenance to be urgently implemented is not identified.
Additional maintenances newly listed in the revised LTMP are measures corresponding to new knowledge.

Summary

Lessons Learned through regulatory activities associated with longer life operation of Japanese LWRs beyond 30 year

(1) Tsuruga#1 completed the 1st PDCA cycle based on LTMP without significant event caused by aging in the past 10 years, and operation beyond 40 year is about to start.

(2) Although some actual data deviated from the prediction of 10 year ago, the reasons were understood by the new knowledge in the past 10 years. LTMP was revised reflecting new knowledge before the deviation grew significantly.

(3) 10 year is probably short enough for timely updating of LTMP, since LTMP is based on the prospect of aging in the far future.