Updated Risk-Informed Regulation and Application in Taiwan

Dr. Wei-Wu Chao
Atomic Energy Council, R.O.C
May 12, 2008
OUTLINE

- On-line maintenance (OLM) application
- Allowed outage time (AOT) extension for startup transformer replacement
- Risk-informed In-service Inspection (RI-ISI) pilot study
- Concluding Remarks
OLM Application


OLM Application (cont’d)

- Up to date, Taipower has successfully performed some OLMs, all completed within 60% AOT
  - For Chinshan NPP, RHR Pump, RHR Booster Pump
  - For Kuosheng NPP, RHR Valve & Instrument, AHU
  - For Maanshan NPP, RHR Valve & Instrument, Containment Spray System, Essential Chilled Water System
OLM Application (cont’d)

- Considering lack of OLM experience in Taiwan and not implementing maintenance rule, the aforementioned Guideline dictated the scope for OLM to be limited to 4 categories of systems: Residual Heat Removal, Emergency Cooling Water, Emergency Chiller, Core Spray System.

- This guideline also regulates that OLM applications will be reviewed in case-by-case bases.
Based on the experience gained from previous successful OLMs, Taipower is proposing to extend OLM scope for further systems.

Taipower has implemented Maintenance Rule starting from 2008, which shall control OLM activities and risk management.

Plant-wide OLM is expected in the near future.
AOT extension for startup transformer replacement

- Permanent risk informed Technical Specification (RI-TS) change can follow USNRC Regulatory Guidance 1.177
- Up to now, no related application was filed by Taipower
- However, one-time extension of 345KV Startup Transformer AOT been has requested by Taipower and approved by AEC
AOT extension for startup transformer replacement (cont’d)

- Chinshan NPP 345kV Startup Transformer experienced severe damage in April, 2007, which required for replacement
  - Taipower requested AOT temporary extension from 3 days to 30 days
  - Taipower’s risk assessment proposed the risk was acceptable within 28 days, they also credited other analysis conservatism and requested for 30 days
  - AEC approved a 28 days one-time AOT and requested Taipower to perform detailed contingency analysis and take appropriate measures to manage the risk during maintenance.
### AOT extension for startup transformer replacement (cont’d)

<table>
<thead>
<tr>
<th>CHI N$\text{SHAN}$ ST-B Maint.</th>
<th>Base case</th>
<th>ST-B Maintenance Case</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IE\RiskMetrics</strong></td>
<td><strong>CDF</strong></td>
<td><strong>LERF</strong></td>
</tr>
<tr>
<td>internal</td>
<td>3.93E-06</td>
<td>1.56E-06</td>
</tr>
<tr>
<td>seismic</td>
<td>5.27E-06</td>
<td>4.46E-06</td>
</tr>
<tr>
<td>Fire</td>
<td>7.38E-06</td>
<td>1.25E-06</td>
</tr>
<tr>
<td>SUM</td>
<td>1.66E-05</td>
<td>7.27E-06</td>
</tr>
<tr>
<td><strong>Acceptance Criteria</strong></td>
<td>$\phi \leq 5.00E-07$</td>
<td>$\phi \leq 5.00E-07$</td>
</tr>
<tr>
<td><strong>Acceptable Extension Based on</strong></td>
<td>$\sim 160 \text{ days}$</td>
<td>$\sim 28 \text{ days}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
RI-I SI pilot study

- NRC Regulatory guide 1.178 provides guidance for using PRA findings and risk insights for decisions on changes proposed to a plant’s inspection program.

- The RI-I SI process generally identifies few risk-significant welds for inspection. This translates to fewer inspections to be performed during outages and lower personnel exposures.
RI-ISI pilot study (cont’d)

RI-ISI applications in some US plants

<table>
<thead>
<tr>
<th>Plant</th>
<th>Scope</th>
<th>Method</th>
<th>Inspection Reduced</th>
<th>Plant</th>
<th>Scope</th>
<th>Method</th>
<th>Inspection Reduced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fitzpatrick</td>
<td>Class1&amp;2&amp;3</td>
<td>EPRI</td>
<td>82%</td>
<td>Beaver Valley-1</td>
<td>Class1&amp;2</td>
<td>WOG</td>
<td>81%</td>
</tr>
<tr>
<td>WNP-2</td>
<td>Class1</td>
<td>EPRI</td>
<td>55%</td>
<td>North Anna-2</td>
<td>Class1</td>
<td>WOG</td>
<td>86%</td>
</tr>
<tr>
<td>Perry</td>
<td>Class1</td>
<td>EPRI</td>
<td>75%</td>
<td>Sequoyah-1</td>
<td>Class1&amp;2</td>
<td>WOG</td>
<td>83%</td>
</tr>
<tr>
<td>Lasalle-1</td>
<td>Class1&amp;2</td>
<td>EPRI</td>
<td>65%</td>
<td>Watts Bar-1</td>
<td>Class1&amp;2</td>
<td>WOG</td>
<td>81%</td>
</tr>
<tr>
<td>Ferry-2</td>
<td>Class1&amp;2&amp;3</td>
<td>WOG</td>
<td>69%</td>
<td>India Point-2</td>
<td>Class1</td>
<td>EPRI</td>
<td>70%</td>
</tr>
</tbody>
</table>

WOG: WCAP-14572  EPRI: TR-112657
RI-1SI pilot study (cont’d)

- Taipower contracted INER (Institute of Nuclear Energy Research) a research project of RI-1SI pilot study for RHR systems at Kuosheng plant
- Adopt similar methodology as being implemented in US
RI-1SI pilot study (cont’d)

- RI-1SI for Kuosheng RHR system:
  - Current inspection ASME requirement, 113 of 900 welds
  - High risk piping welds, select 2 of 8 for inspection
  - Moderate risk piping welds, select 48 of 473 for inspection
  - Low risk (or no fracture mechanism) piping welds, no inspection for 419 welds
  - Total inspection reduction 58% (from 113 to 50)
  - $\text{CDF}: 3.2E-8/\text{yr}$, $\text{LERF}: -2.4E-11/\text{yr}$
Based on this pilot study, INER has developed a RI-ISI implementation guideline for Taipower for setting up RI-ISI program.

Taipower is planning plant-wide applications for operating nuclear plants.
Concluding Remarks

- Probabilistic Safety Assessment (PSA) has been introduced, developed, improved, refined near three decades in Taiwan.
- Early applications were mainly used for betterment of plant systems and safety.
- PSA has been proved to be a useful tool for risk-informed assessment.
- Full scale risk-informed applications are expected in near future for both regulatory decisions and utility operations.
Concluding Remarks (Cont’d)

Future Risk-Informed Applications

- Risk-informed in-service inspection (RI-ISI), Testing (RI-I-ST), and technical specification (RI-TS)
- Plant-wide OLM
- Performance-based fire protection implementation (NFPA-805)
The End