EPRI Strategic Program on Advanced Reactors

Andrew Sowder
Principal Technical Leader

Nuclear Power Council Advisory Meeting
September 1, 2016
Changing Commercial Environment for Nuclear

- Energy infrastructures challenged with maintaining energy and capacity in face of unprecedented and accelerating change

- Uncertainty as only certainty
  - price of natural gas?
  - price of carbon emissions?
  - new technology (or lack thereof)?

- Utilities will need energy options
  - dispatchable
  - energy dense
  - non-emitting
Advanced Reactors Offer New Opportunities for Nuclear

- Enhanced safety and dry cooling for siting flexibility
- High temperatures for diversified products and markets
- Breeding for security of fuel supply
- Flexible operation for grid support and integration with renewables
- Ease of scaling, licensing, construction, operation and maintenance for superior economics
Choice of Primary Coolant Drives Many Key Attributes

- Molten salt reactors
- High-temp gas reactors
- Gas fast reactors
- Liquid-metal fast reactors
- Super-critical water reactors

Temperature:
- 900°C
- 500°C
- 300°C

Pressure:
0 5 10 15 20 25 MPa
Advanced Reactors: Not IF but WHEN and BY WHOM

North America:
- U.S. DOE GAIN Initiative
- > 40 private developers
- ~ $1.5 billion private investment

- national policy and program
- + operational test/demo reactor
- + commercial prototype

Russia: BN-800
800 MWe SFR

France: ASTRID SFR

South Korea: PGSFR

Japan: MONJU SFR

India: Kalpakkam PFBR
500 MWe SFR

China: HTR-PM
210 MWe Tandem HTGR
Why Is EPRI Getting Involved?

- Customer requirements for advanced reactors have not been established.
- EPRI is uniquely positioned to bring potential owner-operators, developers, vendors together.
- EPRI-led collaboration helped bring advanced LWRs to market and can do so again for advanced non-LWRs.
EPRI Advanced Reactor Strategic Program

- **Vision:** EPRI will play a leading role to enable commercialization of advanced nuclear generation on timeframes and at scales needed

- **Approach:** Collaboration and leveraging for impacts commensurate with those of the Advanced Light Water Reactor program

- **Alignment:** Supportive of parallel and cross-cutting EPRI, industry and government initiatives

**Goal:** Mature designs, demonstrations and first-of-a-kind construction by 2030s
What is EPRI Doing?

- URD extension to small modular LWRs
- Technical basis for optimizing SMR staffing, emergency planning zones
- Demo of accelerated (days vs. weeks) manufacture of SMR pressure vessel components at 2/3 scale with NuScale
- Independent technical review of a molten chloride fast reactor with Southern Company and TerraPower
Brief Introduction to CAP200

Qiu Zhongming
Assistant President, SNERDI
Director, Dept. of General Technology
Sep.1 2016

Presented by Fu Zaiwei
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NPPs distribution in Mainland

- 34 units in operation
- 21 units under construction
- Other 24 units under permission
- More than 80 units is proposed
Nuclear power prediction

- About **40** units to be constructed in the next 5 years (Expected according to the development strategy of NEA).
- Nuclear power installed capacity will increase from 1.6% to 3.2% in 2020.
Global first AP1000 construction progress

- 2016-04-25  ALL 4 RCPs installed successfully in Haiyang NPP
- 2016-05-23  ALL 4 RCPs Start up successfully in Sanmen NPP
- 2016-05-26  Cold Test succeeded in Sanmen NPP
- 2016-08  Hot Test performed in Sanmen

Sanmen Site
RCP Installed
Sanmen Site
Buildup CAP Series with R&D

- SNERDI’s Development Strategy

- R&D Platform Established on basis of the 45 years’ experience and advanced passive PWR Technology
CAP—S Series to meet comprehensive requirements

- Advanced Technology
- Proven and IPR
- Small, Simple and Smart
- Passive Safety Design
- Flexible and Multifunctional
- Highly Modularized
- Multi-Functional (Electricity + Heating)

To meet multi-applications for heating, cooling, desalination and electric supply
Target market

- 60% area of China needs heating
- More than 700 million people
- More than $10 billion
- ~100GW 200MW thermal power plant replace before 2022
- ~300GW replace before 2032
### CAP200 General Design Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core thermal power</td>
<td>660 MWt</td>
</tr>
<tr>
<td>Electric power output</td>
<td>&gt;200 MWe</td>
</tr>
<tr>
<td>Design plant lifetime</td>
<td>60 years</td>
</tr>
<tr>
<td>Operating pressure</td>
<td>15.5 MPa</td>
</tr>
<tr>
<td>Fuel Assembly</td>
<td>89 short CAP1400 Fuel assemblies 2.4 m active length</td>
</tr>
<tr>
<td>Control Rod Assemblies</td>
<td>37</td>
</tr>
<tr>
<td>Average Linear Power Density</td>
<td>114 W/cm</td>
</tr>
<tr>
<td>Operation cycle length</td>
<td>24 -33 Months</td>
</tr>
<tr>
<td>Plant layout</td>
<td>Single Arrangement</td>
</tr>
<tr>
<td>Reactor type</td>
<td>2-loop PWR</td>
</tr>
<tr>
<td>Safety system</td>
<td>Passive system, None operator intervention required</td>
</tr>
<tr>
<td>Containment</td>
<td>Underground</td>
</tr>
<tr>
<td>RCS Flow Rate</td>
<td>12000 m³/RCP</td>
</tr>
</tbody>
</table>
Main Equipment

Main Coolant Lines Eliminated

- Pressure nozzles connecting SGs with RPV
- SG head and primary pump Integrated forging
- Nozzles is divided into hot and cold channel with baffle
- Integrated head package

- Forging feasibility and manufactural;
- Flow stratification and thermal expansion;
- Transients strength analysis;
- The support design and analysis
Main system

- Two loops, one SG each loop, two primary pumps each loop
- Passive safety system
- Natural circulation 20%
- Connecting piping optimized (RNS/CVS/PRHR/ADS)

Primary loop pressure drop 403.79 kPa
### Passive Safety System

<table>
<thead>
<tr>
<th>Basic Safety Functions</th>
<th>Key Safety Functions</th>
<th>Related Equipments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactivity Control</td>
<td>Core Subcritical</td>
<td>Control Rod, Boron injection (CMT)</td>
</tr>
<tr>
<td>Core Heat Removal</td>
<td>Core cooling</td>
<td>Depressurization / injection / SG / residual heat removal systems</td>
</tr>
<tr>
<td></td>
<td>Heat Sink</td>
<td>SG, IRWST, Containment Pool, supplement pool</td>
</tr>
<tr>
<td></td>
<td>RCS inventory</td>
<td>High/low pressure injection, Sump</td>
</tr>
</tbody>
</table>

| Radioactivity Confinement | Containment Integrity | Containment Pool / Containment Condensation Back flow |

#### Passive Containment Cooling System
- Remove the decay heat through the steel containment
- Top head of steel containment is submerged in water,
- Capacity of CV Top Water Pool: 7 days,
- Long-term passive cooling: no intervention.
Small consequences of LOCA
- Eliminate main loop piping
- Optimize connecting piping
- Eliminate penetrations in the lower head of RPV

Large safety margin
- Lower average linear power density (114W/cm)
- Large coolant inventory (0.15m3/MWt)
- Large reactor thermal-hydraulic margin (increase power to 800MWt)

Resist external events
- Long-term passive cooling, no intervention
- Nuclear island underground
For beyond design base accident import events, site boundary effective dose less than 10mSv/person

Radioactive waste minimized

- **Source Control:** Low Co material, MSHIM, no fuel cladding damage
- **Advanced Technology:** Active carbon adsorb, ion exchange, chemical flocculation, volume reduction to 10m$^3$/y

10Bq/L
Economy

- Long design life
- High burnup
- High availability
- High reliability
- Mature design & equipment

Design Life 60 years
18 months fuel cycle, burn up >45000MWd/tU
Availability target >95%
Reliability design
Mature fuel, equipment, system
Advanced

Advanced codes & standards and design philosophy

- Apply newest codes & standard and safety review principle
- Apply PSA and reliability to balance plant design
- Apply passive safety philosophy
- Apply intelligent technology
- Innovative refueling method, radiation process
- Smaller plant area (0.091m²/kWt)

Plant thermal efficiency

- Plant thermal efficiency 70% (steam extraction 640t/h, 123MWe electricity)

Load-following

- Daily load-following as low as 20%FP, meet URD SMR requirement
R&D Plan

- **Concept Design** (2014 - 2015)
- **Preliminary Design** (2016 - 2017)
- **Construction Design** (2017 - 2020)
- **2017 PSAR**
- **2019 FCD**

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Summary

- Nuclear energy has a long way to go to realize its goal of 2020, and there is a big market for small reactor in China for heating, desalination and electric energy supply.

- Government has a plan on small reactor peace applications for minimizing the coal using, thus research and construction have already attracted the whole industry attention.

- CAP200 is an advanced, economic and safe small reactor, and it can be fulfill the needs in China.
谢谢！
THANK YOU！
**CAP200 General Design Parameters (thermal plant replace)**

**NSSS**
- Steam Turbine
  - P: 5.86 MPa
  - M: 1321 t/h
  - Exhaust pressure: 1.6, 1.0 MPa
- Industrial heat load
  - HP Extraction: 1.3 MPa
  - 190°C, 140 t/h (Max 300 t/h)

**Industrial heat load**
- Heat exchanger station
  - MSR reheat steam 0.5 MPa
  - 250°C
  - 500 t/h (Max 640 t/h)
- 60 t/h
- 440 t/h

**Heat exchanger station**
- Desalination (420 t/h)
- Heating (5.72 Million m²)
- LiBr Refrigeration

**Power Grid**
- >200 MWe
Refueling

- Replacing the polar crane by a travelling crane both for reactor building aux. building
- Containment head detachable
- IHP located outside containment
- Refueling Machine located in containment
Reactor Core

**Fuel management**

- Low-leakage loading
- **First cycle:** 2.00w/o, 3.00w/o, 4.00w/o
- **Balance cycle:** 36 Reloading assemblies, 3.70w/o, 4.70w/o
- **Average burnup:** 42218MWd/tU (>45000MWd/tU 18 months)

** Reactivity Control**

- 37 control rod assemblies: 5 AO, M 16 grey +8 black, 8 SD
- **Load following without boron control,** daily load
  following as low as **20%FP,** meet URD requirement
Subsequent License Renewal – A Piece of the Solution

Mark Sartain
Vice-President, Nuclear Engineering
September 1, 2016
Overview

- Dominion Decision - Subsequent License Renewal (SLR)
- Industry Updates
  - NRC
  - NEI
  - Research areas – progress / challenges
- Summary
- Your Role
SLR Viability and Considerations

Scope

- Gather available technical, licensing and financial data
- Include only incremental and prudent capital upgrades
- Balance near-term financial impact against risk reduction and long-term operational benefits

Assumptions

- Life Extension to 80 years is very viable using current licensing basis
- Technical areas of interest will be reactor vessel, concrete and cables
- Positively shape externally driven R&D programs
- Actively influence expanding regulation to keep focus
Customer Benefit Over 20 Years

20 years VS 15 years
## Dominion’s Fleet 60-Year Licenses

<table>
<thead>
<tr>
<th>Year</th>
<th>SU1</th>
<th>SU2</th>
<th>MP2</th>
<th>NA1</th>
<th>NA2</th>
<th>MP3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970</td>
<td>May 12</td>
<td>Jan 13</td>
<td>Dec 75</td>
<td>Jun 78</td>
<td>Dec 80</td>
<td>Apr 86</td>
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<tr>
<td>1980</td>
<td>May 32</td>
<td>Jan 33</td>
<td>Jul 15</td>
<td>Apr 18</td>
<td>Aug 20</td>
<td>Nov 25</td>
</tr>
<tr>
<td>1990</td>
<td>May 52</td>
<td>Jan 53</td>
<td>Jul 35</td>
<td>Apr 38</td>
<td>Aug 40</td>
<td>Nov 45</td>
</tr>
<tr>
<td>2000</td>
<td>Jan 13</td>
<td>Jan 33</td>
<td>Jul 55</td>
<td>Apr 38</td>
<td>Aug 60</td>
<td>Nov 65</td>
</tr>
<tr>
<td>2010</td>
<td>May 12</td>
<td>Jan 33</td>
<td>Jan 33</td>
<td>Apr 38</td>
<td>Aug 60</td>
<td>Nov 65</td>
</tr>
<tr>
<td>2020</td>
<td>May 32</td>
<td>Jan 53</td>
<td>Jul 55</td>
<td>Apr 58</td>
<td>Aug 60</td>
<td>Nov 65</td>
</tr>
<tr>
<td>2030</td>
<td>May 52</td>
<td>Jan 53</td>
<td>Jul 55</td>
<td>Apr 58</td>
<td>Aug 60</td>
<td>Nov 65</td>
</tr>
<tr>
<td>2040</td>
<td>Jan 53</td>
<td>Jul 55</td>
<td>Apr 58</td>
<td>Aug 60</td>
<td>Nov 65</td>
<td></td>
</tr>
<tr>
<td>2050</td>
<td>Jan 53</td>
<td>Jul 55</td>
<td>Apr 58</td>
<td>Aug 60</td>
<td>Nov 65</td>
<td></td>
</tr>
<tr>
<td>2060</td>
<td>Jan 53</td>
<td>Jul 55</td>
<td>Apr 58</td>
<td>Aug 60</td>
<td>Nov 65</td>
<td></td>
</tr>
</tbody>
</table>

- **Original License**
- **Current License**
- **Subsequent License**
Surry Power Station

- Two Westinghouse 3-loop PWRs
- Net Capacity: Each unit is 838 MW (net) => 1676

Lifetime Generation over 460,000,000 MWhrs

<table>
<thead>
<tr>
<th></th>
<th>CO</th>
<th>Orig</th>
<th>Current</th>
<th>SLR</th>
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</thead>
<tbody>
<tr>
<td>Unit 1</td>
<td>1972</td>
<td>2012</td>
<td>2032</td>
<td>2052</td>
</tr>
<tr>
<td>Unit 2</td>
<td>1973</td>
<td>2013</td>
<td>2033</td>
<td>2053</td>
</tr>
</tbody>
</table>
Examples of Major Projects - Surry

- Large Dollar items
  - 4th Emergency Diesel
  - Integrated Technical Specifications
  - Large cable replacements
  - Steam Generator replacement
  - Instrumentation & Control upgrades
- Several other smaller items
Political Landscape

- Richmond Times Dispatch front page – 10/21/15
  - “Va. attorney general’s office says Dominion should abandon third North Anna reactor”

- Mr. David Christian, CEO Dominion Generation, White House Summit on Nuclear Energy - 11/6/15
  - “Nuclear Power can and will play a meaningful role in mitigating the potential impacts of climate change.”
Dominion Decision

- First station in fleet to reach end of life (2032/2033)
- Makes sense for Dominion, stakeholders and customers
- Political landscape was supportive
- Notified NRC Nov 2015 of intent to apply for SLR
SLR Timeline

Subsequent License Renewal Timeline

- **2009**: First license renewal. Plants enter the period of extended operation
- **2015**: Begin license renewal submittal preparation
- **2016**: First SLR application submitted
- **2018**: First SLR license approved by NRC
- **2020**: 5 Year minimum to submit SLR for continued operation per timely renewal
- **2024**: SLR approved 0 years before expiration of original license
- **2029**: First plant to reach 60 years of operation

- **2019**: Dominion Announcement
- **2019**: Dominion Submittal

Other Key Dates:
- MADM and EMADA updated
- NRC SLB public meeting series
- EPRI AMP review complete
- AMP audits completed by NRC
- NRC prepares SECY paper on SLR
- Revise GALL and SGP, NEI 95-10
- ~2 Year for SLR application
- ~2 Year for NRC review of lead plant SLR application
SLR is \textit{Not} accomplished in a Silo -
SLR is *Not* accomplished in a Silo -
SLR is *Not* accomplished in a Silo -

Vendor Support

Industry Support

Applicant

Utilities

Westinghouse

NEI

PWROG

Structural Integrity Associates, Inc.
NEI Update

- NEI working with the NRC for greater regulatory efficiency, effectiveness and agility
- Assist in developing enhancements to existing NRC guidance documents
- Coordinate the industry resources to align with SLR priorities
SLR Efficiency & Optimization

- Reduce NRC resources during audits & inspections
- Improved use of E-Portals and electronic media
- Improved Management Oversight and Schedule Adherence
- GOAL – Reduce RAIs and shortened application review from 22→ 18 months or better
NEI Working Group Structure
IAEA Perspective on Safe Long Term Operation

Pal VINCZE
Section Head
Nuclear Power Engineering Section
Nuclear Power Division
P.Vincze@iaea.org
Sustainable Development Goals - UN

Nuclear Technology for the Sustainable Development Goals

28-29 September 2016
Vienna

IAEA
60 Years
Atoms for Peace and Development

#iaeaSDGs
Content

• Status of Nuclear Power Operation
• Challenges
• IAEA support
• Summary
Nuclear Power Reactors

In 2015 nuclear power reactors generated 2441 TWh of electricity (2014: 2410 TWh)

448* operational NPPs (~388 GWe) in 30 countries

61* NPPs under construction in 15 countries (incl. 2 newcomer countries)

* IAEA PRIS, as of 24 August 2016
Post 2011: Making nuclear power safer

- 29 permanent shutdowns
- 30 new reactors in operation
- 28 construction starts (incl. UAE, Belarus)
- All NPPs reviewed & upgraded to meet new requirements based on lessons learned
- Some ‘Newcomers’ reviewed plans
- Few operating countries to phase out
Age of Operating Reactors

Total Number of Reactors: 448

- >25 years: 333
- >30: 273
- >40: 81
Benefits of LTO

- Maximization of return on investment
- Keep high level of safety
Challenges to Long Term Operation

- Policy and strategy for LTO
- Human resource management
- Ageing management review
- Safety improvements and security considerations
- Configuration management
- Financial aspects
IAEA Supports

1. IAEA Safety Standards, and Safety Reports

2. Fostering information exchange
   a. Nuclear Operating Organizations’ Forum
   b. Economic assessment of LTO of NPP
   c. Development of component specific AM guidelines

3. Peer review service SALTO* to assist Member States in application of related Safety Standards

* SALTO – Safety Aspect of Long Term Operation
How it all fits together

Standards

Informative reports

Review services

Good practices

OPEX and other technical information
Int’l Conferences on PLiM

Fourth International Conference on PLiM
Lyon, France, 23 - 27 October 2017
Research Projects

Coordinated Research Project: Benchmark analysis of aged Cable through Condition Monitoring Technology,

- Thermal and Radiation Ageing effects

Thermal (USA)

Irradiation Cell (Canada) Irradiation Thermobox (CZR)
Economic Assessment of LTO

- Economic analysis to support the LTO decision for an NPP
  - LTO economic analysis methodology
- LTO economic assessment
  - Refurbishment investment cost
  - Total cost of LTO
  - Decommissioning contribution to LTO
  - Total revenues from LTO
  - Uncertainties and risks in economic evaluations
  - Treatment of uncertainties in economic assessments by Monte Carlo simulation
  - Software of LTOFIN

Economic Assessment of Long Term Operation of Nuclear Power Plants: Approaches and Experience
Human Resource Development for LTO

- Sufficient human resources are key for LTO
- Education and training programmes are vital processes for LTO
Availability benchmarking

Availability of reactor units
2010-2014

- All reactors
  - Availability Factor [%]: 95.2
  - Planned unavailability [%]: 14.7
  - Unplanned unavailability [%]: 1.4
  - External unavailability [%]: 0.1

- Best performers (10%)
  - Availability Factor [%]: 94.2
  - Planned unavailability [%]: 4.1
  - Unplanned unavailability [%]: 0.1
  - External unavailability [%]: 0.1

IAEA-PRIS
Summary

- Long Term Operation is a competitive power generation option

- Long term operation of nuclear power plants at high levels of safety and economic competitiveness requires sufficiently trained personnel to carry out the work

- The IAEA will continuously support Member States to enhance safety and improve the reliability and performance.
  - To share information, the fourth international conference on plant life management is planned on October 2017 at Lyon, France

- The IAEA provides a peer review service (SALTO: safety aspect of long term operation) to assist Member States in application of related IAEA Safety Standards
4th International Conference on Nuclear Power Plant Life Management

23-27 October 2017 - Lyon, France
...atoms for peace at your service...

Thank you!

www.iaea.org/nuclearenergy
Materials Aging and Japanese License Renewal

Anne Demma
Program Manager, EPRI

Masao Honjin
Japan Office, EPRI International
Issue

As plants enter extended operation, managing material aging is key to keeping plants operating

- Reactor components operate in a harsh environment
- Numerous materials and alloys exist in a plant and the aging of these materials is complex and not always fully understood
- Routine inspections and replacements can mitigate some of these factors, but some failures might still be expected

Challenge: Find the next material vulnerability and address it before any failures occur
Strategically Managing Materials Degradation

• U.S. approach: Documented in “The Materials Initiative”*
  – Motivated largely by a series of events in PWRs

• Approaches in other countries share many of the same elements
  – Proactive, strategically-based, prioritized and coordinated
  – Implementable (e.g., “guidelines”) with executive support

*NEI 03-08 – Guideline for Management of Materials Issues
EPRI’s Systematic Approach

**Materials Degradation Matrix**

- **MDM**
- **3002000628**

**Issue Management Tables**

- **IMTs**
- PWR: 3002000634
- BWR: 3002000690
- CANDU: In Progress

*Describes fundamental understanding of the degradation phenomena/mechanisms*
- Covers BWR, PWR, CANDU and VVER designs
- Mechanisms mapped to 80 years of operation
- Quantifies understanding of gaps

*Summarize applicable mechanisms, consequences of failure, mitigation/repair/replacement approaches, and inspection/evaluation guidance for each component*
- Identify gaps to resolve issues
Similar Frameworks Around the World

- US follows NRC’s Generic Aging Lessons Learned (GALL)
  - Revision 3 in development for 60 to 80 years

- Many utilities outside the US follow IAEA’s International GALL (IGALL)
  - More than 50 EPRI reports referenced from primary system materials alone

EPRI products provide the foundation for aging management in both GALL and IGALL
Foundation for Aging Management

- EPRI developed tools for effective materials management of BWRs and PWRs to at least 60 years
  - Guidelines for reactor vessel and internals and piping
- EPRI is updating the tools up to 80 years or longer to continue effective materials management
  - Substantial testing database, operational experience, and analysis that can provide the bases for safe and reliable operation
- EPRI products satisfy GALL and IGALL
  - Though implementation can be different based on each country’s regulatory environment
Approach in Japan

- Utilities in Japan assembled a team to identify and fill gaps
  - Led by TEPCO and KANSAI
  - EPRI provided support
- Uncertainty of regulatory framework, but “need to follow IGALL”
- Challenging timeline
  - 18 months to construct new aging management programs
EPRI Materials Team Provided support to Japanese IGALL Working group

- Meetings and other communications from 2014 to 2016 to
  - Review the Japanese regulator’s (NRA) requirements based on IGALL, the existing Japanese utilities aging management programs and the resulting gaps
  - Explain the IGALL requirements
  - Address the resulting gaps for the Japanese Utilities
    - Using existing knowledge from EPRI reports and experts
    - Referencing on-going research by EPRI and the Japanese utilities
  - Address some of the questions from the NRA to Kansai during the License Renewal process for Takahama 1 and 2
Nuclear Power Plant Restart (As of August, 2016)

Total units before Fukushima: 54

- Under Decommissioning: 12
- Applied for Restart Approval: 25
- Preparing for Application: 17

Note: Only Decommissioning plants after Fukushima Accident are shown
Aging Japanese Nuclear Fleet

Number of Units for Elapsed Years (as of 2016)
Life Extension and New Plants needed to achieve National Generation Mix Target

Expected Share by Nuclear for Total Generation (20%-22%)
Life Extension up to 60 years on Takahama-1 & 2

- Reactor Regulation Act was amended in 2013 to stipulate:
  - Nuclear power plant life: 40 years
  - Possible life extension permission: 20 years (once and for all)

- License Renewal approval was applied for on April 30, 2015, and granted on June 20, 2016 along with approval on the following documents
  - Special Inspection results on major components
  - Aging Management Technical Evaluation (AMTE)
  - Long-term Maintenance Management Policy

- Required concomitant Approval/Permission
  - Permission on Changes in Reactor Installation License (Granted on April 20, 2016)
  - Approval on the Plan for Construction Work (Granted on June 10, 2016)
Plant Start-Up and Further Licensing Renewal

- The Kansai plans to start up Takahama 1 & 2 soon after the required modifications are implemented
  - It is expected to take two years
- NRA approved the application of the Mihama-3 License Renewal in July, and it is in the process of issuing official license
- Takahama-1 & 2 and Mihama-3 will be good precedence for following plants
  - In Japan, however, local governments, and local communities and courts also get involved in restart of plants
- NRA has taken the position that the Aging Management Technical Evaluation incorporate IGALL requirements and the related requirements are incorporated in the latest AESJ (Atomic Engineer Society in Japan) Code
Summary

- Materials research gaps are known and openly communicated
- Proactive research in place to help stay ahead of issues
- Implementation of applicable EPRI guidelines and technical bases can effectively manage aging
- Japanese Utilities successfully implemented NRA requirements based on IGALL with support of EPRI
- NRA approved application of several plants

The approach taken in Japan can be used in other countries preparing for License Renewal
Together…Shaping the Future of Electricity