The 3rd International Conference on Nuclear Power Plant Management, Salt Lake City, Utah, USA

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The IAEA organized the first and second International Conference on Nuclear Power Plant Life Management in 2002 in Budapest, Hungary, and in 2007 in Shanghai, China. Participants at the first and second conferences recommended that another conference be organized within four to five years. The third International Conference on Nuclear Power Plant Life Management (PLiM) was held in Salt Lake City, Utah, USA from 14 to 18 May 2012. Over 350 participants representing 38 Member States and 3 international organizations attended this Conference. The conference focused on topical issues and advances made in PLiM applications, particularly in the use of (PLiM) techniques in support of longer term operation of nuclear power plants. The closing session included a panel discussion on current national approaches to PLiM and the impact that the Fukushima accident had on PLiM.

1. Introduction

Main objective of the third international conference on Plant Life Management (PLiM) of nuclear power plants was to provide a platform for information exchange about national and international policies, regulatory practices on safety and on technological advances in support of ageing management and PLiM programmes to achieve safer and more reliable operation. Key elements related to the safety aspects of ageing and long term operation were presented together with the economic impacts and advanced methodologies in ageing evaluations. The participants focused on the benefits of high efficiency practices in ageing management, on trends in PLiM, particularly as pertains to operation beyond the nominal plant design life (also referred to as Long Term Operation, LTO) and on the need to further develop ageing programmes.

2. PLiM “Comes to Age”

PLiM in nuclear power generation has gained increased attention over the past decade. Effective ageing management of systems, structures and components (SSCs) has become a key element in the safe and reliable long term operation of nuclear power plants. A PLiM programme brings with it an effective set of tools that greatly helps operators safely and cost effectively manage ageing effects in SSCs and prepare the plant for long term operation (LTO). PLiM facilitate decisions concerning when and how to repair, replace or modify SSCs in an economically optimized way, while maintaining a high level of safety. The feasibility of extending nuclear power plant (NPP) operation has been recognized by operators and regulators alike, as evidenced by the number of license renewal programmes and LTO plans in several Member States.

3. Major Topics Discussed in the International Conference

The international conference was organized into 6 major working sessions. In session 1 the participants discussed the various approaches to plant life management and shared information and best practices in PLiM applications for LTO from the safety and economic point of view. In session 2 the main topic was PLiM economics, implementation experiences and successes. Session 3 focused on ageing management related to other operational programmes. Participants shared technical updates on ageing management issues, including maintenance and inspection planning, control of material degradation. Session 4 explored design modifications to SSCs including large modernizations, refurbishments and replacement projects, dictated by ageing evaluation, obsolescence and new safety requirements. Session 5 engaged in managerial issues and how PLiM greatly enhances system management and facilitates the successful resolution of complex issues in the management of NPPs. Session 6 reviewed regulatory issues concerned with plant life management in which the specialists exchanged information on regulatory requirements, roles and responsibilities of those involved in regulatory and policy matters. Most presenters believe that aging management does not begin at the end of life to help apply for LTO but is rather a living process that continuously incorporates
operating experience. Research was recognized as crucial in establishing the technical basis for long-term operation of nuclear power plants beyond their design life. The industry must take a leading role in driving the process and resolving issues. The closing session included a panel discussion on current national approaches to PLiM and the impact that the severe accident at the Fukushima NPP had on plant life management.

4. The Role of the IAEA in PLiM for LTO

The three main areas of the IAEA mandate are safety, verification and technology. Therefore the IAEA is involved in the development of safety standards, guidelines and specialized technical publications. In addition, it offers expert review and peer review missions. It leads in technical cooperation activities including workshops and training courses.

In parallel the IAEA established and runs the Nuclear Industry cooperation forum in support of its member states. A Cooperation Forum typically increases interactions with utilities and nuclear industry, between operating organizations in experienced countries and newcomers. It fosters more effective communication between member states and complements its capabilities to collect and disseminate best operational practices.

Another IAEA initiative related to PLiM is the International Generic Aging Lessons Learned (IGALL) programme. Its kick-off and scoping meeting was held in 2010 and the program was launched soon thereafter. A progress report was produced in 2011 and the final IGALL report is expected to be issued in 2013. The results will be available to operators, regulators and vendors alike. The IAEA provides in addition a comprehensive program of support services for new comer countries and for countries contemplating nuclear power program. Notably, Safe Long Term Operation (SALTO) is an in-depth peer review of the scoping and screening process, of the assessment and management of SSCs for Ageing Degradation, of the revalidation of the safety analysis, of configuration management, design basis reconstitution, FSAR update and a review of PSR related activities.

In the area of ageing management, existing programmes are being updated to include the new accident mitigating features and additional defenses resulting from the stress tests and safety re-evaluations. Preserving the capabilities and availability of these features, even under accident conditions, must be included in ageing programmes to ensure availability of this new equipment in order to allow emergency response with higher flexibility such as the use of safety components at multiple functional levels and at more than one defense-in-depth layer. PLiM specialists should cover not only physical ageing, but also non-physical ageing issues such as obsolescence of technological solutions, of regulations, of design and operating standards, of staff training and knowledge level. In the USA, NRC staff are reviewing rulemaking for LTO in order to establish whether the commission should require licensees to periodically re-evaluate seismic and flooding hazards and update if necessary their design basis. Rulemaking for station blackout are also changing. Some of the considerations involve determining quality standards for added flexible severe accident equipment and its inclusion in age-management programmes.

5. Drivers of a PLiM Programme for LTO

The top contributors in an LTO decision are safety, security and cost-effectiveness. They must be upheld under LTO, when NPPs operate beyond their original design life. Particularly important are the performance records and the accumulation of a knowledge-base on ageing management and specific LTO related R&D. In many member states, following the Fukushima accident, PLiM Technical Evaluations have been conducted. Operators have updated their technical Information Base on Ageing Management. Critical aspects of ageing are now continually researched including the identification and characterization of expected and potential degradation. This implies a continuing study of mechanisms and their consequences, the development of fitness for service criteria for critical SSCs, the definition of targeted preventive maintenance activities, the use of condition based maintenance and expert tools for active components, of on-line monitoring of critical equipment, updates to new emergency conditions in environmental qualifications, the planning and execution of important interventions age management on heavy equipment and passive components.

In addition, technology watch and obsolescence programmes are being strengthened to prepare for the future, conducting feasibility studies and applying strategic management not just of components but also of manufacturing capabilities and tools, of critical skills through orders and contracts as well as through the implementation of strategic stocks.

6. Key Ageing Management Issues in LTO Programmes

Research and development following the Fukushima accident have taken a more focused and prioritized approach. Selective R&D designed to help ‘know’ some of the current ‘unknowns’ is essential in support of LTO. Where knowledge gaps are identified, R&D is requested to characterize the degradation mechanisms but also their root causes such as environmental conditions or intrinsic ageing stressors. One of the potentially plant life-limiting mechanisms is neutron irradiation embrittlement of RPV steels. Among the
recent successes in the application of PLiM techniques is in the conduct of time limited ageing analysis (TLAA) and life cycle optimization. These techniques are capable of identifying the end of life cycle failure probabilities for large capital assets and associated costs related to their refurbishment or replacement. Well documented programmes for replacements, modifications and inspections of passive, long-lived SCCs provide assurance that all upgrades follow safety and performance requirements, reducing risk and increasing reliability.

Rigorous fatigue analyses are required for LTO. Additional instrumentation may be required to more accurately account for actual loading history during plant operation under particular conditions. Unknown historical loads are usually the main concern in fatigue calculations. Regulators require traceability of all operational transients and actual cyclic loading to demonstrate the plant will remain within its safe licensing envelope and at the same time meet modern evaluation criteria. Unknown entities make it difficult to obtain credible usage factors in the justification for LTO.

Key issues in RPV and passive SSC evaluations to further successes in LTO programmes are the need for improvements in the integrity assessment methods and in the use of probabilistic analysis for safety margin evaluations, the need further the validation of the embrittlement prediction formula to higher fluence and more reliable fluence calculations, more detailed analysis and verification and validation (V&V) and an improved management of the RPV fluence through fracture toughness recovery. Advanced in non-destructive examination (NDE) methods to detect and characterize ageing are also necessary to successfully support LTO such as the customization of existing NDE methods and the development of new ones, improvements in tool resolutions, and in extending applications of on-line monitoring and prognosis tools.

The use of statistical models for the evaluation of irradiation-assisted SCC (IASCC) failures and for the development of the capability to predict them is an encouraging trend in the industry. It is essential to continue supporting the development of “probability of detection” (POD) curves and numerical simulations. The optimum sample size is key to success in this field.

In cable ageing management, of particular importance is the development of in-situ real-time cable condition monitoring methods to detect degradation. Broadband impedance spectroscopy (BIS) was found to be superior to time domain reflectometry (TDR) in locating degraded cable portions. In polymer insulation jackets, replenishing the jacket with plasticizer has proven to be a successful technique to regain jacket flexibility and elasticity. As no one tool that can exactly predict the remaining life of cables, it is necessary to perform gradual, repetitive measurements and tests, preferably through diverse methods and compare the data collected over time.

7. Conclusions

During the 3rd International NPP PLiM conference, successful achievements of PLiM applications were reported in support of LTO in both the technical and economic fields. Advanced ageing management processes were reported, including material degradation and integrity assessments (embrittlement, cracking, and fatigue), maintenance and inspection techniques were presented in support of LTO programmes. Continuous information exchange programmes related to operating experiences, regulatory practices, and the latest acquired knowledge in AM for LTO management (PLiM conference, IGALL, and future R&D) were received with great interest.

Acknowledgement

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Nomenclature

IGALL = International Generic Aging Lessons Learned
NDE = Non-Destructive Examination
POD = Probability of Detection
PSR = Periodic Safety Review
RPV = Reactor Pressure Vessel
SCC = Stress Corrosion Cracking
SALTO = Safe Long Term Operation

References


Profile

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