IAEA ACTIVITIES IN PLANT LIFE MANAGEMENT

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Abstract

The International Atomic Energy Agency (IAEA) has been assisting its 167 Member States with the management of ageing and life extension issues since the early 1980's. National approaches in many countries have shown an increase of interest in Plant Life Management (PLiM) for safe long term operation, both in terms of plant service life assurance and in optimizing the service or operational life of nuclear power plants (NPPs) and other nuclear facilities. This paper describes various activities that the Agency is involved with throughout the world in relation to PLiM and in other areas related to nuclear technology. These include regulatory and technical guidance document production, technical cooperation projects, technical meetings, assist visits, and review services. In keeping with the theme of the conference it will also describe what opportunities exist for Canadian operating organizations and individuals to become more involved in such activities, and their potential benefits.

1. Introduction

Due to its role in developing international nuclear safety standards, the IAEA has reasonable visibility among Canadian Nuclear Regulatory Commission (CNSC) staff across Canada. Staff at operating organizations appear however to have less knowledge of its activities. This is unfortunate since the Agency has developed a large quantity of quality reference publications over its history that could be of use by Canadian nuclear operators. Additionally various IAEA activities (workshops, meetings, and conferences) can permit Canadians to more readily interact with the broader nuclear community beyond North America. The following describes some of the work done by the Agency, and related publications dealing with the topic of plant life management. All IAEA publications referenced are available freely from the IAEA publications web site https://www.iaea.org/Publications.

2. Role of the IAEA

The IAEA is widely known as the world's "Atoms for Peace" organization within the United Nations family. Set up in 1957 as the world's centre for cooperation in the nuclear field, the Agency works with its Member States and multiple partners worldwide to promote the safe, secure and peaceful use of nuclear technologies. Its main work areas include nuclear technologies and applications, nuclear safety and security, and safeguards and verification.

Nuclear technologies and applications activities include helping countries use nuclear and isotopic techniques to promote sustainable development objectives in agriculture, human health, water resource management, marine environment and industrial applications. This

includes support for operating nuclear power plants, for those under construction, for sharing information on advanced reactor designs, and to assist countries planning on introducing nuclear power for the first time. Medical and scientific applications of nuclear technology are also covered.

Country assistance is often provided through the IAEA's technical cooperation (TC) programme. TC projects provide expertise in fields where nuclear techniques offer advantages over other approaches, or where nuclear techniques can usefully supplement conventional means. All Member States are eligible for support, although in practice technical cooperation activities tend to focus on the needs and priorities of less developed countries. A TC project often includes workshops, training courses, or fellowships that cover a particular subject related to nuclear technology. Experts are recruited from around the world to lecture or otherwise assist at such events, and nuclear organizations often host individuals from other countries to help transfer detailed knowledge at a practical level.

Nuclear safety and security efforts provide a strong, sustainable and visible global nuclear safety and security framework, protecting people and the environment from the harmful effects of ionizing radiation. They include publication of international nuclear safety and security standards, a variety of forums for sharing national experience, and a number of review missions such as Operational Safety (OSART) reviews [1]. Regulators around the world such as the Canadian Nuclear Safety Commission participate in the development of IAEA standards, and use such publications to assist in development of their national regulations.

Safeguards and verification activities are carried out to fulfill the duties and responsibilities of the IAEA as the world's nuclear inspectorate, performing an indispensable role in global efforts to stop the spread of nuclear weapons.

3. IAEA plant life management efforts

Plant life management (PLiM) is the process by which nuclear power plants integrate their operations, maintenance, engineering, regulatory, environmental, and economic planning activities in order to manage the material condition of a plant (ageing and obsolescence of systems, structures and components), optimize plant operating life (and consider the options of early plant retirement or licence renewal and plant life extension), and maximize plant value while maintaining plant safety (Figure 1).

Figure 1. Elements of a PLiM programme.

Currently the majority of operating NPPs are greater than 25 years old (Figure 2). This makes obsolescence, ageing management, and overall plant life management a concern for most nuclear operating organizations.

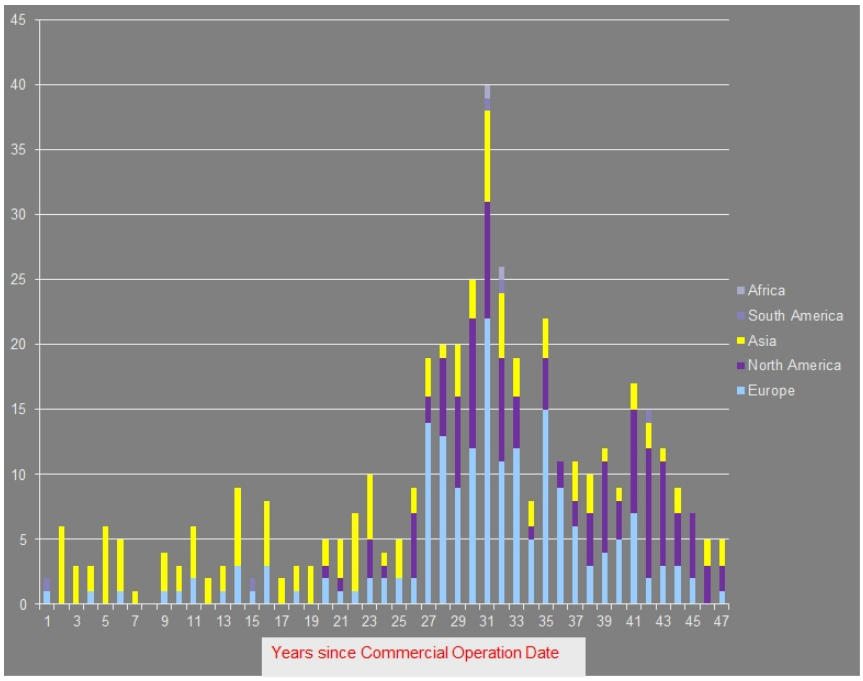

Figure 2. Age of world operating NPP fleet (IAEA Power Reactor Information System (PRIS) data, January 2016).

Work on PLiM at the IAEA began in 1989 with a project related to safety aspects of NPP ageing. The project was designed to assist Member States in understanding ageing of systems, structures and components (SSCs) important to safety, and in effective ageing management of these SSCs. During the late 1980's the signs of ageing degradation mechanisms were first beginning to show on the world's fleet of NPPs, with many at that time entering "mid-life". Results of this project work are documented in References [2–7].

Some important activities resulting from these efforts and on-going work since then by the IAEA include:

- 1989 Pilot studies on management of ageing of NPP components were initiated to assist Member States in application of an ageing management methodology. Four safety significant components were selected for the studies [5]. These four components represented different safety functions and materials susceptible to different types of ageing degradation, and were:
    - primary nozzles of reactor pressure vessels;
    - motor operated valves;
    - concrete containment buildings (CCB); and
    - instrumentation and control (I&C) cables.

  Phase 1 studies were completed via Technical Committee Meetings held in 1990 and 1991 and consisted of paper assessments of the current state of knowledge on age-related degradation, its detection and mitigation, and recommendations for Phase 2 studies. Separate coordinated research programmes were set up for each of the above four components to implement the Phase 2 pilot studies. The overall objective of each pilot study was to identify dominant ageing mechanisms and to develop an effective strategy for managing ageing effects caused by these mechanisms.

- 1991 Data Collection and Record Keeping for the Management of Nuclear Power Plant Ageing [2] was issued

  This document provided information on data requirements and a system for data collection and record keeping. General data needs, which are grouped into three categories (baseline data, operating history data, and maintenance history data), were illustrated by several examples of component-specific data requirements. Actual record keeping systems, including an advanced system, were also described.

- 1992 Methodology for management of ageing of NPP components important to safety was documented [4].

  Managing physical ageing of NPP components important to safety requires predicting and/or detecting when a plant component will have degraded to the point that required safety margins are threatened (taking appropriate corrective or mitigative actions). The methodology for management of ageing of NPP components important to safety was developed and documented in Reference [4]. It consists of three basic steps:

  (1) Selecting, from the safety perspective, plant components in which ageing should be evaluated, by assessing the effects of ageing degradation on the ability of the components to perform their design functions and crediting existing programmes and activities that manage ageing effectively.
  (2) Performing ageing management studies for the selected components to determine appropriate ageing management actions. The two-phased method reviews current understanding, monitoring and mitigation of the components' ageing, and identifies or develops effective and practical technology and practices for its monitoring and mitigation.

(3) Using results of the ageing management studies to take appropriate management actions (i.e. improving existing operations and maintenance practices and the design) and to improve relevant codes, standards and regulatory requirements.

- 1997 – 2001 Numerous component-specific ageing guidelines were published in the IAEA Technical Document (TECDOC) series, including those related to I&C cabling [8–10], concrete containment buildings [11] steam generators [12], pressurized water reactor (PWR) pressure vessels [13], PWR vessel internals [14], CANDU pressure tubes [15], CANDU reactor assemblies [16], and boiling water reactor containment system metal components [17].
- 1999 IAEA Ageing Management Assessment Team (AMAT) Guidelines , a reference document for IAEA Ageing Management Assessment Teams [18] was issued.

  This publication was prepared to document mission guidelines for an IAEA service to provide an assessment of ageing management programmes at an NPP. This service remains available from the IAEA and can be requested by operating organizations.

- 2002 Guidance on ageing management for nuclear power [19] was issued.

  This CDROM / non-serial publication was prepared to consolidate all IAEA information related to ageing management at the time of issue in one easy-to-access location.

- 2006 Nuclear power plant life management processes: Guidelines and practices for heavy water reactors [20] issued.
- 2007/2008 IAEA recommendations for programmes for Long Term Operation of Light Water Reactors [21] and Safety report Series No. 57 Safe Long Term Operation of Nuclear Power Plants [22] were issued.
- 2008 A first edition of SALTO (Safe Long Term Operation) Peer Review Guidelines [23] was issued.

  This publication dealt with ageing management aspects associated with plant life extensions / long term operation of NPPs. The SALTO mission service remains available from the IAEA.

- 2009 IAEA Safety Guide on Ageing Management for Nuclear Power Plants [24] was issued, along with associated Safety report Series No. 62 Proactive Management of Ageing for Nuclear Power Plants [25]. The IAEA ageing management framework is shown in Figure 3 below.

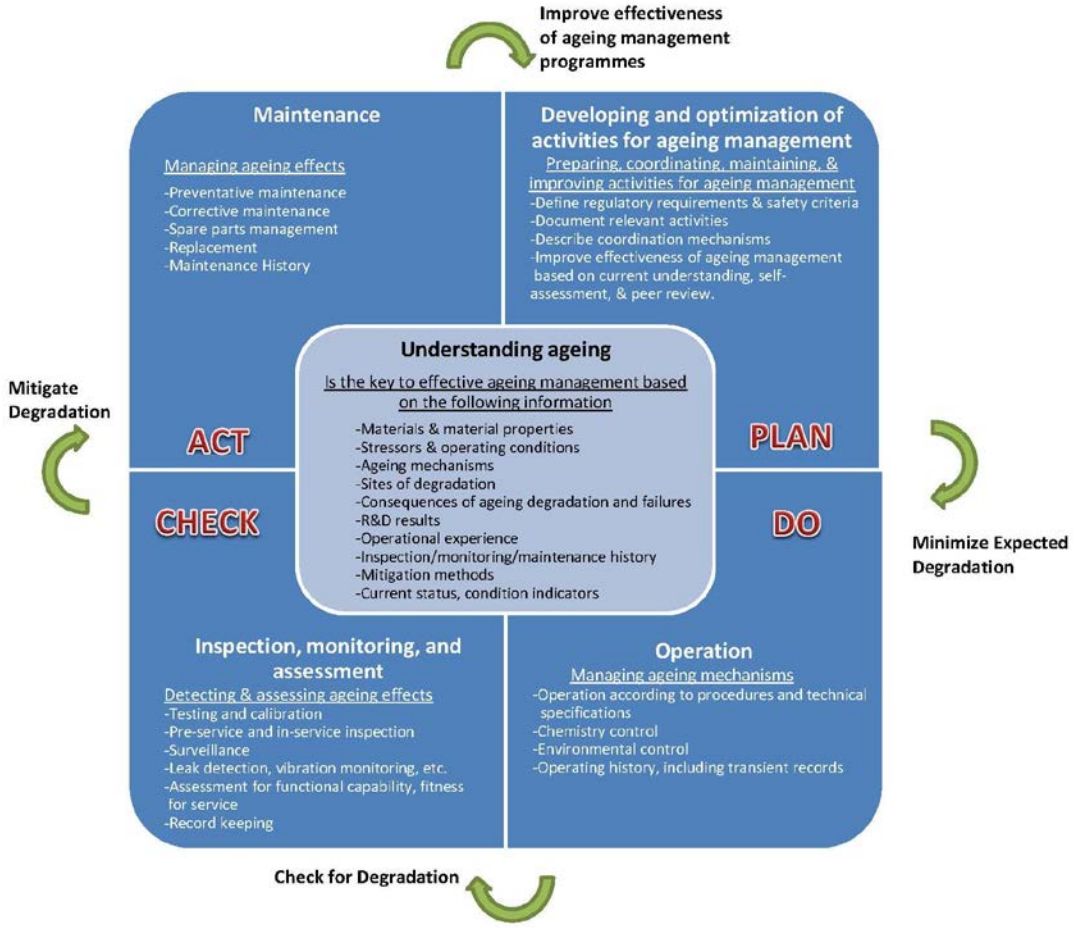

Figure 3. IAEA ageing management framework (adapted from [24]).

- 2010 to 2013 International Generic Lessons Learned (IGALL) programme phase 1 documented proven ageing management programmes for various world reactor types. Various ageing management plans (AMPS), time-limited ageing assessments (TLAAs) were documented and provided on the IAEA IGALL web pages (see https://gnssn.iaea.org/NSNI/PoS/IGALL/SitePages/Home.aspx). Subsequent project phases have been launched, with Phase 2 completed in 2015, and Phase 3 scheduled for 2016-2017. The subsequent phases were to revise and further expand the completeness of the IGALL information, including adding a technical obsolescence programme (TOP) guide.
- 2013 A mission guide for a Construction Readiness Review (CoRR) service was issued [26]. This service is available to the IAEA and can be applied to major CANDU refurbishment or life extension projects.
- 2014 An updated edition of SALTO (Safe Long Term Operation) Peer Review Guidelines [27] was issued.
- 2016. Nuclear Energy Series guide on concrete ageing for nuclear power plants NP-T-3.5 [28] was issued. This guide replaces TECDOC-1025 [11] that was issued in 1998 on concrete containment buildings.
- 2016. Nuclear Energy Series guide on Procurement Engineering and Supply Chain management for nuclear facilities [29] was issued. This guide includes examples of how

certain operating organizations are addressing obsolescence issues via procurement processes.

4. How to take part

As described above, the IAEA's Nuclear Power Engineering Section has been involved with PLiM activities since the late 1980's. Ongoing work of the section can be reviewed at this web site: https://www.iaea.org/NuclearPower/Engineering/home.html. Organizations wishing to participate in current activities (e.g. publication development, research projects, technical working groups, etc.) are encouraged to contact the organization directly using email address nenp@iaea.org.

A PLiM Technical Working Group (TWG) meets in Vienna every two years. It provides advice to the IAEA concerning all aspects of life management of NPPs, and recommends desired future efforts and research that support PLiM. Additional participation from Canadian operating organizations is encouraged.

Opportunities also exist to have your staff gain work experience by working within the section on a temporary / rotational basis.

The IAEA Technical Cooperation Department provides many opportunities for individuals and organizations to participate in its programme. In general, requests for participation are made within the framework of national or regional projects, and are coordinated via a country's embassy or mission to the IAEA in Vienna, or via a country's dedicated National Liaison officer. Experts or lecturers are recruited after completing an on-line application via the IAEA web site: (https://iaea.taleo.net/careersection/ex/jobdetail.ftl?job=PIP-TC20141224-001).

Organizations interested in hosting fellowships (e.g. nuclear facilities, research institutes, industrial facilities, nuclear suppliers, etc.) can contact the IAEA's Technical Cooperation Department via email address tc.communication.team@iaea.org.

5. Conclusion

Plant Life Management continues to be an important consideration for nuclear facility operators. The IAEA has and is continuing to develop guidance publications and to provide other services related to the topic for use by its Member States. Members of operating organizations are encouraged to review the issued publications, and work more closely with the Agency to improve the performance of both domestic and worldwide nuclear facilities.

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