LIFETIME MANAGEMENT

Idom Nuclear Services

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idom
Nuclear Services

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Life management is a commercial brochure from the company Idom

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48015, Bilbao - Spain

CONTENT

IDOM

Idom is an independent international company that delivers professional integrated services in engineering, architecture and consultancy. Excellency, innovation and commitment are the main basis on which Idom has built a solid group with offices distributed worldwide giving support to projects in more than 120 countries, accounting for 80 percent of the global turnover of Idom.

The market and new requirements of our clients mean that Idom is on a path of continuous growth in the scope of the services being offered as well as in the training of personnel.

At present, more than 2,500 people carry out their professional activities in the Company´s offices and projects all around the world.

THE GOAL

Providing the best possible service to each and every client

1957 Idom was founded in 1957, as a result of the effort and unifying work of the engineer Rafael Escolá (Barcelona 1919 - Bilbao 1995).

1995 Idom obtains accreditation of its quality management system to ISO-9001, awarded by Lloyd's Register Quality Assurance.

2000 Idom obtains accreditation of its Environmental Management System to ISO 14001.

2011 Idom successfully gains accreditation to OHSAS 18001 of its Health and Safety Management System.

100% employee owned

The company is employee owned, with 100% of the capital of Idom distributed between staff currently working in the firm.

2500 employees | **12000** clients | **30000** projects

- INDUSTRY & ENERGY
- ARCHITECTURE & BUILDING
- CONSULTING & SYSTEMS
- NUCLEAR SERVICES
- ADVANCED ANALYSIS
- TURNKEY SERVICES
- TELECOMMUNICATIONS
- INFRASTRUCTURES
- ENVIRONMENT

POLAND
BELGIUM
UK
ROMANIA

CANADA
USA
PORTUGAL
MEXICO

SPAIN
MOROCCO
COLOMBIA
UAE

LYBIA
INDIA
CHILE
BRAZIL

In recent years, Idom has expanded the range of its services, both technically and geographically.

IDOM NUCLEAR SERVICES

IDOM NUCLEAR SERVICES

Idom´s experience in the nuclear sector has its origins in the early nuclear generation projects in Spain in the late 70s and 80s, participating in the construction of Ascó and Vandellós II nuclear power plants (NPPs). Our relationship with these and other projects has continued throughout the lives of these facilities.

Working on these projects has enabled us to acquire technical abilities and experience in the fields of engineering technical support, industrial architecture, civil, mechanical, and structural engineering design and advanced analysis.

Our participation in the Energhia consortium, providing engineering services to Fusion for Energy (F4E) and the ITER organisation in the ITER fusion research project marks a milestone in the development of the nuclear services provided by Idom NS.

The spectrum of activities of the business unit covers a wide range of projects, from minor component or subsystems analysis to major design projects for new facilities.

Idom NS can offer nuclear engineering services working both as an integrated resource within the client's engineering team on site and as a resource from the various Idom offices.

Sustainability and innovation are valued aspects of Idom NS' operations and, together with the knowledge acquired from our projects, we look forward to putting these aspects together to assist our clients on the path to a future with lower carbon emissions.

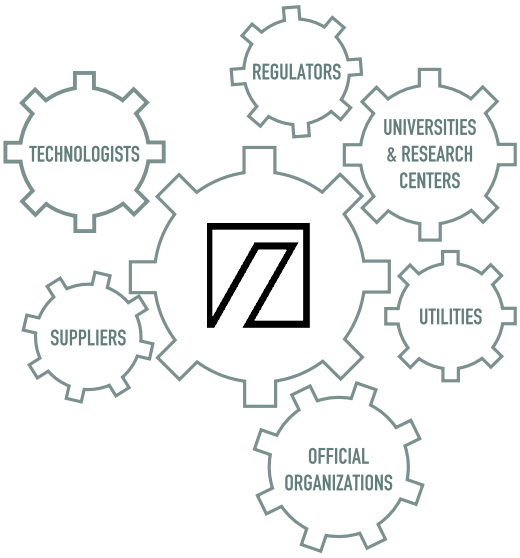
OUR TEAM

Idom NS offers a committed international and multidisciplinary team dedicated to high level performance, ensuring that projects are planned and delivered efficiently. By combining international experience and multidisciplinary expertise, Idom NS adopts a holistic approach to ensure the work is carried out to the client's satisfaction. When required, our core team will receive support from other highly skilled and experienced individuals within the company to ensure that momentum is maintained.

The Idom NS team manages the projects of Idom NS complementing their knowledge and expertise with people from other Idom technical areas working as a Task Force team.

In addition to the certified quality system of Idom, Idom NS operates according to its Nuclear Management and Quality Assurance System, based on UNE 73401, NQA–1 and KTA 1401.

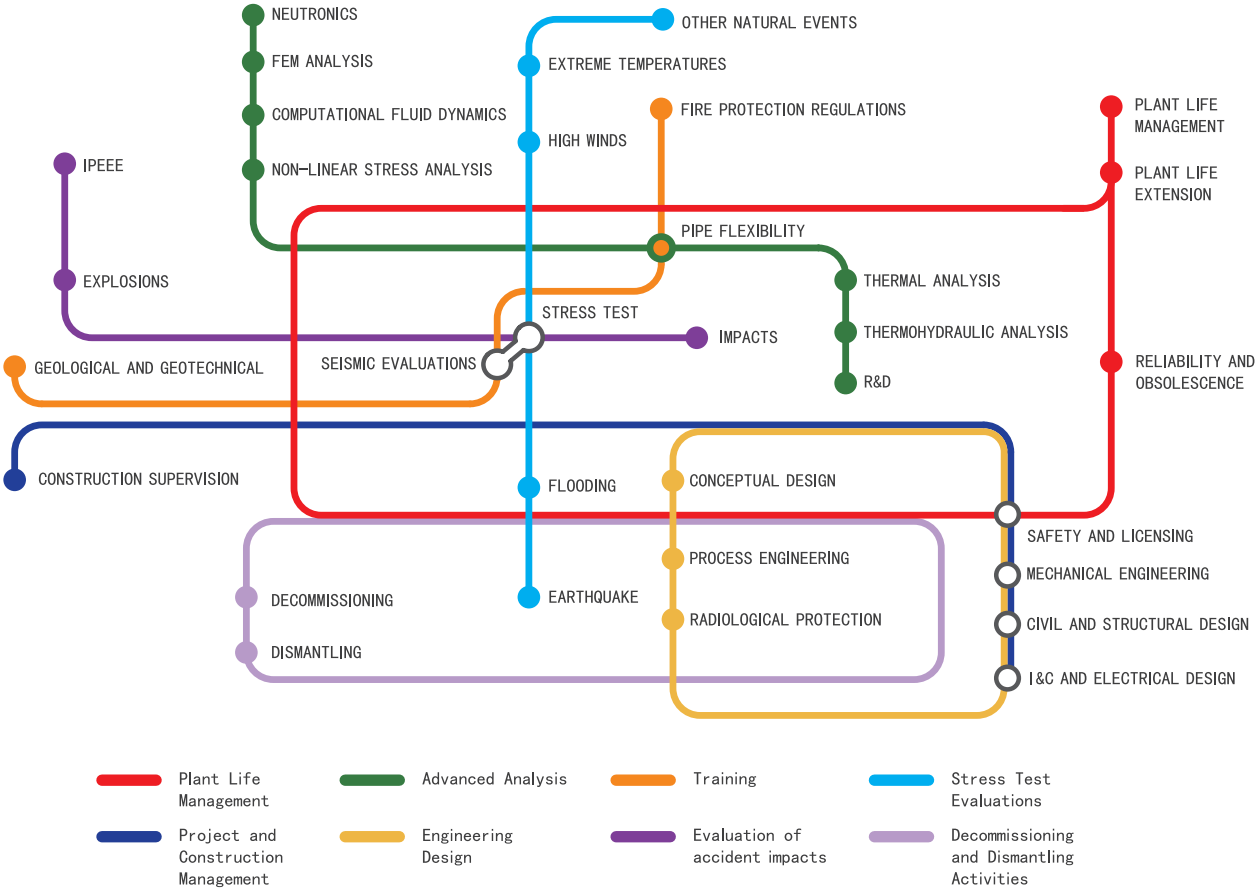
Idom NS is listed in the registry of the Spanish Nuclear Regulator (Consejo de Seguridad Nuclear, CSN), is an approved supplier of AREVA and of all Spanish NPPs and belongs to several communities of suppliers, such as UVBD (UK utilities), REPRO (Southern Europe Oil & Gas utilities industry) and SAGA 7 (Enel-Endesa).



Idom NS is member of the most relevant associations in the field in Spain and Europe: European Nuclear Society (ENS), Spanish Nuclear Society (SNE), United Kingdom Nuclear Industry Association (NIA), Sustainable Nuclear Energy Technology Platform (SNETP) and Spanish Nuclear Forum.

Idom NS is Centre of Reference of the Spanish NPPs for the Electric Power Research Institute (EPRI) projects.

SERVICES PROVIDED BY IDOM WITHIN THE NUCLEAR BUSINESS UNIT



SELECTED CURRENT TASKS RELATED TO THE SAFETY OF THE PLANTS

SAFETY SYSTEMS

Various Safety Related Systems projects have been carried out, from geological and technological studies and site evaluation against extreme natural events, to the development of basic and detailed engineering, equipment purchasing, construction, installation and commissioning of new safety systems of the plants.

Idom NS is also currently carrying out the evaluation of fire protection systems, based on the new Nuclear Safety Council (CSN) IS-30 Safety Instruction, as well as the analysis of emergency Heating, Ventilation and Air Conditioning (HVAC) systems and adequacy to the new regulations.

STRESS TESTS

Idom NS is conducting technical analyses to support the Western European Nuclear Regulators Association (WENRA) stress tests, including safety checks and risk analyses. Our tasks include assessment of the plants' defences against earthquakes, floods and other external events beyond the design basis of the plant, among other aspects.

Idom NS has participated in stress test related services for all the Spanish plants: Ascó, Vandellós II, Cofrentes, Almaraz, Trillo and Santa María de Garoña.

LIFETIME MANAGEMENT

Commencing in 2003 Idom NS developed the necessary studies and evaluations for the Santa María de Garoña NPP operating licence extension. Since 2006, Idom NS has also offered technical support in various areas including planning, development, implementation and monitoring to the Ascó, Vandellós II, Almaraz and Trillo NPPs' Lifetime Management plans.

This task is developed taking into account the considerations included in Safety Instruction IS-22 (CSN document) based on 10CFR54, NEI95-10, NUREG 1800 and NUREG 1801 NRC regulations.

CONTEXT

In addition to the need for new build capacity to be brought online, there is also a need to maintain the current fleet and to continuously improve its operation and safety.

Most nuclear operators have given high priority to licensing their nuclear power plants (NPPs) to operate for terms longer than the time frame originally anticipated (e.g. 30 or 40 years). As of December 2014, out of 438 NPPs operating in IAEA Member States, approximately 80% had been in service for over 20 years. The task of managing plant ageing is assigned to the engineering discipline called plant life management (PLiM), which applies a systematic analysis methodology to the ageing of structures, systems and components (SSCs). This discipline is particularly useful in helping plant owners make an informed decision on continuing to operate their plants longer than their originally assumed design life.

From the licensing standpoint, there are three conceptual approaches that licensees use to obtain an authorization to operate their NPP unit beyond its design service life. One approach is based on the license renewal application (LRA) concept, the second on the PSR concept and the third on a combined approach. The United States of America practices the LRA concept, while most European States and Japan use PSRs to obtain the authorization to continue operation of a plant beyond the original design life, also called long-term operation (LTO). In some countries (e.g. Spain, the Republic of Korea and Hungary), these two different concepts and related regulatory approaches have been combined, encompassing elements of both approaches to better meet local requirements.

In the United States of America, more than 80% of operating reactors have been granted a 20-year license extension that allows reactors to operate up to 60 years. The first applicants are already preparing to ask renewing the license up to 80 years.

Long Term Operation of existing reactors that meet certain safety requirements is very often a way to produce low-carbon electricity in the most cost-effective way for a period of 40 to 60 years (NEA, 2012a). R&D in the ageing of systems and materials is being carried out to address 60+ years of operation.

Reference: Technology Roadmap-Nuclear Energy Agency (NEA) and International Energy Agency (IEA) (2015) http://www.iea.org/publications/freepublications/publication/TechnologyRoadmapNuclearEnergy.pdf

AGEING MANAGEMENT

Operation, maintenance, and other actions to control and / or mitigate degradation by ageing and wear of components.

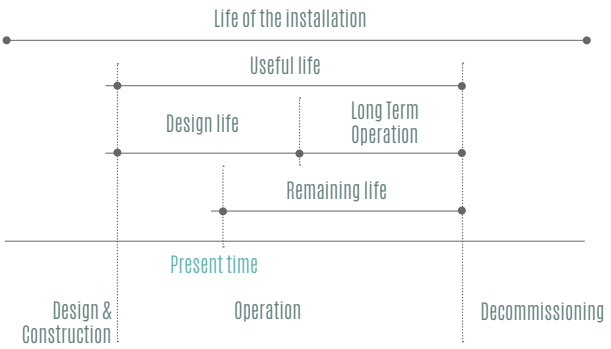
LIFE MANAGEMENT

Integrating Ageing Management and economic planning to optimize the operation, maintenance and remaining life of the systems, structures and components; maintaining an acceptable level of efficiency and safety.

LONG TERM OPERATION

Continuous operation of the facility while maintaining an acceptable level of safety, beyond the design life of the facility, following a safety assessment to ensure that safety requirements are maintained.

PERIODS IN THE LIFE OF A NUCLEAR INSTALLATION



AGEING MANAGEMENT JUSTIFICATION

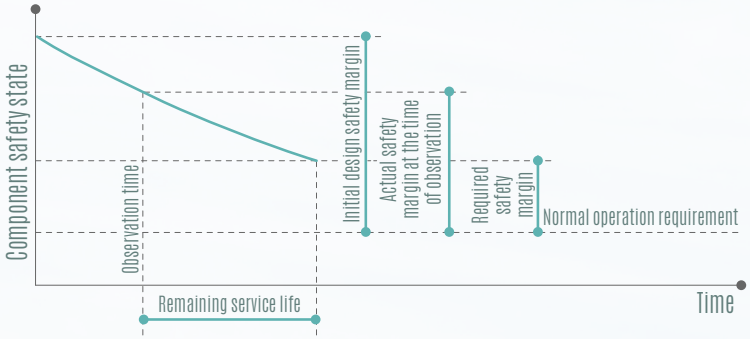
As a consequence of time and operation, nuclear installations in general, and NPPs in particular, suffer ageing processes. These processes affect all Systems, Structures and Components (SSC) and may threaten the NPP´s safety throughout its lifetime. Therefore appropriate measures must be taken to address the wear mechanisms of SSCs, their obsolescence compared to the current standards, and also non-technical challenges like knowledge management. This is especially crucial for the potential life extension of the facility and for deciding about its refurbishment or its shutdown and decommissioning.

Ageing of NPPs, if unmitigated, reduces the safety margins provided in their design and thus increases risk to public health and safety, using safety in a broad sense, meaning the safety state (i.e. integrity and functional capability) of both passive and active plant components in excess of their normal operational requirements (see figure).

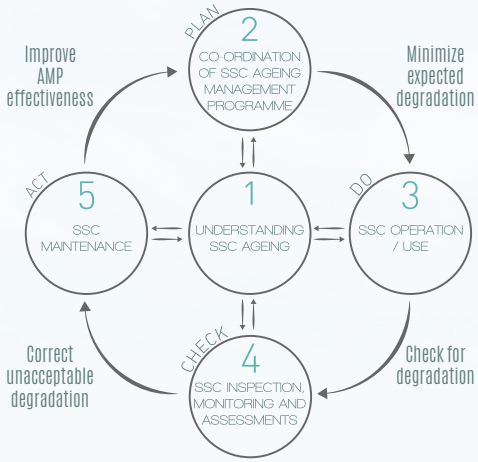
Operating experience shows that age related component failures (i.e. when a component is unable to meet its minimum performance requirements, including required safety margins) have occurred because of degradation processes, such as general and local corrosion, erosion, erosion-corrosion, radiation and thermally induced embrittlement, fatigue, corrosion fatigue, creep, binding and wear. The potential for failures and problems resulting from ageing may increase as more nuclear power plants of the first generation approach the end of their nominal design lives.

Apart from the impact on safety, ageing of SSCs can also have an important economic effect on plant operation. Some examples are the Steam Generators and RPV Head replacement in PWR.

COMPONENT SAFETY STATE AS FUNCTION OF TIME

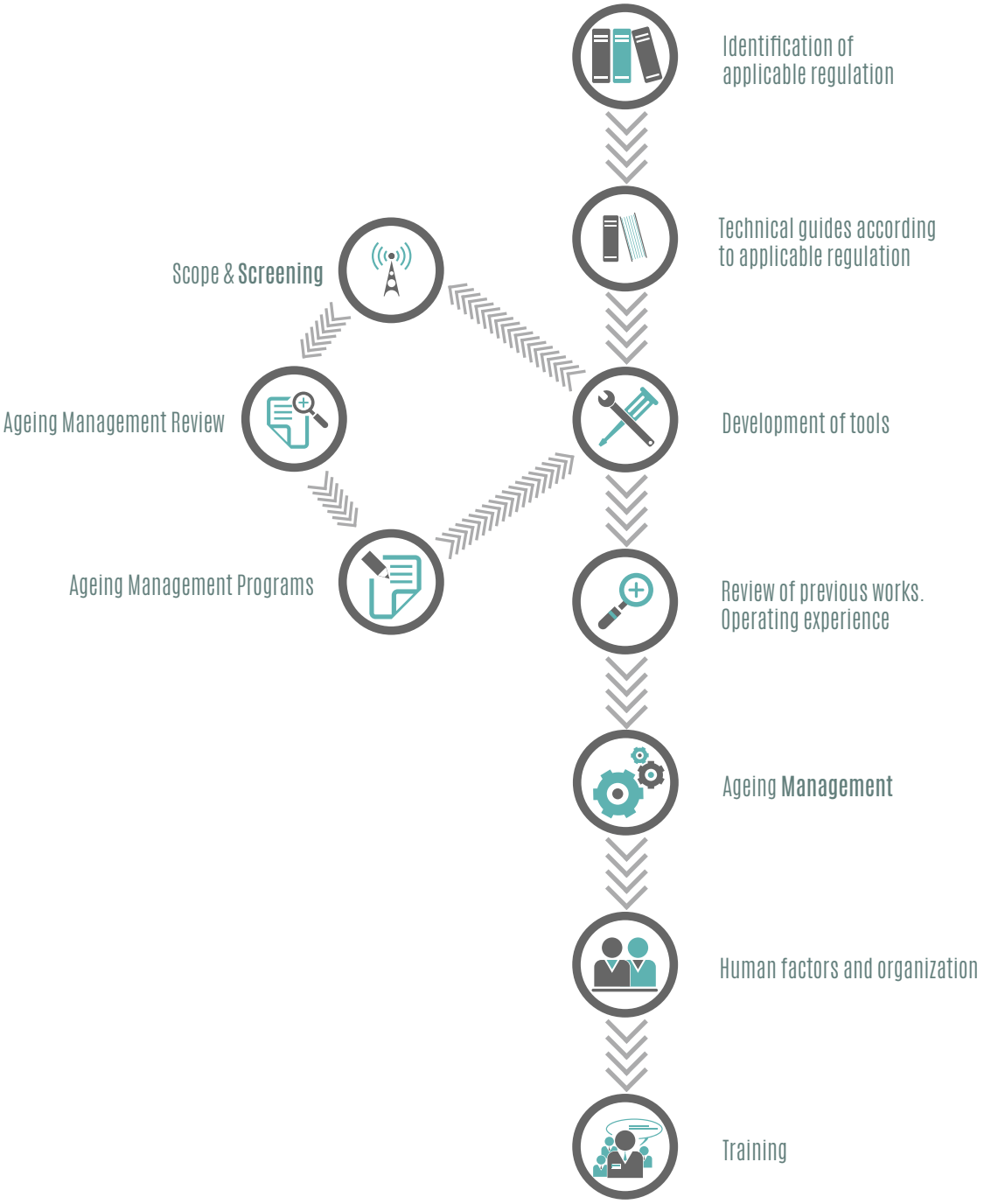


SYSTEMATIC AGEING MANAGEMENT PROCESS



AGEING MANAGEMENT PROPOSAL

AGEING MANAGEMENT METHODOLOGY



AGEING MANAGEMENT OF NUCLEAR POWER PLANT STRUCTURES, SYSTEMS AND COMPONENTS

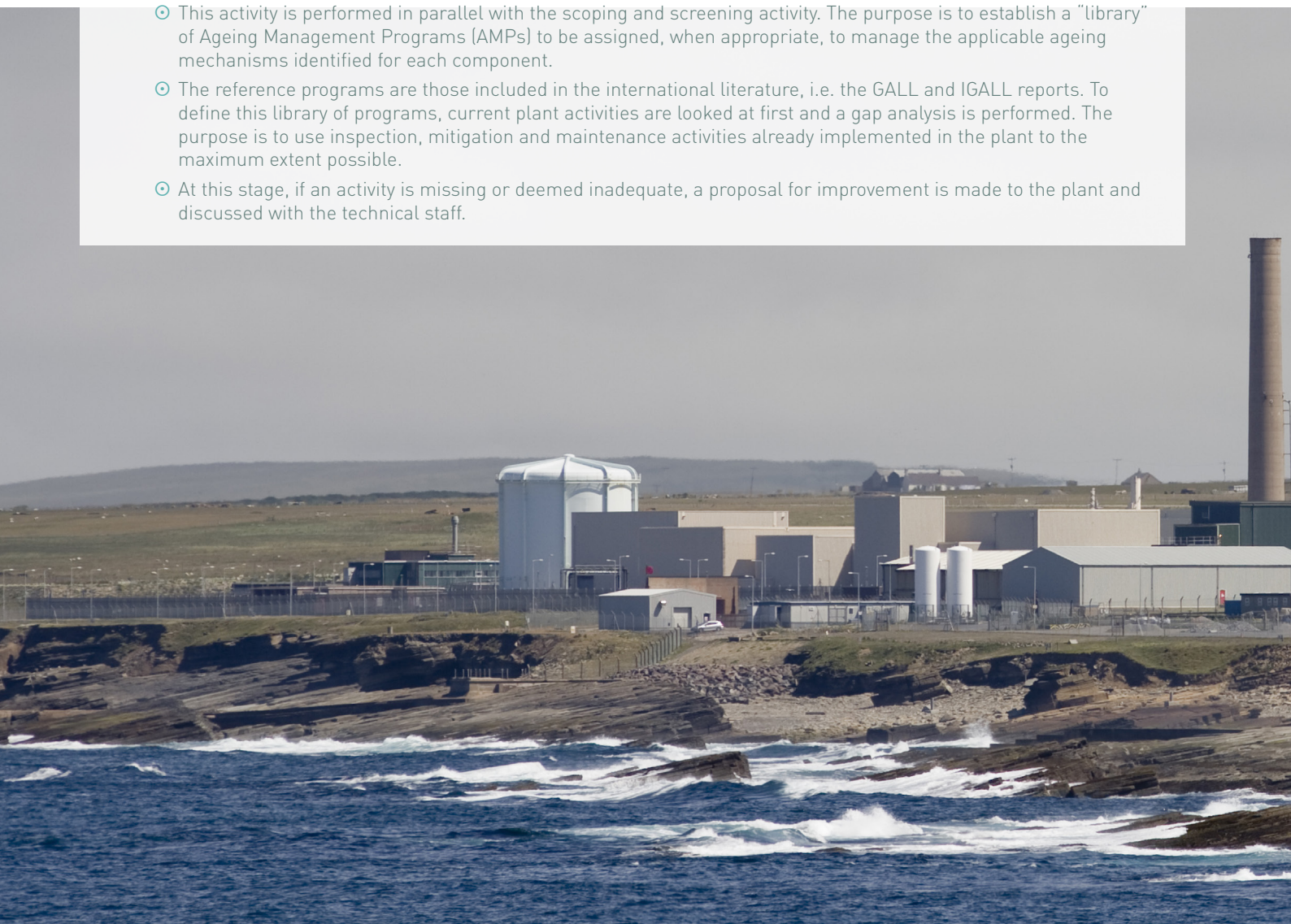
The scope of services provided by Idom NS in the field of Ageing Management comprises:

- Scope of the Ageing Management Programme based on understanding ageing.

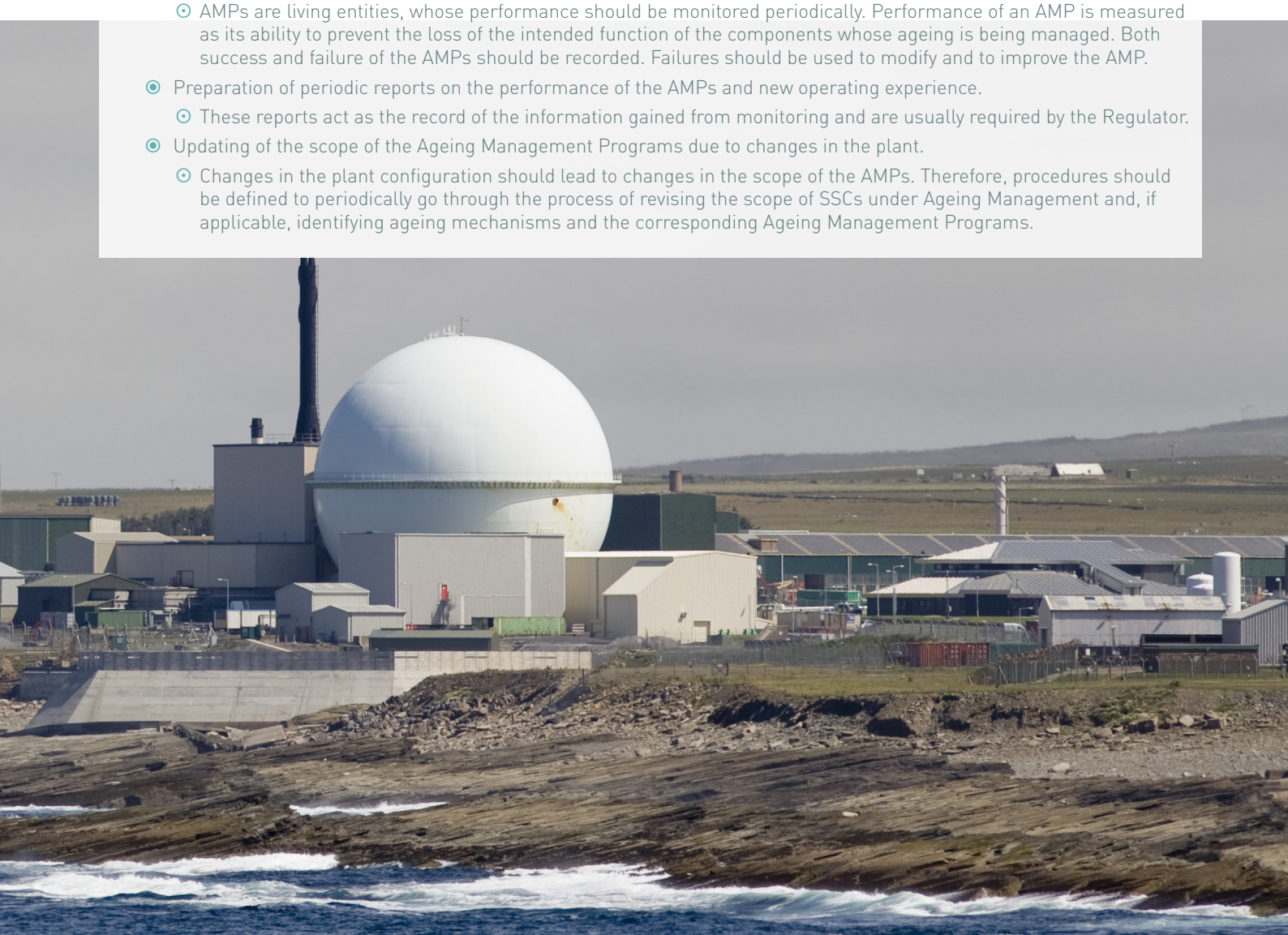
  The scope of the programme should include long-lived structures (including structural elements) and components subject to Ageing Management.

  Understanding of ageing phenomena is based on:

  - Structure/component materials, service conditions, stressors, degradation sites, degradation mechanisms and effects;
  - Structure/component condition indicators and acceptance criteria;
  - Quantitative or qualitative predictive models of relevant ageing phenomena.
- Ageing Management Review (AMR), to justify that applicable ageing mechanisms are adequately managed.
  - Identification of:
    - Materials.
    - Environments.
    - Ageing effects.
    - Degradation mechanisms.
  - Application of Ageing Management Programs to each of the identified ageing mechanisms.
- Definition of the complete set of Ageing Management Programs (AMP).
  - This activity is performed in parallel with the scoping and screening activity. The purpose is to establish a "library" of Ageing Management Programs (AMPs) to be assigned, when appropriate, to manage the applicable ageing mechanisms identified for each component.
  - The reference programs are those included in the international literature, i.e. the GALL and IGALL reports. To define this library of programs, current plant activities are looked at first and a gap analysis is performed. The purpose is to use inspection, mitigation and maintenance activities already implemented in the plant to the maximum extent possible.
  - At this stage, if an activity is missing or deemed inadequate, a proposal for improvement is made to the plant and discussed with the technical staff.

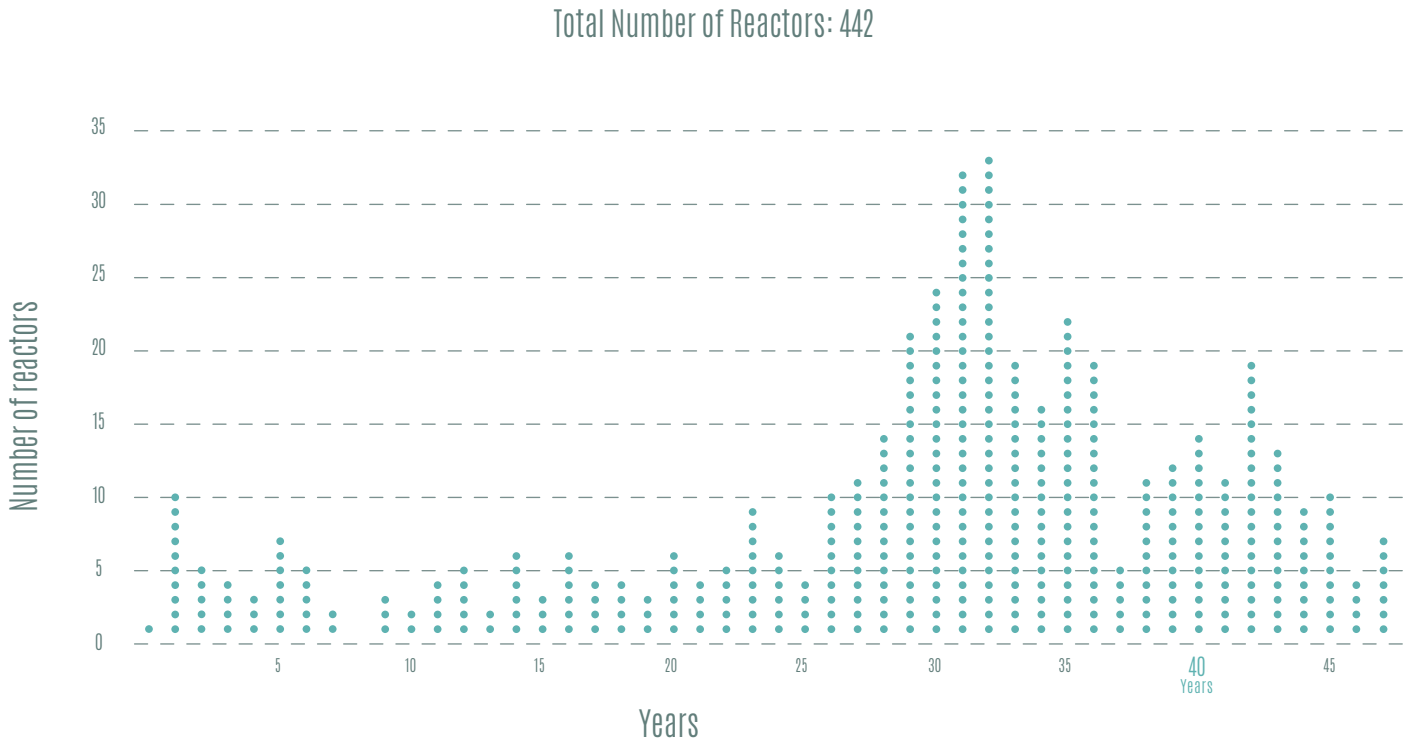


- Assessment of operating experience for the identification of possible plant specific ageing mechanisms.
  - Within this activity, a systematic review of operating experience related with SSCs in the scope is made. Relevant data are unusual transients, failures, degraded conditions or any other unusual event with an effect on the ability of the SSC to perform its intended function. All this information is studied in detail in order to find out if the root cause of the anomalies can be related to ageing and, if so, if the ageing mechanism is specific to the plant.
  - Generally, external operating experience has been taken into account in the reference documentation, mainly, the last revision of the GALL report. On the other hand, recent external operating experience should be reviewed based on SER and SOER reports of WANO or INPO and the reports published by the vendors (Westinghouse, General Electric, Areva, etc.). The purpose is to consider recent experiences of ageing related failures not taken into account in the reference documentation.
- Implementation of the Ageing Management Programs.
  - After the general framework for Ageing Management is established, the process of implementing the new plant activities starts. This process is not straightforward, since it requires co-ordination between several utility departments and the assignment of new functions to each of them. The process usually requires support from the team of engineers who have carried out the main analysis. The purpose and the contents of each AMP have to be explained to the staff responsible for the implementation and the ways to monitor the performance of the AMP have to be defined. This process is very plant specific and normally requires the presence on site of the Ageing Management engineers.
  - Development of specific Ageing Management Programs (AMP): fatigue monitoring, buried pipes surveillance, electrical cable condition monitoring program, inspection of structures, one time inspections, high voltage insulators and transmission conductors monitoring, monitoring of air controller units,...
- Monitoring of the performance of the Ageing Management Programs.
  - AMPs are living entities, whose performance should be monitored periodically. Performance of an AMP is measured as its ability to prevent the loss of the intended function of the components whose ageing is being managed. Both success and failure of the AMPs should be recorded. Failures should be used to modify and to improve the AMP.
- Preparation of periodic reports on the performance of the AMPs and new operating experience.
  - These reports act as the record of the information gained from monitoring and are usually required by the Regulator.
- Updating of the scope of the Ageing Management Programs due to changes in the plant.
  - Changes in the plant configuration should lead to changes in the scope of the AMPs. Therefore, procedures should be defined to periodically go through the process of revising the scope of SSCs under Ageing Management and, if applicable, identifying ageing mechanisms and the corresponding Ageing Management Programs.



LONG TERM OPERATION JUSTIFICATION

Long Term Operation (LTO) of a nuclear power plant may be defined as operation beyond an established time frame set forth by, for example, licence term, design, standards, licence and/or regulations, which has been justified by safety assessment, with consideration given to life limiting processes and features of systems, structures and components (SSCs).



Source: IAEA. Nuclear Power Reactors in the world. 2016 Edition

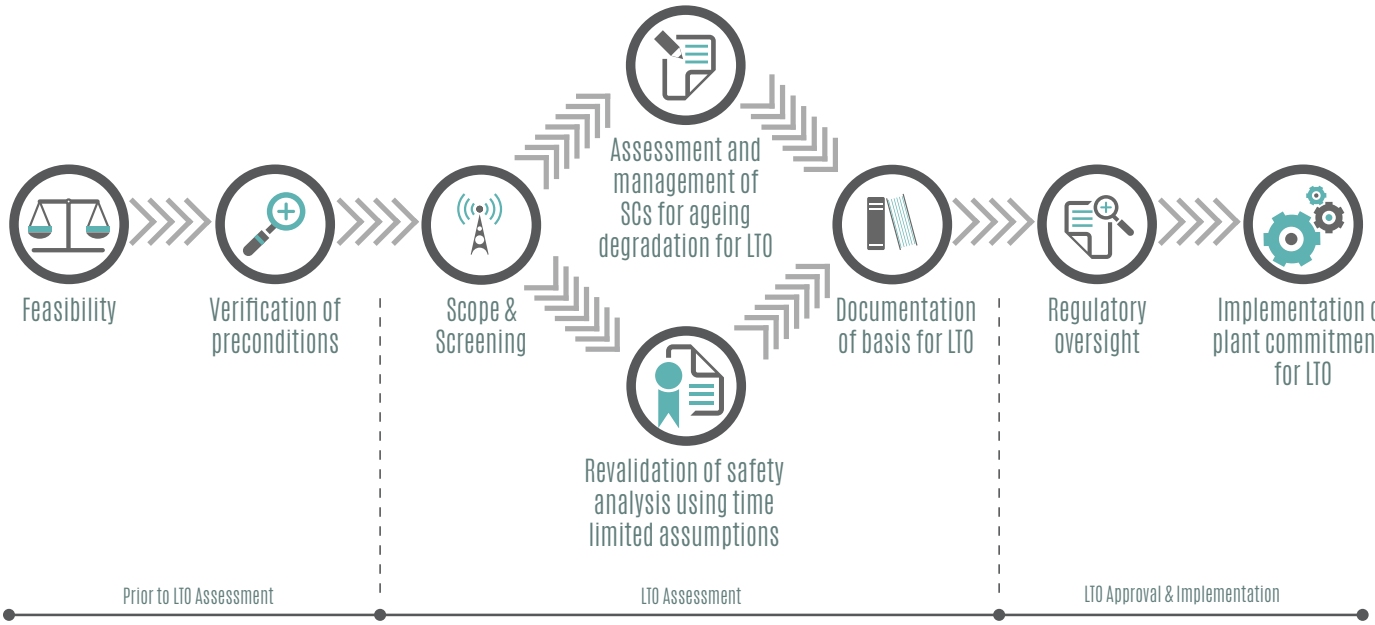
- Worldwide, more than 50% of reactors are more than 30 years old
- 44 reactors are more than 40 years old

From the point of view of safety, reliability and availability, these plants, at the end of their design life, are in optimal conditions to continue operation. Consequently - for technical, environmental and economic reasons - it is justifiable to consider extension of the life of these facilities.

Plants need to carry out projects and studies to justify the safety of the extension of the operating life

LONG TERM OPERATION PROPOSAL

LONG TERM OPERATION METHODOLOGY

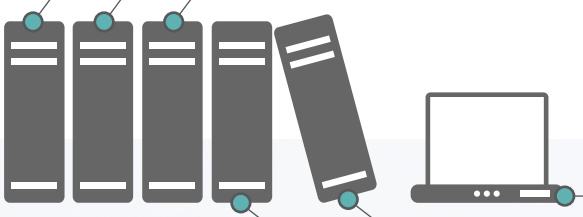


LONG TERM OPERATION OF NUCLEAR POWER PLANT STRUCTURES, SYSTEMS AND COMPONENTS

The scope of services provided by Idom NS in the field of Long Term Operation comprises:

- Identification of Time-Limited Ageing Analyses (TLAA).
  - TLAAs are design-stage or later analyses, required for licensing the plant, in which credit to a limited operation time was given. They are typically related to neutron embrittlement, metal fatigue, environmental qualification or containment fatigue. Identification of the TLAAs requires a thorough review of all the analyses carried out as part of the design or later safety assessments of components within the scope of the Ageing Management Review.
- Resolution of TLAAs.
  - This entails validation for longer periods, re-analysis or definition of new Ageing Management Programs to monitor ageing. Once the TLAAs are identified, their implications on the Long Term Operation have to be assessed. If the analyses are not valid beyond the design life, re-analysis is required. If re-analysis does not justify safety during the extended operation period, new Ageing Management Programs should be defined to monitor the ageing effects which motivated each particular TLAA.
- Preparation of the License Renewal Application to deliver to the regulator.
  - Edition of the License Renewal Application for Long Term Operation, where all the information of the evaluation of Ageing Management is included, for the delivery to the regulator.

METHODOLOGY & DELIVERABLES



01
ORGANIZATION MANUAL

02
AGEING MANAGEMENT PLAN

Selection of components.

Materials, Environments.

Plant programs (surveillance, evaluation and monitoring).

Evaluation Reports of degradation mechanisms, effects and monitoring techniques.

Maintenance practices evaluation.

Improvement proposals.

03
AGEING MANAGEMENT PROGRAMS

Procedures.

Manuals.

Periodic reports on the performance.

04
DATABASES WITH THE RESULTS AND THE INFORMATION USED

05
TIME LIMITED AGEING ANALYSIS (TLAAs)

06
LICENSE RENEWAL APPLICATION (LRA)

OTHER RELATED WORKS

- Application of PLIM&PLEX strategies to new NPPs and to all Nuclear Fuel Cycle Facilities, e.g. Interim Spent Fuel Storage Installations.
- Development of Ageing Management and equipment reliability integrated plans that include both passive and active components.
- Risk analyses applied to Ageing Management.
- Asset management: minimize unplanned capability loss and optimize maintenance programs and capital investments consistent with plant safety and operating strategies/goals.
- Technical obsolescence:
  - Availability of equipment, i.e. I&C spare parts or mechanical elements (seals, actuators,...).
  - Software.
  - Loss of suppliers and support companies.
- Non-technical obsolescence:
  - Inappropriate organization.
  - Inadequate management of knowledge.
  - Deviation from changes in regulation compliance.

Starting in 2003, the above scope of services has been implemented by Idom NS for seven reactors across five nuclear power plants. The technologies assessed include BWR, PWR and fusion reactors. In each case the work is carried out with dedicated engineering teams both on site and in Idom offices. Presently Idom NS staff involved in these projects comprise more than 30 engineers.

Idom NS has provided and is providing Ageing Management and LTO services, or other related services, at the following Nuclear Power Plants:

Santa María de Garoña NPP

- Client: NUCLENOR
- Works at Santa María de Garoña NPP (GE BWR. 1971):
  - Ageing Management Plan.
  - License Renewal Application.

Almaraz and Trillo NPPs

- Client: CNAT
- Works at Almaraz NPP (Westinghouse PWR. 1981 & 1983):
  - Ageing Management Plan.
  - License Renewal Application.
- Works at Trillo NPP (Siemens-KWU PWR. 1988):
  - Ageing Management Plan.

Joint European Torus (JET)

- Client: Culham Centre for Fusion Energy (CCFE)
- Works for magnetic plasma confinement experiment of JET.
  - JET Reliability Study RRP2 and RRP3.

Ascó and Vandellós II NPPs

- Client: ANAV
- Works at Ascó NPP (Westinghouse PWR 1982 & 1985):
  - Ageing Management Plan.
  - License Renewal Application.
- Works at Vandellós II NPP (Westinghouse PWR. 1988):
  - Ageing Management Plan.
  - License Renewal Application.

Laguna Verde NPP

- Client: ININ-CFE
- Works at Laguna Verde I & II NPP (GE BWR, 1990 & 1995):
  - Consultancy services of an international expert with extensive experience in fracture mechanics, fatigue and structural integrity applied to the evaluation of TLAAs for Ageing Management of nuclear power plant components.

Idom NS has taken part in the "International Generic Ageing Lessons Learned (IGALL)" programme promoted by the IAEA (http://www-ns.iaea.org/projects/igall/). This programme was established in September 2010 and its first phase was completed in 2013. Idom NS has also participated in the second phase finished in 2015, and will continue participating in the third phase expected to finish in 2017.

The aim is to develop a document which provides a guide for ageing mechanisms and effects based on both research results and accumulated operational experience. The document will represent an international agreement on what an acceptable Ageing Management Programme involves for standard plant components, structures, material and environments.

- IAEA expert missions.

  Idom NS personnel has participated as experts in various IAEA missions, such as the following:

  - *Supporting Proactive Management for Long Term Operation of Laguna Verde NPP*, Mexico, 2014.
  - *Review and Provision of Guidance on Ageing Management in Laguna Verde NPP*, Mexico, 2012.
  - *Improving the Reliability of Equipment at the Laguna Verde NPP*, Mexico, 2009.
  - *AMAT and SALTO Peer Review MISSION – Review of AMP & Programmatic Ageing Management Procedure*, Shanghai (China), 2008.
  - *Mission / Workshop on TLAA and Equipment of Paks NPP*, Hungary, 2006.
  - *Workshop on Plant Life Management for Laguna Verde NPP*, Mexico, 2005.

- Other collabotarions with IAEA:
  - IAEA Training Workshop (TR-47184) on *Assessment of Degradation Mechanisms of Primary Components in Water Cooled Nuclear Reactors: Current Issues and Future Challenges, CIEMAT*, Madrid (Spain), 29 September – 2 October 2014.

LITERATURE

In this context there are several documents, regulations and recommendations of various national and international organizations that describe and set standards for the development and checking of processes of Lifetime Management and Long Term Operation. The following list includes a selection of references:

- IAEA, Safety Guide NS-G-2.12, *Ageing Management for Nuclear Power Plants, 2009.*
- IAEA, TECDOC-540, *Safety Aspects of Nuclear Power Plant Ageing, 1990.*
- IAEA, TRS-338, *Methodology for the Management of Ageing of Nuclear Power Plant Components Important to Safety, 1992.*
- IAEA, SRS-15, *Implementation and Review of a Nuclear Power Plant Ageing Management Program, 1999.*
- IAEA, SRS-57, *Safe Long Term Operation of Nuclear Power Plants, 2008.*
- IAEA, SVS-26, *Guidelines for Peer Review of Safety Aspects of Long Term Operation of Nuclear Power Plants, 2014.*
- IAEA, TECDOC-1736, *Approaches to Ageing Management for Nuclear Power Plants. International Generic Ageing Lessons Learned (IGALL) Final Report, 2014.*
- IAEA, SRS 82, *Ageing Management for Nuclear Power Plants: International Generic Ageing Lessons Learned (IGALL)*, 2015.
- IAEA, *Nuclear Energy Series Technical Reports, Plant Life Management Models for Long Term Operation of Nuclear Power Plants*, No. NP-T-3.18, 2015.

- 10 CFR 54, *Requirements for renewal of operating licenses for Nuclear Power Plants.*
- NUREG-1800, *Standard Review Plan for Review of License Renewal Applications for Nuclear Power Plants.*
- NUREG-1801, *Generic Aging Lessons Learned (GALL) Report.*

- NEI 95-10, *Industry Guideline For Implementing The Requirements of 10 CFR Part 54 – The License Renewal Rule.*
- NEI 14-12, *Aging Management Program Effectiveness, Revision 0*, December 2014.
- NEI 14-13, *Use of Industry Operating Experience for Age-Related Degradation and Aging Management Programs, Revision 1*, June 2015.

- *Guía GSG-01.10, Revisiones periódicas de la seguridad de las centrales nucleares.*
- *Instrucción IS-22, sobre requisitos de seguridad para la gestión del envejecimiento y la operación a largo plazo de centrales nucleares.*

- NEA/OECD. *The Ecomomics of Long-Term Operation of Nuclear Power Plants.* Nuclear Development, 2012.
- NEA/OECD. *CSNI Technical Opinion Papers No. 15. Ageing Management of Nuclear Fuel Cycle Facilities.* Nuclear Safety, 2012.

CONCLUSION

ADVANTAGES

The implementation of an Ageing Management Plan has many advantages for the plant, both in its operation within the period of design life as well as for Long Term Operation.

ECONOMIC CONSIDERATIONS

Long Term Operation is a cost-effective option. The usual practice of the industry currently is to extend the operating life by 20 years but it is evaluating the possibility of going another 20 years beyond, through 80 years of operation.

- Optimization of the investments, performing activities at the right time (for example power uprates).
- Lower the possibility of:
  - Unforeseen breakdowns - Unavailability of equipment.
  - Unscheduled shutdowns - Loss of production.

WHY NOW?

An Ageing Management Plan can be implemented in a plant starting from zero, or also by adapting currently performed activities, so as to ensure acceptance by the regulator and based on recognized international practice.

- Obtain complete and detailed design, construction and operation information, and store this information in a more organized manner.
- Integration with the operation and maintenance activities.
- Greater benefits the sooner it is implemented.
- Keep open the option of Long Term Operation.

GENERATE A PLANT SPECIFIC SOLUTION

The objective is to generate a specific solution for the plant, taking into account what the plant needs from the items indicated above, with the resources available from Idom NS, such as their experts, the tools developed specifically for the customer and based on a systematic, proven methodology already developed in several plants.

With the solution generated by Idom NS, compliance with regulatory requirements is addressed; increased reliability, availability, and efficiency of the plant are enabled, maintenance and operating costs are reduced and investments optimised.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