Embalse Refurbishment – Pre-Project Condition Assessment

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Abstract

Phase 1 of the Refurbishment and Life Extension (RLE) project for the Embalse Nuclear Power Station consists of all preparatory activities that are required to define the refurbishment scope and costs, for input into the utility business case for the RLE project. One of these activities is the Embalse Refurbishment - Pre-Project Plant Condition Assessment Project (PCAP), as part of an overall Plant Life Management (PLiM) program.

One key element of the PLiM program at Embalse is aging assessments. These will be executed to determine which Systems, Structures, Components (SSCs) are recommended for inspection, modifications, replacement, or repair during the refurbishment outage and which may be performed during normal maintenance outages. They will also provide a health prognosis for continued operation of the SSCs for life attainment and life extension beyond the refurbishment outage, and may identify changes which are necessary and sufficient in order to deal with issues related to equipment obsolescence and aging effects.

The paper will describe the Embalse Refurbishment - Pre-Project Plant Condition Assessment Project (PCAP), the novelties and improvements of the aging assessment methodology and progress made to date.

1. Introduction

According to IAEA methodology and TECDOC [1], a systematic review of the plant is being carried out to determine what equipment refurbishment or replacement will be required due to aging or obsolescence of plant equipment. This Plant Condition Assessment (PCA) provides a structured approach by following these main steps:

1. Determination of systems important to nuclear safety or power production
2. Generation of complete lists of constituent SSCs in each system,
3. Determination of those SSCs that are adequately addressed by normal maintenance activities,
4. Aging Assessment of those SSCs not addressed by normal maintenance, (Condition and Life Assessment)
5. Assessment to determine items that are obsolete, and
6. Development of health prognosis and recommendations for items that need to be refurbished or replaced and the timing for these activities.

This Paper focuses on items 4), 5) and 6) described above.

2. General Considerations About Embalse Nuclear Power Plant

Embalse NPP is located on the shores of the Embalse lake in the Córdoba province, Argentina and is operated by Nucleoélectrica Argentina Sociedad Anónima (NASA) who also operate Atucha I (C.N.A. I, a PHWVR designed by SIEMENS-KWU)

Embalse NPP is a CANDU 6 type with 648 MWe output with the First Critical Start up in 1983, and the Commercial Start up in January 1984. In the last 10 years it has shown an excellent performance with an average 88.25 % Capacity Factor (CF). Since 1992, planned outage programs at 18 month operation intervals have been implemented.

Embalse NPP was designed (as with other early CANDU 6s) with a 30 year Design Life at an average Capacity Factor of 80%. Due to its very good performance in the last ten years at Capacity Factors well over 80%, the plant design life will be reached before the 30 year Design Life, and it is now estimated to be in 2011.

3. Plant Condition Assessment Process

3.1 Methodology

Subsequent to the training provided by AECL in Canada and at Embalse in 2005 and 2006, NASA implemented a Plant Life Management Program in accordance to IAEA Guidelines, but customized to Embalse particulars.

The objective of the Plant Condition Assessment (PCA) is to establish current condition and provide a health prognosis for the attainment of design life and life extension beyond the refurbishment outage (by 30 years) of those structures, components/equipment in the station that are important to safety and production and may identify changes which are necessary and sufficient in order to deal with issues related to equipment obsolescence and aging effects.

3.1.1 Aging Assessments

As part of the PLiM program at Embalse, aging assessments will be executed to determine which Systems, Structures, Components (SSCs) are recommended for inspection, replacement, or repair during the refurbishment outage and which may be made during normal maintenance outages. Aging assessments are a key element of a PLiM program, which provide for the systematic and rigorous assessment of Systems, Structures, Components (SSCs), or groups of components with similar characteristics (Commodities). Aging assessments generally entail a review of design , manufacturing, operational, maintenance and inspection data and the relevant degradation mechanisms in order to assess the effect of aging degradation on (SSCs), establish their current condition, and provide a prognosis for attainment of design life and/or long term operation with associated recommendations. They include:

- Life Assessment (LA): Typically applied to critical and complex components and structures, that are designed not to be replaced as part of normal maintenance program, and that are subject to long term degradation mechanisms. The methodology entails a detailed review of design, manufacturing, installation, operations and maintenance at a sub-component level.

- Condition Assessment (CA): Typically applied to SSCs, or groups of components with similar characteristics (commodities). The methodology entails a general review of design, manufacturing, installation, operations and maintenance at a component level. Recommendations may identify a need for further assessment (e.g. an LA).

PCAP, as part of an overall PLiM program it is scheduled to be performed in 16 months.

3.1.2 Team Effort

The Embalse NGS PCAP provides the division of responsibilities between NASA, other organizations (to be assigned by NASA), and AECL, as following:

- CAs and LAs performed by NASA with final review by AECL – 26 studies
- CAs and LAs performed by NASA with AECLs assistance – 16 studies
- CAs and LAs performed by AECL – 21 studies
- CAs and LAs performed by NASA and others (e.g. ANSALDO for turbine generator and BOP) – 55 studies. On these studies, NASA is cooperating with suppliers and other consultants.

Most of the assessments have already started.

Some key assessments include:

- Steam Generator Life Assessment
- Feeders Life Assessment
- Large Nuclear Pressure Vessels Life Assessment
- Large Nuclear Heat Exchangers
- PHT System Condition Assessment
- P&IC Condition Assessment
- ECC System Condition Assessment
- Piping Systems Life Assessments (both Nuclear and BOP).
- Cables Assessment
- Turbine / Generator assessment

One of the most complex tasks is ensuring that all SSCs are covered, yet not expending unnecessary effort in areas of little concern. Therefore, all the systems and major structures or equipment were reviewed to screen out those areas that can be handled in a normal outage and do not need to be addressed during the refurbishment outage. Then the systems are assessed with a further screening of components. For further assessment efficiency the common components are grouped as commodities. This requires project planning to achieve the desired comprehensive yet efficient result. It also requires effective communication both internally to NASA, AECL and between the respective parties. This requires a strong relationship and creative approaches to ensure information flows effectively.

Figure 1 shows typical links and the interface between different studies.

Estimate Sheet Study Name	SI	Large Nuclear Pumps 0	Large Nuclear Heat Exchangers 0	Large Nuclear Vessels 0	Nuclear Piping 0	PHT & Auxiliary Systems Valves 33000	Steam Generators 0	Motors 50210	Cable Tray 57000	Cables 0
RB Airlocks & Containment Doors	21651									
Shielding Equipment	21652									
Reactor Building Liner	21900									
Turbine Building	22000									
Main Moderator System	32110	X	X		X			X	X	X
Moderator Purification System	32210		X		X					
Main Heat Transport Circuit	33100	X			X	X	X	X	X	X
PHT Feed and Bleed System	33310	X			X	X		X		
PHT Pressure & Inventory Control System	33320	X		X	X	X		X		
PHT D2O Storage, Transfer & Recovery System	33330				X	X			X	X

NASA Alone
NASA Alone with AECL review
NASA lead with AECL help
AECL Lead with NASA input

Figure 1 Typical Project Links

As part of the cooperation between NASA and AECL, the data gathering for all the studies will be performed by NASA, with AECL providing assistance on the walkdowns.

3.2 Tools and Guides

The Embalse NGS PCA is using state of the art methodologies and techniques that are novelties in the industry.

A few of the improved methodologies and techniques are discussed below:

3.2.1 3D Laser Scanning

The 3D Laser Scanning software gives very accurate measurements and will be used to provide a virtual view of the equipment while minimizing radiation dosage on the personnel. AECL's complete and innovative 3D Laser Scanning Service accurately and efficiently gathers 3D point data from any environment. Measurements and notes may also be saved with the scan data for future reference. Generation of this 3D point data is achieved by taking precise 3D pictures/scans of an environment at various locations. Each of these scan files is embedded with millions of three dimensional distance information points relative to the 3D scanner's location. For Embalse, a 3-D laser scan has been done in preparation for the retube task of the refurbishment.

For the Embalse NGS PCAP, the 3D Laser Scanning could be used for the feeders condition assessment and eventual replacement and to determine the as-built condition and to confirm the actual location of some of the piping and supports.

Figure 2 shows a 3D laser scan taken at Embalse

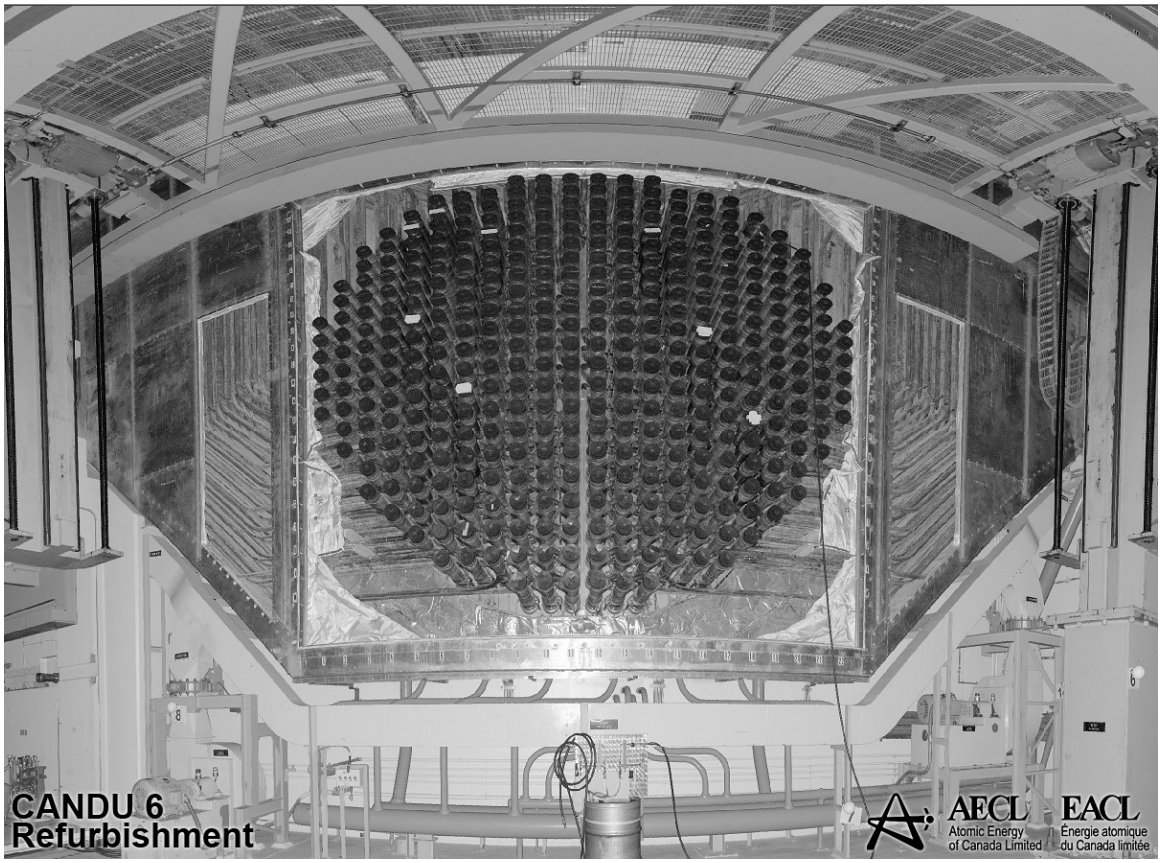

Figure 2
3D Laser scan at Embalse

3.2.2 Guides for Aging Management Reports

For the Embalse NGS PCAP, three set of guides have been developed as following:

a) Procedures

Detailed Procedures for the SSCs Life Assessment and Condition Assessments have been prepared specifically for this Project.

b) Templates

The specific intent of the procedural guidelines is to provide guidance in the form of descriptive text and examples to facilitate carrying out the aging assessment methodology as it applies to the Embalse Refurbishment Project and to produce an aging assessment report that meets the requirements of aging assessment procedures.

The detailed guidance allows the utilization of a broader skill level of the assessors while ensuring that the reports are consistent in style and content.

NASA provided inputs to the guides and developed a chart for ranking Aging Related Degradation Mechanisms (ARDMs) that became a part of the procedural template. The excellent contributions received from NASA helped AECL to improve and refine its procedural templates.

c) Guidelines for Aging Assessment of Equipment

CA and LA methodologies are used to assess the effect of degradation on SSCs and to determine the appropriate inspection and mitigation techniques to manage aging. One of the key elements of both methodologies is an aging evaluation wherein the focus is on ARDMs.

To aid in determining which ARDMs should be considered and evaluated, three detailed guide documents have been prepared:

1. Concrete Structures
2. Instrumentation, Controls and Electrical components
3. Process and Mechanical Equipment

These guide documents include terminology and data related specifically to equipment aging. They provides the user with a standard set of aging related degradation mechanisms for the equipment, and offers guidance on narrowing this list down into those that are relevant to the application.

The Guides use as an input, amongst others, the AECL Maintenance Template Database. The database organizes the information following the logic shown in Figure 3.

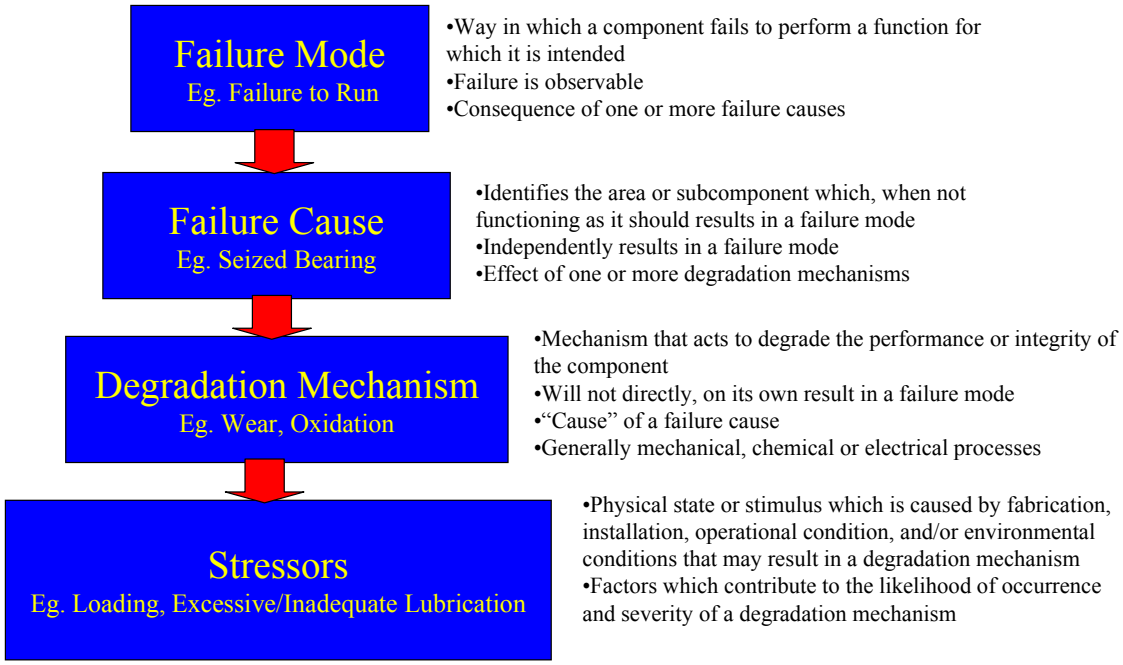

Figure 3 -
Generic Component Maintenance Templates

The ARDM Guide structure identifies the following set of data for each different material applicable at Embalse:

- Material
- ARDM
- Description
- Applicability/Stressors
- Rate of Progression
- Effects
- Detection Management

3.3 Pilot Projects

Following the training provided by AECL, NASA performed four pilot aging assessment studies for the following equipment:

- Steam Generators
- Feeders

- Main Feedwater Pumps
- D2O Feed Pumps

The pilot aging assessment studies have proved to be very beneficial. Based upon assessment findings, Embalse staff, who were involved in developing the PLiM Program for Embalse with AECL, initiated a number of detailed inspections, identifying areas for further assessment or where improvements in existing programs should be implemented.

The pilot studies have determined the health prognosis of the equipment and the path forward for extended operation. As an outcome of the Steam Generator Life Assessment, the replacement of the tube bundle is being evaluated.

The lessons learned from the Pilot studies have been incorporated into the project procedures.

3.4 Walkdowns

As an input to the Aging Assessments, walkdowns are being performed. In addition to the inspections being performed by Embalse personnel, walkdowns of some critical components such as feeders and nuclear piping, and critical areas in the civil and electrical areas have been or are being performed by AECL.

There are many sites under Embalse's existing inspection programs that are already marked for and followed with NDE. The attached Figure 4 shows standard inspection points for one such NDE.

The walkdown is necessary to assess the current condition of the equipment and is complimentary to the existing Inspection Programs.

Figure 4 – Piping walkdown (inspection sites are marked on the piping)

4. Conclusion

At the Emblase NPP in Argentina, a project is successfully underway to define the refurbishment outage scope. This project is systematically assessing the condition of the plant System, Structures, and Components, to compile recommendations for both life attainment and life extension, including those recommendations associated with refurbishment activities.

The Embalse Pre-Refurbishment Project has provided an opportunity for a teamwork approach between NASA and AECL, which is desired in order to deal with the complexities of the project. As part of this effort to work together to achieve the goal of providing a Plant Condition Assessment is to use assessment guides to control the work and ensure consistency. This is further enhanced by using guides providing generic CANDU inputs pertinent to aging assessment. These guides include the appropriate templates, procedures and instructions along with assessment of aging degradation mechanisms guidelines. While developing these the aging assessment methodology has been improved.

Well executed pilot studies have proved an effective launch into the project. The project, with the enhancements incorporated, is expected to be very successful.

5. References

[1] Nuclear Power Plant Life Management Processes**:** Guidelines and Practices for Heavy Water Reactors, IAEA TECDOC-1503, June 2006.

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[4] Maintenance and Life Assessment of Steam Generators at Embalse Nuclear Station, P. Luna, G. Diaz, H. Sveruga, R. Sainz, 5th CNS International Steam Generator Conference**,** Toronto, 2006.