EMERGENT MAINTENANCE ISSUES RELATED TO POINT LEPREAU REFURBISHMENT

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Abstract

Preparation for PLGS refurbishment was a major undertaking that used a separate and dedicated Refurbishment Project organization with a strong focus to achieve important short-term goals. During preparation for refurbishment, several emergent issues were experienced related to outage maintenance and the development of maintenance plans for extended operation. This paper discusses these issues from the perspective of the plant operations and maintenance (O&M) organization, which has the responsibility to manage ageing and maintenance programs after the refurbishment outage.

The observations and examples presented in this paper are shared so that some minor improvements in the interaction between the O&M and Refurbishment Project organizations might be realized in future projects and reduce the risk of emergent maintenance issues.

1. Introduction

Three NBPN initiatives contributed to defining the inspection and maintenance activities required for PLGS life extension, including the scope of work during the Refurbishment Outage. These initiatives are: the Ageing Management Programs (AMPs), the Integrated Safety Review (ISR), and the Condition Assessment Program (CAP). These initiatives have some common objectives related to managing component degradation, but they have organizational differences that affect the control of work activities.

The AMPs are on-going programs, including System Health Monitoring (SHM) and Equipment Program Plans (EPPs) that have long-term objectives. The AMPs use station processes and procedures to implement work activities and use established contacts within the CNSC and station workgroups for implementation and communication. The AMPs are coordinated within the station operations and maintenance (O&M) organization. On the other hand, the ISR and CAP were one-time efforts in the Refurbishment Project, which has a defined end point and shorter-term focus. The ISR and CAP were managed by an organizational structure separate from the plant, and often used contacts and work practices that were different to the O&M organization.

This paper briefly describes these initiatives and shares operating experience about emergent maintenance challenges that arose from organizational issues associated with planning for PLGS life extension. An awareness of these challenges may help other utilities avoid similar

issues that could result in schedule delays and increased O&M costs during planning, refurbishment, and extended operation.

2. Preparation for Extended Operation

In February 2000, the NBPN Board of Directors authorized a feasibility study for PLGS life extension and created a Refurbishment Project, to define the scope and develop a business case. The Refurbishment Project had two distinct tasks that contributed to defining maintenance and inspection scope:

1. A CAP to examine the condition of systems, structures, and components (SSCs) important to the continued safe and reliable operation of the station.

2. An ISR to identify and resolve the nuclear licensing issues associated with refurbishment and with extended operation.

In response to planning for PLGS life extension, AMP activities also expanded. A major objective was to develop long-term inspection and maintenance plans, including plans for the Refurbishment Outage to support the basis for extended operation. This was done simultaneously with the ISR and with inputs from the CAP.

The maintenance-related contributions of these three initiatives to the Refurbishment Outage and the relationship with ongoing ageing management are shown in a simplified flowchart in Figure 1. Two points are noteworthy about this figure. First, there are three sources for establishing the scope of the Refurbishment Outage, the AMPs, the CAP, and the ISR. These three sources were managed by two different parts of the organization, plant O&M and Refurbishment Project, which had varying degrees of interaction in carrying out the work to develop and implement the scope. Second, regardless of the origin, the results and assessment of Refurbishment Outage activities stream back into the plant O&M programs for extended operation. Brief descriptions of the AMPs, CAP, and ISR related to refurbishment scope and life extension are given in the following sub-sections.

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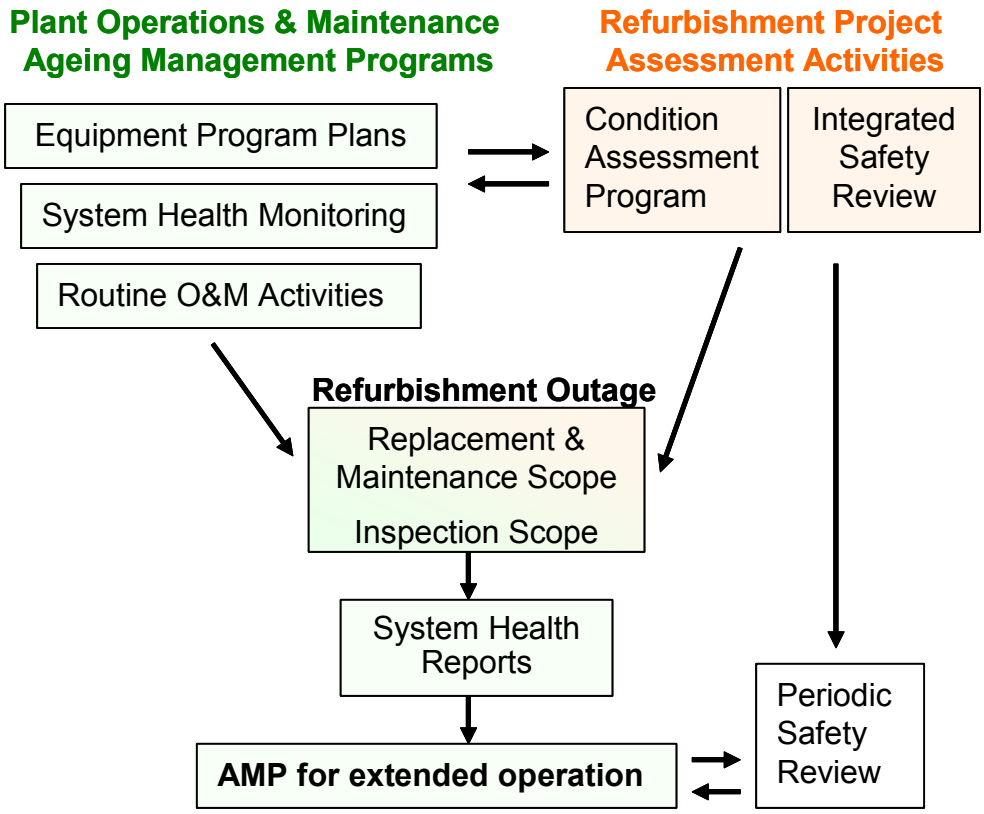

Figure 1. Simple Illustration of the Interrelationships between the Refurbishment Project and AMPs Related to Maintenance.

2.1 Ageing Management Programs

Ageing and degradation of systems, components, and structures (SSCs) are managed at PLGS using the Management System Process Model [1], which was developed in the mid 1990s following a period of poor performance. The main elements of the PLGS AMPs are EPPs for SSCs and degradation mechanisms that are high risk-drivers and the SHM program, which provides on-going condition assessment of safety-related SSCs.

The plant O&M organization and AMPs focussed on the following tasks for refurbishment and extended operation:

- Providing input on the most recent information from OPEX and R&D during design planning for refurbishment
- Providing staff to help ensure fabrication, installation, and commissioning of new SSCs are compliant with procedures
- Developing and implementing activities to protect SSCs from degradation during lay-up
- Collecting baseline condition information for new components (feeders) and original components that are normally impractical to inspect (calandria vessel internals)
- Updating ageing management strategies and EPPs for post-refurbishment operation.

2.2 Condition Assessment Program

One of the first major tasks of the PLGS Refurbishment Project was the CAP [2], a rigorous and comprehensive assessment of the current condition of station equipment including a prognosis for 24 FPY extended operation. The CAP produced 162 assessment reports ranging in length from 25 to 260 pages depending on the complexity of the system being assessed. The CAP reports generated about 1600 final recommendations. After substantial review and input from the plant O&M organization, 162 recommendations were selected for implementation to meet refurbishment goals. Another 697 that could be valuable to longer-term ageing management were provided to system engineers for consideration in their on-going programs.

2.3 Integrated Safety Review

Following CNSC advice, the PLGS Refurbishment Project completed an ISR in 2003, a comprehensive, formal review to demonstrate that the plant meets the intent of modern safety requirements. The requirements of an ISR, described in the CNSC Regulatory Document RD-360 [3] are consistent with the IAEA Safety Standard for a Periodic Safety Review [4]. The two elements (or "safety factors") from the ISR that are relevant to inspection and maintenance are "Management of Ageing" and "Condition of SSCs Important to Safety". The PLGS ISR assessed the effects of ageing, the effectiveness of the AMPs for extended operation, and the need for improved or additional inspection and maintenance activities. Inputs from sources such as CAP design reviews against current codes and standards and specific PLGS studies related to safety margin improvements were used.

Implementation of CAP and ISR maintenance and inspection recommendations began during the same period as CNSC review of the ISR. The majority of the recommended activities were managed with in Refurbishment Project organization. Some of inspection activities were similar in scope and objective to those performed by the plant O&M organization.

3. Examples of Emergent Maintenance Issues

During the preparation for any large project some emergent issues are not unexpected. The PLGS Refurbishment Outage is the first project of this nature for the CANDU 6 design, which makes it important to capture lessons that can benefit subsequent projects. This section provides examples of emergent inspection and maintenance issues related to PLGS Refurbishment that provide insight into how some aspects of the preparation phase can be more effective.

3.1 AMP Feeder Crack Baseline Inspection Method Rejects Acceptable Manufacturing Features

The PLGS AMP requires a relatively small crack inspection scope to manage the low risk of feeder cracking during post-refurbishment operation. From NBPN experience performing baseline inspections of replacement feeder bends, it was known that the COG industry standard procedure to inspect for cracks is more sensitive to volumetric features than the manufacturing

QA inspection method. Some benign, acceptable manufacturing features are rejectable to the COG procedure. As a result, as part of the ageing management strategy for feeders, a baseline volumetric inspection is required to record indications that are manufacturing related. Preventing false positive calls from benign features is especially significant to NBPN because six bends were replaced unnecessarily because of false positive crack indications in 2005 [5].

This operating experience and the AMP requirement for a baseline inspection prior to feeder installation at PLGS was not factored into Refurbishment Project planning. Performing the baseline inspection introduced risk to fabrication schedule and guidelines to manage the possibility of detecting manufacturing features were not available.

Co-ordinating the AMP baseline inspection requirements and Refurbishment Project fabrication requirements early during planning stages can help avoid unanticipated issues and schedule delays.

3.2 AMP Steam Generator Lay-up Requirements Impact Refurbishment Activities

Outage conditions can have acute or, more commonly, cumulative long-term consequences for steam generator (SG) materials degradation [6]. For this reason, the AMP specifies lay-up conditions so that (i) SG components will attain 24 FPY extended operating life and (ii) to keep secondary side chemical cleaning (which also contributes to degradation) available as a maintenance option during extended operation.

Lay-up conditions are strongly dependent on plant state, such as drained down, availability of a nitrogen blanket, recirculation, etc. However, because they are often indirect and not immediate, the impacts of plant state on steam generator degradation are generally not obvious to the outage planning organization. This introduces risk that outage decisions to meet short-term Refurbishment Project objectives will not be in line with long-term operational objectives.

Considering AMP requirements in Refurbishment Outage planning and implementation can reduce the risks to extended operation from plant state and lay-up conditions. Establishing and monitoring success criteria would increase awareness so that risk-based outage decisions are balanced between short and long term needs.

3.3 ISR and CAP Require AMP to Track Specific Maintenance Activities during the Refurbishment Outage to Support Extended Operation

As described in sections 2.2 and 2.3, the CAP and ISR recommended inspection and maintenance activities to be performed to support safety and reliability requirements during extended operation. Because the ISR and CAP were one-time programs, it was not considered the role of the Refurbishment Project to implement and track many of these activities. The station O&M work management system was expected to implement them and on-going AMP programs were expected to follow-up and assess their results.

Establishing a link between the ISR, CAP and the O&M work management system would facilitate implementation and assessment of recommended inspection and maintenance activities to support the basis for safe, reliable extended operation.

3.4 Additional Expectations for Calandria Vessel Management Following Regulatory Review of the ISR

The calandria vessel inspection (CVI) scope for the Refurbishment Outage was developed within the Refurbishment Project, based on CAP results. However, following regulatory review of the ISR and introduction of AMP requirements, the plans for implementing the CVI activities, post-CVI assessment and reporting were enhanced to address the additional expectations. The ISR regulatory review also generated additional requirements for on-going management of the CV within the AMP.

Good interfaces between the AMP and Refurbishment Project to develop inspection scope and early consideration of regulatory concerns can help avoid Refurbishment Outage inspection requirements and possible schedule changes.

3.5 Design Change to Hooked Tight-Fitting Spacers Resulted in Un-Anticipated Effort to Demonstrate Compliance with CSA 285.4-05

Spacers with a welded girdle wire that are detectable with eddy current inspection methods were part of the original PLGS replacement fuel channel design. Part way through the Refurbishment Project, this was replaced with the hooked, tight fitting spacer design that is not reliably detectable until after 100,000 FPH operation. Based on technical arguments, this change was not considered to create a reliability or safety issue. However, license requirements about compliance with CSA 285.4-05 resulted in an unanticipated level of effort to support post-refurbishment AMP activities. New inspection and analysis methods and procedures needed to be developed to demonstrate there would be no pressure tube to calandria tube contact during the first 100,000 FPH post-refurbishment operation.

Considering post-refurbishment AMP requirements to comply with the CSA standard in the design change process would reduce regulatory and schedule risks.

3.6 International Regulations Add Expectations for Post-Refurbishment Operating Limits

During regulatory review of the ISR and CAP, additional regulatory expectations emerged based on USNRC guidelines [7] regarding fatigue management for life extension. The general approach of the American guidelines, which were developed specific to the PWR and BWR designs, is applicable to the CANDU design but the methods are not.

NBPN and COG assessments [8] of this issue indicate that the risk to PLGS post-refurbishment aging management is low because PLGS has relatively low design cycle usage and improvements to HTS start-up chemistry have reduced the impact of environmental effects. This

issue may be more problematic for stations with higher usage of cycles or environmental conditions that are less favourable.

Considering significant issues for license renewal in other countries can reduce the risk of unanticipated regulatory expectations.

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3.7 Additional Requirements for AMP Following Regulatory Review of the ISR

Regulatory review of the ISR safety factor on Management of Ageing was influenced by the CNSC approach to ageing management [9], which follows the IAEA framework. Because the PLGS AMPs are based on INPO processes [10], assessment against CNSC expectations was not straightforward. This contributed to an action item for the plant O&M organization to demonstrate how ageing is managed at PLGS in the context of CNSC expectations. Additional information on this subject is provided in Reference 1.

Preparing the ISR results in context for a more straightforward regulatory review can be facilitated by:

- Interaction with the part of the station organization responsible for activities related to the safety factor, and
- Appreciation of the basis for regulatory review of ISR safety factors.

4. Concluding Remarks

This paper provides insights about the preparations for life extension and refurbishment from the perspective of the plant O&M organization, which has responsibility to manage ageing and maintenance programs after the refurbishment outage. Preparation for refurbishment is a major undertaking that requires a separate and dedicated organization with a strong focus to achieve important short-term goals. Coordination and interaction between the Refurbishment Project and plant AMP organizations is key to ensure long-term goals of the organization are also achieved. Examples of emergent maintenance issues are shared in this paper so that some minor improvements might be realized in future projects. Based on our experience, general advice is presented in three areas below.

First, recognizing that the short and long-term goals sometimes result in conflicting requirements, integrated outage planning processes that include input from both organizations will be more effective. For example, AMP requirements regarding steam generator drain down time and conditions needs to be coordinated with Refurbishment Project activities and schedule.

Second, because the results of all the Refurbishment Project activities eventually become the responsibility of the plant O&M organization, good interfaces between the two organizations can reduce the risk of emerging maintenance issues for the AMPs. For example, inspections specified by the Refurbishment Project need to be consistent with the plant ageing

management methods and procedures. Also, specific work management system processes are needed to effectively transfer accountability for tracking and assessing results that support the technical bases of the CAP and ISR for extended operation. This can be accomplished by using tracking codes that identify work that is required to validate CAP or ISR conclusions.

Finally, it is important to be aware of international experience related to life extension issues, which can influence regulatory reviews of documentation and plans. At PLGS, additional effort was required to manage fatigue and to demonstrate effective ageing management program to address different expectations from NUREG and IAEA standards. As the Canadian regulatory requirements for life extension become more formalized, the risks from this issue will diminish. However, keeping abreast of international experience is prudent.

5. References

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