ELECTIVE MAINTENANCE BACKLOG REDUCTION AT ONTARIO POWER GENERATION DARLINGTON NUCLEAR

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Abstract

Elective Maintenance (EM) work orders document deficiencies in nuclear power plant equipment which is degraded, but still functioning. The detailed definition of EM is found in the Institute of Nuclear Power Operations (INPO) Document AP928, Work Management Process Description. Industry experience shows that there is a direct correlation between low EM backlogs and a low Forced Loss Rate at nuclear power plants.

Since 2005, Darlington Nuclear has reduced its EM backlog from a total of 3100 work orders (775 per unit) to 1600 by year end 2007. Darlington reached a backlog of 1400 (350 per unit) in August, 2008. This level of backlog is considered 'live zero" or sustaining level for a highly reliable four unit Candu nuclear power plant and is in line with Industry Best Practice. Improvement in plant reliability has been evident and consistent throughout Darlington's Backlog Reduction Program.

This paper documents the history of backlog reduction at Darlington Nuclear and the specific methodologies used to achieve this success. It is structured around four phases. Details of each phase are provided and lessons learned discussed.

The four phases are:

1) Data Review and Cleanup/Fix-It-Now (FIN) Team Focus;

2) Improve FIN Performance/Increase EM Work Orders Scheduled;

3) Improve Schedule Rigor/Rapid EM Work Order Turnaround/Increase Resource Utilization;

4) Engineer Solutions for "Hardened"/Aged Backlog.

The role of FIN team is also discussed in detail in terms of their mandate, organization and work methods.

Introduction

Ontario Power Generation (OPG) is an Ontario Canada based electricity generating company with a total installed capacity of 22,000 Megawatts (MW). It owns and operates three nuclear power plants: Pickering A (2 X 542 MW), Pickering B (4 X 540 MW) and Darlington.

Darlington Nuclear is a 4 X 934 MW CANDU nuclear power plant, located on Lake Ontario, 50 kilometres east of Toronto. The first unit was declared in service in 1990 and the last unit in 1993.

OPG Nuclear follows industry standard work management process described in the Institute of Nuclear Power Operations (INPO) document AP928, Work Management Process Description.

AP928 describes a process used to identify, select, plan, schedule and execute work in a manner that helps ensure high levels of safe and reliable plant operation while promoting the efficient use of resources and improvement of equipment material condition. AP928 also provides standard definitions of work classification.

EM work orders document deficiencies in nuclear power plant equipment which is degraded but still meets its design function. Industry experience shows that there is a direct correlation between low EM work order backlogs and a low Forced Loss Rate (FLR), the percentage of time a nuclear power plant is off-line due to unplanned outages or power reductions.

Since 2005, Darlington Nuclear has reduced its EM backlog from a total of 3100 work orders (775 per unit) to 1600 by year end 2007. Darlington reached a backlog of 1400 (350 per unit) in August, 2008. This level of backlog is considered 'live zero" or sustaining level for a highly reliable four unit Candu nuclear power plant and is in line with Industry Best Practice. Improvement in plant reliability has been evident and consistent throughout Darlington's Backlog Reduction Program.

The other major classifications of work orders are:

- Corrective Maintenance (CM) – deficiencies in nuclear power plant equipment which is out-of-service and unable to perform its design function. At Darlington, this is a very low number (less than10 per unit) and is at a level consistent with Industry Best Practice.

- Other Maintenance (OM) – predictive maintenance, modifications or cleaning and painting of nuclear power plant equipment or maintenance on equipment not associated with production of electricity.

This paper documents the history of backlog reduction at Darlington Nuclear and the specific methodologies used to achieve this success. It is structured around four phases of backlog reduction. Details of each phase are provided and lessons learned discussed.

Phase I – Data Review and Cleanup/Fix-It-Now (FIN) Team Focus

In 2004, OPG Nuclear adopted the industry standard classification of work orders as per AP928.

As part of this reclassification to AP928 definitions, a manual data review was undertaken which included:

- Closeout of duplicate work orders;
- Closeout of stranded work orders (work orders which were essentially complete but required final closeout of support tasks).

Good data management and data analysis are essential to the success of any backlog reduction program. The data must clearly represent outstanding plant deficiencies in order to allow for efficient planning, scheduling and execution of work.

Data analysis was used extensively to monitor and manage Darlington's Backlog Reduction Program. OPG uses industry standard software Passport for work management, and Primavera 3 (P3) for scheduling. OPG has built an in-house application, Nuclear Inage Management System (NIMS), to interface these two programs and provide a data warehouse.

A number of metrics were established to monitor overall progress and highlight specific areas that challenged the Program going forward.

Process improvements were continually made based on these metrics and as a result of the changing nature of the remaining backlog work.

The FIN team is a very important part of backlog reduction in all phases.

AP928 defines FIN as a self-sufficient, cross-functional work group capable of independently executing work orders without support. This team executes work outside the plant's Online Weekly Maintenance Schedule (The Schedule).

The team's primary responsibility is to address emergent activities such that Maintenance and Operations resources are not distracted from scheduled work.

The resource make-up of the team evolved over time as well as the nature of work they executed. It is often said that the FIN team's primary role is to "Protect the Schedule".

The mature FIN team, currently in place at Darlington Nuclear, is discussed in the next phase.

Phase II – FIN Performance Improvement/Increase EM Work Orders Scheduled

The mature FIN team at Darlington Nuclear consists of sufficient skilled Maintenance and Operations resources to execute 55 percent of EM work orders.

The team reviews all new incoming work orders each day as part of the New Work Meeting, and selects work it can successfully undertake. The team also takes emergent work at the request of the Shift Manager.

As part of data analysis and to predict backlog reduction going forward, a mathematical model for EM work flow was created.

CHANGE in EM Backlog Per Week = New EM INFLOW – EMs COMPLETED by FIN – EMs CANCELLED – EMs COMPLETED through The Schedule

Data indicated that on an average weekly basis:

- INFLOW = 100 EM work orders
- FIN COMPLETED = 55 EM work orders (55 percent of INFLOW)
- CANCELLED (due to duplicate work or efficient bundling of several work orders) = 12 work orders.

The model calculated that a minimum of 30 EM work orders needed to be completed through the Schedule each week in order to maintain backlog at current levels. Forty (40) EM work orders needed to be completed to achieve the required rate of backlog reduction.

The Work Control Process used this 30 to 40 range as a target for EM work orders scheduled each week.

The plant leadership team and staff were kept focused on EM backlog reduction.

The actual backlog was reported at the Darlington's Plan of the Next Day (POND) meeting, where the participants consisted of senior leaders, managers and coordinators from Maintenance, Operations, and other support groups.

Simple metrics showing current backlog versus target were posted throughout the plant and articles were regularly written for the employee electronic newsletter. This was an important way to keep staff engaged in the Program.

A weekly presentation was made to the senior leadership team where metrics were shown highlighting current challenge areas. A multi-disciplined Strategic Backlog Reduction team presented solutions for discussion and approval.

This Strategic Backlog Reduction team consisted of working-level managers from Maintenance, Engineering, Operations, Work Control and Supply Chain.

Phase III – Improve Schedule Rigor/Rapid EM Work Order Turnaround/Increase Resource Utilization

A maturing backlog reduction program is characterized by:

- Data that is representative of actual work and
- FIN work that is clearly defined with FIN executing a significant amount of all work orders.

Non-FIN work must be rigorously scheduled to ensure efficient planning, scheduling and execution.

Elements of a good schedule include:

- Rigorous reviews of proposed work orders (scope) by all work groups, up to 24 weeks prior to execution
- Rigorous control of additional scope to ensure schedule stability
- Proper alignment of work to maintain safe and efficient plant configuration
- Detailed planning of work to ensure successful and efficient execution
- Bundling of work on single equipment to minimize equipment outages
- Matching work to available Maintenance and Operations resources (resource leveling)
- Final acceptance of the Schedule by all work groups at about three weeks prior to execution (walk down)
- Rigorous adherence to the Schedule during execution.

To further facilitate backlog reduction, a "short cycle" process was introduced.

The work orders selected for this process were simple, but beyond the normal scope of FIN. The work was planned with priority and scheduled through the normal processes.

If maintenance resources became available, this work was reviewed and executed "off schedule". If not completed "off schedule", the work was executed as per its original schedule.

Phase IV – Engineer Solutions for "Hardened"/Aged Backlog

With total backlog reduced to less than 1600 (400 per unit), further reduction required getting difficult "Hardened"/Aged work orders planned and executed.

Much of this work required procurement of substitute parts where original parts were obsolete or otherwise unavailable. Procurement of these types of parts represents a significant challenge across the nuclear industry.

A multi-discipline Holds Removal Team (HRT) was put in place to expedite procurement of parts or engineer other solutions for these work orders.

The HRT consisted of working level staff from Work Control, Supply Chain, Engineering, Operations, and Maintenance. Face-to-face meetings were conducted twice weekly or more frequently as required.

Of key importance was the multi-disciplined nature of this team and face-to-face communication.

Conclusion

This paper has discussed the successful Elective Maintenance Backlog Reduction Program at Ontario Power Generation, Darlington Nuclear using a four phased approach.

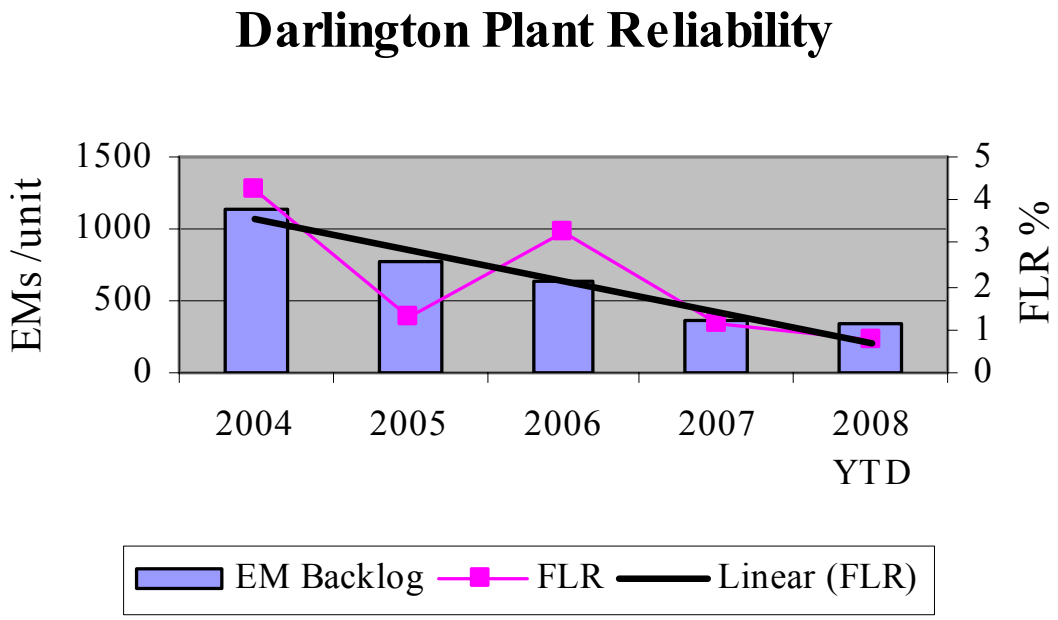
Significant teamwork and process improvements were made at Darlington in order to achieve these results.

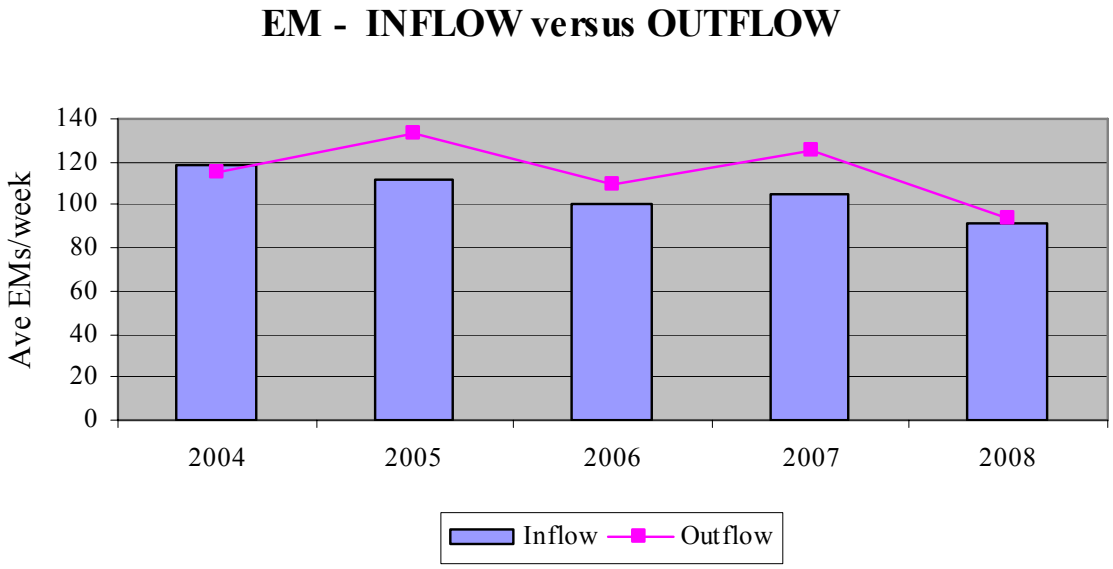
Plant reliability, as demonstrated by Forced Loss Rate, improved from 4.24 percent in 2004 to 0.77 percent in August of 2008.

The role of the FIN Team in support of EM backlog reduction was also discussed.

Work continues in the final phase of the program to plan and execute "Hardened"/Aged work orders. Darlington's stretch target for 2008 is 325 EM work orders per unit.

Appendix A: Darlington EM Backlog Reduction Metrics





Darlington EM Backlog - 2008