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Benchmark Report on Key Outage Attributes: An Analysis of Outage Improvement Opportunities and Priorities

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Benchmark Report on Key Outage Attributes: An Analysis of Outage Improvement Opportunities and Priorities

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ABSTRACT

Advanced Outage Control Center (AOCC), is a multi-year pilot project targeted at Nuclear Power Plant (NPP) outage improvement. The purpose of this pilot project is to improve management of NPP outages through the development of an AOCC that is specifically designed to maximize the usefulness of communication and collaboration technologies for outage coordination and problem resolution activities.

This report documents the results of a benchmarking effort to evaluate the transferability of technologies demonstrated at Idaho National Laboratory and the primary pilot project partner, Palo Verde Nuclear Generating Station. The initial assumption for this pilot project was that NPPs generally do not take advantage of advanced technology to support outage management activities. Several researchers involved in this pilot project have commercial NPP experience and believed that very little technology has been applied towards outage communication and collaboration. To verify that the technology options researched and demonstrated through this pilot project would in fact have broad application for the US commercial nuclear fleet, and to look for additional outage management best practices, LWRS program researchers visited several additional nuclear facilities.

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1.1 Overview of AOCC Pilot Project

Advanced Outage Control Center (AOCC), is a multi-year pilot project targeted at Nuclear Power Plant (NPP) outage improvement. The purpose of this pilot project is to improve management of NPP outages through the development of an AOCC that is specifically designed to maximize the usefulness of communication and collaboration technologies for outage coordination and problem resolution activities.

1.2 Purpose of Benchmarking Activities

This report documents the results of a benchmarking effort to evaluate the transferability of technologies demonstrated at Idaho National Laboratory and the primary pilot project partner, Palo Verde Nuclear Generating Station. The initial assumption for this pilot project was that NPPs generally do not take advantage of advanced technology to support outage management activities. Several researchers involved in this pilot project have commercial NPP experience and believed that very little technology has been applied towards outage communication and collaboration. To verify that the technology options researched and demonstrated through this pilot project would in fact have broad application for the US commercial nuclear fleet, and to look for additional outage management best practices, LWRS program researchers visited several additional nuclear facilities. Additionally, researchers documented various physical layout aspects of the OCCs currently in use to identify best practice attributes to include in an AOCC concept layout.

Figure 1. Advanced Outage Control Center Concept

2 Facilities Observed for Benchmarking

2.1 Arizona Public Service/Palo Verde

Palo Verde has been the primary utility partner supporting this pilot project. LWRS researchers have observed outage activities during the previous 3 refueling outages. LWRS staffs have unescorted access at Palo Verde and have spent time at each of the outage support centers documenting activities. Much of the work involving technology implementation and evaluation has occurred at Palo Verde; therefore Palo Verde is the reference that the benchmark plants will be compared to. The primary observations of outage activities at Palo Verde include:

1. Palo Verde uses 3 OCCs, one for each unit. This arrangement allows the close access to the OCC for unit in outage, but requires upgrades and maintenance of 3 physical centers.
2. At the start of this pilot project, most of the status displayed in the OCC was static information on whiteboards and paper printouts. Currently, most information is displayed in both static and dynamic fashion on a video wall and supported by collaboration software. The use of collaboration software to host the displays allows this information to be viewed and updated from any work station on site. Use of this technology has been noted to reduce the amount of telephone requests for status and reduced the effort required to manually update the status boards.

Figure 2. Palo Verde OCC Before

Figure 3. Palo Verde OCC After

3. Normal staffing levels in the OCC are approximately 14 staff members. During routine briefs, as many as 30 persons are in the OCC. Use of the collaboration software for OCC displays will likely reduce the number of staff assigned to the OCC, as their primary purpose was simply to update status displays.
4. Palo Verde had previously noted weaknesses in their emergent issues response (Issues Response Team). The first process improvement implemented at Palo Verde involved providing communication and collaboration tools for the Issues Response Team (IRT). The process improvement involved implementations of a standard issues package based on the IRT process as it was at the time using existing and new templates for knowledge capture and transfer. The standard issues package was built using collaboration software with the intent of being able to display the information on a PC or a large format touch screen to support team activities.
5. Outage management at Palo Verde have identified that voice communications for outage management are not currently adequate. They currently rely on radio communications for mobile communications and are using all available channels. They are interested in pursuing alternative forms of voice communication, such as Voice over IP (VoIP) or cellular.
6. Outage management is also interested in software to help monitor schedule adherence during the outage. They are currently using a software application called Qlikview that runs on P6 data to provide this function, but the displays are not exactly what are desired. Palo Verde staff has been creating their own displays to work on the Qlikview output to support this need. The particular form of schedule monitoring that supports outage management will become even more important when real time status is available by use of electronic work packages.
7. Palo Verde effectively uses high quality video cameras to monitor work progress in the turbine building, containment and the refuel floor. These cameras are currently power-over-Ethernet type cameras that require running wires at the start of the outage. They are interested in pursuing the concept of WiFi cameras to provide temporary job monitoring capability outside of the currently covered areas.

2.2 St. Lucie

LWRS researchers visited the St. Lucie Nuclear Power Plant March 25th through March 27th 2014. St. Lucie Unit 2 was in refueling during the visit and routine outage activities were observed. LWRS staff obtained unescorted access to facilitate observations and interviews of a support center staff as well as the main OCC. The primary observations were:

1. St. Lucie uses very little technology in the OCC, less than Palo Verde. They primarily rely on dry erase boards and static printouts.
2. Experiences at Palo Verde are directly applicable to St. Lucie. If the research had started at St. Lucie, the results would probably have been the same.
3. The staff was very interested in the pilot project activities. LWRS staff actually set up the maintenance team room with some tools and they were planning on trying some things before the end of the current outage.
4. Data collection forms worked just fine at St. Lucie. Their outage organization was very similar to Palo Verdes.
5. St. Lucie uses a common OCC for both units, while it lacks technology, the size and layout was quite good. They have a large conference room directly next to the OCC and briefs where held in that room to eliminate distractions and allow everyone to see each other and be seated.
6. Normal staffing levels in the OCC where comparable to Palo Verde, approximately 14 staff assigned to the OCC.

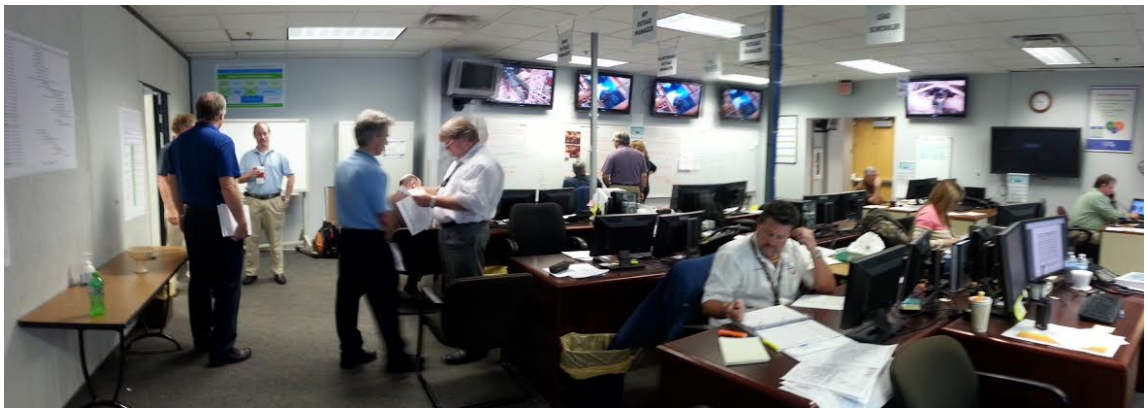

Figure 4. St. Lucie OCC

2.3 Farley

LWRS researchers visited Plant Farley July 22nd through July 23rd 2014. Both units were online during the visit, but an online emergent issue requiring plant down power was in progress and the OCC and IRT were activated. The primary observations were:

1. Farley uses a common OCC for both units. The physical size of the OCC was sufficient, but the layout was not ideal. The layout included large monitors on 2 opposing walls and all the work stations faced inward such that half of the OCC staff could one wall, with the other wall of monitors behind them. The content that was displayed on the monitors was limited to one

workstation that was opposite that monitor. Several additional large screen monitors are available for status. Dry erase boards and paper schedules also relied upon for status tracking.

2. Normal staffing levels in the OCC are lower than observed at Palo Verde; approximately 9 staff assigned to the OCC. Similar satellite outage support centers are also used.
3. Farley has experienced similar communication and collaboration issues with their Issues Response Team as Palo Verde. Farley intends to implement the standard issues package concept during their upcoming fall refueling outage. LWRS staff will observe outage activities at Farley during the outage and evaluate their implementation effectiveness.
4. Farley also uses power-over-Ethernet cameras for job monitoring, and was also interested in the concept of wireless cameras. They currently have a plant wide WiFi program in place, but it will likely take several years to complete.
5. Farley was also interested in the concept of migrating outage status displays in the OCC to collaboration software. They will be performing such a migration prior to their fall refueling outage. They also indicated an interest in making this information available on a tablet device to allow outage managers access to all the OCC displays as they travel around the site and attend meetings outside the OCC. LWRS staff will observe and evaluate the value of this concept during the fall refueling outage.

Figure 5. Farley OCC

Figure 6. Farley OCC alternate view

2.4 Sequoyah

An LWRS researcher visited Sequoyah on August 26th. Both units were online during the visit. The researcher met with outage managers from Sequoyah, Watts Bar and TVA corporate offices to discuss outage technology implementation. The primary observations were:

1. Sequoyah uses a common OCC for both units. The physical size of the OCC provides plenty of room for routine and non-routine meetings. A large conference table is available in the OCC. Several monitors are available to display outage status and video feeds from the field. Several projection style SMART boards are available but primarily used as displays only. Dry erase boards and paper schedules are also used to display status.
2. Normal staffing levels in the OCC are similar to Palo Verde, approximately 15 staff are assigned to the OCC. Similar satellite outage support centers are also used.
3. Sequoyah has experienced similar struggles with emergent issues as Palo Verde. Sequoyah intends to implement the standard issues package prior to their next outage (spring, 2015). INL staff will assist Sequoyah with implementation of the standard issues package.
4. Sequoyah has two small collaboration rooms just outside the OCC. These rooms include a small conference table and two PCs in each room. Each room also contains a projection style SMART board, but they are not currently used.
5. Sequoyah was also interested in the concept of migrating outage status displays in the OCC to collaboration software. They will be performing such a migration prior to their spring refueling outage. They also indicated an interest in making this information available on a tablet device to

allow outage managers access to all the OCC displays as they travel around the site and attend meetings outside the OCC. LWRS staff will observe and evaluate their technology implementation during their next refueling outage.

Figure 7. Sequoyah OCC

Figure 8. Sequoyah OCC alternate view

2.5 Advanced Test Reactor

LWRS researchers are working with staff from INL's Advanced Test Reactor (ATR) to improve outage coordination. While ATR is not a commercial power reactor, they conduct frequent plant outages to change research experiments in the reactor core. Because of the frequency of outages, LWRS staff will be allowed to more quickly implement process changes and observe results. The close proximity of ATR also allows additional research opportunities without the travel costs associated with commercial power plants. The primary observations working with ATR are:

1. The ATR has unique challenges and advantages for our research and data collection:
    a. Reactor runs are typically sixty days or less with two week runs being the mininum
    b. Average of seven outages a year allowing for quicker turn around on response to technology deployment and process changes
    c. The staff that run the outages are always the same staff members which reduces effort needed to get staff up to speed on changes related to out improvement initiative
    d. All outages include refueling and experiment(s) movement
    e. Schedule is driven by experiments not fuel burnup
    f. Upcoming outages will start to be driven by aging equipment and maintenance needs
    g. No pictures or video are allowed without special permissions with the excepting of an underwater camera used to view equipment, experiment, and fuel handling in the canal
    h. Non outage related meeting typically occur in the OCC because of limited meeting rooms
    i. No live video feeds are sent to the OCC to watch outage activities
    j. There is no assigned issue response team, an adhoc process is used
    k. Remoteness that is defined by the INL large desert site has created a physical barrier for research staff to collaborate easily with ATR staff. Initial meetings with research management has revealed a willingness to explore communication and collaboration technologies to allow remote parallel decision making a possibility.
    l. ATR is open to the idea of a virtual OCC where OCC staff and ATR superivors and managers have mobility through the use of wireless mobile technology. At this time it appears that they will deploy Microsoft Surface tablet computers to support this concept.

2. ATR uses an OCC, although they are only staffed on day shift. Monday-Thursday are typically ten-hour days and Friday is a twelve hours. Overtime is a common practice due to staff resource limitations.
3. Normal staffing levels are significantly lower than a commercial power plant with a typical composition of seven staff. On a typical outage day OCC support staff will enter the OCC with information but typically only reside in the OCC during the two daily meetings or special meetings with the exception of the OCC Manager and two other staff members.
4. ATR has a very informal process for emergent issues and does not have a well-defined process to resolve them.
5. No satellite OCCs exist at ATR.
6. Physical configuration of the OCC, current tools and technology in the OCC:

a. Seven laptops with a monitor on desks around the perimeter
b. Ten –place conference table in the middle
c. One semi-office area setup for Outage Manager
d. Two seventy-inch large monitors on south wall– written material displayed (i.e. outage meeting agenda, schedule info, etc.)
e. Three large whiteboards and one very small one behind outage manager
f. Space size approximately 18x14 feet
g. OCC is on second floor of ATR building and requires access by staff
h. No satellite OCCs

7. Security restrictions due to research involving US Navy fuels complicate technology deployment. At this time no electronic devices are allowed pass the access controlled doors to the reactor support building.
8. ATR staff immediately saw the benefit of using collaboration software to support outage planning and execution. LWRS staff are assisting ATR staff with the implementation of collaboration software to support their upcoming outage (September, 2014).
9. LWRS staff are assisting ATR staff with creation of a formal issues response plan that will be supported by a standard issues package similar to that used by Palo Verde.
10. An ATR specific change management process and plan has been developed and is a living document within a dedicated OneNote. More formality is required to identify key stakeholders and outage improvement project team members.
11. Frequent, intensive collaborations occur between experiment researchers located in town and ATR staff at the site that is scheduled on a weekly basis. Collaboration tools including SMART Boards, live video and collaboration software will be utilized to reduce the travel required to support operations.

3 Summary and Conclusions

3.1 Summary of Results

Table 1. Summary Table Comparing Benchmark Sites on Key Outage Attributes

		Key Outage Attributes		
		Physical Layout	**Organizational Structure**	**Level of Technology Adaptation**
Benchmark Site	**Palo Verde (Initially)**	Narrow, crowded. Converted conference room	Distributed, Several satellite centers staffed 24/7.	Some camera feeds, Whiteboards and paper status, several monitors.
	St. Lucie	Larger, Attached conference room and outage managers office	Similar to Palo Verde	Some camera feeds, mostly whiteboards and paper.
	Farley	Larger, center focused	Similar to Palo Verde	Some camera feeds, electronic status monitors for each workstation
	Sequoyah	Large, Conference table in the OCC, 2 collaboration rooms adjacent to the OCC.	Similar to Palo Verde	Some camera feeds, Several Projection type SMART boards but primarily used as displays.
	ATR	Laptops with monitors facing the wall and one center conference table	Much smaller, closer coordination required with experiment managers	Two large screen monitors

3.2 Conclusions

The overall conclusion is that the NPPs visited all use a similar outage organization, have similar levels of technology deployment, and have similar outage management processes. The implication of this conclusion is that process improvements developed at any site should be easily transferable to other NPPs as well as experimental reactors such as the ATR. Despite the overall similarities, each site has adopted various technologies and processes to improve outage management to address unique challenges and each are continuously looking for additional best practices to further improve.

3.3 Recommendations

Based on observation of outage activities and conversations with outage managers and staff at various levels at multiple NPPs, the following are recommendations for future research.

1. Create a website to collect lessons learned from technology deployments and process improvement activities at NPPs. Outage managers are always eager to learn about ideas from other utilities. The typical outage manager is extremely busy preparing for the next outage, and usually does not have time to research all the available technologies and figure out how best to implement them. All of the outage managers that INL researchers have interacted with indicated they would appreciate such a tool to help them identify and implement technology and process improvement ideas. Each utility visited so far has also expressed interest in participating in a Pilot Project Working Group to share lessons learned.
2. Provide on-site demonstration of AOCC concepts and provide support to NPPs attempting to implement these concepts. Although the similarities in outage organizations allow the transfer of outage process improvement and technology implementation ideas from one utility to another, differences in technology infrastructure require customization for effective implementation. It has been shown that providing just a day or two of support can provide the utilities the confidence and clear vision required to commit to outage process improvement.
3. Continue to visit NPPs to benchmark outage processes and technology implementations and to recruit members for the Pilot Project Working Group. Each site visited has provided new ideas and concepts for outage management, and more ideas for individual technology implementation and technology integration. Additional ideas are sure to be discovered by involving more utilities in the Pilot Project Working Group.