

## **Deployment of Performance Management Methodology as part of Liquid Waste Program at Savannah River Site – 12178**

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### **ABSTRACT**

In 2009, Savannah River Remediation LLC (SRR) assumed the management lead of the Liquid Waste (LW) Program at the Savannah River Site (SRS). The four SRR partners and AREVA, as an integrated subcontractor are performing the ongoing effort to safely and reliably:

- Close High Level Waste (HLW) storage tanks
- Maximize waste throughput at the Defense Waste Processing Facility (DWPF)
- Process salt waste into stable final waste form
- Manage the HLW liquid waste material stored at SRS

As part of these initiatives, SRR and AREVA deployed a performance management methodology based on Overall Equipment Effectiveness (OEE) at the DWPF in order to support the required production increase. This project took advantage of lessons learned by AREVA through the deployment of Total Productive Maintenance and Visual Management methodologies at the La Hague reprocessing facility in France. The project also took advantage of measurement data collected from different steps of the DWPF process by the SRR team (Melter Engineering, Chemical Process Engineering, Laboratory Operations, Plant Operations).

Today the SRR team has a standard method for measuring processing time throughout the facility, a reliable source of objective data for use in decision-making at all levels, and a better balance between engineering department goals and operational goals. Preliminary results show that the deployment of this performance management methodology to the LW program at SRS has already significantly contributed to the DWPF throughput increases and is being deployed in the Saltstone facility.

### **INTRODUCTION**

Approximately 140 million liters of high-level waste (HLW) are stored in 49 underground carbon steel tanks at SRS. Savannah River Remediation LLC is responsible for managing the Liquid Waste Program consisting in safely recovering and stabilizing the HLW stream in order to accelerate the tank closure.

With a challenging target to close HLW tanks, the SRR team developed an aggressive program to optimize its chance for success. The complexity of the mission is well depicted by the following figure showing how each part of the Liquid Waste System need to be enhanced to meet the goal set for the project.

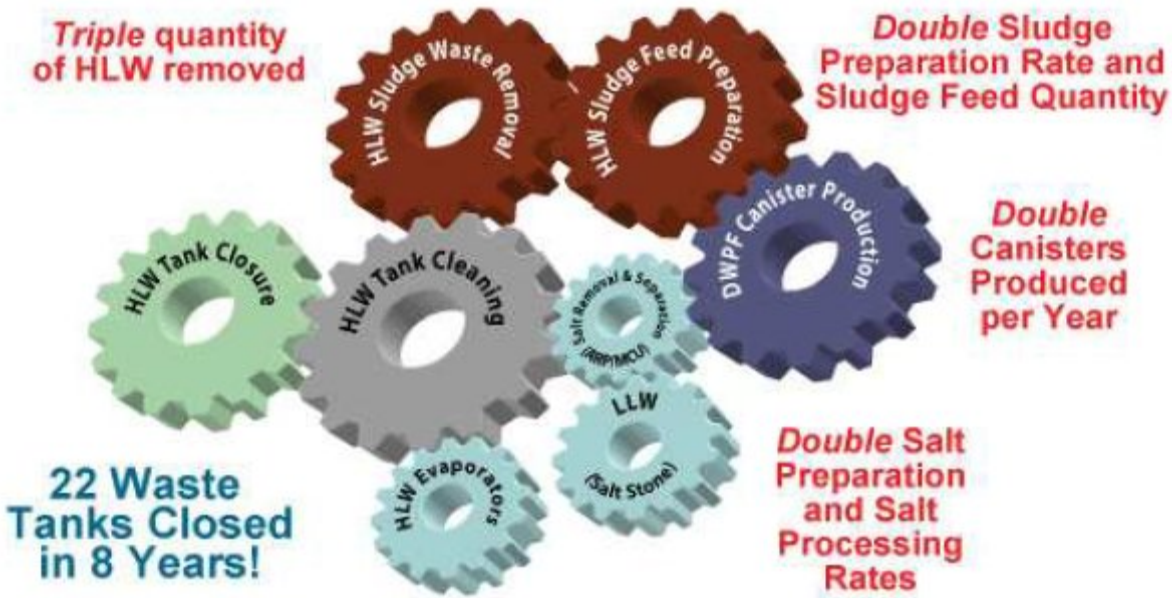


Fig 1. Summary of SRR mission to reach the Liquid Waste Program goals

SRR has applied expertise from its parent companies and subcontractors to develop innovative technical approaches that implement enhancements and technologies that significantly increase waste removal, waste treatment, and base operations capacity through integrating system components to optimize performance.

In parallel to the deployment of enhanced technologies, initiatives were undertaken to encourage organizations in charge of operating the facilities that support the LW program (e.g. DWPF, Saltstone) to more effectively focus on production performance while maintaining the highest level of safety.

In particular, it was determined that doubling the Defense Waste Processing Facility (DWPF) annual throughput was required to support the program. More precisely, the Liquid Waste System Plan [1] shows nominal production rates for DWPF increasing from 186 canisters/yr in FY10 to 325 canisters/yr in FY11 and finally reaching and sustaining 400 canisters/yr from FY12 onward.

Several initiatives were planned to enhance DWPF process and technology and align its performances with the program goals. Prominently, the DWPF melter has been retrofitted with bubblers [2] and extensive work is on going to optimize the chemical characteristics of feeds during its preparation.

Thanks to its experience in managing HLW vitrification facilities in France, including deploying similar throughput enhancement programs [3], AREVA proposed to deploy performance management methodology to support the required production increase at DWPF. Experience in France proved that such methodology and management practices help sustaining high level of industrial performances without compromising safety, which is key for SRR succeeding in its mission.

## METHODOLOGY

## Overall Equipment Effectiveness

Overall Equipment Effectiveness (OEE) is a standard approach to industrial performance management. This tool provides a way to assess plant performances through measuring its:

- Availability
- Performance rate
- Quality

Availability tracks downtime beyond the planned outage periods required to maintain the plant within standards. Performance tracks time when the plant under (or over) performs compared to a defined reference. Quality measures the amount of acceptable product. The values are determined as shown:

$$\text{Availability} = (\text{Feed Time}) / (\text{Feed Time} + \text{Unplanned Outage}) \quad (\text{Eq. 1a})$$

$$\text{OR} \\ = (\text{Feed time}) / (\text{Calendar Time} - \text{Planned Outage}) \quad (\text{Eq. 1b})$$

$$\text{Performance} = (\text{Reference cycle time} \times \text{Output}) / \text{Feed time} \quad (\text{Eq. 2})$$

$$\text{Quality} = (\text{Acceptable product}) / (\text{Total product}) \quad (\text{Eq. 3})$$

$$\text{OEE} = \text{Availability} \times \text{Performance} \times \text{Quality} \quad (\text{Eq. 4})$$

In the DWPF case, the reference cycle time was chosen to be 18 hrs per canister. This is corresponding to the instantaneous design throughput of 228 lbs/hr for the melter and was consistent with the Liquid Waste objectives. Assumptions of required planned outage durations were made to measure availability. Quality was assumed to be unity, based on historical data from DWPF operations. At this point, OEE targets for each Fiscal Year are computed in order to meet the system plan objectives.

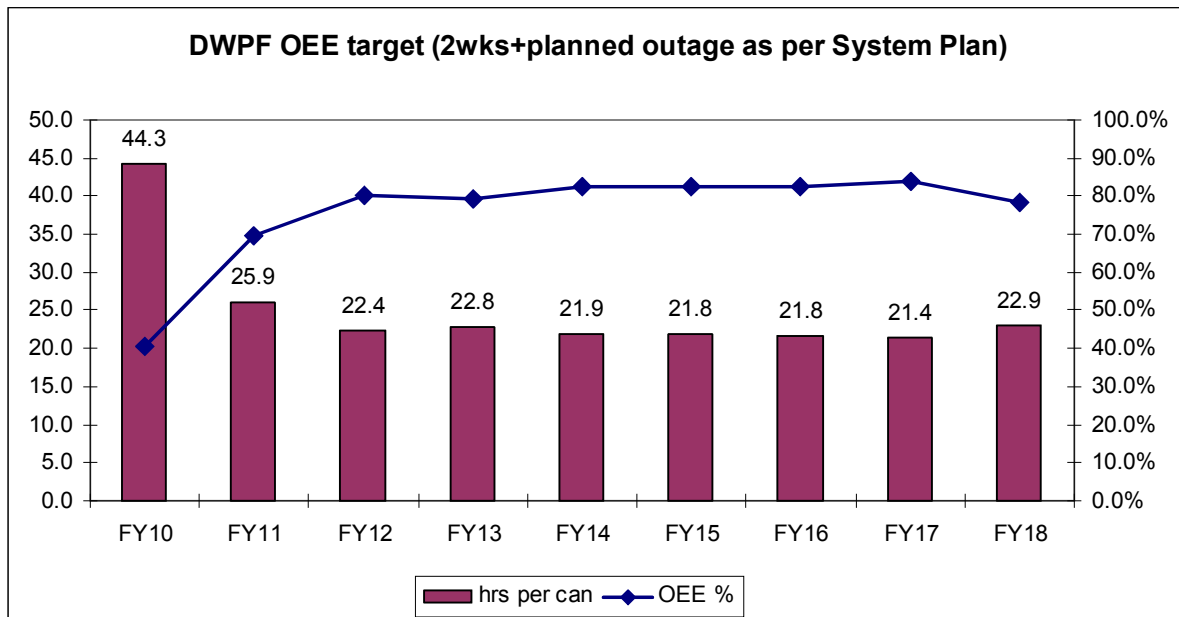


Fig 2. System Plan targets as OEE

## Analysis of process cycle times

The computation of OEE requires the analysis of process times in different locations of the process within the plant. Building on previous experience from DWPF team, it was decided to focus on the Sludge Receipt and Adjustment Tank (SRAT) and Melter to initiate OEE deployment as these were known bottlenecks of the facility:

- On the SRAT side, the Chemical Process Group had led a 6-Sigma initiative to decompose the feed preparation operations performed in SRAT to several elementary steps. The times for each step were recorded for each feed batch processed. It was possible to define reference times for each of these steps consistent with OEE practice. This addition allows systematic collection of data about causes for times spent outside the reference times.
- On the melter side, the Melter Engineering Group had been recording melter feed breaks (including details about feed breaks causes) for a longtime. The addition of the reference cycle time for the melter then allowed a detailed analysis of the feeding time in terms of performances.

Thanks to these existing measurements, some historical OEE and cycle times were computed and analyzed to demonstrate the feasibility of the methodology deployment.

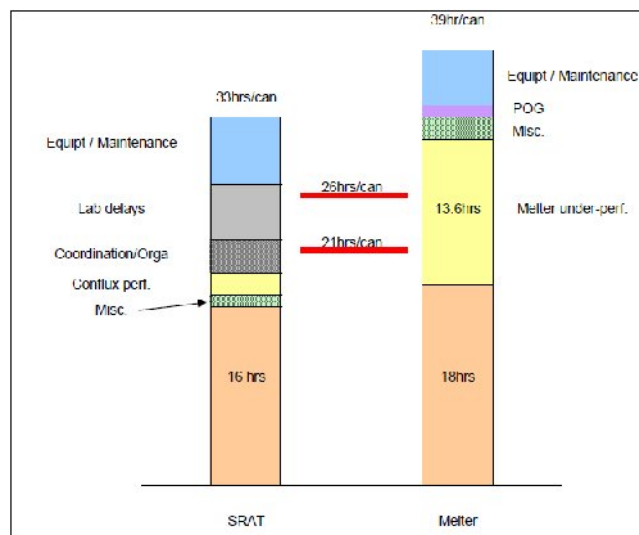


Fig 3. Initial SRAT and Melter cycle time analysis (Dec.08 – Sept.09)

Actually, beyond the computation of OEE, the true benefit of the methodology resides in its ability to provide support in decision making process regarding bottlenecks and identification of the most time consuming problems faced by the plant. To reach this point, the causes for under-performance and downtime have to be tracked and recorded accurately and systematically. The addition of reference cycle times for both DWPF and individual parts of the process (i.e. SRAT, Melter) enabled a more systematic analysis of cycle times and identification of delays. The identified delays can then be ranked using Pareto charts.

Another important concept for practical implementation of such methodology is to harmonize the way cycle times are recorded and analyzed. The definition of a common metric is paramount for the efficiency of the methodology. In particular, this facilitates the communication between teams in charge of different parts of the process. AREVA experience in deploying such methodology in Vitrification facilities suggested that a convenient unified metric is the “hours per can”. As part of

the analysis, standard categories for the times to be recorded were also defined (e.g. normal operation, underperformance, unproductive, administrative, external causes, etc.) helping sorting out the causes for downtime and underperformance.

Finally, the methodology is also providing adequate quantitative data to define KPIs in order to manage the plant performances. The definition of these KPIs is relying on the analysis of cycle times and on the targets derived from the system plan.

### Methodology deployment

The critical aspect for the deployment of OEE was the tight schedule to be met to align with the program objectives. In addition, the deployment came together with several other initiatives to be implemented within DWPF. The challenge was thus to propose a deployment fast enough for benefits to be drawn early while respecting the necessary pace to allow acceptance by the plant teams.

The relevance of data analysis is also key to decide about the frequency of the different support meetings:

- Weekly consolidation meetings are working sessions with data trackers and representatives from operational groups (operation, laboratory, maintenance). These meetings help to reconcile the data between the different groups and gain a common understanding of causes and responsibilities for delays.
- Quarterly steering meetings are dedicated to the presentation of results once data has been analyzed. From experience, it is the minimal time required for aggregating data in a relevant manner. These meetings are dedicated to set new actions and review results from former actions. Shorter time scales would lead to individual events being over emphasized with the risk to modify directions too quickly based on such isolated events.
- In between, at a monthly time scale is coming a meeting dedicated to the review of action plan in order to make sure progress are made swiftly. These meeting can help resolving issues and deciding priorities according to short term events to be manage as part of everyday operation.

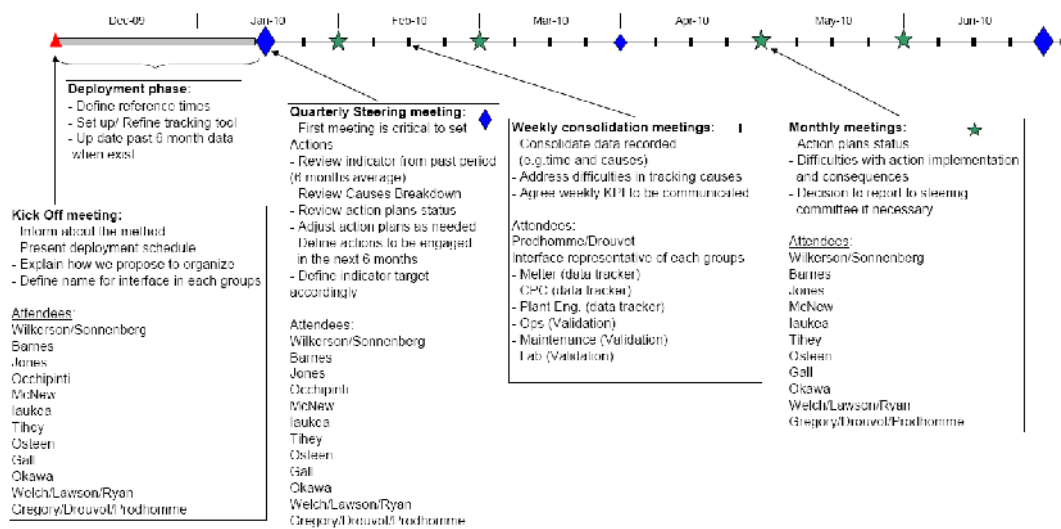


Fig 4. Planned deployment schedule

The dynamic of deployment resulting from the execution of this plan proved to be well tuned to meet SRR objectives.

### **Organizational behavior**

As explained earlier, the success in implementing such methodology within a plant organization requires gaining acceptance by the different teams belonging to the organization. To meet this goal, a preliminary condition is to benefit from a strong support by the top management. In DWPF, the OEE initiative was efficiently supported by the head of the Waste Treatment Operations and sponsored by the DWPF facility manager. The acceptance by the teams also resulted from the fact that pre-existing data and initiatives were re-used whenever possible and that the experience from the different groups (engineering, operation, maintenance, etc.) was accounted for and integrated.

A time period is also necessary for people to get accustomed to the overall methodology. Experience shows that at least one year is necessary for the methodology to find its way within such organizations and gain acceptance.

In parallel, the group in charge with the deployment of the methodology has to seize any opportunities to use the outcome from OEE analysis as inputs to other meetings and initiatives in order to accelerate improvements by other parts of the organization. This was performed in DWPF through:

- Turning the former weekly melter information meeting into a production driven operational meeting between representatives of all groups and DWPF management. During this meeting the performance of the plant was analyzed and short term directions and priority are decided.
- Integrating new KPIs based on OEE analysis within the monthly plant performance meeting.
- Using OEE analysis to support specific 6-Sigma initiatives.
- Using OEE analysis to initiate a review of the Vulnerability Analysis, which defined the criteria for managing preventive maintenance, defining spare parts policy etc.

Finally, the success of the deployment heavily relied on finding the right balance between existing experience and practices versus “fresh-eye” views and benefits from the new methodology.

### **RESULTS TO DATE**

Production results in DWPF are resulting from the hard work of all the teams and necessarily integrate the benefits from the various initiatives deployed to date. Integrative by nature, the deployment of OEE methodology supported these results by providing a standard method for measuring processing time throughout the facility, a reliable source of objective data for use in decision-making at all levels, and a better balance between engineering department goals and operational goals.

### **Review of DWPF OEE**

Over the period considered (from Jul. 09 to Sept.11), DWPF OEE has been influenced by several factors. The chemical and physical characteristics of the sludge batches (from SB5 to SB7a) have a primary impact on production as it can move the bottleneck within the plant.

Depending on these characteristics, the bottleneck has been found being alternatively the Melter, the SRAT, and the Slurry Mix Evaporator demonstrating the complexity of managing the facility performances.

In spite of these aspects, the work performed by the teams resulted in a record production of 267 canisters for FY11. Numerically, this performance resulted from an increase in DWPF OEE from 41% for FY10 to 57.5% for FY11.

The final quarter of FY11 showed outstanding results with an OEE of 75% aligned with the required OEE targets to be met in the coming years.

### **Improvement in smoothing operation management**

One of the areas where the OEE methodology has been very efficient consisted in smoothing operation management of the various steps of the feed preparation process. Historically, this part of the process was not the bottleneck of the facility allowing the operating teams to take liberties with time in managing it.

With enhancements made on the melter, more challenging feed characteristics, and aggressive production targets, the management of feed preparation by the operating team became critical and revealed several paths for improvement.

While keeping its focus on safely operating the facility, operating teams succeeded improving the cycle times of the feed preparation process by smoothing its management (e.g. by anticipating time when laboratory analysis became available, by improving communication with the Tank Farm to perform transfers, etc.).

The gain in cycle time came from reducing underproductive, administrative and underperformance delays by properly communicating to shift personnel the achieved performances and expectation in terms of goals.

### **Extension to visual management**

As the work with the teams on shift proved to be successful, it has been decided to deploy Visual Management tools to further enhance communications within operating teams to manage more challenging production targets.

AREVA has been deploying Visual Management on La Hague site in France for several years as part of a broader Total Productive Maintenance initiative and thus benefitted from lessons learned and templates used in similar type of industrial environment. Building on this experience, a Visual Management board was defined and proposed for DWPF to communicate goals and achievements.

## **CONCLUSIONS**

As part of the liquid waste program on Savannah River Site, SRR committed to enhance production throughput of DWPF. Beyond technical modifications implemented at different location of the facility, SRR deployed performance management methodology based on OEE metrics. The implementation benefitted from the experience gained by AREVA in its own facilities in France.

OEE proved to be a valuable tool in order to support the enhancement program in DWPF by providing unified metrics to measure plant performances, identify bottleneck location, and rank the most time consuming causes from objective data shared between the different groups belonging to the organization.

Beyond OEE, the Visual Management tool adapted from the one used at La Hague were also provided in order to further enhance communication within the operating teams.

As a result of all the initiatives implemented on DWPF, achieved production has been increased to record rates from FY10 to FY11. It is expected that thanks to the performance management tools now available within DWPF, these results will be sustained and even improved in the future to meet system plan targets.

## REFERENCES

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