OMNI™ Condenser Performance and Macrofouling Program Saves Utility $3MM Per Year

OMNI™ Condenser Performance

NALCO Water
An Ecolab Company

CASE STUDY - POWER

CH-2027

BACKGROUND

This 910MW, two-unit nuclear plant uses brackish bay water for once-through condenser cooling. A sponge ball-cleaning system minimizes condenser tube fouling. No chemical treatment program has been used for biological control in circ water because: 1) The Chesapeake Bay, where this plant is located, is an ecologically sensitive ecosystem - gaining environmental discharge approval for a biocide was thought to be impossible. 2) The anticipated cost to treat such large volumes of cooling water (1.2 million gpm per unit) could not be justified.

SITUATION

Macrofouling has negatively impacted the performance of this power plant for most of its nearly 40 year operating life. The hydroid *Garveia Franciscana* grows throughout the twelve cooling water intake tunnels and circulating water piping. Research studies conducted on the Chesapeake Bay have shown conditions that favor the growth of this (invasive, non-native) hydroid species include water temperatures above 55° F and a flow velocity below 2 fps. As the hydroid growth progresses, it restricts the water flow through the circulating water piping. Once the growth of hydroids reaches a

Customer Impact	eROI™	Economic Results
Reduced risk of employee injury during mechanical cleanings	SAFETY	$100,000 was saved by eliminating the labor costs for cleanings
Reduced loss of generating capacity associated with poor condenser performance and downpowers	ENERGY	$3,000,000/yr generating revenue was restored
Improved standing with the NRC by reducing downpowers and associated "reactivity control" risk	ASSETS	Reduced costs to mitigate the reactivity control risk

eROI is our exponential value: the combined outcomes of improved performance, operational efficiency and sustainable impact delivered through our services and programs.

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certain mass on the walls of the intake tunnels and cooling system piping, it sloughs off in matts that foul the inlet tube sheets of the condenser, as shown in this photo. Inlet tube sheet fouling leads to higher temperature rise and backpressure on the condenser. The result is a loss of unit operating efficiency (increased heat rate) and a loss of generating capacity. Approximately 15 mechanical cleanings of the condenser water boxes were performed each year. In addition to manpower costs, each cleaning requires the unit be "downpowered" with an associated loss in generating revenue.

SOLUTION

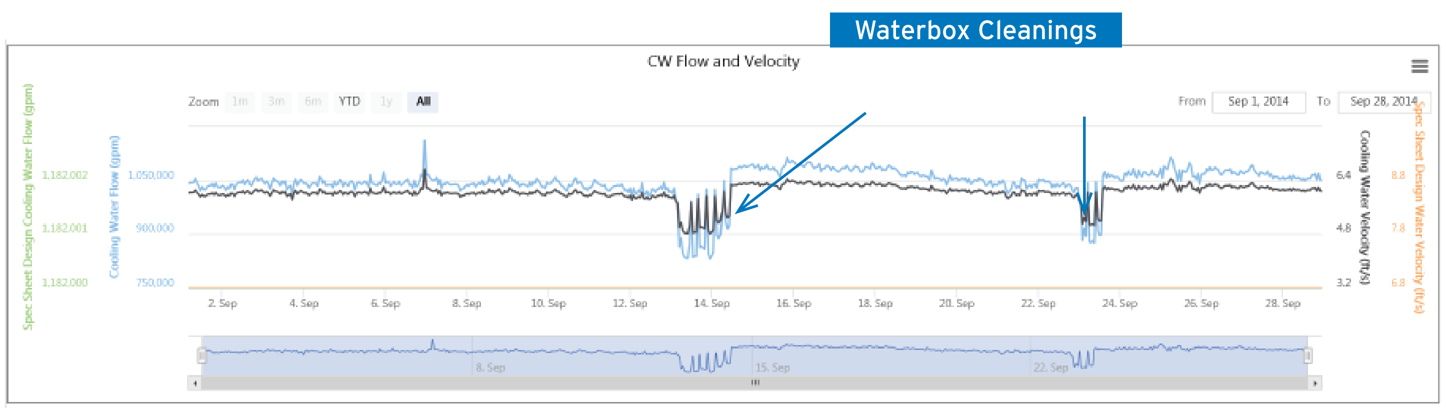
The OMNI Condenser Performance program utilizes actual condenser and unit performance data from the plant historian. The program calculates several performance metrics and compares these to design values to determine the relative cost or "penalties" associated with poor condenser performance. The program was installed at this nuclear plant to better understand and measure the impact of macrofouling on condenser performance, unit operating efficiency and plant profitability. It also measured the value of a proposed macrofouling control program*.

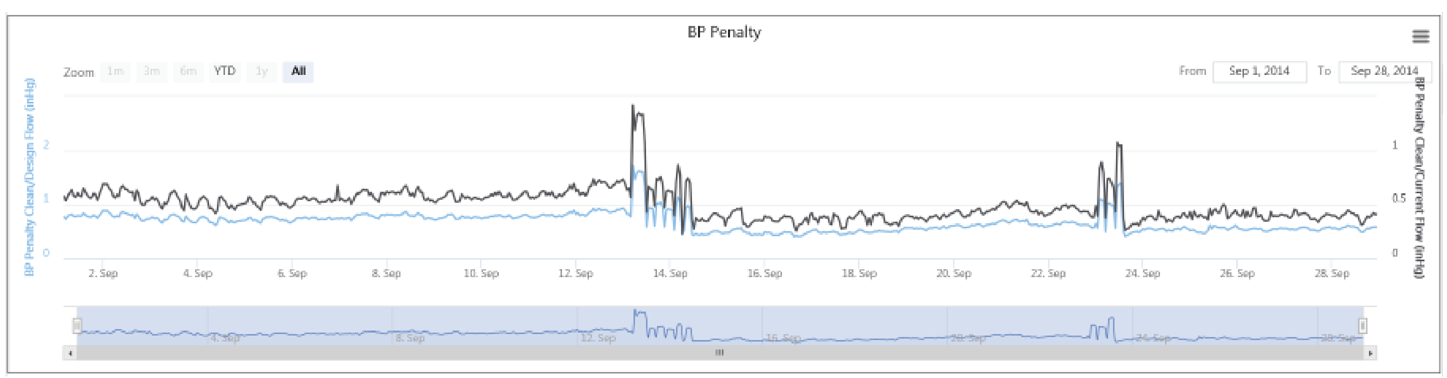
The top trend graph below shows the total circ water flow and velocity before and after two mechanical cleaning events to remove hydroids from a single waterbox. Total cooling water flow increased ~100,000 gpm and the flow velocity increased ~0.5 fps, after the mechanical cleanings. This improved flow resulted in improved heat transfer across the condenser tubes and a reduction in backpressure penalty, as shown in the bottom graph.

With macrofouling, we normally observe several telltale changes in condenser performance metrics. As the inlets to tubes become covered or plugged, the available surface area for condensing steam is reduced. Consequently, steam temperature and backpressure rise. With decreased cooling water flow and flowrate through the condenser, the residence time increases causing each gallon of water passing through the condenser to pick up more heat. The result is an increase in condenser outlet water temperature, and an increase in temperature rise (TR) across the condenser. Likewise, the terminal temperature difference (LP exhaust steam temp minus cooling water outlet temp) will rise along with TR when macrofouling occurs.

A macrofouling control program was initiated to prevent the growth of hydroids on the walls of the intake tunnels and cooling water piping. The OMNI program tracked the impact of that treatment on condenser performance and unit operating efficiency.

These trend graphs compare the TR and TTD deviation from design values without the macrofouling treatment (top graph) and, during the same period a year later, with Actibrom treatment (bottom graph). This comparison shows the TTD deviation decreased from 8°F without the macrofouling control treatment to ~2°F with treatment, and the temperature rise was likewise reduced.





The macrofouling control program was Nalco Water ActiBrom 1338

RESULTS

One of the useful aspects of using the OMNI program is that it quantifies the costs associated with poor performance and the value of implementing treatment programs or other corrective actions. Because of the macrofouling control treatment, condenser performance was improved and it was no longer necessary to perform mechanical cleanings. An estimated 110,000 megawatts of generating capacity was restored as a result of no longer having to perform downpowers for cleaning and improved condenser cleanliness and performance. A conservative value for the revenue associated with this restored generating capacity is $3,000,000 per year. An added $100,000/yr in labor savings was realized by eliminating the many mechanical cleanings of the waterboxes to remove macrofouling.

Nuclear plants strive to eliminate unit downpowers whenever possible. Downpowers pose the risk of "reactivity control" problems as the nuclear reaction is manipulated to reduce steam production and MW generation. The effectiveness of the program allowed this customer to eliminate 15 downpowers per year and the associated reactivity control risks.