Seawater Cooling System Modifications Eliminate Pump to Save 5.5MW in Ultra Mega Power Plant

Power Generation

AFT IMPULSE™ CASE STUDY

Applied Flow Technology

PROBLEM

C Suresh Ram, Tata Consulting Engineers, was tasked with assessing a coal-fired Ultra Mega Power Plant cooling system to address poor pump operation while ensuring any modifications do not introduce waterhammer or surge concerns.

The plant consists of five units, each cooled by independent once-through seawater cooling systems. Each cooling water system is driven by two parallel pumps each with a rated capacity of 63,000 m3/hr (277,000 gpm)

The owner proposed interconnecting the pumps of multiple units to reduce the number of pumps necessary to meet design requirements, reducing energy and improving operational flexibility. The existing system, as drawn and as modeled, is found in Figure 1.

ANALYSIS

Ram's analysis began in AFT Impulse's steady-state solver to calibrate the model's pipe roughness to match pressure and flowrate measurements.

Frictional loss was estimated as the system lacked pressure measurement instruments. The calculated frictional loss was consistently less than the original design loss, indicating oversized pumps leading to poor performance. A comparison between the calibrated model and observed data is found in Table 1.

The calibrated model was then used to evaluate cases with various parallel units connected. It was vital to confirm adequate flow distribution to each condenser unit, testing the system with any one of the connected pumps off in turn. This process was performed with three, four, and all five units connected.

"AFT Impulse was very easy to adopt, creating any number of variations was easy, and the study could be completed in the short given time."

- C Suresh Ram, Tata Consulting Engineers Limited

SOLUTION

The sensitivity study found only four interconnected units met all condenser requirements with any seven of the eight connected pumps, reducing energy requirements by 5.5 MW and improving pump operation.

However, the proposed changes required the system to be re-evaluated for hydraulic transients. The new study was to confirm the adequacy of a previous study's valve closure behavior and surge protection equipment. Ram's study evaluated a range of pump trips using built-in Four Quadrant curves, from planned trips of each pump individually to the worst-case sudden power failure to all working pumps.

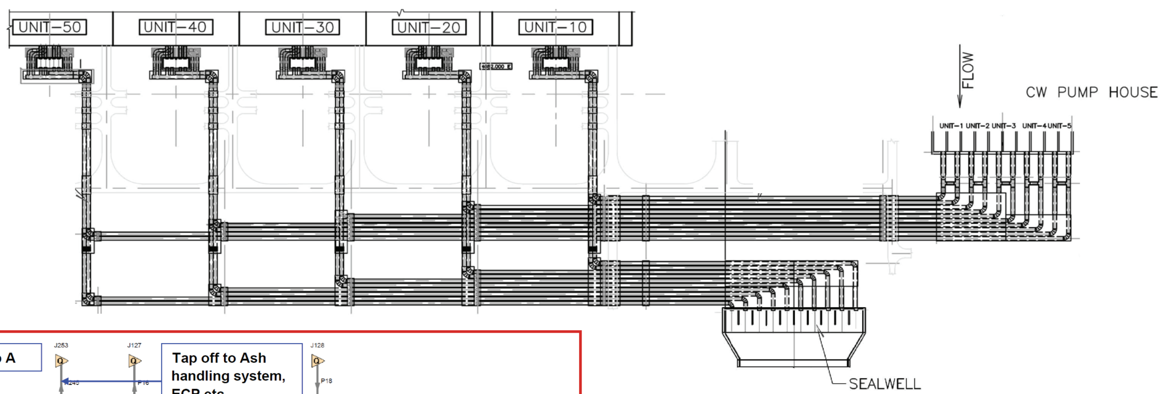
In all tested cases, the transient pressure extremes remained within pipe design limits, the system stabilized to adequate final flowrates, and pumps stayed below manufacturer specifications for maximum reverse speed. Not only did the interconnected design improve steady-state operation, Ram's transient study confirmed no further surge mitigation was required.

Ram noted AFT Impulse had a short learning curve with flexibility to evaluate the full range of steady-state and transient requirements; vital as the project was under tight deadlines.

System Location:
State of Gujarat, India

ELEMENTS OF SUCCESS

The massive system scale, comprehensive steady-state and transient study, and precise calibration to limited field data earned Ram and Tata Consulting Engineers this year's Correlation to Test/Field Data Platinum Pipe award.



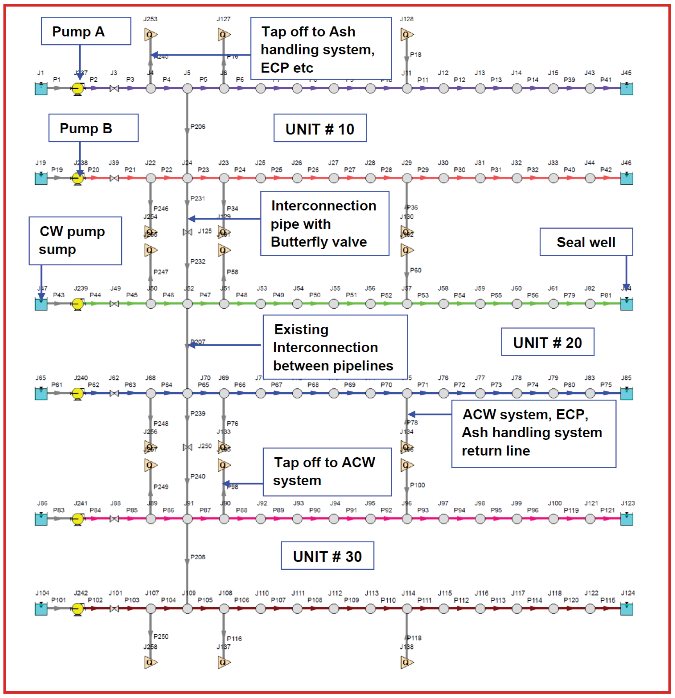


FIGURE 1

A comparison of the five independent cooling water systems as drawn and as modeled, highlighting the interconnections for evaluation between the various units. Pipelines are up to 2.8 m (9 ft) in diameter and lengths of 1000+ m (3300+ ft).

TABLE 1

Pump operating conditions comparison between field data and calibrated model data. Calibration establishes a foundation for further steady-state and transient analysis.

Pump		Observed	Modeled	% Variance
Unit 10 - A	Pump Head *m (ft)*	18.27 (59.94)	18.07 (59.28)	1.09%
	Discharge Flowrate *m^3/hr (gpm)*	75,023 (330,310)	75,432 (332,110)	0.55%
Unit 10 - B	Pump Head *m (ft)*	17.87 (58.63)	18.05 (59.22)	1.01%
	Discharge Flowrate *m^3/hr (gpm)*	75,953 (334,410)	75,480 (332,320)	0.62%
Unit 20 - A	Pump Head *m (ft)*	19.25 (63.16)	19.08 (62.6)	0.88%
	Discharge Flowrate *m^3/hr (gpm)*	72,688 (320,030)	73,113 (321,900)	0.58%
Unit 20 - B	Pump Head *m (ft)*	19.1 (62.66)	19.07 (62.57)	0.16%
	Discharge Flowrate *m^3/hr (gpm)*	73,060 (321,670)	73,126 (321,960)	0.09%