AFT Fathom™ Used to Enhance 40-Year Old Hand Calculations at Nuclear Power Plant

CASE STUDY

Fuel Pool Cooling System
Nuclear Power Generation

Energy Northwest Columbia Generating Station
Richland, Washington, USA
Platinum Pipe Award Honorable Mention - Use of Software Features and Model Creativity

Energy Northwest used AFT Fathom to model a Fuel Pool Cooling (FPC) system at their Columbia Generating Station, a nuclear power plant they own and operate. The FPC system removes decay heat from pools of stored spent fuel and maintains the fuel pool's specified temperature, purity, clarity, and level.

This model was built to enhance the original, hand-performed, 40-year-old calculation and to have it electronically available and easily editable (Figure 1).

> "One great, but often unnoticed feature of AFT Fathom is model size allowance. This model is rather large, and AFT Fathom could have easily handled more. It is beneficial to have large Workspaces."

Ryan Walker, Senior Engineer at Energy Northwest, explains, "Since our version* of AFT Fathom is not safety-related certified... we have to baseline against existing data to verify that the model is accurate. This is our company policy."

The AFT Fathom model used for this case study was extensively baselined against the existing analysis with very good accuracy, ranging from 0.03% to 0.8% difference in results (Figure 2) with an average of 0.28% difference between the hand calculation and the AFT Fathom analysis.

Walker also made good use of the Scenario Manager feature. It allowed him to model the following six operational configurations that show different suction modes where the suction source varies along with different pump configurations (Figure 2):

Mode A: Suction from the spent fuel pool skimmer surge tanks, utilizing one pump with one heat exchanger, and one filter demineralizer, and discharge into the spent fuel pool. Flow rate set to 575 gpm (131 m^3/hr).

Mode B: Suction from the spent fuel pool skimmer surge tanks, utilizing both pumps (FPC-P-1A & 1B) with both heat exchangers (FPC-HX-1A &1B) and one filter demineralizer, and discharge into the spent fuel pool. Flow rate set to 500 gpm (114 m^3/hr) per pump.

Mode C: Suction from the suppression pool, utilizing the suppression pool cleanup pump with filter demineralizer, and discharge back into the suppression pool. Flow rate set to 575 gpm (131 m^3/hr).

Mode D: Suction from the fuel pool skimmer surge tanks, utilizing one pump and one heat exchanger and discharging back into the fuel pool. Flow rate set to 3,000 gpm (681 m^3/hr).

Mode E: Suction from the spent fuel pool skimmer surge tanks, utilizing one pump with one heat exchanger through the bypass line, including either FPC-FCV-1 or FPC-V-175, and discharging back into the spent fuel pool. Flow rate set to 575 gpm (131 m^3/hr).

Mode F: Suction from the spent fuel pool skimmer surge tanks, utilizing both pumps (FPC-P-1A & 1B) with both heat exchangers (FPC-HX-1A & 1B) through the bypass line, including either FPC-FCV-1 or FPC-V-175, and discharging back into the spent fuel pool. Flow rate set to 500 gpm (114 m^3/hr) per pump.

According to Walker, the main benefit of using AFT Fathom is versatility in making future modifications to the fuel pool cooling system and to quickly expand the analysis scope beyond the current basic analysis. Another advantage is the ability to produce multiple models using the Scenario Manager.

**AFT software Nuclear Verification and Validation package is available at:*
www.aft.com/services/nuclear-verification-and-validation

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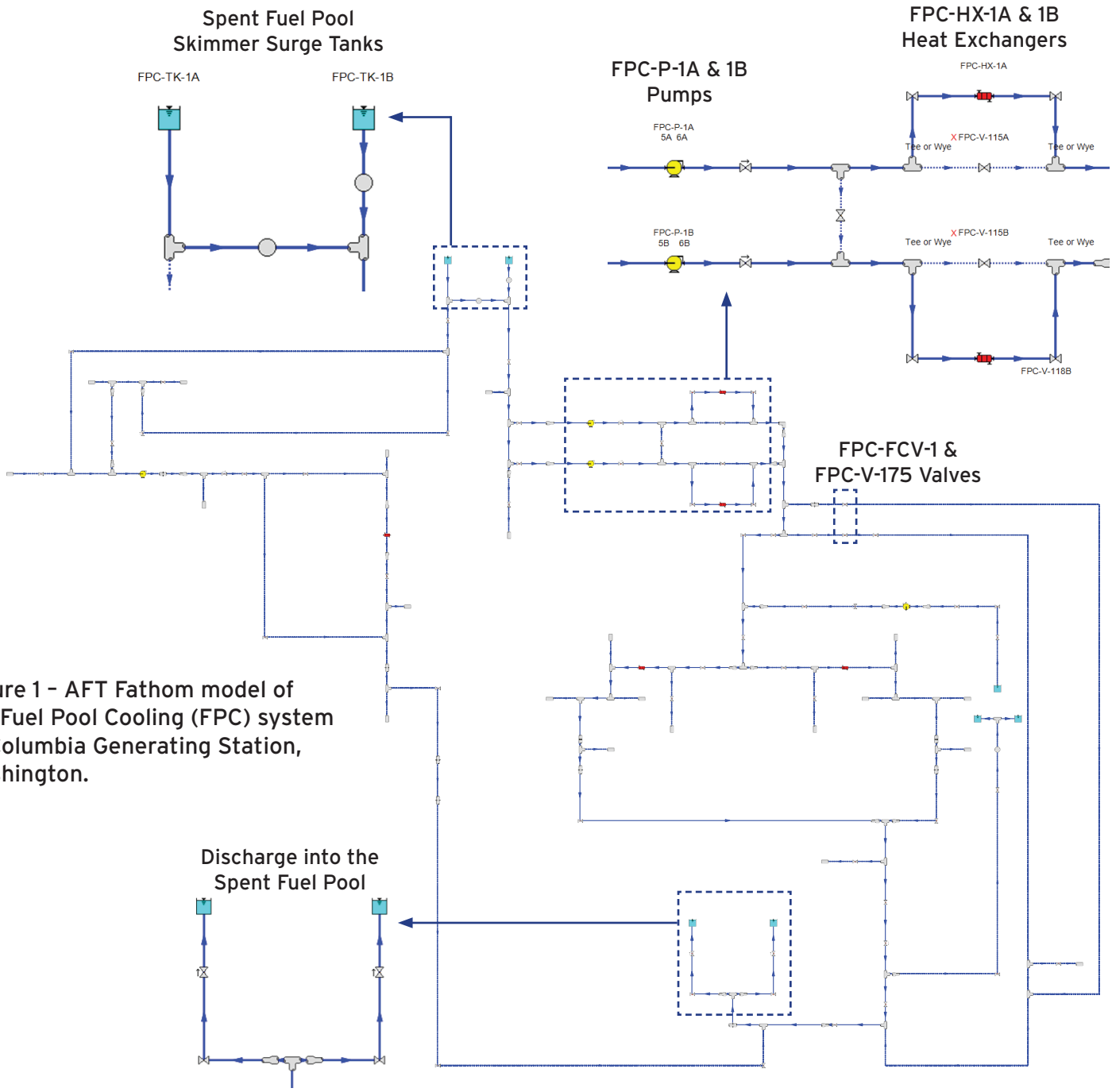

Figure 1 – AFT Fathom model of the Fuel Pool Cooling (FPC) system at Columbia Generating Station, Washington.

	Hand Calculated ft (m)	AFT Fathom ft (m)	% Difference
Mode A	76.80 (23.40)	76.74 (23.39)	0.08%
Mode B	176.47 (53.8)	175.86 (53.6)	0.38%
Mode C	69.36 (21.14)	69.41 (21.15)	0.07%
Mode D	613.8 (187.1)	614.0 (187.14)	0.03%
Mode D Alternate Path	613.4 (187.0)	614.0 (187.14)	0.10%
Mode E FCV Path	158.78 (48.39)	159.24 (48.53)	0.29%
Mode E Orifice Path	29.90 (9.11)	30.14 (9.18)**	0.80%
Mode F FCV Path	194.32 (59.23)	194.51 (59.28)	0.10%
Mode F Orifice Path	35.77 (10.90)	35.52 (10.82)**	0.70%

** = not counting orifice

Figure 2 – Friction loss results comparing AFT Fathom to 40-year-old hand calculations