AFT Arrow™ Powers Gas Turbine Analysis at Fern

CASE STUDY

Gas Turbine System

Power Generation Industry

Applied Flow Technology

Fern Engineering, Inc.
Pocasset, Massachusetts, USA
Platinum Pipe Award Winner - Correlation to Test/Field Data

Fern Engineering, Inc. was contracted by a major refinery to reduce the exhaust gas temperature variations of their gas turbine fleet. According to Hector Bourgeois, Fern Engineering President, the exhaust temperature variations, better known as exhaust gas temperature spread or EGT spread, drastically influence the life of turbine components and operational hardships. Gas turbine manufacturers usually establish a high limit for this spread that, if exceeded, sounds an alarm or can shut the gas turbine down. Ideally, the EGT spread would be low for optimal life and reduced downtime.

Most gas turbines have multiple fuel nozzles arranged around the periphery of the turbine that supply fuel to the combustion chambers. Variations in the fuel quantity to these nozzles are a major contributor to high EGT spreads. Generally, the supply piping and manifolding to these nozzles are comprised of numerous fittings, bends, elbows, differing lengths of tubing and orifices. Tolerance variation and the proximity to the fuel supply all have an effect on fuel quantity to each nozzle.

> "[AFT Arrow has] the ability to model critical (i.e. sonic) orifices or venturis and the capability to model a large number of elements..."

Fern purchased AFT Arrow specifically for this assignment. They surveyed other programs before purchasing AFT Arrow, but the ability to model critical (i.e. sonic) orifices or venturis and the capability to model a large number of elements was the main reason for their selection. Prior to purchasing AFT Arrow, flow analyses were done by hand. According to Hector, searching for coefficients was laborious and large models were impossible and could only be approximated.

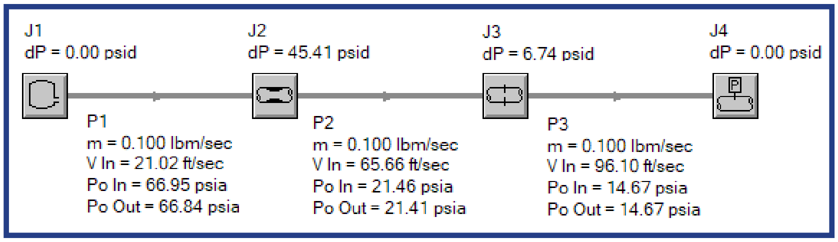
Before building the big model, Fern benchmarked AFT Arrow's sonic choking predictions against test data. They measured the sonic flow rate and orifice pressure in a test rig. Then they built an AFT Arrow model of the system. Results (see Figure 1) were very good. Based on this success, Fern then proceeded to their big model.

The ninety-junction model (see Figure 2) represents the fuel pipes, manifold, and nozzle branches of a Rolls Royce Avon gas turbine. Flow circuit features such as inner diameter, area reductions, area increases, sharp edges, bends, lengths of pipes and fittings all were included.

Numerous runs of the model were conducted. A baseline run was made reflecting the nominal configuration with nominal dimensions. Thereafter, other runs were made with expected tolerance variations in critical parts such as branch fittings and orifices.

The flow variations computed by AFT Arrow for the different cases were then used to estimate the EGT spread resulting from the flow variation. The project also called for another analysis of the high pressure inlet air preheating system for the gas turbine. AFT Arrow was used for this application as well.

Fern Engineering, Inc. is a consulting firm specializing in turbomachinery and particularly gas turbines. They provide services to the power industry in such areas as utilities, petrochemical producers and turbomachinery product OEM's. They have fourteen people in their company, located in Pocasset, MA, about sixty miles from Boston.



Test Data		AFT Arrow Prediction	
Flow	Orifice Pressure	Flow	Orifice Pressure
0.1023 (lbm/s)	21.1 (psia)	0.100 (lbm/s)	21.4 (psia)

Figure 1 - AFT Arrow model of a sonic venturi system

Predictions vs. test data shown in table..

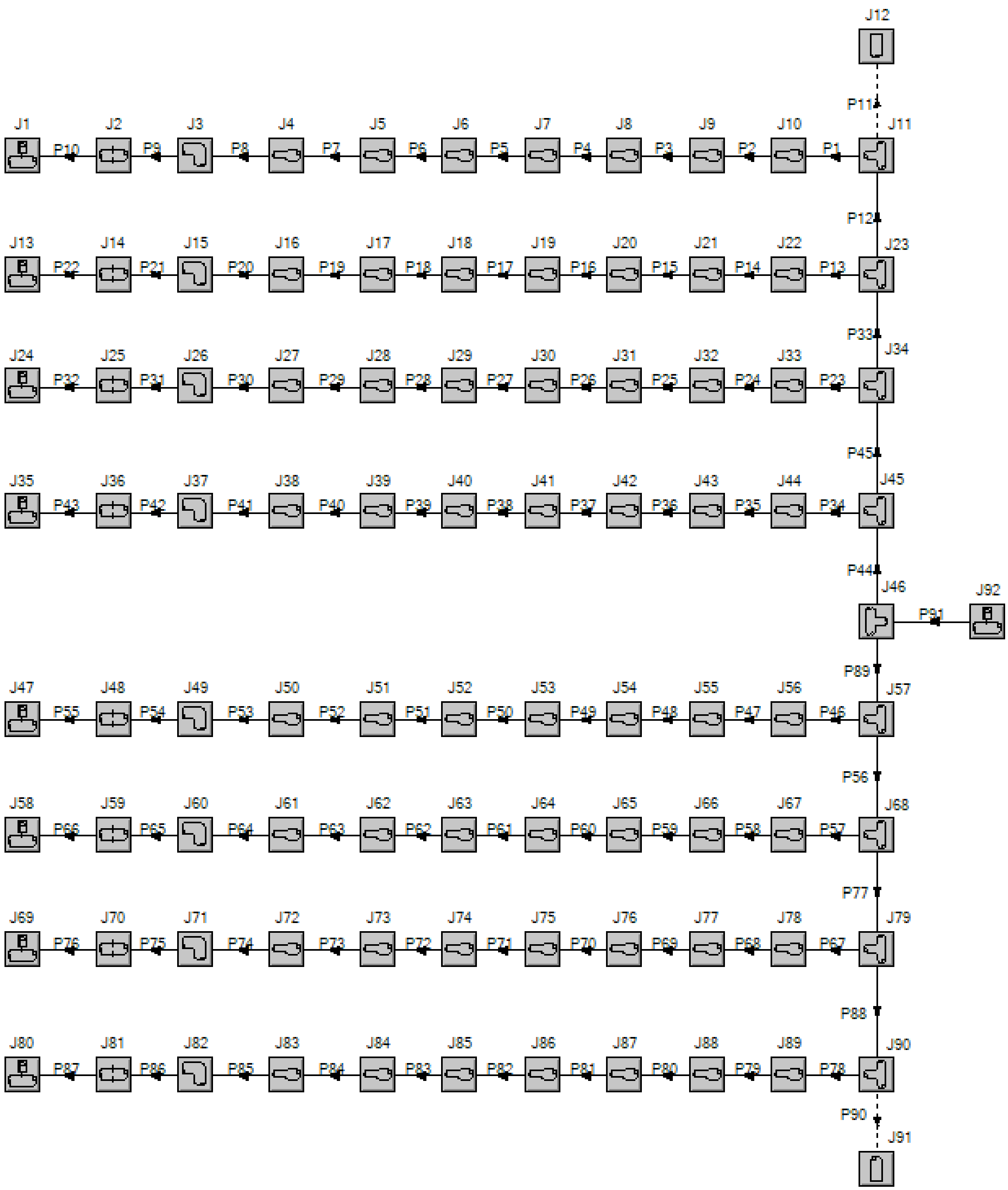


Figure 2 - AFT Arrow model of a Rolls Royce Avon gas turbine for a power generation application.

Gaseous hydrocarbon pressure supply (J92) at right feeds eight known fuel nozzles at left. 91 pipes and 92 junctions.