Flowmaster
Fluid thinking for systems engineers

# Case Study

## Power Generation

## Commonwealth Edison

Commonwealth Edison, based in Chicago, Illinois, USA, a company owned by about a quarter of a million shareholders, is engaged in the production, transmission, distribution and sale of electricity to both wholesale and retail customers. The geographical area in which the company provides retail service extends across one-fifth of the State of Illinois and includes the city of Chicago. The company serves nearly 3.3 million customers, representing some 8.2 million people or approximately 70% of the state's population.

In late 1991, one of Commonwealth Edison's generating plants experienced a major over-pressurisation transient in the feed-water lines after the closure of the feed-water isolation valves. The plant suppliers proposed changes which would have involved considerable expense. Before the changes were accepted Commonwealth Edison's engineers analysed the system using Flowmaster software.

One of Commonwealth Edison's engineers had experience of Flowmaster spending about 20% of his time using the product. Commonwealth Edison's engineers using Flowmaster were able to show that the initial assumption about the cause of the transients was incorrect. Therefore, the proposed changes were inappropriate and Commonwealth Edison was able to avoid considerable expense of a major plant rework.

## The Problem

In late 1991, one of Commonwealth Edison's generating plants experienced a major over-pressurisation transient in the feed-water lines after the closure of the feed-water isolation valves.

## The Analysis

A model of the condensate, heater drain and feed-water systems was built using Flowmaster's graphical user interface. The major components modelled include the condensate booster, heater drain and feed-water pumps with their associated recirculating valves. The high and low pressure heaters were modelled as discrete losses since their characteristics do not change (as a valve could). A discrete loss is a pressure drop that varies with volume flow. Feed-water piping was modelled with fittings as approximate straight lengths of pipe. The condenser and steam generators were constant pressure reservoirs. The modelling data consisted of pump curves, pipe lengths and valve characteristics.

The model was run in steady state and compared to normal operating conditions to verify consistency of model data. Some control data was then entered into the model. This set the operation of the flow controllers and the timing of the valve closures. Then the model was run in transient mode and compared against data from point history for the [observed] transient. The trigger event was the closure of the feed-water isolation valves. As the point history data is only available at one minute intervals minor changes were made to the model.

## Analysis Results

The peak pressures [produced by the transient analysis] in different parts of the model were reviewed. The maximum pressure occurs between the feed-water pump discharge check valve and the main feed-water isolation valves. This happens around the time when the feed-water isolation valve closes fully Pressure rises quickly, then starts to decay before the end of the five second analysis time. The transient analysis was run changing several variables - heater drain pump, feed-water recirculation valve operation - to observe their effect on peak pressures.

The timing of the feed-water pump trip was the most significant. The longer the delay between the isolation valves starting to close and the tripping of the feed-water pump, the higher the peak pressure.

After several discussions with plant engineers, it was concluded that the feed-water pump trips rapidly, and that the small variations of trip timing can account for the different initial pressure of the various transients. However, this did not explain the transients long duration of 5 to 15 minutes. The possibility was raised of the additional pressure from the heat load on the heaters. The heat load is from a MSR vent that is not isolated during the transient. The water trapped in the feed-water heater causing the water to expand due to rising temperature. An attempt to simulate the effect of the heat load was performed by using the estimate of 16 gpm input at the feed-water heater. This was not completely successful due to the very long run times required.

## Conclusion

The analysis performed with Flowmaster shows that the over-pressurisation of the feed-water lines was not caused by the closure of the feed-water isolation valves. The peak pressure from the hydraulic transient happens on the order of seconds, which accounts for the initial pressure of the transient. The peak pressure recorded by the point history data for the two transients occurs several minutes after the valve closure. The heat load on the heaters causes the relatively slower increase of pressure and the long duration of the transients.

Commonwealth Edison's engineers using Flowmaster were able to show that the initial assumption about the cause of the transients was actually incorrect. Therefore, the proposed changes were inappropriate and Commonwealth Edison was then able to avoid the considerable expense of a major plant rework.