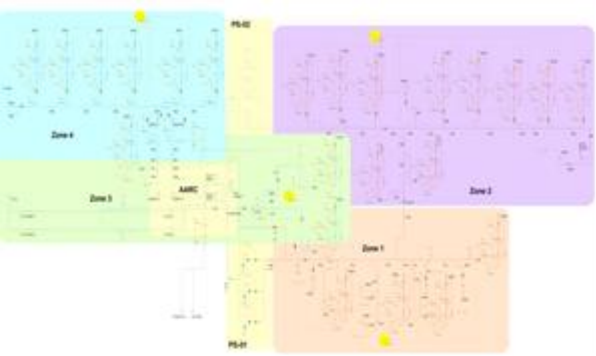
Al Ain Region Water Supply Network - Mathematical Modelling and Surge Analysis.

Torishima Pump MFG asked BHR Group to perform a hydraulic analysis of the new Al Ain water distribution network. Both a steady state and a transient analysis of the network were required.

The Al Ain Water Distribution Network is being implemented to meet the growing demand of the Al Ain City area and to optimise the existing system configuration in order to reduce the actual number of pumping stations. This is being achieved by the installation of new storage tanks/reservoirs, new pumping facilities and transmission/distribution pipelines.

In addition the existing reservoirs and pumping stations are being bypassed to make use of the incoming pressure for direct supply to the various consumer stations.



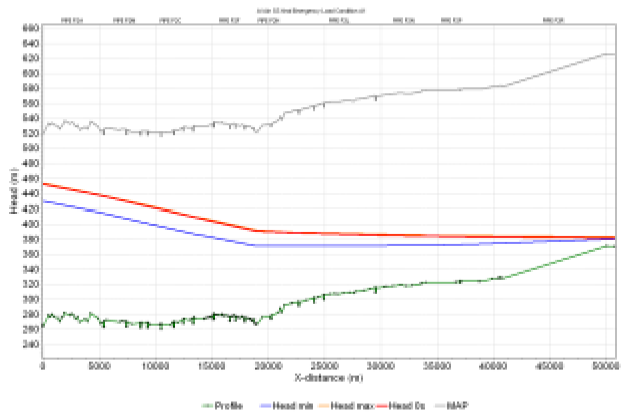
The main objective of the project was to undertake a steady state and surge analysis to assess the suitability of the new implemented and upgraded distribution network.

In particular, to validate the hydraulic control system and the suitability of the selected pumps and to provide recommendations on surge suppression devices.

The sizing of surge suppression devices was undertaken as well as the sizing of the control valves for normal and emergency situations.

Most common and most severe forms of pressure transient event, such as valve closure/opening and pump trip, were amongst the transient scenarios tested.

The network was found to be highly complex, incorporating elements of very high hydraulic inertia. This made the task of safe control highly challenging.



The study involved the detailed mathematical modeling of the main water distribution transmission lines.

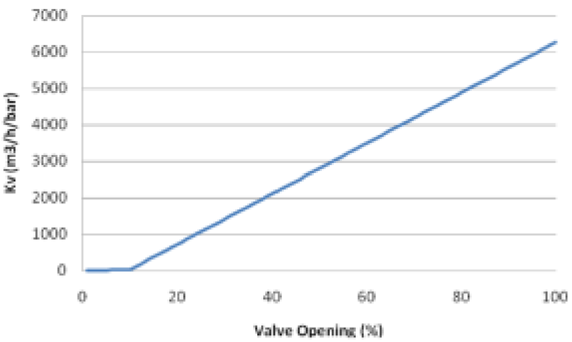
The analysis used a series of different transient models based on the WANDA 3 modelling suite, which uses a method of characteristics solution for the continuity and momentum equations with fixed wave speeds on a fixed time grid.

A detailed model of the distribution network was built including, not only physical components such as pipes, pumps and valves, but also logic control components such as PID controllers that allowed simulation of the variability of pump and valve settings over time.

The simulation of various supply scenarios was undertaken to assess the suitability of the selected pumps and their operating philosophy to achieve maximum efficiency points during normal and emergency operational scenarios.

BHR Group also recommended revised settings for pumps, valves and reservoir levels when meeting the system demands was likely to fail in normal supply scenarios.

Control and pressure relief valve sizing and selection was undertaken, accounting for the various scenarios in order to achieve a stable and reliable control whilst keeping the velocity and pressure losses across the valves at acceptable levels in order to maintain the demand pressure and flow requirements.



BHR Group provided detailed surge vessel sizing to alleviate surge effects as a result of various emergency pump shutdown scenarios.

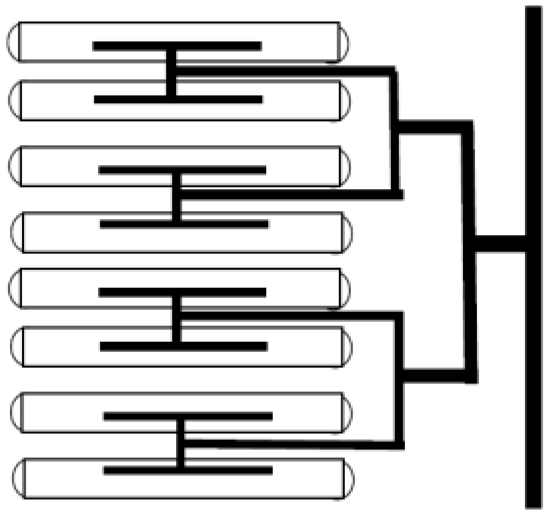
Surge effects due to check valves slamming closures were modelled and high pressures attenuated by selecting check valves with a suitable dynamic response.

BHR Group also recommended suitable pump start-up ramp speeds and valve closure rates to avoid unacceptable surge effects and adverse NPSH conditions.

A key point of the air vessel sizing was not only to ensure the suppression of dangerous transient pressures, but also to sustain the priming of the network.

Recommendations on the most suitable connectivity arrangement between the required vessels, for more stable vessel water level oscillations, were also provided.

Inertially Balanced Connectivity



Further analysis was undertaken to assess how robust and fast the system was to respond to variability of demand. It was essential that pump's response to this variability was not producing further surge effects.

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