Advanced Condition Assessment & Pipe Failure Prediction Project

Bulletin No. 7, May 2015

A non-technical overview of Fact Sheet No. 7 (May 2013)

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Monitoring and modelling of pressure transients for pipe failure analysis

Objectives

In Activity 1, we try to answer the questions how, when and where do pipes fail in a network. Accordingly, the consideration of internal and external factors affecting a pipe is central to the ability to predict pipe failure. One important factor that can contribute to pipe failure is water pressure, including pressure transients. These are dynamic short term fluctuations in water pressure, often lasting less than one second. As part of the development of pipe failure prediction models, it is important to examine the likely development of pressure transients in local networks. Furthermore, any calibration of failure models developed would require knowledge of likely transient pressures on top of static pressure for rational analyses. To facilitate this, a static and transient hydraulic model of a selected network is to be developed and calibrated through field monitoring of transient events. The specific objectives of this component of Activity 1 research can be listed as to:

- Identify a section of network for analysis which has been reported to have experienced pressure transient events;
- Undertake EPS (Extended Period Simulation) to obtain appropriate boundary, or limiting, conditions for the pressure transient modelling for the identified network section;
- Develop the pressure transient model and select locations for monitoring;
- Monitor selected locations in the pipe network to measure pressure transients; and
- Calibrate the pressure transient model and undertake modelling of pressure transient development under various field scenarios.

After calibrating the hydraulic model, the failure prediction models developed will be used to analyse failures within the network against the pressure data, combined with the inspection data, to understand the impact of pressure transients on pipes under certain conditions. Therefore, it is expected that the calibrated failure prediction models developed may be used more reliably with the research on improved pipe condition assessment and corrosion prediction that will be undertaken in Activities 2 and 3 respectively.

Model development

Two separate models have been developed for extended period simulation (EPS) and pressure transient simulation. EPANET, a public domain hydraulic analysis package for water supply networks, was used for EPS while model calibration was undertaken using data from the SCADA (Supervisory Control and Data Acquisition) system of the respective water utility. No “skeletonization” has been made to the original model as this can modify a likely transient wave. Analysis needs to be carried out for a few minutes only as the magnitude of the transient wave damps out with time as a result of pipe friction, customer demands, pipe junctions and loops. Appropriate boundary conditions such as reservoir levels, are obtained from the calibrated EPS model to initiate simulation of transients. A dynamic friction model is used to introduce changes in head losses as the water flow through the network changes with time during transient events. The pressure sensitive demand is used in the

model, since the demand at a particular point needs to be updated with the change in pressure during the simulation. The most up-to-date information about pumps, valves and system demand was obtained through GIS data bases from the respective water utility.

Field monitoring of pressure transients has begun with a Radcom high speed pressure transient data logger with a capacity to record 20 readings per second. The purpose of pressure monitoring is to capture transient events occurring during the normal operational conditions and to obtain the magnitude of pressure events. Preliminary results have been obtained for both extended period model calibration and monitoring of transient pressures.

Concluding remarks

EPS results indicate that the steady-state hydraulic model developed in this work is consistent with SCADA data. This shows that the surge model developed on the basis of GIS data may be able to accurately represent the actual field conditions as the EPS model is based on the same GIS data. Preliminary results of field monitoring show that pressure transients occur during the pump start up and shutdown phases. The pressure transient measurements that have been obtained about 3 km downstream from the pump station were in the order of ±100kPa. More comprehensive monitoring is planned to capture the full extent of transient events across the network, especially closer to the pump stations.

Partners

The partners in this research project include Sydney Water Corporation, UK Water Industry Research Ltd, Water Research Foundation of the USA, Water Corporation (WA), City West Water, Melbourne Water, South Australia Water Corporation, South East Water Ltd and Hunter Water Corporation. Monash University leads the research supported by University of Technology Sydney and the University of Newcastle. Other collaborators include Dr Balvant Rajani from Canada.

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