Drink. Water Eng. Sci. Discuss., 3, C51–C54, 2010
www.drink-water-eng-sci-discuss.net/3/C51/2010/

Drinking Water Engineering and Science Discussions

Interactive comment on "Negative pressures in full-scale distribution system: field investigation, modelling, estimation of intrusion volumes and risk for public health" *by* M. C. Besner et al.

M. C. Besner et al.

mcbesner@polymtl.ca

Received and published: 4 June 2010

The authors would like to thank Dr. Van Zyl for his interest and comments. Here are our responses to the specific comments:

Comment #1: We will remove the sentence " . . . and it is not uncommon to have leakage rates corresponding to approximately 10% of the total amount of water produced" and will replace it by "Water losses between 8 to 24% of the water supplied (unaccounted for water) have been estimated for developed countries based on 1991 data (WHO, 2001) and higher values are now commonly reported. The fraction of water strictly lost through pipe leaks is not always available but in Canada, it is estimated

that up to 30% of the total water entering supply-line systems is lost to leaking pipes (Environment Canada, 2010)."

Comment #2: we will specify "pre-stressed concrete pipes"

Comment #3: We believe that the frequency of measurements used in this study is adequate for the type of investigation conducted. The resolution of pressure data used in this study (1 to 4 readings per second) is typical of what has been used in all other studies characterizing the occurrence of low or negative pressure events in full-scale distribution systems. See the following references:

- Kirmeyer et al., 2001. Pathogen intrusion into the distribution system. AwwaRF Report, Denver, Colorado.

- Friedman et al., 2004. Verification and control of pressure transients and intrusion in distribution systems. AwwaRF Report, Denver, Colorado

- Gullick et al., 2004. Occurrence of transient low and negative pressures in distribution systems. Journal of the American Water Works Association 96 (11), 52-66.

- Fleming et al., 2006. Susceptibility of distribution systems to negative pressure transients. AwwaRF Report, Denver, Colorado

- Hooper et al., 2006. Assessment of microbiological water quality after low pressure events in a distribution system. 8th Annual Water Distribution Systems Analysis Symposium, Cincinnati, Ohio.

o Such resolution is considered adequate to the application presented here, where we are primarily interested in the occurrence of negative pressure. We agree that such resolution would be inadequate for other types of application such as inverse transient analysis, used for leak detection and system parameter calibration. In such case, high frequency pressure information is needed (kHz resolution) as "fast transients" (opening or closing of appurtenances in the range of milliseconds) are created to obtain clear pressure wave reflections from the investigated features.

DWESD

3, C51–C54, 2010

o The very high number of pressure data collected in the distribution system during this study led to pressure profiles that were quite similar at all sites (smooth pressure variations), especially for those events related to sudden pump shutdowns at the plant. If the pressure would have been highly variable (peak low and high pressures not captured through our 4 readings per second), we could at least expect that such variations would have been captured once and a while at some sites, which was not the case.

o In the context of intrusion into a full-scale distribution system, it is hypothesized that shorter duration (<25 ms) transient events, that would not have been captured here, would have a low impact in terms of potential volume coming in.

The measurement frequency will be justified in the revised paper.

Comment #4: We expanded the Conclusions section as follows:

"This paper summarizes an integrated set of studies conducted in the same distribution system where Payment et al. (1991, 1997) conducted their epidemiological studies. Field investigations including the characterization of potential sources of contamination, pressure monitoring, and hydraulic and transient analyses were conducted.

Bacterial indicators of fecal contamination were recovered more frequently in the water from flooded air-valve vaults than in the soil or water from pipe trenches. Because of the potentially large diameter of air-vacuum valve orifices, such result suggests that this intrusion pathway is a critical one when negative pressure occurs in this distribution system. Results of the long-term pressure monitoring showed that this distribution system was in fact susceptible to negative pressure events. While most of the recorded events were isolated, four transient events were associated with sudden pump shutdowns at the water treatment plant, affecting more than one measurement sites in the distribution system. The absence of floating storage makes this distribution system vulnerable to low/negative pressures at high elevations.

The extensive pressure monitoring results were used to develop a surge model that

DWESD

3, C51–C54, 2010

would accurately estimate transient pressure variations, in order to predict reasonable intrusion volumes and ultimately evaluate the risk that low/negative pressure events pose to public health. Transient analysis of a large and complex distribution system was found to be challenging with discrepancies between the energy dissipation simulated with the model and observed from field data. Our results show that one must be careful with the results obtained from transient simulations when no field data is available for verification. Other authors (Fleming et al. 2006; Friedman et al. 2004; McInnis and Karney 1995) have also noted an overestimation of the computed downsurges.

Current work involves the development of a quantitative microbial risk assessment approach to evaluate the risk that intrusion events associated with such negative pressures may have on public health. Our experience indicates that inputs that are fed into a risk analysis model should be carefully analyzed, stressing the importance of collecting field data and not performing such an analysis on the sole basis of modeling outputs."

Marie-Claude Besner, on behalf of the authors

References:

Environment Canada. 2010 Leak Detection and Repair. http://www.ec.gc.ca/eau-water/default.asp?lang=En&n=F25C70EC-1

WHO. 2001 Leakage Management and Control – A Best Practice Training Manual. World Health Organization, Geneva.

Interactive comment on Drink. Water Eng. Sci. Discuss., 3, 133, 2010.