VULNERABILITY OF WATER DISTRIBUTION SYSTEMS TO LEAKAGE

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Abstract. Vulnerability of Water Distribution Systems to Leakage is defined using standard terminology. The use of Water Balance Method illustrates a basic approach to leakage. Moreover, the suitability of various performance indicators is discussed and illustrated using both technical as well as financial data. Methodology to evaluate leakage (e.g. DMA, SCADA) provides the operators with a suitable means how to decrease the leakage. Field measurements of hydraulic parameters and mathematical modelling of Water Distribution Systems may substantially help to quantify leakage and to evaluate the best practice for integrated leakage reduction.

Keywords: definitions / water balance method / performance indicators / real losses / leakage assessment / mathematical modelling

1. Introduction

The first Water Security Summit, which was held in Hartford, Connecticut, USA on December 3-4, 2001, tackled all aspects of vulnerability of Water Distribution Systems (WDS). Every WSD is vulnerable to possible physical, chemical, and biological activities that could interrupt water supply and result in contamination. The paper deals with leakage that is inherent physical property of any WSD. In the beginning the leakage problem is defined, and then it is illustrated how it is possible to evaluate leakage and finally how mathematical models can be used to assess the water system vulnerability.

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2. **Definition of leakage**

Every WDS is vulnerable to leakage. The leakage is universal problem and in order to cope with it, the following approach should be taken into account:

1. Identify the causes of leakage.
2. Use appropriate methodology and tools to quantify the leakage and to reduce it.

It should be pointed out that the leakage might be classified from several points of view. However, from the practical viewpoint, it is useful to distinguish between pipe bursts (PB) and background leakage (BL). PB occurs in the water mains at some particular pipe cross-sections and/or joints and sometimes is called reported (visible) leaks. The amount of lost water is great and PB manifests itself after relatively short time on the street surface. Water flows over the surface and frequently a destruction of surface as well as huge soil erosion occur. It often takes tenths of minutes than the water supply is stopped and the repair can start. Farley and Trow (2003) point out that the lost volume of water depends on awareness, location and repair times. While awareness time is the time until the water company gets know about the leak, location time is needed for the leak location. Repair time needs the water company to repair the leak.

On the other hand, BL is hidden and it cannot be detected just by eye. BL is represented by numerous small leaks that often cause a significant proportion of total leakage. Considering flow rates caused by leakage, there are unreported bursts (UB) between these two groups of leakage.

The vulnerability of WDS to leakage depends on many factors and among others the following are important:

- Pipe material and age of pipelines.
- Protection of pipelines from corrosion, pitting effect, winter conditions. The method of jointing the pipes, ground conditions and soil type, as well as surface loadings is also important.
- Operation of WDS from hydraulic point of view (steady flow, quasi-steady flow, hydraulic transients). The higher is the pressure, the greater leakage is.

3. **Methods for evaluation of leakage**

Figure 1 shows general approaches how to evaluate leakage. Each approach may be applied separately; however, the best results are obtained with suitable combination of more possibilities.