Criteria for Valve Location and System Reliability [Project #2869]

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OBJECTIVES:
The objectives of this research were to develop a rationale for valve location using design rules to optimize system reliability, to develop an easy to use program to analyze the efficiency of valves on the reliability of isolation of distribution networks, and to develop a computer model to analyze complicated networks and assist water utilities in minimizing interruption of supply in isolating water main breaks.

BACKGROUND:
Due to the lack of availability of proper tools for management of valves, it is very difficult for water utilities to supply water with minimum interruption in case of a water main break. Rules or guidelines for the placement of valves in the distribution system are not well defined, and the impact of valve placement rules on system reliability (i.e., minimizing out-of-service customers) has not been quantified in previous studies.

HIGHLIGHTS:
In case of a water main break, the smallest group of pipes in a water distribution system that can be isolated is called a “segment,” and all customers in the pipe segment will be without service. A computer program was developed in this study for use by water system managers to analyze valve performance of a complex water system. An easy to use methodology was developed that produces a performance curve of customers out-of-service versus valve reliability for analysis of valve performance. Rules of thumb or strategies for adding new valves were also developed.

APPROACH:
The researchers performed a literature review and questionnaire survey to determine current practices for placement of valves in water distribution systems. An analytical tool called the Strategic Valve Management Model (SVMM) was developed to identify pipe segments (groups of pipes that must be isolated at the same time) and critical valves. SVMM was applied to a hypothetical water distribution network and two actual water systems. Existing valve configurations, along with other possible additions of valves, were analyzed.

SVMM generated typical performance curves showing the average number of out-of-service customers versus valve reliability. A simplified method based on the system’s customer/valve ratio was developed from the SVMM performance curves. The simplified method can be used by water utilities that do not have all of the data required to run the SVMM.

RESULTS/FINDINGS:
The following were the important findings and recommendations of this study:

• Water utilities need to develop effective and practical valve maintenance and management programs to minimize system supply interruption.

• For proper maintenance and management of valves, the average cost of valve operation, testing, maintenance, replacement, and installation for North American utilities is estimated to be $67 per valve per year.
Valve reliability is important and can be improved substantially with a proper valve exercising and maintenance program.

The software developed in this study (SVMM) worked well for one hypothetical system and two test case water utilities.

Improvements in distribution system reliability to minimize customer interruption can be achieved by increasing the reliability of valves and by adding new valves in critical locations.

The addition of new valves appears to be a good approach to reduce the number of customer outages. However, this approach is more expensive than improving reliability to minimize customer outage.

The following recommendations were made as a result of this study:

- All utilities should collect and maintain valve location, accessibility, exercising, operation, and replacement data.
- The SVMM model and the strategic valving tool (SVT) developed in this study could be used by water utilities to prioritize valve exercising and valve renewal programs.

**IMPACT:**
The study provides analysis tools and rules for valve placement to allow water utilities to improve system reliability by reducing the number of customers affected by necessary water main isolations. The analysis tools can be used to identify critical valves and provide a quantitative basis for making cost-effective decisions about valve placement.

**MULTIMEDIA:**
The report includes a CD-ROM that contains the Strategic Valve Management Model (SVMM). The SVMM was developed to provide utilities with a better tool for valve maintenance and system expansion. The program is used to identify segments in water distribution systems and to simulate pipe and valve failure effects on the system.

**PARTICIPANTS:**
Utilities from the United States and Canada participated in this project.