



## Partnership for Safe Water Distribution Program



### *Distribution System Optimization Program (Overview)*

**M**ost treatment plants now recognize the benefits of optimized operation—largely as a result of the Partnership for Safe Water (PSW) performance improvement program. The program was originally developed to help well-run plants treating surface water improve performance to provide added protection against *Cryptosporidium*. Currently the PSW has 230 utility members with more than 400 treatment facilities serving more than 85 million people in the United States.

The PSW's fundamental approach is to improve performance by optimizing system operations rather than relying solely on significant capital improvements. This approach has been used successfully since the program was introduced in 1995. In fact, the impact of the program has been so widespread that PSW goals defining optimized performance (e.g.,  $\leq 0.10$  NTU turbidity) are now applied at most plants, regardless of whether they formally participate in the program.

#### **Distribution System Optimization Program Development**

Drinking water system customers receive water that has been delivered through an extensive conveyance network. Often the high quality water coming from treatment plants changes as it travels to the users. Optimizing distribution system operation can reduce this transformation. After more than 10 years of discussion, planning, and research, the PSW has developed an optimization program for distribution systems to help water suppliers improve the quality and reliability of water supplied to their customers.

Hundreds of utility representatives, State and Federal regulators, consultants, and other interested experts have provided their advice and support to develop a voluntary continuous improvement program for distribution system operation. Many of these contributors were involved in the Water Research Foundation project #4109 *Criteria for Optimized Distribution Systems*\* that forms the basis for the PSW program.

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\* Friedman, M., G. Kirmeyer, J. Lemieux, M. LeChevallier, S. Seidl, J. Routt. 2010. *Criteria for Optimized Distribution Systems*. Water Research Foundation, Denver, CO. # 4109.

Broad participation in project #4109 was supplemented by many PSW utilities that reviewed and commented on the draft self-assessment guide. The guide was ultimately authorized for use by the PSW Steering Committee representing the six supporting organizations.

## Program Phases

The Distribution System Optimization program is similar to the treatment plant program that has been successful for more than fifteen years. The program consists of four phases.

- Phase I Commitment

Distribution system operators agree to continue the program at least through Phase III and conform to the ethical and regulatory requirements.

- Phase II Baseline and Annual Data Collection

Systems agree to collect disinfectant residual data and send it to the Partnership annually. The initial data set reflects baseline conditions. Disinfectant residual data is from routine sample sites and entry points to the distribution system.

- Phase III Self-Assessment

This is the primary element of the program. Systems conduct a comprehensive assessment of their system operation. A self-assessment guide and performance assessment software are provided with membership. The self-assessment process identifies performance limiting factors that are used to develop an improvement plan. The plan may involve many personnel and can take several years to complete.

Finally the system prepares a summary report (guidance and report generation tools are provided) and presents this to the Partnership. The report is reviewed by a team of utility professionals. If the report demonstrates a “good-faith effort” the Partnership provides the Directors Award of recognition. *Meeting the Partnership optimization goals is not required to receive this Award.*

- Phase IV Optimized Performance

This is the ultimate level of system performance receiving the *Excellence in Distribution System Operation* award. Systems must prove that they are meeting all the optimization goals. Few systems are expected to reach this level but all systems can improve and bring their performance closer to the goals. Specific requirements for this award are yet to be determined. To be eligible a system must be a current recipient of the Directors Award.

### Supporting Organizations

- American Water Works Association
- U.S. Environmental Protection Agency
- Association of Metropolitan Water Agencies
- National Association of Water Companies
- Association of State Drinking Water Administrators
- Water Research Foundation

## The Self-Assessment Process

The objective of the Partnership for Safe Water optimization programs are to identify opportunities for improvement in system operations and to empower system operators with knowledge to recognize and apply procedures that result in water quality and system reliability improvements. Self-assessment is the process used by the PSW to achieve these goals by establishing a system's current status, identifying performance limiting factors, and establishing a plan to make improvements that lead to optimized performance. The PSW self-assessment is unique since it uses challenging performance goals both as comparisons for determining the current level of performance and to measure the effect of improvements.

Distribution system optimization is achieved by preserving system integrity. There are three main components of overall system integrity: water quality preservation, hydraulic reliability, and physical security. To preserve distribution system integrity requires the proper system design, understanding and application of operational optimization practices, and administrative support.

There are many important factors that can be employed to improve each system component from impacts that can affect water quality and system reliability. However, there is a primary performance indicator for each major system integrity component.

### System Integrity Performance Indicators

Water Quality Preservation-	disinfectant residual
Hydraulic Reliability-	pressure
Physical Security-	main break frequency

These indicators are used in the Partnership for Safe Water Distribution System Optimization program self-assessment. The performance goals for each of these indicators are listed below. The Partnership recognizes that these goals may not be suitable for all systems. Therefore, systems can set their own demanding goals and use these in their self-assessment and to develop their improvement plans.

System integrity must be assured in three areas:

2. water quality
3. hydraulic reliability
4. physical security

The Directors Award is for satisfactorily completing the self-assessment.

#### ▪ *Disinfectant Residual*

The Partnership for Safe Water requires that all member systems use secondary disinfection. Optimized systems meet these residual disinfectant goals:

- ≥ 0.20 mg/L and ≤ 4.0 mg/L for free chlorine,
- ≥ 0.50 mg/L and ≤ 4.0 mg/L for total chlorine (chloramines),
- ≥ 0.20 mg/L and ≤ 0.80 mg/L for chlorine dioxide.

These goals are for 95% of the routine readings each month. Individual routine sample sites shall not have consecutive (pre-scheduled) residual readings outside the

performance goals. Additionally, optimized systems include sample locations that target problem sites and storage facilities.

- *Pressure*

An optimized distribution system should maintain a minimum pressure of 20 psi. This goal should be met under normal operating conditions including maximum day demand and fire flow conditions (excluding emergencies). This goal is for 99.5% of the minimum daily readings from permanent pressure sensors located at sites of minimum pressure.

A minimum pressure of 35 psi should be maintained as a monthly average of daily minimum values.

Emergency conditions such as main breaks and power outages require implementation of pre-approved procedures to protect the public health.

The maximum pressure range (difference between the minimum and maximum within a pressure zone) should not be greater than a pre-determined utility-specific goal.

- *Main Break Frequency*

The optimization goal for main break frequency annually is a maximum of 15 for each 100 miles of distribution pipelines. This main break frequency goal may be achieved after many years of optimization efforts. A reduction in the main break frequency (rolling 5-year trend) is an indication of progress toward optimized performance.

In addition to these three performance measures the self-assessment includes system design, application of operational concepts, and administrative support. Also, there is a thorough evaluation of the following performance improvement variables:

- Cross-connection Control
- Customer Complaints
- Disinfectant Residual
- Disinfectant By-products
- Energy Management
- External Corrosion Control
- Flushing
- Maintaining Hydrants, valves, and blow offs
- Internal Corrosion
- Main Break Management
- Nitrification
- Pipeline Installations; Rehabilitation and Replacement
- Post precipitation Control
- Pressure Management
- Security and Online Monitoring
- Storage Facility Operation and Maintenance
- Water Age, Modeling
- Water Loss Control
- Water Quality Sampling and Response

The final element of the self-assessment is to develop an improvement plan based on the results. Tools are provided to help sort and prioritize the performance limiting factors and to construct a plan to improve performance.

## **Water System Optimization Tools**

Improving water system operation using practical optimization methods is the goal of the Partnership for Safe Water. All size participating utilities can assess their operation; identify areas for improvement; and apply proven optimization techniques to improve performance. A unique feature of the program is that data from performance measures provide evidence of progress toward optimization goals.

The program requires considerable effort but the benefits are remarkable and include improved water quality for customers, enhanced system reliability, compliance with future regulations, adoption of a utility culture of excellence, and promotion of superior performance to owners, customers, and regulators.