Water Challenges
“WORKING TOGETHER TOWARDS SOLUTIONS”
California-Nevada AWWA Annual Fall Conference 2013

Large Meter Testing: Analysis and Calibration

M.E. SIMPSON Co., Inc.
Overview

- Water Loss Control
- Water Audit / Balance Format (AWWA/IWA)
- Apparent Losses
- Concentrating on Large Meter Testing (Master Meters)
- Concentrating on Large Meter Testing (Commercial/Industrial Meters)
Water Loss Control

- Monitoring water resources has been conducted for thousands of years.

- *Julius Frontenius* was first Roman Water Commissioner and recognized importance of equitable water distribution (300 BC)

- Concept of “water rights” and water use has been debated for centuries

End result: majority of water is now metered
“How much water are you really putting into the distribution system?”

\[
\text{INFLOW} = \text{METERED OUT} + \text{LEAKAGE}
\]
It’s a Question of Balance

Water Pumped

Water Sold & Leakage
Water Audits and Loss Control Programs


Third Edition

American Water Works Association

The Authoritative Resource on Safe Water
Water Loss Control

- The difference in the water pumped versus water sold is basically termed "water loss"
- Is it not possible to have a "perfect system"
- Concept of "acceptable loss" levels
  - What is "acceptable"?
  - How do you control losses?
Water Loss Control

Water Loss Control is defined simply as the process of “Auditing” the operational procedures and processes of our water utility to determine losses and then provide remediation for those issues.

IWA/AWWA developed a “Water Balance” chart after much research into differences in concept of water losses.
Standard Water Balance Format

- **Water Imported**:
  - Total System Input (allow for known errors)

- **Water Supplied**:
  - Water Exported
  - Authorized Consumption
  - Unbilled Authorized Consumption

- **Water Losses**

- **Apparent Losses**

- **Real Losses**

- **Billed Authorized Consumption**

- **Unbilled Authorized Consumption**

- **Non-Revenue Water**

- **Revenue Water**

- **Billed Water Exported**

- **Billed Metered Consumption**

- **Billed Unmetered Consumption**

- **Unbilled Metered Consumption**

- **Unbilled Unmetered Consumption**

- **Unauthorized Consumption**

- **Customer Metering & Data Inaccuracies**

- **Leakage on Mains**

- **Leakage on Service Lines (before the meter)**

- **Leakage & Overflows at Storage**

Start here

Move this direction
Water systems are not designed to lose money!

- What is considered “acceptable loss” in a system? 10%, 15%, ???
- Why are these losses unacceptable?
- Law of diminishing returns...

Water Loss = $$$ Money Loss
“Master Meters” - Determine Actual Production

- Test all production meters annually to determine the **true** volume of water being introduced into the distribution system

- Test all wholesale meters annually to determine the **true** volume of water being introduced into the distribution system
Why are Large Water Meters so important?

- Used for **Billing** in custody transfers
- Used to determine **Chemical Feed Rates**
- Used to account for the **Total Volume** of Water introduced into a distribution system

**Large Meters Are a Vital Component in any Distribution System**
Meter Types

- Venturi Meters
- Orifice Plate Meters
- Magnetic Flow meters
- Propeller Meters
- Turbine Meters
- Sonic Flow meters
- Vortex Flow meters
- Averaging Pitot meters
Test Taps for comparative testing
Production
Venturi Meter

Production
Mag Meter
New Venturi Meter ready to be installed

Venturi Meters at High Service Pump Station
Large Meters are Prone to Failure for a variety of reasons

- Age
- Mechanical Wear and Tear
- Corrosion
- Mineral Buildup
- Fouling, due to debris
- Mis-Use, or operation outside of the meters range
- Inadequate Plumbing before and/or after the meter
What are the Consequences when these Meters Fail?

- Inaccurate Billing
- Lost Revenue
- Over and Under Feeding of Chemicals
- Inaccurate Annual Reports and Usage Estimates
- An Overall Loss of Control

So What Can You Do?
Master Meter Test Standards

• **M-6** manual addresses turbines and propeller meters but does not address Venturi meters or other types.

• **M-33** doesn’t state allowable accuracy levels (except to mention the manufacturer’s specs)
Should they be removed and sent to a test facility?
Tank & Rotameter Test

Diagram:
- Flow Control Valve
- Rotameter
- Flow Rate Indicator
- Volume Indicator
- Calibrated Test Tank
Weighing Meter Test
It is best to test them **In–Place**

**Advantages**
- Practical - do not have to remove meter
- Test under conditions of current operation
- Able to inspect and assess flow conditions

**Disadvantages**
- Meter may be in a compromised setting
- Test sites may be compromised
- Flows may be limited
- You have to settle for what is available/practical
Comparative Test
Flow Measurement

\[ Q = V \times A \]

- \( Q \) is “Quantity” of water
- \( V \) is velocity of flow measured in ft/s
- \( A \) is inside Area of pipe in ft\(^2\)
“Strap-On” Flow Meters

Doppler Meter

Transit Time Meter
Generally thickness gauges are used to determine Pipe Wall thickness.
Then ID of pipe is determined...
“Strap-On” meters can be inaccurate. This is because the hydraulic conditions inside the pipe are often unknown.
Pitot Test
Pitot Testing can be done On-Site

- **Pitot Testing** is the most accurate portable testing method

This form of Pitot tube was designed by Edward S. Cole in 1896.
Test Site Installation

Pitot tap being installed inside the Plant

Test site outside of the Plant, in trench
A Pitot Corp, Tapped Into Ductile-Iron Pipe
Using a Polcon™ Caliper to Measure the Inside Pipe Diameter
Positioning the Sensor in the Center of the Pipe

Determine Position of Orifices
(From Bottom of Pipe)

Tape
Tap
Pipe Wall
Flow conditioning

- Test sites need conditioned flow
- Meters need conditioned flow
- Site issues come into play such as straight runs of pipe, concrete pipe, valves, tees, elbows...

Two-Thirds Rule: For the ideal location of a Pitot test corp.

Ideal Location for Pitot Test Corp.

- 1/3 Min. 10 Pipe Diam.
- 2/3 Min. 20 Pipe Diam.
- Thirty Pipe Diameters

Direction of Flow
Velocity Profile is Very Important

- Used to help calculate mean velocity of flow
- Used to “see” flow profile inside pipe
Common Velocity Profile Shapes

- BUTTERFLY VALVE
- PARTIALLY CLOSED GATE VALVE
- INCRUSTATION / TUBERCULATION BUILD-UP ON WALLS
- SMOOTH INTERIOR PIPE WALL
Water Loss Control

Large Meter Testing and Repair – Commercial & Industrial Customer Meters
Commercial and Industrial Meters
High Revenue Meters

- Usually 10%-12% of the customers use 50%-60% of the water.
- Test and repair industrial and commercial meters
- Replace obsolete meters
Common Meter Types

- Compound Meters
- Turbine Meters
- Displacement Meters
- Magnetic Flow Meters
- Propeller Meters
- Multi Jet Meters
- Single Jet Meters
Large Meter Testing Program

- Meter testing should be performed as on-going maintenance program
- An annual testing program will insure that revenues stay up
- Test meters within 6 months of installation
- 2 percent of annual revenue should be ear marked for meter testing
Testing Methodology

- Refer to the AWWA M-6 Manual
  - Test specs are for meter test bench situations
  - Field testing (testing meters “on site”) requires following a strict methodology.
    - **M-6 does not spell out field testing requirements.**
- Refer to the meter manufacturer specs
- Newer style meters require different testing approach
Testing Methodology

- Calibrated test meter needs to be used
- AWWA requires tests at 3 flows
  
  *Low, Intermediate, High flows*

- In some cases testing may be limited by flow situation

- It makes sense to conduct several tests at different flows to get full assessment of meter’s performance aside from the three tests.

- Look at how water is being used by water customer
  
  - That will help in determining proper meter size and type.
  - Refer to the M-22 Manual on Service line and Meter sizing.
Testing Frequency

- Is influenced by the cost of water
  - as water costs increase more accounts require annual testing

- The water quality
  - harsh water requires meters be tested more frequently
Using Revenue as a basis for testing frequency

- Using the rule of investing about 2% of a meter’s annual revenue in the “maintenance” (testing) of that meter, the following averages apply.
  - $15,000.00 or greater = annual testing
  - $7,500.00 to $15,000.00 = every 2 years
  - $3,750.00 to $7,500.00 = every 3 years
  - Less than $3,7500.00 = every 4 years
Consequences of not maintaining meters

- These are **your** cash registers!
  (** Do you think it is ok to lose 10% - 20% of your money?)

- All your **operating money** comes from collecting the revenue generated by the meters!

- Make sure **everyone pays** for their fair share

- Sewer revenues often based on meter readings!
  (** Maybe you can get the sewer department to help fund the meter testing program!)
Case study

Gwinnett County Department of Water Resources, Gwinnett County, Georgia

- 225,000 metered accounts, suburban area NE of Atlanta
- (2007) Pilot study with 36 - 3” and larger meters
- 26 testable, 23 failed, 10 untestable (no test ports, no isolation valves)
- 1 failed meter after replacement yielded a monthly revenue return of $38,000 (\$456,000 annually!!!)
- This provided incentive to test and repair all 3” and larger meters
Case study

Gwinnett County Department of Water Resources, Gwinnett County, Georgia

- 732 – 3” and larger meters inventoried and tested
- Initial program costs were estimated at approx. $850,000
- Initial testing failure rate was 52% failure rate (Failed to meet suggested AWWA accuracy limits)
- 68 fireline meters were over 20 years old (past useful meter life) and had failed.
- Many meters in wrong applications.
Case study
Gwinnett County Department of Water Resources, Gwinnett County, Georgia

- Initial program costs were estimated at $850,000.

- 68 fireline meters slated for replacement at estimated cost of $1 million (average of $14,000 each).

- Assumed average large meter annual revenue of at least $14,400, the 68 meters replaced will pay for themselves in 1 year.

- Estimated annualize revenue return for entire program projected to be slightly over $5 million.

- Net annual revenue return after testing, repairs and replacements projected to be $3.2 million.
Why develop a meter testing program?

- To insure that the utility is receiving all the revenue it should
- To promote conservation, reduce water loss and use best management practices
- To make sure that the cost of operating the utility is spread fair and equitably among all customers
THANK YOU!!

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QUESTIONS?

Presenter - Michael Simpson

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