Computation of Real & Apparent Losses through Pressure-Leakage Relationship Analysis

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Keywords: Pressure-Leakage Relationship; Leakage Volume, Real Losses, Apparent Losses

Introduction

This is a method currently being used by Manila Water Company Incorporated (MWCI) in computing for the Real and Apparent Losses of a District Metering Area (DMA). This method utilizes Pressure-Leakage Relationship, and Total Non-Revenue Water comparisons to determine the volume and percentage of Real and Apparent Losses of DMA's.

The Total Non-Revenue Water of DMA's is basically computed by getting the difference between the System Input Volume measured, and the Total Billed Volume delivered.

Non-Revenue Water = System Input Volume – Revenue Water

Table 1.1 IWA Water Balance

System Input Volume	Authorized Consumption	Billed authorized consumption	Billed metered consumption	Revenue Water
			Billed unmetered consumption	
		Unbilled authorized consumption	Unbilled metered consumption	Non Revenue Water (NRW)
			Unbilled unmetered consumption	
	Water Losses	Apparent Losses	Unauthorized consumption	
			Customer metering inaccuracies and data handling errors	
		Real Losses	Leakage on transmission and/or distribution mains	
			Losses at utility storage tanks	
			Leakage on service connections up to point of customer use	

For Manila Water Company, The Total Non-Revenue Water is equal to the Total Water Losses since all the authorized consumptions are billed and metered.

Total Non-Revenue Water is further categorized into two distinct types: Real Losses, which is the physical loss within the system which is primarily, composed of background losses and leakages; and Apparent Losses, which is the loss due to metering inaccuracies, systematic data handling errors, and unauthorized usage. Total Non-Revenue Water can be composed of Real Losses, Apparent Losses, or a combination of both.

Total Non-Revenue Water = Real Losses + Apparent Losses

Table 1.2 MWCI Water Balance

<table>
<tr><td rowspan="6">System Input Volume</td><td colspan="3">Billed Volume</td></tr>
<tr><td rowspan="5">Non-Revenue Water (NRW)</td><td rowspan="2">Apparent Losses</td><td>Unauthorized consumption</td></tr>
<tr><td>Customer metering inaccuracies and data handling errors</td></tr>
<tr><td rowspan="3">Real Losses</td><td>Leakage on transmission and/or distribution mains</td></tr>
<tr><td>Losses at utility storage tanks</td></tr>
<tr><td>Leakage on service connections up to point of customer use</td></tr>
</table>

The Pressure-Leakage Relationship Analysis is widely accepted in accurately estimating the Real Losses in DMA's. The Power Law Formula (Thornton, 2003) is often used to compute for the Real Losses.

$$Q_2 = Q_1 \times PCF$$

Where:

P_1 = Pressure at point 1
P_2 = Pressure at point 2
Q_1 = Flow at P_1
Q_2 = Flow at P_2
PCF (Pressure Correction Factor) = $(P1/P2)^{N}$

Normally, apparent losses are computed by estimating & assuming various factors for metering inaccuracies, systematic data handling errors, and unauthorized consumptions. Often, these estimated & and assumed data are difficult to gather and may require additional analysis and resources.

Methodology

The general concept of the method in computing for the Real Losses and the Apparent Losses of a given DMA makes use of the equation: Total Water Loss is equal to the summation of Real and Apparent Loss.

Total Water Loss is computed from the System Input Volume and the Billed Volume, while Real Losses is attained from the Pressure-Leakage Relationship Analysis, using the Power Law. The Apparent Losses is then derived from the difference of the Total Water Loss and the Real Losses.

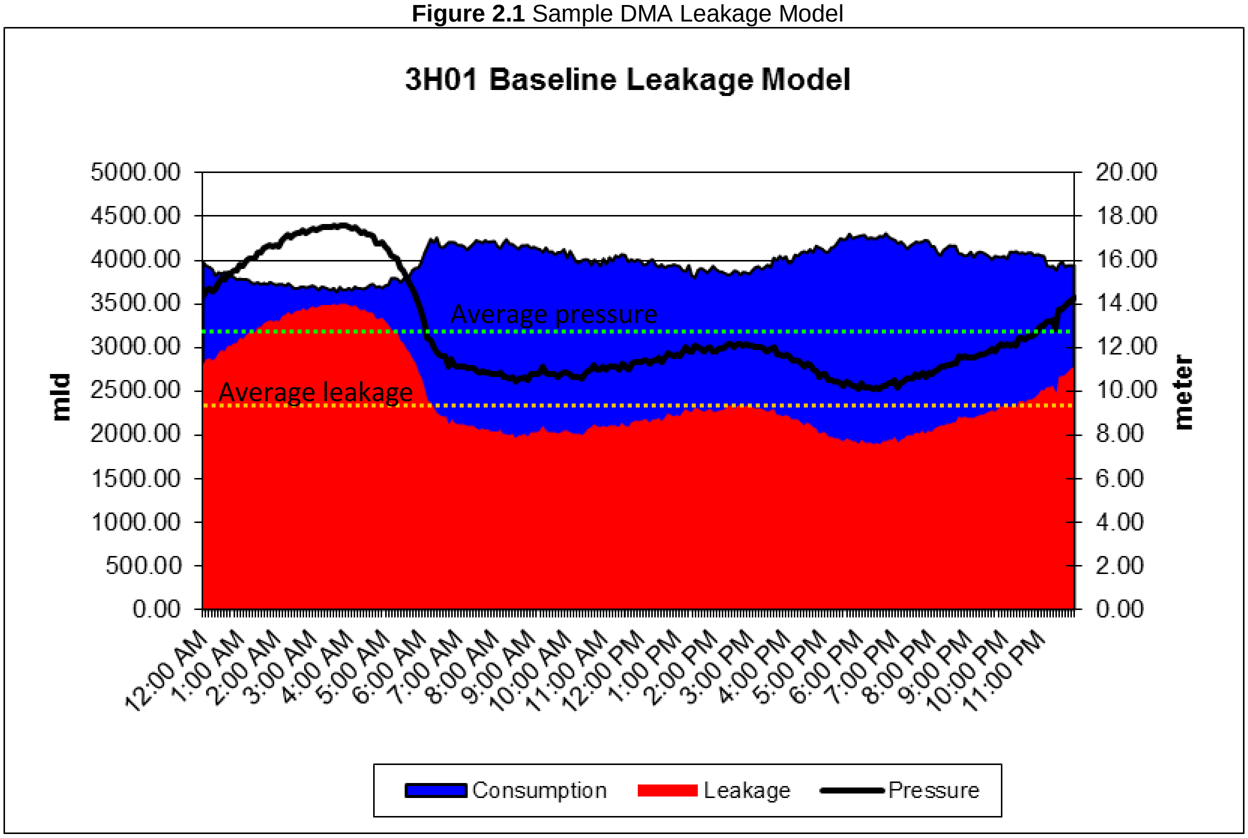
Apparent Losses = Total Water Loss – Real Losses

Where:

Total Water Loss = System Input Volume – Billed Volume

Real Losses = Average Leakage (L_{ave})
$L_{ave} = L_o \times (P_{ave}/P_o)^N$
P_{ave} = Average Pressure
L_o = Minimum Night Flow (MNF) – Allowable Night User (ANU)
P_o = Pressure during the MNF
N = Pressure-Leakage Rate Coefficient

Figure 2.1 Sample DMA Leakage Model



Allowable Night User (ANU)

The Allowable Night User (ANU) is computed in two ways, depending on the given circumstances of a certain DMA.

The first method is by closing the customer meters during the Minimum Night Flow (MNF). Once a DMA is commissioned with a one point supply and with all customer meters identified and accounted, flow and pressure data is logged for at least one week to determine the MNF and at what time it typically occurs. As much as possible, the time of closing of the customer meters should not fall outside the time when the MNF occurs, so timing is very important. After the closing of the customer meters, the MNF is now expected to be lower than when the customer meters were open. The difference between the MNF when the customer meters were open and the MNF when the customer meters were closed is the Allowable Night Consumption.

The second method is by monitoring the customer meters during MNF. Customer meters are read and observed during the time of the MNF. Consumption of customers during the time of the MNF is considered as the ANU.

Pressure-Leakage Rate Coefficient (N)

The Pressure-Leakage Rate Coefficient (N) is computed by also using the Power Law. The "N" Coefficient differs for every DMA, but from various laboratory experiments and actual site trials, the "N" coefficient for Manila Water Company averages at "1".

Trial (IWA-MWC)

Results/benefits

This practical method of computing for the Real and Apparent Losses proved to be a very helpful tool in identifying the applicable solutions in the reduction of the various NRW components in a DMA. The values obtained in the method are used in the cost benefit analysis of the NRW reduction solution. Manila Water Company used this method to compute and forecast possible revenue and billed volume potential from the apparent losses. The computed Apparent Losses for Manila Water is 15% of the total NRW volume.

Conclusion

The method of computing for Real Losses using the Pressure-Leakage Rate relationship and Apparent Losses in a DMA using the Total NRW comparisons is a reliable and efficient tool in the computation of the NRW components.