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# Title: Critical issues in estimating water losses with the algorithms from IWA Good Practices (EU Reference Document)

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**Abstract:** The standard algorithms commonly used for daily water losses estimate in a DMA presents some significant computational difficulties which are emphasized in specific types of Districts: DMA in touristic areas or in metropolitan business/sport areas (Exhibition Centres or similar). The issues are mainly associated with the difficulty of estimating properly the Numbers of daily served inhabitants and the Legitimate nighttime water usage. This Paper addresses the computational issues and the possible size of estimation errors. This situation strongly suggests to look for alternative algorithms less prone to these kind of errors (an example is given by the algorithm of Web HP-Leakage Detector).

**Keywords**: Active Leakage Control (ALC) Systems; Water Losses estimation algorithms

From the IWA Reference Document EU (p. 52) [1] we see below the conceptual scheme for calculating the loss of a DMA:

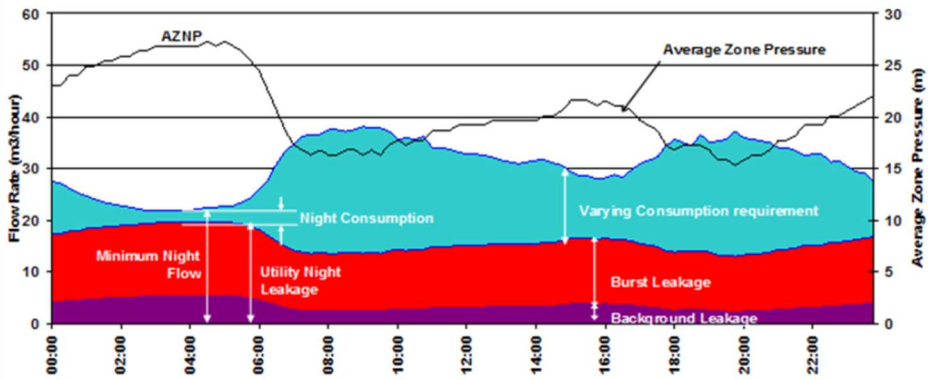


**Figure 1 Conceptual scheme for the estimate of losses in a DMA**

The standard formulas for calculating real losses are as follows:

$$Q_L = Q_{DMA} - Q_{CNU}$$

Where $Q_L$ is the night flow in $m^3/h$ that can be attributed to losses, $Q_{DMA}$ is the total nigth flow (MNF) entering in the DMA (the nigth District Balance) and $Q_{CNU}$ the legitimate night consumption of the users

$$Q_{CNU} = N_U * C_I$$

$Q_{CNU}$ is in turn given by the product of the number of users served for the legitimate nighttime consumption of a single user.
Finally

$$V_L = Q_L * HDF$$

Where $V_L$ is the volume of daily losses in $m^3/g$ and ***HDF*** is the so-called hour-day-factor, which considers the difference in pressures at various hours of the day.
The paper will show the computation (or better the estimate), with these formulas, of losses for a small DMA of 1020 inhabitants in a rural area (10 km of network). For the sake of simplicity of calculation, we assume that, thanks to an accurate regulation of the pressure, it is possible to assume the pressure in AZP (Average Zone Point) almost constant and therefore ***HDF***=24.

Let us consider the computation of $Q_{CNU}$; here the elements of uncertainty are great. The Paper will show some examples of computations which bring to values differences up to about 45%.

So far, we examined the problem with a simplified calculation method. Considering also the HDF factor, the issues would have become more complicated and not a little, because the HDF formula is the following:

$$HDF=\sum_{I=1,24} (P_I / P_N)^{N1}$$

where $P_I$ is the pressure at hour I in a significant point (AZP) of DMA, $P_N$ is the average night pressure and ***N1*** is an exponent to be chosen on the basis of the pipe materials.
An accurate computation of HDF is quite complex (and surely prone to a certain level of error) and could therefore generate additional big variations on the final result of losses estimation, considering that at page 53 of [1] we find this: *NDFs (an alternative acronym for HDF) can vary from 15 hours per day to 30 or more, depending upon the pressure variation*.

The conclusion of the above is very simple. Often, we hear statement like "My ALC System is making losses estimate with the IWA formulas". Now, it is out of any doubt that the computation methodology outlined in [1] is correct and appropriate, but it is on the other hand quite difficult to be applied effectively in an ALC System, especially for DMAs with significant daily variation of served inhabitants and with varying nighttime water usage.

This is the reason why it could be very useful to adopt also other algorithms, which do not require a complex and long refinement of the computational parameters (an activity that can take years to be properly executed on hundreds of DMAs).

An example of a different algorithm can be the one used in the Web HP-Leakage Detector SaS

In this "Software as a Service" the real losses are computed only based on the difference of the entering and exiting flows in the DMA along 24 hours. The algorithm executes a pattern recognition type of analysis on flows and volumes, without the need to know any other data on the DMA. This allows to have a Service which does not require a long refinement of computational parameters and for this reason is fully operational from the first day of operation.

The paper will show a comparison of computational results among Web HP-Leakage Detector and a well-tuned ALC Systems which use the traditional formulas. The results shows differences of about 10%, which can be considered a pretty good result.

## REFERENCES

**Report**:
[1] EU Reference document Good Practices on Leakage management WFD CIS WG PoM Main Report