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Actual status in water loss reduction

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Abstract: Water losses are caused by various influences, especially on the pipe network, and are an essential part of the maintenance strategy for existing water distribution networks. The causes of the loss of pipeline network are varied and must to avoid "old bugs" in for the injury analysis which carefully documented repaired leaks and analyzed too. The level of the network losses and the number of repairs (leaks), or supply interruptions are a measure of the quality of the water supply and for the assessment of the value. It is therefore top priority over 24 hours ensure water supply for the consumers in impeccable quality. Therefore, the steps are represented State of the art to reduce, or in the future to avoid pipe-network losses. The level of the network losses are primarily determined by 3 factors: (a) Number of failures (b) Size of the damaged leaks and (c) Discharge time of water from the damaged failures. Measures to reduce water losses of pipeline network: (a) Renewal of pipes (preventing of leaks) and (b) Leak detection and repair (reduce the outflow time of water)

Keywords: maintenance strategy, water distribution network losses, pipeline network losses

1. WATER BALANCE

Basis for calculating the level of the loss of pipeline network is the water balance, the difference between the inflow quantity into the pipe network and the delivery quantities to customers or other consumption, that are not calculated.

The requirement is that any inflow quantities and all consumed water quantities by means of calibrated meters are measured. The calibration of the measuring points, in particular the inflow quantities must be carried out regularly. According to applicable standard law, water meters, which serve the calculation to the customer, must be regularly renewed or calibrated.

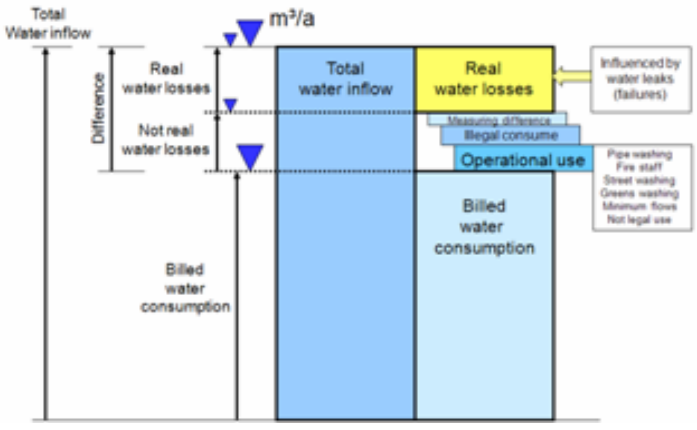

Figure 1. Calculation of water losses.

2. DAMAGE STATISTICS

The damage statistics maintains all repairs, carried out in the network. Accurately defined details are entered in a "failure form" in the course of the repair work, that are required for the analysis of

the damage. It is important that the required information with great care and accountability be added next to the place and date of damage!

The management of failure data is done in a computer program, usually in a PC. At the same time ensuring also that the pipe- and basis data of the management system of GIS for the reports are available. GIS data are used to control of the input data, in particular dimension, material and construction year, but above all to the determination of performance indicators in the evaluation.

Examples for performance indicators:

- Damage per km pipes (total, pressure zones, streets, pipe sections, …)
- Damage per 100 House connection pipes (streets, pipe sections, …)
- Damage to transmission pipes
- Damage to the various dimensions and materials
- Damage in relation to the pipe age
- Other parameters

The loss data evaluated according to various criteria and formats, so that a comprehensive analysis of the damage to the evaluation of the cause is given. Another is the results of the damage evaluation used to determine priority lists on renewals versus setting the inspection rhythms. The determination of the value of the investment is also significantly influenced by the frequency of the damage.

Examples of damage evaluation in different formats are shown in Figure 2.

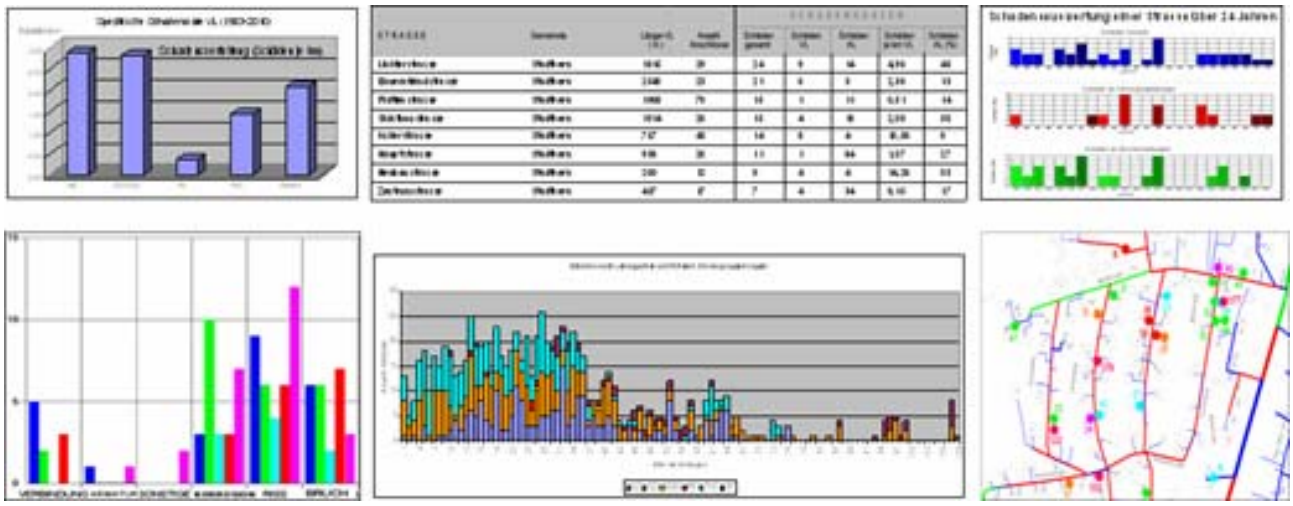

Figure 2. Damage evaluation in different formats.

3. STRATEGY TO REDUCE THE WATER LOSS OF THE PIPELINE NETWORK

The level of the pipe network losses are directly influenced by the number of the losses and the flow quantity through these failures. The reduction of losses in the pipe network is given by leak detection with repair and especially by the renewal of pipes.

The success of loss reduction through inspection and repairs is not sustainable and dependent on the dynamics of the damage, because immediately after the repair can develop a new leak on the same pipe section.

Sustainable reduction of the pipe network losses is given with the additional effect of an improvement of the asset substance by renewal of pipes.

The balance of leak detection and repair on the one hand, and pipe renewal on the other hand must be carefully determined taking into the level of losses and the failure rate, the budget options, the risk of possible supply disruptions and the opportunities together with other supply sectors to carry out a renewal.

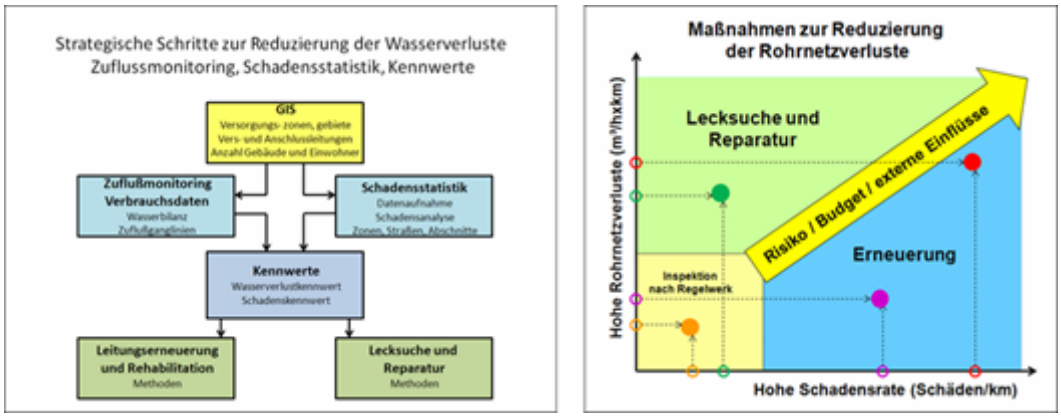

Figure 3. Strategic measures for reducing water losses and assessment of the value.

4. "TARGET SYSTEM PLANNING" AS A TOOL FOR REHABILITATION

"Target system planning" means, as the pipe network in the future must develop in accordance with the investment costs, operating costs and the asset value. Basis for the "target system planning" of the pipe network are the basis data from the GIS with several geographic information and data from the facilities. Further the data from the failure statistic, the consumption quantities and the inflow data.

In different processing modules are reserves of power and performance deficits of the supply system and the facilities and pipe dimensions proposed for renewals. Possible scenarios for the containment of risks, taking into account the local influences are simulated (traffic, geology, etc,) and assessed.

The following can be cited as the result of a "target system planning":

- Renewal planning to the maintaining of the existing system (network, facilities and installations)
- Asset valuation (value of the supply system and facilities)
- Investments in 5, 10 and 30 years (scenarios)
- Constant failure development
- Risk reduction
- Low loss of pipeline network
- Low operating costs
- Stable budget for investment and management over years

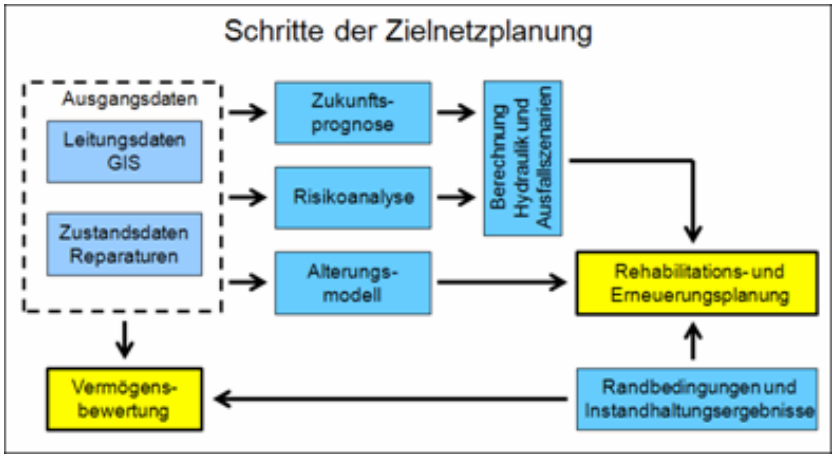

Figure 4. Steps of the "target system planning".

5. STRATEGIES TO REDUCE THE LOSS OF PIPELINE NETWORK

On the structure of pipe networks a monitoring strategy to take into account is in the selection. Here especially the network structure, the pipe materials, the dimensions of the pipes, the number of fittings, the density, the consumption structure and the operating pressure for the early detection of losses, to name a few.

Monitoring of pipe networks are using the inflow quantity, a selective leak detection must be done on the basis of their performance indicators (night minimum values or daily values or others) from the experience. On the basis of the pipe network structure and network size, the division of the network in measuring areas is required for representative characteristics about the presence of loss of pipeline network can be read.

In addition to monitoring the amount of inflow quantities, a damage statistics is run, all repairs in the network are entered into the database. Damages that are by themselves or be found not through systematic leak detection are also to result in the damage file and evaluate.

The following subdivisions have proven for the monitoring of preaction "for the early detection of losses":

- Measuring areas — natural areas of measurement or pressure zones with permanent inflow measurement and registration of rest inflow quantity during the night
- Measuring zones — closing valves of measuring areas and to supply fire hydrants and mobile unit of measurement - measurement of the minimum inflow, some during the night time
- Measuring ranges — Fair rich education virtual measuring ranges and recording existing leak noise by strategically placed noise logger over several days

Important: in addition to the presentation of results of localized failures the kind of procedures as well as the duration and number of the reviews must be documented in the year!

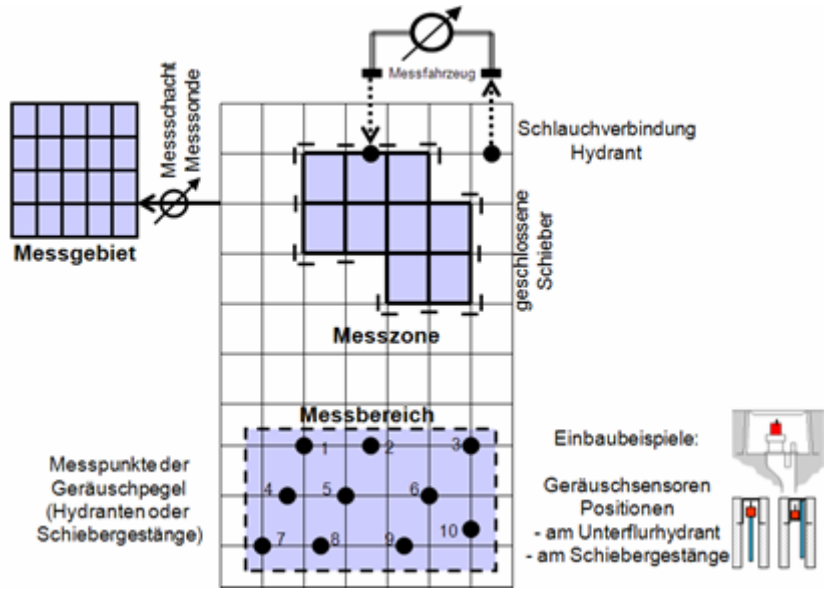

Figure 5. Schematic representation of monitoring system.

5.1 Monitoring of measuring areas

In measuring areas or pressure zones, permanent water meters must be installed that continuously measure the inflow and, where appropriate, the outflow and register. The storage of provided flow should occur in hourly values corresponding reviews on consumption or loss to occur

in the case of the inflow changes. The analysis of the flow data and the creation of flow characteristic can be done today with reasonable effort.

Based on the size of the measurement area and the structure of consumption the measurement inflows are preferred the night minimum, shown in inflow lines with day values (m^3/d) and hourly values (m^3/h), specifically.

For selective analysis daily inflow recordings from the this database can be made out, representing a start, outflow time, and repair time.

With this monitoring are given the following results:

- Load flow of water in the areas of measurement
- Consumer structure in the areas of measurement
- Minimal inflow and analyse the water loss of pipeline network
- Minimal inflow to the assessment of acceptable loss in pipe network
- Evaluate discrepancies pipe network losses after repair

Figure 6. Records of the inflow monitoring over 3 years (Qd, Qmin).

5.2 Monitoring of measuring zones

In a supply network measurement zones on the basis of pipe lengths, type of pipe material, apartments or population, consumer structure and number of functional valves and hydrants supplied number of the house connections, number of formed. This measurement zones are limited by the existing valves. Is the cart with probe, and a hydrant in the measuring zone of a hydrant outside the measuring zone above. The sufficient tightness of the valves is documented by a so-called pressure test. The flow and pressure are measured. The measuring time is chosen by measuring zone size, consumer structure and traffic restrictions.

The registered flow in the mobile measuring van displays supplied consumer consumption. A minimal consumption of consumers is assessed as acceptable quantity of loss can be expected due to the selected measurement time. In the event of a loss quantity present this measuring zone reduced by the existing valves and so a possible small area with loss quantities limited. As a result, the leaks are further circumscribed and located by acoustic method.

The storage of measuring areas is essential, measurements and flow structure in a database, these comparisons for follow-up measurements can be.

5.3 Monitoring of measuring ranges with acoustic sound loggers

A very convenient method to determine of existing leaks in meshed supply networks is given by means of sound data logger. This procedure is preferred on metallic piping, as the acoustic noise propagation with metallic pipes is very good! The noise data loggers are positioned to fire hydrants or valve slides in the network and leave about 2-3 days there. The noise loggers permanently store the incoming signals. The "same" sound shares are associated with the leaks and evaluated together

with the level of the leak sound. The positions and delivers logger numbers must be registered exactly, clear assignments of the results are possible in the evaluation.

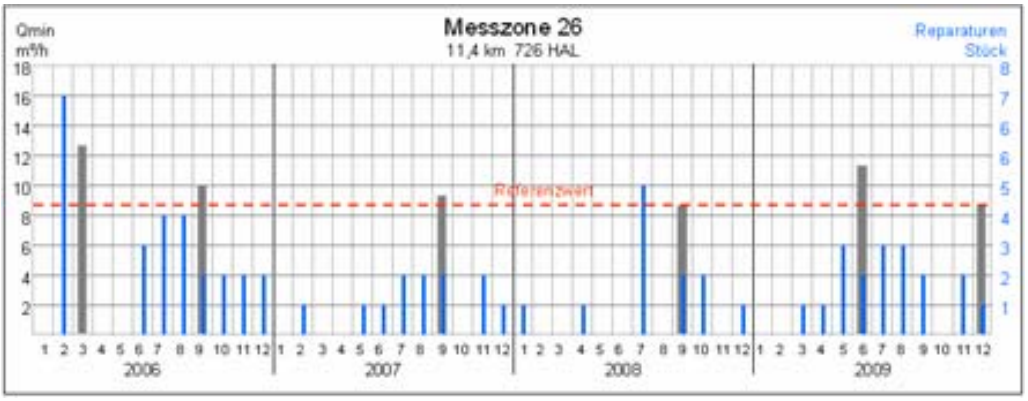

Figure 7. Documentation of the results of zone measuring over 4 years (inflow quantity and damages).

The sounds of a leak spread to both sides, same noise shares come to minimum on two sound loggers, which electronically evaluated and expressed in a key figure. Thus, there is a clear mapping of the leakage noise on a leak point and can be localized.

Also here is the need for the review and the results in the evaluation are documented.

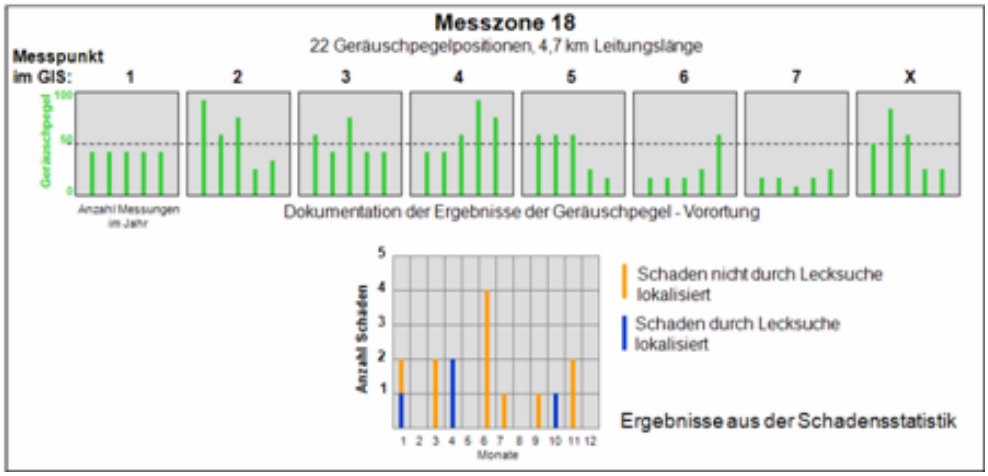

Figure 8. Documentation of results of the acoustic sound logger and damages in one measuring range.

6. LOCALIZATION OF LEAKS

In addition to the point location of leaks using floor microphone and leak noise amplifiers, with the impact of outflow water on the ground is located, the correlation method has prevailed.

Correlation is called compare!

Two body signals are there compared frequency equal and led to the leak noise correlator of two contact points on the network. It should be noted that the leak noise on metallic pipes is better and further spread by the reflection to the metal plate along the pipe than on non-metallic lines. Therefore, greater distances for leaks on metallic pipes are possible.

The correlation function is a mathematical calculation rule to measure speeds and distances. The interaural time difference appears in a maximum in the correlation function.

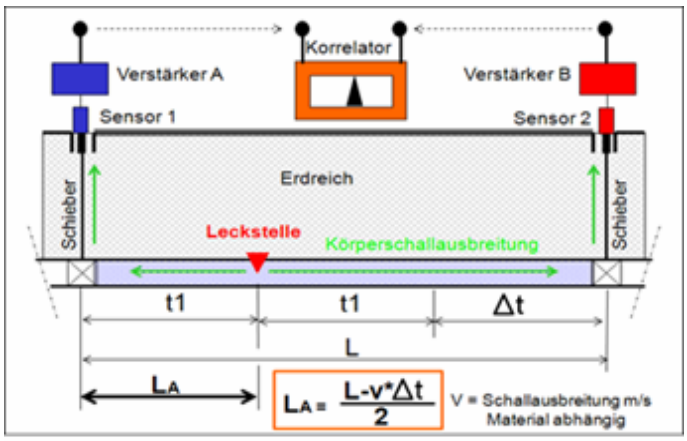

Figure 9. Localization of leaks.

7. RESULT EVALUATION AS A BASIS TO REDUCE THE LOSS OF PIPELINE NETWORK

The reduction of the pipe network losses is dependent on many factors. It is therefore necessary that many operational data, which are related to the pipeline network losses, are collected and fed to a systematic analysis. These are in addition to the documentation of the flow quantities (daily inflow Qd, minimum inflow Qmin,) can be repaired damages and in particular the number and duration of inspections, so that the effort made success compared to.

Characteristic indicators are formed from the collected results, which are basis for decisions (leak detection or renewal) in the long term.

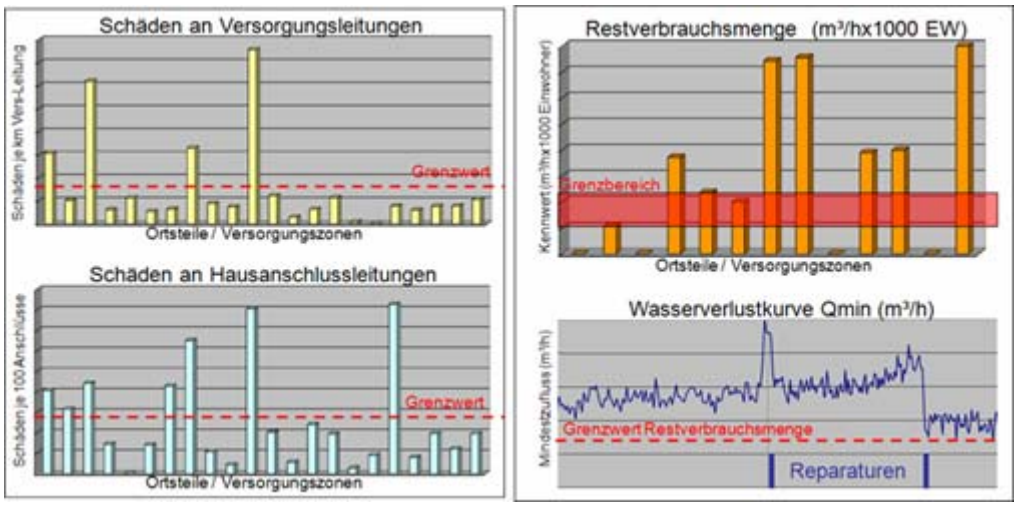

Figure 10. Damage evaluation in measuring areas: damages on main pipes, damages on service pipes (left). Rest consume quantity in measuring areas; Record of the minimum inflow with points of repairs (right).

7.1 What is the minimum water loss?

A minimum of pipeline network loss depends on the damage dynamics of pipelines, which in turn depends on the condition of the network.

A high rate of damage corresponds to corresponding loss patterns and difficulties in locating the leaks, a high quantity of losses.

Main reason for the damage on pipes:

- Underground and location (sandy - clayey - rocky) (Level - Hillside)

- Quality of construction works (qualified installation and pipe-laying, type of bedding)
- Subsidence in underground (parallel pipes, traffic loads)
- Selection of the right pipe material (influences of underground, connection, isolation)
- Age of constructed pipes
- Pressure surges in operation by operating
- Corrosion by stray currents, potential (grounding), type of soil, water stability (mixed water), etc.

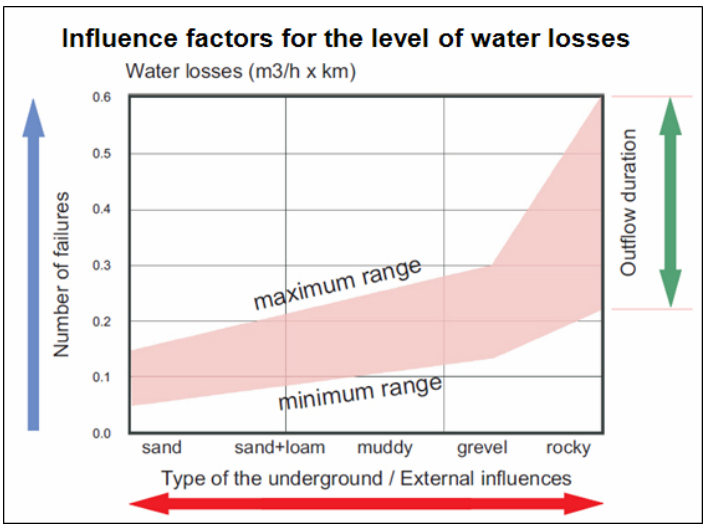

Figure 11. Guideline of the range of acceptable water losses (DVGW W 392).

7.2 Measures of the best prevention of water loss:

- Careful planning on the basis of local conditions
- Choice of suitable material of the pipe due to the local situation and the ground, as well as the composition of the water
- Use of certified materials of pipe and fittings
- Qualified laying of pipes according to standards
- Controls during the construction works (quality assurance)
- Careful pressure test before commissioning of pipes
- Avoiding pressure surges during operation
- Periodic execution of scheduled maintenance
- Control of inflow and outflow measuring points to supply zones and areas

8. TASKS OF THE ASSOCIATION

The tasks of the Association for the water companies are diverse and are not covered by the individual companies. The influence of European directives, national legislation and State of the art in the management of network systems in technical, economic, organisational and hygienic point of view are very complex and will in future continue to rise to selectivity. Served customers expect a high level of security of supply, the food by the companies drinking water. This requirement increases with the increase in the cost of drinking water. It is therefore imperative to make maximum efforts, to include customers in the process of "security of supply" and to satisfy.

The requirements for an association are managerial way to accomplish the required tasks together with the member companies (water companies):

- Creating guidelines for the design, construction, maintenance for the management of the water supply (regulations)

- Consideration of European and national rules
- Certification of products, companies and professionals
- Training of the professional person on the basis of the created guidelines and State of the art
- Interface to ministries, European Union and other institutions related to the supply of drinking water in connection (speak with one voice)
- Monitoring of the market habits of customers and their needs as well as developments and state of the art
- Cooperation with neighbourly and international Associations to plan the future and to exchange experiences
- Organization of congresses, conferences and workshops to exchange experience and imparting current knowledge
- Lead a journal to the current information to members
- Outreach to raise the image drinking water