

AVK NON-REVENUE WATER SOLUTIONS



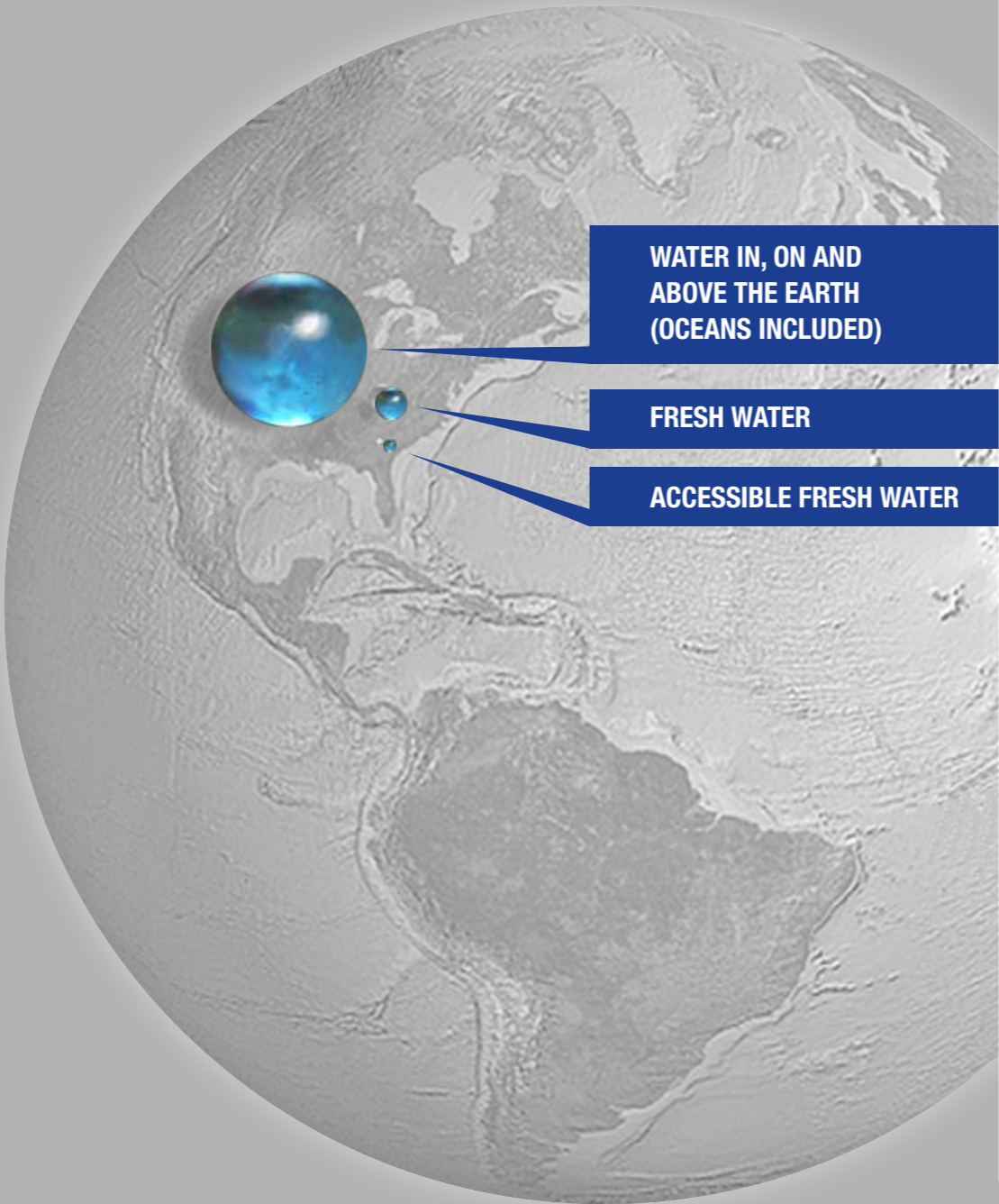
VALUE IN EVERY DROP
STOP WATER LOSSES

Expect... **AVK**

CONTENT:

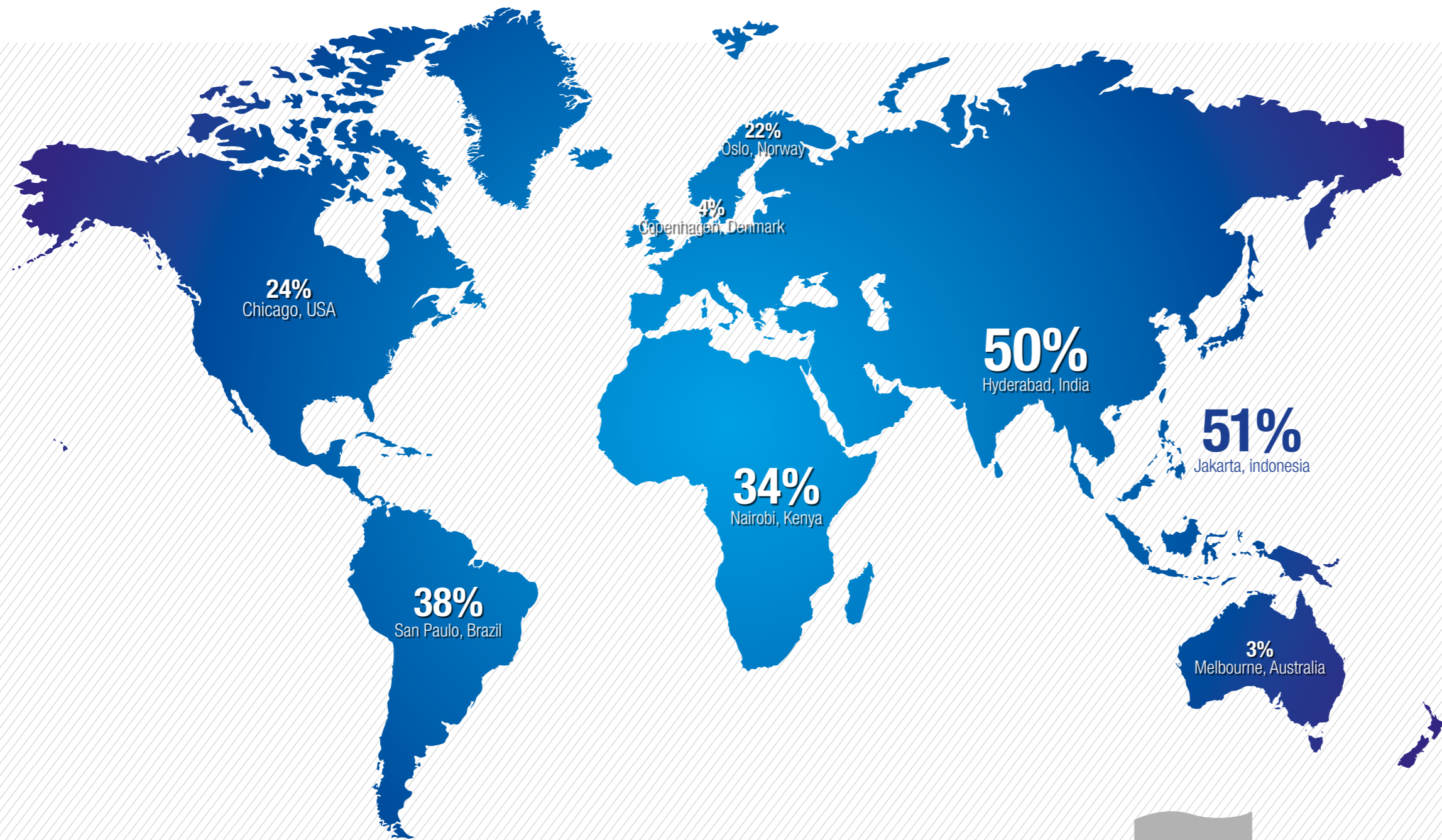
THE EARTH STRIPPED OF ITS WATER

- 72%** of Earth is covered in water,
- 97%** of that is salty ocean water and not suitable for drinking.
- 70%** of freshwater is locked in ice caps
- 1%** of the world's freshwater is readily accessible
 - 6 countries (Brazil, Russia, Canada, Indonesia, China and Colombia) have 50 percent of the world's freshwater reserves
- 33%** of the world's population lives in "water-stressed" countries, defined as a country's ratio of water consumption to water availability. Countries labeled as moderate to high stress consume use 20% more water than their available supply.



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WORLDWIDE DIFFERENCES IN NRW LEVELS



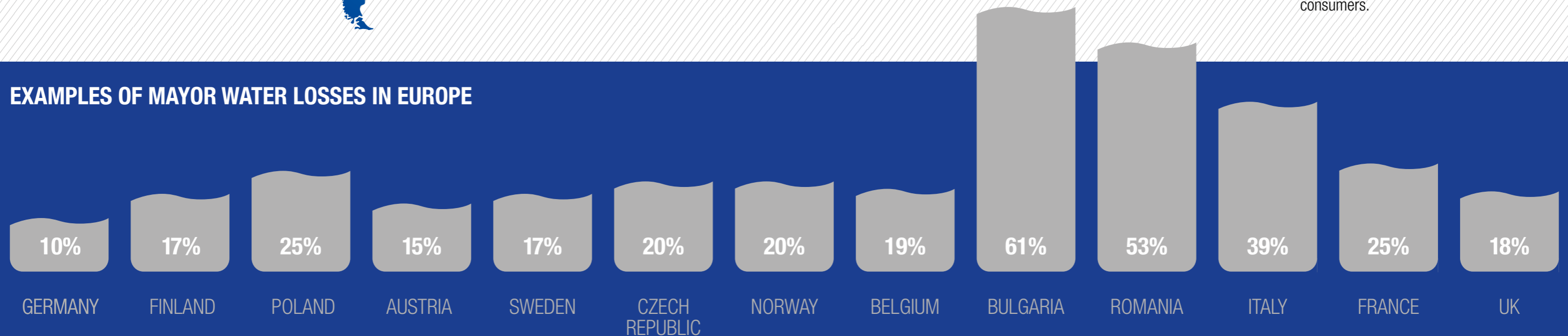
Non-revenue levels differ around the world from close to 5% to as much as 80% with around 40% as average and 26% in Europe.

Huge volumes of clean water are lost through leaks and overflows, and are not accounted for due to metering inaccuracies at consumers and illegal connections (theft). In many parts of the world this results in far more extraction than needed, and limited water resources are being over-exploited.

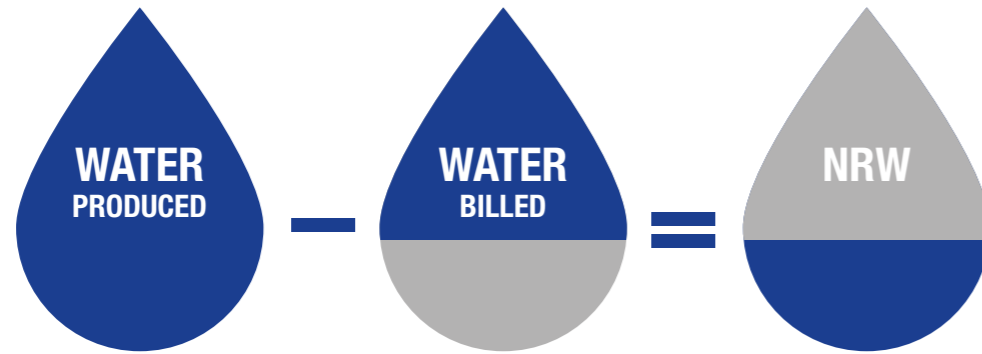
Reducing NRW levels is a pivotal management challenge, and the aspiration should be to reduce NRW down to the Economical Level of Leakage (ELL), an optimal level defined by the International Water Association (IWA), with a view to maximizing benefits in relation to economy and resources.

Sustainable water management is, besides being good for the environment, simply good business. In the long run, a sustainable approach to clean water supply does not cost money – it saves money, for utilities as well as for consumers.

EXAMPLES OF MAYOR WATER LOSSES IN EUROPE



WHAT IS NRW?



Non revenue water (NRW) is water that has been produced and is “lost” before it reaches the customer. Losses can be real losses through leaks, sometimes also referred to as physical losses, or apparent losses for example through theft or metering inaccuracies.

High levels of NRW are detrimental to the financial viability of water utilities, as well to the quality of water itself. NRW is typically measured as the volume of water “lost” as a share of net water produced. However, it is sometimes also expressed as the volume of water “lost” per km of water distribution network per day, expressed as ILL, Infrastructure Leakage Index.

In developing countries, roughly 45 million cubic meters of water are lost daily with an economic value of over US\$3 billion per year.

The need to manage NRW better and protect precious water resources has become

increasingly important. Non-revenue water management allows utilities to expand and improve services, enhance financial performance, make cities more attractive, increase climate resilience and reduce energy consumption.

In a water constrained environment, NRW management often offers superior cost-effectiveness compared to supply augmentation. At the same time, revenues from saved water improve a service providers’ bottom line whilst lower water abstraction increases city resilience.

But the benefits that arise from reducing NRW are yet to become driving forces behind tackling

this endemic challenge in developing countries. Despite the benefits and decades of training and advocacy from international and industry organizations, NRW reduction still receives scant attention amongst those utilities which would most benefit from it – why is that?

Reasons for utilities not making progress include weak capacity, lack of incentives, poor financial discipline and the effort required to find and fix leaks compared to building new treatment facilities. This has created a lethargy which is now being shaken by pressures coming from climate change, water scarcity and increasing expectations of consumers.



A World Bank study puts the global estimate of physical water losses at 32 billion cubic meters each year, half of which occurs in developing countries. Water utilities suffer from the huge financial costs of treating and pumping water only to see it leak back into the ground, and the lost revenues from water that could have otherwise been sold. If the water losses in developing countries could be halved, the saved water would be enough to supply around 90 million people.



A WIDE RANGE OF VALUABLE BENEFITS

An NRW programme will naturally focus on reducing urban water loss and increasing revenue but it can also lead to other important benefits for the water utility and its consumers:

- Reduced stress on the area’s water resources, allowing more people to be served by the same water source.
- Reduced energy consumption for abstraction, treatment and distribution while still meeting the same demand for water as pressure is adapted to demand and smaller volumes of water will need to be treated and distributed.
- A more stable water supply as improved performance will provide full pressure distribution 24 hours a day, 7 days a week.
- Better support for decision making and customer service due to new management systems.
- A strong basis for setting up a long-term rehabilitation and investment plan for the network.
- Improved water quality due to optimized water distribution as chlorine content in the distributed water will be better controlled and risk of pollution related to burst and periods with low pressure or vacuum will be reduced.

IWA WATER BALANCE MODEL

One way of having control of the distribution network is to know, what is going on. The IWA water Balance model help to identify where to address the various types of issues.

The first step in reducing NRW is to develop an understanding of the “big picture” of the water system, which involves establishing a water balance. This process helps utility managers to understand the magnitude, sources and cost of NRW. The IWA developed a standard international water balance structure and terminology that has been adopted by national associations in many countries across the world.

Non-revenue water (NRW) is equal to the total amount of water flowing into the water supply network from a water treatment plant (the 'System Input Volume') minus the total amount of water that industrial and domestic consumers are authorised to use (the 'Authorised Consumption').

$$\text{NRW} = \text{System Input Volume} - \text{Billed Authorised Consumption}$$

SYSTEM INPUT VOLUME	AUTHORISED CONSUMPTION	BILLED AUTHORISED CONSUMPTION	BILLED METERED CONSUMPTION	REVENUE WATER	
			BILLED UNMETERED CONSUMPTION		
	WATER LOSSES	UNBILLED AUTHORISED CONSUMPTION		UNBILLED METERED CONSUMPTION	NRW (NON REVENUE WATER)
				UNBILLED UNMETERED CONSUMPTION	
APPARANT LOSSES			UNAUTHORISED CONSUMPTION		
			LEAKAGE ON TRANSMISSION AND/OR DISTRIBUTION MAINS		
REAL LOSSES		LEAKAGE AND OVERFLOWS AT UTILITIES STORAGE TANKS			
		LEAKAGE ON SERVICE CONNECTIONS UP TO POINT OF CUSTOMER METERING			

- System Input Volume is the annual volume input to that part of the water supply system.
- Authorised Consumption is the annual volume of metered and non-metered water taken by registered customers, the water supplier, and others who are implicitly or explicitly authorised to do so (e.g. water used in government offices or fire hydrants). It includes exported water and the leaks and overflows after the point of customer metering.
- Non-Revenue Water (NRW) is the difference between System Input Volume and Billed Authorised Consumption. NRW consists of Unbilled Authorised Consumption (usually a minor component of the water balance) and Water Losses.

- Water Losses is the difference between System Input Volume and Authorised Consumption. It consists of Commercial Losses and Physical Losses
- Commercial Losses, sometimes referred to as 'apparent losses', consist of Unauthorised Consumption and all types of metering inaccuracies
- Physical Losses, sometimes referred to as 'real losses', are the annual volumes lost through all types of leaks, bursts and overflows on mains, service reservoirs and service connections, up to the point of customer metering.

WHY LEAKS OCCUR



The most problematic leakages are those that are not visible on the surface. The reason for the leakages can be the below mentioned reasons or combination of them.

- Bad quality of equipment like valves, joins, connections and pipes
- Deterioration of the distribution system
- Poor workmanship like bad welding or wrong handling during laying of the pipes
- Water hammer and poor water pressure management
- Corrosion of material due to acid soil condition
- Settings or movements in the soil
- Load from heavy traffic or construction work
- Frost settings in the soil
- Drying out of the soil
- Earthquake
- Illegal connections from water thieves
- Accident done by contractors during construction work



DISTRICT METERING AREAS (DMA) IN SUSTAINABLE AND SMART CITIES

Generally NRW management in an open system is undertaken in a passive manner where NRW reduction activities are initiated only when the loss becomes visible or is reported. A more effective approach is to move towards Active NRW Management where dedicated teams are established and sent out to look for water losses, such as leaks, reservoir overflows, and illegal connections.

Active NRW Management is only possible using zones, where the system as a whole is divided into a series of smaller sub-systems for which NRW can be calculated individually. These smaller sub-systems, often referred to as District Meter Areas (DMAs) should be hydraulically isolated so that utility managers are able to calculate the volume of water lost within the DMA.

Sustainable SMART water management is about monitoring and controlling the supply system, and water authorities and operators often face a series of challenges when monitoring the water volume conveyed by networks and detecting leaks in order to preserve the water supply.

“HIGH QUALITY, FUNCTIONAL AND OPERATIONAL VALVES ARE THE BACKBONE IN ANY WATER DISTRIBUTION SYSTEM”

When the utility company in the city of Al Ain in the United Arab Emirates modernized a part of its water distribution system in 2014, the responsible engineer stated: “High quality, functional and operational valves are the backbone in any water distribution system”. This statement was based on the outcome of the city’s modernization with a reduction of the water loss from 19 % to 8 % through a SMART water management project and in addition, the proportion of sold water was increased by 19 %.



Dividing a network into sections called district metering areas (DMA) is an effective tool to prevent water loss. A high-quality reliable AVK gate valve is the perfect choice to shut off the flow between the different DMAs completely. Each DMA has one or two inlets on which a bulk water meter is installed to measure the amount of water flowing into the DMA. All consumers within the DMA are also supplied with a house hold water meter to measure how much water is consumed. A negative difference between the water into the DMA and the water used by consumers indicates a leak inside the DMA. However, if the difference is positive, it suggests that water from the neighboring DMA sends water into this DMA. Even though, the latter may not be a direct leak, they are both harmful in relation to managing each DMA individually.

So, in order to control the water distribution system it is of vital importance to install reliable high-quality valves. By choosing high-quality shot-off valves, leakages from the valve itself can be avoided. Gate valves with high-quality gasket of rubber ensure that the valves are 100% drop-tight. And this is exactly what the Al Ain engineer meant by his statement that high quality, functional and operational valves are the backbone in any water distribution system!

BENEFITS OF THE DMA

For each DMA, utility managers should develop a detailed operations manual to assist future teams in managing the water supply. The operations manual includes a schematic of the pipe network; location drawings of the flow meters, pressure control valves, and boundary valves; and a copy of the billing database for the DMA. The manual is a working document and operational data should be continually updated, including information on the following:

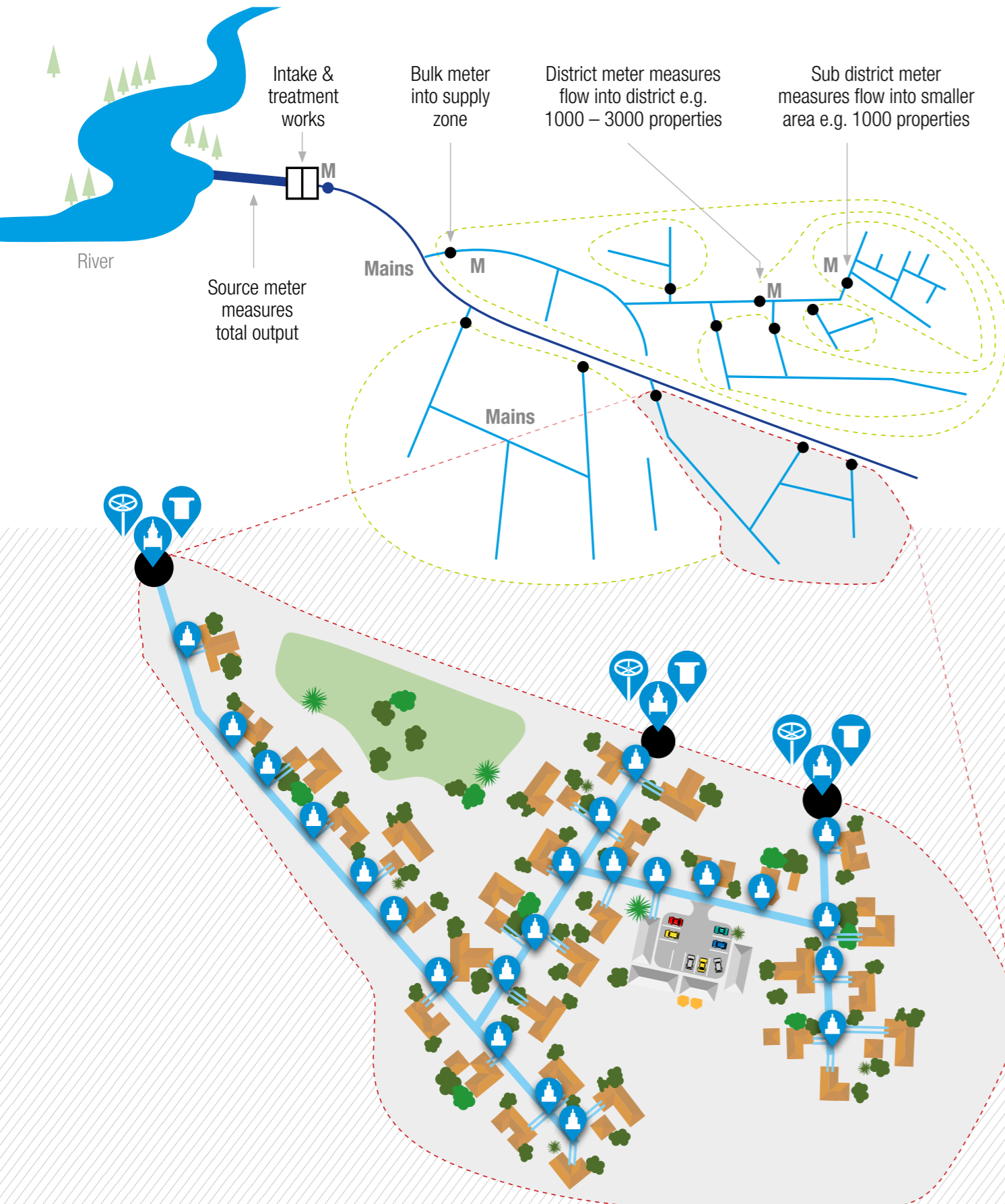
- Flow and pressure graphs
- Leakage step tests data
- Leak locations
- Illegal connection locations
- Legitimate night flow (LNF) test data
- Pressure T Factor test data

Establishing a series of DMAs not only targets NRW reduction but it also improves asset condition and customer service by:

- Maintaining asset life through pressure management
- Safeguarding water quality
- Enabling continuous water supply



DISTRICT METERED AREAS, DMA



AVK SERIES 36

AVK offers a wide range of resilient seated gate valves according to all major international standards and approvals, with a numerous of connections to most pipe and material used around the globe.



AVK SERVICE CONNECTION VALVE

A wide range of multi turn service connection valves in ductile iron, brass and plastic with a wide range of connection types to fit all kind of service pipe from mains to house hold meter.



AVK SURFACE BOXES

A dedicated surface box in high strength plastic has been developed to hold the noise logger assembly. The lid of cast ductile iron on the surface box is acting as platform for the antenna to transmit noise logger data. To avoid theft, the surface box can be supplied with lockable lid.



AVK STEM EXTENSION

Stem extension in fixed length or telescopic execution makes it simple and easy to operate the gate valve from street level. The stem extension also act as the listening point for the noise logger microphone, thus full metal to metal contact all the way to the water way, ensures optimum listening conditions.

LEAKAGE MONITORING AND CONTROL



NOISE LOGGERS INTEGRATED IN THE SURFACE BOX

Avoiding leakages on water pipes altogether is not possible as even new pipes can experience breaks. Modern Information Communication Technology tools can be used to design, monitor and report Key Performance Indicators (KPIs) for NRW. Based on this, water utilities can establish a long-term rolling plan for their NRW operations which can support the operational management in carrying out pressure management and active leakage control in the network.

Noise loggers narrow down areas of a DMA that contain suspected bursts or number of leaks. It can save water utilities both time and maintenance costs. Using deployed noise loggers integrated in AVK surface box reduces the runtime of invisible leaks significantly. It enables leakage teams react quickly and efficiently and target weakest areas and pipeline segments.

Together with the traditional Minimum Night Flow and estimated leakage, these technologies provide a proper set of KPIs which focus directly on leakage.



REHABILITATION OF DISTRIBUTION SYSTEMS

In addition to the daily NRW management, successful NRW reduction requires a long-term rehabilitation strategy for the network. Water distribution networks are often constructed over a period of many years and continuously adjusted to urban development and new regulatory requirements for drinking water supply. Pipe materials, valves and other components as well as construction methods have also changed over time and the potentials in upgrading to best available technologies are often quite significant. AVK offers a various solutions for rehabilitation of all sorts of pipes.



REPAIR CLAMPS

Whenever a leakage in a water mains occurs due to a crack, it is essential that the repair is done quickly and efficiently so that the consumers and surroundings experience a minimum of disturbance. As most cracks occur without any prior notification it is of greatest importance that the repair products are available ex-stock either at the waterworks, the contractor or as minimum at the wholesaler. To make this possible the repair products must have multi functionality, flexibility and wide tolerances.

Furthermore the key demands when conducting repairs are easy and fast installation and reliable functionality.

For all these specific purposes and demands AVK offers a comprehensive range of products specially designed for all sorts of cracks in the most common pipe materials.



AVK offers a wide range of single band, double band or triple band stainless steel repair clamps for any type of pipe size and material. Repair clamps can also be supplied with threaded or flanged tapping connection.



For large diameter pipes, AVK offers both external as well as internal stainless steel repair clamps. All repair clamps are vulcanized with drinking water approved EPDM rubber.



AVK also offer a wide range of couplings and adaptors, tensile and non-tensile, dedicated and multi tolerance for any type of pipe and pipe material.

PRESSURE MANAGEMENT ADDS YEARS TO YOUR PIPES

Improved pressure control presents dual benefits of reducing leakages and stabilizing system pressures, which increase asset life.

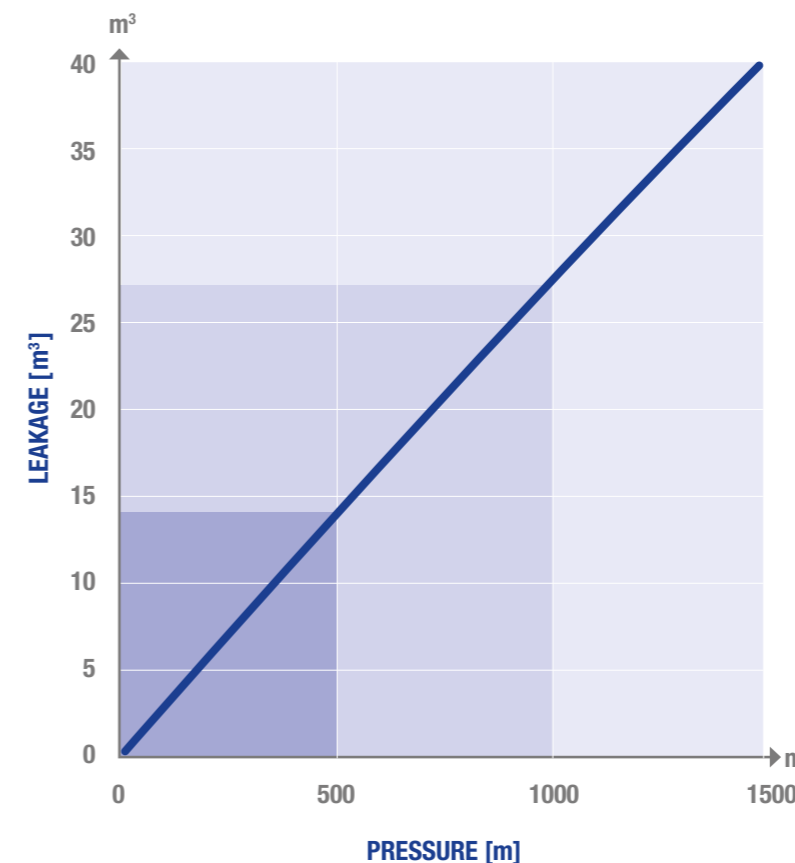
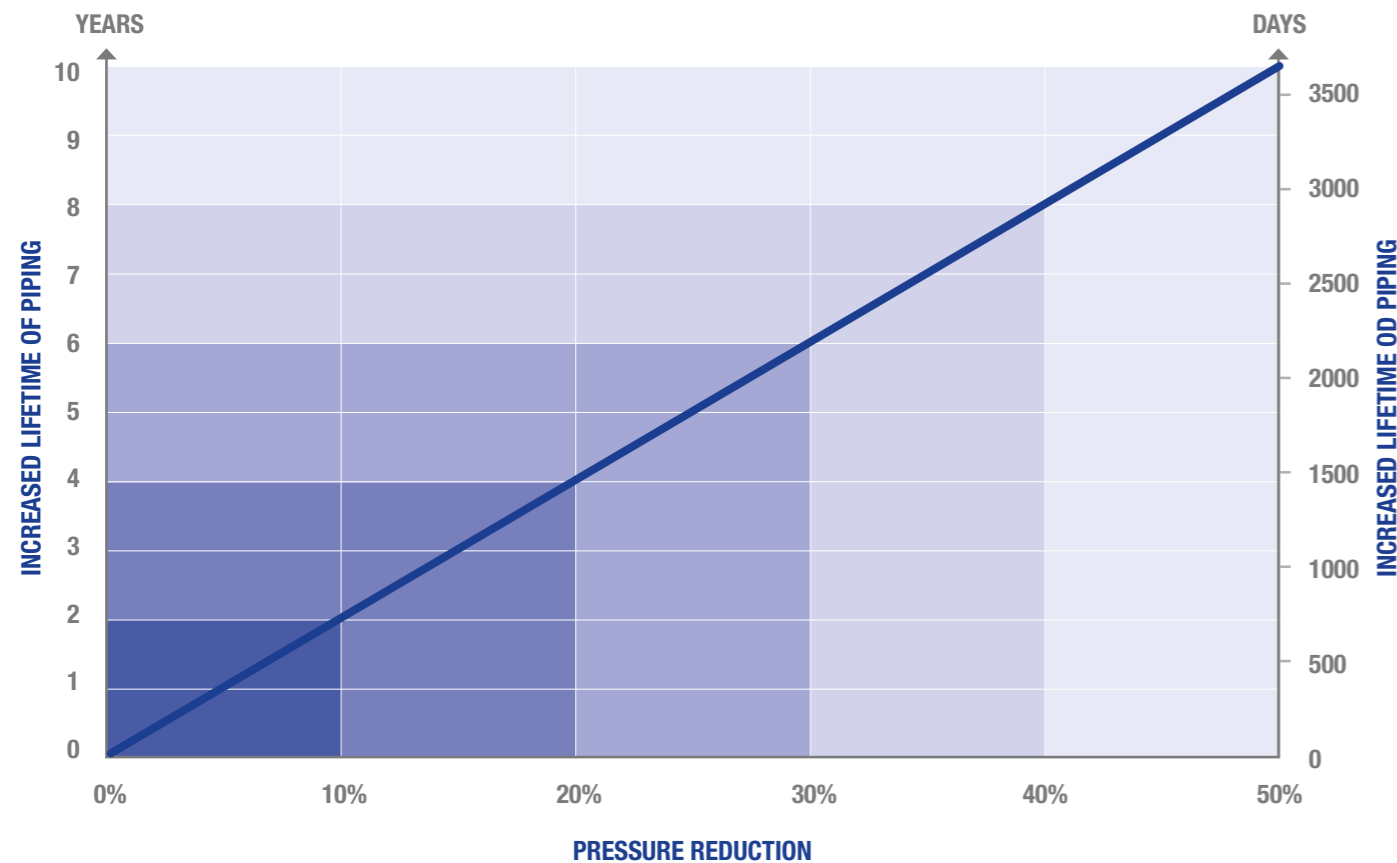
Most pipe bursts occur not only because of high pressure but rather due to ongoing pressure fluctuations that force the pipe to continually expand and contract, resulting in stress fractures. Installing a pressure control device, such as a pressure reducing valve (PRV), helps to reduce pressure throughout the day, stabilize fluctuations, and reduce stress on pipes.

There are a number of methods for reducing pressure in the system, including variable speed pump controllers and break pressure tanks. However the most common and cost effective is the automatic pressure reducing valve or PRV. PRVs are instruments that are installed at strategic points in the network to reduce or maintain network pressure at a set level. The valve maintains the pre-set downstream pressure regardless of the upstream pressure or flow-rate fluctuations. PRVs are usually sited at the entrance of a pressure zone, next to the flow meter.

The PRV should be downstream of the meter so that turbulence from the valve does not affect the meter's accuracy. It is good practice to install the PRV with a bypass pipe to enable future major maintenance works.

STABLE PRESSURE MEANS:

- Reduced bursts
- Reduced Leakage Recurrence
- Reduced Detect and Repair Activity
- Reduced Cost to maintain stable leakage level
- A calm network for Operations and the Customer
- The number of unscheduled network events



BENEFITS OF LOW PRESSURE

Pressure management is one of the fundamental elements of a well-developed leakage management strategy. The rate of leakage in water distribution networks is related to the pressure applied by pumps or by gravity. There is a physical relationship between leakage flow rate and pressure and the frequency of new bursts is also a function of pressure:

- The higher or lower the pressure, the higher or lower the leakage
- The relationship is complex, but utility managers should initially assume a linear relationship (10% less pressure = 10% less leakage)
30% pressure lower pressure = 30% less water waste
- Pressure level and pressure cycling strongly influence burst frequency
1% pressure reduction = 0,2 years life time extension of pipe network
38% lower pressure = 53% pipe burst

PRESSURE MANAGEMENT WITH INTELLIGENT CONTROL VALVES FROM AVK

AVK offers various solutions for reduction of water loss in the water distribution network. So far, we have primarily described leakage monitoring and reduction of leakage by recommending high-quality and long lasting shut-off gate valves. But another solution - which AVK is also able to be part of - is pressure management.

Pressure management is considered the single most beneficial, important and cost effective leakage management activity. Pressure management is based on district metering area (DMA), which is a defined area with only one inlet for water flow. The aim is to reduce pressure within the area to a minimum without affecting the consumers. However, there is no point in keeping the same high water pressure in the network during night-time as has been defined for the daytime. Another aspect is that when the water consumption is low, the pressure in the network increases to the maximum adjustable pressure, and when water is consumed, the pressure drops or fluctuates according to the consumption. These issues are essential in order to obtain a comprehensive understanding of the water consumption. It means that the pipes are constantly exposed to a variable pressure which will eventually wear out the pipes and cause a rupture; a kind of metal fatigue.

In pressure management, critical points must be established to control and vary the water pressure by means of a control valve. A critical point is a decisive

place within the DMA in relation to water supply; it could be an apartment building with the need for delivering water to the top floor, or a larger water consuming industry like a brewery, dairy or the like. Such critical points can be prioritised according to the daily routines or other parameters important to the supply safety, and thereby, the critical points regulate the pressure level in the DMA.

It is well-known that one of the major factors that influence the leakage rate is a high pressure in the distribution system and thus, lowering the pressure will save water. You can calculate water savings by using AVK's new toolbox App. So in order to avoid a fluctuating pressure in the distribution system, it is possible to control a fluctuating pressure at the inlet. The critical points in the DMA keep an eye on the pressure and will constantly send signals to the control valve that will automatically adjust the pressure accordingly.

Y-STRAINERS AND CHECK VALVES

Strainers are important components of piping systems to protect equipment from potential damage due to dirt and other particles that may be carried by the process fluid. Check valves are different from other types of valves in their ability to pass fluid in solely one direction. This sort of function is essential for a variety of safety applications, as well as for preventing overflow.



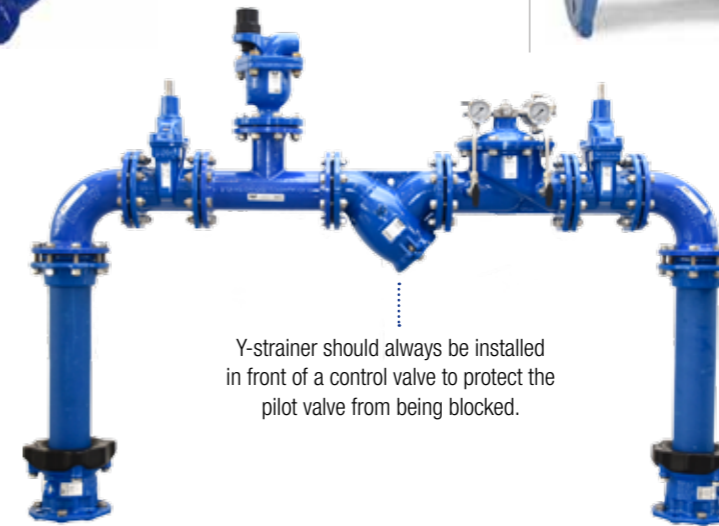
Y-STRAINERS

The Y-strainers are installed in water systems to filter out pebbles and other impurities that could damage the equipment. They are designed with focus on easy maintenance and low head loss.

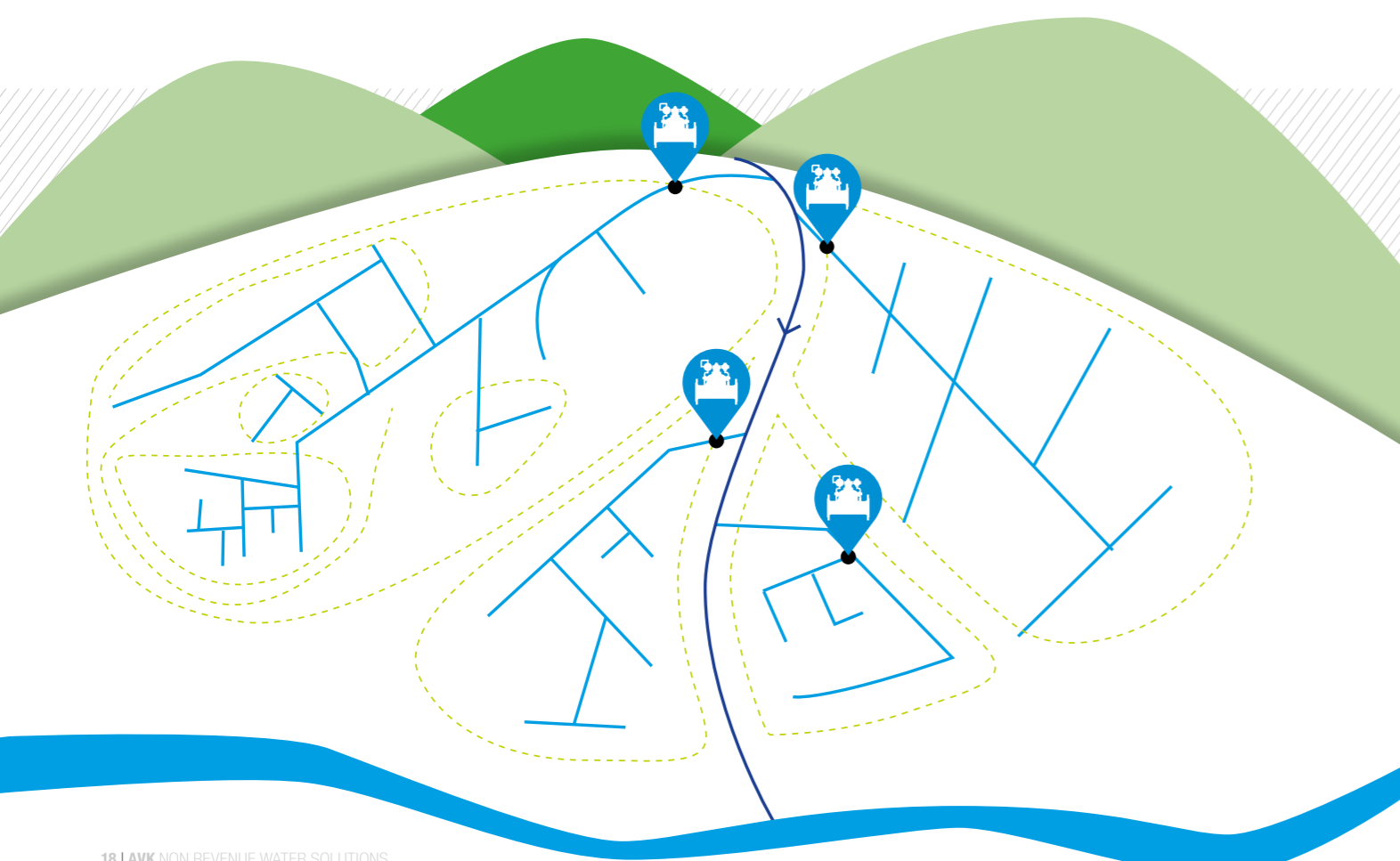


SWING CHECK VALVES

AVK series 41 swing check valves come with both metal and resilient seats. Installed in pumping applications to prevent back flow. The disc is connected to the shaft via a flexible bush that allows disc and valve seat to adjust exactly. All interior parts are stainless steel or coated with drinking water approved epoxy or EPDM. The series 41 valves are available with either closed bushings or protruding shaft end where a lever with a weight or a spring can be fitted to mitigate pressure surges.



Y-strainer should always be installed in front of a control valve to protect the pilot valve from being blocked.



controlvalves 859

PRESSURE REDUCING CONTROL VALVE

A pressure reducing control valve automatically reduces a higher inlet pressure to a lower outlet pressure regardless of changes in flow rate or inlet pressure. By adding intelligence to the control valve, the pressure in the zone can be adjusted according to data collected at the critical points, thus adjusting to the demand from the consumers. In this way the pipe network is protected from pressure fluctuation, over load and stress, resulting in less pipe burst.

Single Function Modules (SFM) Surge Anticipation

Description:

This model is used to control and eventually dissipate surges within a pipeline commonly caused by pump failure or system issues.

Operation:

The 2 pilots control a maximum set point and minimum set point. They are hydraulic balanced to enable the valve to slowly control any fast moving dynamic changes until they balance out and a constant pressure is re-instated to the system.

Example:

A pump fails and causes a fast rise in the pressure, followed by a quick slump. The surge anticipation pilot counteract the surge and smooth the network pressure.



ENERGY SAVING BY USING AVK PRODUCTS

Air in the pipe network will always create problems. It is causing increased energy consumption for pumping, accelerate corrosion in the pipes, cause inaccurate meter reading and will inforce water hammer when they occur. Pipe network shoul always be equiped with air valves on strategic places where air will accumulate, typical on the high points of the network.



Air valves

The problems caused by air in pipelines are well documented and include but are not limited to;

- Reduced pump efficiencies
- Increased energy costs
- Noise and vibration
- Lower flow rates
- Problems with PRV's and other flow control equipment
- Surges and water hammer problems
- Increased corrosion potential

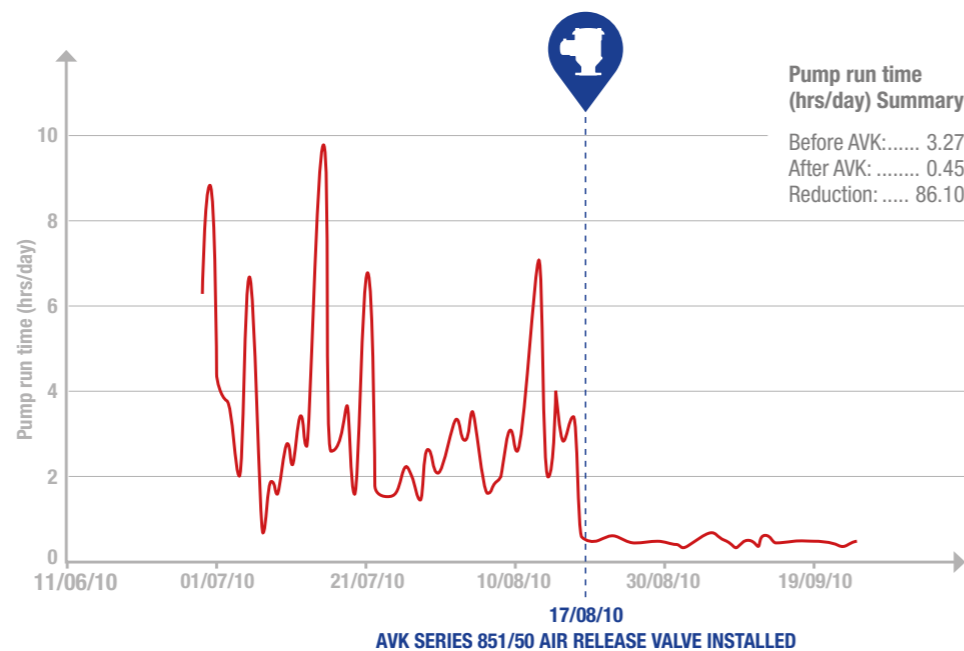
Because of these problems, air should be removed from pipelines as quickly as possible when filling or recharging the main after maintenance. This is also equally true for allowing air into the system should there be a conduit break. AVK offers various solutions for energy saving for water pipeline systems.

How to place the air valves

Series 851 large orifice air release valves incorporate the exclusive Glenfield Aerokinetic Principle which prevents premature closure while air is being released from a pipeline. The valve only closes when water reaches and lifts the float into contact with the seal.

It cannot be prematurely shut by discharging air or a mixture of air and water spray irrespective of emitting velocity. The valve float and the valve internal body profiles are specially shaped, and the positioning of the float relative to the valve inlet is critical. Thus, when air is discharging the resultant direction of aerodynamic forces is downward on the float which increases as the emergent air velocity increases.

Significant energy savings have been the immediate result of this installation and benefitted in energy saving certificates (ESCs) revenue.



THE AVK APP CALCULATION TOOL

The AVK app is a tool, that help you calculate your assets in the best possible way, taking energy and environmental aspects into consideration. The calculating functions are:

- Flow calculator
- Water loss calculator
- Pressure loss calculator
- Power consumption calculator
- CO2 Emission calculator



The flow calculator

needs two out of three inputs to make the calculator calculate the third – DN-class, flow velocity or flow rate. It doesn't matter which of the three you type. If you give the input of flow velocity and flow rate, the DN-class will be calculated, but in a nominal size. The flow calculator knows the standard DN-classes and will therefore suggest a standard size and make you adjust the flow velocity or the flow rate, up or down.



The water loss calculator

is calculating the amount of water lost through a leakage. The water loss calculator needs two inputs, the pressure in the pipe and the hole diameter. When these two inputs have been typed, the amount of water lost per hour, day and year is calculated.



The pressure loss calculator

is calculating the pressure loss in a specific valve to a given flow rate. Therefore, the pressure loss calculator needs the input of the flow rate and the valve flow factor (Kv-value). The valve flow factor can be typed as an arbitrary value, or by the use of the AVK valve picker. In the AVK valve picker a variety of AVK valves are present, with Kv-values to each specific valve series and DN-class. The pressure loss is calculated in bars.



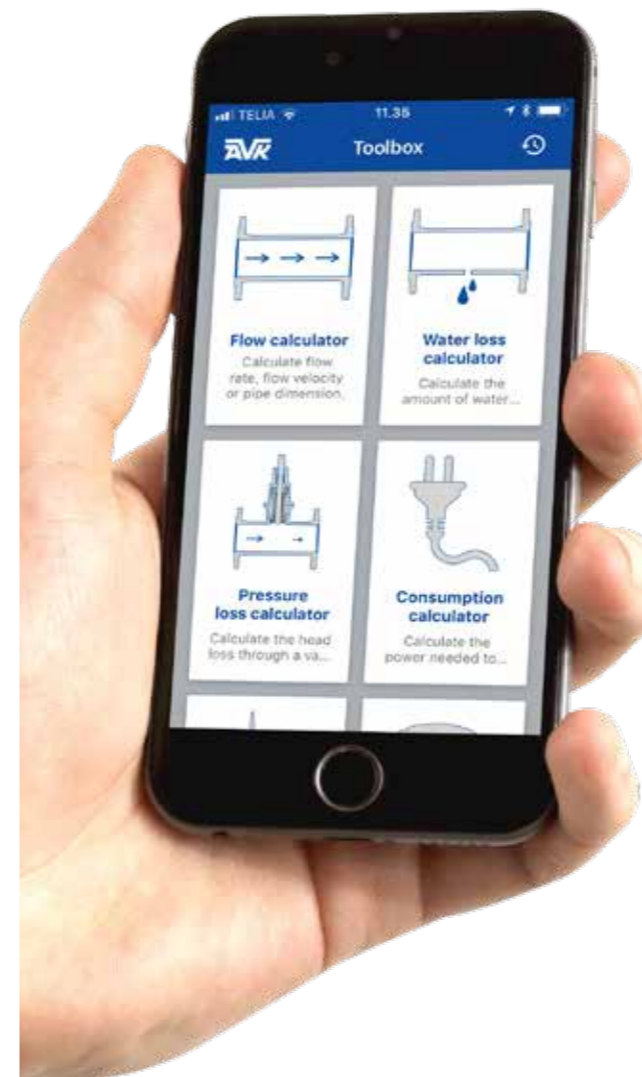
The power consumption calculator

is calculating the corresponding power consumption to a pressure loss over the valve at a given flow rate. Therefore, the power consumption calculator needs the input of the flow rate, pressure difference and an efficiency grade for a pump. The efficiency is 0.80 as default. When the input is typed the power consumption is calculated in the amount of kWh/yr.



The emission calculator

is calculating the CO2 emission stemming from the power consumption at a given energy source. The emission calculator needs the input of the power consumption, in the amount of kWh/yr, and the emission factor, in the amount of g* CO2eq/kWh. The emission factor can be typed as an arbitrary value or an energy source can be picked from the app. In the energy source picker nine different energy sources will appear. It is possible to pick one energy source and set it for 100% of the energy, or divide the amount of energy on more than one energy source, by setting the percent relation between them.



ASSET MANAGEMENT

AVIT - AVK VALVE INSTALLATION TRACKER

In addition to the daily NRW management, successful NRW reduction requires a long-term rehabilitation strategy for the network.

The AVK Valve Installation Tracker is all you need for full traceability of your valves. The tracker is an asset management system with a user-friendly mobile app and web portal. In a few simple steps it provides full traceability for all asset in the water pipe network.



THE APP



THE PORTAL



Scan the QR code using the AVIT App



Accurate GPS pin location



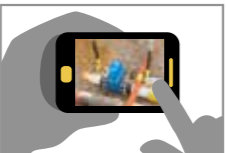
Secure Customer log in



Valve location on map (colours represent different pressures)



AVIT pin shows valve location



Take installation picture



Verify pictorial record



Data record includes: valve type, materials, size, pressure and who installed the valve



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Expect... **AVR**