VALVES FOR WATER SUPPLY SYSTEM

PAKISTAN WATER OPERATORS NETWORK

(March-2022)

PREFACE

On behalf of All water utilities in Pakistan PWON is thankful to JICA for providing Support for ***Management of Water & Sanitation Services in Punjab against Covid-19*** through which lectures / webinars were arranged January 2022, to end March 2022, for ***Better Management of Water & Sanitation Services during Outbreak*** as well *as* ***Awareness & Preventive Measures against Covid-19*** *and* ***Preparation of in house Disinfection by Water & Sanitation Utilities*****.**

On demand of PWON members, lectures for capacity building of utilities in Pakistan about various important technical topics were also added along with above lectures / webinars / seminars. All these events were well participated and appreciated by all utilities

On demand of member utilities PWON has published these lectures for capacity building and references for improvement of their day to day working for the benefit of their consumers at large. This book on the topic of **VALVES FOR WATER SUPPLY SYSTEM** is published by PWON for the benefit of all its members

PWON is thankful to Capt. (R) Muhammad Hafeez for Preparing this valuable document.

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CHAIRMAN
PWON, Pakistan

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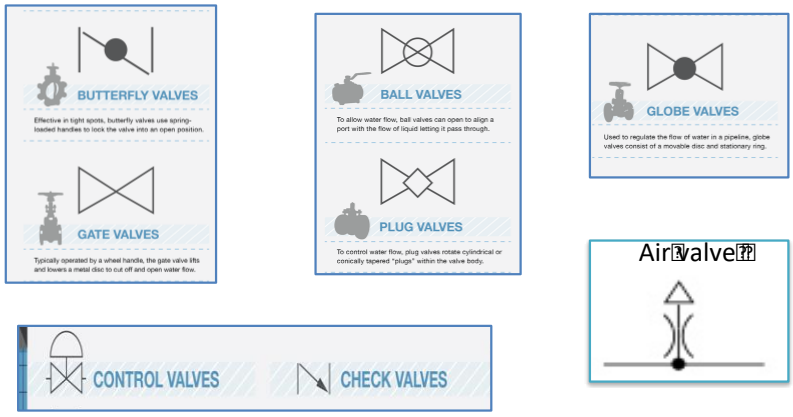
1. COMMON VALVES FOUND IN WATER SUPPLY SYSTEM

- Gate Valves
- Butterfly Valves
- Ball Valves
- Plug Valves
- Control Valves
- Air Valves

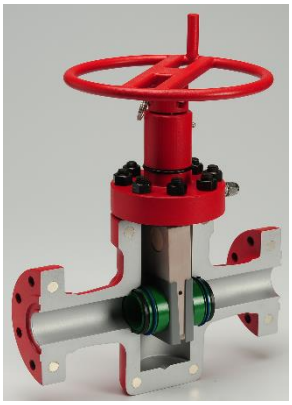
1.1 VALVE SYMBOLS USED IN PIPE DRAWINGS



1.2 How to select valves?

- For which application the valve is required? Isolation, Regulation.
- Capacity: The capacity includes the flow rate This parameter also accounts for the safe internal pressure capacity of the valve.
- Pressure drop: Do you afford pressure drop across the valve?
- Select Specifications:
- Do the manufacturer have the proper certification?
- Do not feel satisfied only with ISO 9001-2015 certificate. Demand other safety certificates like NSF certificates, ECP type Examination certificate, WRAS or any other applicable certificate.
- Is there an After Sales Service and repair service?
- Do they have warranties?

2. GATE VALVES



- Gate valves control water flow by sliding the metal gate up or down.

i. These are on off valves.
ii. Gate valves should never be used to reduce the flow of water; Using them to adjust water flow can wear them out.
iii. Has allowable leakage rate
iv. Pressure loss is minimum
v. Metal seated gate valves have a pocket between the seats to enable the wear travel
vi. Erosion& chattering

- Resilient gate valves

i. The disc is encapsulated with a resilient material (usually vulcanized rubber) that presses against the smooth, body of the valve.
ii. The valve is restricted to nearly horizontal pipelines.
iii. These valves are suitable up to 200psi.

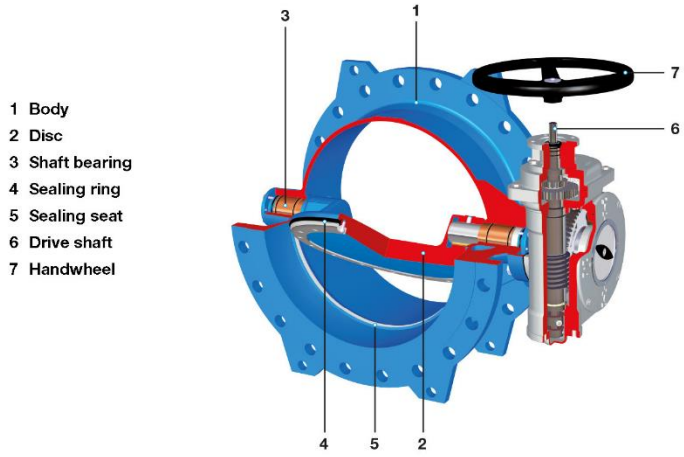
2.1 Maintenance of Gate valves

- ❖ Use lubrication:
- ❖ As time goes by, the steel gate valve will start to get stuck.
- ❖ periodically lubricate the stem of the valve wheel
- ❖ Any type of spray lubricant can do the work.
- ❖ Be watchful of rust: It can stick the disc.
- ❖ Use wire brush to scrape the rust off of the metal
- ❖ Operate the valve periodically: Make regular valves turning program
- ❖ Replace the seat seals: If Worn out over time.

❖ The seat of a metal seated gate valve has a pocket that can entrap solids and prevent the valve from closing fully. The resilient seat type greatly reduces this problem because it has no pocket in the body in which the gate seats.

2.2 BUTTERFLY VALVES

- Butterfly valve is a shut-off valve. It is also used for regulating flow.
- Quarter turn valve: Basically, the disk is operable up to 90 degrees and that's why it is called a quarter-turn valve.



2.2.1 Advantages/Disadvantages butterfly valves

Advantages

- Lightweight and compact
- Easy to install
- Low maintenance
- Simple, rapid operation

Disadvantages

- The disc can interrupt flow even when it is open
- Not recommended for high differential pressures
- Pressure drop is an important parameter when sizing the valve.
- With pressure drop of 1 psi across a butterfly valve: Its flow decreases up to 10 % by opening at 80 degree as compared to opened at 90 degree(Full)

2.2.2 Maintenance of butterfly valves

- **Apply grease** to the gearbox at constant intervals, based on manufacturer's recommendations. To apply grease, the grease fitting is located at the top of the valve.

- If cleaning is necessary, you can use **silicon-based lubricants** and other silicon-based products.
- When not used regularly, **exercising the valve by rotating it once a month** can ensure the valve will continually be operational.

2.3 Shutoff Valves spacing

Sufficient shutoff valves should be provided (gate or sluice valves) to permit isolation of parts of the water distribution system for emergency repairs and maintenance, without having to interrupt service to very large sectors.

Size of secondary water main	Average valve spacing suggested
inches	Feet
12	1500 to 2000
10	900 to 1200
8	800 to 1000
6	600 to 800
4	400 to 600
3	200 to 400

2.4 TYPES OF CHECK VALVES

- SWING CHECK VALVE
- FLAP CHECK VALVE
- SILENT CHECK VALVE



2.4.1 Resilient seals or metal-to-metal seals check valves

Check valves have either resilient seals or metal-to-metal seals.

- The goal of a resilient seat is to provide a long-lasting, drop-tight seal .
- For better resistance to temperature, EPDM is often used.
- For pressure applications less than 150 psig, resilient seats will provide the best service.
- For pressures above 300 psig, a metal seated

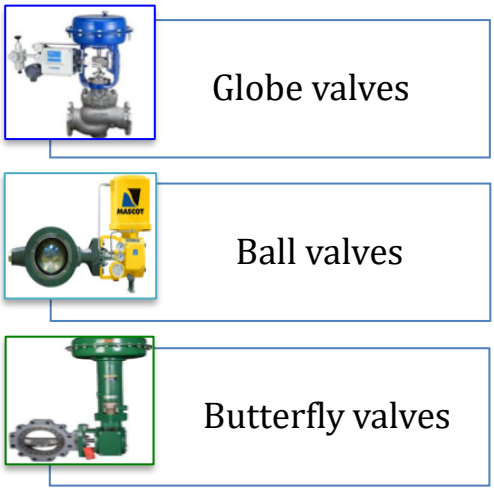
2.3.2 SUITABILITY FOR VARIOUS WATER APPLICATIONS?

- ❖ Swing check valve with external lever and weight is also good for non slam application
- ❖ Silent check valve is the best for lines feeding water at heights (OHR& multistory buildings). Short linear stroke and spring return action combine to close the valve prior to flow reversal which effectively eliminates the shock and water hammer

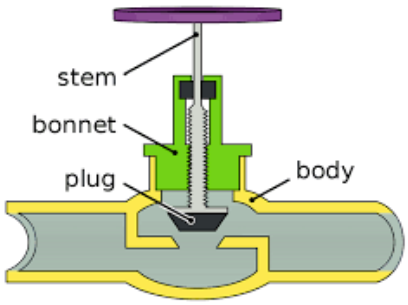
2.4 CONTROL VALVES

- A control valve is a valve used to control fluid flow by varying the size of the flow passage as directed by a signal from a controller.
- This enables the direct control of flow rate and the consequential control of process quantities such as pressure, temperature, and liquid level.
- Any valve can be converted into control valve by adding a diaphragm

2.4.1 Types of common control valves



2.4.2 GLOBE VALVES



- Globe valves are extensively employed to control flow.
- **Linear motion valve**.
- Size Limitation(up to 300mm). Larger valves would require that enormous forces be exerted on the stem to open or close the valve under pressure.
- Lower Capacity than Ball or Butterfly
- Overall expensive specially in large sizes

These valves exhibit slightly higher pressure drops than gate, plug, ball

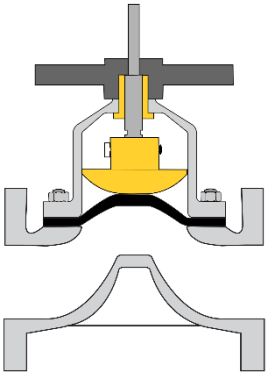
2.4.3 BALL VALVES

- The ball valve, along with butterfly and plug valves, is part of the quarter-turn valve family.
- Limited in allowable pressure drop and temperature than globe valves
- Good shutoff capabilities
- Less price than globe valves
- Due to the potential of constant wearing on the seats, ball valves are not ideal for throttling applications.

2.4.4 Types of control valve actuators

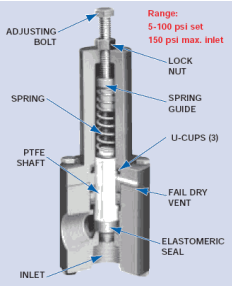
Pneumatically operated control valve actuators are the most popular type.

- Electric,
- Hydraulic



2.5 Pressure-Relief Valve

- It is normally a closed valve whose function is to limit the pressure to a specified maximum value by diverting pump flow back to the tank.
- The pressure relief valve features are designed to EN ISO 4126-1 standard, they have a lower whole life time cost and they optimize outlet flow for faster relieving.



- These valves usually release in to the drain or environment meaning that the steam or fluid that goes into the pressure release valve is naturally lost to the system.

2.6 WATER HAMMER OR SURGE

- A water hammer occurs when water suddenly changes direction.
- It can cause very high pressures in pipes.
- It can cause burst of pipes, damaged supports and pipe racks, and leakage at joints. For example, if a flow of 8 ft./sec is suddenly stopped in a pipe, a surge pressure as high as 400 psi above the static pressure may be produced.

2.6.1 Water hammer due to Check valve

- ❖ After pump stoppage, the flow reverses and may flow backwards through the check valve.
- ❖ Second the closure member suddenly shuts off the reverse flow.
- ❖ The change in flow velocity turns into pressure which instantaneously stretches the pipe wall causing the audible water hammer sound wave.
- ❖ For every 1ft/sec change in velocity, there will be approximately a 50 psig pressure spike.
- ❖ It may produce an audible noise that will carry across the building annoying operating personnel or even neighboring houses.

2.6.2 Source of Air

- Water contains about 2 percent air by volume based on normal solubility.
- Variations in flow velocity caused by changing pipe diameters and partially open valves may cause rise in temperature or a drop in pressure cause dissolved air to come out of solution.
- Air can enter through equipment such as pumps, fittings, and valves when vacuum conditions occur.

2.6.3 How can air become a physical obstacle?

- The air pocket is compressed by the water acting against it.
- The sudden and rapid decrease in fluid velocity when the air pocket encounters creates a pressure spike in the pipeline.
- The water pressure often shears away parts of, or the whole of the air pocket.SEP Once free in the system again, the air pocket will then travel downstream with unpredictable results.
- When the traveling air pocket finds a home again at another bend, or high point of the pipeline, its' sudden arrest there creates another surge event.

2.6.4 Consequences of Air in the pipelines

- Pipeline Corrosion: Depending on the pipeline's temperature, oxygen in the trapped air can be a powerful corrosive agent. The oxygen oxidizes the metal gradually, which leads to rusting, blockage, and structural failure of the pipe.

- Faulty Metering and Instrumentation Devices: Air pockets and vacuums can cause problems for flow measuring and control devices.

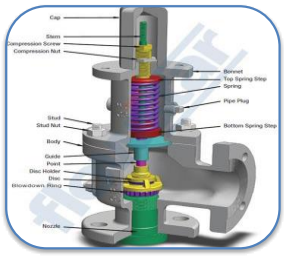
- Air Hammer: When a trapped air pocket is present in a pipe, pressure builds up around the blockage. The pressure of the water swirling around this blockage sends vibrations throughout the pipe.

- Pipe Failure: Vacuums can cause catastrophic failures in pipelines. If there is a substantial vacuum, the pipe can collapse inwards due to the pressure difference on both sides of the pipe's walls.

2.7 Remedial Measures for water hammering

Slow down the check valve closure it should take 5 seconds per inch diameter, or more.

Use surge tanks.



Use pressure relief valves

Use air valves

REDUCE THE PUMPING VELOCITY.

This can be done using a larger pipe diameter or lower flowrate.

2.8 Air valves

Air valves in pipeline systems serve two primary functions.

1. Release of accumulated air that comes out of solution within a pressurized pipeline.
2. To admit air into the system when the internal pressure of the pipeline drops below atmospheric pressures.
3. By admitting air into the pipeline help prevent the pipeline from experiencing excessive deflection and/or collapse as well as help prevent the formation of a full vacuum condition in which vapor cavities may form from the fluid vaporizing

2.8.1 If Air valve at the discharge of a pump is faulty

- At pump startup, the pipeline contains air. As the pipeline is filled, much of the air will be pushed downstream in a pressurized pipeline that can damage the pipe.
- Air Valves are mounted upstream of the check valve and are designed to vent the air before the check valve is pushed open by the pump pressure.
- When the pump stops, the Air Valve will reopen and admit air into the pump column to prevent the formation of a vacuum as the water column drains.

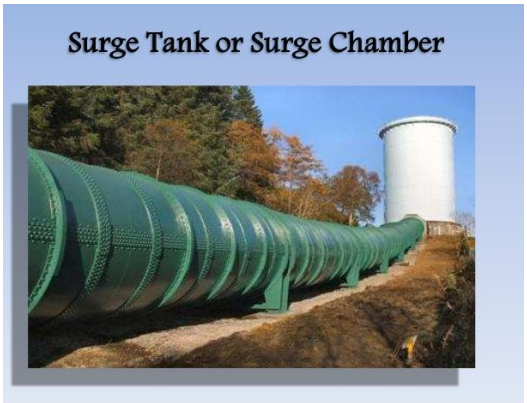
2.8.2 Main types of Air Valves

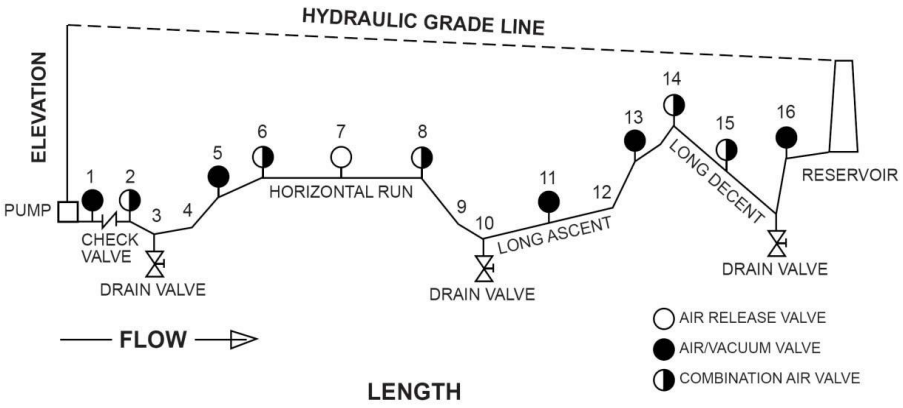
- **Air Release Valve**:To release air under pressure continuously during pipeline operation
- **Air /Vacuum Valve**: Exhausts large volumes of air during pump start-up and pipeline filling. Admit large volumes of air to prevent a vacuum condition from occurring in the pipeline and to allow for draining.

2.8.3 Sizing of Air/Vacuum Valve

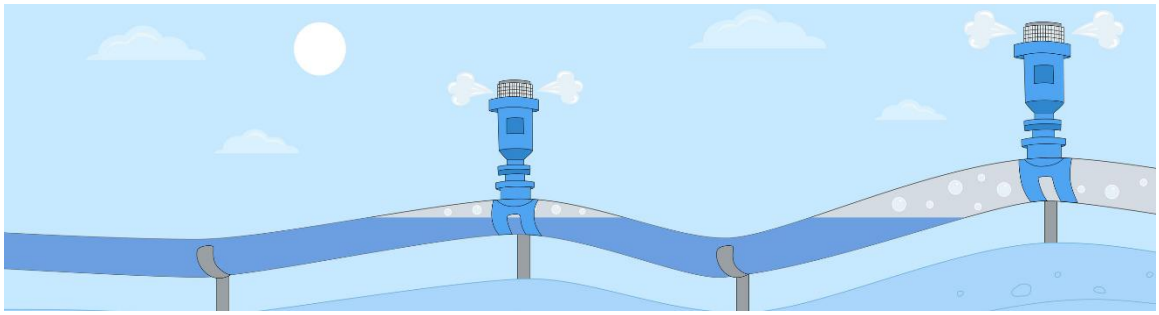
- As a rule of thumb Air/Vacuum Valves be 1 in. (25 mm) per 1 ft. of pipe diameter.

2.8.4 Recommendations of AWWA for air valves location





1. **High Points**: Combination Air Valve.
2. **Long Horizontal Runs**: Air Release or Comb. Valve at **1250 to 2500 ft.** intervals.
3. **Long Descents**: Combination Air Valve at **1250 to 2500 ft. intervals**.
4. **Long Ascents**: Air/Vacuum Valve at **1250 to 2500 ft intervals.**
5. **Decrease in an Up Slope**: Air/Vacuum Valve.
6. **Increase in a Down Slope**: Combination Air Valve.



2.8.5 Surge tank

A **surge tank** is a storage reservoir at the downstream end of a closed aqueduct, feeder pipe to absorb sudden rises of pressure, as well as to quickly provide extra water during a brief drop in pressure.

2.9 Reasons of Valves failure

- Poorly selected Specifications
- There are two ways for a specification to lead to a valve to failure:
- poorly selected valve models and materials due to incorrect information. (2) the assumptions used are not in agreement with the realities of the process.

- Not arranging Inspection before shipment
- As the old saying goes: “You do not get what you expect; you get what you inspect”.
- Wrong Operation
- A classic example is the use of block valves, such as a gate valve, as a throttling valve.
- **Lack of Field maintenance**
- A periodic inspection for early detection of problems such as corrosion and leakages before they turn the valve useless.
- The inspection frequency will depend on the severity of the conditions surrounding the valve, but usually should be around a year.
- Low quality repair :
- Refurbished valves by companies with no access to OEM parts and assembly methods generally fail more rapidly than the originals.
- look for an authorized repair facility, one that was trained and certified by the OEM to perform repairs.

3. INTERNATIONAL STANDARDS FOR VALVES

3.1 MISCONCEPTION ABOUT STANDARDS

British Standards (BS withdrawn in 2015)	BSEN
European Standards	EN
American Water Works Association	AWWA
International Organization For Standardization	ISO
Japanese International Standards	JIS
American Society For Testing & Materials	ASTM
American Society For Mechanical Engineers	ASME
American National Standards Institute	ANSI
American Petroleum Institute	API
Standards Australia & Standards New Zealand	AS/NZS

- Specific International standard covers all detailed specifications required for quality valves.
- Simply giving a general reference of a standard like "as per BSEN standard or AWWA standard" is sufficient to meet our requirement.
- Simple reference number of a standard binds a contractor to supply valves of the highest quality which will not leak or malfunction.

It must be understood that;

- The specification given just as "as per BSEN or AWWA standard does not bound the supplier to fulfill your complete requirements .
- Even if you mention only standard like "AWWA C 508,the contractor is free to supply material of the most parts as per his desire.
- Standards cover only the design parameters, testing requirement and general requirements.
- Choice of material and type of accessories are left at the choice of the manufacturer or user.

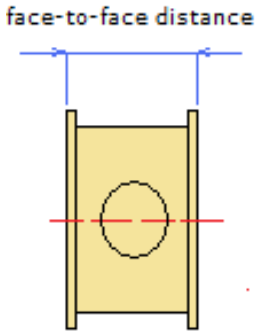
WHAT DOES AWWA SAY ABOUT ITS STANDARDS?

"AWWA standards describe minimum requirements and do not contain all the engineering and administrative information normally contained in specifications"

"It is the responsibility of the user of an AWWA standard to determine that the products described in that standard are suitable for use in the particular application being considered".

-AWWA does not test, certify or approve any product.

3.2 Gate valves according to EN/ISO standards EN 558 & ISO 5752



- This European Standard specifies the **"face-to-face" (FTF)** and "centre-to-face" (CTF) dimensions for PN and Class designated metal valves used in flanged pipe systems.
- **No other specification like material or type is given in this standard**

3.3 Double Flanged Butterfly Valve to EN 593

Items	**Specs/material**
Design	EN593/EN558-1, ISO 5752, API609
Working Pressure:	16 bar
Test Pressure	Shell 24Bar
Working Temp	-20°C to 110°C with EPDM seat -10°C to 80°C with NBR Seat
Body	Cast Iron Gr. 220 Ductile Iron Gr. 420/12
Disc	Ductile iron Gr.420/12 Aluminum Bronze1400 AB2 Stainless Steel 304 Strainless Steel 316
Shaft	Stainless Steel 410 Stainless Steel 431 Stainless Steel 316

3.4 AWWA STANDARD C-508 FOR IRON CHECK VALVES

SR.No	Parameter	AWWA C 508	Remarks
1	Design	AWWA C508	OK
2	Body	CI OR DI of given ASTM specifications	Consumer choice
3	Disc	CI,CS,DI,SS of given ASTM specifications	Consumer choice
4	Testing	AWWA C508	OK
5	Pressure rating	Minimum200 PSI for 2 in to 12 150 PSI from 14-24 inch	Consumer choice
7	Flanges	flanges	Mention as ANSI B 16.1 class 125
9	Disc seat	Metal to metal or resilient material	Consumer choice CI,CS,DI,SS
10	External Lever	Nothing mentioned	Should be mentioned

3.5 Options provided by manufacturers in AWWA C512 Air Valves

Combination air release and vacuum valve.

Design and manufacturing standard: AWWA C512

Testing Standard: AWWA C512

Choice	Pressure rating	Body	Nozzle	Float	O ring	Flanges
Standard	PN 10	CI	Bronze with natural rubber	AISI 304	Natural Rubber	**ANSI B16.1/16.5**
Optional	PN 16 or higher	**DI, SS, Duplex SS**	MS	AISI 316	EPDM	BSEN 1092, DIN 2532

3.6 Comparison of flange standards for 600 mm

Standard	Class	Flange Dia	Bolt Hole Dia	Flange Thickness	N0.of Bolts
ASME B16.5	150	813	35	48	20
	300	914	41	70	24
EN 1092 Old BS 4504	10	780		42	20
	16	840	36	54	20

ASME B16.5

EN 1092

4. INTERNATIONAL CERTIFICATION FOR VALVES

Notified Body under Pressure Equipment Directive (PED 97/23/EC) Of European Commission
NSF: National Sanitation Foundation and FM certification
WRAS: (Water regulations advisory scheme)
Third Party Validation (From reputed Firms like SGS or TUV etc.

4.1 NSF & E C TYPE EXAMINATION CERTIFICATE

NSF - National Sanitation Foundation

- A non-profit, non-governmental organization that issues certifications for valve and fitting components
- It certify according to NSF/ANSI 61 standards

E C TYPE EXAMINATION CERTIFICATE

- Applied to pressure equipment placed on the market within the European Economic Area as per *"Pressure Equipment Directive : 97/23/EC of EU"*
- The PED has a wide scope, covering the design, manufacturing and conformity assessment of pressure equipment (Vessels Piping, Pressure accessories and Safety accessories)

4.2 WATER REGULATIONS ADVISORY SCHEME (WRAS) UK BASED

It requires that:

- A water fitting should not cause waste, misuse, undue consumption or contamination of the water supply
- and must be 'of an appropriate quality and standard'.
- It is granted directly by representatives of the water suppliers and is therefore accepted by every water supplier in the UK.
- Whole products such as valves, boilers & showers undergo mechanical and water quality testing.

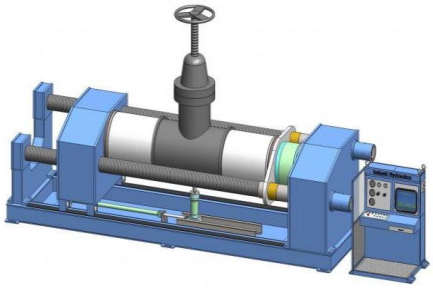
4.3 3rd Party Validation

- Besides others SGS and TUV are almost in every country including Pakistan for 3rd party inspections.
- Utilities have to decide detail of inspection every time to get the type and extent of verification.
- If any contractor is asked for just 3rd party validation of any imported item. The 3rd party will issue certificate for quantity and visual quality only.

4.4 PRESSURE TESTING OF VALVES

As per Testing standards ISO 5208, EN 12266-2012, AWWA M44

- **Shell Test** With the valve in the open position, a hydrostatic test pressure equal to twice the rated working pressure of the valve should be applied to the body.
- **Seat Test.** A test is made from each direction at closed seat at the rated working pressure to prove the sealing ability of each valve from both directions of flow.
- **Torque Test**
- A sample of each valve should be torqued in both the open and closed position to ensure that there is no **stem damage or seating damage and a resulting failure to seal.**



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- *Jeffrey A. Gilbert, P.E. "*Practical Design of Water Distribution Systems"
- *AWWA Standards for valves*
- EU Standards
- **National Sanitation Foundation. NSF/ANSI 61**
- EC Type examination by EU
- *"Pressure Equipment Directive : 97/23/EC of EU"*
- Water Regulation Advisory Scheme(WRAS)
- ASME B16.5
- EN 1092
- ISO