ME 329 – BOILER AND STEAM DISTRIBUTION SYSTEM DESIGN

GROUP 05

E/18/269 – Ragulan K.

E/18/270 – Rajapaksha J.S.P.K.

E/18/391- Wickramasinghe W.G.T.D.

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CHAPTER 01

1.1 Design Requirements

Development of concept of steam distribution system & estimate of capacities based on design guidelines & standards.

Main focus is to design a boiler and steam distribution system which is fired using coal. Here is the specification of the thermal power plant.

Table 1.1: Power Plant Specifications

Boiler Operating pressure	22 bar
Power generating capacity	650 kWe
Fuel	Coal
Location	Biyagama
Number of Bends	32
Inlet Temperature to the Turbine	300 ^{o}C

CHAPTER 02

2.1 Fuel Selection and Stoichiometric Equations

Coal is considered as a fossil fuel which is highly consumed in the world. There are different kind of coal types with different carbon compositions. This fossil fuel generates nearly 40% of the world's electricity and about 25% of the primary energy needs.

Lignite

Lignite is the lowest rank of coal and has the least carbon content, typically ranging from 25% to 35%. It has a high moisture content and a lower heat value compared to other coal types. Lignite is often brownish or black in color and has a relatively soft and crumbly texture. It is primarily used in power generation and for heating purposes.

Sub-bituminous coal

Sub-bituminous coal has a higher carbon content than lignite, typically ranging from 35% to 45%. It has a lower moisture content and higher energy value compared to lignite. Sub-bituminous coal is usually dark brown to black in color and has a relatively soft texture. It is commonly used for electricity generation.

Bituminous coal

Bituminous coal is a higher-ranked coal with a carbon content ranging from 45% to 86%. It has a relatively high energy content and a lower moisture content compared to sub-bituminous coal. Bituminous coal is typically black in color and has a relatively hard texture. It is widely used in industries such as steel production, electricity generation, and as a fuel in boilers and furnaces.

Bituminous has more volatile materials in percentage. These volatile materials have higher caloric value and can be burnt in pulverized form easily.

Bituminous coal varies in its chemical composition; a typical composition is taken as,

84.4% - Carbon

5.4% - Hydrogen

6.7% - Oxygen

1.7% - Nitrogen

1.8% - Sulphur

Anthracite coal

Anthracite is the highest rank of coal and has the highest carbon content, usually exceeding 86%. It has a low moisture content and the highest energy value among coal types. Anthracite is typically shiny black in color and has a very hard and brittle texture. It is primarily used for residential and commercial heating purposes and in industrial applications that require high temperatures, such as metal smelting.

Stoichiometric equations are,

$$C + O_2 \longrightarrow CO_2$$

$$S + O_2 \longrightarrow SO_2$$

$$2H + \tfrac{1}{2} O_2 \longrightarrow H_2O$$

$$N + O_2 \longrightarrow NO_2$$

2.2 Fuel Feeding Mechanism

Coal pulverizing technique can be used for the fuel feeding mechanism. It is the most widely used fuel feeding technique in power plants. In this technology coal particles are injected and combustion occurs with burners inside the furnace. This mechanism consists with coal bunker, coal feeder and a pulveriser.

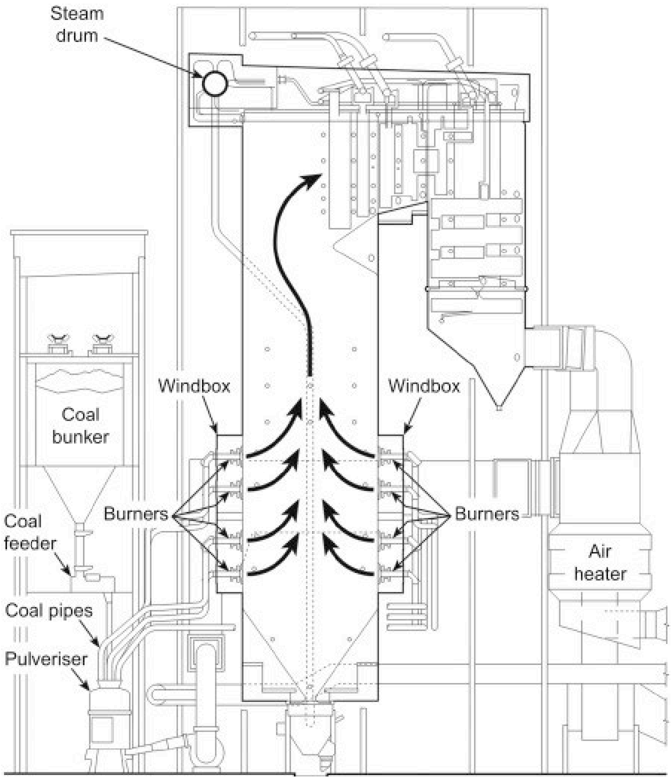


Figure 2.1: Pulverized coal feeding

2.3 Coal Storage Requirements

Maintaining the coal storage facility requires careful attention to various factors, especially when dealing with seasonal variations in fuel supply and concerns related to moisture. Here are some guidelines to effectively manage the coal storage,

- Ensure that the storage infrastructure is designed to protect the coal from moisture and environmental elements. The storage facility should have a robust roof, walls, and proper drainage systems to prevent water ingress. Adequate ventilation is essential to prevent the accumulation of moisture and condensation.
- Proper stockpile management is crucial for minimizing moisture-related issues. Implement a "first-in, first-out" system to ensure that older coal is used first. This practice prevents coal from sitting in storage for extended periods, minimizing the chances of moisture absorption.
- Regularly test the moisture content of the coal using appropriate methods, such as the ASTM standard test methods. This helps in monitoring the quality of coal and identifying any moisture-related issues early on. Adjust storage and handling procedures accordingly based on the test results.
- Implement measures to control moisture in the storage facility. Consider using desiccants, such as moisture-absorbing materials or dehumidifiers, to maintain a dry environment within the storage area. Proper ventilation can also help in reducing moisture levels.
- Cover the coal stockpiles with appropriate materials, such as tarps or weatherproof sheets, during periods of rain or snowfall. This protects the coal from direct exposure to precipitation and helps minimize moisture absorption.
- Implement proper handling procedures to minimize coal degradation and moisture absorption. Avoid excessive dropping, crushing, or grinding of the coal during storage and handling operations, as these actions can increase the coal's susceptibility to moisture.
- Conduct regular inspections of the storage facility to identify any signs of moisture damage or degradation. Check for leaks, damaged roof or walls, and signs of excessive moisture. Promptly address any issues found during inspections.
- Train employees involved in coal storage and handling on best practices for moisture control. Provide education on the importance of proper storage procedures, handling techniques, and the impact of moisture on coal quality.
- Maintain effective communication with coal suppliers to ensure timely delivery and minimize the storage duration. Coordinate with suppliers to schedule deliveries based on consumption patterns and seasonal variations in fuel supply.
- Maintain suitable temperature conditions in the storage area to prevent spontaneous combustion. Monitor and control the temperature regularly, especially in areas prone to heat build-up or during warmer seasons.
- Ensure proper ventilation within the storage facility to reduce the risk of combustible gas accumulation. Adequate airflow helps prevent the build-up of carbon monoxide and other hazardous gases. Regularly inspect and clean ventilation systems to ensure their proper functioning.
- Implement appropriate fire safety measures in the storage area. Install fire detection and suppression systems, such as smoke detectors, fire extinguishers, and sprinkler systems. Train employees on fire safety protocols and conduct regular fire drills.

2.4 Selection of the Boiler

Initially it was assumed that the turbine and the pump operate isentropically. The power plant operates under the Rankine cycle.

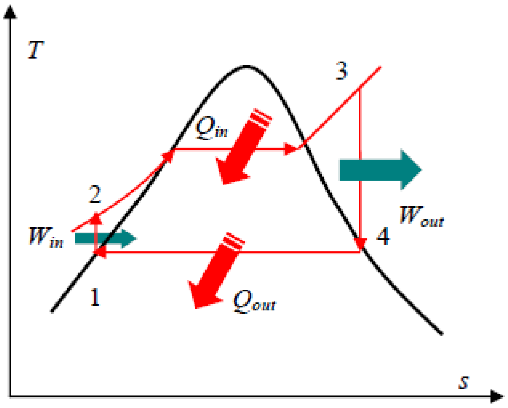


Figure 2.2: Rankine Cycle of a Steam Power Plant

As first step, the steam generating conditions were found with regard to the initial assumptions made and basic data given. The steam generating conditions were found with the help of a T-s diagram according to the current system operating data.

Operating pressure of the boiler,

Gauge pressure = 22 bar

Absolute pressure = 23 bar

Considering Figure 2.2 this pressure is actuated at the Point 3,

Thus, P_2 = 23 bar

From saturated steam property table,

T_{sat} = 219.518 ^{0}C

Since T_3 = 300^{0}C,

Specific Enthalpy, h_3 = 3015.44 kJ/kg

Specific entropy, s_3 = 6.6949 kJ/kg.K

For Point 4,

With the assumption of isentropic process,

$s_3 = s_4 = 6.6949$ kJ/kg.K

From Saturated Steam Property tables,

Pressure, P_4 = 7.26 bar

Temperature, T_4 = 166.415^0C

Specific enthalpy, h_4 = 2764.31 kJ/kg

At point 1,

T_1 = $T_4 = 166.415^0C$

P_1 = 7.26 bar

V_1 = $0.001110\ m^3/kg$

Enthalpy h_1 = 703.421 kJ/kg

Pump work = $\Delta P \times V$

= $(23 - 7.26) \times 10^5 \times 0.001110$

= 1.7471 kJ/kg

At point 2, enthalpy h_2 = h_1 + Pump work

= 703.421 + 1.7471

= 705.1681 kJ/kg

Operating hoursing the Efficiency of the Turbine as 88%,

Input Power, P_{input} = $\frac{\text{Pout}}{\eta}$

= $\frac{650}{0.88}$

= 738.64 kW

Boiler operating temperature T = $219.518\ ^0C$

Turbine output = $h_3 - h_4$

= 251.13 kJ/kg

Degree of superheat

Degree of superheat = $T_3 - T$

= $300^0C - 219.518^0C$

= 80.482^0C

Steam Flow Rate

For 100 % efficiency consideration,

Flow rate = P_{in} / (Power Output of the turbine)

Flow rate = 738.64 KW / 251.13 kJ/kg

= 2.9413 kg/s

= 10588.68 kg/hr

Boiler Capacity

Boiler capacity = $(h_g - h_f) \times$ Flow rate

= $(2800.78 - 941.342) \times 2.9413$

= 5469.16 kW

F & A Rating

Taking Feed Water Temperature, $T_f = 130\ ^0C$

F & A Rating = Actual rating $\times (h_g - T_f)/540$

= $10588.68 \times (669.403 - 130)/540$

= 10576.97 kg/hr

2.5 Fuel Consumption Rate

Bituminous coal has been used as the fuel,

Calorific value = 24000 kJ/kg

Assuming that 70 % of the energy is being used for the steam generation,

Fuel consumption rate = $\frac{Boiler\ capacity}{GCV\ coal \times 0.70}$

= $\frac{5469.16}{24000 \times 0.70}$

= 0.32555 kg/s

= 1171.98 kg/hr

2.6 Flue Gas Flow Rate

Mass of products is being calculated using the stoichiometric equations,

Mass of the carbon in fuel per hour	=	1171.98 kg × 84.4 %
	=	989.15 kg
Then, the Mass of the Carbon dioxide	=	$989.15 \times \frac{44}{12}$
	=	3626.88 kg/hr
Mass of the hydrogen in fuel per hour	=	1171.98 kg × 5.4 %
	=	63.29 kg
Then, the Mass of the Water	=	$63.29 \times \frac{18}{2}$
	=	569.61 kg/hr
Mass of the Nitrogen in fuel per hour	=	1171.98 kg × 1.7 %
	=	19.92 kg
Then, the Mass of the Nitrogen dioxide	=	$19.92 \times \frac{46}{14}$
	=	65.45 kg/hr
Mass of the sulphur in fuel per hour	=	1171.98 kg × 1.8 %
	=	21.10 kg
Then, the Mass of the Sulphur dioxide	=	$21.10 \times \frac{64}{32}$
	=	42.2 kg/hr

Then, the total mass flowrate of the flue gas is,

Flowrate of flue gas = 4304.14 kg/hr

2.7 Water Supply to the Boiler and Water Treatment

Feed water storage tank of a minimum of three to four hours capacity of boiler evaporation is usually recommended for this purpose to have the time for the regeneration of the water treatment plant. Recommended water characteristics for shell boilers as per IS:10392 & BS-2486-1978.

Table 2.2: Feed water characteristics

Characteristics	Value
Total hardness	5
pH	8.5 – 9.5
Total dissolved solid (ppm)	3500

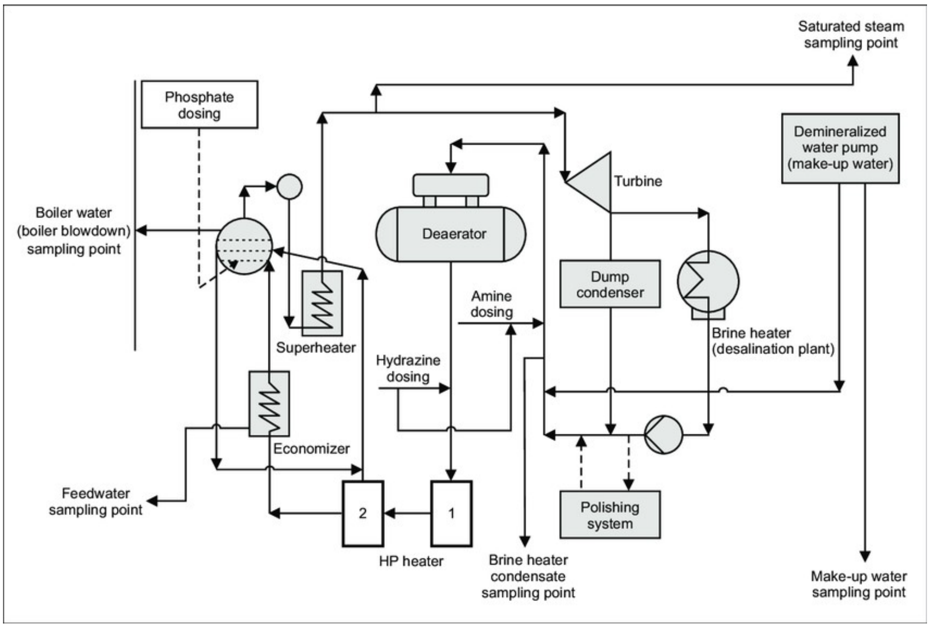


Figure 2.3: Water Consumption of Boiler

Total dissolved solids (TDS) should be kept at minimum values to reduce blow down quantity. Therefore, assume a TDS value of 150 ppm for the selected boiler.

Blowdown rate, $\dot{V}_{blowdown}$ $= \dfrac{\dot{m}_{steam} \times TDS_{feedwater}}{TDS_{desired} - TDS_{feedwater}}$

$= \dfrac{10588.68 \times 150}{3500 - 150}$

$= \underline{474.09 \text{ kg/hr}}$

Feed water mass flowrate, $\dot{m}_{feedwater}$ = Blowdown rate + Steam rate

= 474.09 + 10588.68

$= \underline{11062.77 \text{ kg/hr}}$

Volume flowrate $= \dfrac{11062.77}{1000 \times 3600}$

$= \underline{3.073 \times 10^{-3} \text{ m}^3/\text{s}}$

Volume of the feed water tank,

Feed water tank capacity = $3.073 \times 3600 \times 4$

= $\underline{\underline{44.251 \text{ m}^3}}$

Normally the boiler should receive RO (reverse osmosis) water but it can vary and the impurities that comes to the boiler should be blown down by the discharge of water to the drains. The feed water is stored before supplied to the boiler and it is pumped using feed pumps. Control valves are being used to regulate the flow and deaerators are used to remove dissolved gases from the feed water. Water treatment is done to protect the boiler from contaminants.

WATER TREATMENT

Boiler water treatment is the quality improvement and refinement of boiler feed water to make it fit for use in boilers. There are various water treatment processes such as surface and bottom blowdown, filtration (and ultrafiltration), deaeration, evaporation, membrane processes

(nanofiltration and reverse osmosis), etc. for water treatment. Boiler water treatment can be carried out in various steps.

- External treatment
    - Evaporation
    - Softening
    - Dealkalinization
    - Deoxygenation
    - Deionization
- Internal treatment

Following chemicals are being used for water treatment,

Table 2.3: Boiler water treatment chemicals

Treatment Purpose	**Chemical**
To increase alkalinity	• Sodium Carbonate • Sodium Hydroxide
Sludge conditioning	• Poly electrolytes • Starch • Tannin
Scale prevention	• Sodium Phosphates
To eliminate oxygen	• Sodium Sulphate • Hydrazine

Reduce foam carryover risk	• Antifoaming agent
CO_2 neutralization	• Neutralizing amines
Reduce caustic embrittlement	• Sodium sulphite
Steam line protection	• Filming amines

2.8 Waste Heat Recovery and Efficiency Improvement

Boiler is the main component of the steam power plant which generates the steam. Increasing the boiler efficiency will increase the overall efficiency of the steam power plant, which will increase the output and reduce the operating expenses of the system. Generating the lowest possible amount of flue gas at lowest temperature is a key factor increasing boiler efficiency. Other than this, steam and condensate (hot water) losses may also decrease boiler efficiency. Therefore, the following points can be used to recover waste heat and increase the boiler and plant efficiency.

1. Preheating and heat recovery systems

Waste heat recovery can be achieved through preheating and heat recovery systems. Heat exchangers or economizers are installed to recover waste heat from the flue gases generated during the combustion process. This recovered heat is then used to preheat the combustion air or feedwater before entering the boiler. By preheating these streams, the energy required to reach the desired operating temperature is reduced, resulting in improved overall efficiency.

2. Minimizing condensate leakages and wastages

The working fluid is water in this process. Water evaporates at the boiler and then condensate at the condenser. Even small losses of this condensate amount to large losses in terms of energy.

Furthermore, since this water has a higher temperature than new water, it requires lesser fuel energy to convert to steam. Reusing the water will also reduce the expensive chemicals and treatments that are required for the boiler. Rerouting condensate back into the feed water system can reduce the wastewater treatment cost inside the power plant as well.

3. Recover Heat from Blowdown

Blowdown is a technique that use in boilers to remove the soluble and insoluble solids in the water. These soluble and insoluble solids cause surface damage to the boiler. During blowdown, a significant amount of heat goes out as the waste heat. By installing a blowdown heat exchanger and connecting it to the feed water pipe, some of the waste heat can be transferred to the feed water.

4. Control of Blowdown Rate

As mentioned previously, blowdown results in high heat waste in the boiler. Some boilers have continuous blowdown systems that do not change the output with boiler load. To minimize heat lost this way, it is necessary to calculate the right amount of blowdown at current boiler load. To optimize this function, an automatic blowdown valve can be installed to the blowdown pipe.

5. Reduce Excess Air

The stoichiometric air to fuel ratio does not give the maximum efficiency of the boiler. The boiler requires some more air to the combustion to give maximum efficiency. But if the amount of air is too high the efficiency will decrease again. And if the amount of air is high, carbon monoxide will produce as a result of the combustion. By installing an automatic combustion control system, it can monitor the right air requirement for the combustion and supply the correct amount of air into the system.

6. Proper Insulation of Pipes and Valves

It is necessary to insulate all the pipelines and valves of the system properly. Improperly insulated pipes and valves transfer heat to the outside and can decrease the net output of the plant. All applications of insulation should be optimized, because less insulation leads to heat loss, while more insulation leads to high initial costs.

7. Variable Frequency Drives (VFDs)

Variable frequency drives can be installed on pumps, fans, and other equipment to match their operation with the plant's load requirements. VFDs allow the speed of these devices to be adjusted according to the actual demand, resulting in energy savings and improved efficiency. Instead of running at a constant speed, which may not be necessary under all operating conditions, the equipment operates at the optimum speed for the given load, minimizing energy consumption.

8. Proper Servicing of Boiler Tubes

With the continuous use of the boiler the fire side of the tubes can be blocked by the impurities which are emitted during combustion. These impurities deposit on the water tubes (in water tube boilers) and decrease the heat transfer rate to the water. Cleaning the water side of the boiler clean will also increase the boiler efficiency. Scaling can occur on the surfaces of the water side because of high water hardness, improper chemical treatment and irregular blowdown. This scale will impede the heat transfer and reduce the boiler efficiency. Therefore, periodic water side cleaning will also ensure increased efficiency, reduction of overheating problems and leaks.

2.9 Cooling System

Heat rejection, H_{reject} = mass flow rate x ($h_4 - h_1$)

= 10588.68 kg/hr x (2764.31 – 703.421) kJ/kg

= 21.822 GJ/hr

Cooling towers are primarily used for heating, ventilation, and air conditioning (HVAC) and industrial purposes. Cooling towers provide a cost-effective and energy efficient operation of systems in need of cooling. That are used to remove heat absorbed in the circulating cooling water systems used in power plants, petroleum refineries, petrochemical plants, natural gas processing plants, food processing plants, and other industrial facilities.

AIR FLOW GENERATION METHODS

I. Natural Draft cooling towers

II. Mechanical Draft towers

III. Cross Flow cooling towers

IV. Counter flow cooling towers

HEAT TRANSFER METHODS

I. Dry cooling towers

II. Wet cooling towers

III. Fluid cooling towers

COOLING TOWERS BY BUILD

I. Package type

II. Field erection type

Field erected cooling towers are cooling towers that are being erected on site, Typically, field erected cooling tower is much larger in size than the packaged cooling tower. They are used to serve facilities with large heat load rejection, for example power plants, refineries & large manufacturing plants.

Assuming,

Inlet temperature of condenser = 28 ^{0}C

Outlet temperature of condenser = 76 ^{0}C

Condenser efficiency = 84 %

Heat capacity of water, C =4200 kJ/kgK

Cooling water flow rate, $\dot{m}_{cooling}$ $= \frac{h_{\text{loss}} \times \eta}{C \times \Delta T}$

$= \frac{21822094.14\ kJ/hr \times 0.84}{\frac{4200kJ}{kgK} \times (76-28)K}$

= 90.925 kg/hr

2.9 Stack Design

Stack is an important component of a coal fired thermal power plant. They are used to,

- Remove flue gases or smoke out of the boiler.
- Provide the draught that feeds air to the fire to keep it burning.

The height of the Thermal Power plant chimney depends on SO_2 concentration in flue gas and the amount of fuel consumed by that Steam Generator. Usually, it is in between 100 m to 300 m in height.

Height (m) = $14 \times Q^{0.3}$

Q = Fuel quantity (kg/hr) × SO_2 Content (%) × 2 /100

From Section 2.6, Flue gas compositions,

SO_2 = 0.98 %

Fuel Quantity = 1171.98 kg/hr

From above equations,

Height, h = 35.85 m

- Height of the chimney is taken as 36 meters for the design.

The breeching should be as short as possible. They should be constructed of round ducts only. Round ducts are more efficient, and the large flat sides of square or rectangular ducts contribute to noise caused by resonance. The breeching must be installed with a slight upward pitch toward the stack to ensure it is self-venting.

Since 1:10 is the ration between the height and width of a stack,

Diameter, d = 3.6 m

2.10 Pipe Sizing

Steam line pipes from the boiler to turbine convey superheated high-pressure steam. In here pressure drop method is used to estimate the pipe sizing.

The pressure drop considered as 0.2 bar g for a 100m along pipeline

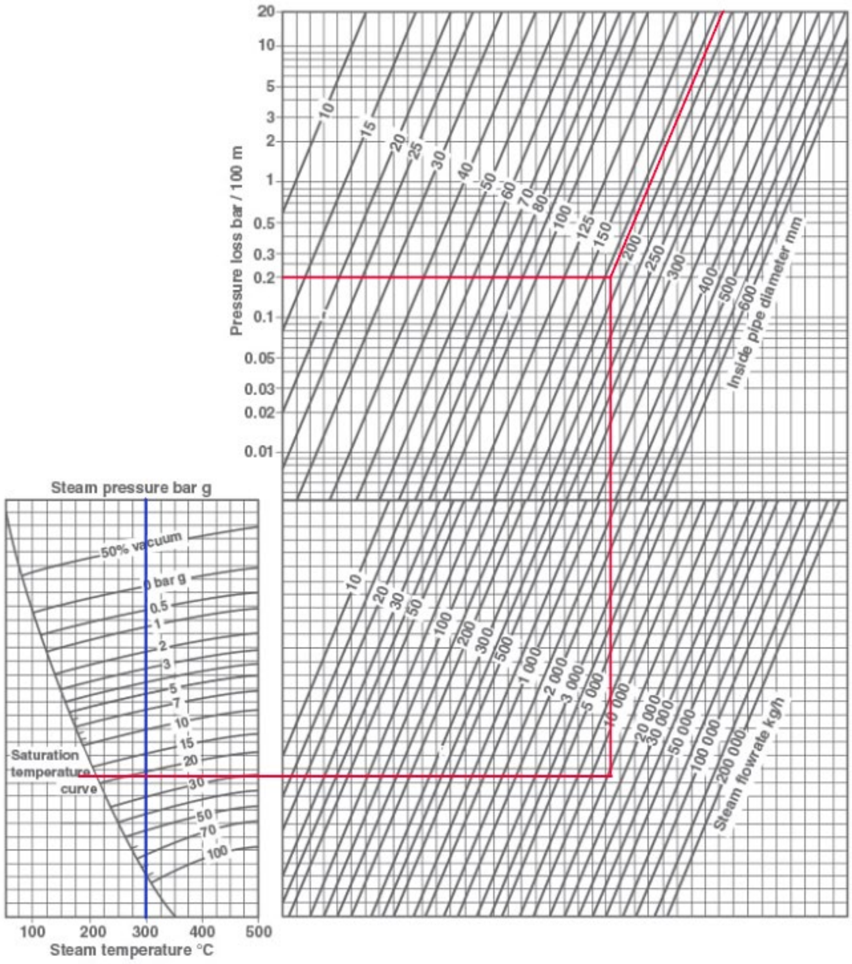


Figure 2.4: Pipeline Sizing

Assumptions,

Pipe length = 160m

Allowance for fittings = 10%

Steam distribution pipe has a pressure drop of 0.2 bar per 100 m

Total pipe length = 176m

Pressure drop for 176m line = 0.352bar g

Pipe size DN200 is suitable for this application, and it is schedule 40.

Selected pipe material is Carbon Steel (Standard: ASME/ANSI B36.10/19).

-Size : DN200 mm

-Inside Diameter: 202.717 mm

-Outside Diameter: 219.075 mm

-Pipe Wall Thickness: 8.179 mm

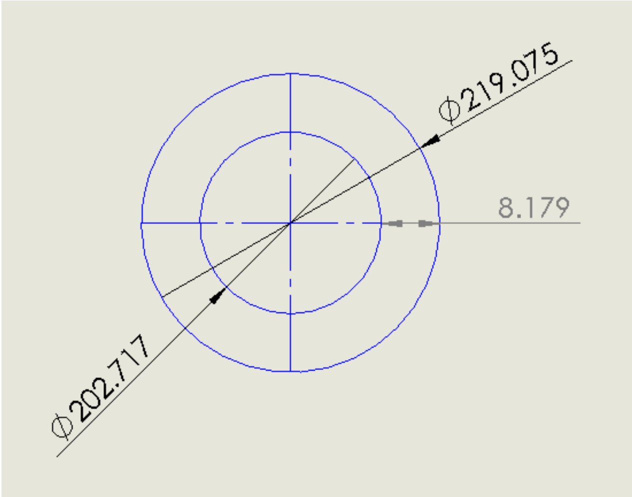


Figure 2.5: DN200 Schedule 40 Carbon Steel Pipe

Condensate Pipeline Sizing

Since the pipelines from turbine consist of saturated steam or 2-phase medium (no super-heated steam) velocity method is used to calculate the pipe sizing. Assuming that there are no leakage and losses in the pipes,

Diameter of the pipe, D $= \sqrt{\dfrac{4 \times Volumetric\ flowrate}{\pi \times \text{flow velocity}}}$

$= \sqrt{\dfrac{4 \times 2.9413kg/s \times 0.26400m^3/kg}{\pi \times 25\ \text{m/s}}}$

$= 0.19886\text{m}$

$\approx 200\text{mm}$

Pipe size DN200 is suitable for this application, and it is schedule 40.

Selected pipe material is Carbon Steel (Standard: ASME/ANSI B36.10/19).

-Size : DN200 mm

-Inside Diameter: 202.717 mm

-Outside Diameter: 219.075 mm

-Pipe Wall Thickness: 8.179 mm

2.11 Insulation of Pipes

The insulation material used for steam line insulation is typically selected based on its ability to provide effective thermal insulation and withstand high temperatures. Commonly used insulation materials include:

- Mineral Wool
- Calcium Silicate
- Fiberglass
- Cellular Glass

Fiber glass is selected for the insulation of steam lines in the system. Fiber glass insulation has the following advantages;

- Easy Installation and Maintenance
- Fire Resistance
- Acoustic Insulation
- Durability
- Cost-Effectiveness
- Environmentally Friendly
- High-Temperature Resistance

Table 6.8.3A Minimum Pipe Insulation Thickness
Heating and Hot Water Systems[a,b,c,d] (Steam, Steam Condensate, Hot Water Heating and Domestic Water Systems

Fluid Operating Temperature Range (°F) and Usage	Insulation Conductivity		Normal Pipe or Tube Size (in)				
	Conductivity Btu•in./(h•ft²•°F)	Mean Rating Temperature, °F	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness (in)				
>350 °F	0.32-0.34	250	4.5	5.0	5.0	5.0	5.0
251°F - 350°F	0.29-0.32	200	3.0	4.0	4.5	4.5	4.5
201°F - 250°F	0.27-0.30	150	2.5	2.5	2.5	3.0	3.0
141°F - 200°F	0.25-0.29	125	1.5	1.5	2.0	2.0	2.0
105°F - 140°F	0.22-0.28	100	1.0	1.0	1.5	1.5	1.5

Figure 2.6: Steam Pipeline Insulation Thickness

Therefore, the suitable insulation thickness was chosen as 5” = 127mm.

2.11 Steam Accessories

- STEAM TRAPS

Thermodynamic stream trap

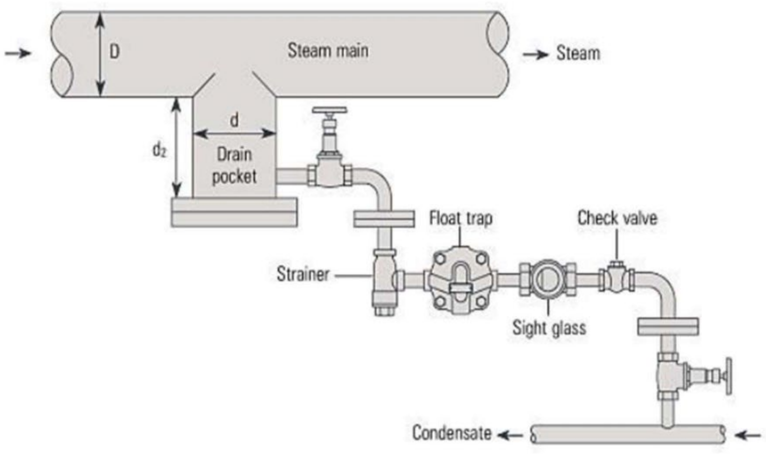


Figure 2.7: Steam Trap Circuit

For steam mains drainage, the condensate load for each drain trap is typically 1% of the steam capacity of the main based on drain points at 50 m intervals, and with good insulation.

Condensate load (Steam Flowrate)	=	10588.68 kg/hr × 1 %
	=	105.887 kg/hr

Differential pressure = 22 bar

It is best practice to install steam traps at least every 30 to 50 meters. Such that assuming steam traps are installed in every 40 meters distance for the design,

Number of steam trap circuits = 4

From manuals, Size of the trap is selected by using the capacity charts of the TIS of the trap

Thermodynamic traps used	=	FMTD 64
Size of the thermodynamic trap	=	DN 15

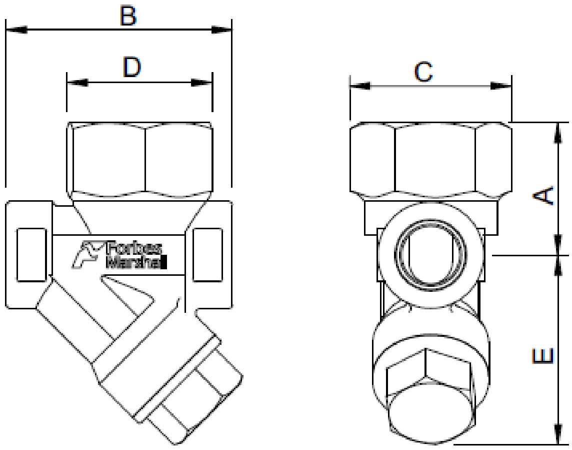


Figure 2: Dimensional Drawing of FMTD64

Dimensions (approx.) in mm:

Size	A	B	C	D	E	Weight
DN 15 DN 20	42	78	50	44	57	0.8 kg

Figure 2.8: Thermodynamics Steam Trap

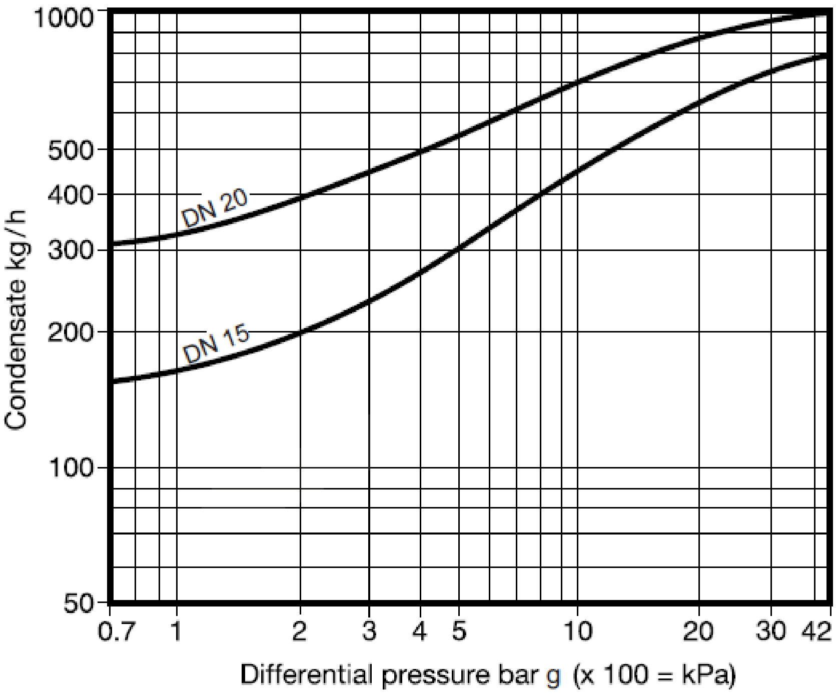


Figure 2.9: Capacity Chart Steam Trap

- DRAIN POCKET SIZING

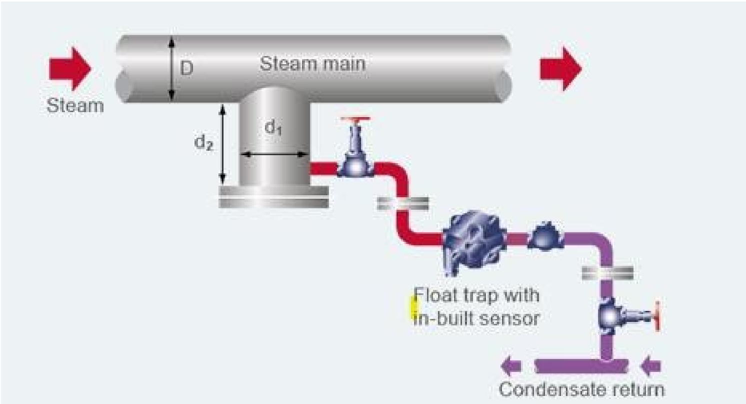


Figure 2.10: Process Steam Line with Drain Pocket

Table 2.4: Drain pocket dimensions

Mains diameter - D	Pocket diameter - d1	Pocket depth - d2
Up to 100 mm nb	d1 = D	Minimum d2 = 100 mm
125 - 200 mm nb	d1 = 100 mm	Minimum d2 = 150 mm
250 mm and above	d1 ≥ D / 2	Minimum d2 = D

Drain pocket dimensions

D : 200 mm

d_1 : 100 mm

d_2 : 150 mm

- VALVES AND STRAINERS

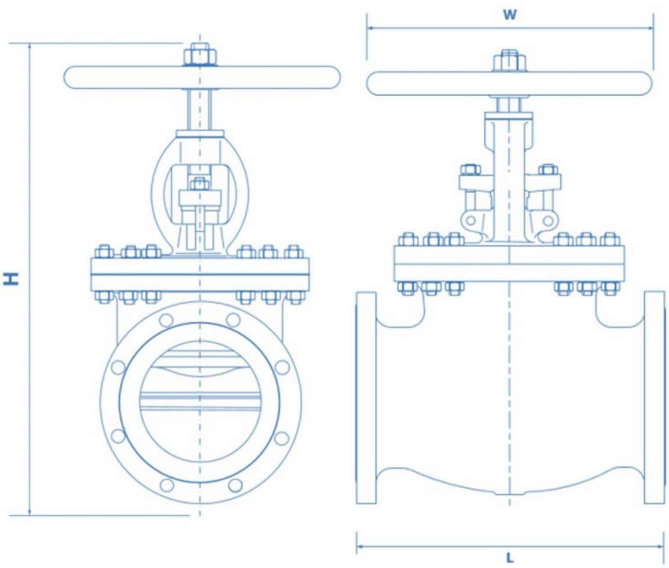


Figure 2.11: Globe Valve

From the references 4-inch ANSI class 150 Globe valve is selected.

Table 2.5 Globe Valve specifications

Size	ANSI Class 150				
	L	H	W	lb	kg
2"	203	350	200	49	22
3"	241	405	250	93	42
4"	292	478	350	132	60
6"	406	555	350	214	97
8"	495	610	450	355	161
10"	622	730	500	679	308
12"	699	1008	600	904	410

For the strainers,

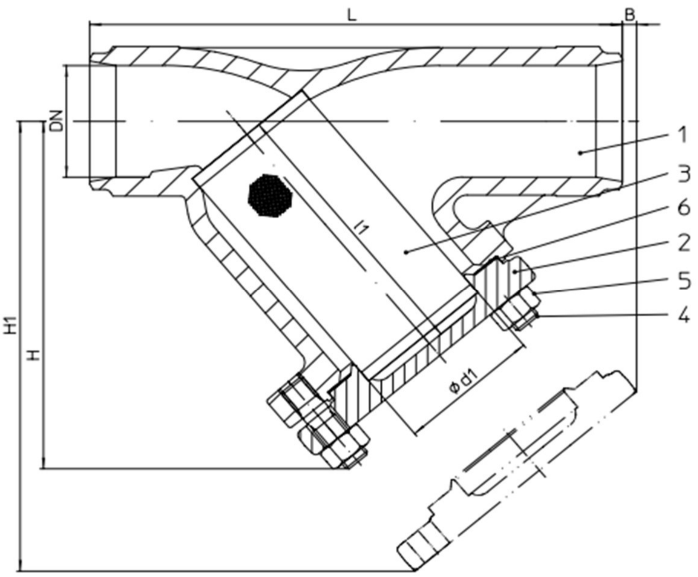


Figure 2.12: Strainer

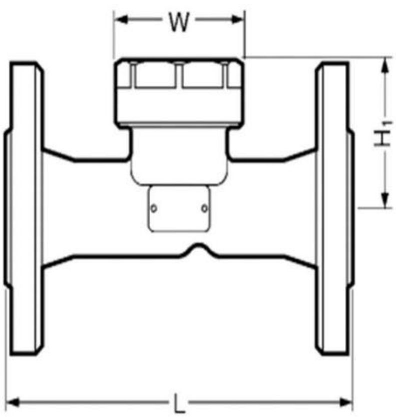
DN 100 mm, Cast Iron strainer is selected for the design, dimensions of the strainer is given below.

Table 2.6: Strainer Specifications

DN			15	20	25	32	40	50	65	80	100	125	150	200	250	300
Face-to-face dimension ETE series 1 according to DIN EN 12982																
L		(mm)	130	150	160	180	200	230	290	310	350	400	480	600	730	850
Dimensions																
H		(mm)	90	100	115	125	150	160	180	215	235	275	305	390	540	680
H1		(mm)	135	150	180	205	235	250	285	330	365	425	480	610	915	1110
B		(mm)	10	10	25	35	45	45	25	40	55	65	50	80	230	350
l1		(mm)	56	68	82	98	114	119	134	149	169	199	224	284	283	317
Ød1		(mm)	23	28	36	42	50	61,5	78,5	89,5	109,5	137,5	160	210	260	314
Standard screen	Mesh width	(mm)	1	1	1	1	1	1	1,25	1,25	1,6	1,6	1,6	1,6	1,6	1,6
	Kvs-value [1)]	(m^3/h)	6,9	10,8	17,8	26,1	36,7	61	98,6	146	234	376	394	652	1225	1873
	Zeta-value	--	1,7	2,2	2	2,5	3	2,7	2,9	3,1	2,9	2,8	5,2	6	4,2	3,7
Fine screen	Mesh width	(mm)	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25
	Kvs-value [1)]	(m^3/h)	6,2	10,1	16,8	24,3	32,9	49,5	80,3	115	189	303	405	590	1231	1883
	Zeta-value	--	2,1	2,5	2,2	2,8	3,8	4,1	4,4	4,9	4,4	4,5	4,9	7,3	4,1	3,6
Ratio of the free screen surface area to the area of the nominal diametSp.p.			10	8,4	8,3	7,1	6,8	5,2	4,4	3,7	2,8	2,7	2,4	2,3	2,7	2,9
Zeta-value ... range of tolerance for Kvs-values acc. to VDI/VDE 2173											1) Kvs-values based upon clean screen !					
Weights																
35.080		(kg)	2,5	3	3,5	4	5,5	7,5	12	15	23,5	33	49	106	135	240

- SIGHT GLASS

Selected sight glass is TF8N Flanged of Size 40 mm



TF8N/TF10N Flanged (mm)

Size	L ASME Class 125FF	L ASME Class (150RF)	L ASME Class 250RF	L ASME Class (300RF)	H	ϕW	Through-hole Diameter**	Weight* (kg)
(15)	—	175	—	175	64	65	10	[2.9]
(20)	—	180	—	180	61		15	[4.6]
25	180		184	184	64		18	4.8
32	200	200	200	200	69		20	5.8
40			204	204	71		25	8.2
50					76		30	10

Figure 2.13: Sight Glass

- NON-RETURN DISK CHECK VALVE

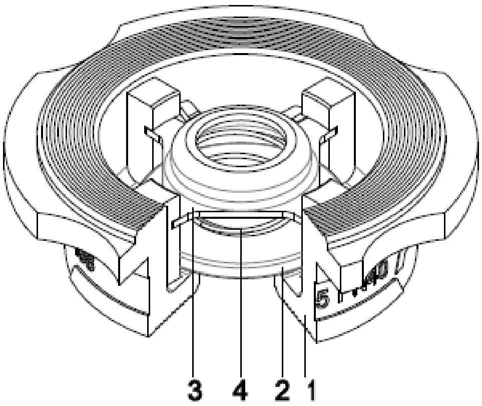


Figure 2.14: Spring Loaded Disc Check Valve

Selected spring-loaded disk check valve is Forbes Marshall DN 15.
Minimum operating temperature is 300 ^{0}C & Maximum operating pressure is 40 bar g.

- SAFETY RELIEF VALVE

Safety relief valves are an essential component in any steam system for a firewood boiler. These valves are designed to protect the system from overpressure by releasing steam from the system when the pressure exceeds a predetermined level.

Here selected Safety Relief Valve is PN40 Nodular Iron ARI SAFE.

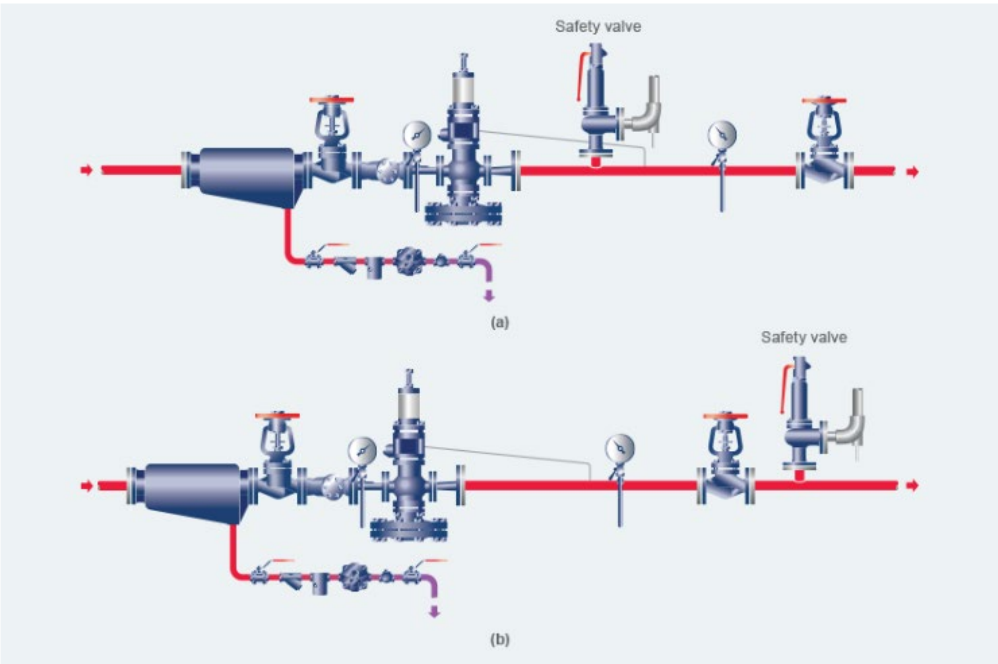


Figure 2.15: Possible Positioning of a Safety Valve In a pressure Reducing Station

2.12 Safety and Environmental Regulations

- Occupational Safety: Coal-fired power plants have various safety regulations to protect workers and ensure a safe working environment. These regulations cover aspects such as hazard identification, personal protective equipment (PPE), training programs, emergency response procedures, and regular equipment inspections.

- Air Emissions: Coal combustion releases pollutants into the air, including sulfur dioxide (SO2), nitrogen oxides (NOx), particulate matter (PM), and mercury. Power plants are required to comply with emissions limits and install pollution control technologies, such as electrostatic precipitators, scrubbers, selective catalytic reduction (SCR), and fabric filters, to reduce these emissions. Compliance with emissions standards is essential to minimize air pollution and protect public health.

- Ash and Waste Management: Coal-fired power plant generate significant amounts of ash and other solid wastes, such as bottom ash, fly ash, and gypsum. Proper management and disposal of these byproducts are necessary to prevent contamination of soil and water. Regulations often require power plants to implement measures for safe storage, handling, and disposal of ash and other waste materials, such as utilizing lined landfills or recycling ash for beneficial use.

- Water Usage and Discharge: The power plant requires substantial amounts of water for steam production and cooling purposes. Regulations typically mandate the implementation of water management systems to minimize water consumption and ensure the responsible discharge of wastewater. Technologies like closed-loop cooling systems, cooling towers, and wastewater treatment facilities are often employed to comply with water usage and discharge standards.

- Noise Pollution: The coal-fired power plant can generate noise from machinery, fans, and other equipment. Regulations may establish limits on permissible noise levels to protect nearby communities and wildlife. Power plants may need to employ noise reduction measures, such as sound barriers or equipment enclosures, to comply with these regulations.

- Workplace Health and Safety: Apart from occupational safety, power plant is subject to regulations pertaining to workplace health and safety. This includes providing appropriate ventilation systems, ensuring proper handling and storage of hazardous materials, conducting regular safety audits, and maintaining adequate fire protection measures.

- Monitoring and Reporting: Power plant is often required to install monitoring systems to track emissions, water usage, and other environmental parameters. Data collected from these systems must be reported to regulatory authorities to demonstrate compliance with safety and environmental standards.

It is important to note that regulations can vary significantly across different jurisdictions. Power plant operators must adhere to the specific regulations and permits applicable to their location and consult with environmental and safety experts to ensure compliance with all relevant requirements.

CHAPTER 03

3.1 Overall Plant Layout

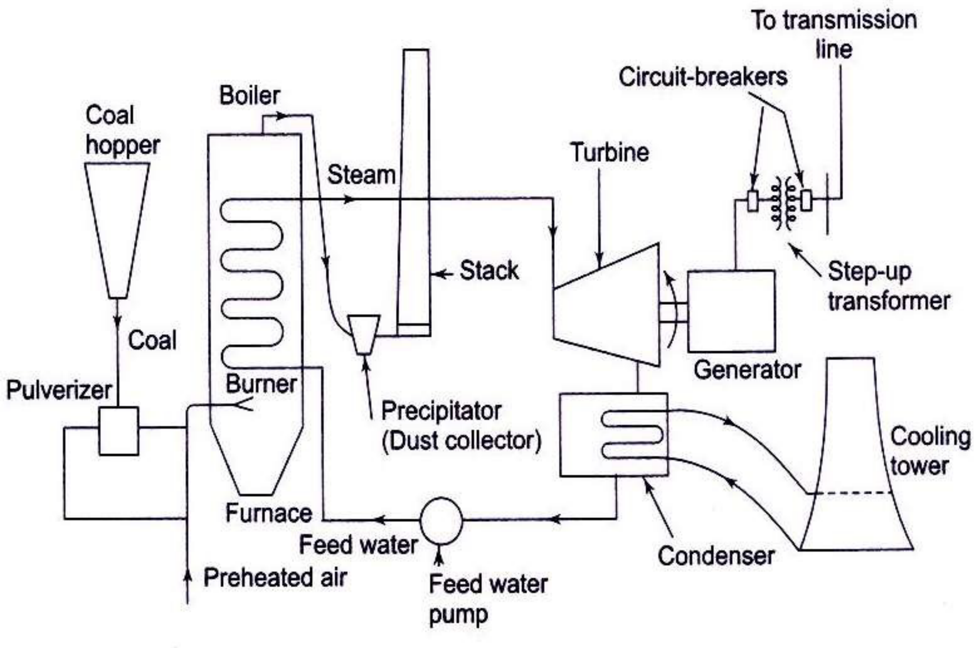


Figure 3.1: Overall Power Plant Layout

3.2 Manpower Requirements

The manpower requirements for a coal-fired power plant can vary depending on factors such as the plant's capacity, technology, operational complexity, and level of automation. The following are typical manpower roles and departments found in the coal-fired power plant:

- Operations Department:

- Plant Manager/Operations Manager: Oversees overall plant operations and manages staff.
- Shift Supervisors: Responsible for supervising and coordinating operations during each shift.
- Control Room Operators: Monitor and control the plant's equipment and systems from the control room.
- Field Operators: Carry out manual operations, inspections, and maintenance tasks in the field.

- Maintenance Department:

- Maintenance Manager: Responsible for planning and coordinating maintenance activities.
- Mechanical Technicians: Conduct mechanical maintenance, repairs, and equipment inspections.
- Electrical Technicians: Handle electrical maintenance, troubleshooting, and repairs.
- Instrumentation and Control Technicians: Maintain and calibrate control systems and instruments.
- Welders and Pipefitters: Perform welding and pipefitting tasks for repairs and installations.

- Environmental and Safety Department:

- Environmental Compliance Officers: Ensure compliance with environmental regulations and manage environmental monitoring programs.

- Safety Officers: Develop and enforce safety policies and procedures, conduct safety training, and perform incident investigations.

- Environmental Technicians: Conduct air and water quality monitoring, handle waste management, and oversee environmental compliance.

- Chemistry Department:

- Chemists: Perform water chemistry analysis, monitor chemical treatment systems, and ensure compliance with water quality standards.

- Laboratory Technicians: Assist chemists in conducting tests, analyzing samples, and maintaining lab equipment.

- Administrative and Support Functions:

- Human Resources: Handle recruitment, employee training, benefits administration, and personnel management.

- Finance and Accounting: Manage budgeting, financial reporting, and procurement activities.

- Warehouse and Inventory Management: Maintain inventory of spare parts, tools, and consumables.

- Security: Ensure plant security and manage access control systems.

- Other Roles:

- Plant Engineers: Provide engineering support for plant modifications, upgrades, and troubleshooting.

- Quality Assurance/Quality Control: Implement quality control programs, inspections, and audits.

- Training and Development: Develop training programs and provide ongoing training for plant personnel.

- IT/Information Systems: Manage plant automation systems, data acquisition, and cybersecurity.

The actual number of personnel required for each role will depend on the size of the power plant, its operational needs, and the level of automation in place. It's important to note that advancements in automation and digitalization can reduce manpower requirements in certain areas of power plant operations.

3.3 Cost Estimation

Cost estimation based on bill of quantities is an important process in the design and construction of a coal-fired power plant.

A cost estimation analysis was done using indicative values and available values to estimate the total cost of implementing the steam generation and distribution system. This is shown in Table 3.1. (Please note that prices of some components can vary).

Table 3.1: Total cost estimate based on BOQ

No.	Item	Unit	Rate / Rs.	Quantity	Cost / Rs.
01	Boiler	pcs	2,500,000	1	2,500,000
02	Strainer DN40	pcs	16,200	5	81,000
03	DN15 Thermodynamic trap	pcs	30,000	8	240,000
04	DN40 Float trap	pcs	80,000	2	160,000
05	DN125 Carbon steel pipe (6m)	m	200,000	35	7,000,000
06	DN15 Carbon steel pipe (6m)	m	18,000	10	180,000
07	Non return valve	pcs	42,000	3	126,000
08	Globe valve	pcs	220,000	1	220,000
09	PRV	pcs	250,000	2	500,000
10	Sight glass	pcs	43,000	3	129,000
11	Bends	pcs	30,000	32	900,000
12	Moisture separator	pcs	220,000	1	220,000
13	Safety relief valve	pcs	300,000	2	600,000
14	Ball valves	pcs	9,000	10	90,000
15	DN15 Strainer	pcs	9,000	5	45,000
	Total Cost				**12,991,000**

3.4 Operating Costs

Operating costs for a coal-fired power plant include various expenses associated with the day-to-day operation and maintenance of the plant. These costs can vary depending on factors such as plant capacity, fuel costs, labor expenses, maintenance requirements, and regulatory compliance. Here are some common operating costs for a coal-fired power plant:

- Fuel Costs: Coal is the primary fuel for a coal-fired power plant, and fuel costs typically constitute a significant portion of the operating expenses. The cost of coal can vary depending on factors such as coal quality, transportation costs, and market prices.

- Labor and Workforce: Operating a power plant requires a skilled workforce to manage and operate the plant efficiently. Labor costs include salaries, wages, benefits, and training expenses for various positions such as plant operators, maintenance personnel, technicians, and administrative staff.

- Maintenance and Repair: Regular maintenance is crucial to ensure the safe and reliable operation of the plant. Operating costs include expenses related to equipment inspections, routine maintenance, repairs, and replacement of components. These costs can vary depending on the age of the plant, equipment condition, and maintenance strategies employed.

- Consumables and Chemicals: Power plants require various consumables and chemicals for efficient operation. This includes items such as lubricants, filters, cleaning agents, water treatment chemicals, and reagents for emissions control systems. The cost of these consumables and chemicals contribute to the overall operating expenses.

- Electricity and Utilities: Power plants require electricity for internal processes, lighting, and auxiliary systems. The cost of electricity, as well as other utilities such as water and gas, are included in the operating expenses.

- Waste Management: Coal-fired power plants generate various types of waste, including ash, sludge, and other byproducts. Proper disposal or recycling of these wastes, along with associated transportation and treatment costs, are part of the operating expenses.

- Regulatory Compliance: Power plants must comply with environmental regulations, emissions limits, and safety standards. Operating costs include expenses related to emissions monitoring, environmental compliance reporting, and implementing necessary control technologies to meet regulatory requirements.

- Insurance and Administrative Costs: Power plants require insurance coverage for property, equipment, liability, and workers' compensation. Administrative costs include expenses related to permits, licenses, inspections, and administrative personnel.

It is important to note that operating costs can vary significantly depending on plant-specific factors and external factors such as fuel prices and regulatory changes. Regular cost monitoring, optimization efforts, and efficient operational practices can help manage and control operating expenses in a coal-fired power plant.

CHAPTER 04

4.1 Results

Table 4.1: Finalized Design Results for The Steam Distribution System

Parameter	Value
Boiler Capacity	5469.16 kW
F&A rating	10576.97 kJ/hr
Steam flow rate	10588.68 kJ/hr
Degree of superheat	80.482 ºC
Fuel	Coal
Fuel consumption rate	1171.98 kg/hr
Flue gas flowrate	4304.14 kJ/hr
Blowdown rate	474.09 kg/hr
Feed water tank capacity	44.251 m^3
Check valve	Forbes Marshall DN 15, Spring Loaded Disc Check Valve
Isolation valve	Cast steel globe valve
strainer	DN 100 mm, Cast Iron strainer
PRV	Pneumatically actuated spira – tool
Sight glass	TF8N Flanged of Size 40 mm
Safety relief valve	PN40 Nodular Iron ARI SAFE
Ball valve	Mars series 50 carbon steel
Moisture separator	FMSEP53 cast steel
Insulation thickness	127 mm
Stack Height	35.85 m
Stack diameter	3.6 m
Cooling water flow rate	90.925 kg/hr
Heat rejection	21.822 GJ/hr

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APPENDICES

APPENDIX 1

SOFT53

Single Orifice Float Trap (with SLR / TV)

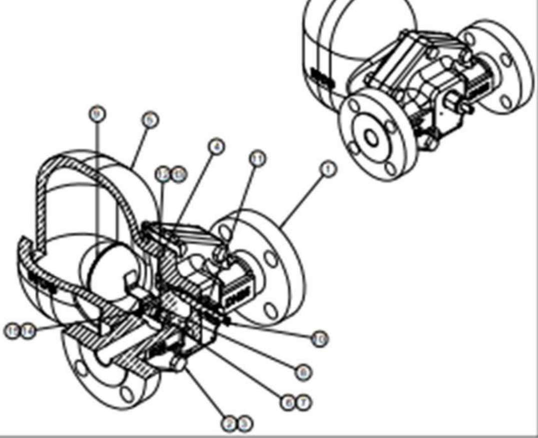
Description
The Forbes Marshall Single Orifice Float Trap SOFT53 is a condensate drain trap of cast steel body, cover and stainless steel internals.

Sizes and Pipe Connections
DN 15, 20, 25, 40 and 50
Screwed BSPT / NPT / BSP Socket weldable to ANSI B 16.11
Flanged ANSI B 16.5 class 150, 300, 600
BS Table H, J, K, R; PN 10, 16, 25 and 40

Note
1) Available with IBR certificate
2) DN15 Class150 / PN Flanged Versions are available only with weld on flanges.
3) Flange thickness is common for all Flange ratings as shown in dimensional details.

Available Types
SOFT53 with built in Thermostatic Air Vent (TV)

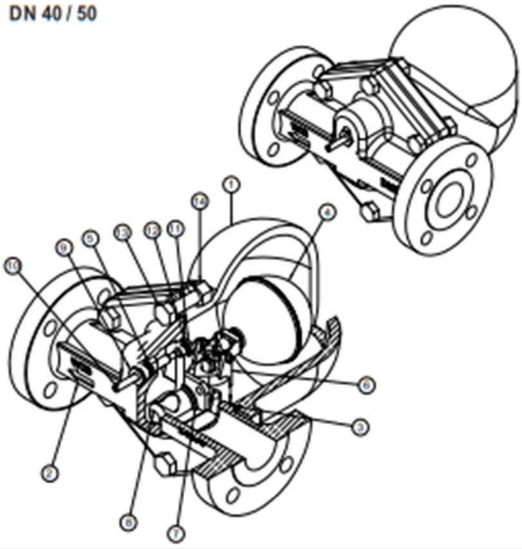
DN15/20/25



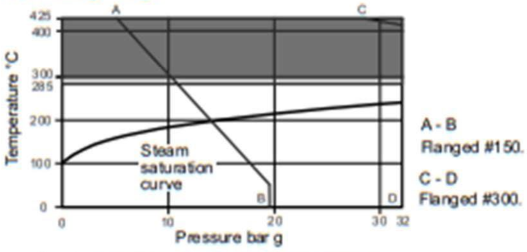
Limiting Conditions

PMA Maximum allowable pressure	32 bar g @ 425ºC
TMA Maximum allowable temperature	425ºC
PMO Maximum operating pressure	32 bar g
TMO Maximum operating temperature	300ºC @ 32 bar g
Minimum operating temperature	0ºC
DPMX Maximum Differential pressure	
SOFT53-4.5	4.5 bar g
SOFT53-10	10 bar g
SOFT53-14	14 bar g
SOFT53-21	21 bar g
SOFT53-32	32 bar g
Cold hydraulic test pressure	64 bar g

DN 40 / 50



Operating range



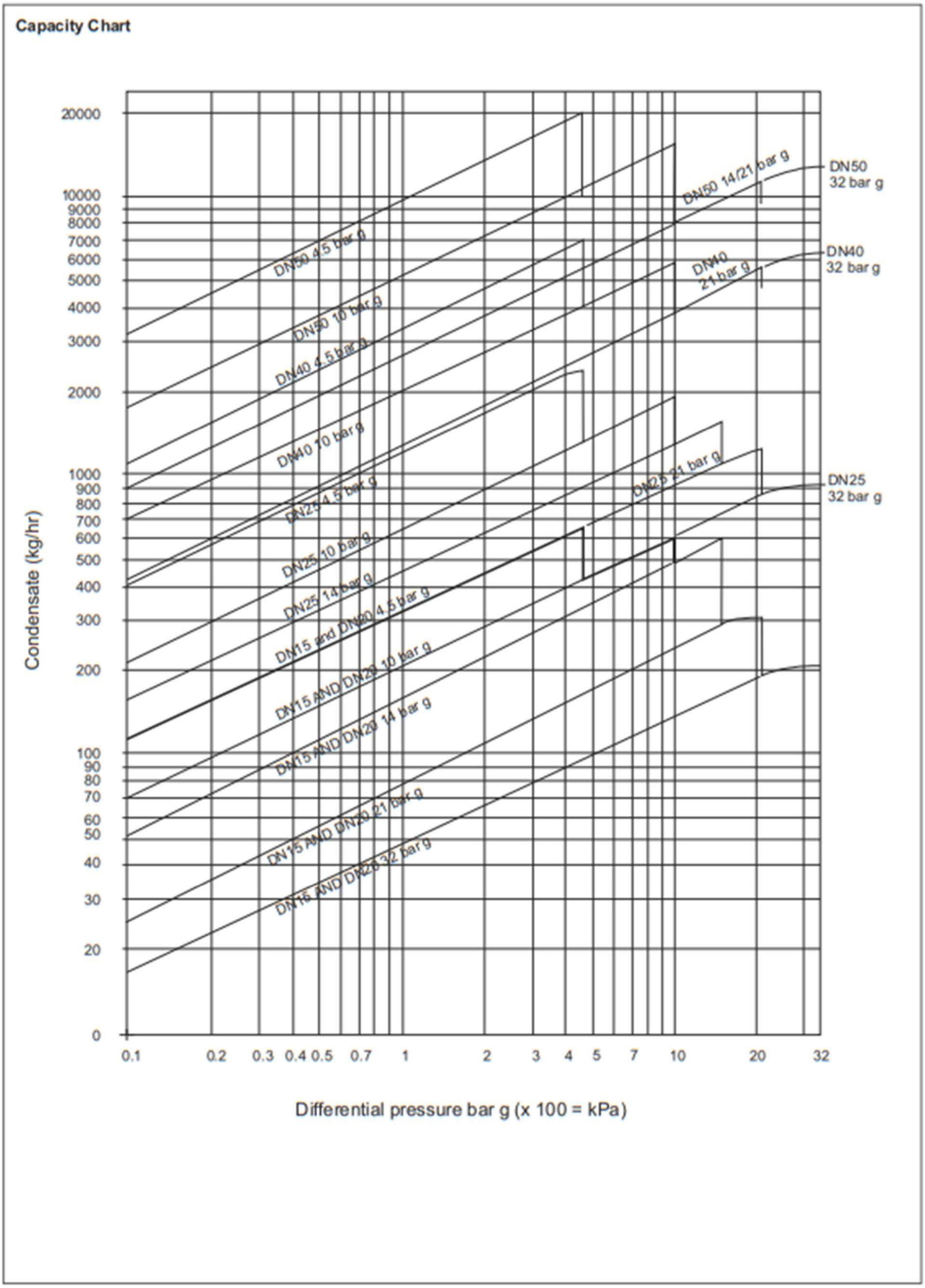
This product **must not** be used in this region.

This product should not be used in this region as damage to the internals may occur.

How to Order
Example DN 25 Single Orifice Float Trap, SOFT53 - 4.5 bar g, TV, screwed BSPT

Energy Conservation | Environment | Process Efficiency www.forbesmarshall.com

APPENDIX 2



Capacity Chart
Condensate (kg/hr)
Differential pressure bar g (x 100 = kPa)
DN50 4.5 bar g
DN50 10 bar g
DN40 4.5 bar g
DN40 10 bar g
DN25 4.5 bar g
DN25 10 bar g
DN25 14 bar g
DN15 and DN20 4.5 bar g
DN15 AND DN20 10 bar g
DN15 AND DN20 14 bar g
DN15 AND DN20 21 bar g
DN15 AND DN20 32 bar g
DN50 14/21 bar g
DN40 21 bar g
DN25 21 bar g
DN50 32 bar g
DN40 32 bar g
DN25 32 bar g

Material (15-25)

No.	Part	Material	Standard
1a.	Base flange DN 20-50	Cast Steel	ASTM A216 Gr.WCB
1b.	Base Screwed/SWE DN 15-20	Forged Carbon Steel	ASTM A105
1c.	Base Screwed/SWE DN 25	Cast Steel	ASTM A216 Gr.WCB
2.	Bolts	Alloy Steel	ASTM A193 B7
3.	Nuts	Carbon Steel	ASTM A194 2H
4.	Cover Gasket	SS Reinforced Exfoliated graphite	
5.	Cover	Cast Steel	ASTM A216 Gr. WCB
6.	Valve Seat	Stainless Steel	ASTM A276 SS 410
7.	Valve Seat Gasket	Stainless Steel	ASTM A240 SS 410
8.	Pivot Frame Assly. Set Screws	Stainless Steel	IS-1364 SS304
9.	Ball Float & Lever	Stainless Steel	ASTM A240 SS304
10.	SLR Stem	Stainless Steel	ASTM A276 SS316
11.	Gland Packing	Graphite	
12.	SLR Seat	Stainless Steel	ASTM A743 CA40
13.	SLR Seat Gasket	Stainless Steel	ASTM A240 SS410
14.	Support Frame	Stainless Steel	ASTM A240 SS304
15.	Pivot Frame	Stainless Steel	ASTM A240 SS304

Installation

The arrow on the nameplate must point downwards. The arrow on casting indicates the flow direction.

Servicing

I) For DN 15, 20 and 25 main valve assembly : Unscrew cover bolts and lift off the cover. Remove complete float assembly by undoing the two screws on the pivot frame, main valve seat and gasket and if damaged replace with a new one. Fit support frame and pivot frame by using two set screws but do not fully tighten. Place the float arm and complete the assembly by placing the pin. Now tighten the set screws. Refit the cover.

II) For DN 40 and 50 main valve assembly : Unscrew cover bolts and lift off the cover. Unscrew the assembly set screws. Remove the main assembly, if damaged replace with a new one. Refit the cover by using the cover bolts and nuts.

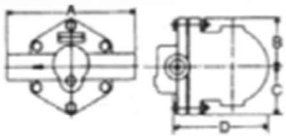
Dimensions (approx) in mm.

For Screwed / Socket Weld End and CLASS 600 FLG

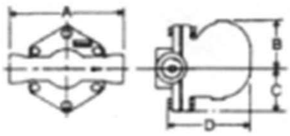
Size (DN)	A	B	C	D	E	T*	W (kg)
15/20	230	84	84	172	120	23	10
25	220	119	88	225	160	24	13
40	297	131	111	250	200	26	20
40 (# 600)	350	131	121	250	200	29	25
50	320	134	123	250	200	26	27
50 (# 600)	335	134	127	250	200	32	31

* For screwed/socket weldable ends: T = 0 Gen Tol. ± 3

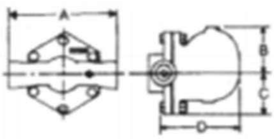
(SOFT53 DN15/20)



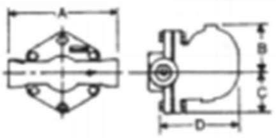
(SOFT53 DN25)



(SOFT53 DN40)



(SOFT53 DN50)



Dimensions - (approx) in mm.

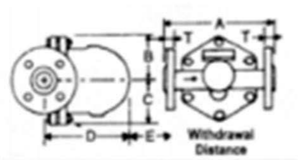
All Flanged – (Except CLASS 600)

Size (DN)	A	B	C	D	E	T*	W (kg)
15/20	230	84	84	172	120	23	11
25	240	119	88	225	160	24	14
40	297	131	111	250	200	26	26
50	320	134	123	250	200	26	32

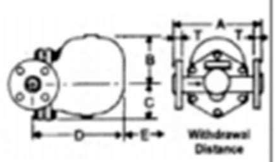
Gen.Tol. ρ 3

* **DN15 Class150 / PN Flanged Versions are available only with weld on flanges.**

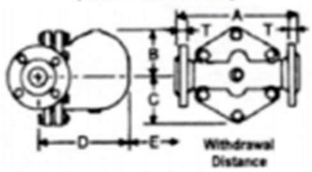
(SOFT53 DN 15/20)



(SOFT53 DN 25)



(SOFT53 DN 25)



Material (DN 40-50)

No.	Part	Material	Standard
1.	Cover	Cast Steel	ASTM A216 Gr.WCB
2.	Base	Cast Steel	ASTM A216 Gr.WCB
3.	Gasket for Base and Cover	SS Reinforced Graphite	
4.	Float Unit Assembly	Stainless Steel	ASTM A240 SS304
5.	Gland Packing	Graphite	
6.	Valve Housing Assembly	Stainless Steel	BS 3146 ANC2
7.	Gasket for Valve Housing	SS Reinforced Graphite	
8.	Erosion Deflector	Stainless Steel	ASTM A276 SS 410
9.	Gland Nut	Stainless Steel	ASTM A743 GR. CA40
10.	SLR Stem	Stainless Steel	ASTM A276 SS316
11.	SLR Seat	Stainless Steel	ASTM A743 GR. CA40
12.	Gasket for SLR Seat	Stainless Steel	ASTM A240 SS 410
13.	Hex Bolt	Alloy Steel	ASTM A193 B7
14.	Hex Nut	Carbon Steel	ASTM A194 2H

Available Spares

Main Valve Assembly with Float (DN 15, 20 & 25)	A
Main Valve Assembly (DN 40, 50)	A+D
Air Vent Assembly	B
Steam Lock Release Unit	C
Sets of Gaskets (Pkt of 3)	E
Float	D

How to Order Spares

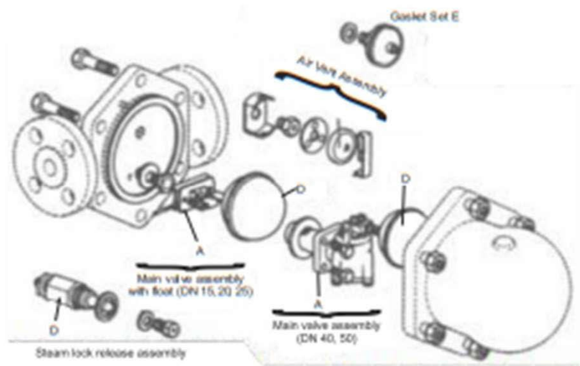
Always order spares using the description given in the column above, headed "Available Spares", and stating the size and type and differential pressure of the trap. For codes refer the user manual.

Recommended Tightening Torques

Sr.No.	Part	Torque (Nm)
1.	TV seat	45 - 55
2.	SLR seat	45 - 55
3.	SLR body	60 - 70
4.	Valve housing (studs)	15 - 20
5.	Cover bolts	70-80

Spare Parts

The available spare parts are shown in heavy outline in the figure below. Parts drawn in broken line are not available as spares.



FORBES MARSHALL

Forbes Marshall
Krohne Marshall
Forbes Marshall Arca
Codel International
Forbes Solar
Forbes Vyncke
Forbes Marshall Steam Systems

Opp 106th Milestone
Bombay Poona Road
Kasarwadi, Pune - 411 034. INDIA
Tel : 91(0)20-27145595, 39858555
Fax : 91(0)20-27147413

B-85, Phase II, Chakan Indl Area
Sawardari, Chakan, Tal. Khed
Dist. Pune - 410 501. INDIA
Tel : 91(0)2135-393400

A-34/35, MIDC H Block
Pimpri, Pune - 411 018. INDIA.
Tel : 91(0)20-27442020, 39851199
Fax : 91(0)20-27442040

CIN No.: U28996PN1985PTC037806
www.forbesmarshall.com

Email : seg@forbesmarshall.com, ccmidc@forbesmarshall.com

DOC# FMSS/1117/TIS-SOFT53/R2

APPENDIX 3

SDS M4404-08

TLV®

SIGHT GLASS

MODEL T8N/T10N

COMPACT SIGHT GLASS WITH FLOW INDICATING BALL

Features

Lightweight sight glass for installation at the outlet side of steam traps to monitor trap performance and to check for steam leakage. Also recommended for checking the line flow of air and water. Suitable for small-to-large flow rates.

1. Clear sighting through self-polishing, heat-resistant glass.
2. Ball movement indicates the flow status.
3. Model T(F)10N is designed for large flow rates due to through-hole in the partition between inlet and outlet.
4. Compact design saves space.
5. Inline repairable.

Specifications

Model		T8N/T10N	TF8N/TF10N
Connection		Screwed	Flanged
Size (mm)		15, 20, 25, 32, 40, 50	
Maximum Operating Pressure (MPaG)	PMO	1.6	
Maximum Operating Temperature (˚C)	TMO	200	
Applicable Fluids*		Steam, Water, Air	

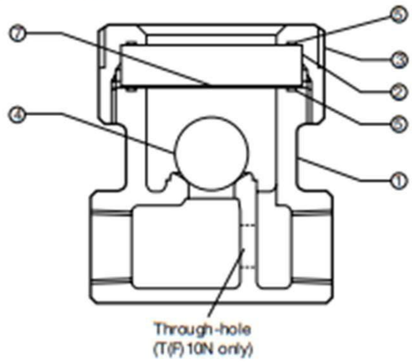
* Do not use for toxic, flammable or otherwise hazardous fluids. 1 MPa = 10.197 kg/cm²

PRESSURE SHELL DESIGN CONDITIONS (**NOT** OPERATING CONDITIONS): Maximum Allowable Pressure (MPaG) PMA: 1.6
Maximum Allowable Temperature (˚C) TMA: 200

CAUTION To avoid abnormal operation, accidents or serious injury, DO NOT use this product outside of the specification range. Local regulations may restrict the use of this product to below the conditions quoted.

No.	Description	Material	JIS	ASTM/AISI*
①	Body	Cast Iron	FC250	A126 Cl.B
②R	Sight Glass	Heat Resistant Glass	—	—
③	Glass Holder	Cast Iron	FC250	A126 Cl.B
④R	Ball	Fluorine Resin	PTFE	PTFE
⑤R	Gasket	Fluorine Resin	PTFE	PTFE
⑥	Nameplate**	Stainless Steel	SUS304	AISI304
⑦R	Guard Plate	Mica	—	—

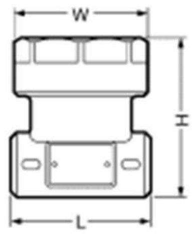
* Equivalent ** Shown overleaf
Replacement kits available: (R) repair parts



CAUTION The heat-resistant glass must be replaced every year.

Dimensions

● **T8N/T10N**
Screwed



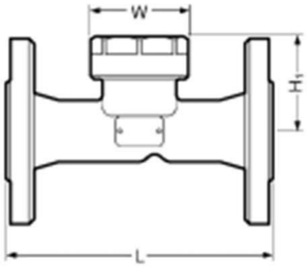
T8N/T10N Screwed*

(mm)

Size	L	H	φW	Through-hole dia.**	Weight (kg)
15	68	79	65	10	0.9
20	75	87		15	1.0
25	79	94		18	1.2
32	120	106		20	1.9
40		113		25	2.1
50	126	127		30	2.7

* Rc(PT), other standards available ** T10N only

● **TF8N/TF10N**
Flanged



TF8N/TF10N Flanged

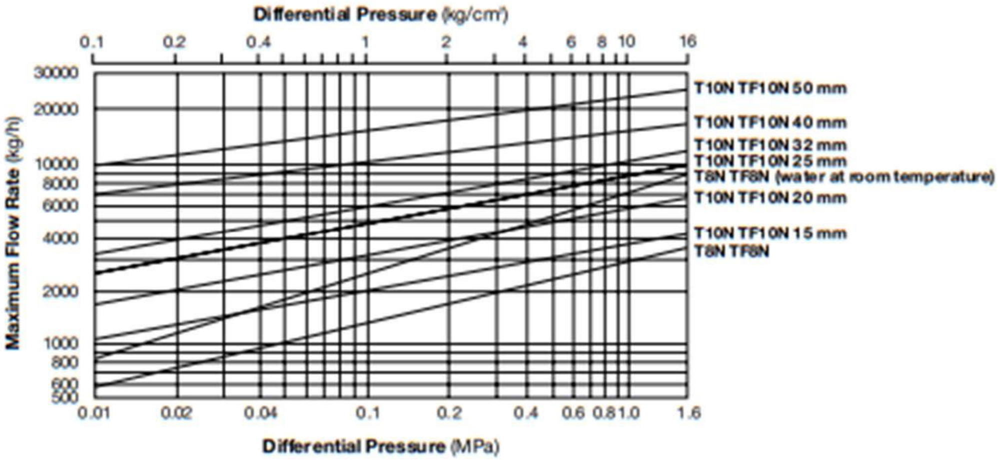
(mm)

Size	L ASME Class 125FF	L ASME Class (150RF)	L ASME Class 250RF	L ASME Class (300RF)	H	φW	Through-hole Diameter**	Weight* (kg)
(15)	—	175	—	175	64	65	10	[2.9]
(20)	—	180	—	180	61		15	[4.6]
25	180		184	184	64		18	4.8
32	200	200	200	200	69		20	5.8
40			204	204	71		25	8.2
50					76		30	10

( ) No ASME standard exists for cast iron; machined to fit steel flanges
Class 125 FF can connect to 150 RF, 250 RF can connect to 300 RF
Other standards available, but length and weight may vary
* Weight is for Class 250 RF [300 RF]
** TF10N only

CAUTION Install a check valve on the outlet side if there is the danger of downstream water hammer!

Capacities



1. Capacities are based on continuous discharge of condensate 6 °C below saturated steam temperature (or continuous discharge of water at room temperature if so stated).
2. Differential pressure is the difference between the inlet and outlet pressure of the sight glass.

Manufacturer
TLV CO., LTD.
Kakogawa, Japan
is approved by LRQA Ltd. to ISO 9001/14001

ISO 9001/ISO 14001

http://www.tlv.com

ARI-Strainer - Screen and supporting basket made of stainless steel

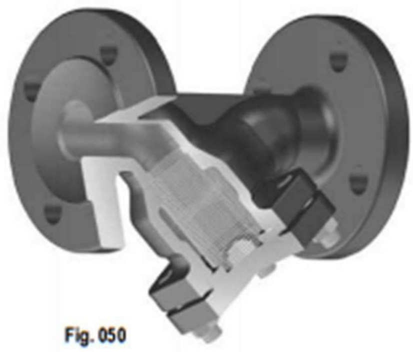
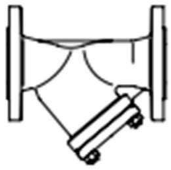


Fig. 050

ARI-Strainer - Y-pattern with flanges

- TRB 801 Annex II No. 45 (except EN-JL 1040)
- EN ISO 15848-1 / TA - Luft
  TÜV-Test-No. TA 09 2016 C04

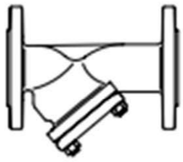


Grey cast iron
SG iron
Cast steel

Fig. 050 Page 2

ARI-Strainer - Y-pattern with flanges

- TRB 801 Annex II No. 45
- EN ISO 15848-1 / TA - Luft
  TÜV-Test-No. TA 09 2016 C04

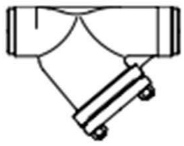


Stainless steel

Fig. 059 Page 3

ARI-Strainer - Y-pattern with butt weld ends

- TRB 801 Annex II No. 45
- EN ISO 15848-1 / TA - Luft
  TÜV-Test-No. TA 09 2016 C04



Cast steel

Fig. 080 Page 4

Features:

- Screen and supporting basket made of stainless steel
- Screen from DN50 with reinforced ring
- Screen from DN150 with supporting basket
- Precise guidance of screen in cover and body

Strainer - Y-pattern with flanges (Grey cast iron, SG iron, Cast steel)

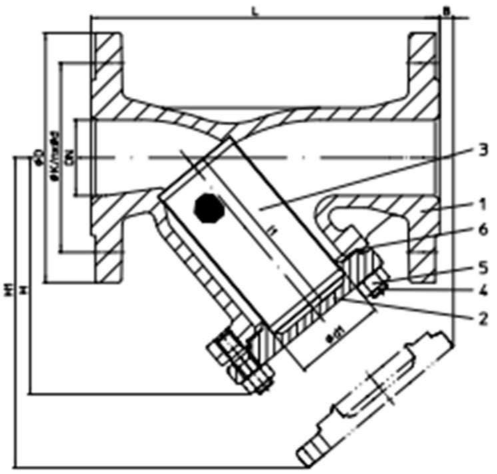


Figure	Nominal pressure	Material	Nominal diameter
10.050	PN6	EN-JL1040	DN15-200
12.050	PN16	EN-JL1040	DN15-300
22.050	PN16	EN-JS1049	DN15-300
23.050	PN25	EN-JS1049	DN15-150
34.050	PN25	1.0619+N	DN15-200
35.050	PN40	1.0619+N	DN15-200

A supporting basket is necessary, with higher differential pressures, dependent on clogging-up (DN >125 standard)

Test:	• EN ISO 15848-1 / TA - Luft TÜV-Test-No. TA 09 2016 C04

Parts					
Pos.	Sp.p.	Description	Fig. 10./12.050	Fig. 22./23.050	Fig. 34./35.050
1		Body	EN-JL1040, EN-GJL-250	EN-JS1049, EN-GJS-400-18U-LT	GP240GH+N, 1.0619+N
2		Cover	DN ≤150: EN-JL1040, EN-GJL-250 DN > 150: P265GH, 1.0425	DN ≤80: EN-JS1049, EN-GJS-400-18U-LT DN >80: P265 GH, 1.0425	DN ≤80: P250 GH, 1.0460 DN >80: P265 GH, 1.0425
3	x	Screen	X5CrNi 18-10, 1.4301		
3.1		Supporting basket	DN > 125: X5CrNi 18-10, 1.4301		
4		Stud	25CrMo4, 1.7218		
5		Hexagon nut	C35E, 1.1181		
6	x	Gasket	Pure graphite (CrNi laminated with graphite)		
	└ Spare parts				

DN			15	20	25	32	40	50	65	80	100	125	150	200	250	300	350	400	500
Face-to-face dimension FTF series 1 according to DIN EN 558		Standard-flange dimensions refer to page 6																	
L		(mm)	130	150	160	180	200	230	290	310	350	400	480	600	730	850			
Dimensions																			
H		(mm)	90	100	115	125	150	160	180	215	235	275	305	390	540	680			
H1		(mm)	135	150	180	205	235	250	285	330	365	425	480	610	915	1110			
B		(mm)	10	10	25	35	45	45	25	40	55	65	50	80	230	350			
l1		(mm)	56	68	82	98	114	119	134	149	169	199	224	284	434	555			
Ød1		(mm)	23	28	36	42	50	61,5	78,5	89,5	109,5	137,5	160	210	258	308			
Standard screen	Mesh width	(mm)	1	1	1	1	1	1	1,25	1,25	1,6	1,6	1,6	1,6	1,6	1,6			
	Kvs-value [1]	(m^3/h)	6,9	10,8	17,8	26,1	36,7	61	98,6	146	234	376	394	652	1225	1873			
	Zeta-value	–	1,7	2,2	2	2,5	3	2,7	2,9	3,1	2,9	2,8	5,2	6	4,2	3,7	on request possible in straight through form		
Fine screen	Mesh width	(mm)	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25			
	Kvs-value [1]	(m^3/h)	6,2	10,1	16,8	24,3	32,9	49,5	80,3	115	189	303	405	590	1231	1883			
	Zeta-value	–	2,1	2,5	2,2	2,8	3,8	4,1	4,4	4,9	4,4	4,5	4,9	7,3	4,1	3,6			
Ratio of the free screen surface area to the area of the nominal diametSp.p.			10	8,4	8,3	7,1	6,8	5,2	4,4	3,7	2,8	2,7	2,4	2,3	2,7	2,9			
Zeta-value ... range of tolerance for Kvs-values acc. to VDI/VDE 2173		[1] Kvs-values based upon clean screen!																	
Weights																			
10.050		(kg)	2,5	3	4,5	5,5	7	9	13	19	26	38	54	110	–	–			
12.050		(kg)	3	4	5	7	9	12	16	21	30	43	61	121	154	335			
22.050		(kg)	3,5	4	5,5	7	9	12	16	21	28	41	58	115	154	335			
23.050		(kg)	3,5	4	5,5	7	9	12	16	21	32	47	64	–	–	--			
34./35.050		(kg)	4	5	6	8	10	13	19	24,5	35	51	71	144	--	--			

Information / restriction of technical rules need to be observed!
Operating and installation instructions can be downloaded at www.ari-armaturen.com.
ARI-Valves of EN-JL1040 are not allowed to be operated in systems acc. to TRD 110.
A production permission acc. to TRB 801 No. 45 is available (acc. to TRB 801 No. 45 EN-JL1040 is not allowed.)
The engineer, designing a system or a plant, is responsible for the selection of the correct valve.
Resistance and fitness must be verified (contact manufacturer for information, refer to Product overview and Resistance list).

Strainer - Y-pattern with flanges (Stainless steel)

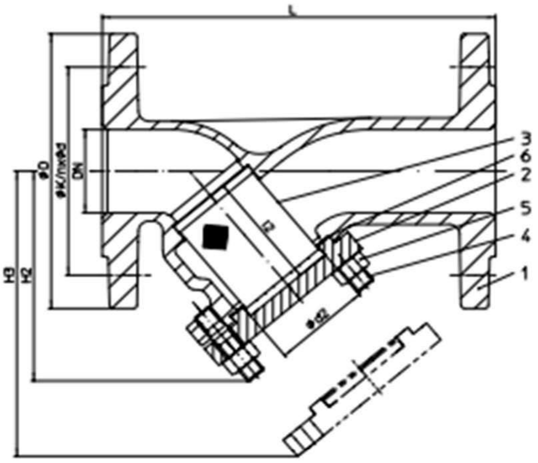


Figure	Nominal pressure	Material	Nominal diameter
52.059	PN16	1.4408	DN15-200
54.059	PN25	1.4408	DN15-200
55.059	PN40	1.4408	DN15-200

A supporting basket is necessary, with higher differential pressures, dependent on clogging-up (DN >125 standard)

Test:	• EN ISO 15848-1 / TA - Luft TÜV-Test-No. TA 09 2016 C04

Parts			
Pos.	**Sp.p.**	**Description**	**Fig. 52./54./55.059**
1		Body	GX5CrNiMo19-11-2, 1.4408
2		Cover	X6CrNiMoTi 17-12-2, 1.4571
3	x	Screen	X6CrNiMoTi 17-12-2, 1.4571
3.1		Supporting basket	DN >125: X6CrNiMoTi17-12-2, 1.4571
4		Stud	A4-70
5		Hexagon nut	A4
6	x	Gasket	Pure graphite (CrNi laminated with graphite)
	└ Spare parts		

DN			15	20	25	32	40	50	65	80	100	125	150	200	250	300	350	400	500
Face-to-face dimension FTF series 1 according to DIN EN 558		Standard-flange dimensions refer to page 6																	
L		(mm)	130	150	160	180	200	230	290	310	350	400	480	600					
Dimensions																			
H2		(mm)	94	94	102	102	123	126	148	170	202	285	320	417					
H3		(mm)	130	138	150	143	166	172	206	234	282	388	443	585					
l2		(mm)	48	48	57	57	68	70	85	97	112	138	169	230					
Ød2		(mm)	25	25	31	36	46	55,5	69,5	85,5	105,5	131,5	159	210					
Standard screen	Mesh width	(mm)	1	1	1	1	1	1	1,25	1,25	1,6	1,6	1,6	1,6					
	Kvs-value [1]	(m^3/h)	6,9	10,8	17,8	26,1	36,7	61	98,6	146	234	376	394	652	on request				
	Zeta-value	–	1,7	2,2	2	2,5	3	2,7	2,9	3,1	2,9	2,8	5,2	6					
Fine screen	Mesh width	(mm)	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25					
	Kvs-value [1]	(m^3/h)	6,2	10,1	16,8	24,3	32,9	49,5	80,3	115	189	303	406	590					
	Zeta-value	–	2,1	2,5	2,2	2,8	3,8	4,1	4,4	4,9	4,4	4,5	4,9	7,3					
Ratio of the free screen surface area to the area of the nominal diametSp.p.			10	8,4	8,3	7,1	6,8	5,2	4,4	3,7	2,8	2,7	2,4	2,3					
Zeta-value ... range of tolerance for Kvs-values acc. to VDI/VDE 2173		[1] Kvs-values based upon clean screen !																	
Weights																			
52./54./55.059		(kg)	4	5	6	8	10	13	19	24,5	35,0	51	71	144					

Information / restriction of technical rules need to be observed!
Operating and installation instructions can be downloaded at www.ari-armaturen.com.
A production permission acc. to TRB 801 No. 45 is available.
The engineer, designing a system or a plant, is responsible for the selection of the correct valve.
Resistance and fitness must be verified (contact manufacturer for information, refer to Product overview and Resistance list).

Strainer - Y-pattern with butt weld ends (Cast steel)

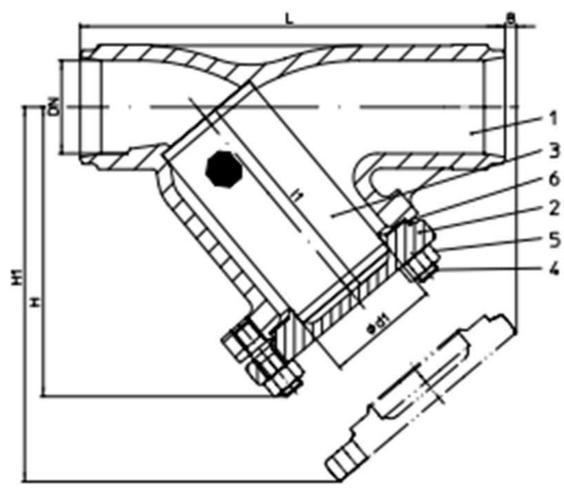


Figure	Nominal pressure	Material	Nominal diameter
35.080	PN40	1.0619+N	DN15-300

Butt weld ends according to DIN EN 12627 - 4 (refer to page 5)

A supporting basket is necessary, with higher differential pressures, dependent on clogging-up (DN >125 standard)

Test:	• EN ISO 15848-1 / TA - Luft TÜV-Test-No. TA 09 2016 C04

Parts			
Pos.	Sp.p.	Description	Fig. 34/35.080
1		Body	GP240GH+N, 1.0619+N
2		Cover	DN ≤100: P250 GH, 1.0460 DN >100: P265 GH, 1.0425
3	x	Screen	X5CrNi 18-10, 1.4301
3.1		Supporting basket	DN >125: X5CrNi18-10, 1.4301
4		Stud	25CrMo4, 1.7218
5		Hexagon nut	C35E, 1.1181
6	x	Gasket	Pure graphite (CrNi laminated with graphite)
	└ Spare parts		

DN			15	20	25	32	40	50	65	80	100	125	150	200	250	300
Face-to-face dimension ETE series 1 according to DIN EN 12982																
L		(mm)	130	150	160	180	200	230	290	310	350	400	480	600	730	850
Dimensions																
H		(mm)	90	100	115	125	150	160	180	215	235	275	305	390	540	680
H1		(mm)	135	150	180	205	235	250	285	330	365	425	480	610	915	1110
B		(mm)	10	10	25	35	45	45	25	40	55	65	50	80	230	350
l1		(mm)	56	68	82	98	114	119	134	149	169	199	224	284	283	317
Ød1		(mm)	23	28	36	42	50	61,5	78,5	89,5	109,5	137,5	160	210	260	314
Standard screen	Mesh width	(mm)	1	1	1	1	1	1	1,25	1,25	1,6	1,6	1,6	1,6	1,6	1,6
	Kvs-value [1]	(m^3/h)	6,9	10,8	17,8	26,1	36,7	61	98,6	146	234	376	394	652	1225	1873
	Zeta-value	--	1,7	2,2	2	2,5	3	2,7	2,9	3,1	2,9	2,8	5,2	6	4,2	3,7
Fine screen	Mesh width	(mm)	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25	0,25
	Kvs-value [1]	(m^3/h)	6,2	10,1	16,8	24,3	32,9	49,5	80,3	115	189	303	405	590	1231	1883
	Zeta-value	--	2,1	2,5	2,2	2,8	3,8	4,1	4,4	4,9	4,4	4,5	4,9	7,3	4,1	3,6
Ratio of the free screen surface area to the area of the nominal diametSp.p.			10	8,4	8,3	7,1	6,8	5,2	4,4	3,7	2,8	2,7	2,4	2,3	2,7	2,9
Zeta-value .... range of tolerance for Kvs-values acc. to VDI/VDE 2173														[1] Kvs-values based upon clean screen!		
Weights																
35.080		(kg)	2,5	3	3,5	4	5,5	7,5	12	15	23,5	33	49	106	135	240

Information / restriction of technical rules need to be observed!

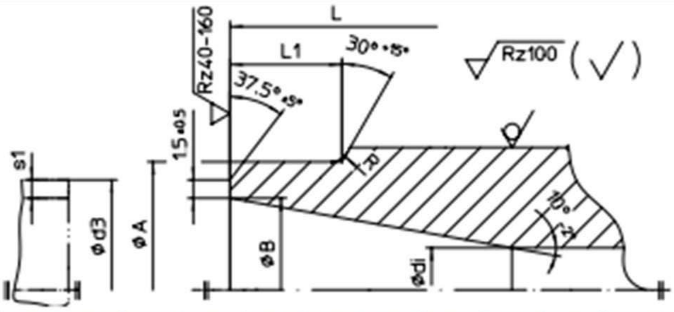
Operating and installation instructions can be downloaded at www.ari-armaturen.com.

A production permission acc. to TRB 801 No. 45 is available.

The engineer, designing a system or a plant, is responsible for the selection of the correct valve.

Resistance and fitness must be verified (contact manufacturer for information, refer to Product overview and Resistance list).

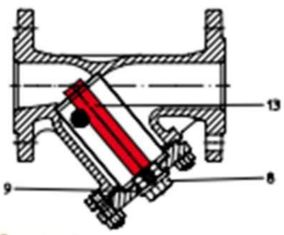
L = Face-to-face dimension
Edge shaping acc. to DIN EN 25817



DN		15	20	25	32	40	50	65	80	100	125	150	200	250	300	350	400
Butt weld ends according to DIN EN 12627																	
L	(mm)	130	150	160	180	200	230	290	310	350	400	480	600	730	850	980	1100
ØA	(mm)	22	28	35	44	50	62	77	91	117	144	172	223	278	329	362	413
ØB	(mm)	17,3	22,3	28,5	37,2	43,1	53,9	68,9	80,9	104,3	130,7	157,1	204,9	257	307,9	338	384,4
Ødi	(mm)	15	20	25	32	40	50	65	80	100	125	150	200	250	300	330	375
R	(mm)	3	3	3	3	3	3	3	3	3	3	3	5	5	5	5	5
L1 (similar)	(mm)	10	10	10	10	10	10	10	12	14	18	20	20	25	33	45	45
Ød3	(mm)	21,3	26,9	33,7	42,4	48,3	60,3	76,1	88,9	114,3	139,7	168,3	219,1	273,0	323,9	355,6	406,4
s1	(mm)	2	2,3	2,6	2,6	2,6	3,2	3,6	4	5	4,5	5,6	7,1	8	8	8,8	11

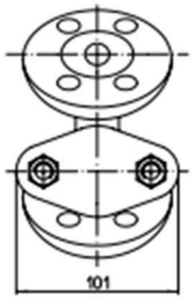
Face-to-face dimension ETE series 1 according to DIN EN 12982
Butt weld ends according to DIN EN 12627 Fig. 4
Weld joint according to DIN EN 29692 code number 1.3.3
The material used for ARI valves with butt weld ends are:
GP240GH+N, 1.0619+N acc. to DIN EN 10213-2.

Based on our experience we recommend electric welding process for connecting valves or strainers with tubes or with each other.
Lime based electrodes with an appropriate composite material should be used as filler material for welding.
Gas welding should be avoided.
Because of the different material compositions and wall thickness of the steam traps and the pipe gas welding shall not be applied. Quenching cracks and coarse grain structure may develop.

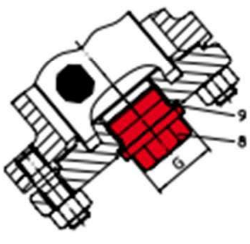


Bar magnet
Operating temperature: up to +450°C
DN15 to DN300

Pos.	Description	Fig. 10/12/22/23./34./35.050; 34/35.080	Fig. 52/54/55.059;
8	Drain screw	C35E, 1.1181	A4
9	Bellows housing	St	Aramid
13	Bar magnet	1.4571 / AlNiCo	1.4571 / AlNiCo



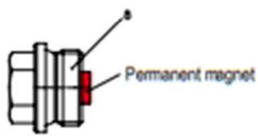
Only DN15:
view on the cover flange
(not for stainless steel)



DN	G
(mm)	(inch)
15-20	3/8
25-32	3/4
40-80	1
100-150	1 1/2
200-300	2
350-500	on request

Drain screw

Pos.	Description	Fig. 10/12/22/23./34./35.050; 34/35.080	Fig. 52/54/55.059;
8	Drain screw	C35E, 1.1181	A4
9	Bellows housing	St	Aramid



Alternative:
Permanent magnet
Operating temperature: up to +210°C

Pos.	Description	Fig. 10/12./22./23/34/35.050; 34/35.080	Fig. 52/54./55.059;
8	Permanent magnet	C35E, 1.1181 / AlNiCo	A4 / AlNiCo

ARI-Strainer

Flange dimensions / Pressure-temperature-ratings

DN			15	20	25	32	40	50	65	80	100	125	150	200	250	300
Standard-flange dimensions			Flanges acc. to DIN EN 1092-1/-2 (Flange holes / -thickness tolerances acc. to DIN 2533/2544/2545)													
PN6	ØD	(mm)	80	90	100	120	130	140	160	190	210	240	265	320	–	--
	ØK	(mm)	55	65	75	90	100	110	130	150	170	200	225	280	–	--
	n x Ød	(mm)	4x11	4x11	4x11	4x14	4x14	4x14	4x14	4x18	4x18	8x18	8x18	8x18	–	--
PN 16	ØD	(mm)	95	105	115	140	150	165	185	200	220	250	285	340	405	460
	ØK	(mm)	65	75	85	100	110	125	145	160	180	210	240	295	355	410
	n x Ød	(mm)	4x14	4x14	4x14	4x18	4x18	4x18	4x18 [1]	8x18	8x18	8x18	8x22	12x22	12x26	12x26
PN25	ØD	(mm)	95	105	115	140	150	165	185	200	235	270	300	360	425	485
	ØK	(mm)	65	75	85	100	110	125	145	160	190	220	250	310	370	430
	n x Ød	(mm)	4x14	4x14	4x14	4x18	4x18	4x18	8x18	8x18	8x22	8x26	8x26	12x26	12x30	16x30
PN40	ØD	(mm)	95	105	115	140	150	165	185	200	235	270	300	375	450	515
	ØK	(mm)	65	75	85	100	110	125	145	160	190	220	250	320	385	450
	n x Ød	(mm)	4x14	4x14	4x14	4x18	4x18	4x18	8x18	8x18	8x22	8x26	8x26	12x30	12x33	16x33

[1] also with 8 bore holes acc. to DIN EN 1092-1/-2 possible.

Pressure-temperature-ratings — Intermediate values for max. permissible operational pressures can be determined by linear interpolation of the given temperature / pressure chart.

acc. to DIN EN 1092-2			-60°C to <-10°C [1]	-10°C to 120°C	150°C	200°C	250°C	300°C	350°C	400°C	450°C
EN-JL1040	6	(bar)	–	6	5,4	4,8	4,2	3,6	–	–	–
EN-JL1040	16	(bar)	–	16	14,4	12,8	11,2	9,6	–	–	–
EN-JS1049	16	(bar)	on request	16	15,5	14,7	13,9	12,8	11,2	–	–
EN-JS1049	25	(bar)	on request	25	24,3	23	21,8	20	17,5	–	–

acc. to manufacturers standard			-60°C to <-10°C [1]	-10°C to 120°C	150°C	200°C	250°C	300°C	350°C	400°C	450°C
1.0619+N	25	(bar)	18,7	25	23,9	22	20	17,2	16	14,8	8,2
1.0619+N	40	(bar)	30	40	38,1	35	32	28	25,7	23,8	13,1
1.0460	25	(bar)	18,7	25	23,9	22	20	17,2	16	14,8	10
1.0460	40	(bar)	30	40	38,1	35	32	28	25,7	23,8	16

acc. to DIN EN 1092-1			-60°C to <-10°C [1]	-10°C to 100°C	150°C	200°C	250°C	300°C	350°C	400°C	450°C
1.4408	16	(bar)	16	16	14,5	13,4	12,7	11,8	11,4	10,9	–
1.4408	25	(bar)	25	25	22,7	21	19,8	18,5	17,8	17,1	–
1.4408	40	(bar)	40	40	36,3	33,7	31,8	29,7	28,5	27,4	–

[1] Studs and nuts made of A4-70 (at temperatures below -10°C)

Please indicate when ordering:

- Figure-No.
- Nominal pressure
- Nominal diameter
- Special design / accessories

Example:

Figure 35.050; Nominal pressure PN40; Nominal diameter DN100; with drain screw.

Technology for the Future.
GERMAN QUALITY VALVES

APPENDIX 5

GV4223

Valves ONLINE

Sizes 2" - 12"

Cast Steel Globe Valve API 600 ANSI Class 150 & 300

- Swivel Plug Disc Design Standard
- Bolted Bonnet Construction
- Outside Screw and Yoke, Rising stem
- Handwheel Operated (Actuation Available)
- Renewable Threaded-in Backseat Bushing
- Renewable Threaded-in or Welded-in Seat Ring

Description

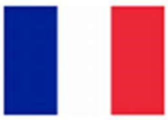
A heavy duty globe valve to API and BS standards. The seat Ring and Wedge Disc are ground and lapped to a mirror finish that provides matching sealing surfaces. A plug type disc is supplied as standard with flat and regulating type discs available on request. Heat treated stainless steel STEM with precision machined ACME threads for long lasting service. Machined Backseat Bushing to provide a secondary metal-metal stem seal. Rising Stem gives open and closed indication of position with large diameter Handwheel for easy operation. Austenitic ductile iron YOKE SLEEVE gives resistance to heat, corrosion and wear. Two piece self-aligning GLAND BUSHING and GLAND FLANGE to prevent damage with high strength alloy steel STUD BOLTS.

Design	**: API 600 / BS 1873**
Shell Thickness	**: API 600 / BS 1873**
Flanged Ends	**: ANSI B16.5**
Face to Face	**: ANSI B16.10**
Testing	**: API 598 / EN12266-1**

Description
Designed to BS 1873 / API 600 and pressure tested in accordance with API 598/EN12266-1. This heavy duty flanged globe valve offers durability throughout a wide range of industrial applications, boiler plant and rugged environments. Handwheel operated and offered in both ANSI 150 and ANSI 300, offering maximum service life.

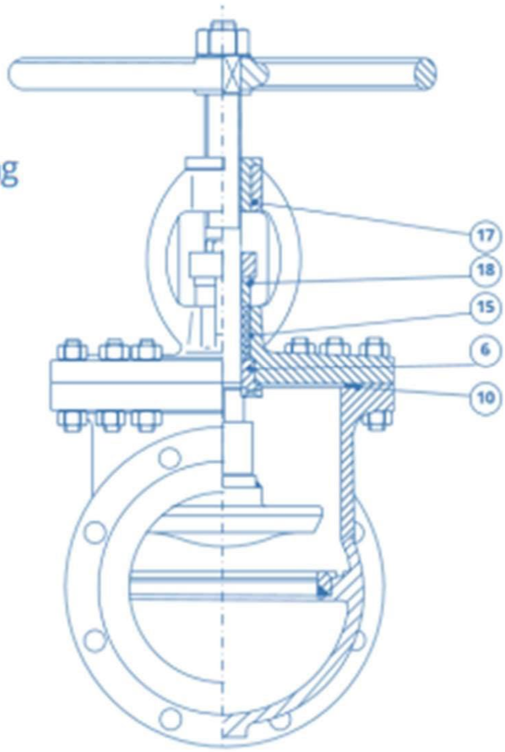
Beschreibung
Entwickelt gemäß BS 1873 / API 600 und druckgeprüft gemäß API 598 / EN 12266-1. Dieses robuste Flansch-Kugelventil bietet Haltbarkeit für eine Vielzahl industrieller Anwendungen, Kesselanlagen und robuste Umgebungen. Das Handrad wird sowohl in ANSI 150 als auch in ANSI 300 betrieben und angeboten und bietet eine maximale Lebensdauer.

Descripción
Diseñada para BS 1873 / API 600 y sometida a pruebas de presión de acuerdo con API 598 / EN12266-1. Esta válvula de globo con bridas para trabajo pesado ofrece durabilidad en una amplia gama de aplicaciones industriales, plantas de calderas y entornos resistentes. El volante se maneja y se ofrece en ANSI 150 y ANSI 300, ofreciendo una vida útil máxima.

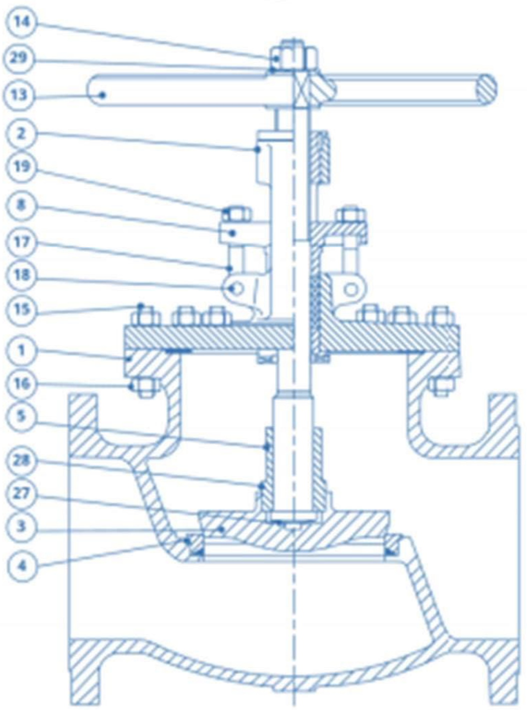


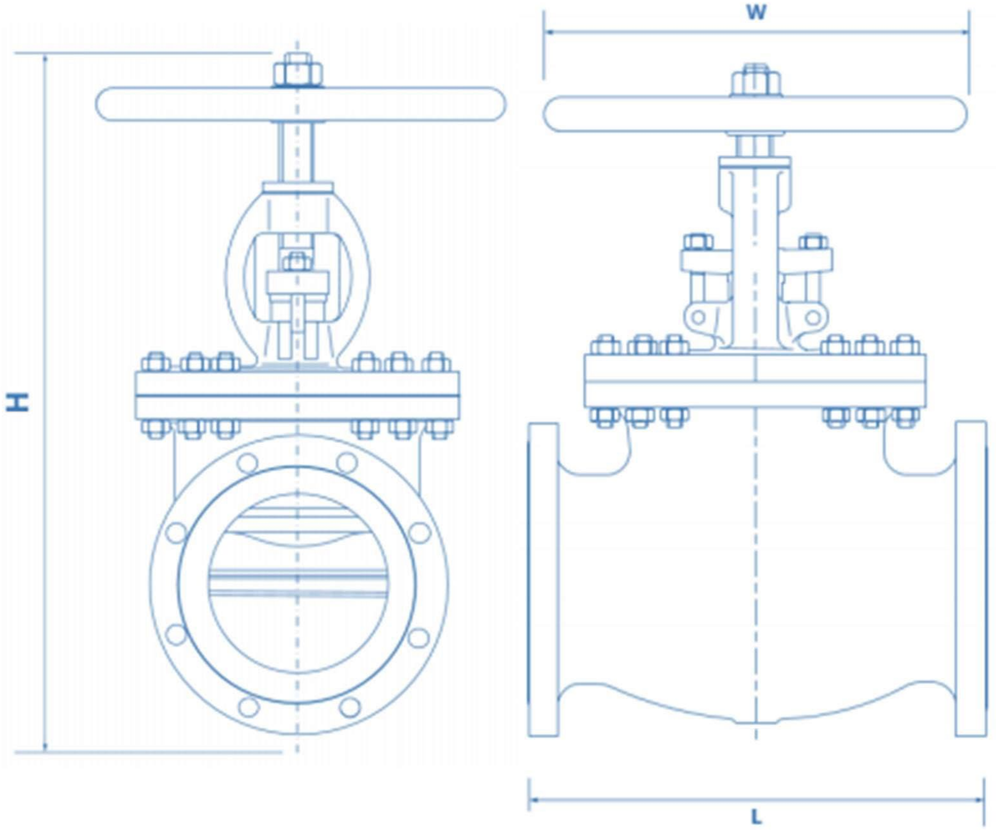
La description
Conçu conformément à la norme BS 1873 / API 600 et soumis à des essais de pression conformément à la norme API 598/EN 12266-1. Ce robinet à tournant sphérique pour applications lourdes offre une longue durée de vie dans une large gamme d'applications industrielles, de chaudières et d'environnements difficiles. Le volant est actionné et proposé dans les normes ANSI 150 et ANSI 300, offrant une durée de vie maximale.

- Swivel Plug Disc Design Standard
- Bolted Bonnet Construction
- Outside Screw and Yoke, Rising stem
- Handwheel Operated (Actuation Available)
- Renewable Threaded-in Backseat Bushing
- Renewable Threaded-in or Welded-in Seat Ring



DESCRIPTION OF PARTS	
1	Body
2	Bonnet
3	Disc
4	Seat Ring
5	Stem
6	Backseat Bushing
7	Gland Bushing
8	Gland Flange
9	Packing
10	Gasket
11	Yoke Bushing
13	Handwheel
14	Handwheel Nut
15/16	Stud Bolt / Hex Nut
17	Eyebolt
18	Pin
19	Hex Nut
27/28	Disc Washer / Nut
29	Washer





Dimensions										
Size	ANSI Class 150					ANSI Class 300				
	L	H	W	lb	kg	L	H	W	lb	kg
2"	203	350	200	49	22	267	420	200	61	28
3"	241	405	250	93	42	318	450	250	126	57
4"	292	478	350	132	60	356	520	350	331	83
6"	406	555	350	214	97	445	650	450	875	150
8"	495	610	450	355	161	559	800	500	1162	397
10"	622	730	500	679	308	622	1040	500	1341	527
12"	699	1008	600	904	410	711	1140	600	1041	608

APPENDIX 6

GV4223

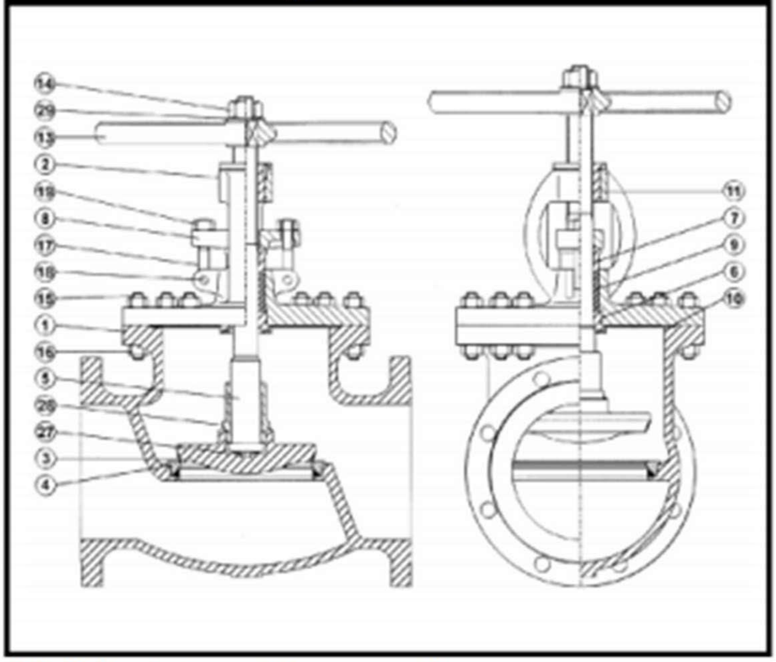
Valves ONLINE

GLOBE VALVE DESIGN FEATURES

- Swivel Plug Disc Design Standard
- Flat and Regulating Type Disc Available
- Bolted Bonnet Construction
- Outside Screw and Yoke, Rising Stem
- Manual Operated, Actuation Available
- Renewable Threaded-In Backseat Bushing
- Renewable Threaded-In or Welded-In Seat Ring

- Design : BS 1873 / API 600
- Shell Thickness : BS 1873 / API 600
- Flanged Ends : ANSI B16.5 (Sizes ≤ 24")
  MSS SP-44 (Sizes > 24")
  API 605 (Sizes > 24")
- Face-to-Face : ANSI B16.10
- Testing : API 598 / EN12266-1

Typical Construction



Note: Weld end valves available upon request

No.	Part Name
1	Body
2	Bonnet
3	Disc
4	Seat Ring
5	Stem
6	Backseat Bushing
7	Gland Bushing
8	Gland Flange
9	Packing
10	Gasket
11	Yoke Bushing
13	Handwheel
14	Handwheel Nut
15 / 16	Stud Bolt / Hex Nut
17	Eyebolt
18	Pin
19	Hex Nut
27 / 28	Disc Washer / Nut
29	Washer

- Heavy duty BODY with shell thickness to API / BS standards (where applicable)
- SEAT RING and WEDGE DISC ground and lapped to a mirror finish to provide matching sealing surfaces
- Plug Type DISC supplied as standard. Flat and Regulating Type DISC available upon request.
- Heat treaded stainless steel STEM with precision machined ACME threads for long-lasting service
- Machined BACKSEAT BUSHING to provide a secondary metal-to-metal stem seal
- RISING STEM for open/close position indication
- Austenitic ductile iron YOKE SLEEVE to provide resistance to heat, corrosion and wear
- Two piece self-aligning GLAND BUSHING and GLAND FLANGE to prevent stem damage
- High strength alloy steel STUD BOLTS and heavy series HEX NUTS used
- Large diameter HANDWHEEL for easy operation
- Optional Deep Stuffing Box with Lantern Ring
- Angle and Y Body Patterns available

STANDARD MATERIALS OF CONSTRUCTION

Part	ANSI B16.34 Material Group				
	Carbon Steel	C-Mn Steel	Alloy Steel		
	1.1	1.2	1.9	1.10	1.13
Body / Bonnet	A216 Gr. WCB	A352 Gr. LCC	A217 Gr. WC6	A217 Gr. WC9	A217 Gr. C5
Gland Bushing	← 13% Chromium ASTM A182 Gr. F6a →				
Stud Bolts & Hex Nuts	B7 / 2H	L7 / 7	← ASTM A193 Gr. B16 / ASTM A194 Gr. 2H →		
Yoke / Gland Flange	← Carbon Steel →				
Yoke Bushing	← Austenitic Ductile Iron ASTM A439 Type D2 →				
Handwheel	← Ductile / Malleable Iron →				
Handwheel Nut	← Carbon Steel →				
Gland Eyebolts & Nuts	← Carbon Steel ASTM A307 Gr. B →				
Part	Corrosion Resistant Steel				
	2.1		2.2		3.17
Body / Bonnet	A351 Gr. CF8	A351 Gr. CF3	A351 Gr. CF8M	A351 Gr. CF3M	A351 Gr. CN7M
Gland Bushing	304SS	304L SS	316SS	316L SS	Alloy 20
Stud Bolts & Hex Nuts	← Corrosion Resistant Steel ASTM A193 Gr. B8 / ASTM A194 Gr. 8 →				
Yoke / Gland Flange	← Corrosion Resistant Steel →				
Yoke Bushing	← Austenitic Ductile Iron ASTM A439 Type D2 →				
Handwheel	← Ductile / Malleable Iron →				
Handwheel Nut	← Carbon Steel →				
Gland Eyebolts & Nuts	← Corrosion Resistant Steel ASTM A193 Gr. B8 / ASTM A194 Gr. 8 →				

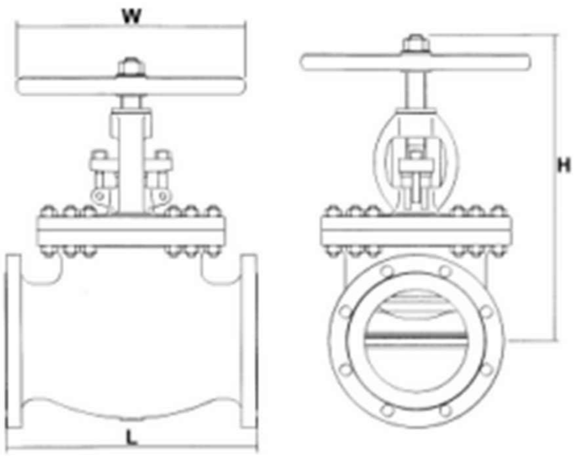
Note: Other materials available upon request.

Trim Materials

Part	API Trim No.										
	1	2	5	8	9	10	11	12	13	14	15
Disc	F6	304SS	HF	F6	Ni-Cu	316SS	Ni-Cu	316SS	Alloy 20	Alloy 20	HF
Seat Ring	F6	304SS	HF	HF	Ni-Cu	316SS	HF	HF	Alloy 20	HF	HF
Stem	F6	304SS	F6	F6	Ni-Cu	316SS	Ni-Cu	316SS	Alloy 20	Alloy 20	304SS
Backseat	F6	304SS	F6	F6	Ni-Cu	316SS	Ni-Cu	316SS	Alloy 20	Alloy 20	304SS
Washer / Nut	F6	304SS	F6	F6	Ni-Cu	316SS	Ni-Cu	316SS	Alloy 20	Alloy 20	304SS
Part	API Trim No.			DPV Trim No.							
	16	17	18	A	B	C	D	E	F	G	H
Disc	HF	HF	HF	HF	Bronze	F6	304SS	316SS	Ni-Cu	Alloy 20	Bronze
Seat Ring	HF	HF	HF	HF	Bronze	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE
Stem	316SS	347SS	Alloy 20	Ni-Cu	Brass	F6	304SS	316SS	Ni-Cu	Alloy 20	Brass
Backseat	316SS	347SS	Alloy 20	Ni-Cu	Brass	F6	304SS	316SS	Ni-Cu	Alloy 20	Brass
Washer / Nut	316SS	347SS	Alloy 20	Ni-Cu	Brass	F6	304SS	316SS	Ni-Cu	Alloy 20	Brass

Note: Trim will be supplied either as a base material equal to body with overlay or solid trim at manufacturer's option.

DIMENSIONS



ANSI Class 150					
Size	Dimensions (mm)			Approx. Wt.	
	L	H	W	(lb.)	(kg.)
2"	203	350	200	49	22
2½"	216	403	250	66	30
3"	241	405	250	93	42
4"	292	478	350	132	60
5"	356	513	350	170	77
6"	406	555	350	214	97
8"	495	610	450	355	161
10"	622	730	500	679	308
12"	699	1,008	600	904	410
14"	787	1,200	600	1,191	540
16"	914	1,270	650	1,676	760
18"	978	1,300	650	2,315	1,050
20"	978	1,350	700	2,701	1,225
24"	1,295	1,450	750	3,638	1,650

ANSI Class 300					
Size	Dimensions (mm)			Approx. Wt.	
	L	H	W	(lb.)	(kg.)
2"	267	420	200	61	28
2½"	292	435	250	110	50
3"	318	450	250	126	57
4"	356	520	350	182	83
5"	400	620	400	298	135
6"	445	650	450	331	150
8"	559	800	500	875	397
10"	622	1,040	500	1,162	527
12"	711	1,140	600	1,341	608
14"	838	1,250	700	1,687	765
16"	864	1,295	750	2,426	1,100
18"	978	1,340	800	3,241	1,470
20"	1,016	1,385	915	3,704	1,680
24"	1,346	1,475	915	5,457	2,475

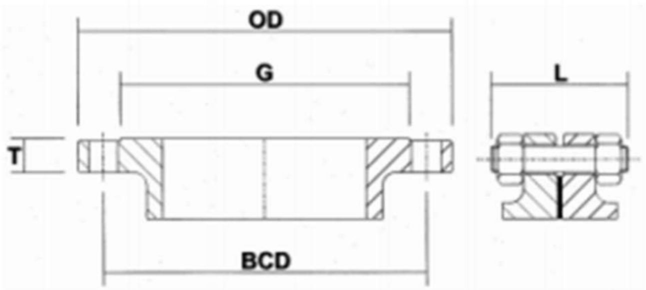
DPV Figure Numbers		
Material	ANSI Class	
	150	300
A216 Gr. WCB	1522F	3022F
A352 Gr. LCC	152CF	302CF
A217 Gr. WC6	1526F	3026F
A217 Gr. WC9	1529F	3029F
A217 Gr. C5	1525F	3025F
A351 Gr. CF8	1524F	3024F
A351 Gr. CF3	1524LF	3024LF
A351 Gr. CF8M	1523F	3023F
A351 Gr. CF3M	1523LF	3023LF
A351 Gr. CN7M	1527F	3027F

APPENDIX 7

GV4223

Valves ONLINE

END FLANGE DIMENSIONS (in.)



Size	OD	T		G	BCD	Bolt	No. of	Stud	L	Size
	Outside Ø	Companion Flange	Valve Flange	R.F. Ø	Bolt Circle Ø	Hole Ø	Bolt Holes	Bolt Ø	Bolt Length	
ANSI / ASME B16.5 Class 150 R.F. (1/16" Raised Face)										
2	6	3/4	5/8	3 5/8	4 3/4	3/4	4	5/8	3	2
2½	7	7/8	11/16	4 1/8	5 1/2	3/4	4	5/8	3 1/4	2½
3	7 1/2	15/16	15/16	5	6	3/4	4	5/8	3 3/4	3
4	9	15/16	15/16	6 3/16	7 1/2	3/4	8	5/8	3 3/4	4
5	10	15/16	15/16	7 5/16	8 1/2	7/8	8	3/4	4	5
6	11	1	1	8 1/2	9 1/2	7/8	8	3/4	4	6
8	13 1/2	1 1/8	1 1/8	10 5/8	12	7/8	8	3/4	4 1/4	8
10	16	1 3/16	1 3/16	12 3/4	14 1/4	1	12	7/8	4 3/4	10
12	19	1 1/4	1 1/4	15	17	1	12	7/8	4 3/4	12
14	21	1 3/8	1 3/8	16 1/4	18 3/4	1 1/8	12	1	5 1/4	14
16	23 1/2	1 7/16	1 7/16	18 1/2	21 1/4	1 1/8	16	1	5 1/2	16
18	25	1 9/16	1 9/16	21	22 3/4	1 1/4	16	1 1/8	6	18
20	27 1/2	1 11/16	1 11/16	23	25	1 1/4	20	1 1/8	6 1/4	20
24	32	1 7/8	1 7/8	27 1/4	29 1/2	1 3/8	20	1 1/4	6 3/4	24
MSS SP-44 / ASME B16.47 Series A Class 150 R.F. (1/16" Raised Face)										
22	29 1/2	1 13/16	1 13/16	25 1/4	27 1/4	1 3/8	20	1 1/4	6 3/4	22
26	34 1/4	2 11/16	2 11/16	29 1/2	31 3/4	1 3/8	24	1 1/4	8 1/2	26
28	36 1/2	2 13/16	2 13/16	31 1/2	34	1 3/8	28	1 1/4	8 3/4	28
30	38 3/4	2 15/16	2 15/16	33 3/4	36	1 3/8	28	1 1/4	9	30
36	46	3 9/16	3 9/16	40 1/4	42 3/4	1 5/8	32	1 1/2	10 3/4	36
API 605 / ASME B16.47 Series B Class 150 R.F. (1/16" Raised Face)										
26	30 15/16	1 5/8	1 5/8	28	29 5/16	7/8	36	3/4	5 1/2	26
28	32 15/16	1 3/4	1 3/4	30	31 5/16	7/8	40	3/4	5 3/4	28
30	34 15/16	1 3/4	1 3/4	32	33 5/16	7/8	44	3/4	5 3/4	30
36	41 5/8	2 1/16	2 1/16	38 1/4	39 3/4	1	44	7/8	6 1/2	36

ANSI CLASS 150 PRESSURE-TEMP RATINGS

Temperature °F	Pressure (psig)										Temp. °C
	ANSI B16.34 Material Group										
	1.1	1.2	1.9	1.10	1.13	2.1		2.2		3.17	
	WCB[1]	LCC[2]	WC6[3]	WC9[3]	C5[3]	CF8[4]	CF3[5]	CF8M[4]	CF3M[6]	CN7M[7]	
-20 to 100	285	290	290	290	290	275	275	275	275	230	-29 to 38
200	260	260	260	260	260	230	230	235	235	200	93
300	230	230	230	230	230	205	205	215	215	180	149
350	215	215	215	215	215	198	198	205	205	170	177
400	200	200	200	200	200	190	190	195	195	160	204
450	185	185	185	185	185	180	180	183	183	155	232
500	170	170	170	170	170	170	170	170	170	150	260
550	155	155	155	155	155	155	155	155	155	145	288
600	140	140	140	140	140	140	140	140	140	140	316
650	125	125	125	125	125	125	125	125	125		343
700	110		110	110	110	110	110	110	110		371
750	95		95	95	95	95	95	95	95		399
800	80		80	80	80	80	80	80	80		427
850	65		65	65	65	65		65	65		454
900	50		50	50	50	50		50			482
950	35		35	35	35	35		35			510
1,000	20		20	20	20	20		20			538
1,050			20[a]	20[a]	20[a]	20[a]		20[a]			566
1,100			20[a]	20[a]	20[a]	20[a]		20[a]			593
1,150					20[a]	20[a]		20[a]			621
1,200					15[a]	20[a]		20[a]			649
1,250						20[a]		20[a]			677
1,300						20[a]		20[a]			704
1,350						20[a]		20[a]			732
1,400						20[a]		20[a]			760
1,450						15[a]		20[a]			788
1,500						10[a]		20[a]			816

[1] Upon prolonged exposure to temperatures above 800 °F (427 °C), the carbide phase of steel may be converted to graphite. Permissible, but not recommended for prolonged use above 800 °F (427 °C).

[2] Not to be used over 650 °F (343 °C).

[3] Use normalized and tempered material only.

[4] At temperatures over 1,000 °F (538 °C), use only when the carbon content is 0.04% or higher.

[5] Not to be used over 800 °F (427 °C).

[6] Not to be used over 850 °F (454 °C).

[7] Use solution annealed material only.

[a] For welding end valves only. Flanged end ratings terminate at 1,000 °F (538 °C).

ANSI CLASS 300 PRESSURE-TEMP RATINGS

Temperature °F	Pressure (psig) ANSI B16.34 Material Group 1.1 WCB[1]	1.2 LCC[2]	1.9 WC6[3]	1.10 WC9[3]	1.13 C5[3]	2.1 CF8[4]	2.1 CF3[5]	2.2 CF8M[4]	2.2 CF3M[6]	3.17 CN7M[7]	Temp. °C
-20 to 100	740	750	750	750	750	720	720	720	720	600	-29 to 38
200	675	750	750	750	745	600	600	620	620	520	93
300	655	730	720	730	715	540	540	560	560	465	149
350	645	718	708	718	710	518	518	538	538	443	177
400	635	705	695	705	705	495	495	515	515	420	204
450	618	685	680	685	685	480	480	498	498	405	232
500	600	665	665	665	665	465	465	480	480	390	260
550	575	635	635	635	635	450	450	465	465	375	288
600	550	605	605	605	605	435	435	450	450	360	316
650	535	590	590	590	590	430	430	445	445		343
700	535		570	570	570	425	425	430	430		371
750	505		530	530	530	415	415	425	425		399
800	410		510	510	510	405	405	420	420		427
850	270		485	485	485	395		420	420		454
900	170		450	450	370	390		415			482
950	105		320	375	275	380		385			510
1,000	50		215	260	200	320		350			538
1,050			145[a]	175[a]	145[a]	310[a]		345[a]			566
1,100			95[a]	110[a]	100[a]	255[a]		305[a]			593
1,150					60[a]	200[a]		235[a]			621
1,200					35[a]	155[a]		185[a]			649
1,250						115[a]		145[a]			677
1,300						85[a]		115[a]			704
1,350						60[a]		95[a]			732
1,400						50[a]		75[a]			760
1,450						35[a]		60[a]			788
1,500						25[a]		40[a]			816

[1] Upon prolonged exposure to temperatures above 800 °F (427 °C), the carbide phase of steel may be converted to graphite. Permissible, but not recommended for prolonged use above 800 °F (427 °C).

[2] Not to be used over 650 °F (343 °C).

[3] Use normalized and tempered material only.

[4] At temperatures over 1,000 °F (538 °C), use only when the carbon content is 0.04% or higher.

[5] Not to be used over 800 °F (427 °C).

[6] Not to be used over 850 °F (454 °C).

[7] Use solution annealed material only.

[a] For welding end valves only. Flanged end ratings terminate at 1,000 °F (538 °C).

SHELL MATERIAL SPECIFICATIONS

Carbon and Alloy Steel Castings

	Unit	A216 Gr. WCB	A352 Gr. LCC	A217 Gr. WC6	A217 Gr. WC9	A217 Gr. C5
C[1]	%	0.300[3]	0.250[4]	0.05-0.20	0.05-0.18	0.200
Si[1]	%	0.600				0.750
Mn[1]	%	1.000[3]	1.200[4]	0.50-0.80	0.40-0.70	
P[1]	%	0.040				
S[1]	%	0.045				
Cr[1]	%	0.500	0.500[5]	1.00-1.50	2.00-2.75	4.00-6.50
Ni[1]	%	0.500	0.500[5]	0.500		
Mo[1]	%	0.200	0.200[5]	0.45-0.65	0.90-1.20	0.45-0.65
Cu[1]	%	0.300	0.300[5]	0.500		
V[1]	%	0.030	0.030[5]	-		
T.S.	MPa	485-655				620-795
Y.S.[2]	MPa	250	275			415
El.[2]	%	22.0		20.0		18.0
R.A.[2]	%	35.0				

Corrosion Resistant Steel Castings

	Unit	A351 Gr. CF8	A351 Gr. CF8M	A351 Gr. CF3	A351 Gr. CF3M	A351 Gr. CN7M
C[1]	%	0.08		0.03		0.07
Si[1]	%	2.00	1.50	2.00	1.50	
Mn[1]	%	1.50				
P[1]	%	0.04				
S[1]	%	0.04				
Cr	%	18.0-21.0		17.0-21.0		19.0-22.0
Ni	%	8.0-11.0	9.0-12.0	8.0-12.0	9.0-13.0	27.5-30.5
Mo[1]	%	0.50	2.0-3.0	0.50	2.0-3.0	
Cu	%	-				3.0-4.0
T.S.[2]	MPa	485				425
Y.S.[2]	MPa	205				170
El.[2]	%	35.0				

[1] Values listed are permitted maximums, unless otherwise stated.

[2] Values listed are required minimums, unless otherwise stated.

[3] For each reduction of 0.01% below the specified maximum carbon content, an increase of 0.04% Mn above the specified maximum will be permitted up to a maximum of 1.28%.

[4] For each reduction of 0.01% below the specified maximum carbon content, an increase of 0.04% Mn above the specified maximum will be permitted up to a maximum of 1.40%.

[5] Specified Residual Elements - The total content of these elements is 1.00% maximum.

TRIM MATERIAL SPECIFICATIONS

<table>
<tr><th></th><th></th><th colspan="4">Corrosion Resistant Alloys</th></tr>
<tr><th></th><th>Unit</th><th>A182 Gr. F6a</th><th>A182 Gr. F304</th><th>A182 Gr. F316</th><th>A182 Gr. F347[3]</th></tr>
<tr><td>C[1]</td><td>%</td><td>0.150</td><td colspan="3">0.080</td></tr>
<tr><td>Si[1]</td><td>%</td><td colspan="4">1.000</td></tr>
<tr><td>Mn[1]</td><td>%</td><td>1.000</td><td colspan="3">2.000</td></tr>
<tr><td>P[1]</td><td>%</td><td colspan="4">0.040</td></tr>
<tr><td>S[1]</td><td>%</td><td colspan="4">0.030</td></tr>
<tr><td>Cr</td><td>%</td><td>11.5-13.5</td><td>18.0-20.0</td><td>16.0-18.0</td><td>17.0-20.0</td></tr>
<tr><td>Ni[1]</td><td>%</td><td>0.500</td><td>8.0-11.0</td><td>10.0-14.0</td><td>9.0-13.0</td></tr>
<tr><td>Mo</td><td>%</td><td colspan="2">-</td><td>2.0-3.0</td><td>-</td></tr>
<tr><td>N[1]</td><td>%</td><td>-</td><td colspan="2">0.100</td><td>-</td></tr>
<tr><td>Tensile Str.[2]</td><td>MPa</td><td>485</td><td colspan="3">515[4]</td></tr>
<tr><td>Yield Str.[2]</td><td>MPa</td><td>275</td><td colspan="3">205</td></tr>
<tr><td>Elongation[2]</td><td>%</td><td>18.0</td><td colspan="3">30.0</td></tr>
<tr><td>Reduc. of Area[2]</td><td>%</td><td>35.0</td><td colspan="3">50.0</td></tr>
<tr><td>Hardness</td><td>HB</td><td>143-187</td><td colspan="3">-</td></tr>
<tr><th></th><th></th><th colspan="2">Nonferrous Alloys</th><th colspan="2">Bolting</th></tr>
<tr><th></th><th>Unit</th><th>Alloy 20[5]
B462
UNS N08020</th><th>Ni-Cu Alloy
UNS N04400
B164</th><th>Alloy Steel
A193
Gr. B7</th><th>Carbon Steel
A194
Gr. 2H</th></tr>
<tr><td>C[1]</td><td>%</td><td>0.070</td><td>0.300</td><td>0.37-0.49</td><td>0.400 Min.</td></tr>
<tr><td>Si[1]</td><td>%</td><td>1.000</td><td>0.500</td><td>0.15-0.35</td><td>0.400</td></tr>
<tr><td>Mn[1]</td><td>%</td><td colspan="2">2.000</td><td>0.65-1.10</td><td>1.000</td></tr>
<tr><td>P[1]</td><td>%</td><td>0.045</td><td>-</td><td>0.035</td><td>0.040</td></tr>
<tr><td>S[1]</td><td>%</td><td>0.035</td><td>0.024</td><td>0.040</td><td>0.050</td></tr>
<tr><td>Cr</td><td>%</td><td>19.0-21.0</td><td>-</td><td>0.75-1.20</td><td>-</td></tr>
<tr><td>Ni[2]</td><td>%</td><td>32.0-38.0</td><td>63.0[6]</td><td>-</td><td>-</td></tr>
<tr><td>Mo[1]</td><td>%</td><td>2.0-3.0</td><td>-</td><td>0.15-0.25</td><td>-</td></tr>
<tr><td>Cu[1]</td><td>%</td><td>3.0-4.0</td><td>28.0-34.0</td><td>-</td><td>-</td></tr>
<tr><td>Fe[1]</td><td>%</td><td>Balance[6]</td><td>2.500</td><td>-</td><td>-</td></tr>
<tr><td>Tensile Str.[2]</td><td>MPa</td><td>551</td><td>480</td><td>860</td><td>-</td></tr>
<tr><td>Yield Str.[2]</td><td>MPa</td><td>241</td><td>170</td><td>720</td><td>-</td></tr>
<tr><td>Elongation[2]</td><td>%</td><td>30.0</td><td>35.0</td><td>18.0</td><td>-</td></tr>
<tr><td>Reduc. of Area[2]</td><td>%</td><td>50.0</td><td>-</td><td>50.0</td><td>-</td></tr>
</table>

[1] Values listed are permitted maximums, unless otherwise stated.

[2] Values listed are required minimums, unless otherwise stated.

[3] Shall have a columbium plus tantalum content of not less than ten times the carbon content and not more than 1.10%.

[4] For sections over 5 inches in thickness, the minimum tensile strength shall be 485 MPa.

[5] Shall have a columbium plus tantalum content of not less than eight times the carbon content and not more than 1.0%.

[6] Shall be determined arithmetically by difference.