Application Guide

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DFT® INC.

DFT specializes in spring assisted ***In-Line*** Check Valves that prevent **Water Hammer** and reverse flow and insure long life if **properly sized** for the flow not the line size. DFT customizes the internal components for optimal performance without changing the line size.

DFT In-Line check valves do not rely on gravity or reverse fluid flow to close. Instead as the forward velocity of the fluid slows, the spring assist starts to close the disc.

Due to the spring assist and short travel distance of the disc, by the time forward velocity has decreased to zero, the valve disc has reached the seat and the valve is closed.

With reverse flow eliminated, the forces necessary to produce water hammer on both the upstream and downstream sides of the valve are substantially eliminated.

DFT's objective is to solve and prevent check valve problems and failures in critical service applications. All valves are manufactured at our facility in Exton, PA.

DFT is considered the control valve of check valves, the "Check Valve Doctor™".

Our check valve sizing program insures you will know in advance what to expect from the check valve as opposed to after start up.

Application Guide

This guide provides a Water Hammer Solution and various applications where DFT In-Line check valves are used.

DFT In-Line check valves are used in all industries. They include chemical, mining, oil & gas, power, pulp & paper, refining and steel.

The Water Hammer Solution describes how a consultant solved a clients water hammer problem by using DFT In-Line check valves.

DFT is available to review your check valve sizing requirements and assist in selecting the proper check valve.

Contact DFT at **800-206-4013**.

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WATER HAMMER SOLUTION

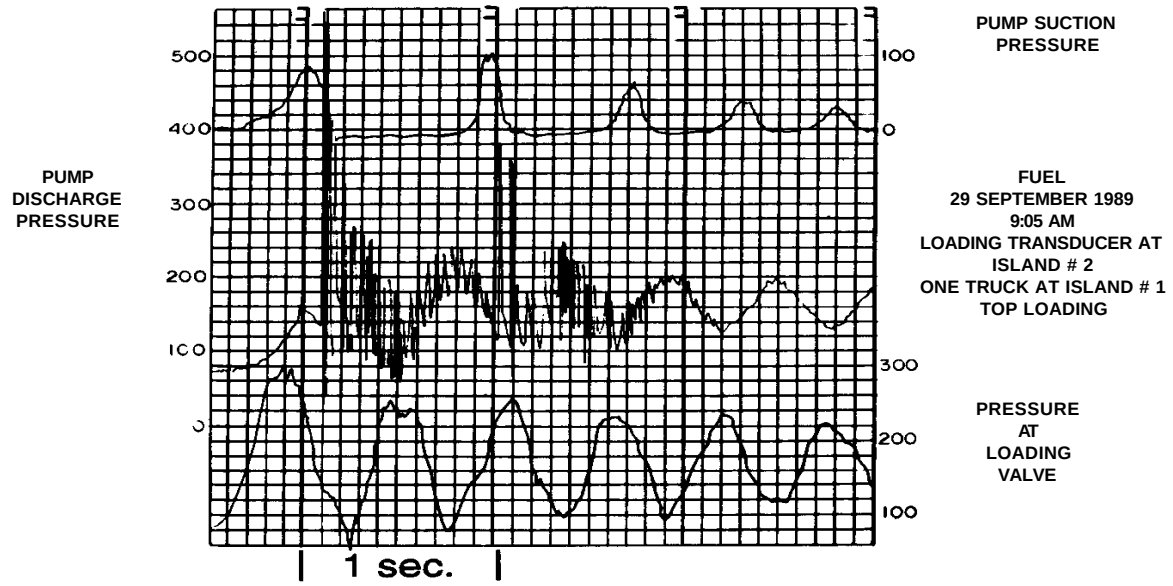
A consulting engineer submitted to DFT® some very convincing data on the effectiveness of DFT Non-slam Check Valves in combating water hammer.

An oil company was experiencing some very severe problems at one of their fuel truck loading stations. Severe vibrations and noise were occurring in their lines from the pump to the loading stations. The company was concerned about possible damage to the pump and associated equipment. In an attempt to correct the situation, they hired a consultant to examine the system and determine the exact cause of the problems.

The installation consisted of a pump, a discharge swing check valve, approximately 700 feet of piping leading to the loading platforms and a shut-off valve at each platform.

To determine exactly what was happening, the consultant attached sensitive pressure transducers and a strip recorder to the pump suction, the outlet of the check valve and the inlet of the shut-off valve. What he documented was the "classic" water hammer situation shown below. When the truck loading valve was closed, a standing wave develops causing the pressure at the pump discharge to rise from about 150 psi to **over <u>600 psi</u> in about 1/100th of a sec**. This pressure spike obviously caused severe stress in the system piping, the pump and other system components. With an effectively closed system, the pressure spike caused smaller continued pressure instability for approximately two seconds more.

ORIGINAL INSTALLATION SHOWING SEVERE WATER HAMMER



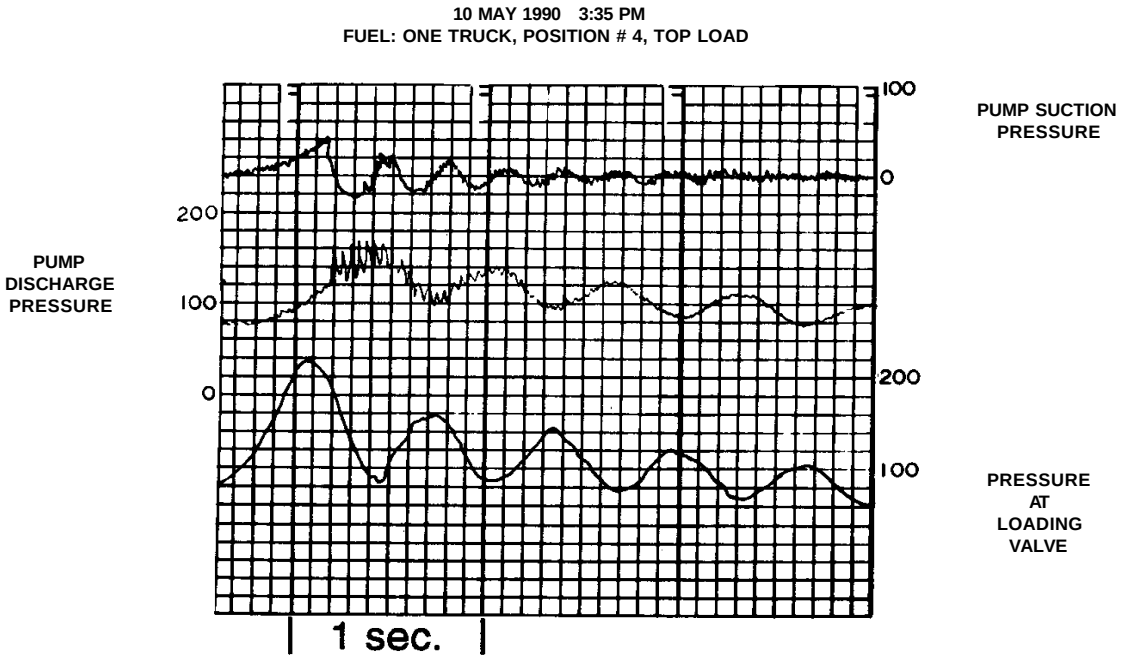
Experience indicated to the consultant that this water hammer occurred due to the use of a swing check valve on the discharge of the pump. A swing check closes fairly slowly and allows back flow to occur. When the valve finally closes, the back flow is abruptly stopped, causing extremely rapid pressure build-up (water hammer).

The solution was also very easy for the consultant to recognize and recommend; a DFT® Excalibur® Non-slam Check Valve. Based on the proven successes in the past, the consultant knew that the dual guided, in-line, spring assisted design of the DFT Excalibur would prevent back flow from occurring. With no back flow, the cause of the water hammer would disappear.

The very economical recommendation of an 8" Class 150 DFT Excalibur was accepted by the oil company. The valve was installed and all of the vibration, noise and system damage was eliminated.

Some time later the consultant was in the area and decided to document the change in the system. Shown below is a strip chart of the same installation with the readings taken after the installation of the DFT Excalibur Non-slam Check Valve. This shows that the Excalibur not only eliminated the pressure spikes at the pump discharge, it also greatly reduced the pressure changes at the pump suction and at the discharge valve.

AFTER INSTALLATION OF DFT EXCALIBUR NON-SLAM CHECK VALVE



Needless to say, both the consultant and DFT gained a very satisfied customer.

AUTOCLAVE APPLICATIONS

TYPICAL CHECK VALVE APPLICATIONS

1. PROCESS WATER LINES TO THE AUTOCLAVE.
2. HIGH PRESSURE STEAM TO THE AUTOCLAVE.
3. OXYGEN LINES TO THE AUTOCLAVE.
4. UPSTREAM OF THE OXYGEN FLOW TRANSMITTER AND FLOW CONTROL VALVE.

DFT® SOLUTIONS

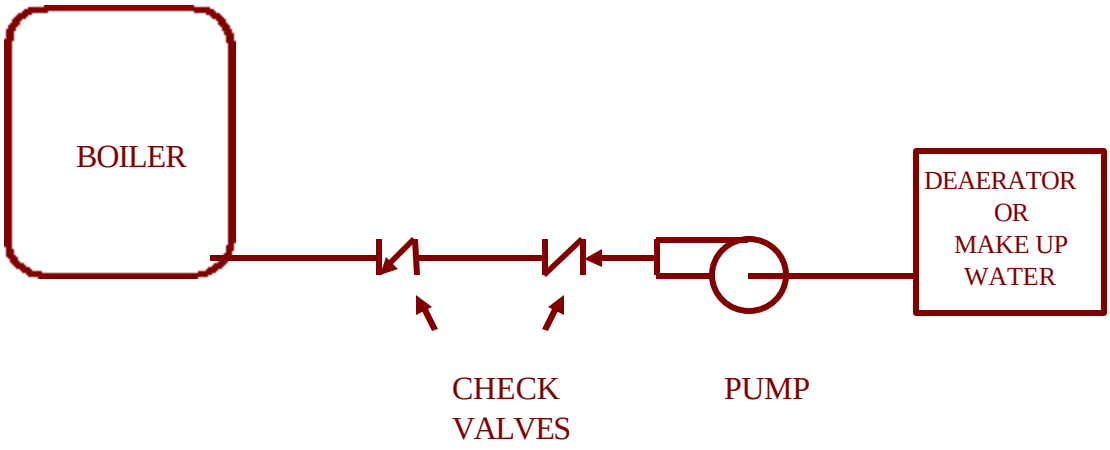
Process Water Lines: DFT Model **WLC®** In-Line Wafer Check Valves.

High Pressure Steam Lines: DFT Model **WLC** In-Line Wafer Check .

Oxygen Lines: To protect incoming lines to the autoclave from backflow of acidic slurry when the autoclave is under pressure and incoming flow is shut off a DFT Model **WLC** In-Line Wafer Check Valves is recommended.

Upstream of the Oxygen Flow Transmitter and Flow Control Valve:
To protect the oxygen service lines from fire line water backflow a DFT Model **WLC** In-Line Wafer Check Valve is recommended.

BOILER FEED SYSTEM



SYSTEM: All steam boilers have a need for intermittent water flow to replace the water generated into steam to feed the system.

TYPICAL CHECK VALVE APPLICATIONS

Generally two check valves are located on the discharge side of the pump to prevent water and/or steam backup from the boiler through the pump to the water makeup tank or deaerator.

TYPICAL CHECK VALVE RELATED PROBLEMS

Typically swing check valves are used in boiler feed lines. Swing checks cause problems based on their design. They have build up problems due to lime in the water or improper use of the boiler compound. The clapper (disc) can hold full open due to the lime build up around the hinge pin and clapper or build up on the face of the clapper and seat. These problems allow return flow of water and/or steam through the check valves to the pump spinning it backwards, possibly causing damage or causing the makeup water tank to overflow.

DFT® SOLUTIONS

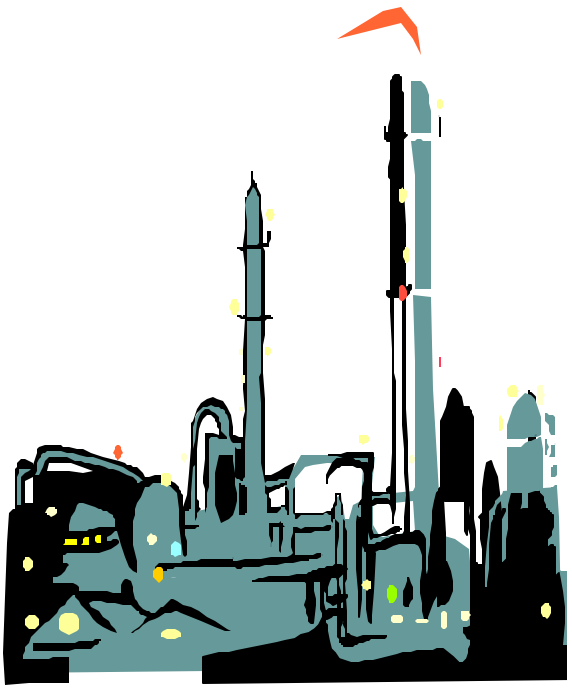
DFT Non-slam Check Valves minimize these problems based on their design. The DFT in-line check valves tend to be self cleaning - the velocity of the water flowing across the face of the seat and disc have a tendency to wash off build up plus the spring assist feature helps the valve to close. Also it appears that stainless steel does not seem to allow build up to occur as quickly as bronze.

All plants with steam boilers have potential. Valve sizes range from 1/2” and 3/4” through 8” and 10” Class 600. Based on DFT’s success with this application, we have secured other installations in the boiler room such as vacuum breakers on the deaerator, boiler discharge check valve and other applications in the plant.

CHEMICAL APPLICATIONS

CHEMICAL PROCESS

DFT® In-Line check valves are used with various mediums including acetone, acids, air, ammonia, brine water, caustics, chlorine, DMA, dowtherm, ethyl carbonates, chlorine, ethylbenzene, ethylene, ethylene oxide, expoxy resins, hexane, hydrogen, hydrochloric acid, in block & out block gas, Kevlar® pre-mix, lethal service, methane, monochlorobenzene, naptha, ni gas, nitrogen, oxide vapor, oxygen, polyethylene, potable water, propylene, steam, sulfuric acid, toluene, etc.



APPLICATIONS

Air Lines

Boiler Feed

Chemical Additive Cylinders

Chemical Process

Compressor

Condensate Pumps

Cooling Towers

Dryers

Flare Lines

Gas Purge Lines

Gas Separation

Heat Exchanger

Heater Drains

Loading/Unloading

Nitrogen Blanket

Pharmaceutical Intermediates

Pump Discharge

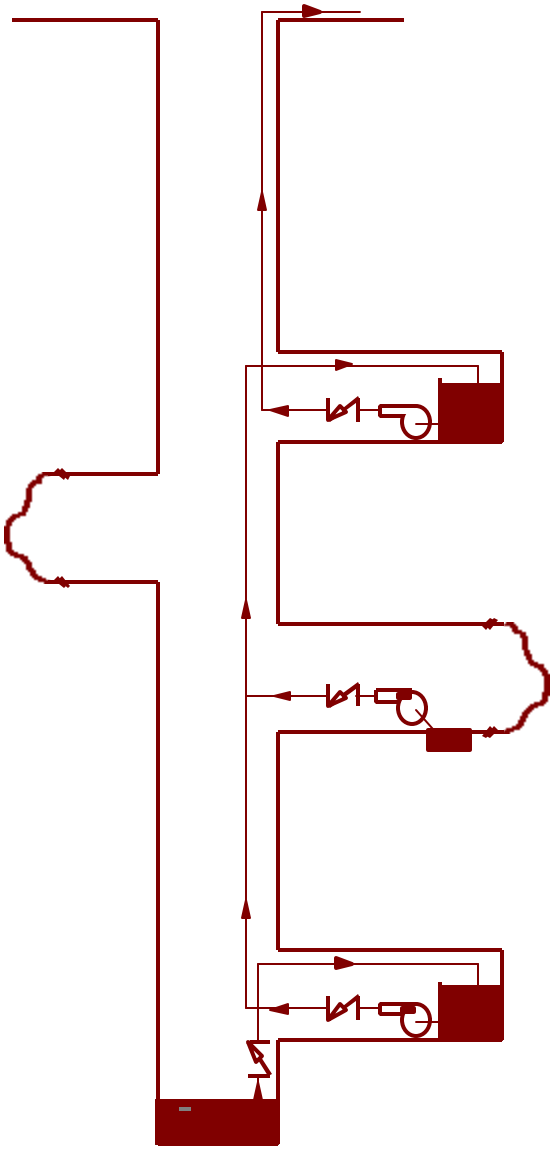
Refrigerants

Steam Lines

Thermal Oxidizer

Utilities

MINING APPLICATIONS



UNDERGROUND APPLICATIONS

Mine Dewatering

DFT® In-Line check valves are very popular on mine dewatering applications to prevent reverse flow and water hammer. The long life and tight shutoff make them a favorite as the costs of "**change outs**" is enormous and very unpopular with mine personnel.

Fuel Storage Tanks

DFT In-line check valves are used on pump discharge because of their "**positive**" shutoff.

Air Equipment

Jumbo drills
Compressor discharge
Booster Compressors - inlet and discharge

Other Underground

Process water
Potable water

ABOVE GROUND APPLICATIONS

Extraction Process

SX Plants
(Solvent Extraction)
DFT In-Line check valves are used at pump discharge on the aqueous leach & organic solutions.

PLS PROCESS
(Pregnant Leach Solutions)
DFT In-Line check valves are used at pump discharge and steam applications.

Refining

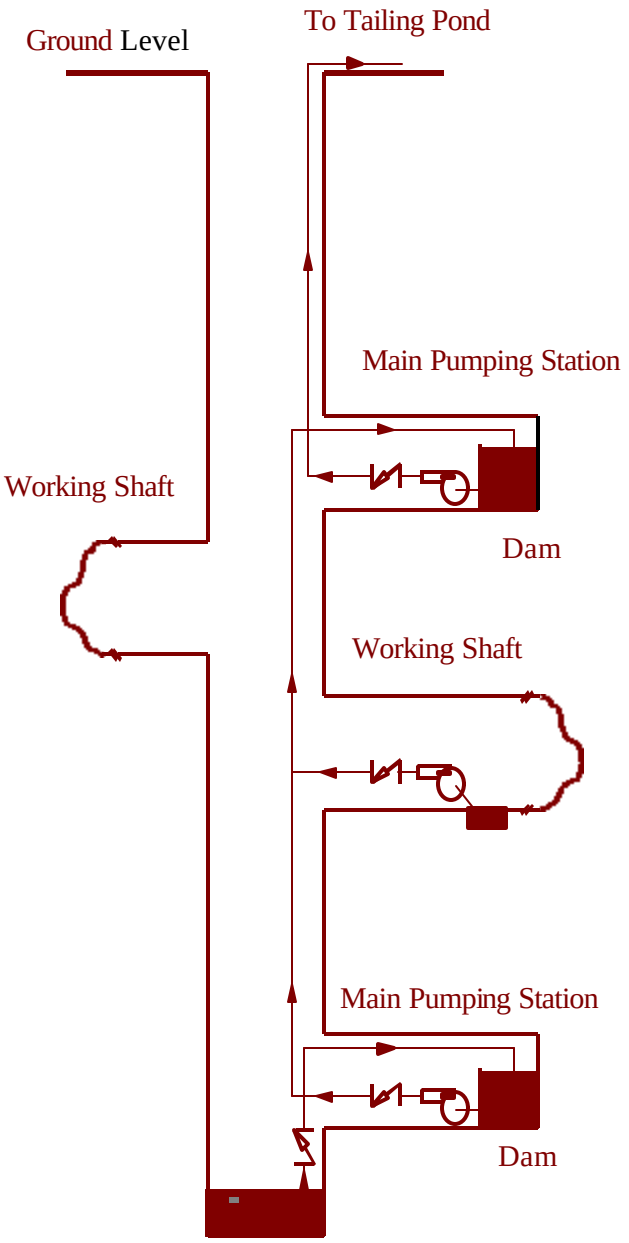
All DFT check valves are suitable for applications involving air, chemicals, cooling water and steam.

Other

Acid plant
Air dryer systems
Condensate recovery
Dilution pumps
Instrumentation air
Power plant
Raw water pumps/waste treatment
Stockpile process
Transfer lines

MINING - MINE DEWATERING SYSTEM

TYPICAL MINE



SYSTEM: During underground mining, there is usually a large amount of water that collects in the mine shafts. This water comes from underground springs that flow through the walls and from water that is pumped into the mine for operational use. All of this water needs to be removed.

TYPICAL CHECK VALVE APPLICATIONS

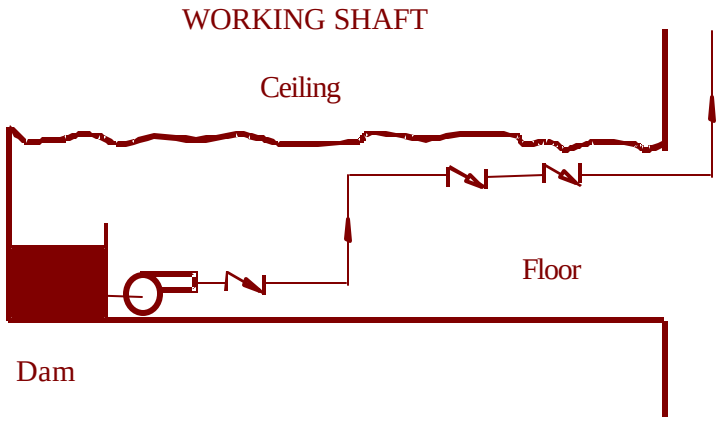
1) Pump Discharge: Due to the very high static head, a check valve is required on the discharge of each pump. These check valves are used to prevent water hammer and to insure that the lines do not drain back through the pump when it is not in operation.

2) Long Horizontal Pipe Runs: As shown on the diagram on the next page, horizontal runs in a mine are seldom, if ever, installed at an optimum angle. The high points on the horizontal runs tend to collect entrained air in the water when the system is shut down. During start-up, this column separation can cause water hammer to occur as the two water columns impact together. Check valves are used to decrease the likelihood of large air pockets forming.

TYPICAL CHECK VALVE RELATED PROBLEMS

Water Hammer: Water hammer is a very severe problem on pump discharge applications when swing checks and double door check valves are used. These types of valves have very slow closing characteristics. This slow closing, combined with the extremely high static head that is very often over 1,000 feet (432 psi), produces severe shock waves that can cause pipe deflection, pump damage, pipe ruptures and other high hazard situations.

Pump Reversal: The check valves on pump discharge applications must seal very tightly so that the water column does not leak past the valve. Due to the tendency of the swing check and double door check valves to not seal properly, it is very common for significant leakage to occur. This leakage can cause the pump to spin backwards (impeller reversal) causing severe pump damage.



Long Horizontal Pipe Runs: If the check valves do not provide tight sealing, the entrained air that separates from the water during shut-down can leak past the check valve. This can cause significant air pockets to form. Since there is little or no back pressure on the swing checks, they will allow the air to bleed past the valve causing large air pockets to develop. Water hammer and its associated damage is then a very common problem during start-up.

DFT® SOLUTIONS

Pump Discharge: DFT **Excalibur**® Non-slam Check Valves installed on the pump discharge prevent backflow and eliminate the water hammer associated with it. The amount of static head does not impair the action of the valve. DFT **Excalibur** units are often used on applications with static heads of over 2,000 feet. The spring assisted, in-line design of the **Excalibur** helps eliminate pump damage, extremely loud noises, pipe deflections, etc. caused by the water hammer.

Pump Discharge: Due to its very good seating characteristics, the DFT **Excalibur** also prevents damaging leakage. The in-line design of the disc helps insure that the water column does not bleed past the valve into the pump. This insures that pump reversal and damage does not occur.

Long Horizontal Pipe Runs: By installing light weight DFT **WLC**® check valves at proper intervals, column separation can be dramatically reduced. The tight closure of these units prevents bleed-back of the entrained air in the water. This eliminates the potential for water hammer during start-up.

OIL & GAS APPLICATIONS

Casing Gas Vents

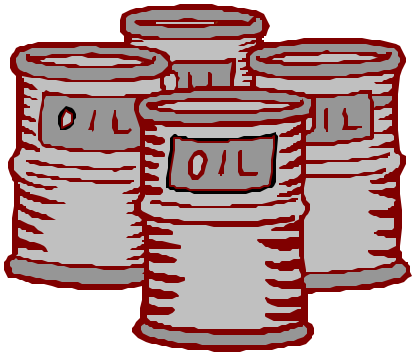
Compressors

Reciprocating

Rotary

Turbine

Fuel Storage Tanks



Gas Metering

Gas Scrubbers

H_2O Disposal

Header Lines
Gas/oil gathering

Hot Bitumen

Injection/Flood
Chemical Injection

CO_2 Injection

Steam Injection

Water Injection

Producing Wells

Pump Discharge

Recirculation Pumps

Salt Water Disposal (brine)

Sour Gas

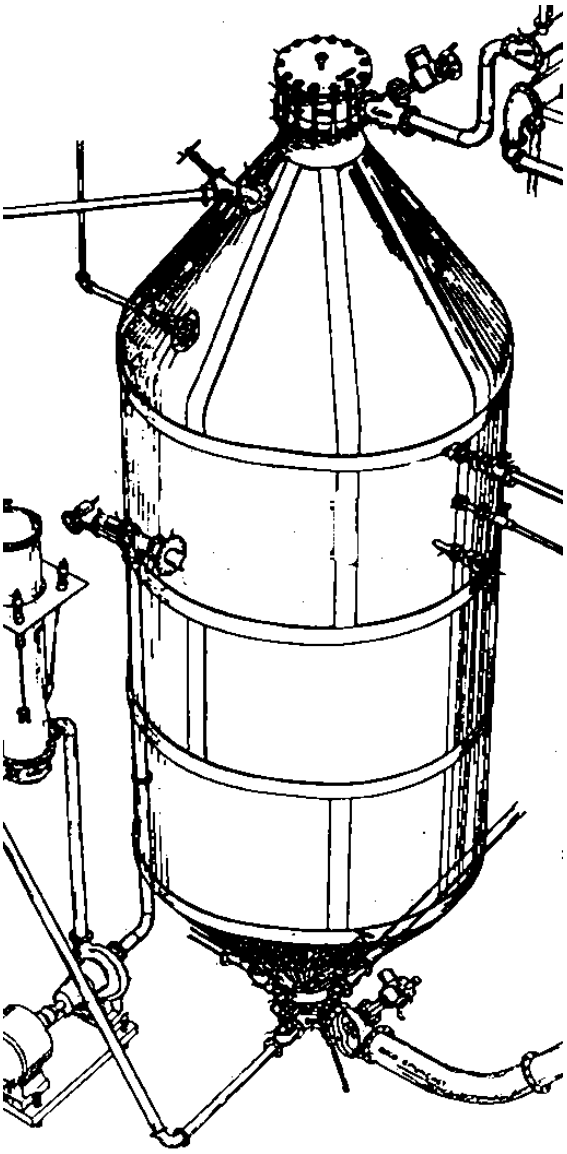
Sour Water

Steam Generators

Surplus Water Pumps

Water Treatment Plant

PULP & PAPER APPLICATIONS



BOILER HOUSE

Feed pumps
Deaerator
Chemical
Condensate
Black liquor guns/recovery

DIGESTER SERVICE

DFT® In-Line check valves have been used for continuous and batch digesters. The special DFT **Excalibur**® and **GLC**® Digester check valves are manufactured with a modified trim package to withstand severe batch steam cook processes.

OTHER

Air dryer systems
Chemical lines
Chip-Pack steam lines – red liquor
Dilution pumps(bleach room)
Instrumentation air
Raw water pumps/waste treatment
Steam lines

WHITE WATER/ STEAM SPARGING LINES

DFT **WLC®'s** are installed on the steam sparging lines coming off the main header into the white water (gray water) silo of the paper machine area.

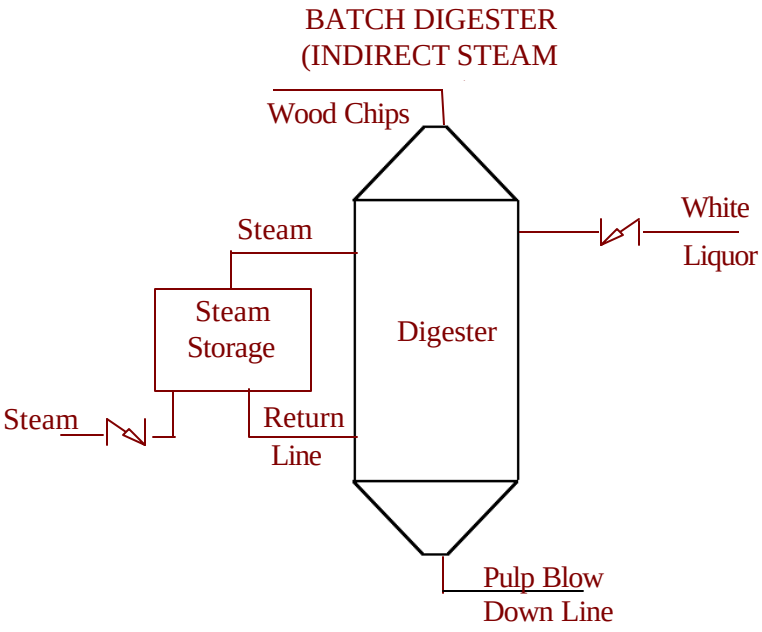
Two problems were encountered and solved by the **WLC**:

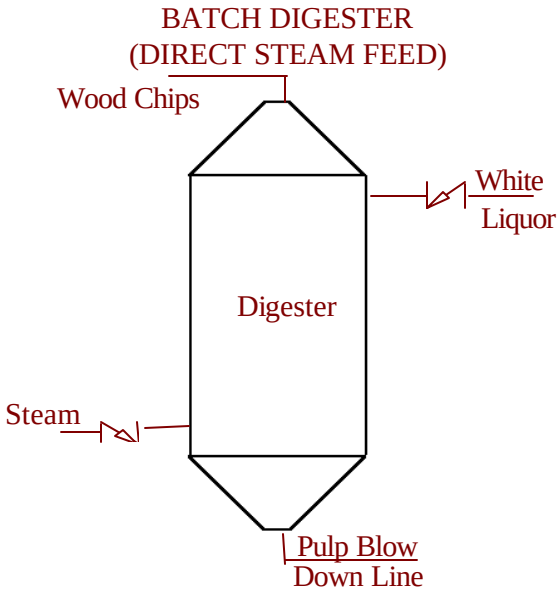
1. Steam flow varies depending on the season from almost -0- flow in the summer to 80% of full flow capacity in the winter.

2. The downstream valve is flanged directly to the silo resulting in constant exposure to the white effluent.

PULP & PAPER

DIGESTER SERVICE





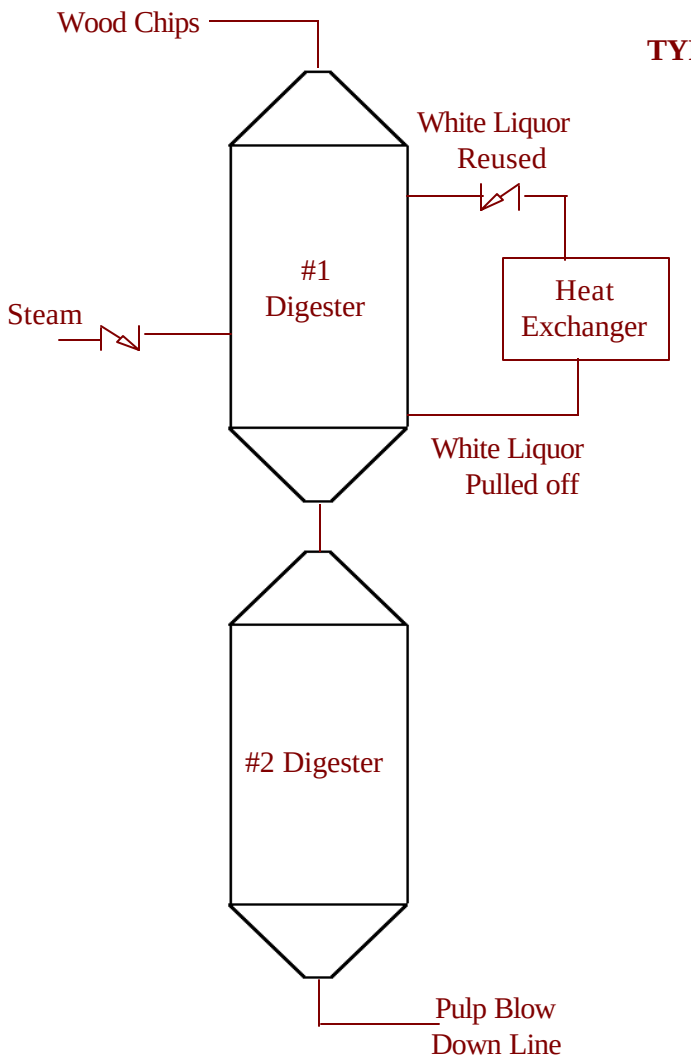
SYSTEM: A digester is a large piece of equipment that cooks wood chips and produces the raw pulp. Steam and White Liquor are added to the wood chips to produce the raw pulp. After they are reduced to pulp, the pulp is "blown" out of the digester. The digester is similar in operation to a large pressure cooker. Digesters range in size from 10-20 feet in diameter and 40-70 feet high. They usually operate at pressures up to 150 psi.

TYPICAL CHECK VALVE APPLICATIONS

1) Steam Injection: Steam is injected into the digester to cook the wood chips. A check valve is required on the steam line to insure that chip, liquor and pulp do not backflow into the steam line both during cooking and during the blowing cycle.

2) White Liquor Injection: A check valve is used on the white liquor line to insure that the steam and pulp do not flow back into this line. It is also required for pump protection to insure that the pump does not spin backwards and allow contaminated liquor into the white liquor line.

CONTINUOUS DIGESTER



TYPICAL CHECK VALVE RELATED PROBLEMS

Steam Injection: In most digesters (particularly batch digesters), this is a very severe application. It is intermittent service causing the check valve to constantly open and close. Also, during the initial heating of the digester, large amounts of steam are injected. After the proper temperature is achieved, small amounts of steam are used to just maintain the temperature. This intermittent service with a wide range of flow conditions causes swing checks to fail very rapidly, usually within 2 to 4 months. Clappers break off, the clapper sticks in the open position or the valve allows leakage of pulp into the steam line.

White Liquor Injection: This is also intermittent service for the check valve promoting rapid wear and failure. Swing check pivot pins are normally the primary wear point. Wear in this area causes excessive leakage with potential pump damage and liquor contamination due to backflow.

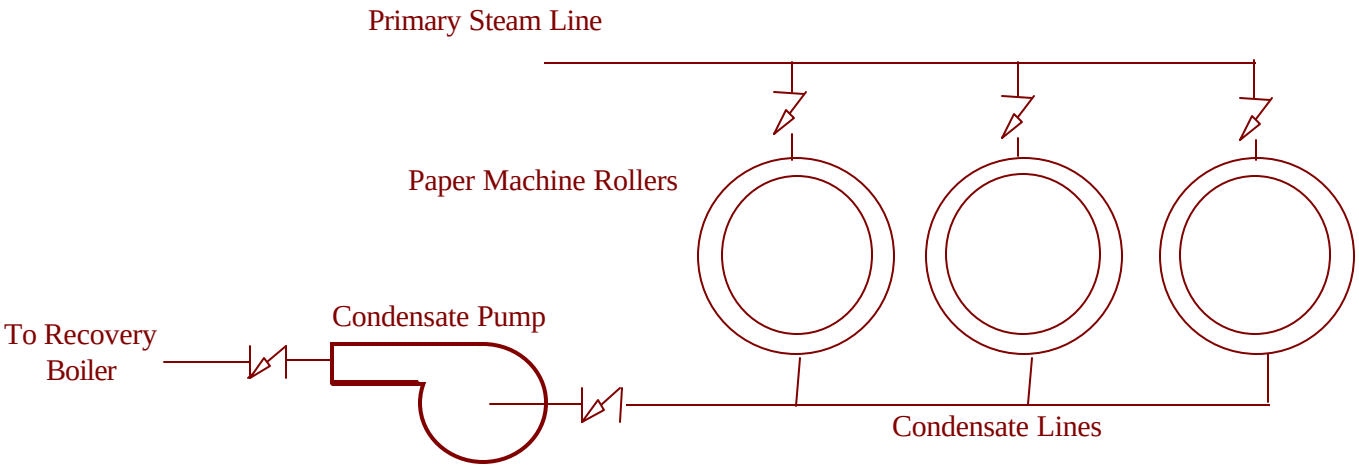
DFT® SOLUTIONS

Steam Injection: DFT **Excalibur**® and **GLC**® Non-slam Check Valves are designed to handle very severe service. The in-line, dual guided design eliminates the problem of the clapper breaking off of the arm. The DFT Non-slam check Valves can also be "sized" to insure that the valve is fully open for the normal flow during the cooking cycle. This greatly increases the life of the check valve and eliminates the problem of chips and pulp entering and plugging the steam lines.

White Liquor Injection: The design of the **Excalibur**, **WLC**® and **GLC** valves dramatically reduces the damaging effects of intermittent service. The dual guided disc eliminates the problem of hinge pin wear and, therefore, leakage. The in-line, spring assisted feature of the design means that the disc has a shorter distance to travel during closure and it will not slam shut. Therefore, there is less likelihood of disc and seat damage due to the intermittent nature of the service.

PULP & PAPER

PAPER MACHINE ROLLER SERVICE



SYSTEM: Pulp is passed through the fourdrinier machine to produce paper. After the fourdrinier, the paper moves to the paper machine roller. The roller is a series of steam-heated rollers that remove most of the remaining water from the paper. The paper moves over and under these rollers. These rollers are used to insure that the paper finishes with the correct moisture content.

TYPICAL CHECK VALVE APPLICATIONS

1) Steam Lines: Check valves are used on the steam lines into each cylinder to eliminate backflow into the steam lines and the boiler.

2) Condensate Recovery: Check valves are used on the discharge of the condensate pump to insure that the pump does not turn backwards due to backflow and to eliminate flashing problems.

TYPICAL CHECK VALVE RELATED PROBLEMS

Steam Lines: Constant low volumes of steam are generally fed into the dryer cylinders. Since these volumes are usually not sufficient to keep swing checks and double door style check valves in the full open position, there is a tremendous amount of wear on the hinge pins from the constant movement. This wear on the hinge pin (and double door springs) leads to high leakage and eventual failure of the check valves.

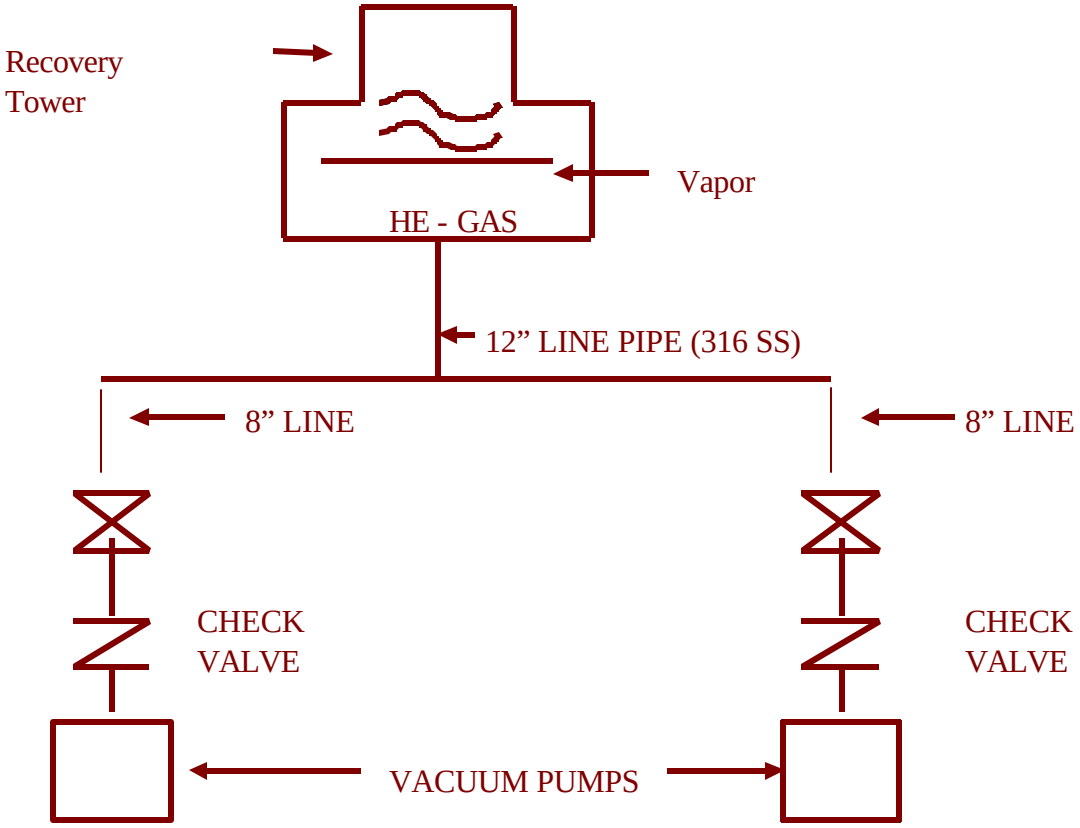
Condensate Recovery: The intermittent (on/off) action of the pump in combination with fairly high pressures causes the swing checks and double door style of check valves to be constantly slammed open and closed. This causes wear on the hinge pins (and springs) causing the valves to malfunction. This leads to pump damage and failure.

DFT® SOLUTIONS

Steam Lines: DFT **Excalibur®**, **WLC®** and **GLC®** check valves can be sized for the specific application. With the valves properly sized, the valves are maintained in a full open condition even with the fairly low steam flows. In combination with the in-line, spring assisted design, this insures that premature wear will not occur and that the valves will have a long, dependable service life.

Condensate Recovery: Since all of the DFT check valves are designed so that they are closed before flow reversal, valve slam (and water hammer) is virtually eliminated. Also, with the in-line design, the disc only has a very short distance to travel. Therefore, there is very little opportunity for valve damage during rapid opening cycles.

PETROCHEMICAL - VACUUM SERVICE
VAPOR RECOVERY SYSTEM



SYSTEM: Helium gas vapor recovery system by process of a vacuum suction. The object of the check valve is to prevent flow from being sucked by vacuum towards the recovery tower.

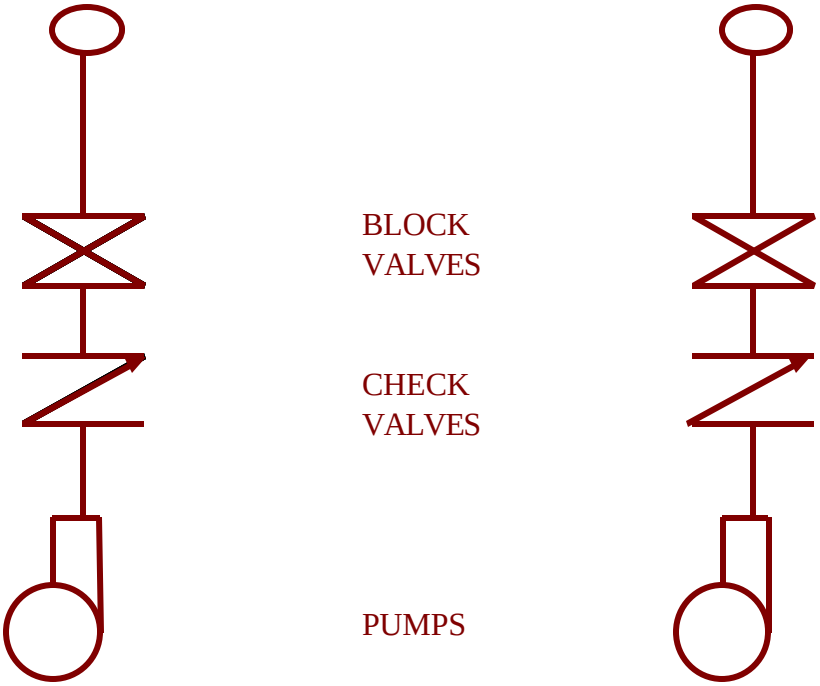
TYPICAL CHECK VALVE APPLICATIONS

This application requires a low cracking pressure valve that doesn’t slam closed. A normal swing check would not be suitable because of slow closing and slamming conditions. Also, the vertical flow could be difficult for this valve.

DFT® SOLUTIONS

DFT **Excalibur**® Non-slam Check Valve installed with a mechanical stop in a vertical line with flow down position would be preferred due to the fact the flow and pressures are low and in a horizontal position the lighter spring might not seal well. This is because of the friction of the disc/stem in the guides. On a vertical flow down this friction is essentially eliminated plus the weight of the disc/stem reduces the cracking pressure without changing the spring.

REMOTE CONDENSATE PUMPS



SYSTEM: A check valve is used for pump protection to insure backflow doesn't damage the pumps.

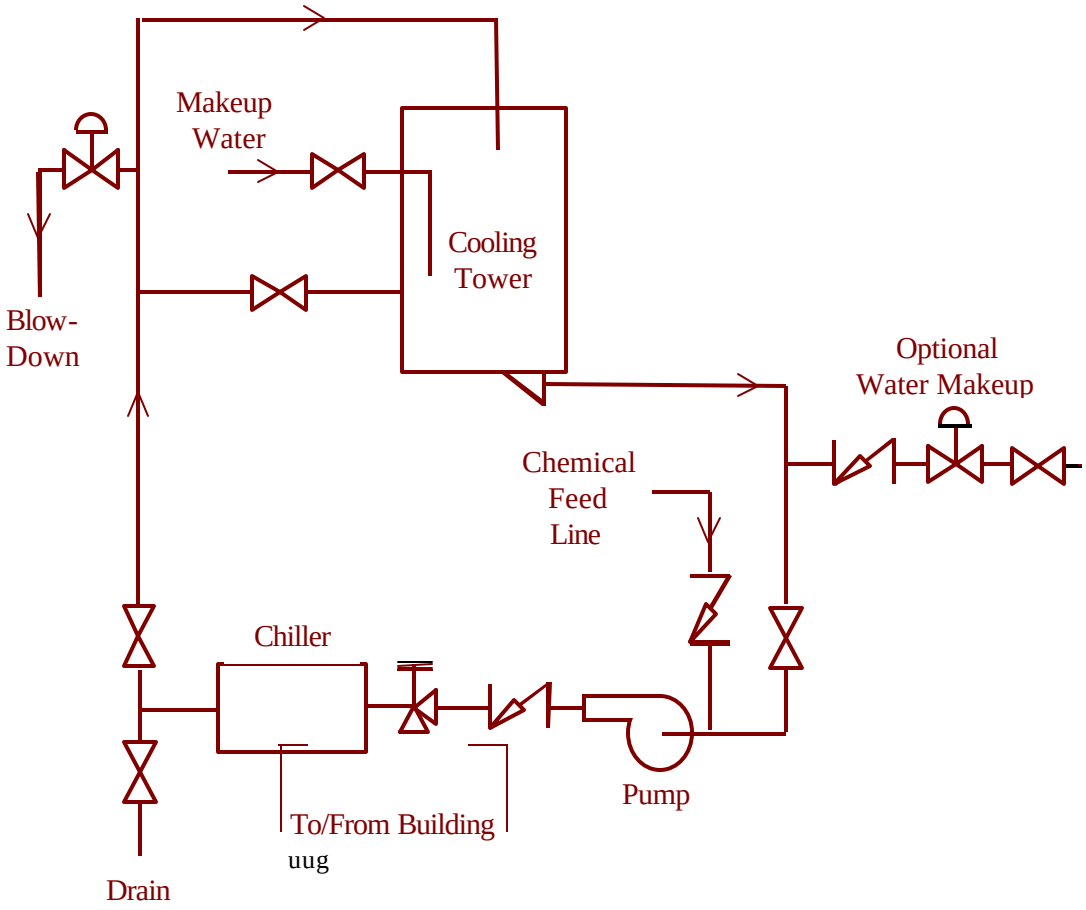
TYPICAL CHECK VALVE RELATED PROBLEM

Water hammer and short check valve life. Double door check valves were failing after a few months of service. Water hammer was an ongoing problem. Check valve was installed on top of the pumps between the pump and a gate valve.

DFT® SOLUTION

A DFT Model **WLC**® In-Line Wafer Check Valve was installed in the vertical line approximately 12" above the pump. The in-line design of the **WLC** eliminated the water hammer problem.

SINGLE CELL COOLING TOWER



SYSTEM: A typical single cell cooling tower installation provides chilled water to a building, plant or hospital. The basic components of the system are a circulating pump, a chiller and the cooling tower along with the associated valving, piping and control equipment.

TYPICAL CHECK VALVE APPLICATIONS

1) Pump discharge. This valve is used for pump protection to insure that backflow does not cause the pump impeller to reverse. Quite often, space limitations dictate this valve to be mounted in the vertical position with flow up.

2) Chemical feed. This valve is required to insure that water in the system does not back-up into and contaminate the chemicals used to treat the water.

3) Water makeup. Protection is required to insure that the treated water in the system does not back-up and contaminate the potable water supply.

TYPICAL CHECK VALVE RELATED PROBLEMS

Pump Discharge: Water hammer is a very common problem in this type of system. This is particularly true in systems that use a swing check but it can also be evident when double-door or externally weighted swing check is used. The water hammer can be evident with noise, vibration and/or equipment damage. Other problems generally associated with water hammer can be excessive pump maintenance due to flow reversal on the pump impeller and valve seat damage and clapper/door breakage due to low flow conditions.

Chemical Feed: The most common problems in this area are low flow conditions causing premature check valve wear and failure and sticking valves allowing water to backflow into the chemical reserve. This causes dilution/contamination of the chemicals and increases the possibility of a chemical spill.

Water Make-up: The intermittent nature of this service often causes rapid wear and failure on valve hinge and pivot pins. This wear also promotes seat leakage which can cause the control valve to operate erratically with the need for more frequent calibration.

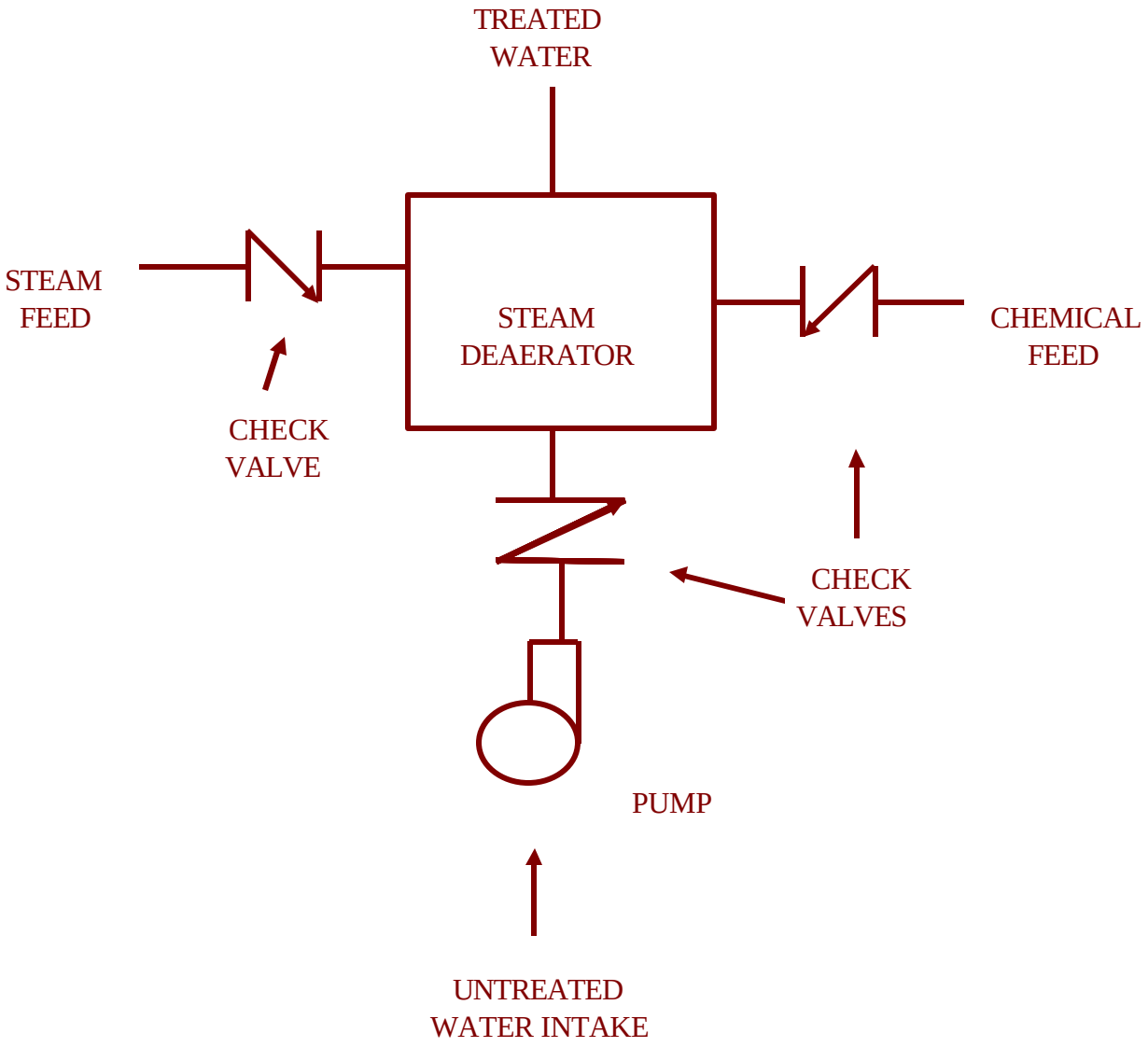
DFT® SOLUTIONS

Pump Discharge: With the short travel and fast closure of the DFT spring assisted **Excalibur®**, **WLC®** and **GLC®** check valve caused water hammer problems can be eliminated. This reduces maintenance costs and helps improve pump reliability. Valve reliability and life is greatly increased thus further decreasing maintenance costs.

Chemical Feed: The DFT **SCV** and **Basic-Check®** provide positive closure to insure that no backflow of water will occur thus eliminating the problems of contaminated chemicals and environmental spills.

Water Make-up: The in-line, dual guided design of all of the DFT Check Valves greatly reduce the damaging effects of intermittent service. This prolongs the life of the check valves. System efficiency is improved with better operation of the control valve.

STEAM DEAERATOR SYSTEM



SYSTEM: Typically in a steam plant water has oxygen removed before entering the boiler to prevent boiler corrosion. This is accomplished by adding chemicals and steam to the water.

TYPICAL CHECK VALVE APPLICATIONS

1. PUMP DISCHARGE: Prevents backflow into the pumps to prevent impeller damage.

2. CHEMICAL FEED: Prevents mixture of chemicals with water.

3. STEAM LINE: Prevents water from flowing through the steam line.

TYPICAL CHECK VALVE RELATED PROBLEMS

PUMP DISCHARGE: Fluid hammer occurring on pump shutdown.

CHEMICAL FEED: Ball checks become "balled up" and sticking causing the pump to overwork and possibly blow seals.

STEAM LINE: Normally low flow conditions exist resulting in valve chatter and premature valve failure.

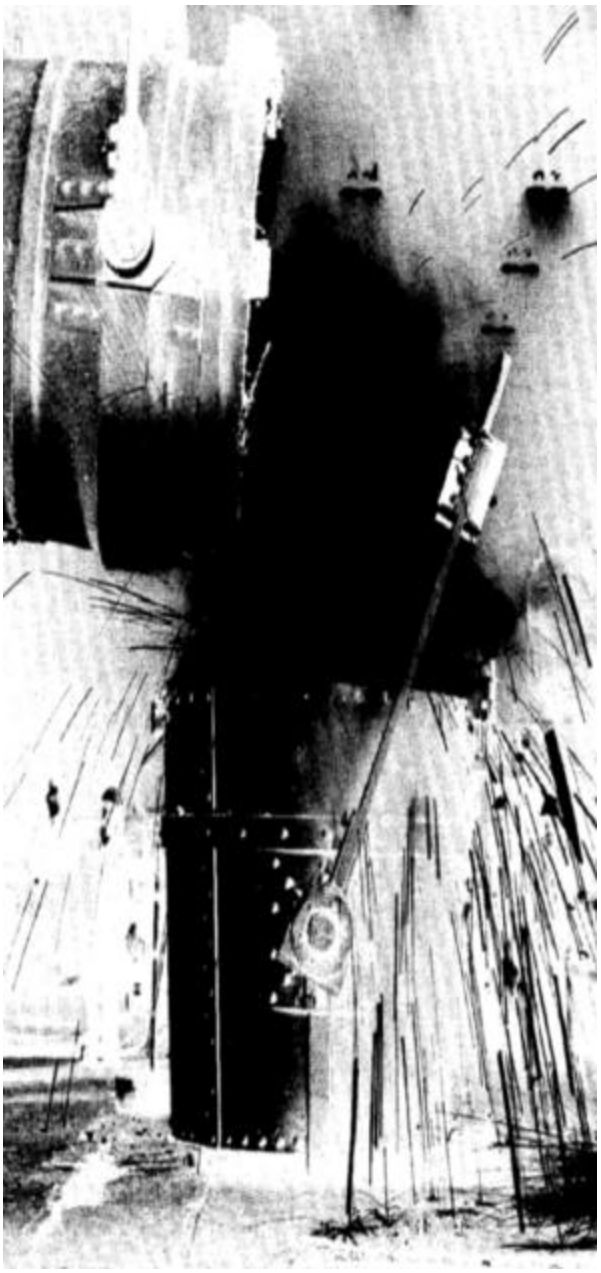
DFT® SOLUTIONS

PUMP DISCHARGE: DFT in-line check valves can be sized to prevent water hammer.

CHEMICAL FEED: The flow area of DFT in-line check valves will act to self clean and keep the discharge clean.

STEAM LINE: Proper sizing of a DFT in-line check valve will prevent chattering thus prolonging the life of the check valve in this low flow condition as long as a pressure drop of 1 psi is maintained across the DFT silent check valve.

STEEL APPLICATIONS



BOF/BOP SERVICES

DFT® **Excalibur**® and **GLC**® In-Line check valves are used in the quench system on pump discharge applications to prevent reverse flow and Water Hammer. The check valves are installed in vertical lines and handle a medium composed of water and scale.

H. P. DESCALING WATER

DFT **Excalibur** and **GLC** check valves are used in the Hot Strip and Plate Mills on pump discharge applications. The **Excalibur** and **GLC** prevent flow reversal and Water Hammer each time the pumps are shut down. The DFT check valves are exposed to severe cycling each time a blast of water is used to remove scale from the steel.

HYDRAULIC PRESSES

DFT **Excalibur** and **GLC** In-Line check valves are used on the pump discharge to prevent flow reversal and Water Hammer. DFT check valves handle the high pressures and intermittent or continuous cycling as the water pushes the rolls together.

OTHER APPLICATIONS

Air Lines
BOF/BOP Services
Boiler Feed
Breakdown Mill - Contact Water
Bug Plant
Caster Air Lines
Coating Lines
Coke Ovens
Descaling
High Pressure Descaling
Hydraulic Presses
Pickling Lines
Receiprocating Pump Discharge
Utilities
Waste Water
Water treatment