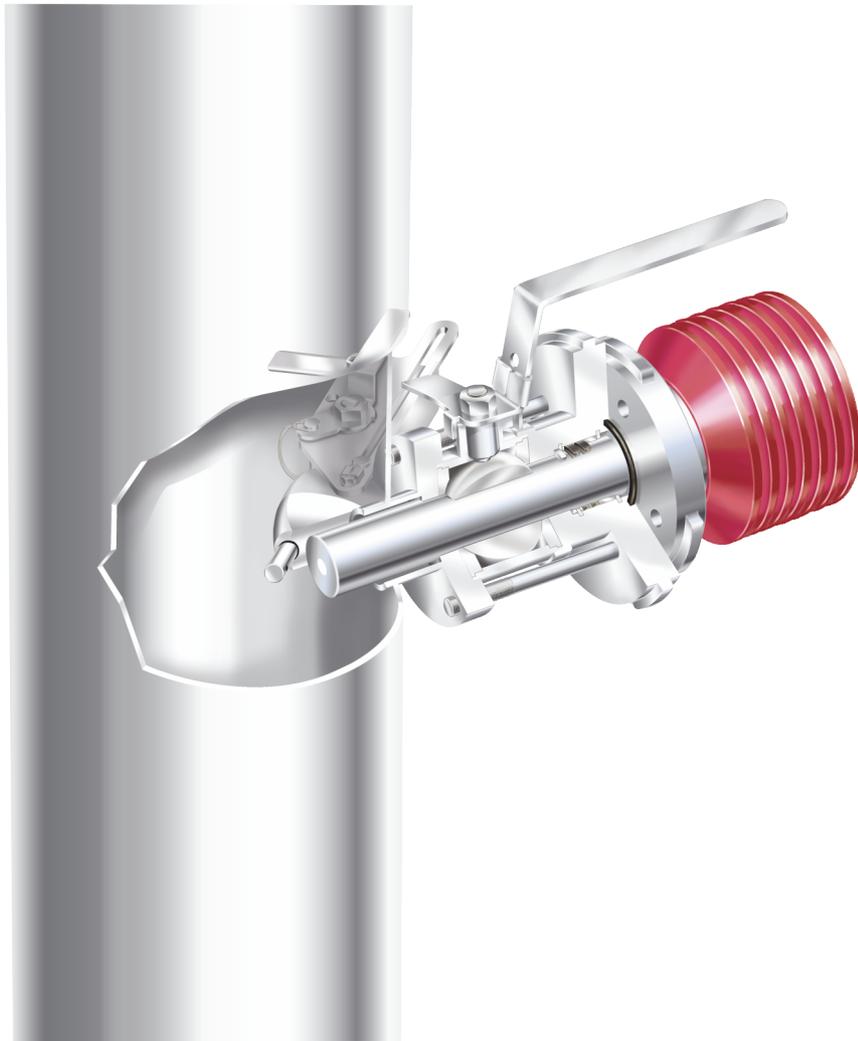


# Best Practices

for Brown Stock Total Dissolved Solids (TDS)  
Control and Optimization  
Safe-Drive Process Refractometer Gen 2.1  
**PR-23-SD**



**VAISALA**

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# SAFE-DRIVE™ Process Refractometer PR-23-SD for Brown Stock Washing (BSW) Application Best Practices

## 1 About This Document

This document is intended for individuals installing, commissioning, operating, and/ or servicing the SAFE-DRIVE Process Refractometer PR-23-SD generation 2.1 model in brown stock washing application. The purpose of this document is to provide a quick guide for the above-mentioned tasks in the form of K-Patents recommended best practices.

Specifically this document is intended for the following process refractometer mounting options and applications:

1. SAFE-DRIVE Process Refractometer PR-23-SD with Isolation valve SDI2-23-SN2-XS and steam wash used in the wash filtrates and weak black liquor.
2. SAFE-DRIVE Process Refractometer PR-23-SD with Isolation valve SDI2-23-PL-SS and pulp line installation plate without wash used in the blow line and pulp stock line.

**NOTE:** The instructions presented in this document are for quick reference only. For more thorough guidance, please refer to K-Patents user manual and documentation.

## 2 Background

### 2.1 Why optimize the Brown Stock Washing process?

The Brown Stock Washing (BSW) process is an important operation in the pulp mills. Its purpose is to remove as much dissolved solids as possible (both organic and inorganic soluble compounds) from the pulp suspension (brown stock) while using the lowest amount of wash liquor or water. These compounds are essential for the chemical recovery system and to maintain the economic viability of the pulping process. Recovery of the black liquor solids is important because:

- Organic compounds are used for energy production in the recovery system, and have a direct effect on the requirements of bleaching chemicals and the environmental load.

- Inorganic compounds are used for regeneration of cooking chemicals. Inorganics lost with the pulp increase the requirements for make-up chemicals in the recovery system.

BSW optimization is important to increase production rates and stability, minimize steam and chemicals consumption, improve washing efficiency and bleaching plant operation, avoid process disturbances and substantially reduce operating costs. An optimized washing line has a positive impact on the economics of the pulping process as well as the environmental load of the mill.

## 2.2 Measuring washing efficiency

The performance of the washing process has traditionally been controlled in two main ways: using wash loss and dilution factor (DF). Wash loss refers to the quantity of washable compounds (organics and inorganics) in the pulp suspension that could have been removed by washing. The DF indicates the amount of water per ton of pulp added during washing, and which ultimately dilutes the black liquor.

The evaluation of the washing process is complex and multivariable. The main variables include the dilution factor, the inlet and outlet consistencies of the pulp, distribution and temperature of the wash liquor, air entrained in the pulp and the liquor, and the drum speed. Mass balances, the Displacement Ratio (DR) and the Nordén Efficiency Factor (E-value) are useful control tools that indicate the performance of the washing process and can be used for detecting problems. However, the calculation of these variables has been difficult due to the lack of information and robust instruments that measure wash loss in-line reliably.

Conductivity is widely used for this purpose, even though it is based on the measurement of the ionic sodium species in the liquor (inorganic phase) and does not directly measure the organic phase, notably lignin and hemicellulose. Similarly, Chemical Oxygen Demand (COD) tests performed on the filtrate, only indicate organic compounds. Furthermore, off-line laboratory methods, such as standard dry solids analysis, TOC or COD analysis, require considerable time, rendering them unsuitable for advanced process control.

Total Dissolved Solids (TDS) has proven to be a reliable parameter for measuring washing efficiency, because it takes account of both the inorganic and organic fractions, thus all washable solids (real wash loss) are quantified (Figure 1). TDS is measured in-line with a process refractometer that provides real-time wash performance information, while enabling a quick response to potential changes or disturbances in the process. The refractometer's output can also be calibrated to read COD.

K-Patents refractive index measurement technology is accurate, and reliable and has become an industry standard – it is widely used to measure black liquor dry solids and green liquor density in Kraft chemical recovery processes worldwide. The technology addresses the critical factors required for measuring TDS in all types of brown stock washers and washing processes.

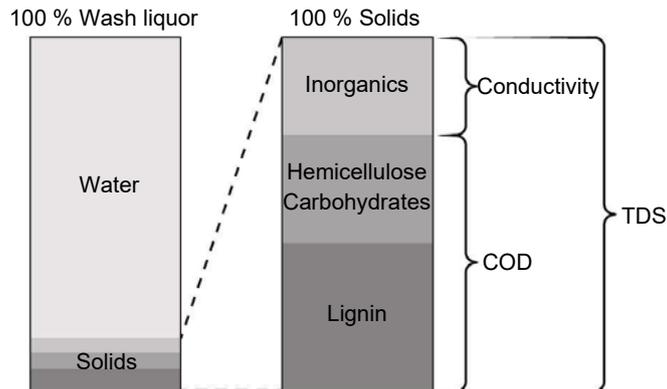


Figure 1 Black liquor composition

## 2.3 TDS measurements: Control strategies and benefits

When examining the overall economic relationship between operating cost and efficiency (Figure 2), the first considerations are maximizing the solids yield due to its heat value in the recovery boiler and minimizing the dilution factor to save steam in the evaporators. The next key factors are the cost of make-up chemicals for replacing sodium losses and the cost of effluent treatment. Other important considerations include evaporator efficiency limitations in many mills and bleach chemical consumption in bleachable grade mills.

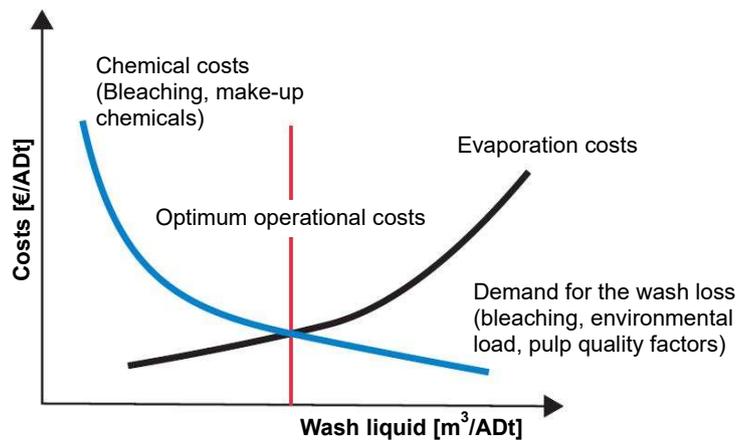


Figure 2 Relationship between wash liquid and operating costs. The optimal point of operation is given by a balance between evaporation and chemical costs.

The development of K-Patents SAFE-DRIVE Process Refractometer PR-23-SD for the continuous measurement of TDS in the liquid phase of a fiber suspension makes it possible to follow the performance of individual process steps continuously. K-Patents SAFE-DRIVE Process Refractometer is installed directly in the pulp or filtrate line. TDS changes are detected immediately in the feed and outlet stock lines, as well as in the incoming and outgoing filtrate lines.

The SAFE-DRIVE Process Refractometer PR-23-SD offers BSW optimization through:

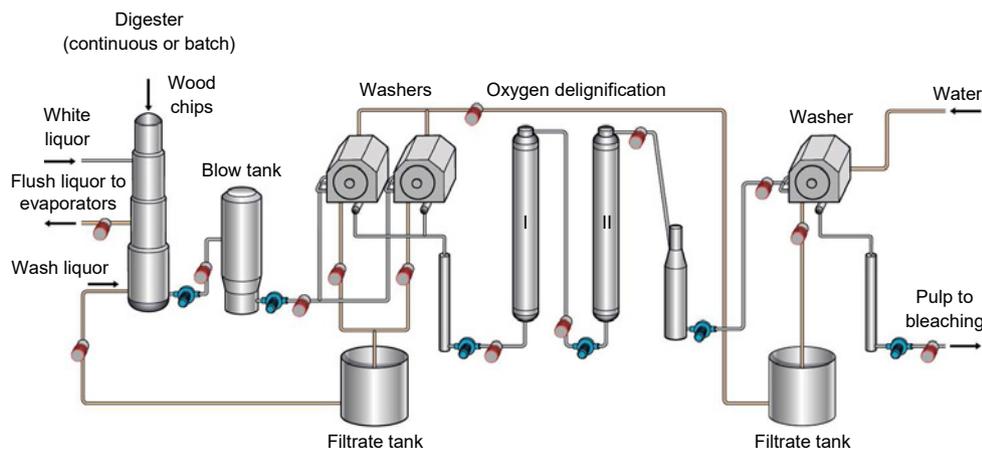
- Accurate, reliable and continuous TDS measurements in the liquid phase from the pulp suspension, for better control and continuous monitoring of individual washing stages.
- Improved economics and environmental performance of washing and the entire process.

Once the mill has the appropriate number of in-line total dissolved solids measurements, it can calculate and optimize its brown stock washing variables, such as the optimum Dilution Factor (DF), Displacement Ratio (DR), relative washing loss (1-Y), and the entire plant Efficiency Factor (E).

The washing system efficiency in its most basic form can be calculated from TDS measurements. The ratio of dissolved solids entering the system with the pulp and leaving the system with the filtrate represents the quantity of solids removed:

$$\% \text{ Efficiency} = \frac{\text{Dissolved Solids to evaporation} \left( \frac{\text{weight}}{\text{ton of pulp}} \right)}{\text{Dissolved Solids to the washing system} \left( \frac{\text{weight}}{\text{ton of pulp}} \right)}$$

Figure 3 shows potential TDS measuring points in the fiber line. The number of measurements are customized to meet the requirements of each mill.



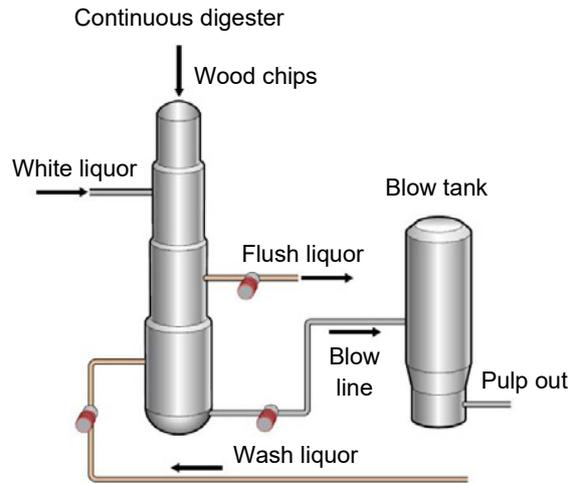
**Figure 3** Optimized Brown Stock Washing line by TDS measurements.

## 2.4 TDS measurements in individual washing stages

### 2.4.1 Digester and blow line

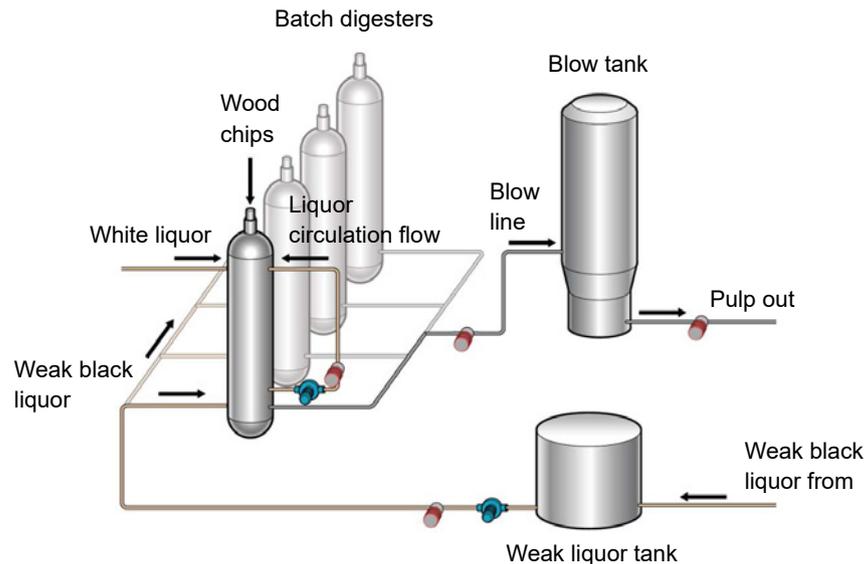
TDS measurement in the liquid from the blow pulp suspension after the digester enables monitoring of the diffuser operation. Together with other measurements (e.g. filtrate and flush liquor) this provides the mill with the ability to control the performance of the washing

zone in the digester. In addition, TDS measurement in the blow line allows the performance of the digester to be monitored, ensuring that it yields the correct concentration. K-Patents recommends three TDS measurement points around a continuous digester (Figure 4): wash liquor feed to the washing zone, flush liquor outlet and blow line. The combination of these measurements facilitates continuous calculation of the mass balances and the creation of operating models of the digester.



**Figure 4** TDS measurements in a continuous digester.

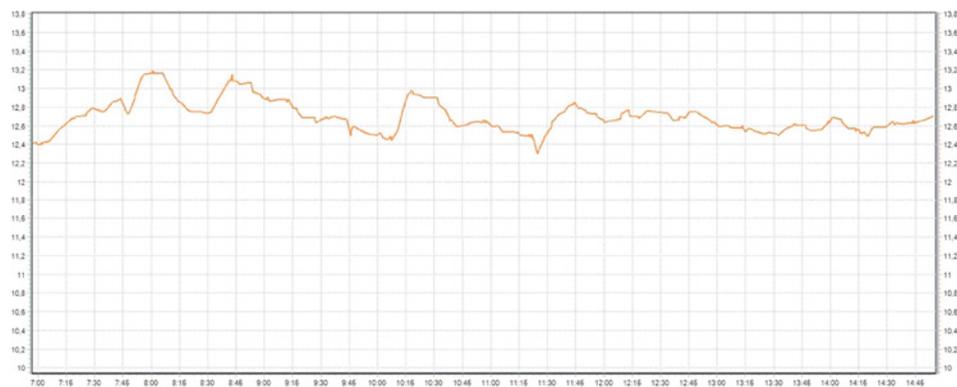
Monitoring TDS in the liquor circulation flow of a batch digester helps to determine when the batch is ready. K-Patents recommends to implement three measurement points in this stage: weak liquor inlet, liquor circulation flow and pulp out (Figure 5).



**Figure 5** TDS measurements in batch digesters and blow line.

## 2.4.2 Pulp feed to washers

TDS content in the pulp suspension to the washing system varies continuously and significantly (Figure 6). Accurate and real-time TDS measurement within the feed pulp allows a quick response to process changes and prevents disturbances from being carried over into subsequent washing stages. Process variables, such as the dilution factor, are controlled in accordance with the properties of the inlet pulp, and the mass balances are continuously monitored.



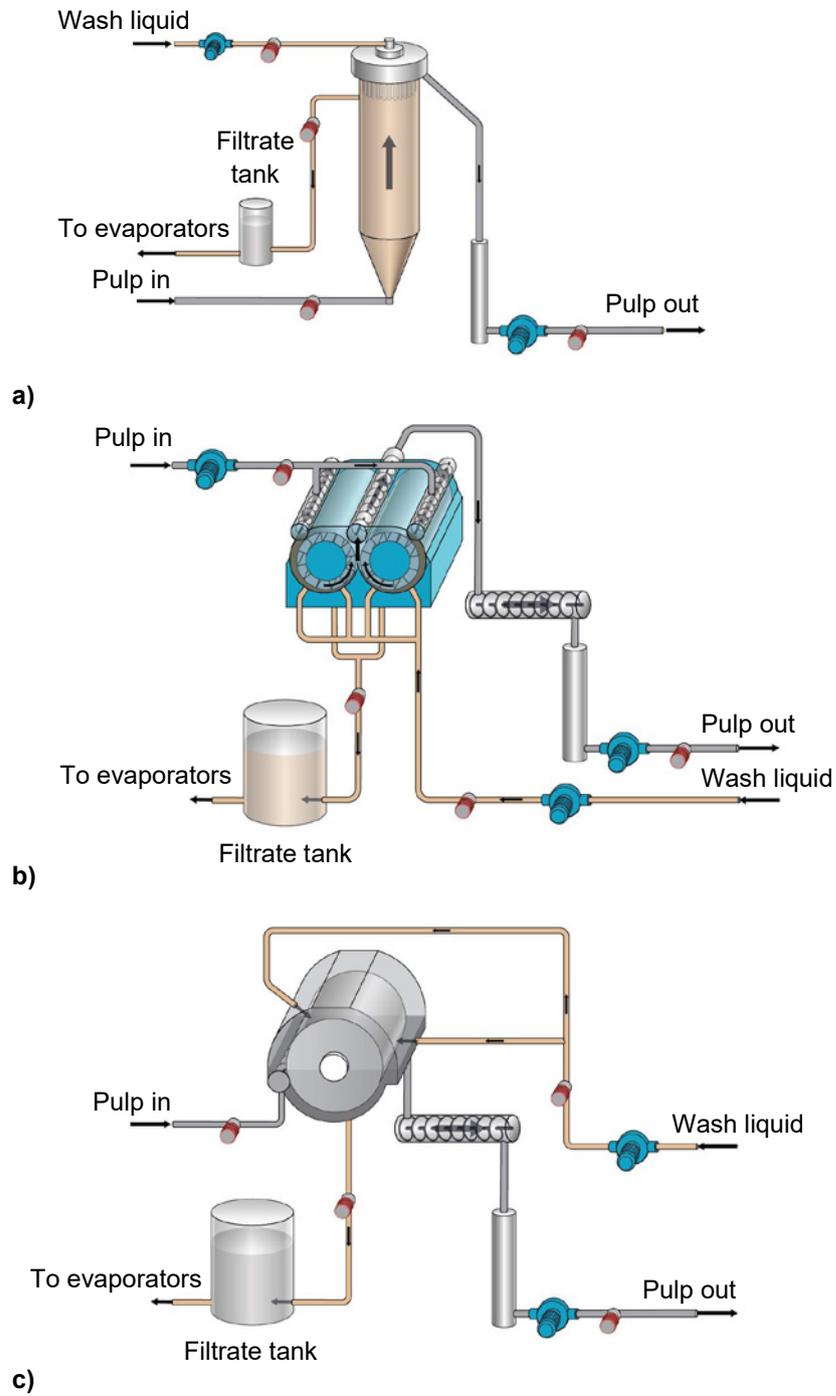
**Figure 6** Example of a control chart showing TDS content in the pulp feed to a fiberline. This data is obtained only by K-Patents Process refractometers.

## 2.4.3 Washing stage

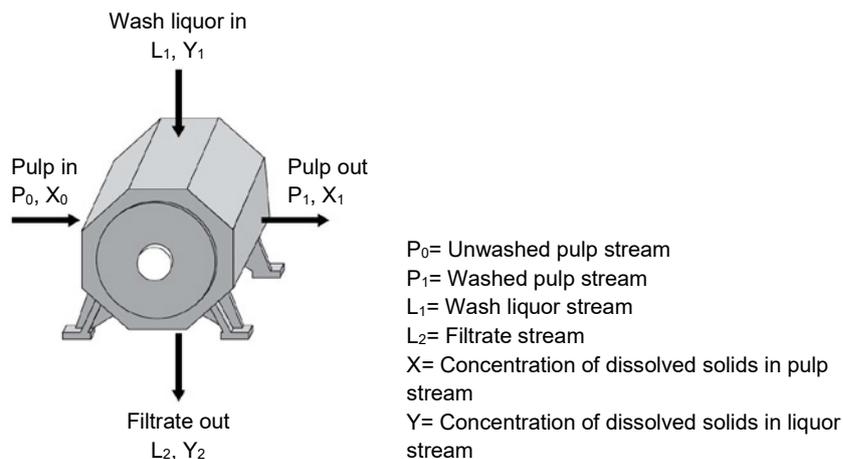
Typical types of washers in pulp mills are rotary drums, diffusers and extraction presses. Important TDS measurement points in all types of washers are the pulp inlet, pulp outlet, wash liquid feed and wash filtrate (Figure 7).

The efficiency of the brown stock washing process has a substantial impact on subsequent process stages. In theory, all solids dissolved in the pulp can be recovered if excess of water is employed. In practice, this is not possible due to the evaporator limitations at the mills. In-line TDS measurements facilitate the control of the washing stage and help to determine the optimum dilution factor, right operation consistency and optimum concentration of solids in the stream to the recovery boiler. This prevents excess consumption of water in the washers and consequently reduces the consumption of energy and make-up chemicals.

Moreover, TDS measurements allow monitoring the mass balances easily and continuously and facilitate the creation of washing efficiency models, either of the whole washing line, or only of a single washer (Figure 8). Real time calculation of efficiency metrics such as E-value and Displacement Ratio (DR), provides important information for the operators to alter washing parameters when necessary, and ensures the best washing result.



**Figure 7** TDS measurements in different types of washers. a) Diffuser b) Press c) atmospheric drum.



**Figure 8** Modelling individual washer for efficiency calculation.

The Norden Efficiency Factor E defines the number of ideal stages required to achieve the same washing result than a given washing system or single washer. For example, a system with an E-value of 6, is equivalent to having 6 ideal counter-current mixing stages. Thus, the higher the value value, the better the efficiency:

$$E = \frac{\log \frac{P_0}{P_1} \left( \frac{X_0 - Y_2}{X_1 - Y_1} \right)}{\log(L_1/P_1)}$$

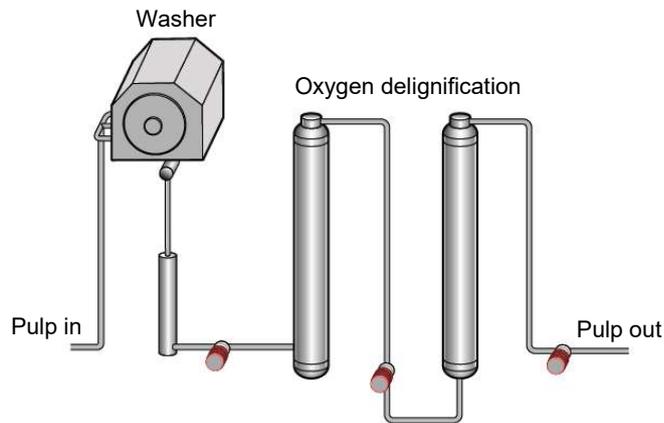
The Displacement Ratio (DR) is defined by the ratio of the actual reduction in solids content of a specific stage compared to the maximum possible reduction. Ideally, the wash water leaving the washing system would have the same dissolved solid content than the feed pulp (DR=1):

$$DR = \frac{X_0 - X_1}{X_0 - Y_1}$$

#### 2.4.4 Pulp to Oxygen Delignification (OD)

It is common practice to use COD tests for estimating the wash loss to the OD stage. COD tests represent only the amount of organic compounds present in the pulp suspension, yet many of these organics have no effect on the delignification reactions and some may in fact have a positive effect. In addition, inorganics compounds, which are not quantified by COD tests, can interfere with the oxidation reactions, consume the oxygen and increase the temperature in the reactors. Therefore, wash loss measurements to the OD stage should consider all solid compounds dissolved in the pulp suspension.

In-line TDS measurements optimize the cost and performance of the OD process (Figure 9). Wash loss reduction in the inlet pulp to the reactors decreases the amount of alkali, which is consumed in neutralization reactions of the organic acids. Additionally, the temperature of the reactor is optimized and the amount of oxygen decreased.



**Figure 9** TDS measurements in Oxygen Delignification stage.

### 2.4.5 Pulp Discharge to bleaching

Wash loss to bleaching is usually measured by COD tests. However, many compounds that cause COD (e.g. methanol) do not have any effect in the Kappa number, viscosity or ISO brightness of the pulp. It is important that the wash loss measurement to bleaching is based on both the organic and inorganic compounds. The remaining dissolved organics in the pulp increase the consumption of bleaching chemicals, while the inorganics may increase the final pH of the pulp slurry and require the addition of acids to adjust it to the optimum value. This increases the operating costs.

K-Patents refractometers provide reliable continuous measurements of wash loss in the discharge pulp and make it possible to control the success of the washing process. By minimizing the wash loss, the subsequent process steps are optimized. Lower wash loss in the outlet pulp will improve its quality while also decrease the requirements of chemicals in the bleaching stage. Reliable measurements improve environmental performance of the mill and reduce effluent treatment costs.

## 2.5 Upper Level Control

K-Patents in-line TDS measurements can be used for the creation of an Upper Level Control (ULC) system. This provides better control of washing and enhances washing efficiency by real-time feedback from the refractometers. TDS measurements in the ULC are used for:

- Adjusting the Dilution Factor
- Controlling and minimizing the wash loss
- Monitoring the dry solids contents to evaporation
- Operating within evaporation capacity
- Monitoring continuously washer performance, e.g. DR or E-value (including alarm and/or automatic settings).

K-Patents encourages the integration of TDS measurements to the mills' own control system, but recommends the development of an ULC system which allows a more

automated control, less active operation time and easier monitoring. Some ULC examples are:

**1. Dilution Factor control.** Conventionally, the washers have been fed the amount of wash liquor considered appropriate depending on the conductivity of the outlet streams (e.g. filtrates). In-line TDS measurements along the washing line, offer the possibility of adjusting the Dilution Factor in an automated manner by using feedback from the dissolved solids content, liquor balance and conductivity. This helps to achieve a specific goal of solid content to evaporation.

**2. Washer specific control.** For example, drum rotation speed control in a DD-washer. This control can be constructed by a torque set-point given by the operators which controls the drum rotation speed to maintain the torque constant. Torque control can maintain a higher and steadier washing consistency than the conventional feed pressure control, resulting in higher washing efficiency.

**3. Wash liquor control.** Real time TDS measurements in the pulp feed to the washing line detects changes in the concentration of the inlet liquor immediately, and helps to keep the concentration in a desired level throughout the whole line by using a wash liquor feedforward. This allows to react to disturbances already at the beginning of the line.

**4. Filtrate tank level control.** Filtrate tank levels are controlled automatically to prevent overflows and to ensure sufficient wash liquor amount.

**5. Oxygen delignification control.** TDS measurement in the feed to the OD stage helps to adjust the delignification reaction parameters in accordance to the measured inlet concentration. For instance, an automatic control can be constructed and alarms can be set up to indicate if the dissolved solids content increase from its optimal point. This helps to identify the correct chemical dosage, and the need for improving pre-oxygen washing parameters in order to avoid a rise in the temperature inside the reactor.

## 2.6 Documentation

K-Patents recommends as a Best Practice guideline the implementation of good documentation of control strategies and management of work procedures, as well as control monitoring and reporting effective diagnostic and troubleshooting for better operation after the implementation of the refractometers and TDS in-line measurements.

K-Patents also recommends a well-establish training of the operators for adequate knowledge and better operation of the washing line, as well as the training of key users in charge of fine-tuning the parameters of the ULC system and more complex problems.

**NOTE:** The K-Patents Best Practices for Brown Stock Washing summarized in this document are only recommended guidelines. In some mills, it might not be possible or necessary to implement all recommended measurement points. For this purpose, K-Patents offers a Brown Stock Washing Pre-study service to deliver an in-line TDS measurement package tailored to the specific demands of each mill.

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## 3 Before installation

### 3.1 Installation Location Checklist

#### 3.1.1 SAFE-DRIVE Process Refractometer and steam wash system mounting for filtrates and weak black liquor

Before the SAFE-DRIVE refractometer sensor PR-23-SD and isolation valve with steam wash nozzle SDI2 23-SN2 are installed in the filtrates and weak black liquor lines, it is important to inspect the installation location carefully for the following conditions:

- Install the SD sensor system onto either vertical or horizontal pipeline. The recommended flow rate is 0.4 m/s – 2 m/s (1.5 ft/s – 6 ft/s).
- Mount the system at waist level. This is the natural and safe height for the system and enables you to use the tools more ergonomically.
- Leave a 1 m (approximately 3 ft) space around the installation for operating around the SD sensor system. For the same reason, the steam connections should be installed on the sides or back of the sensor system.
- Recommended maximum ambient temperature of installation location is 45°C (120°F)
- Avoid locations that are blocked by other piping and/or equipment, or require additional tools, such as a ladder, to access the sensor. The installation location must be level, firm, and free of clutter to provide safe and easy access to the system.
- Use suitable type of steam for cleaning the prism. Dry saturated steam and 10-12 bar (150-180 psi) are recommended.
- Access to steam source. The distance between the steam supply and the SD sensor system should be minimized for the length of steam piping.
- Access to drain for steam trap condensate outlet.
- Emergency shower and eye wash should be easily accessible. Water can also be used for cleaning SDI2 valve lip seals and sensor after sensor removal.
- Shut-off valve needs pressurized instrumentation air (5-10 bars / 70-150 psi).
- Ensure connection to the power supply (110-230V AC).

If these conditions do not apply, please reconsider the intended location for your installation or contact K-Patents.

**NOTE:** If the sensor will be installed between pipe bends, it should always be mounted on the outside region of the pipe. This will ensure the optimal flow condition for the measurements (Figure 10).

#### 3.1.2 SAFE-DRIVE Process Refractometer and pulp line installation plate mounting for blow line and pulp stock line

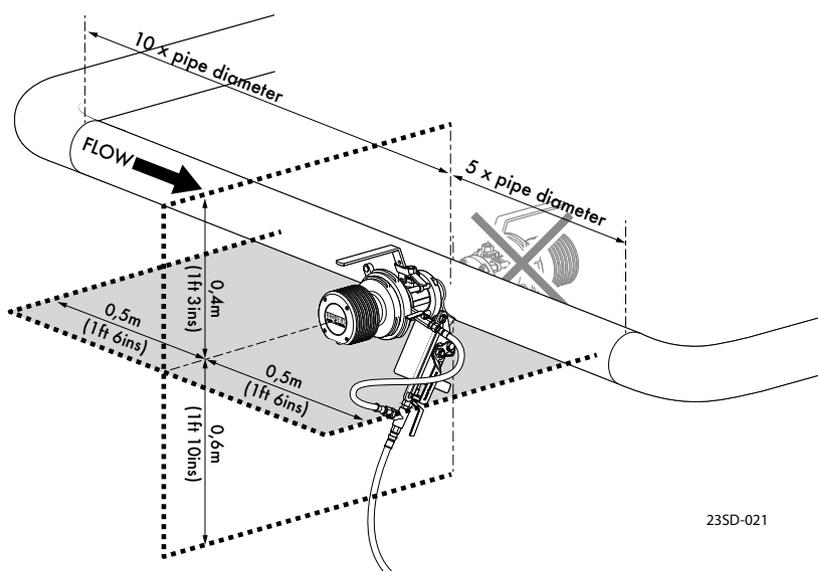
The SAFE-DRIVE refractometer sensor PR-23-SD and isolation valve with pulp line installation plate SDI2-23-PL is installed in the blow and pulp stock lines. In case there are

calcined stones or metal objects in the discharge line, the installation of an optional knife part -KN is recommended inside the pipe prior to the prism. This prevents solid objects from reaching and damaging the prism surface. The installation location should meet the following conditions:

- Install the SD sensor system onto either vertical or horizontal pipeline. The recommended flow rate is 0.4 m/s – 2 m/s (1.5 ft/s – 6 ft/s).
- Mount the system at waist level. This is the natural and safe height for the system and enables you to use the tools more ergonomically.
- Leave a 1 m (approximately 3 ft) space around the installation for operating around the SD sensor system. For the same reason, the steam connections should be installed on the sides or back of the sensor system.
- Recommended maximum ambient temperature of installation location is 45°C (120°F)
- Avoid locations that are blocked by other piping and/or equipment, or require additional tools, such as a ladder, to access the sensor. The installation location must be level, firm, and free of clutter to provide safe and easy access to the system.
- Emergency shower and eye wash should be easily accessible. Water can also be used for cleaning SDI2 valve lip seals and sensor after sensor removal.
- Ensure connection to the power supply (110-230V AC).

If these conditions do not apply, please reconsider the intended location for your installation or contact K-Patents.

**NOTE:** If the sensor will be installed between pipe bends, it should always be mounted on the outside region of the pipe. This will ensure the optimal flow condition for the measurements (Figure 10).



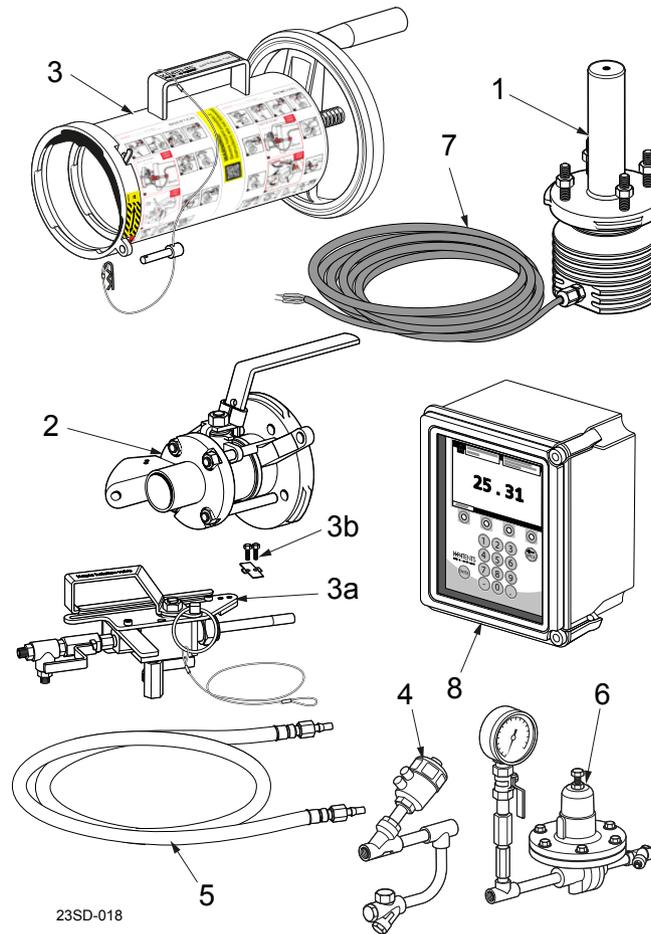
23SD-021

**Figure 10** Optimal installation points for sensors between pipe bends. The sensor should be installed on the outside region of the pipe.

## 3.2 Component Checklist

Before starting installation, make sure you have all the tools and components listed in Sections 3.2.1 or 3.2.2.

### 3.2.1 SAFE-DRIVE Process Refractometer and steam wash system components for filtrates and weak black liquor



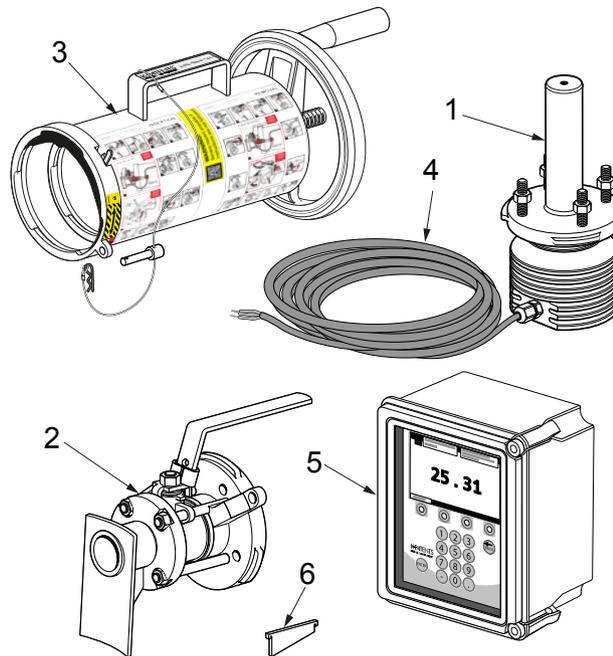
**Figure 11** System components included in K-Patents delivery

<input type="checkbox"/> 1	PR-23-SD sensor
<input type="checkbox"/> 2	SDI2-23-SN2-XS Isolation valve, process wetted parts material SAF 2205 and AISI 316L
<input type="checkbox"/> 3	SDR2-23 Retractor tool
<input type="checkbox"/> 3a	Prism wash nozzle assembly
<input type="checkbox"/> 3b	Wash nozzle installation bolts and locking plate
<input type="checkbox"/> 4	PR-3340 Compressed air operated solenoid shut-off valve with steam trap
<input type="checkbox"/> 5	PR-3515 Steam connection hose
<input type="checkbox"/> 6	PR-3341-J Pressure reducer valve and pressure gauge
<input type="checkbox"/> 7	PR-8230-010 Sensor connection cable
<input type="checkbox"/> 8	DTR transmitter
	Spool piece 150 mm and larger (optional)

**NOTE:** Components 4 and 5 are connected by a union nipple or piping not included in the delivery.

**NOTE:** If any of the tools or components are missing, contact your supplier before starting installation.

### 3.2.2 SAFE-DRIVE Process Refractometer and pulp installation plate components for blow line and pulp stock line

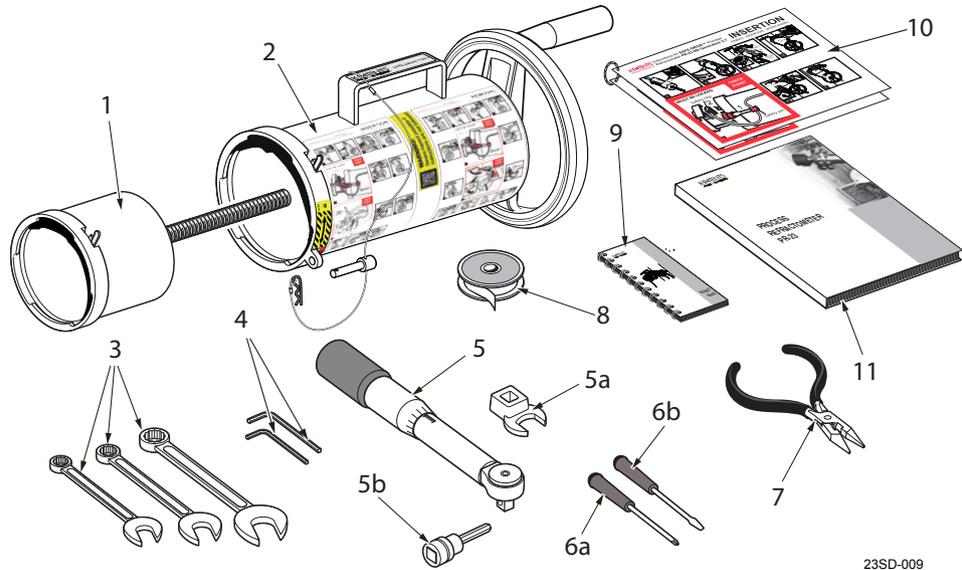


**Figure 12** System components included in K-Patents delivery.

<input type="checkbox"/> 1	PR-23-SD sensor
<input type="checkbox"/> 2	SDI2-23-PL-SS Isolation valve with pulp line installation plate for process line diameter of 250 mm or larger, process wetted parts material AISI 316 L
<input type="checkbox"/> 3	SDR2-23 Retractor tool
<input type="checkbox"/> 4	PR-8230-010 Sensor connection cable
<input type="checkbox"/> 5	DTR transmitter
<input type="checkbox"/> 6	-KN Knife part (optional, only when installed in discharge lines where calcined stones or metal objects may be present) Spool piece 150 and 200 mm (optional)

**NOTE:** If any of the tools or components are missing, contact your supplier before starting installation.

### 3.3 Installation Equipment



23SD-009

**Figure 13** Installation equipment

<input type="checkbox"/> 1	Retractor inner casing	Supplied by K-Patents
<input type="checkbox"/> 2	Retractor outer casing	Supplied by K-Patents
<input type="checkbox"/> 3	Combination wrenches, 32 mm (1 pc), 14 mm (1 pc), 8 mm (1 pc)	
<input type="checkbox"/> 4	Allen keys 8 mm (1 pc), 5 mm (1 pc)	
<input type="checkbox"/> 5	Torque wrench	
<input type="checkbox"/> 5a	open end fitting 19 mm	
<input type="checkbox"/> 5b	hex bit socket 8 mm	
<input type="checkbox"/> 6	Screw driver	
<input type="checkbox"/> 6a	Phillips head	
<input type="checkbox"/> 6b	Flathead	
<input type="checkbox"/> 7	Pliers	
<input type="checkbox"/> 8	Thread seal tape	
<input type="checkbox"/> 9	Pocket guide for insertion and retraction of sensor and wash nozzle	Supplied by K-Patents
<input type="checkbox"/> 10	Laminated instructions for insertion and removal of SAFE-DRIVE sensor	Supplied by K-Patents
<input type="checkbox"/> 11	SAFE-DRIVE Process refractometer PR-23-SD Generation 2.1 Best Practices IM-EN-SDGEN21-BP	Supplied by K-Patents

## 4 Safety requirements

These safety requirements must be followed at all times when installing, operating, or servicing PR-23-SD sensor. These are the minimum safety requirements – your company may require additional PPE (personal protective equipment).

For more information on safety issues, please see K-Patents Safety Instructions.



**Figure 14** Safety symbols

**WARNING:** Watch out for hot steam and process pipes. Wear protective clothing as instructed below to work safely.

- Only authorized personnel can perform the tasks instructed in this document.
- Long-sleeved safety clothing.
- Safety glasses and/or goggles.
- Hard hat or helmet.
- Protective gloves.
- Locate the nearest emergency shower and eye wash before starting the work.
- Never operate the Safe-Drive Retractor alone.
- Hard-cap safety boots.

It is the user's responsibility to follow manufacturer's safety and operating instructions. The client's organization has the responsibility to develop and maintain occupational safety and create a safety culture where individuals are expected to follow safety instructions at all times. Any negligence towards safety instructions or failure to comply with safe practices should not be tolerated. It is the manufacturer's responsibility to produce goods that are safe to use when instructions are followed.

## 5 Installation Process

For more thorough instructions, please refer to K-Patents user documentation or visit the K-Patents website to see the instructional video ([www.kpatents.com](http://www.kpatents.com), PR-23-SD Safe-Drive™ Operation Guide Video).

### 5.1 Installation of SAFE-DRIVE Process Refractometer and steam wash system for filtrates and weak black liquor

Installation of the SAFE-DRIVE Process Refractometer and steam wash system for filtrates and weak black liquor consists of:

- Cutting pipe opening for SDI2-23 isolation valve
- Welding and assembling the SDI2-23 valve onto the processing piping.

- Installing the steam prism wash system.
- Installing the DTR transmitter.
- Installing the PR-23-SD sensor.

### 5.1.1 Spool piece assembly for filtrates and weak black liquor lines

If the SDI2-23 valve was supplied pre-welded and assembled onto a pipe spool piece for integration in existing piping on site, please skip ahead to installing the prism wash system.

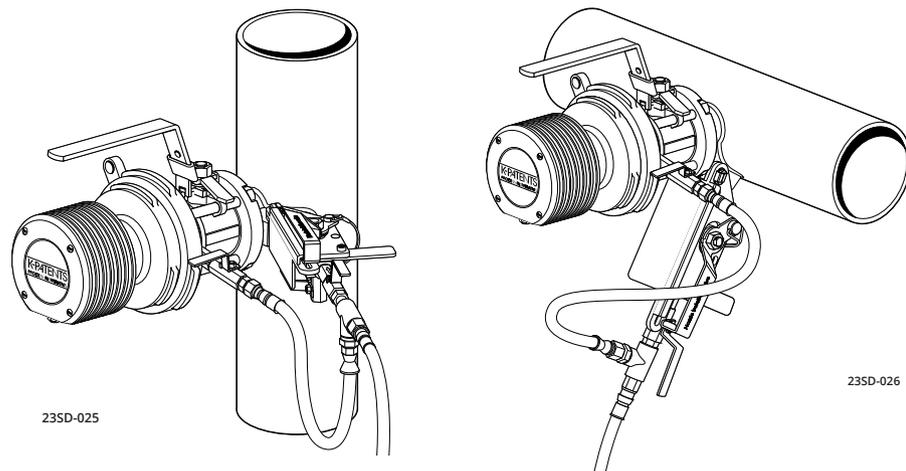
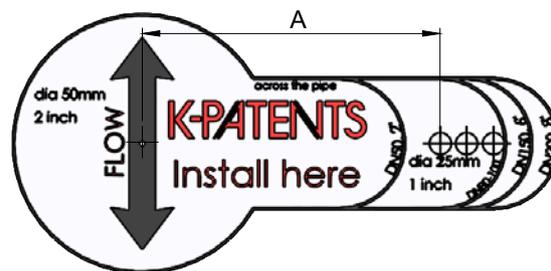


Figure 15 Vertical and horizontal spool piece assemblies (steam wash system).

### 5.1.2 Cutting Installation Opening for SDI2-23 Valve

Use the installation guide sticker provided by K-Patents to determine the installation opening shape and size suitable for your process pipe. If you do not have the guide sticker at hand, please follow the instructions in the images below:



Pipe size	A(mm)	A(inch)
DN50 (2")	37	1.5
DN80 (3")	56	2.2
DN100 (4")	56	2.2
DN150 (6")	61	2.4
DN200 (8")	66	2.6
DN250 (10")	69	2.7
DN300 (12")	70	2.8
DN350 (14")	71	2.8
DN400 (16")	72	2.8
DN600 (24")	75	3.0
>DN600 (24")	76	3.0

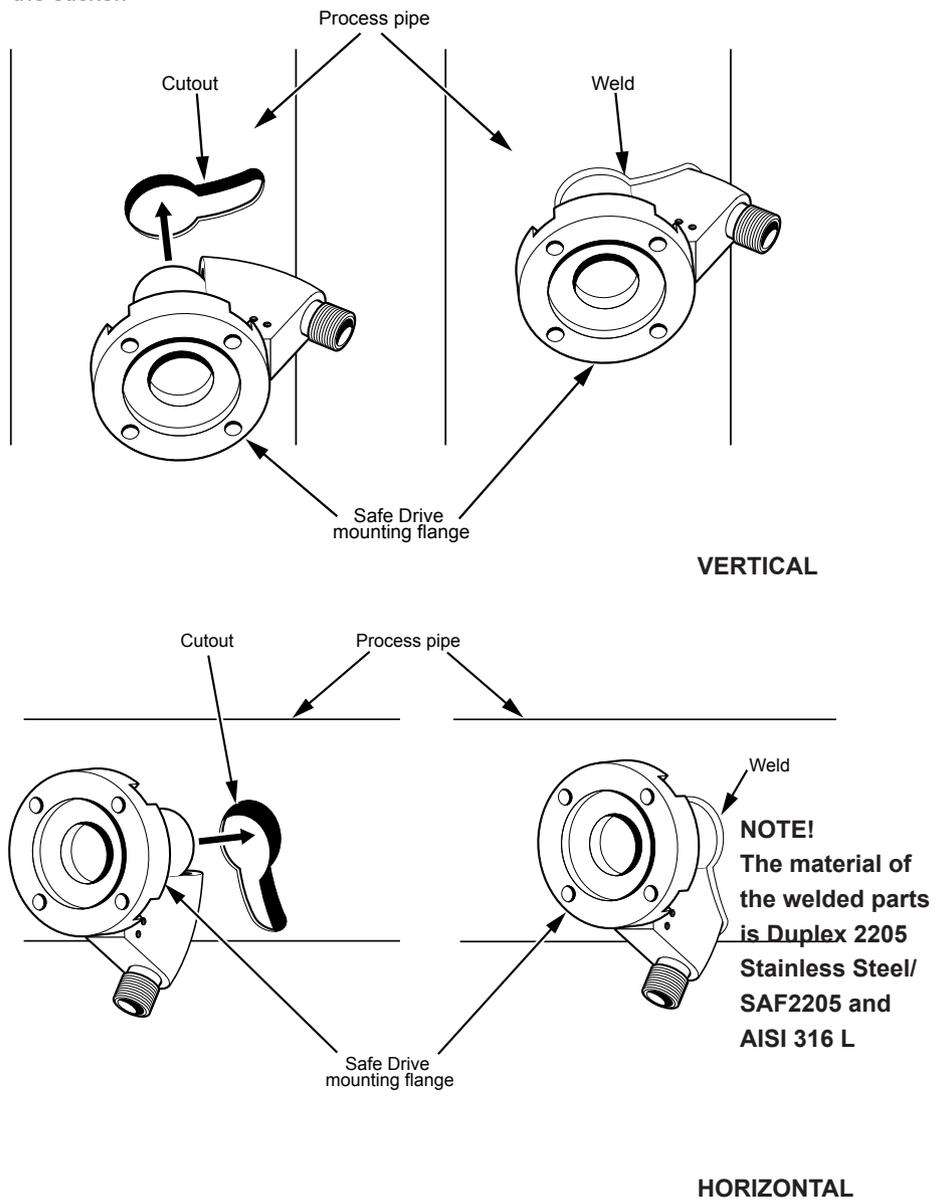
Figure 16 Installation guide sticker.

**NOTE:** For larger pipes, use the same dimensions as for 24" (610 mm) pipes.  
To cut the installation opening

1. Cut the installation guide sticker to match the pipe size.
2. Clean the surface of the pipe around the installation area and attach the sticker onto the pipe.

**NOTE:** Make sure that the FLOW marker is parallel to the pipe and points to the correct flow direction. On a horizontal pipe the nozzle points downwards and on a vertical pipe it points to right. The SD sensor system must always be installed in horizontal position and on the side of the pipe.

3. Drill two holes – 50 mm (2") and 25 mm (1") – as guided by the table in Figure 16.
4. Remove the bridge between the holes so that the opening is exactly the shape of the sticker.



**Figure 17** Installation on vertical and horizontal pipes.

### 5.1.3 Disassembling SDI2-23 Valve for Welding

To avoid thermal damage to the isolation valve sealing, you must separate the valve body from the valve assembly before it is welded onto the pipe.

**NOTE:** Be very careful not to drop or lose any parts that come loose when separating the body from the assembly.

To disassemble the SDI2-23 valve, open the four (4) M10 allen key bolts with an 8 mm (5/16") allen key (1).

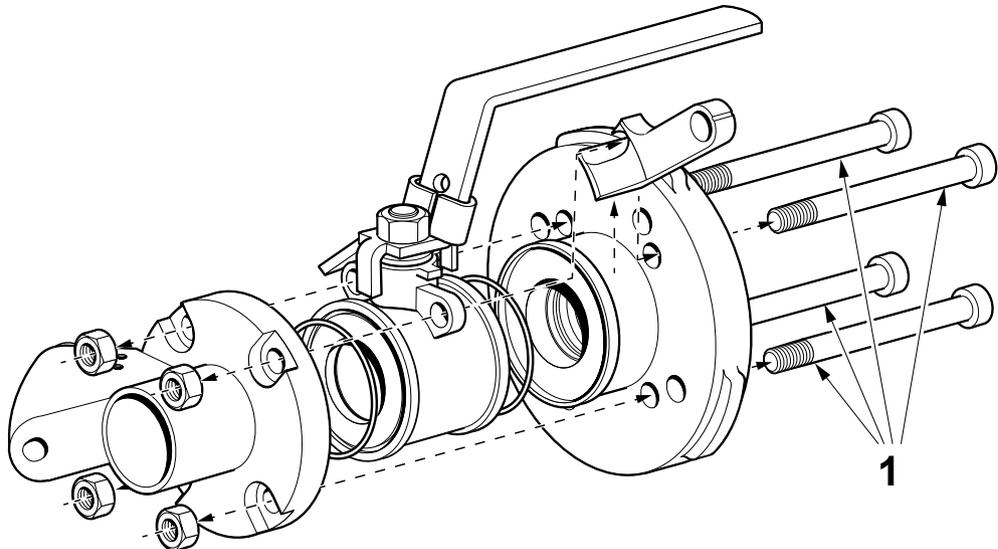
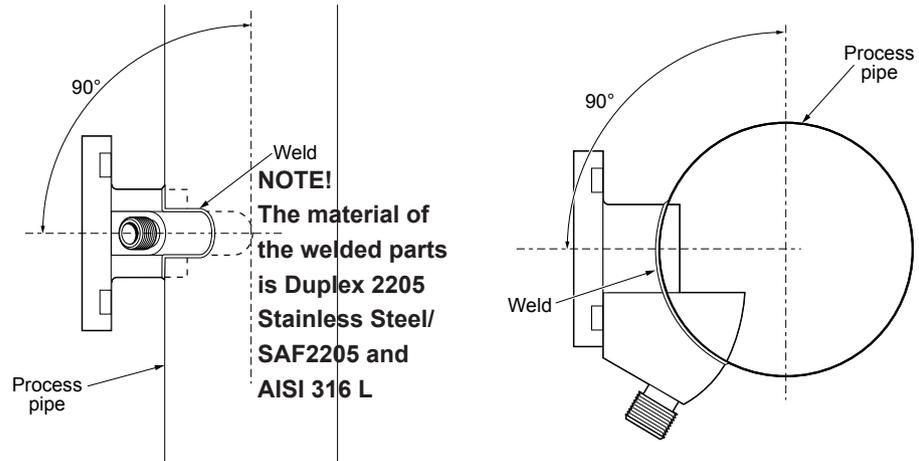


Figure 18 Disassembling valve.

### 5.1.4 Welding SDI2-23 Valve in Place

After you have disassembled the SDI2-23 valve, the valve body is welded onto the process pipe.

- The material of the SDI2-23 valve body is Duplex 2205 Stainless Steel/SAF2205 and AISI 316 L (EN 1.4462, ASTM S32205/S31803). Choose the welding method and a filler accordingly.
- See the attached drawings 2149 (MTG) and MTG472 for more detailed welding instructions.
- Follow all local requirements for welding.
- K-Patents recommends complying with the applicable EN / ASTM standards.
- Consider the materials and shapes of the welded objects when performing welding pre-processing (tools, cleaning, preheating).
- Consider the materials and shapes of the welded objects when performing welding post-processing (postheating, fluxing).



**Figure 19** Welding on vertical and horizontal pipes.

### 5.1.5 Reassembling SDI2-23 valve

After the SDI2-23 valve body has been welded in place, reassemble the valve in reverse order.

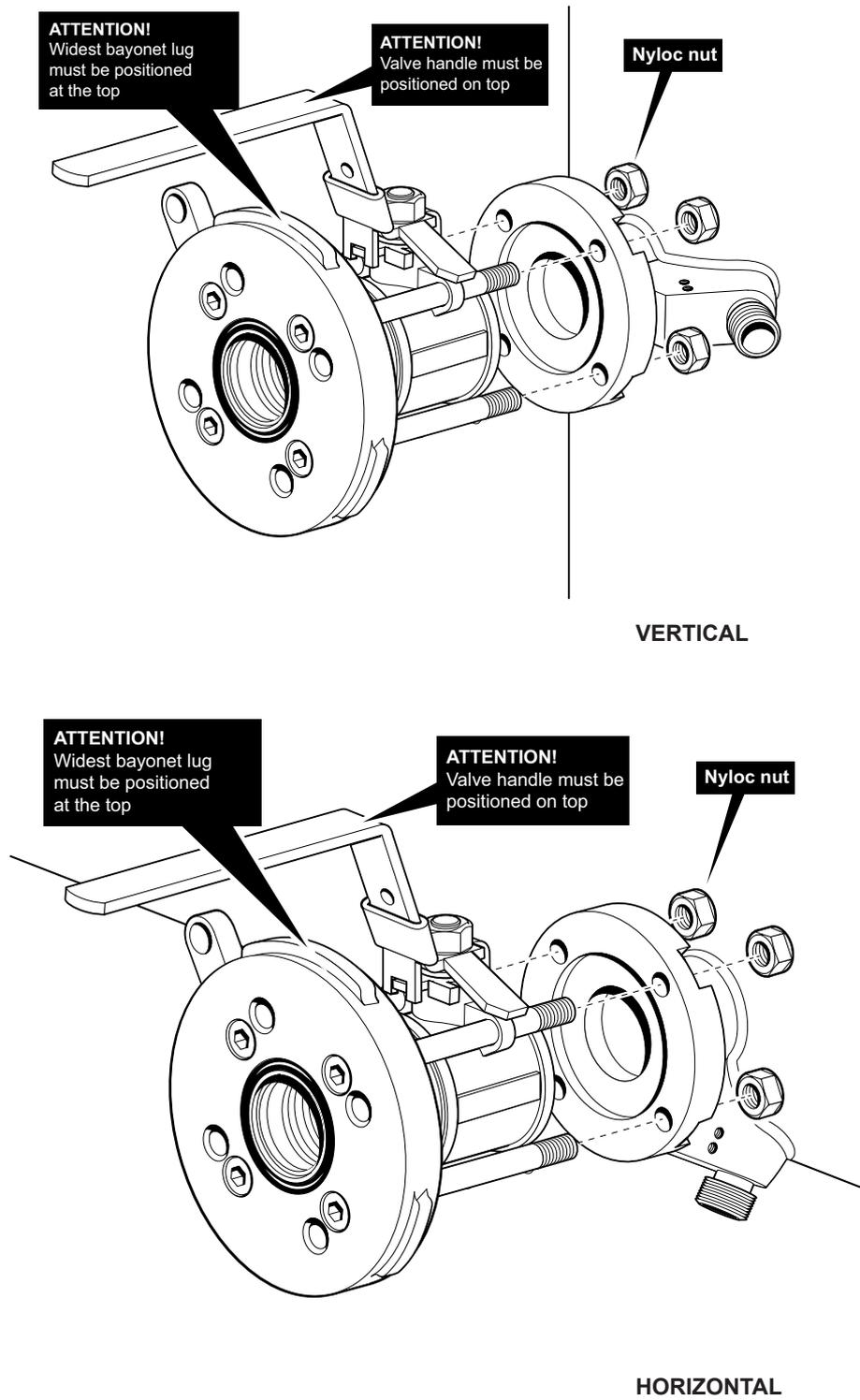
**NOTE:** Make sure that the seals for the ball valve are properly aligned.

- Make sure that the SDI2-23 valve handle and the largest bayonet connection are on top. Otherwise, you will not be able to insert the sensor in its place.
- Use Nyloc nuts. Tighten the bolts to a torque of 17 N-m (13 lb-ft) with an 8 mm (5/16") allen key.

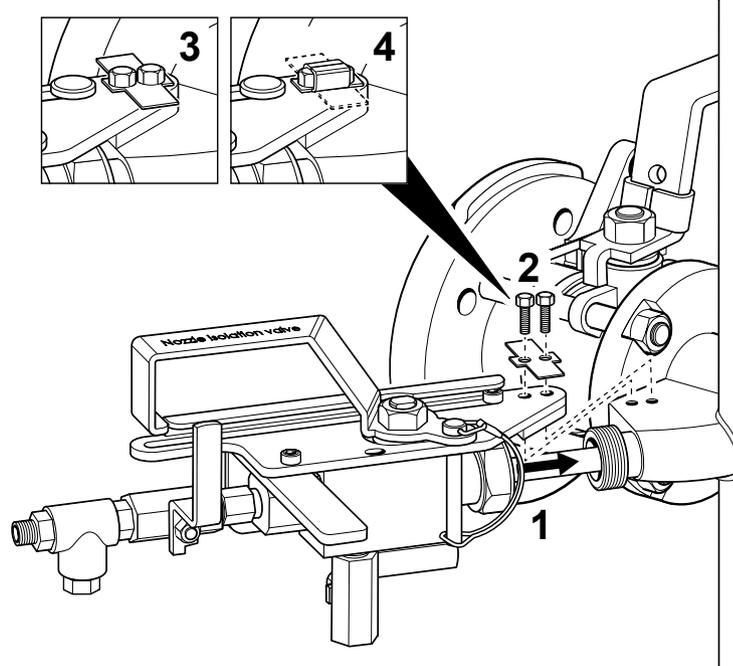
**WARNING:** Always shut the main steam/water valve before performing any work on the wash nozzle.

To re-install the wash nozzle assembly

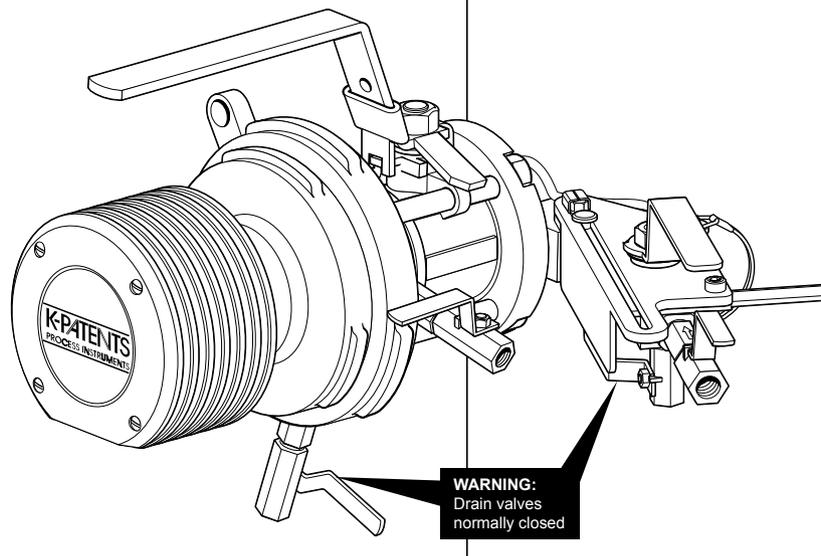
1. Insert the wash nozzle assembly to its place (1).
2. Place the nozzle guide plate in the correct position and tighten the two (2) M5 bolts (2).
3. Secure the wash nozzle with a locking plate (3, 4).



**Figure 20** Reassembling valve on vertical and horizontal pipes.



Unless otherwise indicated, the drain valves should be closed.



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### 5.1.6 Installing the steam prism wash system

In black liquor service material deposit, scaling or coating may occur on the prism surface. To avoid this, you need to install an integral prism wash with steam that uses the retractable nozzle included in the SDI2-23 valve.

#### Important steam prism wash considerations

- The distance from the steam nozzle on the SDI2-23 valve to the steam shut-off valve should be kept as short as possible to avoid condensate. The recommended length of the distance is 0.6 m (2 ft) or less.
- Separate or isolate the power to the solenoid from the power to the transmitter by installing a safety switch. This enables the steam wash to be serviced without having to power down the whole SD sensor system.
- Pipe the steam trap properly to drain so that the trap is not blowing hot steam.
- Steam piping upstream of shut-off valve is ½" or larger.
- In addition to the SDI2-23 valve steam fittings, the following components must be included in the steam wash installation:
  - steam shut-off valve
  - air-operated solenoid valve
  - steam trap
  - switch or terminal for power isolation

For K-Patents recommendations, please see *K-Patents Steam Instructions*.

- OPTIONAL, in case of contaminants: To remove any contaminants within the steam source, installing a steam strainer is recommended.
- OPTIONAL, in case of excessive pressure: If the steam pressure exceeds to maximum pressure differential, a pressure reducing valve (PR-3341-J) needs to be installed to reduce the steam pressure to optimal design.

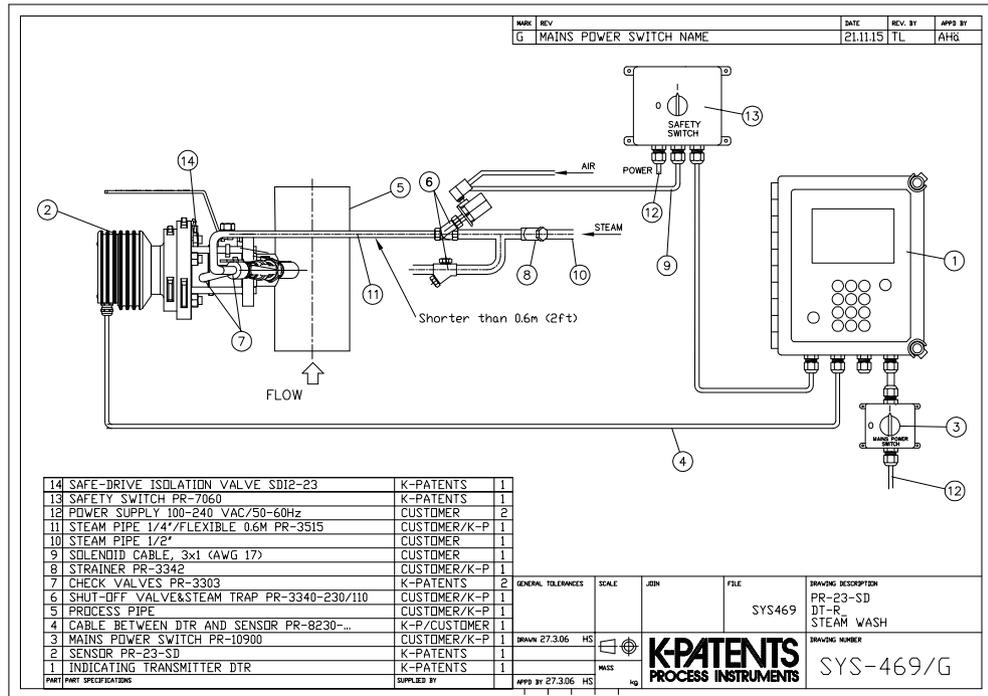


Figure 21 Mounting steam wash system.

To install the wash system

- Define the wash setting values for the wash system:
  - steam source minimum and maximum pressures
  - wash time – the time one wash will last (seconds)
  - recovery time – the time after the wash has finished, before the measurement is live data again (seconds)
  - interval – the time between washes (minutes)

### Recommended steam prism wash settings

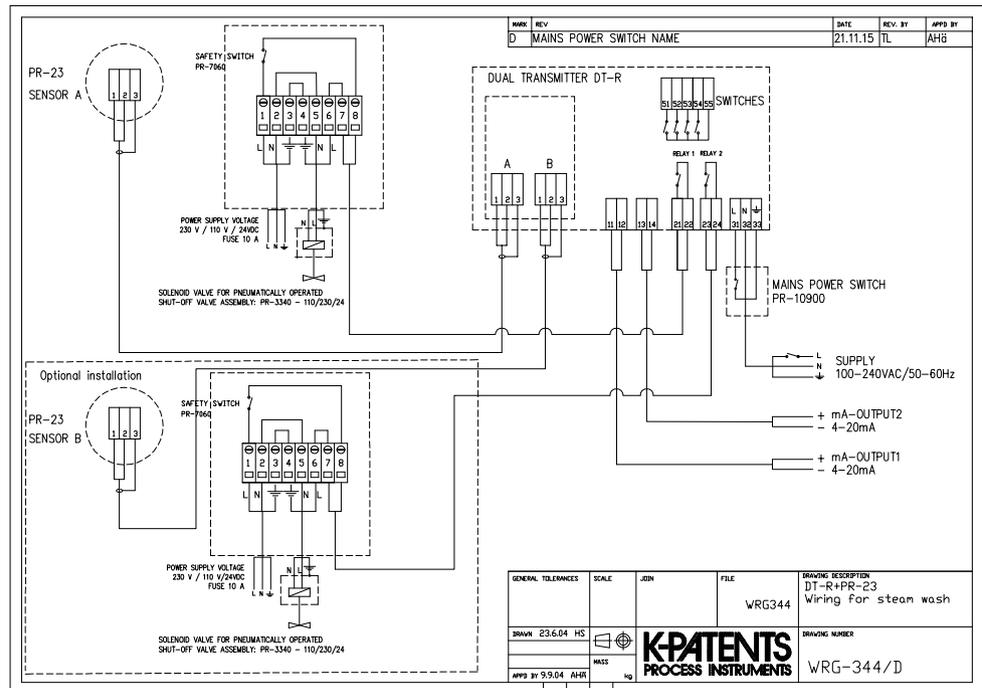
CONC % value	Minimum above process pressure	Maximum above process pressure	Wash time	Recovery	Interval
0-30 %	2 bar (30 psi)	4 bar (60 psi)	2-3 s	20 s	120-360 min

**NOTE:** Damage caused to prism by excessive pressure or washing is not covered by the product warranty.

Choose the correct steam source pressure by comparing it to the process pressure. The steam source pressure must be higher than process pressure to provide adequate washing, but excessive pressure may also cause premature damage or etching of the prism. Also, if the washing phase is programmed to last too long, the prism may wear out prematurely.

2. Install the steam pipes in the SDI2-23 valve, as instructed below.  
**NOTE:** All the necessary wash fittings are included in the valve.
3. Connect the steam wash system power supply.

For more information, please see *K-Patents Steam Instructions*.



**Figure 22** Wiring steam wash system

For more information on controlling the prism wash cycle, please refer to chapter *Configuring relays* in K-Patents user documentation.

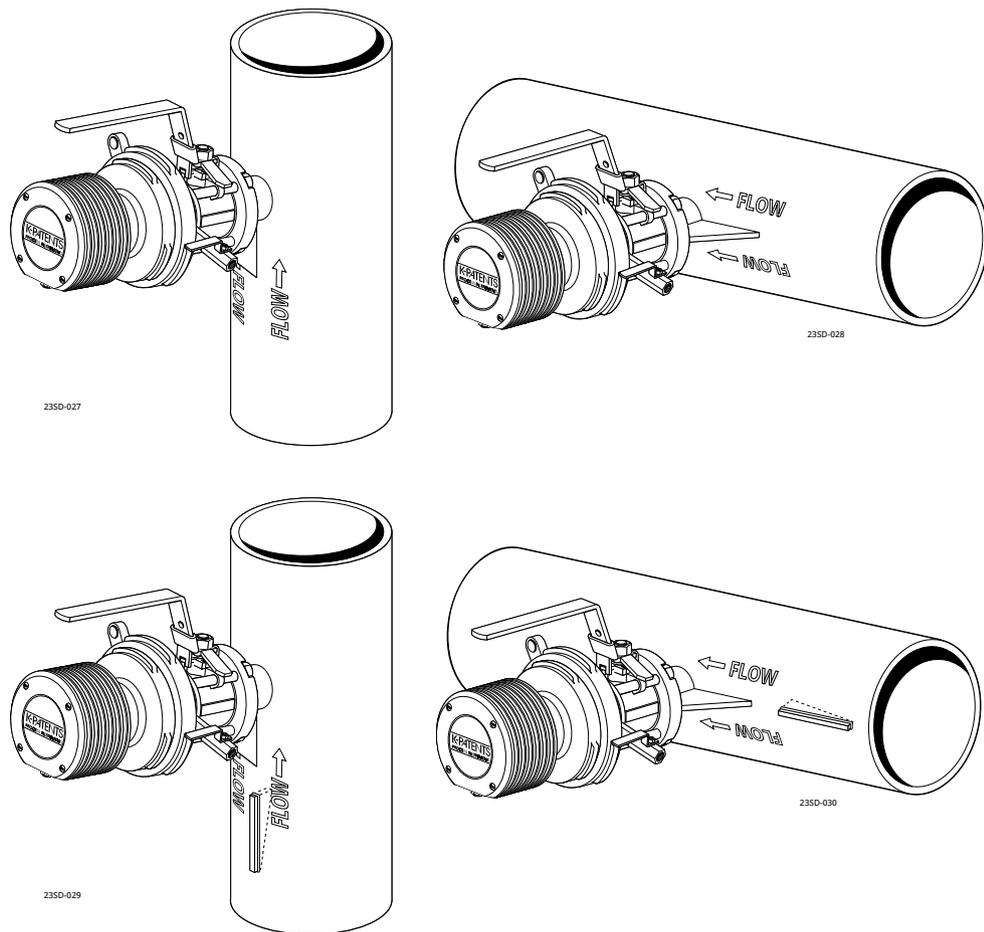
## 5.2 Installation of SAFE-DRIVE Process Refractometer and pulp installation plate for blow and pulp stock lines

Installation of the SAFE-DRIVE refractometer sensor system in the blow line and pulp stock line consists of:

- Welding the SDI2-23-PL isolation valve with pulp line installation plate
- Welding the knife guide -KN (optional and applicable for discharge line only, if calcined stones and metal objects are present).
- Assembling the SDI2-23-PL valve onto the processing piping.
- Installing the DTR transmitter.
- Installing the PR-23-SD sensor.

### 5.2.1 Spool piece assembly for blow and pulp stock lines

If the SDI2-23 valve was supplied pre-welded and assembled onto a pipe spool piece for integration in existing piping on site, please skip ahead to installing the DTR transmitter. For blow and pulp stock lines, K-Patents can provide 150 mm and 200 mm spool pieces with or without knife part -KN depending on the customer's preferences.



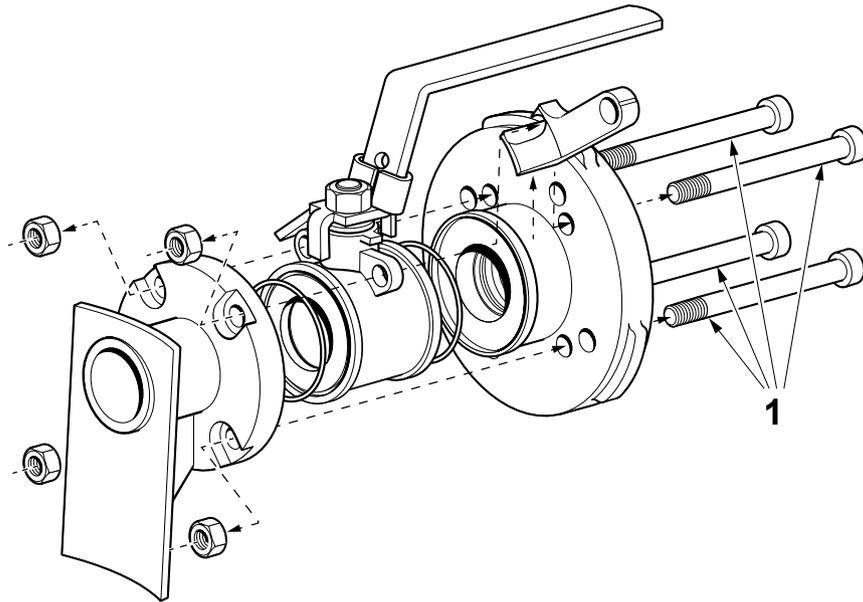
**Figure 23** Vertical and horizontal spool piece assemblies for blow and pulp stock lines systems without and with knife part.

### 5.2.2 Disassembling SDI2-23-PL valve for welding

To avoid thermal damage to the isolation valve sealing, you must separate the valve body from the valve assembly before it is welded onto the pipe.

**NOTE:** Be very careful not to drop or lose any parts that come loose when separating the body from the assembly.

To disassemble the SDI2-23-PL valve, open the four (4) M10 allen key bolts with an 8 mm (5/16") allen key (1).



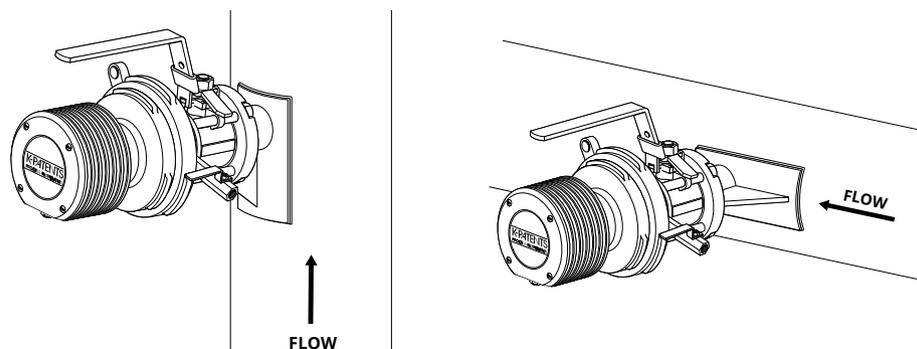
**Figure 24** Disassembling the SDI2-23-PL valve.

### 5.2.3 Welding SDI2-23-PL valve with installation plate in place

After you have disassembled the SDI2-23-PL valve, the installation plate is welded onto the process pipe.

- The material of the SDI2-23-PL installation plate is AISI 316 L stainless steel. Choose the welding method and a filler accordingly.
- See the attached drawings MTG 1147 for more detailed welding instructions.
- Follow all local requirements for welding.
- K-Patents recommends complying with the applicable EN / ASTM standards.
- Consider the materials and shapes of the welded objects when performing welding pre-processing (tools, cleaning, preheating).
- Consider the materials and shapes of the welded objects when performing welding post-processing (post-heating, fluxing).

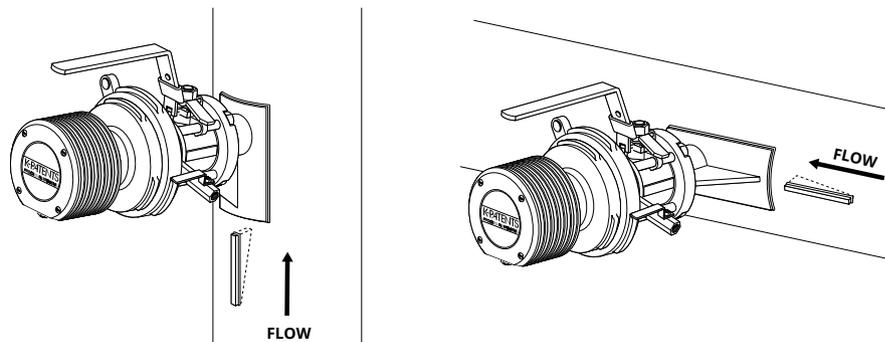
**NOTE:** Make sure that the FLOW markers on the plate are parallel to the pipe and that they point to the correct flow direction.



## 5.2.4 Welding the knife part (for discharge lines only)

For installations in pulp discharge lines where there may be calcined stones or metal objects in the line, an optional knife part is recommended before the location of the sensor. This part directs the metal objects or stones away and prevents them from hitting and damaging the prism surface.

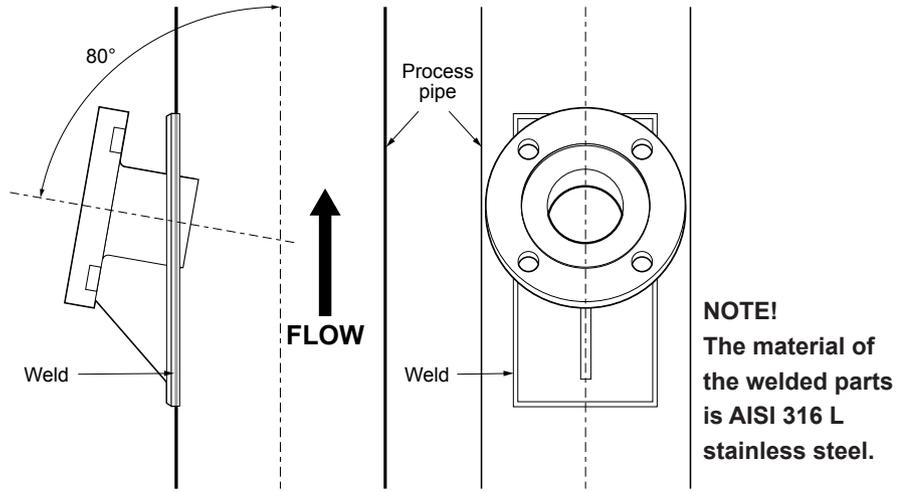
**NOTE:** The knife should be located before the sensor. Make sure that the FLOW markers on the plate are parallel to the pipe and that they point to the correct flow direction.



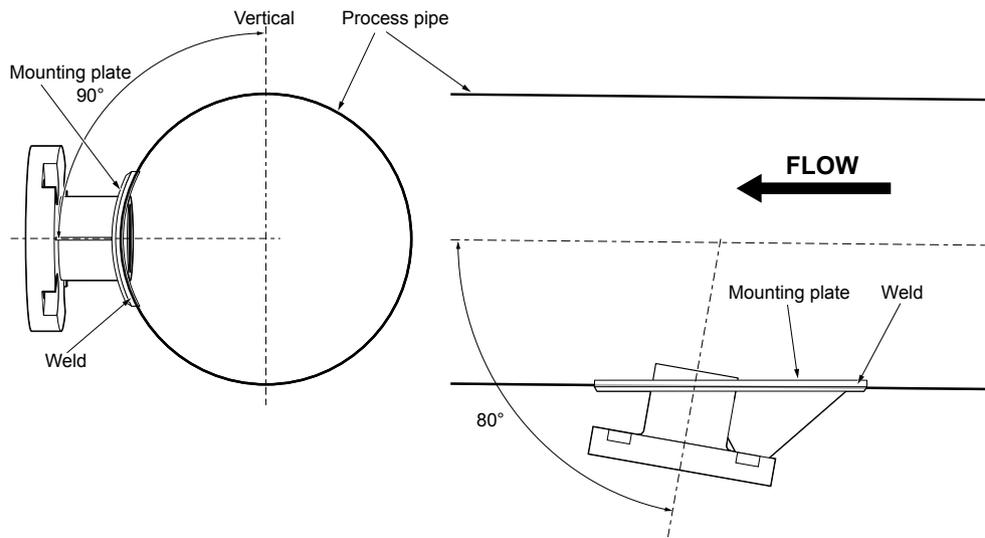
- The material of the knife part is AISI 316 L. Choose the welding method and a filler accordingly.
- Chamfer around the slit for the knife 6x100 mm (0,24 x 3,94 in) and 30 mm (1,18 in) before the installation plate.
- Tack weld the knife into the pipe.

**NOTE:** The ends of the knife act as stop logs and prevent it from falling inside the pipe. Cut the ends **only after** the knife is tacked weld in the pipe.

- Cut the ends of the knife.
- Continue welding.
- See Figure 27 and the attached drawing MTG 1147 for more detailed welding instructions.
- Follow all local requirements for welding.
- K-Patents recommends complying with the applicable EN/ASTM standards.
- Consider the materials and shapes of the welded objects when performing welding pre-processing (tools, cleaning, preheating).
- Consider the materials and shapes of the welded objects when performing welding post-processing (post-heating, fluxing).



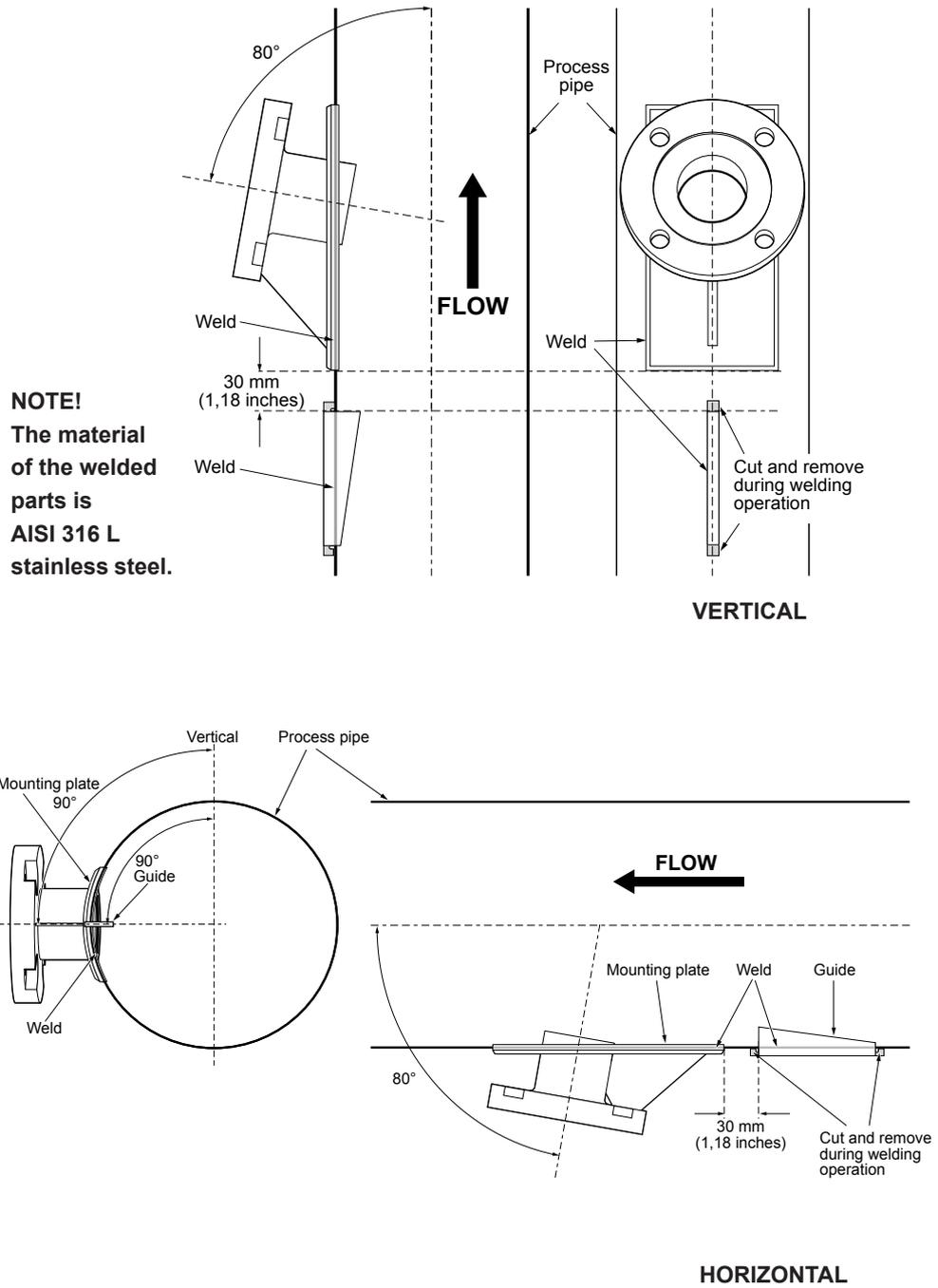
**VERTICAL**



**HORIZONTAL**

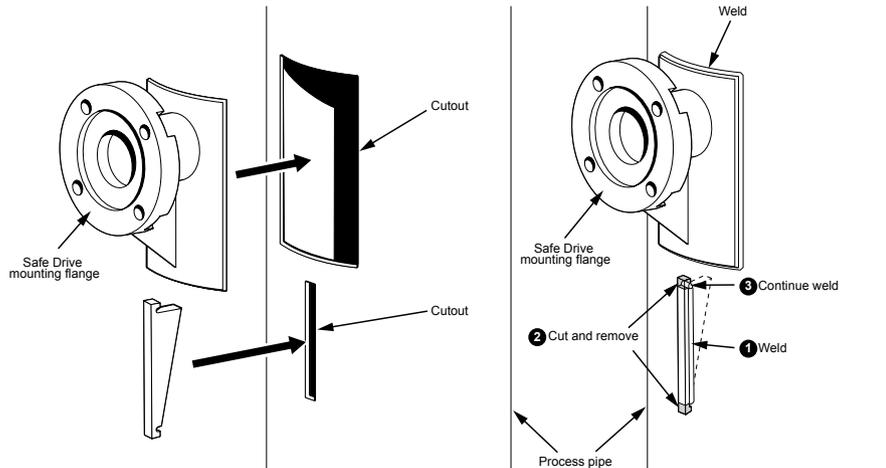
**Figure 25** Welding the installation plate without knife part on vertical and horizontal pipes.

**NOTE!** The material of the welded parts is AISI 316 L stainless steel.

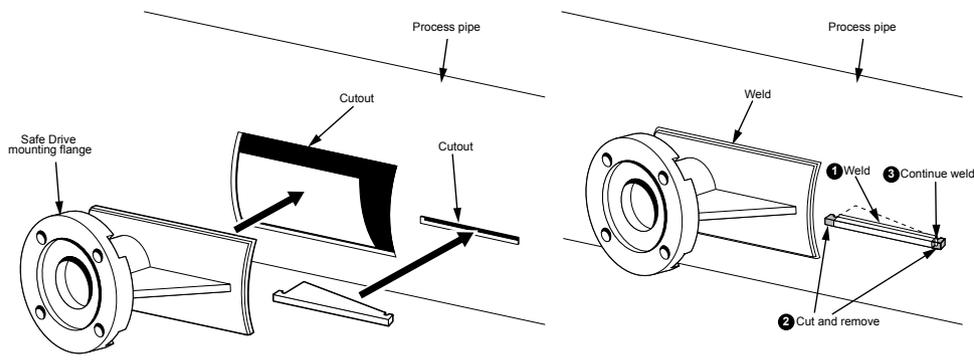


**Figure 26** Welding the installation plate and knife part on vertical and horizontal pipes.

**NOTE!** The material of the welded parts is AISI 316 L stainless steel.



**VERTICAL**



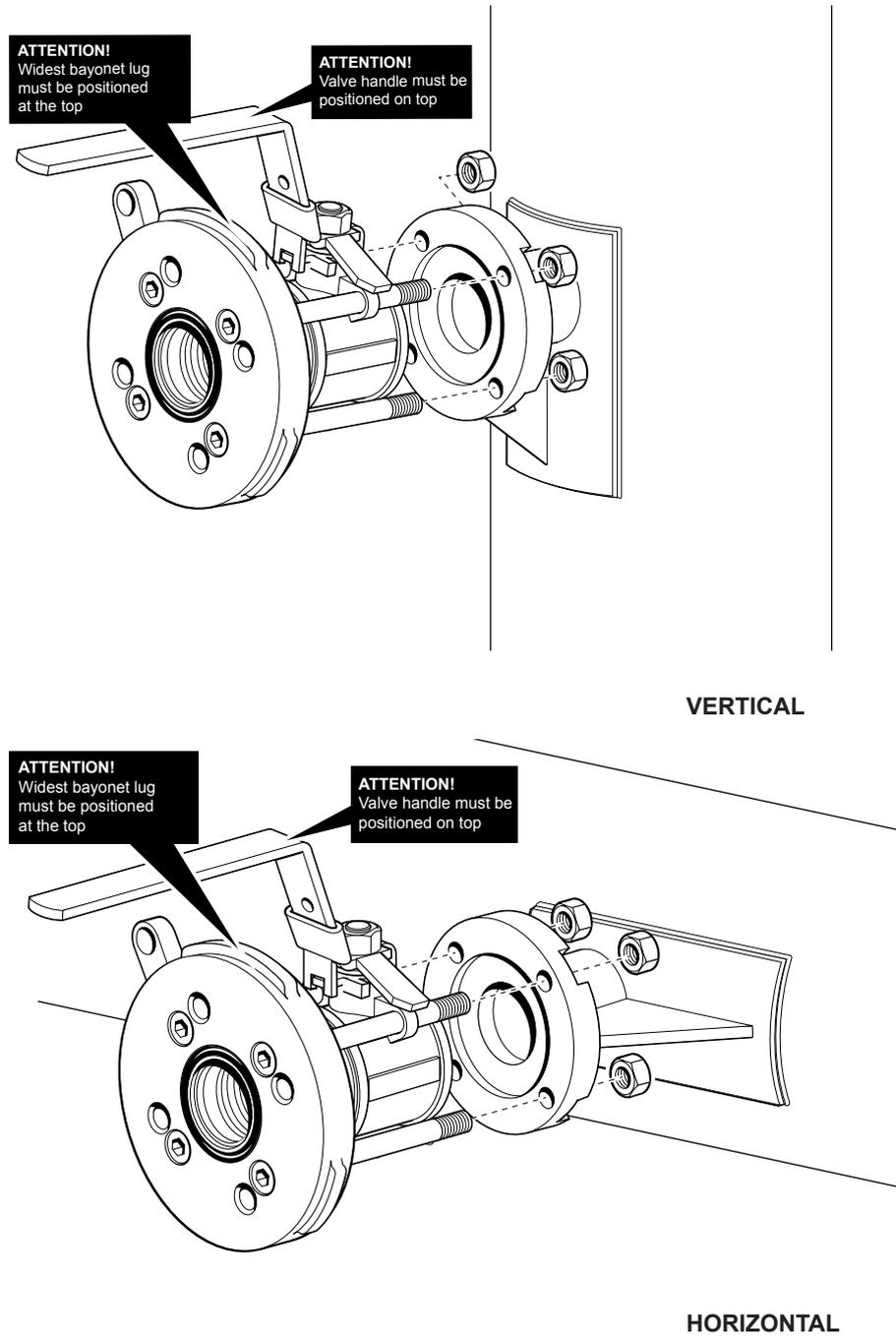
**HORIZONTAL**

**Figure 27** SDI2-23-PL-KN installation plate with knife on vertical and horizontal pipes.

### 5.2.5 Reassembling SDI2-23-PL valve

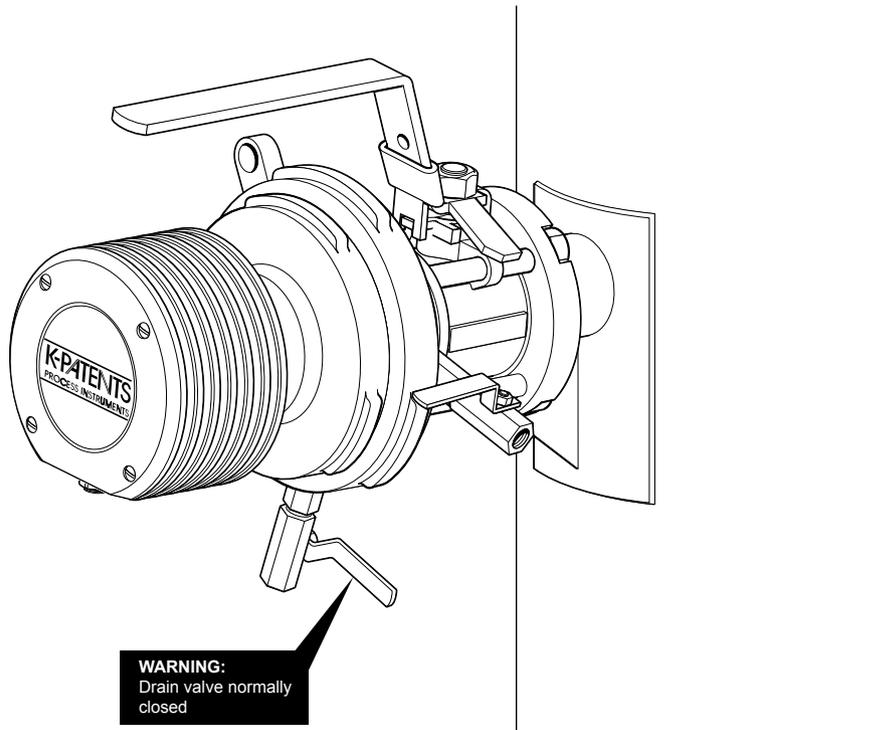
After the SDI2-23-PL valve body has been welded in place, reassemble the valve in reverse order.

**NOTE:** Make sure that the seals for the ball valve are properly aligned.



**Figure 28** Reassembling valve on vertical and horizontal pipes.

- Make sure that the SDI2-23-PL valve handle and the largest bayonet connection are on top. Otherwise, you will not be able to insert the sensor in its place.
- Use Nyloc nuts. Tighten the bolts to a torque of 17 N-m (13 lb-ft) with an 8 mm (5/16") allen key.



### 5.3 Before inserting and removing PR-23-SD sensor

**WARNING:** Always use the Safe-Drive Retractor tool for inserting and removing the sensor. Removing the sensor without the Retractor tool may cause a life-threatening situation, if there is any pressure in the process pipe. Inserting or removing sensor without Retractor tool may also cause damage to the lip seal. Always store the Retractor tool indoors in a clean and dry location.

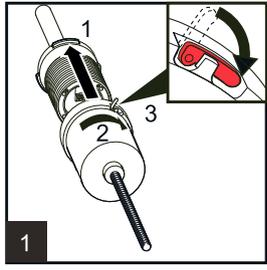
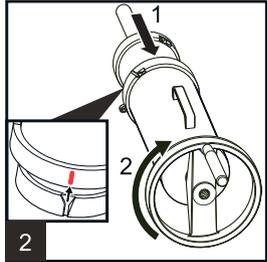
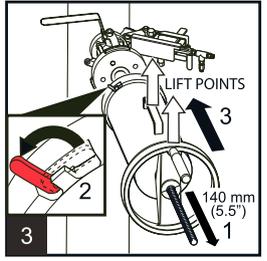
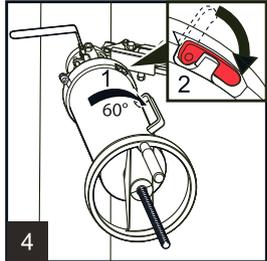
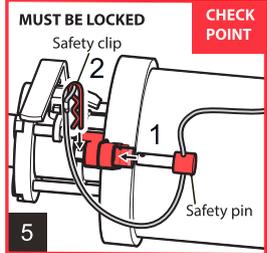
Successful sensor insertion and removal can only be guaranteed when the Retractor tool is used and the instructions for insertion or removal are carefully followed.

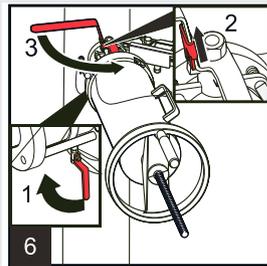
**NOTE:** Check the Retractor tool visually before starting insertion / removal process. Make sure the handwheel rotates freely.

**WARNING:** If you detect leaking at any point of sensor insertion or removal process, revert immediately to the previous step in the process. Do not continue insertion / removal until the reason for leakage has been cleared and fixed.

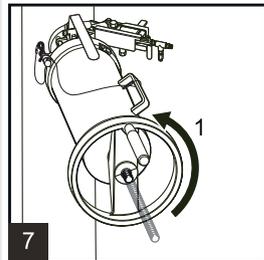
Insert and remove the sensor as instructed in the following chapters. For more thorough instructions, please refer to K-Patents user documentation or visit the K-Patents website to see the instructional video on inserting and removing the sensor ([www.kpatents.com](http://www.kpatents.com), PR-23-SD Safe-Drive™ Operation Guide Video).

## 5.4 Inserting sensor

	<ol style="list-style-type: none"> <li>1. Insert the sensor into Inner casing. Make sure that the sensor cable gland has been taken off. Match the bayonet closing with sensor flange so that the latch is slightly to the left of the top and the sensor cable passage is straight down.</li> <li>2. When sensor flange is flush with the bottom of Inner casing, rotate Inner casing 60 degrees clockwise to lock it to the flange.</li> <li>3. Push down locking latch to secure the connection.</li> </ol>
	<ol style="list-style-type: none"> <li>1. Fit Outer casing over Inner casing. To match the casings, check that the rail on the Inner casing matches the groove on Outer casing. The latch of Inner casing should be slightly to the right from the top and the handle of Outer casing should point up.</li> <li>2. Turn the hand-wheel clockwise until it stops to draw the Inner casing with sensor into Outer casing.</li> </ol>
	<ol style="list-style-type: none"> <li>1. The sensor should now be inside Retractor and about 140 mm (5.5") of the screw thread should stick out of the middle of the wheel.</li> <li>2. Unlock the latch on Outer casing.</li> <li>3. Take a firm hold of the hand-wheel and handle and lift Retractor (with sensor) over the isolation valve flange. Keep handle up.</li> </ol>
	<ol style="list-style-type: none"> <li>1. Rotate Outer casing 60° clockwise to lock the bayonet.</li> <li>2. Lock Outer casing latch.</li> </ol>
	<ol style="list-style-type: none"> <li>1. Insert the safety pin.</li> <li>2. Lock the safety pin with safety clip.</li> </ol> <p><b>DO NOT PROCEED UNTIL YOU HAVE COMPLETED THIS STEP!</b></p>



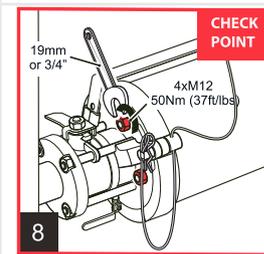
1. Close the blow-out ball valve under Isolation valve.
2. Lift up the Isolation valve handle locking plate.
3. Open Isolation valve by turning the valve handle 90°. The valve is open when the ball valve handle is parallel to Retractor and sensor.



Now the sensor can be inserted into the process.

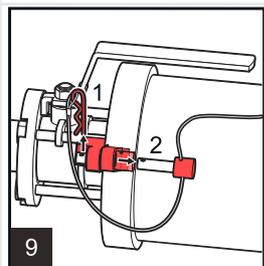
1. Turn the hand-wheel counterclockwise until it stops, i.e. until the sensor flange connects with Isolation valve and only the end of the screw thread is visible.

**Warning!** If you detect leaking, revert immediately to the previous step. Do not continue the installation until the reason for leakage has been cleared and fixed.

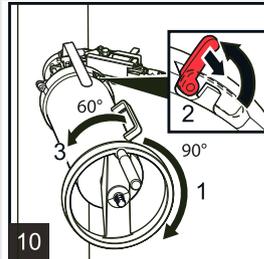


Fit the four M12 nuts to the bolts holding the sensor to Isolation valve and screw them on with a 19 mm or 3/4" wrench. Important: Do not tighten the nuts too hard, set the torque at 50 Nm (37 ft/lbs).

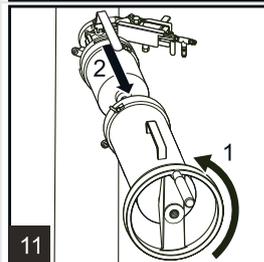
**DO NOT PROCEED UNTIL YOU HAVE COMPLETED THIS STEP!**



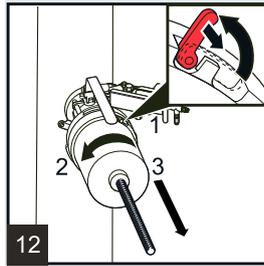
1. Remove the safety clip.
2. Remove the safety pin.



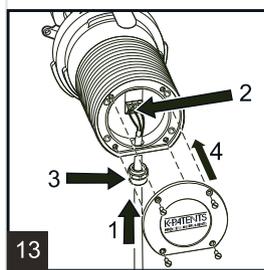
1. Turn the wheel 90° clockwise.
2. Open the locking latch on Outer casing.
3. Rotate Outer casing handle 60° counterclockwise.



1. Turn the hand-wheel counterclockwise to drop the thread.
2. Lift off Outer casing.



1. Lift up the latch of Inner casing to unlock it.
2. Rotate the casing 60° counterclockwise to release it from the flange.
3. Lift Inner casing away from the sensor head.



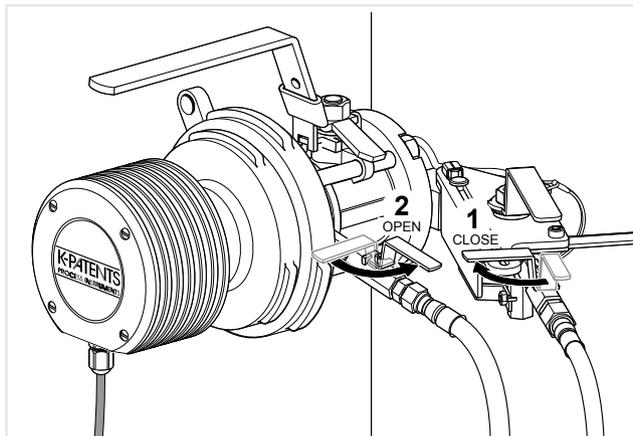
Ensure the DTR is switched off. Connect the sensor cable to the DTR.

1. Push the interconnecting cable through the cable gland and into the sensor.
  2. Connect the interconnecting cable to the sensor.
  3. Tighten the cable gland onto the sensor
  4. Fit the nameplate onto the sensor and screw it on.
- Turn on DTR power to power up the Safe-Drive™ system. Open wash valve.

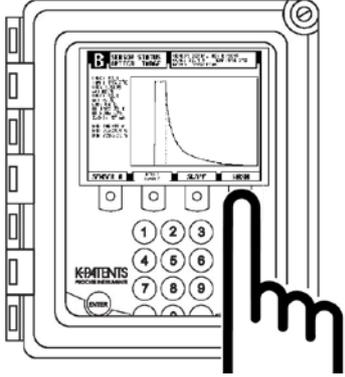
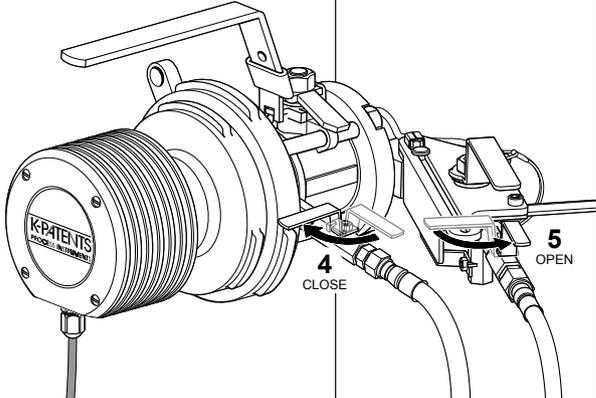
## 5.5 Box flushing

Carry out box flushing before sensor removal when the sensor has been in process for several months. Box flushing removes dried process medium from isolation valve and makes sensor removal easier.

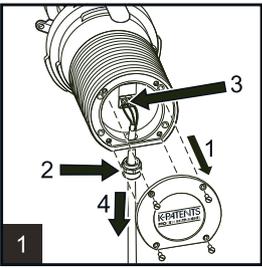
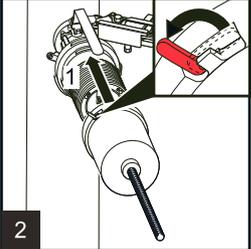
**WARNING:** Do not activate box steam flush, if the sensor and the Retractor tool are not installed to the isolation valve!

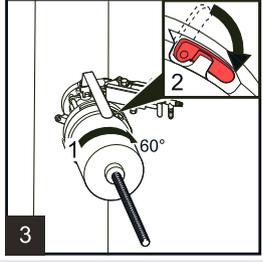
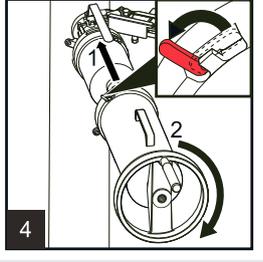
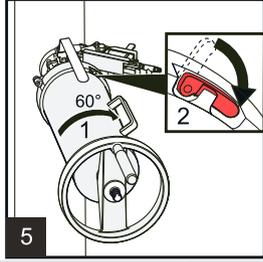
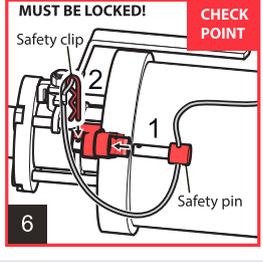
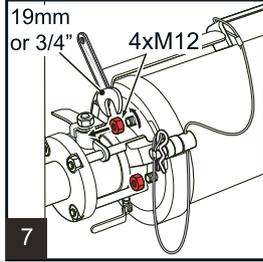
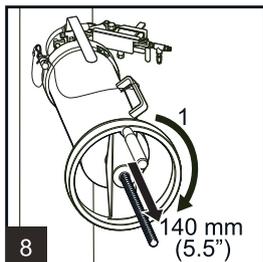


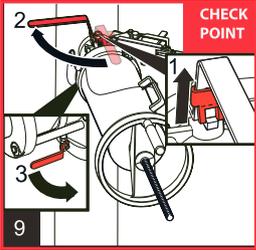
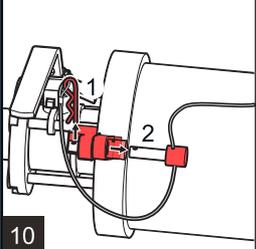
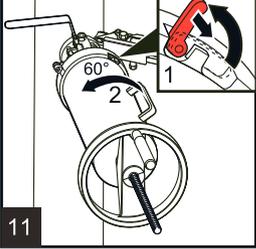
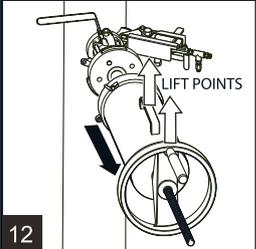
1. Close the 1/4" valve to the nozzle (1).
2. Open the 1/4" valve to the box (2).

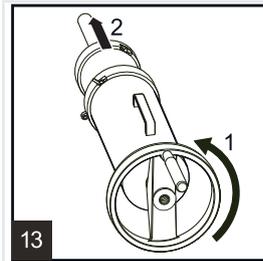
	<p>3. In the DTR transmitter, go to MENU › SENSOR STATUS and activate wash by pressing WASH button.</p> <p>Repeat the wash 3–5 times.</p>
	<p>4. Close the 1/4" valve to the box (4).</p> <p>5. Open the 1/4" valve to the nozzle (5).</p>

## 5.6 Removing sensor

	<p>Switch off the DTR to cut off power from the sensor. Close wash valve.</p> <ol style="list-style-type: none"> <li>1. Unscrew and remove sensor nameplate</li> <li>2. Loosen the cable gland</li> <li>3. Unscrew the wires</li> <li>4. Remove the sensor cable and cable gland</li> </ol> <p>Note: If another in-line sensor is connected to the same DTR, disconnect the loose cable from the DTR and turn on power again.</p>
	<ol style="list-style-type: none"> <li>1. Lift up the latch of Inner casing to unlock it. Lift Inner casing over the sensor head. The latch of Inner casing should be slightly to the left.</li> </ol>

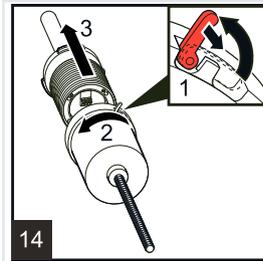
 <p>3</p>	<ol style="list-style-type: none"> <li>1. Rotate Inner casing 60° clockwise to lock it onto the flange.</li> <li>2. Lock Inner casing latch.</li> </ol>
 <p>4</p>	<ol style="list-style-type: none"> <li>1. Open the locking latch on Outer casing. Grab Outer casing with one hand on the handle and the other hand on the wheel. Fit Outer casing over Inner casing.</li> <li>2. Turn the hand-wheel clockwise to get the thread of Inner casing running through the hand-wheel.</li> </ol>
 <p>5</p>	<ol style="list-style-type: none"> <li>1. Rotate Outer casing 60° clockwise to lock the bayonet.</li> <li>2. Lock Outer casing latch.</li> </ol>
 <p>6</p>	<ol style="list-style-type: none"> <li>1. Insert the safety pin.</li> <li>2. Lock the safety pin with the safety clip.</li> </ol> <p><b>DO NOT PROCEED UNTIL YOU HAVE COMPLETED THIS STEP!</b></p>
 <p>7</p>	<p>Open and remove the four M12 nuts on the bolts holding the sensor to Isolation valve using a 19 mm or ¾" wrench.</p>
 <p>8</p>	<ol style="list-style-type: none"> <li>1. To remove the sensor from the process, turn the hand-wheel clockwise until it stops. At this stage about 140 mm (5.5") of the thread should stick out from the middle of the wheel.</li> </ol> <p>Warning! If you detect leaking, revert immediately to the previous step. Do not continue removal until the reason for leakage has been cleared and fixed.</p>

	<ol style="list-style-type: none"> <li>1. Lift up Isolation valve handle locking plate.</li> <li>2. Close Isolation valve by turning the handle 90° Important: Isolation valve is properly closed when the handle points away from the sensor and the locking plate drops down over the handle.</li> <li>3. Open the blow-out valve under Isolation valve for box cleaning to get rid of any process liquid inside Isolation valve. Warning! Some process liquid will leak out through the small ball valve, beware of splashing!</li> </ol> <p><b>DO NOT PROCEED UNTIL YOU HAVE COMPLETED THIS STEP!</b></p>
	<ol style="list-style-type: none"> <li>1. Remove the safety clip.</li> <li>2. Pull out the safety pin.</li> </ol>
	<ol style="list-style-type: none"> <li>1. Lift open Outer casing locking latch.</li> <li>2. Rotate Outer casing 60° counterclockwise so that the handle comes up on top.</li> </ol>
	<p>Take a firm hold on the hand-wheel and the handle and pull out Retractor with sensor inside. Warning! A firm hold of the tool is essential as the combination of the tool and the sensor is noticeably heavier than Retractor alone.</p> <p>Note: To ensure Isolation valve after the Safe-Drive tool with the sensor has been removed, you can bolt a standard ANSI 1.5" 105 lbs blind flange to Isolation valve with 1/2" (M12) bolts and nuts.</p> <p>A lock can be added to Isolation valve handle. Warning! The sensor tip is hot and may be covered with liquor. It is recommended to rinse the sensor tip and Isolation valve with hot water.</p>



Put Retractor with sensor onto a table or similar surface so that the hand-wheel has space to turn.

1. Turn the hand-wheel counterclockwise to drop the thread, i.e. until Outer casing is no longer connected to the parts inside.
2. Pull off Outer casing

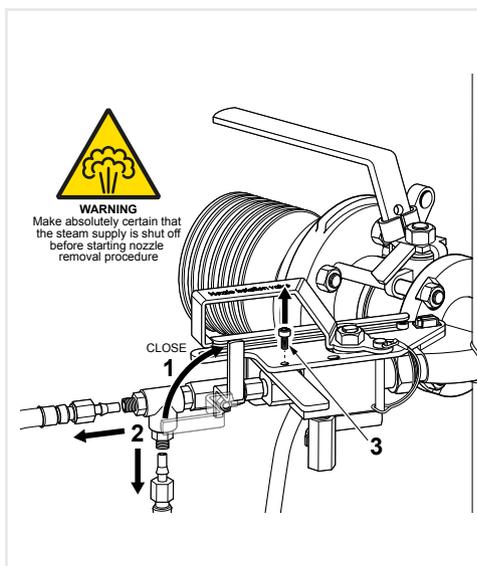


1. Open the latch on Inner casing.
2. Keep sensor steady with one hand and rotate Inner casing counterclockwise with the other hand to unlock Inner casing from sensor.
3. Pull off the sensor.

## 5.7 Removing wash nozzle

Remove the wash nozzle as instructed in the following illustrations: For more thorough instructions, please refer to K-Patents user documentation or visit the K-Patents website to see the instructional video on inserting and removing the sensor ([www.kpatents.com](http://www.kpatents.com), PR-23-SD Safe-Drive™ Operation Guide Video).

**WARNING:** Always shut the main steam valve before performing any work on the wash nozzle.

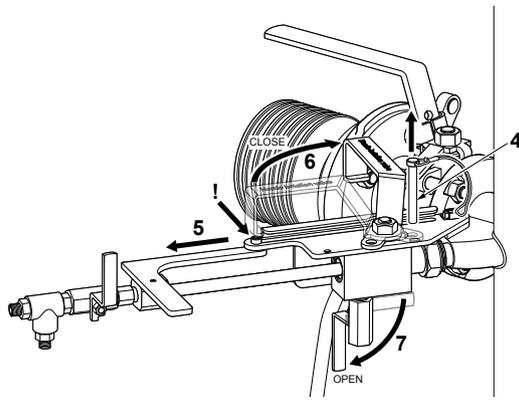
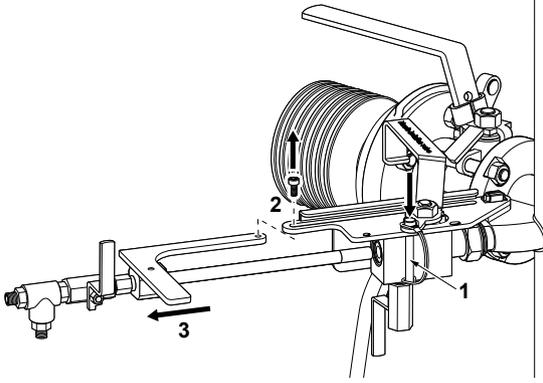


**WARNING:** Before you start removing the wash nozzle, make sure that the steam supply is shut off and the steam system is depressurized.

1. Close the steam line (1).
2. Detach the flexible steam line from the nozzle (2).

**NOTE:** Do not remove the check valve!

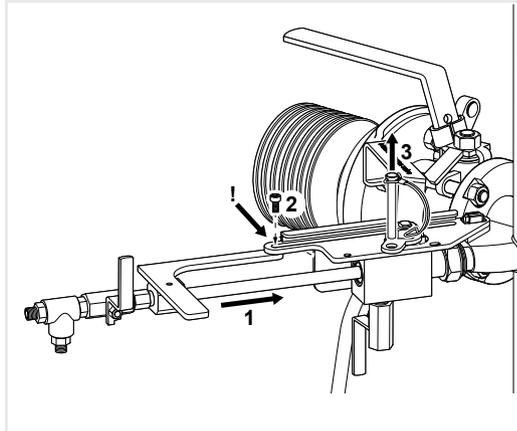
3. Open nozzle locking screw (3) with 4mm allen key.

	<ol style="list-style-type: none"> <li>4. Remove the isolation valve locking pin (4).</li> <li>5. Pull the nozzle (5) out until the nozzle guide stops it.</li> <li>6. Close the nozzle isolation valve (6).</li> <li>7. Open the check port 1/4" ball valve (7).</li> </ol> <p><b>NOTE:</b> Only little process liquid should flow from the nozzle. If process liquid keeps on flowing, the nozzle isolation valve is damaged and it is not safe to remove the nozzle. Do not proceed with nozzle removal.</p>
	<ol style="list-style-type: none"> <li>8. Lock the isolation valve handle (1).</li> <li>9. Open the nozzle attachment screw (2) using a 5 mm allen key and pull the nozzle (3) out.</li> </ol> <p><b>WARNING:</b> The nozzle tip is hot and may be covered with liquor. It is recommended to rinse the nozzle tip and the isolation valve with hot water.</p>

## 5.8 Inserting wash nozzle

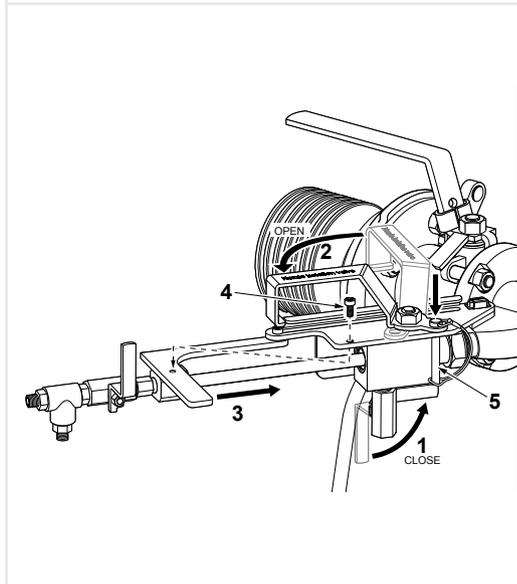
Insert the wash nozzle as instructed in the following illustrations: For more thorough instructions, please refer to K-Patents user documentation or visit the K-Patents website to see the instructional video on inserting and removing the sensor ([www.kpatents.com](http://www.kpatents.com), PR-23-SD Safe-Drive™ Operation Guide Video).

**WARNING:** Always shut the main steam valve before performing any work on the wash nozzle.

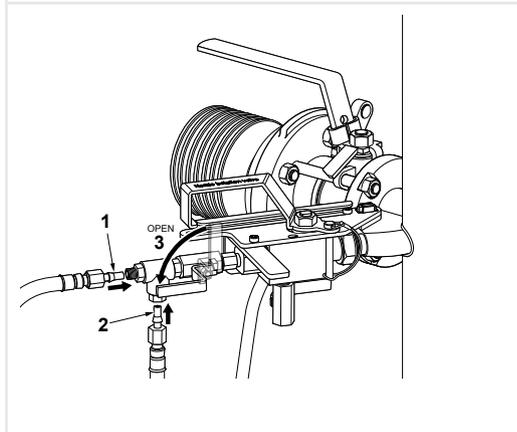


Check the nozzle and valve before installing the wash nozzle. Use thread seal tape for all thread connections.

1. Insert the nozzle into the isolation valve (1).
2. Attach the nozzle to the nozzle guide with one M5x10 screw (2) using a 5 mm allen key.
3. Remove the safety pin (3).



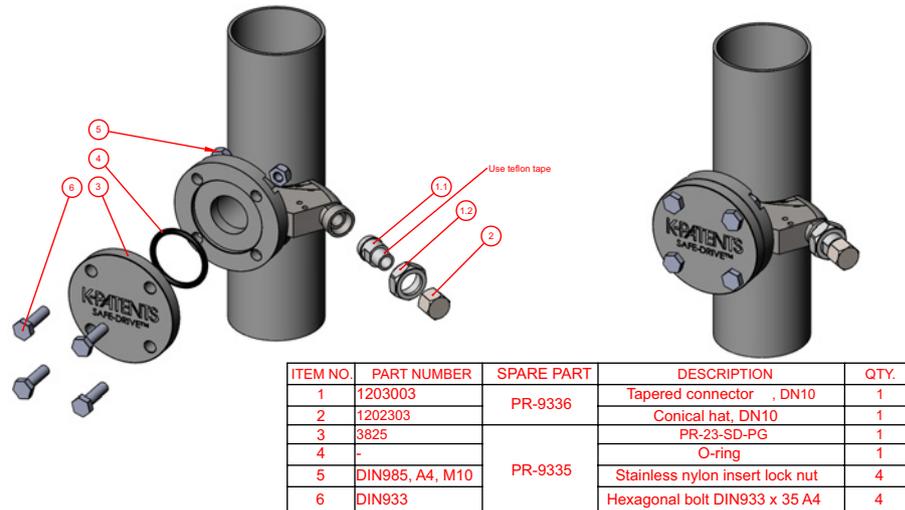
4. Close the 1/4" check port valve under the nozzle isolation valve (1).
5. Open the isolation valve (2) by turning the handle counterclockwise.
6. Push the nozzle to the process (3).
7. Attach the nozzle to the nozzle guide with one M5x10 screw (4) using a 4mm allen key.
8. Lock the isolation valve handle with the safety pin (5).



9. Connect the steam line and sensor flush flexible line to the nozzle T-piece (1,2).
10. Open the steam supply line valve (3).
11. Check the functionality of washing from the optical image window.

## 5.9 Blinding the SD system

A SD connection that is no longer used can be secured with blind plugs.



## 5.10 Installing Indicating transmitter DTR

The indicating transmitter DTR is a specialized computer designed to process data received from one or two sensors. The transmitter consists of a protecting enclosure, a front panel, an LCD display and a keyboard. Knockout padlock provisions are included for locks to prevent unauthorized access.

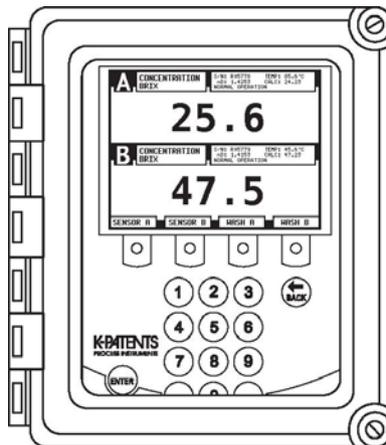


Figure 29 DTR transmitter.

- DTR transmitter location:
  - easily accessible
  - well lit, but no direct sunlight
  - dry
  - ambient temperature range of the transmitter is 0–45 °C (32–113 °F)
  - free of vibration or other such disturbances

- Consider the interconnecting cable length when choosing the installation location. The standard delivery is 10 meter (33 feet) of cable and the maximum allowed length is 200 meters (660 feet). You can use your own cable as long as it meets IEC 61158-2 type A standard requirements. For more information, please refer to chapter *Interconnecting cable specifications* in K-Patents user documentation.
- Consider installing a drip shield to protect the transmitter from rain, sun and dust, especially if the transmitter is installed outside.

**WARNING:** The transmitter does not have a built-in power switch so it is always powered when connected to a power source. K-Patents recommends mounting an external power switch to control the power supply.

To install the transmitter

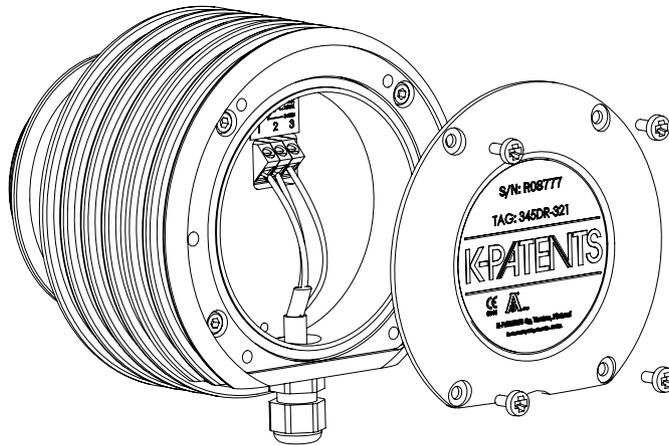
1. Install the transmitter vertically on an upright surface (wall) using the four mounting feet, preferably on the eye level of the user.

**WARNING:** Do not drill mounting holes in the enclosure. That will affect the protection class of the enclosure and damage the electronics.

2. Connect the PR-23-SD sensor:

- Remove the four (4) screws holding the sensor nameplate.
- Connect the signal wires to terminals 1 and 2.
- Connect the cable shield to terminal 3.
- Tighten up the cable gland.
- Screw the nameplate back on.

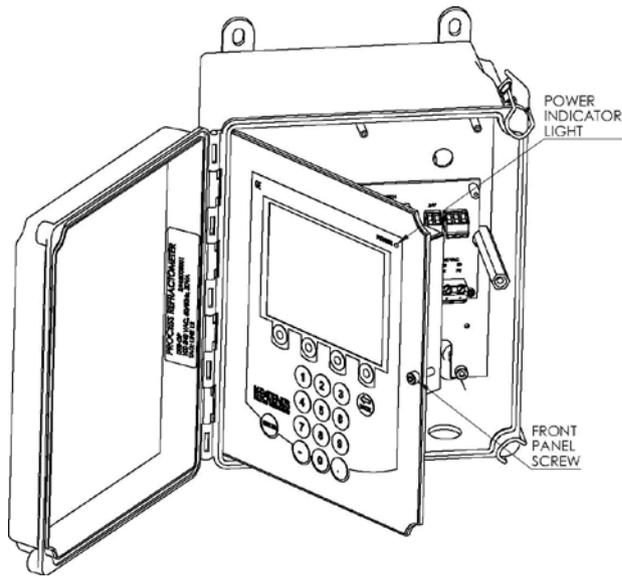
**NOTE:** To avoid damage from stray voltages and short-circuiting, always disconnect the sensor cables from the transmitter before removing the sensor.



**Figure 30** Sensor electrical connections.

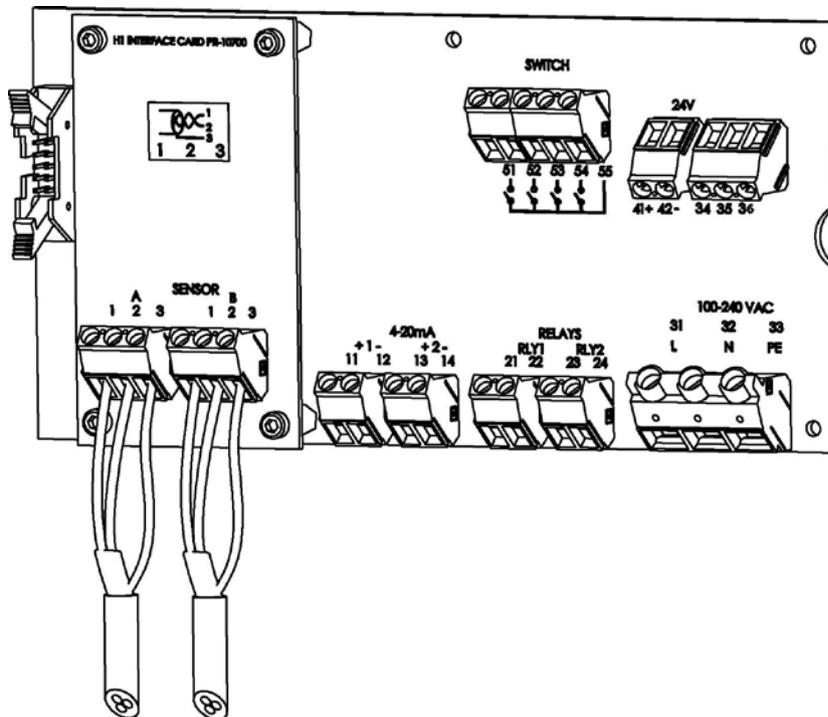
3. Open the front panel by loosening the front panel screw.

**WARNING:** Always check that the power is off before opening the front panel. If the green power indicator light is on, there is still power in the system. To completely turn off the power, disconnect the power supply cord or use the external power switch (if installed).



**Figure 31** Opening transmitter front panel

4. Connect the primary AC power to a separate terminal strip in the lower right-hand corner of the motherboard. The three terminals are marked 31/L, 32/N, and 33/PE (protective earth), which is directly connected to the exposed metal parts of the transmitter.
5. Connect the wiring wash relay to solenoid valve from the RELAYS terminals.
6. Connect the 4-20mA output.



**Figure 32** Transmitter H1 and motherboard connections

**H1**

<b>A 1 2 3</b>	Connection for Sensor A, signal wires (1, 2), cable shield (3).
----------------	---

<b>B 1 2 3</b>	Connection for Sensor B, signal wires (1, 2), cable shield (3).
----------------	---

**Motherboard**

<b>11 12</b>	4–20 mA output 1, positive (11), negative (12), max. load 1000 Ohm, galvanically isolated.
--------------	--

<b>13 14</b>	4–20 mA output 2, positive (13), negative (14), max. load 1000 Ohm, galvanically isolated.
--------------	--

<b>21 22</b>	Relay 1, one contact output, max. 250 V AC, max. 3 A.
--------------	---

<b>23 24</b>	Relay 2, one contact output, max. 250 V AC, max. 3 A.
--------------	---

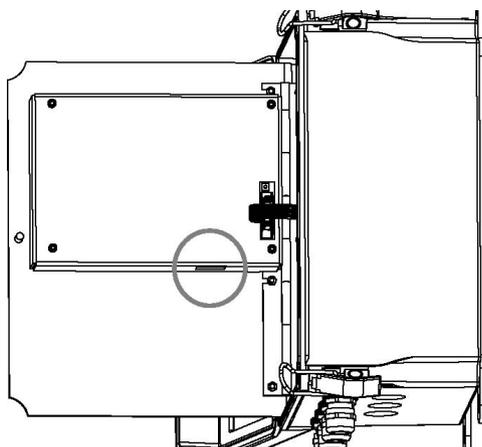
<b>31 32 33</b>	Power, L (31), N (32), protective earth (33), 100-240 V AC, 50–60 Hz. An external power switch is recommended.
-----------------	--

<b>41 42</b>	24V terminal for DTR internal use only.
--------------	---

**NOTE:** Connecting terminal to external 24V supply will void warranty. Connecting external devices to 24V terminal will void warranty.

<b>51 52 53 54 55</b>	Switch inputs: switch 1 (51), switch 2 (52), switch 3 (53), switch 4 (54) and common (55). A voltage of 3 V DC is provided over each switch. The switch terminals are galvanically isolated.
---------------------------	--

7. **OPTIONAL:** Setting up an Ethernet connection. Data can be downloaded from the transmitter to a computer via an Ethernet connection. The Ethernet connector can be found on the underside of the front panel.



**Figure 33** Ethernet connection location

For more information on Ethernet connection, please refer to chapter Ethernet connection specification in K-Patents user documentation.

## 6 Commissioning SD sensor system

After installing the SDI2 valve, PR-23-SD sensor, and DTR transmitter, go through the following check list to make sure the SD sensor system is functioning correctly.

For more thorough instructions, please refer to K-Patents user documentation or visit the K-Patents website to see the instructional video ([www.kpatents.com](http://www.kpatents.com), PR-23-SD Safe-Drive™ Operation Guide Video).

## Commissioning checklist

### Safe-Drive™ start-up

Task	OK	Failed	Menu path	Notes
Check that the wiring has been done according to the attached wiring diagram.	<input type="checkbox"/>	<input type="checkbox"/>		
Connect the power.	<input type="checkbox"/>	<input type="checkbox"/>		
Check that the status is NORMAL OPERATION (if there is a sample) NO SAMPLE (if the process pipe is empty)	<input type="checkbox"/>	<input type="checkbox"/>		
Check process temperatures.	<input type="checkbox"/>	<input type="checkbox"/>		
Check the serial number.	<input type="checkbox"/>	<input type="checkbox"/>		
Check that the parameters are set according to the delivery data sheet (DDS).	<input type="checkbox"/>	<input type="checkbox"/>	CALIBRATION › CHEMICAL & FIELD PARAMETERS	
Configure the mA output.	<input type="checkbox"/>	<input type="checkbox"/>	CALIBRATION › OUTPUTS › mA OUTPUTS	For more information, see section <i>Configuring mA Outputs</i> in K-Patents PR-23 Instruction Manual.
Configure prism wash relay (relay 1 or 2).	<input type="checkbox"/>	<input type="checkbox"/>	CALIBRATION › RELAYS	For more information, see section <i>Configuring relays</i> in K-Patents PR-23 Instruction Manual.
<b>Prism wash test</b>				
Task	OK	Failed		Notes
Observe the temperature and optical image for slight changes that indicate that wash is functioning. One or more of the following changes should take place: - nD value decreasing (most apparent change) - T value increasing - QF value decreasing or increasing	<input type="checkbox"/>	<input type="checkbox"/>		For more information, see section 5.1 <i>Prism Wash Test</i> in these instructions and chapter <i>Prism wash</i> in K-Patents PR-23 Instruction Manual.
<b>Calibration check</b>				
Task	OK	Failed		Notes
Check that calibration corresponds to the lab results	<input type="checkbox"/>	<input type="checkbox"/>	CALIBRATION › CHEMICAL & FIELD PARAMETERS › FIELD PARAMETERS	For more information, see section 5.2 <i>Calibration Check</i> in these instructions and section <i>Calibrating the concentration measurement</i> in K-Patents PR-23 Instruction Manual.

## 6.1 Prism wash test

Prism wash system is essential for a fully functional refractometer. Regular testing of the prism wash is highly recommended.

The curve should react to the wash and the temperature change slightly.

**NOTE:** Your transmitter may not look exactly like the image above during the wash. The visible changes in the curve and the temperature depend on viscosity, steam pressure and temperatures of solids and steam and also to your version of the software.

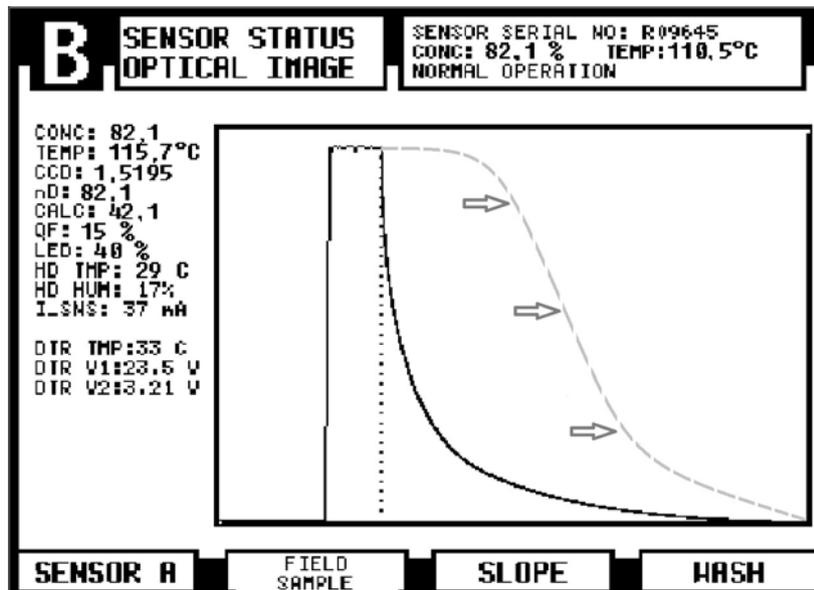


Figure 34 Changes in concentrations during succesful prism wash.

## 6.2 Calibration check

Extract 3-5 samples within a time frame of 2 days. Results from these samples can be used as a reference for calibration. K-Patents recommends following standard procedures, such as TAPPI Test Method T 650 for solid content of black liquor, or SCAN-N 22 for Black liquors - dry matter content and fiber content.

In case there are deviations from the laboratory results, check that the washes are functioning correctly (see Prism wash test in the commissioning checklist). When comparing laboratory results, check for persistent offsets, perform a BIAS adjustment from CALIBRATION menu. For more information, see section Calibrating the concentration measurement in K-Patents PR-23 Instruction Manual.

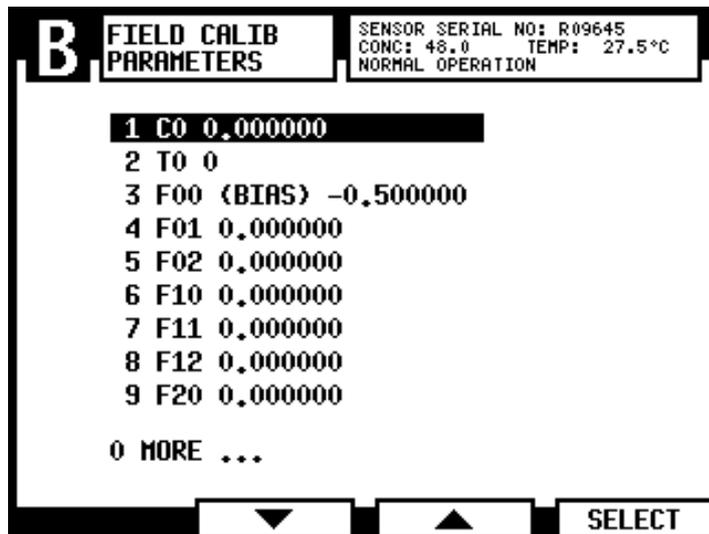


Figure 35 BIAS

If there is a need for frequent calibration, make sure that wash is functional and remove the sensor to check visually that the prism is clean and has not been damaged. Re-install the sensor and run complete field calibration (see section *Entering field calibration parameters* in K-Patents PR-23 Instruction Manual). After this, contact your local supplier.

## 7 Operating and monitoring SD sensor system

The SD sensor system runs automatically and does not need to be separately operated. If there are no alarming changes in the diagnostic values or no alarm messages, you do not need to adjust the operation. The main task of the operator is to make sure that the washes and steam connections are functioning as they should.

To rehearse the use of DTR transmitter, please visit [demo.kpatents.net](http://demo.kpatents.net).

K-Patents recommends that all new users participate in K-Patents training before using the product.

## 7.1 Preventive maintenance plan (PMP)

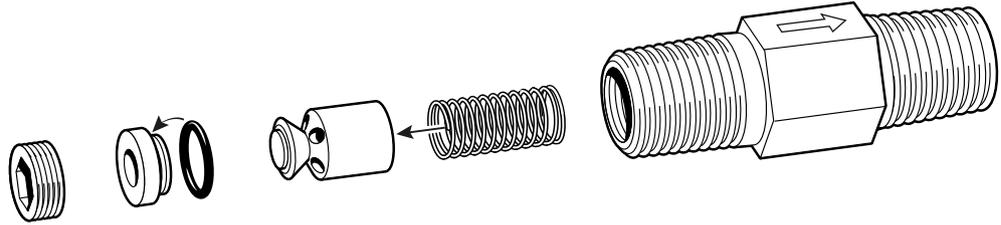
Preventive Maintenance Plan (PMP) should be adopted in order to prevent bigger maintenance procedures. Here are the recommended tasks:

Task	Weekly	Annual	Notes
Check the functionality of diagnostics:	X		See the attached PMI checklist.
CONC (measurement value of output)			This value should be closely monitored daily for a week to set the default reading for weekly inspections
CALC (chemical curve of calibration)			This is the default reading from the chemical curve concentration reading set in calibration, to which you can compare the CONC values to.
TEMP (temperature)			Process temperature.
QF (quality factor)			Typically 30-100. If QF drops 20 units below the normal level, perform a prism wash test (see Commissioning checklist).
LED (exposure time)			Typically <30. If the LED value increases significantly, perform a prism wash test (see Commissioning checklist).
HD HUM (internal humidity% of sensor)			If HUM HD rises above 50%, the system issues an alarm to replace the desiccant. For more information, see K-Patents PR-23 Instruction Manual.
Check the functionality of wash system.	X		See Prism wash test in Commissioning checklist.
Check the steam pressure. (In steam wash systems)	X		Typically 5-6 bar (75-90 psi) over process pressure.
Remove the sensor and check the prism visually for dirt and wear.		X	If the prism looks worn, run an nD verification and replace the prism, if needed. For more information on nD verification, see K-Patents PR-23 Instruction Manual
Inspect the check valve: clean the small holes and see that the valve sealing is intact.		X	Replace the check valve every 2 years. For more information, see chapter 6.3 <i>Check Valve Maintenance</i> .
Clean the filter in the steam connection line. (In steam wash systems)		X	
Verify calibration.			Do this as often as your own quality system and local requirements demand.

Please use the attached Preventive Maintenance Inspection (PMI) Checklist for recording the weekly preventive maintenance tasks.

## 7.2 Check valve maintenance

Check valve is one of the few moving parts in the wash system. Checking the valve sealing and cleaning the small holes in case of dirt particles annually is essential.

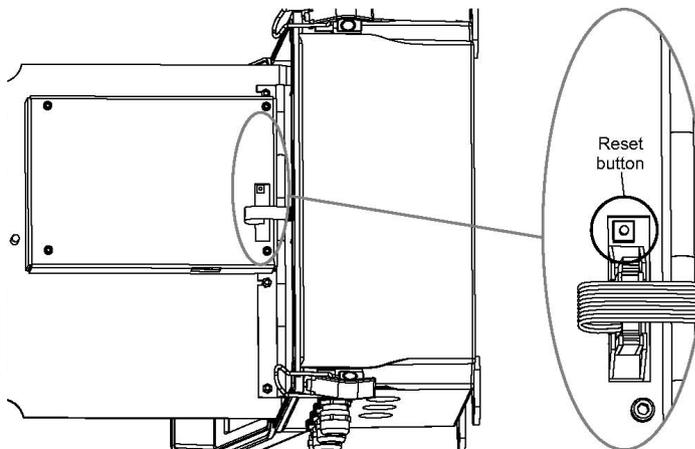


**Figure 36** Taking check valve apart for maintenance.

## 7.3 Resetting SD sensor system

If the SD sensor system needs to be reset, you can either

- Switch the power off and back on again,
  - Restart the sensor through transmitter from MENU › SENSOR STATUS › SLOPE › SENSOR RESTART or
  - Press the reset button, as instructed below.
1. Open the DTR transmitter front panel.
  2. Press the reset button on the inside of the front panel using a thin stick or a similar tool.  
The display will black out for a few seconds. The SD sensor system will be back up in operation within 30 seconds.



**Figure 37** Reset button.

## **8 Appendices**

**Preventive Maintenance Inspection Weekly Checklist**

**Data Sheets for Accessories**

**Welding diagrams**

**Installation diagrams (MTG DIM)**

**Wiring Diagrams (WRG)**





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