Global partnership and reliability
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Technical data for boiler unit

1 General data

- Project No.: ........................................ 735365, 735367
- Hull No.: ........................................... 1408, 1409
- Classification society: ................................ DNV
- Pressure gauge calibration: ................................ kg/cm²
- Thermometer calibration: ..................................... °C
- Language for signs: ................................................ UK

2 Dimensions for boiler unit

- Height excl. of mountings: ........................................ 7,010 mm
- Diameter incl. insulation: ...................................... 3,870 mm
- Total height incl. retraction of burner lance: .................. 10,050 mm
- Weight of boiler unit excl. water: .............................. 39700 kg
- Weight of boiler unit incl. water: ................................. 55100 kg

3 Water/steam process data

- Steam output: ............................................. 35,000 kg/h
- Working pressure: ........................................ 16.0 kg/cm²
- Max. allowable working pressure: .......................... 18.0 kg/cm²
- Working temperature: ...................................... 203.35°C
- Feed water operation: ...................................... Modulating
- Feed water temperature, operation: ......................... 85-95°C
- Feed water temperature, layout: .............................. 60°C

4 Combustion process data

- Min. calorific value of diesel oil: .......................... 42,200 kJ/kg
- Min./max. viscosity of diesel oil: .......................... 3-12 cSt at 50°C
- Density of diesel oil: .......................................... 890 kg/m³
5 Data for atomising steam

- Atomising steam pressure at burner, max.: 6.0 kg/cm²
- Atomising steam consumption: 120 kg/h
- Atomising air pressure at burner, max.: 7.0 kg/cm²
- Atomising air consumption, max.: 210 kg/h

6 Data for electric systems

- Power supply: 3 x 690 V, 50 Hz
- *Control voltage: 1 x 230 V, 50 Hz
- Pilot voltage: 24 V
- Insulation class: F
- Degree of protection: IP 44
- Colour of boiler control panel: Munsell 7.5 BG 7/2
- Colour of boiler power panel: Munsell 7.5 BG 7/2

7 Data for pressure part

- Boiler type: Large oil fired boiler
- Model: MISSION™ OL
- Test pressure: 27.0 kg/cm²
- Max. allowable shrink: 0.650 m³
• Max. allowable swell: 1.350 m³
• Number of pin tubes: 140
• Protection of boiler body: trapezoid plate
• Colour of insulation plates: hot dip galvanized

8 Data for burner

• Burner type: Steam atomising, modulating
• Model: KBSD 2650
• Burner capacity on diesel oil, min./max.: 260/2,445 kg/h
• Burner capacity on fuel oil, min./max.: 260/2,566 kg/h
• Colour of burner: red (RAL 3000)

9 Data for water level operation

• Too high water level alarm: +165 mm
• High water level warning: +135 mm
• Normal water level: 0
• Start stand-by feed water pump: not AI supply
• Low water level warning: -145 mm
• Too low water level alarm and burner off: -190 mm

10 Data for steam pressure operation

• Safety valve: 18.0 kg/cm²
• High steam pressure alarm and burner off: 17.8 kg/cm²
• High steam pressure warning: 17.5 kg/cm²
• Burner start/stop: 16.2/17.2 kg/cm²
• Burner operation: 16.0 kg/cm²
• Low steam pressure warning: 4.0 kg/cm²
11 Manuals

- Language for manuals: UK
- Set of instruction manuals: 6
- Document revision date: 24 JAN 2003
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NOTE:
- All heavy fuel oil piping to be steam traced piping and insulated
- Components specified by Tag No. are supplied by AI
- Components: see separate list of parts

Customer: Samsung Heavy Industries Koe Shipyard

Title: 1 x KBSD 2650
Oil system
Burner operation modulating
Flow diagram
NOTE:

- Components specified by item no. are supplied by Al
- Items; see separate list of parts
- For electrical connections, see actual electrical wiring diagrams.
- For connections X - see burner arrangement drawing.

Customer: Samsung Heavy Industries Koje Shipyard

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MISSION™ OL boiler

1 Description

The MISSION™ OL boiler is a vertical two-drum boiler, insulated and pre-assembled with boiler mountings for easy installation and operation. The boiler is top-fired and equipped with a steam atomising burner. As the burner, the local control panel and all relevant boiler mountings are mounted on top of the boiler, this can easily be operated and monitored from the burner platform. Most of the cabling for instrumentation and drain are pre-wired before delivery. The control system supplied with the MISSION™ OL boiler unit provides fully automatic operation of the boiler and the steam atomising burner.

1.1 Boiler pressure part

The principal drawing of the MISSION™ OL boiler is shown in Figure 1. The steam drum is cylindrical with two flat plates of equal thickness. Because of the internal pressure, the flat plates are mutually connected by vertical solid stays. The steam drum is furnished with the necessary internal fittings to ensure an even distribution of the feed water, of the circulation water from the exhaust boiler and to ensure a sufficient dryness of steam.

The burner cone in the furnace opening are an integrated part and accordingly no refractory are provided in the top of the furnace room.

Manholes are conveniently placed in both drums and inside the drums enough space is available for inspection and maintenance.

The water drum is designed similar to the steam drum. The drum size gives optimal space for the heating coil and easy access for inspection.

For the foundation the boiler is provided with four supports, one as fixed foot and the others designed with possibility of thermal expansions. Counter plates are provided for welding to deck.

Both the furnace and the generating tube bank are located asymmetrically and are separated by the screen wall. Besides the screen wall the furnace consists of gas tight polygon shaped membrane walls. The generating tube bank consists of vertical pin-tubes arranged in a staggered configuration. To avoid any risk of vibration problems supports are arranged.

The flue gas passes through the deflected tubes at the bottom of the screen wall, up through the generating tube bank and out through the smoke outlet box.

An effective circulation in the boiler is achieved bye means of down comers.

The bottom tube plate is first covered with coat of insulation refractory and above with castable refractory.

Access to the furnace is possible through the access door at the bottom of the furnace. Inspection of the generating tubes is also possible through the inspection door at the bottom of the furnace.

Inspection of the burner flame is possible through the two inspection holes arranged in two heights on the furnace panel wall.
Principal drawing of MISSION™ OL boiler

Figure 1
Boiler mountings

1 Mountings

The following is a brief description of the most important items of the boiler mountings. The components mentioned in this section are referring to the general arrangement drawing of the boiler.

**Safety valves**
Two safety valves are fitted to the pressure vessel of the boiler. They are installed for security reasons, and designed to prevent the boiler pressure from rising above the design value. The safety valves must be supplied with waste steam pipes and either expansion devices, or bellows.

**Main steam valve**
The main steam valve is a shut off/non-return valve. When closed, it isolates the boiler from the main steam line. When open, it prevents steam from flowing backwards into the boiler. The main steam line should be equipped with an expansion joint next or close to the valve.

**By-pass valve**
The by-pass valve is a shut off valve. The purpose of the valve is to equalise the pressure between the boiler and the steam system when the main steam valve is closed. Please note that the by-pass valve is only supplied for larger boilers.

**Feed water valve / feed water valve (sdnr)**
Two groups of feed water valves are provided in the boiler. Each group comprises a shut-off valve and a non-return valve. The shut-off valve in the ordinary group must be open when the boiler is in operation, or if the boiler is used as a steam drum. The shut-off valves should be closed when the boiler is not in use.

**Water level gauges**
Two local water level gauges are connected to the front of the boiler, each gauge being provided with two shut-off valves and a drain valve. The shut-off valves, fitted at the top and bottom of the sight glass, have a quick-closing mechanism to be used in case of broken glass. The pipes from the drain cocks on the water level gauge must lead to an open drain, visible for inspection.

**Blow-down valve**
Two blow-down valves of the shut-off/non-return type are mounted at the bottom of the boiler body. The shut-off function is for security and the non-return function prevents steam/water from flowing into an empty boiler by mistake.
Air valve
The air/ventilation valve located on top of the boiler is a shut-off valve. It is normally closed except when the boiler is being filled or completely drained. The end of the drain pipe from the air valve must be visible in order to determine when water or steam is coming out.

Scum valve
The scum valve is a combined shut-off/non-return valve. In the event of scum in the boiler, this scum can be blown off from the water surface by opening this valve.

Sample valve
A sample valve is installed enabling connection to a sample cooler for taking test samples to perform boiler water analyses.

Inspection hole
Two small inspection holes are provided in the furnace wall to enable inspection of the burner flame. A proportion of the air supply is bled off from the burner fan to cool the window of the inspection hole, and prevent soot deposits.

Manhole
Two manholes placed at the boiler top and boiler bottom allow inside inspection of the steam/water drum.

Access doors
Access to the furnace and smoke outlet box are possible through the access doors placed at the bottom of the furnace and at the smoke outlet box respectively. Both access doors enable inspection of the generating tube bank.

Drain for furnace
The furnace bottom is provided with a socket for drain of the washing water.
Water level control

1 Description

The water level control is a modulating system at this type of boiler. The system is illustrated in Figure 1. The safety device system for too low water level alarm and burner cut out consists of a level float switch mounted as an external unit. For measuring and control of the water level, the boiler is equipped with a dp water level transmitter unit, which includes external reference and variable legs, and a dp-transmitter. The continuous 4-20 mA output signal from the dp-transmitter is processed in the control system, which provides level warnings/alarms and control of the regulating feed water valve.

Water level control system

Figure 1
Gauge board

1 Description

The function of the gauge board is to control the burner and to give warning and alarm for low and high steam pressure.

- A pressure gauge is fitted for analogous reading of the actual steam pressure in the boiler. The pressure gauge is located on the local control panel.

- A pressure switch "high steam pressure" gives alarm and cut-off the burner when the steam pressure rises above the pre-adjusted set point. Furthermore, the pressure switch locks the burner in stop mode. Operation of the burner is only possible when the steam pressure falls below the differential set point of the pressure switch and the alarm is reset.

- A pressure transmitter connected directly on the boiler converts the actual steam pressure of the boiler into corresponding electric signals. The signals are used to give warnings for low/high steam pressure and alarm/burner cut-off for high steam pressure. Furthermore, the signals are used to control start/stop and modulation set point of the burner.
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## Operation and maintenance

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Start/stop of the boiler

1 General

The following chapters of the instruction manual describe the operation and maintenance of the pressure part. As this is only a part of the complete boiler plant, it is important to study the remaining chapters in this manual very thoroughly. It is especially important that the operator of the boiler plant becomes familiar with the operation instructions of the burner and the control panel.

Important: To ensure a safe and reliable operation of the boiler plant, all operation and/or maintenance of the boiler should be carried out only by skilled personnel.

2 Start-up

When the boiler is started, the lighten-up rate of the boiler must not be accelerated too much as this might cause an unnecessary overstrain of the boiler material by quick and uneven temperature rises. It might be necessary to perform a number of start/stop sequences to reduce the lighten-up rate.

Attention: At the commissioning start-up of the boiler and after any repair work of the refractory, it is very important to further reduce the lighting-up rate. This is because the new refractory still contains a small amount of water. When heated the water vaporises and expands which might cause fissures and cracks in the refractory. The burner must therefore only be operated at minimum load and in intervals of 1-2 minutes for the first hours. Between each operation interval the burner should remain stopped for approximately 8-10 minutes.

Before start-up of the boiler plant, some general work and check procedures must be considered.

Step A: Check that the main steam valve, by-pass valve and circulation valves if provided, scum valve, and blow-down valves are closed.

Step B: Open the feed water valves and the air valve. Fill the boiler with feed water to approximately 50 mm below normal water level. The water level rises due to expansion when the boiler is heated. If the temperature difference between the boiler and feed water exceeds approximately 50°C, the boiler must be filled very slowly.
Note: When filling a pressure less boiler, the shut-off valve after the feed water pump must be throttled. Otherwise the pump motor will be overloaded.

Step C: Check the water level in the water level gauges. Check frequently during the complete start-up. The water level gauges should be blown down several times to ensure a correct indication.

Step D: Check that the water level control system is connected and operational.

Step E: Check the oil system and start the fuel oil supply pump. Pre-heat the fuel oil if the burner should operate on heavy fuel oil.

Step F: Check the burner and the safety functions according to the separate instruction.

2.2 Start and pressure rise

The following work procedures must be followed during start-up of the boiler.

Step A: Check that the gauge board valve and pressure gauge valves are opened.

Step B: Check that the air valve is open if the boiler pressure is below 1.0 barg.

Step C: Start the burner on manual control and on low load. Check that the water level does not rise too high during the pressure rising period.

Step D: Drain via the blow down valves if the water level is too high.

Step E: If the air valve was opened close it when only steam blows out. A pressure reading should be indicated on the boiler pressure gauge before the air valve is closed.

Step F: Tighten all covers such as manholes, hand holes, inspection doors, etc. during the pressure rising period. If required, check all flange joints on the plant.

Step G: Change to automatic control of the burner when the boiler pressure is 0.5 barg lower than the working pressure of the boiler.

Step H: Open the by-pass valve slowly to heat-up and pressurise the steam system. If the boiler is not provided with a by-pass valve, the main steam valve should be used to heat-up and pressurise the steam system.

Step I: Open the main steam valve and close the by-pass valve.

Step J: Open the valves to the steam consumers carefully in order to avoid water chocks.

Step K: When the boiler is in normal operation, check that the water level control system and the gauge board functions are fully operational.
Note: After 3-4 weeks in operation, mud and deposits in the piping system may have accumulated in the boiler water. This may cause level variations which disturb the steam generation, and it is therefore recommended to blow down the boiler. It should then be inspected, cleaned, and refilled with boiler water.

3

Boiler stop

3.1 Normal boiler shut down

If necessary, the boiler can be shut down at any load without special preparations.

Note: When the boiler is stopped, sudden temperature and pressure drops should be avoided as they might expose mountings, pipe lines, and the boiler plant to inadmissible temperature gradients.

Step A: When minimum load is obtained, stop the burner.

Step B: Keep the water level at normal level until the boiler stops producing steam.

Step C: Stop the feed water pump and close the feed water valves.

Step D: Close the main steam valve.

3.2 Emergency shut down

The boiler must be taken out of service immediately if:

- parts of the heating surface have been glowing or the boiler shows recognisable deformations. The supervising authorities must be informed, and the boiler must not be used until approval from these authorities is available
- a substantial loss of water is noted
- the feed water system is unable to provide the necessary amount of feed water, e.g. due to failure of parts
- the safety valve cannot function
- sudden cracks or damage are noted in the refractory, and if steam or moisture is coming out of the refractory
- oil in the feed water is detected
- too high salinity level is detected

If an emergency shut down must be carried out, the fuel supply should be stopped. The main steam valve should be closed gradually, and the boiler must be cooled. The safety valves must not be operated. Parallel working boilers should be disconnected at once.
3.3 Stop for repair or inspection

The following describes the measures to be taken when the boiler is shut down for repair or inspection.

Step A: Clean the boiler from soot with water.

Step B: Operate the burner for at least 15 minutes after the soot removal to dry out the remaining water.

Step C: Stop the boiler as mentioned previously.

Step D: Check the furnace and the pin tubes with regard to cleanliness.

Step E: Empty the boiler from water and clean it. Check if lime stone appears.

Step F: Check and clean the outer fittings. Change gaskets where required.

Step G: Clean the feed water tank and feed water pipes.

Step H: Clean and grease the bearings of motor, pump, and fan.

Step I: Check and align the burner, if necessary.

Step J: If the boiler is shut down for a long period of time, the pin tubes must be thoroughly cleaned.

Step K: Check that the necessary spare parts are available. Order complementary parts in time.

Warning: It is of extreme importance that the boiler is NOT operated without water when the oil burner is in operation, e.g. due to disconnection of the water level safety devices. This will immediately cause complete break down of the boiler.
Boiler maintenance

1 Boiler maintenance

The boiler maintenance should always be executed with skill and in accordance with valid rules and regulations from the authorities, and below are given some recommendations for periodical inspections and maintenance.

1.1 Daily operation

During normal operation of the boiler some work and check procedures have to be considered every day.

Step A: Check the boiler steam pressure and the water level.

Step B: Check that the feed water control system is operational, see separate instructions.

Step C: Check the boiler water condition and make necessary countermeasures with regard to the feed and boiler water treatment. If necessary blow-down the boiler.

Step D: Check the function of the oil burner at different capacities through the inspection holes on the boiler.

Step E: Check the flue gas temperature after and/or the draft loss across the boiler. If either the temperature or the draft loss is too high, the pin-tube section must be cleaned.

1.2 Weekly routine checks

Step A: Drain each water level glass for about 10-15 seconds.

In case of contaminated boiler water or insufficient water treatment, the draining of the water level glasses must be done more often.

Step B: Check the safety water level device.

Step C: Depending on the boiler water tests blown-down the boiler. Open the blow-down valves quickly for a few seconds, and then close and open again for about 5-10 seconds.

Repeat this operation when required according to the boiler water tests.

Step D: Perform scum blow out by means of the scum valve when required. The scum blow out must be carried out until the drained water is clean.
1.3 Monthly routine checks

Step A: Test all stand-by pumps.

Step B: Check all boiler mountings for damage or leaks and repair/replace if necessary.

Step C: Check the function of the high steam pressure switch by lowering the set point or by raising the steam pressure, e.g. by closing the main steam valve slowly.

The burner must stop automatically.

2 Inspection of the boiler

2.1 Inspection of furnace

The furnace should be inspected at least twice a year. During this inspection the following issues should be taken into consideration:

- Check for cracks at the refractory lining and that the furnace walls are free from excessive soot deposits.
- Examine carefully the area opposite the burner. Too much soot deposits indicate that the burner should be adjusted.
- Check that the pin-tube elements are intact and that soot deposits are within normal limits.

2.2 Inspection of boiler water side

The boiler water side (interior) must be carefully inspected at least twice a year. This inspection of great importance and no doubt the most important of all the maintenance measures, since it has a direct influence on the boiler longevity and on the security.

At these inspections, hard deposits, corrosion and circulation disturbances can be found at an early stage, and preventive measures must be taken to avoid unexpected material damage and boiler breakdown.

Presence of hard deposits at the furnace wall and the pin-tubes reduces their heat transfer properties and decrease the capacity of the boiler.

Further, it is possible to make out if the feed water treatment has been satisfactory and if the blow-down has been carried out sufficiently. Incorrect feed water treatment is commonly causing hard deposits or corrosion. Insufficient blow-down will cause sludge deposits in the tubes and accumulation of sludge in the bottom of the boiler.

If hard deposits are not removed, it may lead to overheating in the boiler plate material which is exposed to the flame in the furnace wall area. This may cause material damages.

Incorrect feed water treatment does not always lead to hard deposits. For example, a too low or too high a pH-value may give an electrolytic reaction, causing corrosion in the boiler.
When the boiler interior is inspected, examine all parts carefully and be attentive to deposits, corrosion and cracks. It is advisable to pay special attention to this inspection. If any unusual signs are found, contact Aalborg Industries at once for advice.

2.3 Procedure and remarks for inspection

Step A: Shut off the boiler and allow it to cool (below 100°C).

Note: The boiler should NOT be depressurised by lifting the safety valves and then filled with cold feed water since the stress induced by too rapid cooling may cause damage.

Step B: Empty the boiler and close all valves. If the boiler is connected to a second boiler, check that the valves between them are closed.

Step C: Unscrew and remove the manhole hatch(es) on the boiler and enter the boiler when it is sufficiently cold.

Check the welding in the boiler. A careful examination should be carried out with respect to any possible corrosion or crack formation. Special care should be taken to the water line area in the pressure vessel where oxygen pitting may occur.

If deposits are found to be forming in the boiler tubes, the boiler should be chemically cleaned. It is advisable to consult a company of cleaning specialists who will examine the boiler deposits and treat the boiler accordingly.

Note: After chemical treatment the boiler should be blown-down at least twice a day for approximately one week. This will ensure that excessive sludge deposits due to chemical treatment do not collect in the bottom of pressure vessel.

2.4 Contamination

If the boiler is contaminated with foreign substances like oil, chemicals, corrosion products etc., it is very important to act immediately to avoid damages to the boiler. Layers of thin oil films, mud, etc. exposed to the heating surfaces causes a bad heat transfer in the boiler, leading to overheating followed by burned out pressure parts. In order to remove such contamination, a boiling out or acid cleaning have to be performed immediately.

Note: Corrosion products from the pipe system or insufficient boiler water treatment may result in corrosion in the boiler itself. It is therefore important to observe that such circumstances do not occur in the system.
Boiling out

Before putting the boiler into operation for the first time, it should be boiled out to remove all protecting remedies and impurities on the boiler waterside. The boiling out procedure is recommended to be carried out as described below:

Caution: Extreme care should be taken while handling the chemicals. The person handling the chemicals/solution should be properly dressed/protected.

Step A: Fill the boiler with a solution consisting of 4-5 kg trisodiumphosphate \( \text{Na}_3\text{P}0_4 \) per 1000 kg water. The chemicals can be added through the manhole.

Step B: Add feed water until the solution is visible in the water gauges above "lower water level".

Step C: Close the feed water valve (pump stopped).

Caution: Do never fill feed water into the boiler if the temperature difference between boiler and feed water exceeds 50°C.

Step D: Raise steam pressure slowly to working pressure, and keep the pressure for approx. 3-4 hours with closed main steam valve.

Step E: Scum until water level is between "Normal water level" and "High water level". By this procedure grease and other impurities are removed from the internal surfaces of the boiler.

Step F: Start skimming by opening the scum valve, and lower the water level to lower edge of "Normal water level" mark.

Step G: Close the scum valve.

Step H: Refill the boiler with feed water and start skimming again in intervals of 30 minutes for a period of two hours.

Step I: Stop the boiling out procedure by switching off the burner.

Step J: Let the boiler water rest for about five minutes.
Step K: Carry out a final skimming.

Step L: Blow off the boiler water by opening the blow down valves.

Step M: Remember to open the air escape valve, to avoid a vacuum in the boiler when the boiler pressure decreases to approx. depressurised/atmospheric pressure.

Step N: Open the manhole and let the boiler cool down to approx. 100°C.

Step O: The boiler is to be flushed with clean water on the boiler waterside, when the temperature has decreased. The flushing removes remaining impurities.

Step P: Dismantle the bottom blow down valves, for cleaning and inspection because deposits/foreign substances will usually be accumulated in these valves and cause leaking if not cleaned.

Step Q: Inspect the boiler and remove any remaining deposits and foreign substances.

Step R: Finally, new gaskets to be fitted in all hand- and manholes before refilling the boiler with water to upper edge of “Low water level”.

The boiler is now ready to be taken into service.

Note: During the first two weeks in operation we recommend to carry out frequently skimming and bottom blow down to remove impurities entering the boiler from the pipe system.
Water washing

1 Description

In order to keep the heat transfer area sufficiently clean the boiler is designed with a high flue gas velocity through the generating tube bank. However, after long term operation, e.g. during combustion of poor quality oil or with reduced combustion quality, deposits can be formed on the heating surface. As most deposits mainly consist of non-soluble particles, which are held together by a water soluble bonding material, it is possible to clean the heating surface with water washing.

Water washing of the generating tube bank

![Diagram of water washing process](ol_wash.cdr)
The MISSION™ OL boiler is easily cleaned from the smoke outlet box with a water hose. When water washing is carried out the boiler must be out of operation and the boiler temperature below 110°C.

After the water washing is completed the refractory at the furnace bottom must be cleaned with alkaline water due to the washing water is very corrosive. It must be observed that all the washing water and loosened deposits are removed from the boiler.

When the water washing has begun it must be completed so that all deposits are removed. This is because some types of coatings hardens and accordingly gets very difficult to loosen when they first have been saturated and then dry out.

The boiler must be boiled out immediately after the water washing has been completed in order to avoid damage on refractory and heating surfaces. The boiler must be lightened-up and pressurised as described in the chapter "Start/stop of the boiler".
Soot blowing

1 Description

Generally, there will be a self cleaning effect of the generating tube bank due to the high flue gas velocity. However, deposits are formed on the heating surfaces, e.g. due to combustion of poor quality oil or reduced combustion quality. These deposits will accumulate on the heating surface of the generating tube bank if not removed by cleaning.

The MISSION™ boiler is equipped with soot blowers for cleaning of the generating tube bank. The soot blowers are manually operated and are arranged for direct connection to the steam system of the ship. In order to obtain an efficient soot cleaning, the steam pressure must be at normal working pressure. Furthermore, the boiler load should not be lower than 50%. This ensures a sufficiently high velocity of the flue gas, which is necessary to carry loosened soot deposits out of the boiler. Figure 1 shows a soot blowing arrangement.

Because of the varying combustion parameters, it is impossible to specify exact time intervals between soot blowing. In general soot blowing is recommended every 24 hours.

Note: Excessive soot blowing by means of steam might cause erosion damage on the generating tube bank.

During operation of the boiler plant, the operating personnel should determine the necessity with regard to time intervals for soot blowing. This interval should then be increased or decreased to fit the specified plant.

2 Cleaning procedure

Step A: Check that the steam pressure is at normal working pressure.

Step B: Check that the main valve for soot blower and the two manually operated ball valves are closed.

Step C: Open the drain valve to drain water from the main tube for a few seconds and close it again.

Step D: Open the main valve.

Step E: Open the lower manually operated ball valve and soot blow for approximately five seconds.

Step F: Close the lower manually operated ball valve again.
Step G: Open the upper manually operated ball valve and soot blow for approximately five seconds.

Step H: Close the upper manually operated ball valve again.

Step I: Repeat step “D” to “G” 3-4 times.

Step J: Close the main valve.

Step K: Check that both ball valves are closed.

Illustration of a soot blowing arrangement

Figure 1 sootblow1a.cdr
Preservation of the boiler

If the boiler is to be shut down for a period of 1-30 days, it should be top filled to prevent corrosion. Before top filling, it should be cleaned from soot deposits. If the boiler is to be shut down for more than one month, different methods to prevent corrosion can be applied:

- Dry preservation.
- Wet preservation.
- Nitrogen preservation.
- VCI preservation.

The work procedures related to each of these preservation methods are described in the following:

1.1 Dry preservation

When this method is applied the boiler should be totally emptied off water and dried out.

Step A: Empty the water/steam contents inside the boiler by means of the bottom blow down at a boiler pressure of 3-5 barg. Open the boiler when it is depressurised and drain off any remaining water.

Step B: Manhole doors and hand hole covers should be opened when the boiler is still hot. If there is water left in the bottom of the boiler it must be removed, e.g., by using a vacuum cleaner.

Step C: If the boiler is cold, drying of the boiler can be done by either circulating dried air from a fan or by placing bags of silicagel inside the boiler.

Step D: Before the manhole doors and hand hole covers are closed, place a tray with burning charcoal to remove oxygen. As soon as the tray with charcoal is in position, close the manhole doors and hand hole covers using new gaskets.

Step E: Alternatively, a small steam phase inhibitor can be added to the boiler after cooling and careful draining. Afterwards the boiler should be closed completely.

1.2 Wet preservation

While dry preservation is a question of draining off water to avoid corrosion, the principle of wet preservation is to prevent oxygen from entering the boiler. This method can be used for a short period of 'lay-up' (1-3 months).
Step A: The boiler is filled with treated boiler water and hydrazine is added until an excess of 100-200 ppm is obtained.

Step B: The water should be circulated continuously or at least once per week to avoid corrosion from any penetration of oxygen, and it is necessary to check the hydrazine concentration and add the necessary amount to have an excess of 100-200 ppm. Other oxygen binding agents can also be used.

The pH-value should be 9.5-10.5.

Note: If there is any risk of the temperature falling back below 0°C, this method should not be used to avoid frost damages.

As this preservation method involves applying hydrazine to the water inside the boiler, the boiler must be completely drained and refilled with fresh water before taken into service again.

### 1.3 Nitrogen preservation

The boiler should be drained, dried and sealed in the same way as mentioned in section “1.1, Dry preservation”.

Step A: Make a connection point to the bottom of the boiler and open the air escape valve on top of the boiler.

Step B: Connect cylinders with nitrogen to the bottom connection point via a reduction valve and purge the boiler until there is no oxygen left.

Step C: Close the air escape valve.

Step D: Leave a cylinder with nitrogen connected to the boiler via a reduction valve and keep an overpressure of approximately 0.2 bar inside the boiler.

### 1.4 VCI preservation

An alternative to the above mentioned preservation methods may be the use of a so-called volatile corrosion inhibitor (VCI).

The VCI is a water soluble chemical which partly evaporates and protects both the water and steam spaces of the boiler. It should be able to eliminate the need for complete drainage and/or application of nitrogen, and may in particular be interesting when a forced circulation type exhaust gas boiler is installed in the steam system. The boiler must be effectively sealed from the atmosphere to maintain the corrosion protection.

The VCI is offered by various chemical companies and must be used in accordance with their recommendations.
Boiler repair - plugging of tubes

1 Plugging of tubes

In case of a leakage on a boiler tube, the burner must be stopped and the pressure lowered to atmospheric pressure. If the leaking tube cannot be located immediately the boiler should be set on pressure by means of the feed water pumps so that the leakage will indicate which tube is damaged.

Step A: When the boiler is emptied of water remove the manhole covers in the steam drum and the water drum.

Step B: When the damaged tube is located it must be plugged with a conical tube plug. Before the tube plug is mounted clean the inside of the tube ends with a steel brush, so that no deposits are present in the tube.

Step C: When tubes have been plugged those should be renewed as soon as possible. Plugging of tubes results in reduced efficient heating surface and accordingly the boiler efficiency will decrease.

Note: Temporary repairs require more attention than a normal working boiler.

1.2 Plugging of furnace panel wall tubes

When a furnace tube has been plugged the furnace side of the damaged tube should be cut vertically along the connections with the fins between the tubes in the panel wall, see Figure 1.

Inside the rest of the tube and on the fins next to the damaged tube a number of anchors of heat resistant or stainless steel must be welded on. Afterwards erection of refractory against the damaged tube and the neighbouring fins must be carried out in the full height inside the furnace.
Plugging of furnace tubes

Figure 1
1.3 Plugging of generating tubes

Plugging of the generating tubes are shown in Figure 2. Up to 10% of all generation tubes can be plugged with a conical plug but if more tubes are damaged, an exchange of tubes are necessary.

Plugging and replacement of generating tubes
Boiler repair - refractory

1 Refractory repair

The furnace floor is lined with an insulating material (Verilite R6), close to the casing covered with a layer of castable refractory (Plicast 31).
The refractory is made with expansion joints, which should under no circumstances be blocked or filled on purpose.
Even though the refractory is made with expansion joints, it will tend to make additional natural expansion joints, which will be seen as fissures. However, the fissures will generally close when the boiler is put into service. Please note the following guidelines when examining the fissures:

- white/light fissures, which are getting darker over the time and are closing when the boiler is in service and opening in cold condition, need no further attention.

- dark/black fissures suddenly occurred, seen in cold condition and are not closing when boiler is in service need to be repaired/filled up with refractory (Plicast 31).

All refractory subjected to wear will, eventually, need to be repaired. This can be done as a temporary repair or on a permanent basis.

1.1 Temporary repair

Smaller areas can be temporarily repaired making use of the repair mix Plistix 14, supplied separately with the boiler equipment.
The durability of such a repair depends on the location, but the more exposed to heat, the shorter lifetime. Generally, it is recommended to replace a temporary repair with a repair on a permanent basis within one year.
Temporary repairs in vertical places ought to be made “swallow tailed”, see Figure 1, if possible. This secures a better attachment to the existing refractory.

Sketch indicating a “swallow tail” repair

![Diagram showing a swallowtail repair](swaltail.cdr)
The surface to which the temporary repair is performed, must always be clean, dry and rugged.
Mixing instructions for the castable refractory appears from the instruction on the plastic bucket.

Note: Plistix 14 must be applied to the site immediately when mixed.

The boiler can be lightened-up approx. 1 hour after the refractory has been applied. The refractory needs no further time for hardening. If the boiler is pressurized, the lighting-up should be started with the burner in “on” position for one (1) minute and then in “off” for two (2) minutes, during the first half (½) hour. Then it can be started up according to the ordinary lighting-up procedure.

Note: Observe the safety rules regarding the refractory which can be seen on the plastic bucket.

1.2 Permanent repair

Major repairs and renewal of temporary repairs shall always be carried out and supervised by maker’s specialists, among other things securing that correct drying-out time and lighting-up is observed.

1.3 Boilers with membrane furnace wall

The refractory applied to a damaged membrane furnace wall must be carried out as shown in Figure 2.

Refractory applied to a membrane furnace wall

![Figure 2](plugrefrac.cdr)
Warning: Failed Y-anchors must only be replaced by Y-anchors made from heat resistant steel. Y-anchors made from incorrect materials will cause damage to the refractory.

2 Maintenance of refractory

Note: The refractory should be inspected once a year for shape and wear. It is recommended to carry out an inspection in due time prior to long repair periods such as dry docking, etc. Should a repair be required castable refractors and bricklayers can then be ordered on short notice.

If the refractory has been exposed to water, the refractory should be dried out as soon as possible. The drying out can be done by hot air (approx. 50°C) or by operating the oil burner.

Warning: However, if the burner is being used, the burner should be operated with great care.

Warning: Generated steam evaporated from water absorbed into the refractory might cause fissures and cracks when expanding, if the heat input from the oil burner is too heavy.

2.1 Typical refractory data

Below in Table 1 is a list of typical refractory data shown.

<table>
<thead>
<tr>
<th>Refractory data</th>
<th>Verilite R6</th>
<th>Plicast 31</th>
<th>Plistix 14</th>
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<tr>
<td>Al₂O₃</td>
<td>32%</td>
<td>44%</td>
<td>48%</td>
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<tr>
<td>SiO₂</td>
<td>24%</td>
<td>46%</td>
<td>43%</td>
</tr>
<tr>
<td>Fe₂O₃</td>
<td>12%</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>TiO₂</td>
<td>1.6%</td>
<td>1%</td>
<td>1.9%</td>
</tr>
<tr>
<td>CaO</td>
<td>23.3%</td>
<td>6.5%</td>
<td>4.8%</td>
</tr>
<tr>
<td>MgO</td>
<td>6.1%</td>
<td>0.3%</td>
<td>0.2%</td>
</tr>
<tr>
<td>Alkane</td>
<td>1%</td>
<td>1%</td>
<td>-</td>
</tr>
<tr>
<td>Na₂O</td>
<td>-</td>
<td>-</td>
<td>0.1%</td>
</tr>
<tr>
<td>K₂O</td>
<td>-</td>
<td>-</td>
<td>0.2%</td>
</tr>
<tr>
<td>Operating range</td>
<td>100-1000°C</td>
<td>20-1450°C</td>
<td>100-1420°C</td>
</tr>
</tbody>
</table>

Table 1
Lighting-up curve

1 Lighting-up curve for MISSION™ OL boiler

Figure 1 shows the lighting-up curve for the MISSION™ OL. When the burner is started the firing capacity must be adjusted to match the lighting-up curve. Further start/stop instructions are described in the chapter "Start/stop of the boiler".

Lighting-up curve for the MISSION™ OL boiler

![Diagram of lighting-up curve]

Figure 1

startcur.cdr
# Table of contents

## Feed and boiler water

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<th>Page</th>
</tr>
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<td>Feed and boiler water characteristics</td>
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</tr>
<tr>
<td>Feed and boiler water maintenance</td>
<td>4</td>
</tr>
<tr>
<td>Treatment systems / injection points</td>
<td>5</td>
</tr>
</tbody>
</table>
Feed and boiler water

1 General

Note: The recommended feed and boiler water characteristics are only valid for boilers with a working pressure below 20 barg.

There is a number of ways to produce good quality feed water for boiler plants. Methods such as e.g. reverse osmosis plants or ion exchange plants produce good quality distillate. Also evaporators generally produce good distillate. The important thing is that the distillate used should be clean and without foreign salt contamination.

In practice most distillates used contain minor parts of various salt combinations which can and must be chemically treated away. Furthermore, the distillate may contain dissolved gases like for example oxygen \((O_2)\) and carbon dioxide \((CO_2)\) which may lead to corrosion in the boiler, steam, and condensate system.

Important: Boiler and feed water must be chemically treated in order to avoid corrosion and scaling in the boiler.

2 Layout of the treatment system

The condition of the feed and boiler water is an essential part of the boiler operation and operation philosophy. The design and construction of the treatment system should therefore be considered carefully during layout of the plant. Aalborg Industries gives some general requirements and recommendations regarding the conditions of the feed and boiler water. However, there is several ways to obtain this results, or similar, by using different treatment systems. The following should therefore be considered already at the layout stage:

- Choose the treatment system that should be used.
- Present the condensate and feed water system to the supplier of the treatment system and inform about the operation philosophy of the plant.
- Let the supplier indicate where the injection points should be located and also inform if special equipment is required.
- Let the supplier inform about which test facilities is needed.
- Purchase the recommended equipment and install it in the correct way.
- Use the treatment system as soon as the boiler is taken into operation.
3 Feed and boiler water characteristics

The following text regarding feed and boiler water treatment is the normal recommendations given by Aalborg Industries. These recommendations should be followed strictly in order to have the best working conditions for the boiler plant and to extend the working life of the plant. The requirements/recommendations of the various values for feed and boiler water are listed in Table 1 below.

<table>
<thead>
<tr>
<th>Requirements for feed and boiler water</th>
<th>Feed water</th>
<th>Boiler water</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Appearance</strong></td>
<td>ppm CaCO&lt;sub&gt;3&lt;/sub&gt;</td>
<td>0 - 5</td>
</tr>
<tr>
<td><strong>Hardness</strong></td>
<td>ppm Cl&lt;sup&gt;-&lt;/sup&gt;</td>
<td>&lt;15</td>
</tr>
<tr>
<td><strong>Chloride content</strong></td>
<td>ppm CaCO&lt;sub&gt;3&lt;/sub&gt;</td>
<td>-</td>
</tr>
<tr>
<td><strong>&quot;P&quot; alkalinity</strong></td>
<td>ppm CaCO&lt;sub&gt;3&lt;/sub&gt;</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total (T) alkalinity</strong></td>
<td>ppm CaCO&lt;sub&gt;3&lt;/sub&gt;</td>
<td>-</td>
</tr>
<tr>
<td><strong>PH-value at 25°C</strong></td>
<td>-</td>
<td>8.5 - 9.5</td>
</tr>
<tr>
<td><strong>Hydrazine excess</strong></td>
<td>ppm N&lt;sub&gt;2&lt;/sub&gt;H&lt;sub&gt;4&lt;/sub&gt;</td>
<td>-</td>
</tr>
<tr>
<td><strong>Phosphate excess</strong></td>
<td>ppm PO&lt;sub&gt;4&lt;/sub&gt;&lt;sup&gt;-3&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td><strong>Specific density at 20°C</strong></td>
<td>Kg/m&lt;sup&gt;3&lt;/sup&gt;</td>
<td>-</td>
</tr>
<tr>
<td><strong>Conductivity at 25°C</strong></td>
<td>μS/cm</td>
<td>-</td>
</tr>
<tr>
<td><strong>Oil content</strong></td>
<td>-</td>
<td>NIL</td>
</tr>
</tbody>
</table>

### Table 1

If hydrazine (N<sub>2</sub>H<sub>4</sub>) is not used, sodium sulphate (Na<sub>2</sub>SO<sub>4</sub>) can be used instead, and the excess should be 30 - 60 ppm.

In cases where other kinds of oxygen binding agents are used, it is recommended that an excess of oxygen binding agents can be measured and indicates that no oxygen has been dissolved in the boiler water.

If it is requested to measure the content of dissolved oxygen directly, it is recommended to keep the value < 0.02 ppm.

In addition to the above values, the various water treatment companies will add further demands, depending on the method used for treatment of feed and boiler water.

However, the most important point is that the above values or their equivalents are observed and that a regular (daily) test of feed and boiler water is carried out.

### 3.1 Units of measurement

Concentrations are usually expressed in "ppm" i.e. parts solute per million. Concentrations for parts solution by weight are the same as "mg/litre".

#### 3.1.1 Specific gravity

As guidance the following conversion can be used:

- 1 Be° = 10.000 mg/l total dissolved solids (TDS)
- 1 mg/l total dissolved solids = 2 μS/cm
- 1 μS/cm = 1 μmho
4 Feed and boiler water maintenance

The following are recommended water maintenance instructions. More exact details concerning analyses and blow downs should be set up together with the supplier of chemicals for water treatment.

4.1.1 Daily

Step A: Analyses of feed and boiler water.

4.1.2 Weekly

Step A: Skimming (surface blow down) according to analyses, but at least once per week (2 minutes with fully open valve).

Step B: Blow down (bottom blow down) according to analyses, but at least once per week (each blow down valve 1 minute in low load condition).

4.1.3 Monthly

Step A: Check the functions for salinity and oil detection systems.

4.1.4 Every six months

Step A: The boiler water side (interior) must be carefully inspected at least twice a year.

4.1.5 Yearly

Step A: Check of the water side of the boiler and hotwell/deaerator for corrosion and scaling.

Step B: Check the chemical pump unit.
5 Treatment systems / injection points

In the following tables and illustrations a number of different feed and boiler water treatment systems are shown together with the recommended location for the injection point of the individual chemicals as stated by the manufacturer. The general information regarding the injection point principle can be used as guidelines for the most common systems. But should there be any doubt for a specific system the manufacturer/supplier should be consulted in order to obtain the correct result.

Notes for tables/illustrations:
- Note No. 1: the preferred injection point of chemicals stated by the manufacturer/supplier.
- Note No. 2: the alternate injection point of chemicals stated by the manufacturer/supplier.
- Note No. 3: Valid for modulating feed water systems.
- Note No. 4: valid for on/off operating feed water systems. The chemical pump starts/stops together with the feed water pump.
- Note No. 5: valid for two boiler installation. Control of the chemicals in question work properly at an equal load condition (feed water flow) on the two boilers.

How to use the tables:
The tables can be used in different ways but the main idea is to do following:

Step A: Discover which manufacturer and type of chemicals that should be used for the actual boiler plant.

Step B: Use the name of the manufacturer and type of chemicals to select which tables that can be used.

Step C: Check the flow diagrams (Figure 1, Figure 2, or Figure 3) to find a diagram that matches the actual boiler plant.

Step D: Find in the selected tables the table which includes the matching diagram.

Step E: If more than one table is found to match the actual boiler plant in question it is recommended to use the method/table which includes note No. 1.

Step F: If no table is found to match the actual boiler plant in question it is recommended to seek assistance by the chemical manufacturer/supplier.
### Chemical Injection Points

<table>
<thead>
<tr>
<th>Manufacturer / supplier:</th>
<th>Ashland Chemical / Drew Marine Division</th>
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<tr>
<td>Product name / method:</td>
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<table>
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### Chemical Injection Points (continued)

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| B.W.T. powder            | 2, 2a, 2b | X              |       | 1, 3, 4  | 1, 2, 3 |
| Marichem CCl             | 2, 2a, 2b | X              |       | 1, 3, 4  |               |

| Manufacturer / supplier: | Marichem | | Table No. 18 |
|--------------------------|----------|-----------------|
| Product name / method:   | BWT      |
| Chemical name            | Injection point No. | Continuous | Batch | Note No. | Valid flow diagram No. |
| B.W.T. powder            | 1         | X              |       | 2, 3, 4, 5 | 1, 2, 3 |
| Marichem CCl             | 2, 2a, 2b | X              |       | 3, 4      |               |

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| Chemical name            | Injection point No. | Continuous | Batch | Note No. | Valid flow diagram No. |
| Hardness control         | 3, 3a, 3b       | X              |       | 1         | 1, 2, 3 |
| Alkalinity control       | 3, 3a, 3b       | X              |       | 1         |               |
| Oxygen control           | 2, 2a, 2b       | X              |       | 1, 3, 4  |               |
| Condensate control       | 2, 2a, 2b       | X              |       | 1, 3, 4  |               |

| Manufacturer / supplier: | Unitor Chemicals | | Table No. 20 |
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| Product name / method:   | I               |
| Chemical name            | Injection point No. | Continuous | Batch | Note No. | Valid flow diagram No. |
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| Alkalinity control       | 1               | X              |       | 2         |               |
| Oxygen control           | 2               | X              |       | 3, 4      |               |
| Condensate control       | 2               | X              |       | 3, 4      |               |
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Flow diagram No.: 1

Figure 1

Single boiler operation with or without forced circulation exhaust gas boiler
Double boiler operation with separate feed water pumps with or without forced circulation exhaust gas boiler

Figure 2

flowdiag_2.cdr
Flow diagram No.: 3

Double boiler operation with common feed water pumps with or without forced circulation exhaust gas boiler

Figure 3

flowdiag_3.cdr
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Water level gauge

Maintenance and service instructions .......................................................... 1
Water level gauge

1 Maintenance and service instructions

This section describes the maintenance and service instructions for the water level gauge.

Illustration of the water level gauge

Figure 1

1.1 Maintenance

The item nos. mentioned in the following maintenance instructions refer to Figure 1. When out of service with the gauge body in cool and depressurised condition the hexagon screws (6) can be re-tightened.
Step A: Start at the centre, working to opposite sides alternately. Max torque: 60 Nm in cold and under working conditions.

1.1.2 Maintenance during service check-up

Step A: Tighten the nuts (1).

Step B: Bolts on boiler flanges.

Step C: Union nuts (4).

Step D: Bolt form screws (7) with cocks in open positions.

If a leak cannot be stopped by tightening the bottom screws (7), the sealing surface of the cock plug (8) may be damaged or corroded. It can also be necessary to change the packing (3).

1.2 Blowing down

The item nos. mentioned in this following blowing down procedures refer to Figure 1.

Step A: The gauge should be blown down before lighting up the boiler and just before closing down the boiler.

1.2.2 Cleaning the water side:

Step A: Shut the cock S and open the cock W.

Step B: Open the drain cock D for a short time. This sucks the water out of the glass without, however, totally depressurising the gauge body.

Step C: Shut the cock D and then water is forced upwards into the glass again.

Step D: Repeat this procedure several times, opening and shutting the cock D. The water level in glass rises and falls.

1.2.3 Cleaning the steam side:

Step A: Shut the cock W.

Step B: Open the cock S.

Step C: Blow through the steam side and gauge body by opening the drain cock D for 1-2 seconds.

Step D: A steam blowing of longer duration is not advisable considering the service life of glass.

Step E: Turn the cocks to operating position.
1.3 Dismantling

The following dismantling instructions refer to Figure 1 and Figure 2.

Sectional view of the water level gauge

![Diagram showing parts 6-14: Screws, Wedge piece, Centre piece, Reflex, Sealing gasket, Cushion gasket, Cover plate]

**Figure 2**

**Step A:** Shut the cocks S and W.

**Step B:** The drain cock D to be opened until the glass is completely emptied.

**Step C:** Remove nuts (1) and lift off stuffing box heads (2) together with the gauge body from the cocks S and W.

**Step D:** Slacken the union nuts (4) and pull off the stuffing box head (2).

**Step E:** Place the gauge body (G) horizontally with the screws (6) turning upwards and loosen the screws.

**Step F:** Move the wedge piece (9) length wise and lift upwards.

**Step G:** Lift off centre piece (10) reflex glass (11) and gaskets (12 and 13).

**Step H:** Clean sealing surface of cover plate (14) and centre piece (10) and examine for through going scars.

1.4 Assembling

The following assembling instructions refer to Figure 2.

**Step A:** Insert following items into the centre piece (10): sealing gasket (12) reflex glass (11) cushion gasket (13).
Step B: Place cover plate (14) on top.

Step C: Insert wedge piece (9) and move length wise for correct position.

Step D: Tighten screws (6) evenly starting at the centre, working to opposite alternately. Max torque: 60 Nm in cold and under working conditions.

1.5 Maintenance of the straight-through cock

1.5.1 Operation principle and maintenance
The following assembling instructions refer to Figure 3.

Detail drawing of the straight-through cock

Figure 3

The cylindrical plug (18) is sealed with a resilient packing sleeve (17). Should leakage arise during service the packing sleeve must be further compressed by tightening the bottom screw (19) until the leakage is stopped. This must only be done with the cock in open position.

1.5.2 Dismantling

Step A: Remove bottom screw (19).

Step B: Remove screw (15), washer and handle.

Step C: Knock the plug (18) together with split ring (16) and packing sleeve (3) out of the cock body by means of a soft mandrel.

Step D: Remove split ring and knock plug out of the packing sleeve.

Step E: Clean all sealing surfaces carefully and lubricate threads with a high temperature grease before installation.
1.5.3 Assembly

Step A: Place the split ring (16) in the recess of the plug (18).

Step B: Push new packing sleeve onto plug.

Step C: Press the complete unit into cock body.

Note: Turn the packing sleeve until the ridge fits with the groove in the cock body. The eyelets of the packing sleeve must neither protrude nor be tilted.

Step D: Screw in bottom screw (19).

Step E: Place the handle and washer on the plug and fit screw (15).

Step F: Tighten the bottom screw (19) and check if the plug can be turned.
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Safety valves

General ............................................................................................................................................. 1
Maintenance and start-up of boiler ............................................................................................... 2
Adjustment and dismantling ........................................................................................................ 3
Safety valves

1 General

In the following the measures required to achieve a safe and reliable maintenance of the safety valves will be described, together with adjustment and dismantling instructions. An example of an installation of the safety valve is shown in Figure 1.

Mounting of safety valves, example

![Diagram of safety valve setup]

Figure 1

2 Maintenance and start-up of boiler

A regular inspection of the safety valve is recommended at least once a year. Some media and appliances require a more frequent inspection, this is according to the experience of the supplier.

Warning: Before handling and dismantling of the safety valve ensure that the system is NOT pressurised!

Before lighting-up the boiler the pipe connections must be thoroughly cleaned for dirt and foreign bodies.
If the valve is not completely tight, which often happens after starting up the plant, this is usually caused by impurities between the seat and the cone. In order to remove these impurities the valve must be heavily blown out by means of the lifting device. If the valve is not tight after several blows, it may be due to the fact that a hard foreign body has got stuck between the cone and the seat, and it will then be necessary to dismount the valve for overhaul.

Warning: In case of a leaking safety valve the valve must be inspected and over-hauled at earliest possible opportunity. It must be ensured that the boiler is totally depressurised before dismounting the valve.

Note: Before dismantling the safety valve in the workshop the position of the adjusting screw must be measured and noted which will facilitate the adjustment later when the valve is to be adjusted when in service.

If the facings between the cone and the seat have been damaged, they must be grinded.

Step A: The cone can be grinded against a cast iron plate, using a fine grained carborundom stirred in kerosene.

Step B: The seat in the valve body can be grinded in the same way by using a cast iron punch of suitable size.

Note: Never use the cone itself when grinding the seat.

Warning: The spindle and the valve cone must always be secured against turning as the seat and the cone may thus be damaged.

Step C: Before assembly the valve must be thoroughly cleaned, and all traces of grinding material and impurities must be removed.

When the valve has been mounted the boiler is commissioned, and the valve is then checked for leakage and adjusted to the set pressure.

Step D: The adjustment screw is secured by means of its lock nut, and the valve is sealed.

2.2 Routine check

The following should be regarded as recommendations of routine checks on the safety valves, in order to keep a proper functioning.
Yearly
Step A: The safety valve should be tested in operation by raising the boiler pressure.

Step B: Expansion and exhaust pipe should be examined at the same time.

Monthly
Step A: Examine the safety valves for any leaking, such as:
- Is water seeping from the drain plug at the valve body?
- Is the escape pipe hot due to seeping steam from the valve seat?

Step B: Examine the drain and expansion device at the escape pipe.

Step C: Examine the lifting gear device, i.e. clean up and grease all sliding parts.

3 Adjustment and dismantling

Safety valves are delivered with the required spring setting and sealed against unauthorised adjustment.
Adjustments are only allowed in the spring margins. Outside the margin a new spring is required. The pressure in a system should not exceed 90% of the set pressure.
All item nos. mentioned in the following sections refer to Figure 2.

3.1 Dismantling of lifting device

Safety valve with open cap
Step A: Remove bolt(39) and remove lift lever (41)

3.2 Set Pressure change without spring change

Note: Pay attention to spring range

Step A: Spindle (14) must be held fast by all alterations

Step B: Loosen lock nut (21)

Step C: Turn the adjusting screw (17) clockwise for higher and anticlockwise for low set pressures

Step D: Secure the new setting with the lock nut (21) and Reassemble lifting device

3.3 Spring change

Step A: Spindle (14) must be held fast by all alterations
Step B: Loosen lock nut (21) and turn adjusting screw (17) anticlockwise, then the spring (37) is not under tension.

Step C: Loosen the nuts (8) and remove the bonnet (42).

Step D: Remove the upper spring plate (26) and spring (37).

Step E: Remove the spindle (14) with disc (12), guide plate (4) and lower spring plate (26).

Step F: Clean the seat (2) and disc (12).

Step G: Remount the spindle unit with the new spring and upper spring plate.

Step H: Assemble bonnet (42) and adjust to the spring range.

Step I: Secure the spring setting through the lock nut (21) and remount lifting device.

Assembling drawing of safety valve

![Diagram of safety valve with parts labeled]

Figure 2

safe_03a.cdr
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**Feed water system**

- Water level control .............................................................. 1
- Safety device ........................................................................ 2
- Water level control system ................................................... 3

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Language UK

Page 1/1
Water level control

1 Description

The water level control is a modulating system at this type of boiler. The system is illustrated in Figure 1. The safety device system for too low water level alarm and burner cut out consists of a level float switch mounted as an external unit. For measuring and control of the water level, the boiler is equipped with a dp water level transmitter unit, which includes external reference and variable legs, and a dp-transmitter. The continuous 4-20 mA output signal from the dp-transmitter is processed in the control system, which provides level warnings/alarms and control of the regulating feed water valve.

Water level control system
Level float switch

1 General

The level float switch of type RBA 24 supervises the water level in the boiler. It is installed in a vertical position and connected to the boiler sockets, provided for this purpose, by means of shut-off valves.

A float and float rod carry a transmitting magnet which runs in a stainless steel transmitting tube. The transmitting magnet operates the externally installed magnet switches. When the magnet switches have been triggered, they remain in that position until trigged again. Figure 1 illustrates the level float switch.

Illustration of the level float switch

2 Commissioning

2.1 Electrical connection

When installing the level float switch use acetic acid-free silicon cable in the internal part of the switch housing.

Step A: Unscrew the switch housing and check for correct assembly and wiring.
2.2 Adjusting the switch point

The switch point of the level float switch should be pre-adjusted before the boiler is pressurised and started for the first time.

**Step A:** Open both shut-off valves and close the drain valve.

**Step B:** Open the feed water valves and the air valve. Fill the boiler with evaporated water until the "Too low water level" mark has been reached and adjust the magnet switch to the switch point. It should be moved in upwards direction until the switch is triggered and secured in this position. The magnet switch must rest against the transmitting tube.

**Note:** If the temperature difference between the boiler and feed water exceeds approximately 50°C, the boiler must be filled very slowly. When filling a pressure less boiler, the shut-off valve after the feed water pump must be throttled. Otherwise the pump motor will be overloaded.

2.3 Function test

During commissioning a live test of the level float switch must be carried out before the boiler is put into normal operation. The purpose of the live test is to check that the alarm for too low water level and cut out function of the burner is operational. When the boiler is pressurised and the burner is in operation carry out the following work steps:

**Step A:** Slowly decrease the water level in the boiler by means of the blow down valves until the water level has fallen to the "Too low water level" mark. Ensure that the boiler is not refilled with water by closing the feed water valves.

**Step B:** Note that both the alarm and cut out function is delayed via a timer in the control panel.

**Step C:** Adjust the switch point, if necessary.

**Step D:** After completion of the function test open the feed water valves fully and raise the water level to the normal level.

3 Operation and maintenance

**Attention:** Both shut-off valves must always be fully open during normal operation of the boiler.

To ensure a safe and reliable operation of the boiler plant check the level float switch whenever an opportunity occurs by comparing the magnetic switch function with the level indicated in the water level gauges.
A great difference in the water levels may indicate either blocked connections to the float chamber or a water filled level float. Therefore it is recommended to blow-through the level float switch and connection pipes frequently (see below). The blow-through procedures can be performed, e.g. in connection with stopping the boiler plant, in order to get rid of dissolved particles that could settle during the stop periods. In case of prolonged standstill the level float switch should be checked for the correct function before the boiler plant is restarted.

3.1 Blow-through procedure

The blow-through procedure with cleaning of the float chamber should be performed as describe below when the boiler plant is in operation. The procedure should be carried out at least once each week.

Step A: Slowly open the drain valve to fully open position, and allow the chamber to blow-through for a few seconds.

Step B: Close the drain valve again.

In case of contaminated boiler water, e.g. sludge, mud, etc., the blow-through procedure of the level float switch must be done more often.

3.2 Blow-through and test procedure

The blow-through procedure with test of the alarm and burner cut out function should be performed as describe below when the boiler plant is in operation. The procedure should be carried out at least once each month.

Step A: Fully close the upper shut-off valve.

Step B: Slowly open the drain valve to fully open position, and allow the chamber to blow-through for a few seconds.

Step C: Then close the drain valve and open the upper shut-off valve again.

Step D: Fully close the lower shut-off valve.

Step E: Slowly open the drain valve to fully open position, and allow the chamber to blow-through for a few seconds. As the water level falls inside the float chamber check that the alarm function is activated and the burner cuts out. Please note that both the alarm and cut out function is delayed via a timer in the control panel.

Step F: After performing the blow-through and test procedure close the drain valve and open the lower shut-off valve again.

In case of contaminated boiler water, e.g. sludge, mud, etc., the blow-through procedure of the level float switch must be done more often.

3.3 Cleaning

The float chamber, transmitting tube, and transmitting magnet must be opened, checked, and cleaned from dirt at least once a year. Carry out the following work procedures:
Step A: Perform a blowing-through procedure as described above.

Step B: Close the two shut-off valves and slowly open the drain valve.

Step C: Remove the top flange of the chamber.

Step D: Loosen the float and float rod with transmitting magnet from the top flange.

Step E: Clean the transmitter tube and transmitting magnet.

Step F: Clean the float chamber for any fossilised mud.

Step G: Check the condition of the float and that it is not water filled.

Step H: Check the condition of the electrical wiring. Exchange damaged wires if necessary.

When the cleaning procedure is completed the level float switch must be assembled as follows:

Step I: Assemble the transmitting magnet in the top flange.

Step J: Assemble the top flange on the float chamber.

Step K: Perform a function test as described previously when the boiler is pressurised.
dp water level transmitter unit

1 General

The dp water level transmitter unit controls and supervises the water level in the boiler. The complete unit is installed in a vertical position and connected to the boiler sockets, provided for this purpose, by means of shut-off valves (see Figure 1). The dp water level transmitter unit includes reference leg, variable leg, transmitter connection valves mounted on a manifold, and a differential pressure transmitter. The differential pressure transmitter converts the detected water level into an analogue signal (4-20 mA) which is transmitted to the control system. The signal can also be used for remote level indication in the engine control room.

Illustration of the dp water level transmitter unit

Figure 1
dpunit.cdr

The differential pressure transmitter is installed with the process connections upward to prevent trapping of air. The pipes are mounted with continuous fall (at least 5°) from the boiler connections to the transmitter also to prevent trapping of air. The reference impulse leg (upper connection point) is connected to the high pressure connection (+), and the variable impulse leg (lower connection point) to the low pressure connection (−).

Note: The dp water level transmitter unit or any part of it must not be insulated to ensure the correct function.
2 Commissioning

2.1 Initial commissioning

Before the boiler is pressurised and started for the first time some initial commissioning procedures can be performed with regard to the valves of the dp water level transmitter unit. The shut-off valves, transmitter connection valves, and equalising valve should be operated in the following sequence during the initial commissioning:

Step A: Initial setting; all valves of the dp water level transmitter unit closed (see Figure 1).

Step B: Open the equalising valve located on the valve manifold.

Step C: Unscrew the filling plugs for the reference leg and variable leg. Fill the legs with feed water.

Step D: Open the transmitter connection valve and venting facility on the reference leg side of the transmitter.

Step E: Close the venting facility on the reference leg side of the transmitter when no more air escapes.

Step F: Open the venting facility on the variable leg side of the transmitter.

Step G: Close the transmitter connection valve on the reference leg side of the transmitter when no more air escapes.

Step H: Close the transmitter connection valve on the variable leg side of the transmitter.

Step I: Open the venting facility on the variable leg side of the transmitter.

Step J: Close the transmitter connection valve on the variable leg side of the transmitter.

Step K: Close the equalising valve.

Step L: Refill the legs with feed water and screw on the filling plugs for the reference leg and variable leg.

Step M: Open both transmitter connection valves fully.

2.2 Commissioning of the differential pressure transmitter

The differential pressure transmitter can be commissioned either through "blind calibration" or "live calibration". In the following sections both methods are described.
2.2.1 Blind calibration

Blind calibration of the differential pressure transmitter can be performed if no pressure source is available. This means when the boiler cannot be operated at normal working pressure and the water level cannot be increased/decreased. The "start of scale" and "full scale" differential pressures are calibrated on the basis of calculated values. The start of scale value should be calibrated to obtain a 4 mA output signal from the transmitter when the water level is at the lower connection point and the full scale value to obtain a 20 mA output signal when the water level is at the upper connection point. To ensure an accurate calibration it is necessary to take the density difference between the water in the reference leg and in the boiler into consideration when calculating the differential pressure values.

4 mA output signal from the differential pressure transmitter:
- When the water level in the boiler is at the lower connection point the pressure difference over the transmitter is equal to the height between the connection points (column of water) corrected with the density of the water in the reference leg. The value must be specified and entered in engineering unit, e.g. in mm H2O.

20 mA output signal from the differential pressure transmitter:
- When the water level in the boiler is at the upper connection point the pressure difference over the transmitter is equal to the height between the connection points corrected with the density difference between the water in the reference leg and in the boiler. The value must be specified and entered in engineering unit, e.g. in mm H2O.

Figure 2 indicates the calculation procedures of the differential pressures. As standard it is assumed that the temperature in the reference leg (condensate receiver) is 40°C. Table 1 shows the calculated values for some standard heights between the connection points. If the actual boiler plant does not fit any of the standard calculations the specified calculated values can be entered in the table for calibration record purpose.

If the boiler plant is intended to operate at different set points (high/low pressure mode) the differential pressure transmitter must be calibrated so that the minimum indicated "Too low water level" on the control system not is lower than the actual "Too low water level" mark. Because of the density difference in the boiler water at different working pressures/temperatures the indicated water levels will not be identical. This means that the differential pressures for start of scale and full scale should be calculated using the parameters from operation in high pressure mode.

When the differential pressures corresponding to the "start of scale" and "full scale" have been calculated carry out the following work steps (please also see the specific instruction for the differential pressure transmitter):

**Step A:** Unscrew the screws that hold the protective cover of the differential pressure transmitter for access to the push buttons.

**Step B:** Use the "M" key to select modes on the differential pressure transmitter.
When a mode is selected, the keys ↑ and ↓ are used to change the mode value.
Step C: Set the values in mode 4 (electrical damping), 9 (output in error situation), 10 (pushbuttons functions), 11 (characteristic), 13 (value displayed), and 14 (engineering units). In mode 14 select e.g. "mm H₂O" as engineering units.

Step D: Select mode 5 using the "M" key.

Step E: Use the ↑ or ↓ key to set the start of scale in the selected engineering unit. If mm H₂O is selected as engineering units, then set the start of scale to the calculated value in mm H₂O (differential pressure at 4 mA).

Step F: Press both the ↑ and ↓ keys simultaneously for about 2 seconds, and the start of scale is set to zero (in the selected engineering unit).

Step G: Select mode 6 using the "M" key.

Step H: Use the ↑ or ↓ key to set the full scale in the selected engineering unit. If mm H₂O is selected as engineering units, then set the full scale to the calculated value in mm H₂O (differential pressure at 20 mA).

Step I: Press both the ↑ and ↓ keys simultaneously for about 2 seconds, and the full scale is set to the upper limit (in the selected engineering unit).

Step J: Mount the protective cover of the differential pressure transmitter again.

<table>
<thead>
<tr>
<th>Height between connection [mm]</th>
<th>Working pressure [bar - kg/cm²]</th>
<th>Connection point</th>
<th>Transmitter output, [mA]</th>
<th>Differential pressure calibration [mm H₂O]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Calculations for standard heights, working pressures, and ambient temperature (40 °C)</strong></td>
<td></td>
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<tr>
<td>525</td>
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<td>Lower connection</td>
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<td></td>
<td></td>
<td>Upper connection</td>
<td>20</td>
<td>50</td>
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<tr>
<td></td>
<td>16.0</td>
<td>Lower connection</td>
<td>4</td>
<td>521</td>
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<td>Upper connection</td>
<td>20</td>
<td>70</td>
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<tr>
<td>700</td>
<td>7.0</td>
<td>Lower connection</td>
<td>4</td>
<td>695</td>
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<td>Upper connection</td>
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**Calculation records for other heights, working pressures, and/or ambient temperatures**

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<th>Upper connection</th>
<th>Lower connection</th>
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</tbody>
</table>

Table 1
Calculation of the differential pressures

\[ t_1 = 40^\circ C, \text{ density: } 992.2 \text{ kg/m}^3 \]

Differential pressure between connections:
\[ 525 \times 0.9922 = 521 \text{ mm } H_2O \text{ (at 4 mA)} \]

Height between connections, e.g.:
\[ 525 \text{ mm} \]

Water level

\[ t_2 = 170^\circ C \text{ at 7 barg, } 204^\circ C \text{ at 16 barg} \]

\[ t_2 = 40^\circ C, \text{ density: } 992.2 \text{ kg/m}^3 \]

Differential pressure between connections (at 7 barg):
\[ 525 \times (0.9922 - 0.8970) = 50.0 \text{ mm } H_2O \text{ (at 20 mA)} \]

Differential pressure between connections (at 16 barg):
\[ 525 \times (0.9922 - 0.8596) = 69.0 \text{ mm } H_2O \text{ (at 20 mA)} \]

\[ t_2 = 170^\circ C \text{ at 7 barg, density } 897.0 \text{ kg/m}^3 \]

204^\circ C \text{ at 16 barg, density } 859.6 \text{ kg/m}^3

Figure 2
dpunit_cali1.cdr

2.2.2 Live calibration

Live calibration of the differential pressure transmitter can be performed when a pressure source is available. This means when the boiler can be operated at normal working pressure and the water level can be increased/decreased. The "start of scale" and "full scale" output signals of the differential pressure transmitter are set during actual operating conditions. It is therefore not necessary to take the density difference between the water in the reference leg and in the boiler into consideration. However, if the boiler plant is intended to operate at different set points (high/low pressure mode) the differential pressure transmitter must be calibrated so that the...
minimum indicated "Too low water level" on the control system not is lower than the actual "Too low water level" mark. Because of the density difference in the boiler water at different working pressures/temperatures the indicated water levels will not be identical. This means that the differential pressure transmitter should be calibrated when the boiler plant operates in high pressure mode.

When the boiler operates at normal working pressure carry out the following work steps (please also see the specific instruction for the differential pressure transmitter):

**Step A:** Unscrew the screws that hold the protective cover of the differential pressure transmitter for access to the push buttons.

**Step B:** Use the "M" key to select modes on the differential pressure transmitter. When a mode is selected, the keys ↑ and ↓ are used to change the mode value.

**Step C:** Set the values in mode 4 (electrical damping), 9 (output in error situation), 10 (pushbuttons functions), 11 (characteristic), 13 (value displayed), and 14 (engineering units). In mode 14 select "mA" as engineering units.

**Step D:** Ensure that the boiler cannot be filled with feed water by closing the feed water valves or stopping the feed water pumps.

**Step E:** Slowly decrease the water level in the boiler until the lower connection point is reached (socket centre line of the variable leg). The water level can be decreased by means of the blow down valves.

**Step F:** The upper and lower connection points will normally be beyond the visual indication area of the water level gauges. It is therefore impossible to see when the water level is at these points. However, the rising/falling rate of the water level can be controlled, by throttling the feed water valves/blow down valves. By clocking the rate it can be calculated when the water level has reached the connection points.

**Step G:** Select mode 2 using the "M" key.

**Step H:** Set the output current corresponding to the start of scale using the ↑ and ↓ keys. Or set the output current to 4 mA by pressing the ↑ and ↓ keys simultaneously for about 2 seconds.

**Step I:** Slowly increase the water level in the boiler until the upper connection point is reached (socket centre line of the reference leg). The water level can be increased by means of the feed water pumps.

**Step J:** When the water level is increased operate the burner so that the boiler pressure is kept at normal working pressure.

**Step K:** Select mode 3 using the "M" key.

**Step L:** Set the output current corresponding to the full scale using the ↑ and ↓ keys. Or set the output current to 20 mA by pressing the ↑ and ↓ keys simultaneously for about 2 seconds.
Step M: Mount the protective cover of the differential pressure transmitter again.

2.3 Final commissioning

During final commissioning a function test of the dp water level transmitter unit must be performed before the boiler plant is put into normal operation. The purpose of the function test is to check that the output signals from the differential pressure transmitter are correct. Furthermore, it should be checked that the connected warnings/alarms and control functions are operational. The boiler should be operated at normal working pressure during the test to provide for correct indications. When the boiler is at normal water level and the burner is in operation, carry out the following work steps:

Step A: Slowly increase the water level in the boiler by forcing operation of the feed water pump until the water level has risen to the "High water level" level. The control system should indicate a warning, (if provided).

Note: Note that alarms, warnings, and cut out functions can be delayed via timers in the control system.

Step B: Increase the water level somewhat until the "Too high water level" mark is reached. The burner should stop, and an alarm should be indicated on the control system, (if provided).

Step C: Increase the water level somewhat until the upper connection point is reached (socket centre line of the reference leg). Check that the output signal from the differential pressure transmitter is at 20 mA or the full scale value in the selected engineering units.

Step D: The upper and lower connection points will normally be beyond the visual indication area of the water level gauges. It is therefore impossible to see when the water level is at these points. However, the rising/falling rate of the water level can be controlled, by throttling the feed water valves/blow down valves. By clocking the rate it can be calculated when the water level has reached the connection points.

Step E: Ensure that the boiler cannot be filled with feed water by closing the feed water valves or stopping the feed water pumps.

Step F: Decrease the water level in the boiler by means of the blow down valves until the water level has fallen to the "Low water level" level. The control system should indicate a warning.

Step G: Decrease the water level somewhat until the "Too low water level" mark is reached. The burner should stop, and an alarm should be indicated on the control system.

Step H: Decrease the water level somewhat until the lower connection point is reached (socket centre line of the variable leg). Check that the output signal
from the differential pressure transmitter is at 4 mA or the start of scale value in the selected engineering units.

**Step I:** After completion of the function test open the feed water valves or start the feed water pumps.

### 3 Operation and maintenance

**Attention:** Both shut-off valves between the boiler and impulse legs must always be fully open and the reference leg must be totally filled with water during normal operation of the boiler.

To ensure a safe and reliable operation of the boiler plant check the dp water level transmitter unit whenever an opportunity occurs by comparing the water level indicated by the control system with the level indicated in the water level gauges. A great difference in the water levels may indicate blocked connections to the differential pressure transmitter. Therefore it is recommended to blow-through the impulse legs and connection pipes frequently. The blow-through procedures can be performed, e.g. in connection with stopping the boiler plant, in order to get rid of dissolved particles that could settle during the stop periods. In case of prolonged standstill the dp water level transmitter unit should be checked for the correct function before the boiler plant is restarted.

#### 3.1.1 Blow-through procedure of the impulse legs

The blow-through procedure should be performed as describe below when the boiler plant is in operation and in steady load condition. The procedure should be carried out at least once each month. When the blow-through procedure is carried out, it is very important that the water level in the boiler is carefully and continuously supervised by the ship engineering personnel. The feed water control valve must be operated manually, if necessary.

**Step A:** Isolate the differential pressure transmitter by closing the two transmitter connection valves in the manifold. The equalising valve must remain closed during the blow-through procedure and normal operation.

**Step B:** Slowly open the drain valves of the impulse legs, and allow the legs to blow-through for a few seconds.

**Step C:** Close the shut-off valve for the reference leg.

**Step D:** Close the drain valves again when the reference leg is completely depressurised.

**Step E:** Unscrew the filling plug of the reference leg and fill the leg with feed water.

**Step F:** Screw on the filling plug and slowly open the shut-off valve for the reference leg.

**Step G:** Open the two transmitter connection valves in the manifold.
Step H: After performing the blow-through check that the dp water level transmitter unit and feed water control valve are fully operational.

In case of contaminated boiler water, e.g. sludge, mud, etc., the blow-through procedure of the impulse legs must be done more often.

3.1.2 Blow-through procedure of the connection pipes

The blow-through procedure should be performed as describe below when the boiler plant is stopped, but still pressurised. The procedure should be carried out at least once each year.

Step A: Open the venting facilities located on the valve manifold for the impulse legs. The transmitter connection valves must remain open and the equalising valve closed during the blow-through procedure.

Step B: Close the venting facilities on the valve manifold when only clean water escapes.

Step C: Close the shut-off valve for the reference leg.

Step D: Slowly open the drain valve of the reference leg.

Step E: Close the drain valve again when the reference leg is completely depressurised.

Step F: Unscrew the filling plug of the reference leg and fill the leg with feed water.

Step G: Screw on the filling plug and slowly open the shut-off valve for the reference leg.

In case of contaminated boiler water, e.g. sludge, mud, etc., the blow-through procedure of the connection pipes must be done more often.

3.1.3 Function test of the dp water level transmitter unit

During normal operation of the boiler plant a function test of dp water level transmitter unit should be carried out at least once each month. The purpose of the function test is to check that the connected warnings/alarms and control functions are operational. The boiler should be operated at normal working pressure during the test to provide for correct indications. When the boiler is at normal water level and the burner is in operation, carry out the following work steps:

Step A: Slowly increase the water level in the boiler by forcing operation of the feed water pump until the water level has risen to the "High water level" level. The control system should indicate a warning, (if provided).

Note: Note that alarms, warnings, and cut out functions can be delayed via timers in the control system.

Step B: Increase the water level somewhat until the "Too high water level" mark is reached. The burner should stop, and an alarm should be indicated on the control system, (if provided).
Step C: Ensure that the boiler cannot be filled with feed water by closing the feed water valves or stopping the feed water pumps.

Step D: Decrease the water level in the boiler by means of the blow down valves until the water level has fallen to the "Low water level" level. The control system should indicate a warning.

Step E: Decrease the water level somewhat until the "Too low water level" mark is reached. The burner should stop, and an alarm should be indicated on the control system.

Step F: After completion of the function test open the feed water valves or start the feed water pumps.
**Type:**
- Monitor LCD, flush mounted
- (0628-047)

**Application:**
- Accessories for the PC

**Material:**
- Black powder coating aluminium (front)

**Technical data:**
- Size: 15” TFT colour
- Operating temperature: 0°C to +50°C
- Operating humidity: 20% to 85%, non condensing
- Storage temperature: -20°C to +60°C
- Storage humidity: 20% to 85%, non condensing
- Weight: 10 kg

**Installation:**

*Mounting into the control panel in the engine room.*
- Cut out dimension: 318 mm x 393 mm
- Ensure that there is sufficient space behind the monitor for connection purposes.

*Warning!! Be sure that the computer is off before removing or attaching any cables.*
- Insert VGA cable into VGA port on the back panel of display.
- Insert other end of VGA cable into VGA port on the computer.
- Insert power cord into power cord port and plug into power outlet.
- Remove protective covering from screen and turn on the computer.
- Once the system is up and running, insert driver CD into disk drive and copy the folder NAVN AF MAPPE onto your hard disk.
- Open the folder you have just copied and double click the file named setup.exe and follow the dialog in the set up program.
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Control valves, type 470/471

1 General

This type of control valve is suited to regulate fluids, gases and steams. The valve plug is normally a parabolic plug, but can also be supplied in a perforated design. Both types of plugs can have either linear or equal percentage flow characteristic. The flow direction for parabolic plugs is always against the closing direction. However, with perforated plugs for steam and gases, it is in the closing direction. If a valve with a perforated plug is operated by means of a pneumatic actuator with the flow in the closing direction, the pneumatic actuator should have a stronger thrust force. This is necessary to prevent thumping near to the closing position. All control valves can be fitted alternately with manual-, pneumatic-, electric- or hydraulic operation devices.

Illustration of control valves type 470 and 471

Figure 1
2 Operation

2.1 Fitting instructions

The valve should be inserted so that the spindle has a vertical position together with the actuator. The valve can also be tilted to a maximum horizontal position if the installation point does not allow any better condition.

To guarantee a disturbance free function of the control valve, the inlet and outlet stretches of the piping should be of straight piping length (min. two times the pipe diameter by inlet and six times by outlet). The piping should be rinsed to clear out any pollution, welding beads, rust, etc. before inserting the control valves. A strainer should be fitted in front of the control valve to catch the remaining particles. Bolts should be tightened after taking into operation.

The flow direction is signalled by an arrow on the valve body. The valves should be insulated against high temperatures to guard the actuator.

2.2 Actuator assembly

The control valves are normally delivered with actuators already fitted. For alternations or maintenance of actuator, the assembly should occur in accordance with the operation instructions for the actuator.

2.3 Setting into operation

When the piping system is filled, the spindle sealing should be checked for leakage and, if necessary, tightened. A PTFE-V-ring unit does not require any tightening as the spring tension maintains the necessary force.

The bolts must be tightened gradually in steps, diametrically in pairs, but not tighter than it is necessary for the sealing. Flange connection bolts should never be loosened or tightened when the valve is under temperature or pressure even if a leakage may arise.

For actuators please see to the appropriate actuator operation instructions.
3 Maintenance

Before any maintenance of the control valve is carried out, the piping system must be shut off and pressure free.

3.1 Exchange of the stuffing-box packing

A leak stuffing-box packing should initially be carefully tightened to stop the leakage. If this does not help, a new layer should be inserted, or the complete packing should be replaced.

3.1.1 Additional packing layer

Step A: Open the valve fully and unscrew the hexagon nuts (17).

Step B: Lift the gland flange (7) and the spindle guiding (8) upwards.

Step C: Insert adequate quantity of packing rings (split ring-displacement, splitting at 180° to avoid overlapping).

Step D: Fix the hexagon nuts (17) properly.

3.1.2 Exchange

Step A: Drive the actuator into middle position and dismantle the actuator.

Step B: Unscrew the hexagon nuts (17) from the studs (15).

Step C: Remove the gland flange (7), the spindle guiding (8) and the old stuffing box (10) and clean the packing compartment.

Step D: Clean the valve spindle and check for damage and if necessary replace. If the damaged spindle is not replaced, the new packing will leak after a short period.

Step E: Insert the new packing rings (split ring-displacement, splitting at 180° to avoid overlapping).

Step F: Fix the hexagon nuts (17) properly.

Note: Strenuous tightening will prevent leakage, but will also have a brake effect on the spindle which aggravates the movement of the spindle.

3.2 Exchange of a PTFE-V-ring sealing unit

A PTFE-V-ring unit is spring loaded and has enough set pressure to ensure a good seal even by low operation pressures. It is replaced as mentioned above. The PTFE-V-ring sealing unit should be lubricated before it is inserted. The sealing lips must face against the pressure direction.
Note: Special care should be given to the spindle surface. Rough surfaces wear the sealing lips enormously and can be due to failure of the packing unit.

### 3.3 Exchange of the bellow unit

**Step A:** Drive the actuator into middle position and dismantle the actuator.

**Step B:** Unscrew the screw joint (7.1).

**Step C:** Unscrew the hexagon nuts (17) and remove the bellow housing (25). Dismantle the plug as described in the next section.

**Step D:** Unscrew the hexagon nuts (17.1) and dismantle the mounting bonnet (3.1).

**Step E:** The bellow unit (26) is removed from the bellow housing (25).

**Step F:** Replace the two gaskets (14.1) and the gasket (14).

**Step G:** When the bellow unit (26) is replaced, the proper position of the anti-twisting device must be observed.

**Step H:** The set pins (21) have to drive within the slots of the anti-twisting device. Check for friction-free movement.

**Step I:** Replace mounting bonnet (3.1) and screw down the hexagon nuts (17.1) crosswise.

### 3.4 Exchange of the plug-spindle unit

**Step A:** Drive the actuator into middle position and dismantle the actuator.

**Step B:** Unscrew the gland flange (7).

#### 3.4.2 Control valve type 470

**Step A:** Unscrew the hexagon nuts (17) and dismantle the mounting bonnet (3).

**Step B:** Pull out the plug with the spindle and exchange this unit.

**Step C:** Remove the spring-type straight pin (19) and unscrew the spindle (6).

**Step D:** Replace the old parts and assemble it.

**Step E:** Drill a hole through the plug shaft and insert a new pin.

**Step F:** Replace the gasket (14) and assemble the mounting bonnet (3).

**Step G:** Tighten the nuts (17) evenly, crosswise.
3.4.3 Control valve type 471

Step A: Unscrew the hexagon nuts (17) and dismantle the bellow housing (25) with plug (5).

Step B: Drive the spindle in the bottom position and remove the spring-type straight pin (19).

Step C: Unscrew the plug.

Step D: Screw a new plug at the spindle and drill through the shaft. Drive the spring-type straight pin (19) into the hole.

Step E: Replace the gasket (14).

Step F: Assemble the bellow housing (25) with plug (5) together with the body (1) and fix it by screwing the hexagon nuts (17) crosswise.

The spindle can only be completely replaced together with the bellow.

3.5 Changing the seat ring

The seat ring is screwed into the valve body. The seat ring can be obtained after removing the bonnet and can then be refinished or replaced as required.

Step A: Clean and lubricate the thread and conical sealing surface before insertion.
Pneumatic actuator, type dp

1 General

The pneumatic linear actuator is designed to be mounted directly on a control valve. The pneumatic actuator converts positioning command signals into stem thrust forces. The required back setting force is produced by the spring arrangement inside the actuator. The rolling-diaphragm produces linear spindle movements over the complete stroke.

The preferred mounting position is with the actuator and valve spindle in vertical position.

The mode of operation for the actuator depends on how the springs are inserted when the actuator is assembled. Even when the actuator is fitted in a piping system, the mode of operation can be changed.

The pneumatic actuator can be operated as:

- Spring opens valve/air closes valve operation mode
- Air opens valve/spring closes valve operation mode

Illustration of a pneumatic actuator

Figure 1  dpactuat.tif
Table 1 below shows a list of the position numbers in Figure 1 and Figure 2.

<table>
<thead>
<tr>
<th>Part</th>
<th>Denomination</th>
<th>Part</th>
<th>Denomination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rolling diaphragm</td>
<td>15</td>
<td>Stroke indicator</td>
</tr>
<tr>
<td>2</td>
<td>Diaphragm housing</td>
<td>16</td>
<td>Hexagon nut</td>
</tr>
<tr>
<td>3</td>
<td>Diaphragm lid</td>
<td>17</td>
<td>Mounting rod</td>
</tr>
<tr>
<td>4</td>
<td>Diaphragm plate</td>
<td>18</td>
<td>Bellows</td>
</tr>
<tr>
<td>5</td>
<td>Spindle</td>
<td>19</td>
<td>Collar nut</td>
</tr>
<tr>
<td>7</td>
<td>Spring</td>
<td>21</td>
<td>O-ring (spindle)</td>
</tr>
<tr>
<td>10</td>
<td>Coupling flange</td>
<td>22</td>
<td>O-ring (bushing)</td>
</tr>
<tr>
<td>11</td>
<td>Guide flange</td>
<td>26</td>
<td>Slotted guide bearing</td>
</tr>
<tr>
<td>12</td>
<td>Rotation guard</td>
<td>27</td>
<td>Spindle guide</td>
</tr>
<tr>
<td>13</td>
<td>Socket screw</td>
<td>30</td>
<td>Hexagon nut</td>
</tr>
<tr>
<td>14</td>
<td>Threaded bushing</td>
<td>31</td>
<td>Hexagon nut</td>
</tr>
</tbody>
</table>

**Table 1**

**1.1 Pneumatic connection**

The air supply should be dry and at a low service temperature. A heat-guard should be installed to prevent high service temperature. The pneumatic supply tube must be connected to the diaphragm housing (2) by operation mode “spring closes” and to the diaphragm lid (3) by operation mode “spring opens”. By air failure the stem automatically returns into the original position caused by the inserted springs.

**Warning:** The actuator diaphragm may only be pressure loaded on the side opposite of the springs. The vent hole in the other connection must remain open.

**1.2 Assembly of the actuator on the valve**

The assembling of the actuator on the valve is shown in Figure 2. For both “spring closes” and “spring opens” operation modes the following assembling procedure should be followed:

**Step A:** If the actuator and the valve are separated, press the plug and spindle unit (5) into the closed position for operation mode “spring closes” or into the open position for operation mode “spring opens”.

**Warning:** Make sure that the plug does not turn while pressing on the seat during assembly.

**Step B:** Loosen the socket screws (13), remove the rotation guard (12) and the guide flange (11). The threaded bushing (14) is now free.
Step C: Turn the locking hexagon nut (30) onto the valve spindle. Place the rotation guard (12) and the guide flange (11) over the valve spindle and then turn the threaded bushing (14) onto the valve spindle.

Step D: Check the actuator for proper operation mode and connect the pneumatic supply to the connection piece in the diaphragm housing (2) for operation mode "spring closes" or in the diaphragm lid (3) for operation mode "spring opens".

Step E: Drive the actuator into approximately mid-stroke position over the air supply and mount it onto the valve (read the value from the pressure gauge - middle of the spring range).

Step F: Tighten the hexagon nuts (31).

Assembly of the actuator on the valve

Operation mode: Spring closes valve - Air opens valve

Operation mode: Spring opens valve - Air closes valve

Pneumatic connection

Figure 2
1.3 Adjustment of the starting pressure signal

Step A: Drive the actuator to the required spring-starting point over the air supply.

Step B: Turn the threaded bushing (14) up against the coupling flange (10) so that the collar enters into the flange and presses against it. Make sure that the plug is lying on the valve seat.

Attention: Note that sufficient thread of the valve spindle is inside the threaded bushing (14). If not, turn the coupling flange (10) downwards from the actuator spindle and pull the threaded bushing (14) against it.

Step C: For operation mode: “spring closes”:
— Attach the guide flange (11) and the rotation guard (12) with the socket screws (13) to the coupling flange (10).
— Check that the plug lifts off the seat at the required spring starting point.

Step D: For operation mode: “spring opens”:
— Check that the plug leaves the end position at the required spring starting point, and finishes the valve stroke at the spring-range end value.
— The plug must then also press on the valve seat.

Step E: After the test operation set the stroke indicators (15) into the end positions.

Step F: Lock the hexagon nuts (16 + 30) at the valve mid-stroke.

Step G: Do not turn the plug on the seat when it is under force.

2 Reversal of the actuator action

The actuator action can be reversed even when the valve is installed in a piping system. The position numbers mentioned in this section refer to Figure 1 and Figure 2.

Step A: Drive the actuator into approximately mid-stroke position with the air supply.

Step B: Loosen and remove the socket screws (13) from the coupling flange (10) and drop the rotation guard (12) over the valve spindle.

Step C: Remove the hexagon nuts (31) from the actuator and lift off the valve.

Step D: Reduce the air supply until the chamber is pressure free.
Step E: Loosen and remove the diaphragm lid screws.

Step F: Remove the diaphragm lid (3).

---

**Warning:** The actuators DP 32 and DP 33 have two longer screws when fitted with stronger spring ranges. The actuator DP 34 has four. These screws should be the last screws to be loosened, and must be loosened evenly to reduce the high spring tension.

---

Step G: For reversal from “spring closes” into “spring opens”:

- Remove the springs (7) and the diaphragm plate (4) with the diaphragm (1) and the spindle (5).
- Loosen and remove the seal lock nut (19) and remove the spindle (5). Turn over the diaphragm plate (4) with the diaphragm (1) and the diaphragm clamping flange, and place it over the spindle (5).
- Tighten with the seal lock nut (19). Make sure that the spindle surface is not damaged.
- Grease the spindle surface and the 0-ring.
- Place the diaphragm plate (4) with the diaphragm (1) into the diaphragm lid (3).
- Arrange the springs (7) onto the moulds pressed into the diaphragm plate (4).
- Place the diaphragm housing with the spindle sealing unit over the spindle, and screw it together. Make sure that the springs stay properly arranged.
- Turn the hexagon nut (16) and the coupling flange (10) onto the spindle (5).
- Mount the actuator as described previously, and connect the air supply tube to the diaphragm lid (3).

Step H: For reversal from “spring opens” into “spring closes”:

- Remove the diaphragm (1) and the diaphragm plate (4) with the spindle (5) and the springs (7).
- Loosen and remove the seal lock nut (19) from the spindle (5). Turn over the diaphragm plate (4) with the diaphragm (1) and the diaphragm clamping flange, and place it on the spindle (5).
- Tighten with the seal lock nut (19). Make sure that the spindle surface is not damaged.
- Grease the spindle surface and the 0-ring.
- Stick the diaphragm plate (4) with the diaphragm (1) and the spindle (5) into the diaphragm housing (2).
- Arrange the springs (7) onto the moulds pressed into the diaphragm plate (4).
Place the diaphragm lid (3) on the top, and screw it together. Make sure that the springs (7) stay properly arranged.

- Turn the hexagon nut (16) and the coupling flange (10) onto the spindle (5).
- Mount the actuator as described previously, and connect the air supply tube to the diaphragm housing (2).

3 Manual operation device

Some actuators are fitted with a manual operation device. The device is connected to the actuator by means of a new diaphragm lid, a spindle extension with a USIT-ring and a spindle sealing unit.

The manual operation device is equipped with stroke indicators. The stroke indicators of both the actuator and the manual operation device must be in the same end positions when the actuator is pressure free.

The manual operation device must be set into neutral position when the actuator is running automatically.

The locking device of the manual operation device must be unlocked before operating. The locking device prevents an unwanted disarrangement of the setting during operation, e.g. due to vibration, etc.

4 Maintenance

The pneumatic actuator is maintenance free. To maintain a disturbance free operation, the air should be supplied by an air-supply station.

The diaphragm, spindle sealing unit and springs are wear parts and should be replaced when necessary.

4.1 Exchange of spindle sealing

When the spindle sealing is changed, the slotted PTFE-guide bearing and the 0-ring should be replaced. The spindle surface must be clean and undamaged. Before the actuator is assembled, the spindle unit and the spindle must be greased.
The following instruction is a general description of SIPART positioners and covers the complete range in the PS2 6DR5000 series. The electronic pneumatic positioner is used as the final control element of a pneumatic linear actuator or a part-turn actuator (rotary movements). The positioner converts a current output signal (4 to 20 mA) from a process controller or control system to a set point value and into a corresponding movement. The positioner changes the pressure in a pneumatic actuator chamber or cylinder until the position corresponds to the set point value.

The positioner can be set up either as a single-action positioner or a double-action positioner. The single-action positioner is mainly used together with a control valve. The opposite movement for the control valve is supplied by means of springs. The double-action positioner is mainly used to control an air damper via a pneumatic cylinder (actuator). All movements of the pneumatic cylinder are supplied by the positioner. An illustration of the function diagram for the positioner is shown in Figure 1. The function diagram is shown with option modules.

1.1 Mode of operation

Comparison of the set point and the actual value takes place electronically in a micro controller. If the micro controller detects a deviation, it uses a 5-way switch procedure to control the piezoelectric valves, which in turn regulate the flow of air into the actuating chambers. When connected in a two-wire system, the SIPART PS2 draws its power exclusively from the 4 to 20 mA set point signal. The piezoelectric valve converts the command into a pneumatic positional increment. The positioner outputs a continuous signal in the area where there is a large control deviation (high-speed zone). In areas of moderate control deviation (slow-speed zone) it outputs a sequence of pulses. No positioning signals are output in the case of a small control deviation (adaptive or variable dead zone).

Commissioning (initialisation) is carried out automatically to a large extend. During initialisation, the micro controller automatically determines the zero, full-scale value, direction of action, and positioning speed of the actuator. It uses these to determine the minimum pulse time and dead zone, thus optimising the control.

The positioner can also be operated manually by the pushbuttons and the LCD of the SIPART PS2.

The installation of the positioner must be carried out in the following order:

- Mechanic connection
- Electric connection
- Pneumatic connection
- Commissioning
Illustration of a function diagram

Figure 1

2 Mechanic connection of the positioner

Normally the positioner is pre-mounted on the actuator or cylinder. If not, follow the installation guide lines below.

2.1 Mechanic connection to an actuator

Figure 2 shows the mechanic connection of the positioner to an actuator for a control valve.

Step A: Mount clamping assembly (3) with hexagon socket cap screws (17) and lock washers (16) on the actuator spindle.

Step B: Insert the pick-up bracket (2) into the recesses of the clamping assembly. Set the necessary length and tighten the screws so that the pick-up bracket can still be shifted.
Step C: Push the roll (5), spring (13), and guide washer (22) onto the pin (4).

Step D: Insert the pin in the lever (6) and assemble with nut (18), spring washer (14), and U-washer (12).

Step E: The value of the stroke range specified on the actuator should be set or if this does not exist as a scaling value, the next greatest scaling value should be set. The centre of the pin must be in line with the scaling value. The same value can be set later under parameter “3.YWAY” in commissioning to display the way in [mm] after initialisation.

Step F: Assemble the hexagon socket cap screw (17), spring washer (16), washer (12), and square nut (19) on the lever.

Step G: Push the pre-mounted lever onto the positioner axis up to the stop and fix with the hexagon socket cap screw (17).

Step H: Fit the mounting bracket (1) with two hexagon head screws (9), lock washer (10), and flat washer (11) on the rear of the positioner.

Step I: Selection of the row of holes depends on the width of the actuator yoke. The roll (5) should engage in the pick-up bracket (2) as close as possible to the spindle but may not touch the clamping assembly.

Step J: Hold the positioner with the mounting bracket on the actuator so that the pin (4) is guided within the pick-up bracket (2).

Step K: Tighten the pick-up bracket.

Step L: Position the mounting parts according to the type of actuator.
- Actuator with ledge: hexagon head screw (8), flat washer (11), and lock washer (10).
- Actuator with plane surface: four hexagon head screws (8), flat washer (11), and lock washer (10).
- Actuator with columns: two U-bolts (7), four hexagon nuts (21) with flat washer (11), and lock washer (10).

Step M: Secure the positioner onto the yoke using the previously positioned mounting parts.

Note: Set the height of the positioner so that the horizontal lever position is reached as close to the stroke centre as possible. The lever scale can be used as orientation. It must be guaranteed that the horizontal lever position is passed through within the stroke range.
Mechanic connection of the positioner (linear actuator)

Figure 2
2.2 Mechanic connection to a pneumatic cylinder

The positioner is connected to a pneumatic cylinder by means of fixing bracket, lever arm with Allen screw, extension arm, and roller. The pneumatic piston is connected to a guide rail with an oblique angle via a linkage. The guide rail moves together with the piston, and the roller/lever connection senses the position of the piston. By operating both sides of the pneumatic cylinder, the set point is reached. A spring inserted between the fixing bracket and the lever arm secures that the roller is pressed down against the guide rail.

2.3 Mechanic connection to a rotary actuator

Figure 3 shows the mechanic connection of the positioner to a rotary actuator.

Step A: Attach the mounting console (9, actuator specific) onto the rear of the positioner and secure using the hexagon head screws (14) and lock washers (15).

Step B: Adhere pointer (4.2) onto the mounting console in the centre of the centring hole.

Step C: Push coupling wheel (2) onto the positioner axis, pull back by about 1 mm and tighten the hexagon socket head screw (18) with the Allen key provided.

Step D: Place the carrier (3) onto the end of the actuator and secure using Fillister head screw (16) and washer (17).

Step E: Carefully place the positioner with mounting console onto the actuator such that the pin of the coupling wheel engages in the driver.

Step F: Align the positioner/mounting console assembly in the centre of the actuator and screw tight (screws are not included in the delivery, they are part of the actuator mounting console).

Step G: Follow the start-up sequence as described later. Drive the actuator to the end position and adhere the scale (4.1) onto the coupling wheel (2) according to the direction of rotation and rotary actuator. The scale is self-adhesive.
Mechanic connection of the positioner (rotary actuator)

Figure 3
3 Electric connection of the positioner

When the positioner is connected in a two-wire system, the positioner draws its power exclusively from the 4 to 20 mA set point signal. Figure 4 indicates the input circuits for the positioner.

View of the controls and connections

![Diagram of the positioner controls and connections](sips2_5d.tif)

4 Pneumatic connection

Ensure that the air quality is suitable. Grease-free instrumental air with a solid content $< 30 \mu m$ and a pressure dew point 20 K below the lowest ambient temperature must be supplied.

Warning: For reasons of safety, pneumatic power may only be supplied after assembly when the positioner is switched to operating level “P manual” operation with electrical signal applied.

4.1.1 Selection of P manual mode

Before pneumatic power is connected, the positioner must be in P manual mode. The display must show “NOINIT” in the bottom line.
4.1.2 Pneumatic connections
Figure 4 shows a view of the positioner controls and connections.

Step A: If required, connect a manometer block for supply air and actuating pressure.

Step B: The silencer in the exhaust output can be removed if necessary.

Step C: Connect actuating pressure Y1 and/or Y2 (Y2\textsuperscript{*}) is only used with double-acting actuators) according to the desired safety position.

Step D: Connect the supply air (1). The pressure should be between 1.4 to 7 bar.

Note: In order for spring-loaded pneumatic actuators to be able to reliably exploit the maximum possible actuating path, the supply pressure must be sufficiently greater than the maximum required final pressure of the actuator.

4.1.3 Safety position when the electric power supply fails
For a single-action actuator is Y1 deaerated. For a double-action actuator is Y1 equal to the supply air pressure and Y2 is deaerated.

4.1.4 Restrictors
To increase the positioning times for fast actuators when necessary, the air flow can be reduced with the restrictors Y1 and Y2 (only for double-action valves). Turning the restrictors in the clockwise direction reduces the air flow until it is shut off. To set the restrictors it is recommended to first close them and then open them again slowly (see initialisation process RUN 3).

4.1.5 Purging air switchover
The purging air changeover switch located above the pneumatic terminal block on the valve manifold can be accessed when the housing is open. When the switch is in position “IN” the interior of the housing is purged with very small quantities of clean and dry instrument air. In position “OUT” the purging air is led directly out of the instrument.

5 Commissioning

Commissioning (initialisation) is carried out automatically to a large extent. During initialisation, the micro controller automatically determines the zero value, full-scale value, direction of action and positioning speed of the actuator. It uses these to determine the minimum pulse time and dead zone, hereby optimising the control.

The positioner can also be operated manually by the pushbuttons and the LCD of the SIPART PS2.

The commissioning of the positioner can be divided into the following steps:
- Preparation for initialisation
- Start the automatic initialisation procedure
• Set additional parameters if required
• Select automatic mode

Figure 5 shows the possible operation modes for the positioner and gives an overview of how to change between them. The levels are P-manual mode, configuration and initialisation, manual mode, automatic mode, and diagnostic display. From these modes it is possible to select operation mode, set operation parameters, restore to factory setting, run an automatic initialisation, etc.

**Operation levels**

<table>
<thead>
<tr>
<th>Mode</th>
<th>Display</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual mode</td>
<td>Manual mode</td>
</tr>
<tr>
<td>Configuration</td>
<td>Configuration</td>
</tr>
<tr>
<td>Change parameter</td>
<td>Change parameter</td>
</tr>
<tr>
<td>name using</td>
<td>name using</td>
</tr>
<tr>
<td>Change value using</td>
<td>Change value</td>
</tr>
<tr>
<td>▲ ▼</td>
<td>▲ ▼</td>
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<tr>
<td>Manual mode</td>
<td>Manual mode</td>
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<tr>
<td>Automatic</td>
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<td>Position [%]</td>
<td>Position [%]</td>
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<td>Error code</td>
<td>Error code</td>
</tr>
<tr>
<td>Mode and Setpoint [%]</td>
<td>Mode and Setpoint [%]</td>
</tr>
</tbody>
</table>

![Figure 5](sips2_5e.tif)

**5.1 Preparation for initialisation**

**Step A:** Check and set the gear transmission switch to the correct position. Figure 4 (position 8) indicates the location of the switch. For linear actuators the gear transmission switch is set according to the stroke range as described in Table 1 for the parameter “3.YWAY”. For part-turn actuators 90° must be selected.

**Step B:** Check that the pneumatic supply power (inlet air) is present. The operating pressure should be at least one bar greater than is necessary for closing/opening the valve during initialisation.
Step C: Without initialisation the positioner is in “P manual mode” and “NOINIT” flashes in the display. This level can also be reached by using “55.PRST” function (see Table 1).

Step D: Check the free running of the mechanics in the whole actuating range by moving the actuator with the keys “↑” and “↓” and driving to the respective end position.

Step E: With linear actuators drive the actuator to horizontal lever position. The display must indicate 48% to 52%. If necessary, correct the value by adjusting the sliding clutch. After the check is completed, the actuator must be approximately half way along its stroke. This is due to establishment of the action direction during automatic initialisation.

5.2 Automatic initialisation

Figure 6 shows the configuration mode including the operation in this mode and Table 1 shows the parameter/configuration list. Figure 7 shows the initialisation process of the positioner. The initialisation process is stored in the microprocessor. This means that an additional initialisation only is necessary if any parts of the unit have been changed.

Note: The numerical values used in Figure 5, Figure 6, and Figure 7 are examples.

Step A: Call the configuration mode by pressing the hand symbol key for longer than 5 seconds.

Step B: Set the actuator type, linear or part-turn, in the menu item line “1.YFCT”.

Step C: Switch to the second parameter by pressing the hand symbol key briefly.

Step D: Set the rated angle of rotation for feedback in the menu item line “2.YAGL”. It is vital that this value corresponds to the setting of the gear transmission ratio selector (Figure 4, position 8), 33° or 90°.

Step E: Switch to the next parameter by pressing the hand symbol key briefly.

Step F: This parameter (“3.YWAY”) is only set for linear actuators and if the total stroke in mm should be displayed at the end of the initialisation phase. To do this, select the same value in the display to which the carrier pin to the scale on the lever is set to.

Step G: Switch to the following parameter by pressing the hand symbol key briefly.

Step H: Start the initialisation (“4.INITA”) by pressing the “↑” key for longer than 5 seconds.
Step I: During the initialisation phase “RUN1” to “RUN5” appear one after another in the bottom of the display. Please note that the initialisation process may last up to 15 minutes depending on the actuator.

Note: The ongoing initialisation can be aborted at any time by pressing the hand symbol key. The previous settings are retained. All the parameters are reset to the factory setting only after performing a preset “55.PRST”.

Step J: If problems occur, carry out the measures as described in the table “Possible messages” shown in Figure 7.

Step K: The initialisation is completed when “FINISH” appears in the bottom of the display.

Step L: When pressing the hand symbol key briefly the menu item line “4.INITA” is displayed.

Step M: To exit the configuration operating mode, press the hand symbol key for longer than 5 seconds. The software version is displayed after about 5 seconds. The instrument is in manual operation after releasing the key.

Step N: The positioner can be changed to automatic mode by pressing the “I” key once as indicated in Figure 5.

Step O: The automatic mode is the normal mode. In this mode the positioner compares the set point current with the current position and moves the actuator until the control deviation reaches the dead zone.

Operation in the configuration mode

![Diagram](sips2_5f.tif)
**5.3 Parameters**

After the initialisation process, the positioner can be configured to meet the requirements of a specified task. The factory settings correspond to the requirements for a typical application. This means that normally only a few parameters will need to be changed.

Table 1 shows the parameter list for the positioner. The parameter name is written in plain text in the “menu line” column. The function of the parameter is described briefly in the “Function column”. In addition, the possible parameter values, the physical unit and the factory setting of the parameters are shown.
### Parameter list

<table>
<thead>
<tr>
<th>Menu line</th>
<th>Function</th>
<th>Parameter values</th>
<th>Unit</th>
<th>Factory setting</th>
<th>Customer setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.YFCT</td>
<td>Type of actuator</td>
<td>turn (part-turn actuator)</td>
<td>WAY</td>
<td>WAY</td>
<td>WAY</td>
</tr>
<tr>
<td></td>
<td></td>
<td>WAY (linear actuator)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>LWAY (linear actuator without sine correction)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>ncSt (part-turn actuator with NCS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>-ncSt (part-turn actuator with NCS, inverted)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.YAGL</td>
<td>Rated angle of rotation for feedback (must correspond to gear ratio)</td>
<td>$90^\circ$</td>
<td>Degrees</td>
<td>33$^\circ$</td>
<td></td>
</tr>
<tr>
<td>3.YWAY</td>
<td>Stroke range (optional setting)</td>
<td>OFF</td>
<td>mm</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>When used, the value must correspond with the set of the leverage ratio on the actuator</td>
<td>$5, 10, 15, 20$</td>
<td>mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(short lever $33^\circ$)</td>
<td>$25, 30, 35$</td>
<td>mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(short lever $90^\circ$)</td>
<td>$40, 50, 60, 70, 90, 110, 130$</td>
<td>mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.INITA</td>
<td>Initialisation (automatically)</td>
<td>noini / no</td>
<td></td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>5.INITM</td>
<td>Initialisation (manually)</td>
<td>noini / ## ## / Stt</td>
<td></td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>6.SCUR</td>
<td>Current range of set point</td>
<td>0 to 20 mA</td>
<td>mA</td>
<td>0 MA</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4 to 20 mA</td>
<td>mA</td>
<td>4 MA</td>
<td></td>
</tr>
<tr>
<td>7.SDIR</td>
<td>Set point direction</td>
<td>rising</td>
<td></td>
<td>rise</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>falling</td>
<td></td>
<td>FALL</td>
<td></td>
</tr>
<tr>
<td>8.SPRA</td>
<td>Set point for start of split range</td>
<td>0.0 to 100.0</td>
<td>%</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>9.SPFR</td>
<td>Set point for end of split range</td>
<td>0.0 to 100.0</td>
<td>%</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>10.TSUP</td>
<td>Set point ramp up</td>
<td>Auto</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.TSDD</td>
<td>Set point ramp down</td>
<td>0 to 400</td>
<td>s</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>12.SFCT</td>
<td>Set point function</td>
<td>Linear</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Equal-percentage 1:25, 1:33, 1:50</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Inverse equal-percentage 1:25, 1:33, 1:50</td>
<td></td>
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<td></td>
<td></td>
<td>Freely adjustable</td>
<td>FrEE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.SLO</td>
<td>Set point turning point at</td>
<td>0%</td>
<td>%</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>14.SL1</td>
<td></td>
<td>5%</td>
<td>%</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>15.SL2</td>
<td></td>
<td>95%</td>
<td>%</td>
<td>95.0</td>
<td></td>
</tr>
<tr>
<td>32.SL19</td>
<td></td>
<td>100%</td>
<td>%</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>33.SL20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34.DEBA</td>
<td>Dead zone of controller</td>
<td>Auto</td>
<td></td>
<td>Auto</td>
<td></td>
</tr>
<tr>
<td>35.YA</td>
<td>Start of manipulated variable limiting</td>
<td>0.0 to 100.0</td>
<td>%</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>36.YE</td>
<td>End of manipulated variable limiting</td>
<td>0.0 to 100.0</td>
<td>%</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>37.YNRM</td>
<td>Standardisation of manipulated variable</td>
<td>To mech. travel</td>
<td></td>
<td>MPOS</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>To flow</td>
<td></td>
<td>FLOW</td>
<td></td>
</tr>
<tr>
<td>38.YDIR</td>
<td>Direction of manipulated variable for display</td>
<td>Rising</td>
<td></td>
<td>rise</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Falling</td>
<td></td>
<td>FALL</td>
<td></td>
</tr>
<tr>
<td>39.YCLS</td>
<td>Tight closing with manipulated variable</td>
<td>Without</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Top only</td>
<td></td>
<td>uP</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bottom only</td>
<td></td>
<td>do</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Top and bottom</td>
<td></td>
<td>uP do</td>
<td></td>
</tr>
<tr>
<td>40.YCDO</td>
<td>Value for tight closing, bottom</td>
<td>0.0 to 100.0</td>
<td>%</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>41.YCUP</td>
<td>Value for tight closing, top</td>
<td>0.0 to 100.0</td>
<td>%</td>
<td>99.5</td>
<td></td>
</tr>
<tr>
<td>Menu line</td>
<td>Function</td>
<td>Parameter values</td>
<td>Unit</td>
<td>Factory setting</td>
<td>Customer setting</td>
</tr>
<tr>
<td>-----------</td>
<td>----------</td>
<td>-----------------</td>
<td>------</td>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>42.BIN1†</td>
<td>Function of BI 1:</td>
<td>OFF</td>
<td></td>
<td></td>
<td>OFF</td>
</tr>
<tr>
<td>None</td>
<td></td>
<td>OFF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Only message (NO/NC contact)</td>
<td></td>
<td>on / -on</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Block configuring (NO contact)</td>
<td></td>
<td>bLoc1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Block configuring and manual (NO contact)</td>
<td></td>
<td>bLoc2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drive valve to pos. up (NO/NC contact)</td>
<td></td>
<td>uP / -uP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drive valve to pos. down (NO/NC contact)</td>
<td></td>
<td>doWn / -doWn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Block movement (NO/NC contact)</td>
<td></td>
<td>Stop / -Stop</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Function of BI 2:</td>
<td>OFF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td></td>
<td>OFF</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Only message (NO/NC contact)</td>
<td></td>
<td>on / -on</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drive valve to pos. up (NO/NC contact)</td>
<td></td>
<td>uP / -uP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drive valve to pos. down (NO/NC contact)</td>
<td></td>
<td>doWn / -doWn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Block movement (NO/NC contact)</td>
<td></td>
<td>Stop / -Stop</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alarm function</td>
<td>Without</td>
<td>OFF</td>
<td></td>
<td></td>
<td>OFF</td>
</tr>
<tr>
<td>A1= min. A2=max.</td>
<td>N, NA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1= min. A2=min.</td>
<td>N, N</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1= max. A2=max.</td>
<td>NA, NA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response threshold of alarm 1</td>
<td>0.0 to 100.0</td>
<td>%</td>
<td></td>
<td>10.0</td>
<td></td>
</tr>
<tr>
<td>Response threshold of alarm 2</td>
<td>0.0 to 100.0</td>
<td>%</td>
<td></td>
<td>90.0</td>
<td></td>
</tr>
<tr>
<td>Function of alarm output</td>
<td>ON fault</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fault + not automatic</td>
<td></td>
<td>l_nA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fault + not automatic + BI</td>
<td></td>
<td>l_nAb</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(“+” means logical OR operation)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monitoring time for fault message</td>
<td>Auto</td>
<td>0 to 100</td>
<td>s</td>
<td>Auto</td>
<td></td>
</tr>
<tr>
<td>“control deviation”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response threshold for fault message</td>
<td>Auto</td>
<td>0.0 to 100.0</td>
<td>%</td>
<td>Auto</td>
<td></td>
</tr>
<tr>
<td>“control deviation”</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limit for stroke integral</td>
<td>OFF</td>
<td>1 to 1.00E9</td>
<td></td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>Limit for direction change</td>
<td>OFF</td>
<td>1 to 1.00E9</td>
<td></td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>Limit for end stop monitoring, bottom</td>
<td>OFF</td>
<td>0.0 to 100.0</td>
<td>%</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>Limit for end stop monitoring, top</td>
<td>OFF</td>
<td>0.0 to 100.0</td>
<td>%</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>Limit for dead zone monitoring</td>
<td>OFF</td>
<td>0.0 to 100.0</td>
<td>%</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>Preset (factory setting)</td>
<td>&quot;no&quot; nothing activated</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Sttr&quot;: start of factory setting after pressing key for 5 sec.</td>
<td></td>
<td>Sttr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;oCAY&quot;: display following successful factory setting</td>
<td></td>
<td>oCAY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAUTION: preset results in &quot;NO INIT&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1

1) If turn is selected it is not possible to set 33°.
2) Parameter does not appear if 1.YFCT = turn has been selected.
3) Turning points only appear with selection 12.SFCT = FrEE.
4) Alternatively "no" if initialisation has not yet been carried out
5) NC contact means; action with opened switch or low level. NO contact means; action with closed switch or high level.
Diagnosis

In the diagnostic mode the current operating data (such as number of strokes, number of changes in direction, number of fault messages, etc.) can be displayed. From the automatic or manual modes the diagnostic mode can be reached by simultaneously pressing all three keys for at least 2 seconds.

Table 2 shows an overview of the displayable values. The diagnostic display has a similar structure as the parameter menu displays. The respective next diagnostic value can be selected with the hand symbol key. Certain values can be set to zero by pressing the "f" key for at least 5 seconds. These are menu item line "1, 2, 3, and 4". Some diagnostic values may be greater than 99999. In this case the display switches to exponential display.

<table>
<thead>
<tr>
<th>No.</th>
<th>Abbreviation</th>
<th>Meaning</th>
<th>Displayable value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>STRKS</td>
<td>Number of strokes</td>
<td>0 to 4.29E9</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>CHDIR</td>
<td>Changes of direction</td>
<td>0 to 4.29E9</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>L4CNT</td>
<td>Fault counter</td>
<td>0 to 4.29E9</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>A1CNT</td>
<td>Alarm counter 1</td>
<td>0 to 4.29E9</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>A2CNT</td>
<td>Alarm counter 2</td>
<td>0 to 4.29E9</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>HOURS</td>
<td>Operating hours</td>
<td>0 to 4.29E9</td>
<td>Hours</td>
</tr>
<tr>
<td>7</td>
<td>WAY</td>
<td>Determined actuating path</td>
<td>0 to 130</td>
<td>mm or *</td>
</tr>
<tr>
<td>8</td>
<td>TUP</td>
<td>Travel time up</td>
<td>0 to 1000</td>
<td>s</td>
</tr>
<tr>
<td>9</td>
<td>TDOWN</td>
<td>Travel time down</td>
<td>0 to 1000</td>
<td>s</td>
</tr>
<tr>
<td>10</td>
<td>LEAK</td>
<td>Leakage</td>
<td>0.0 to 100.0</td>
<td>%</td>
</tr>
<tr>
<td>11</td>
<td>P0</td>
<td>Potentiometer value below stop (0%)</td>
<td>0.0 to 100.0</td>
<td>%</td>
</tr>
<tr>
<td>12</td>
<td>P100</td>
<td>Potentiometer value bottom stop (100%)</td>
<td>0.0 to 100.0</td>
<td>%</td>
</tr>
<tr>
<td>13</td>
<td>IMPUP</td>
<td>Impulse length up</td>
<td>2 to 100</td>
<td>ms</td>
</tr>
<tr>
<td>14</td>
<td>IMPDN</td>
<td>Impulse length down</td>
<td>2 to 100</td>
<td>ms</td>
</tr>
<tr>
<td>15</td>
<td>DBOP</td>
<td>Dead zone up</td>
<td>0.1 to 100.0</td>
<td>%</td>
</tr>
<tr>
<td>16</td>
<td>DBDN</td>
<td>Dead zone down</td>
<td>0.1 to 100.0</td>
<td>%</td>
</tr>
<tr>
<td>17</td>
<td>SSUP</td>
<td>Short step up</td>
<td>0.1 to 100.0</td>
<td>%</td>
</tr>
<tr>
<td>18</td>
<td>SSDN</td>
<td>Short step down</td>
<td>0.1 to 100.0</td>
<td>%</td>
</tr>
<tr>
<td>19</td>
<td>TEMP</td>
<td>Current temperature</td>
<td>-45 to 85</td>
<td>°C</td>
</tr>
<tr>
<td>20</td>
<td>Tmin</td>
<td>Minimum temperature</td>
<td>-45 to 85</td>
<td>°C</td>
</tr>
<tr>
<td>21</td>
<td>Tmax</td>
<td>Maximum temperature</td>
<td>-45 to 85</td>
<td>°C</td>
</tr>
<tr>
<td>22</td>
<td>T1</td>
<td>Number of operating hours in Temperature range 1</td>
<td>0 to 4.29E9</td>
<td>Hours</td>
</tr>
<tr>
<td>23</td>
<td>T2</td>
<td>Number of operating hours in Temperature range 2</td>
<td>0 to 4.29E9</td>
<td>Hours</td>
</tr>
<tr>
<td>24</td>
<td>T3</td>
<td>Number of operating hours in Temperature range 3</td>
<td>0 to 4.29E9</td>
<td>Hours</td>
</tr>
<tr>
<td>25</td>
<td>T4</td>
<td>Number of operating hours in Temperature range 4</td>
<td>0 to 4.29E9</td>
<td>Hours</td>
</tr>
<tr>
<td>26</td>
<td>T5</td>
<td>Number of operating hours in Temperature range 5</td>
<td>0 to 4.29E9</td>
<td>Hours</td>
</tr>
<tr>
<td>27</td>
<td>T6</td>
<td>Number of operating hours in Temperature range 6</td>
<td>0 to 4.29E9</td>
<td>Hours</td>
</tr>
<tr>
<td>28</td>
<td>T7</td>
<td>Number of operating hours in Temperature range 7</td>
<td>0 to 4.29E9</td>
<td>Hours</td>
</tr>
<tr>
<td>29</td>
<td>T8</td>
<td>Number of operating hours in Temperature range 8</td>
<td>0 to 4.29E9</td>
<td>Hours</td>
</tr>
<tr>
<td>30</td>
<td>T9</td>
<td>Number of operating hours in Temperature range 9</td>
<td>0 to 4.29E9</td>
<td>Hours</td>
</tr>
<tr>
<td>31</td>
<td>VENT1</td>
<td>Number of cycles pre-control valve 1</td>
<td>0 to 4.29E9</td>
<td>-</td>
</tr>
<tr>
<td>32</td>
<td>VENT2</td>
<td>Number of cycles pre-control valve 2</td>
<td>0 to 4.29E9</td>
<td>-</td>
</tr>
<tr>
<td>33</td>
<td>STORE</td>
<td>Store current values as &quot;last maintenance&quot;</td>
<td>Press the up key for at least 5 seconds (store)</td>
<td>-</td>
</tr>
</tbody>
</table>

Table 2
7 Service and maintenance

The positioner is largely maintenance-free. The positioner is fitted with filters in the pneumatic connection as protection against coarse particles of dirt. If the pneumatic energy supply contains particles of dirt, the filters may be clog and impair the function of the positioner. In this case the filters can be cleaned as follows:

**Step A:** Switch off the pneumatic power supply and remove the pipes.

**Step B:** Unscrew the cover.

**Step C:** Remove the three screws from the pneumatic connector strip.

**Step D:** Remove the filters and O-rings behind the connector strip.

**Step E:** Clean the filters (e.g. with compressed air).

**Step F:** After cleaning first insert the filters in the recesses in the housing and then place the O-rings on the filters.

**Step G:** Align the pneumatic connector strip on the two lugs and screw tight with the three self-tapping screws.

---

**Note:** Make sure that the same thread is used. To do this, turn the screws anticlockwise until they snap into the thread audibly. Only then should the screws be tightened.
INSTRUCTION MANUAL

FOR INSTALLATION,
OPERATING,
AND MAINTENANCE.

Dosing pump

mROY A & B

This manual should be made available to the person responsible for installation,
operating and maintenance.

Date : 12/99
O / Ref : T.160.0401.001.Rev. E
1.1 - INTRODUCTION
The mRoy pump is a dosing pump with incorporated hydraulic diaphragm, oil-lubricated with sealed housing, with a variable swept-volume adjustment which can be set when stopped or running. It is designed for continuous service in industrial operation.

1.2 - OPERATING PRINCIPLE
- Worm (052A) / tangent wheel (052) pair drives connecting rod (214) through means of the eccentric of wheel (052).
- Connecting rod (214) gives piston (012) a reciprocating motion with constant stroke.
- Through means of oil contained in chamber (D), the piston drives diaphragm (298A) held fast between 2 contour plates (298).
- Relief valve (212A) protects the pump.

Suction phase:
Piston (012) draws back and sucks in the oil (H) behind diaphragm (298A). The differential pressure which is created is transmitted by flexible diaphragm (298A) enabling the pumped fluid to be drawn in with perfect separation between the pump mechanical parts and the pumped fluid. When adjusting sleeve (E) linked mechanically to piston (012) opens orifice (B) of oil bypass (C), the additional oil is supplied by housing (081).

Discharge phase:
Piston (012) moves forward and forces the oil back to housing (081) through by-pass (C) and orifice (B) until this orifice is blocked by adjustment sleeve (E). The oil then pushes diaphragm (298A) which moves forward proportionally to the fraction of remaining swept-volume, after blocking orifice (B). The dosed liquid is pushed back by the diaphragm through the discharge check-valves.

Flowrate adjustment:
The discharge flowrate is adjustable when running, from 0 to 100%, by turning adjustment knob (255) which displaces, in the oil bath, and thus without any effort, adjustable liner (012A) and thus the position of orifice (B).
1.3 - TECHNICAL CHARACTERISTICS

The nominal pump flow depends on the piston diameter and the actual pumping stroke speed. The influence of pressure is low, on the order of -2% per section of 10 bars.

1.3.1 Technical characteristics for mRoy A

<table>
<thead>
<tr>
<th>Type of pump</th>
<th>mRoy A</th>
</tr>
</thead>
<tbody>
<tr>
<td>piston diameter ( \phi )</td>
<td>11.1</td>
</tr>
<tr>
<td>(1) (2) Maximum discharge pressure in bars relative</td>
<td>123 123 46 59 21</td>
</tr>
<tr>
<td>(4) Maximum suction pressure in bars (Pa)</td>
<td>35 17.5 6</td>
</tr>
<tr>
<td>(3) Maximum flow in L/H (Q): at pressure of 10 b</td>
<td>2.6 10 5.5 22 66</td>
</tr>
<tr>
<td>at maximum pressure</td>
<td>1.95 7.8 4.1 19.8 64.5</td>
</tr>
<tr>
<td>Speed in strokes / min</td>
<td>29 112 29 112 112</td>
</tr>
<tr>
<td>Motor power in kW</td>
<td>0.25</td>
</tr>
<tr>
<td>Motor speed in rpm</td>
<td>1440</td>
</tr>
<tr>
<td>Motor mounting: Flange</td>
<td>F130</td>
</tr>
<tr>
<td>Shaft</td>
<td>14 x 30</td>
</tr>
<tr>
<td>(5) Maximum height of suction in mce (Ha)</td>
<td>2</td>
</tr>
<tr>
<td>Volume of pulsation dampener in suction</td>
<td>0.13 L</td>
</tr>
<tr>
<td>Volume of pulsation dampener in discharge</td>
<td>0.13 L</td>
</tr>
<tr>
<td>Pre-expansion of pulsation dampener in discharge</td>
<td>50% of service pressure</td>
</tr>
<tr>
<td>Noise level: Acoustic pressure</td>
<td>&lt; 70 dB (A)</td>
</tr>
<tr>
<td>Simplex pump weight</td>
<td>25</td>
</tr>
<tr>
<td>Duplex pump weight</td>
<td>40</td>
</tr>
</tbody>
</table>

1.3.2 Technical characteristics for mRoy B with \( \phi 15 \) piston

<table>
<thead>
<tr>
<th>Type of pump</th>
<th>mRoy B</th>
</tr>
</thead>
<tbody>
<tr>
<td>piston diameter ( \phi )</td>
<td>15</td>
</tr>
<tr>
<td>(1) (2) Maximum discharge pressure in bars relative</td>
<td>105</td>
</tr>
<tr>
<td>(4) Maximum suction pressure in bars (Pa)</td>
<td>35</td>
</tr>
<tr>
<td>(3) Maximum flow in L/H (Q): at pressure of 10 b</td>
<td>14 21 34 53</td>
</tr>
<tr>
<td>at maximum pressure</td>
<td>11 17 27 42</td>
</tr>
<tr>
<td>Speed in strokes / min</td>
<td>36 66 90 140</td>
</tr>
<tr>
<td>Motor power in kW</td>
<td>0.55 0.75 0.55 0.75</td>
</tr>
<tr>
<td>Motor speed in rpm</td>
<td>900 1440 900 1440</td>
</tr>
<tr>
<td>Motor mounting: Flange</td>
<td>F165</td>
</tr>
<tr>
<td>Shaft</td>
<td>19 x 40</td>
</tr>
<tr>
<td>(5) Maximum height of suction in mce (Ha)</td>
<td>1.5</td>
</tr>
<tr>
<td>Volume of pulsation dampener in suction</td>
<td>0.13</td>
</tr>
<tr>
<td>Volume of pulsation dampener in discharge</td>
<td>0.13 L</td>
</tr>
<tr>
<td>Pre-expansion of pulsation dampener in discharge</td>
<td>60% of service pressure</td>
</tr>
<tr>
<td>Noise level: Acoustic pressure</td>
<td>&lt; 70 dB (A)</td>
</tr>
<tr>
<td>Simplex pump weight</td>
<td>65</td>
</tr>
<tr>
<td>Duplex pump weight</td>
<td>85</td>
</tr>
</tbody>
</table>

G1.2
### 1.3.3 Technical characteristics for mRoy B with a 22.2 piston

<table>
<thead>
<tr>
<th>Type of pump</th>
<th>mRoy B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piston diameter $\phi$</td>
<td>22.2</td>
</tr>
<tr>
<td>(1) (2) Maximum discharge pressure in bars relative</td>
<td>49</td>
</tr>
<tr>
<td>(4) Maximum suction pressure in bars (Pa)</td>
<td>17.5</td>
</tr>
<tr>
<td>(3) Maximum flowrate in L/H at pressure of 10b at maximum pressure</td>
<td>30</td>
</tr>
<tr>
<td>Speed in strokes / min</td>
<td>36</td>
</tr>
<tr>
<td>Motor power in kW</td>
<td>0.55</td>
</tr>
<tr>
<td>Motor speed in rpm</td>
<td>900</td>
</tr>
<tr>
<td>Motor mounting: Flange</td>
<td>F165</td>
</tr>
<tr>
<td>Shaft</td>
<td>19x40</td>
</tr>
<tr>
<td>(5) Maximum height of suction in mce (Ha)</td>
<td>1.5</td>
</tr>
<tr>
<td>Volume of pulsation damper in suction</td>
<td>0.13 L</td>
</tr>
<tr>
<td>Volume of pulsation damper in discharge</td>
<td>0.13 L</td>
</tr>
<tr>
<td>Pre-expansion of pulsation damper in discharge</td>
<td>60% of service pressure</td>
</tr>
<tr>
<td>Noise level: Acoustic pressure</td>
<td>$&lt; 70$ dB (A)</td>
</tr>
<tr>
<td>Simplex pump weight</td>
<td>65</td>
</tr>
<tr>
<td>Duplex pump weight</td>
<td>85</td>
</tr>
</tbody>
</table>

### 1.3.4 Technical characteristics for mRoy B with a 36.5 piston

<table>
<thead>
<tr>
<th>Type of pump</th>
<th>mRoy B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piston diameter $\phi$</td>
<td>36.5</td>
</tr>
<tr>
<td>(1) (2) Maximum discharge pressure in bars relative</td>
<td>14</td>
</tr>
<tr>
<td>(4) Maximum suction pressure in bars (Pa)</td>
<td>6</td>
</tr>
<tr>
<td>(3) Maximum flowrate in L/H at pressure of 10b at maximum pressure</td>
<td>80</td>
</tr>
<tr>
<td>Speed in strokes / min</td>
<td>36</td>
</tr>
<tr>
<td>Motor power in kW</td>
<td>0.55</td>
</tr>
<tr>
<td>Motor speed in rpm</td>
<td>900</td>
</tr>
<tr>
<td>Motor mounting: Flange</td>
<td>F165</td>
</tr>
<tr>
<td>Shaft</td>
<td>19x40</td>
</tr>
<tr>
<td>(5) Maximum height of suction in mce (Ha)</td>
<td>0.6</td>
</tr>
<tr>
<td>Volume of pulsation damper in suction</td>
<td>0.5 L</td>
</tr>
<tr>
<td>Volume of pulsation damper in discharge</td>
<td>0.5 L</td>
</tr>
<tr>
<td>Pre-expansion of pulsation damper in discharge</td>
<td>60% of service pressure</td>
</tr>
<tr>
<td>Noise level: Acoustic pressure</td>
<td>$&lt; 70$ dB (A)</td>
</tr>
<tr>
<td>Simplex pump weight</td>
<td>65</td>
</tr>
<tr>
<td>Duplex pump weight</td>
<td>85</td>
</tr>
</tbody>
</table>

(1) Contact us for higher pressures
(2) 10 bars for the "P" versions
(3) Flow obtained on standard configuration, with water
(4) 6 Bars for "P" versions
(5) mce = Water column meter
II. INSTALLATION

2.1 - UNPACKING AND STORAGE
The packing must be carefully examined at reception in order to ensure that the contents have not suffered any obvious damage. Open the packing carefully; one should be careful not to damage certain accessories which may be fastened to the inside of the packing. Examine the contents and check them against the delivery slip.

The packing contains:
- One pump.
- Oil, depending on versions (see chapter 3.9)
- A list of wear-and-tear parts, accompanied by section drawings and space-requirement drawings.
- An instruction manual for pump installation, upkeep and maintenance

Storage precautions
For storage less than 6 months:
Storage is to be carried out preferably in the original packing and protected from inclement weather conditions.

For storage longer than 6 months:
Preserve the original packing. Also provide packing under plastic heat-sealing wrapping and dehydrating bags. Store the pump in protected, covered premises with full oil charge.

2.2 - RECOMMENDATION FOR INSTALLING THE PUMP

2.2.1 Manutention

Put the sling under the motor terminal box and under the motor flange. Cross the two ends of the sling and close the loop (see diagrams). Before attempting to move it, check that the entire unit is well balanced.

Nota: As soon as the pump is in position, fasten it down.

2.2.2 - Installing the pump

- Fasten the pump to a horizontal support using its fastening holes. Arrange enough free space around the pump so as to be able to have easy access, and to ensure the upkeep and adjustments (accessibility to the liquid end, filling, and housing oil draining).
- Connect the priming drain of the liquid end to a drip-collecting tank
- If the service pressure is greater than 3.5 bars, remove the spring located in the discharge check-valve box.

CAUTION: Pumps installed outdoors must be protected from the elements.

2.2.3 Oil filling (Fig. 1A).

- Unscrew the oil filler plug located on top of the pump.
- Unscrew the level indicator located on the side of the pump.
- Pour the oil in until it reaches the threading of the level indicator.
- Screw the level indicator back in.
- Fill up with oil to the middle of the level indicator.
- Screw the oil filler plug back on.
2.3 - ELECTRICAL INSTALLATION

Verify the motor data against your available mains supply for the plant before carrying out connections. Connect the motor according to the indications given in the terminal box.

For 230 V delta connection

For 400 V star connection

Before operating the pump, check the direction of rotation of the motor which must be according to the arrow stamped on the motor (Counter-clockwise direction when seen from top). To reverse the direction of rotation, just reverse A and B or A and C.

CAUTION: DO NOT FORGET TO CONNECT THE PUMP TO EARTH

Electric protection of the motor (thermic protection or by means of fuses) is to correspond to the rated current indicated on the motor data plate.

2.4 - HYDRAULIC SYSTEM

Pipework - Generalities

As far as possible, avoid exerting stresses due to incorrect alignments between rigid pipes and the centreline of valve boxes. Provide facilities for disassembly (union-pieces, and so forth...). Clean piping before assembly.

2.4.1 Suction pipings

The pump is to be located as close as possible to the suction point and the piping is to be as short and as direct as possible. If possible, have the suction point located slightly above the pump; in the event of long period of rest, the pump will not unprime.

The diameter of the piping must be bigger or equal to the connection diameter of the liquid end. The suction piping is to be ABSOLUTELY AIR TIGHT (check after assembly). When it is not possible to avoid long suction pipework, use a RESERVOIR tank or a balancing column located as close as possible to the suction aperture of the pump.

2.4.2 Delivery pipework

The diameter of the piping is to be bigger or equal to the connection diameter to the liquid end. Be sure that the piping and accessories fitted on the delivery line are sufficiently strong to withstand the delivery pressure.
2.5 - INSTALLATION SKETCHES

2.5.1 Installation on suction side

2.5.1.1 Recommended installations

Fig.2: The pump in suction placed above the tank (Ha = maximum 2.5 m water column) is equipped with a foot valve fitted at the suction end (F). Vertical suction.

Fig.3: Long sized pipework (L) requires the installation of a damper which is to be placed as close as possible to the pump. L1 = Maximum 10 metres water column.

Fig.4: The pump "in suction" offset in relation to the tank (Height [Ha] see chapter 1.3), is equipped with a foot valve (F).

2.5.1.2 Installations to be avoided

Fig.5: Inclined suction pipe, risk of un-priming (See Fig. 4, Chap. 2.5.1.1)

Fig.6: Suction piping long. Suction height too great.

Fig.7: Accumulation of gas (goose neck) and risk of unpriming.

2.5.1.3 Special installation

Degassing liquids.

Fig. 8: Setting up a degassing vessel (Chap. 2.6.3.) at the pump suction (one thus avoids frequent un-priming). Connection between the pump and the inclined degassing vessel in order to facilitate degassing.
2.5.2 Installations on delivery line

2.5.2.1 Recommended installation

Fig. 9: Long pipe lengths and delivery in a pressurized conduit (P): Install an injection pipe (E), a buffer tank (D) and a safety valve (C).

Fig. 10: Long pipe lengths and delivery in a non-pressurized conduit: Install a nonreturn valve (B) or check valve (A) and a buffer tank (D).

For short lengths of discharge pipe (L), the buffer tank (D) can be dispensed with although it increases the service life of the metering pump and of the installation.

If the delivery pressure is less than 2 bars, an injection pipe or nonreturn valve should be used.

2.5.2.2 Installations to be avoided

Fig. 11
Pulsation dampener (D) not very efficient. (pulsation dampener (D) too far from the liquid end)

Fig. 12
Pulsation dampener (D) inefficient. (nonreturn valve installed before pulsation dampener (D)).

Fig. 13
Siphoning.
2.6 - INSTALLATION OF ACCESSORIES

Proper functioning of the pump depends on whether certain accessories available from DOSAPRO MILTON ROY are fitted or not. The salesman is at your disposal to determine the accessories which are best adapted to your plant.

2.6.1 Non return valve (F)

Necessary when the pump is fitted above the suction point. Thus minimizing the risk of unpriming; it is fitted with a filter.

2.6.2 Filter

It is very CAUTION when there is gravity feed; it avoids accumulation of solid particles in the valve assemblies and guarantees precision and pump life.

2.6.3 Safety valve (C)

The safety valve is to be vertically installed just above the liquid end, after the damper and before any other accessory. The return line of the valve should be connected to the drainage tank or to the sump. The safety valve protects the metering pump, the piping and accessories in the event of accidental overpressure (e.g. shutting off of valve). This accessory contributes to safety for users by eliminating risks of the bursting or rupture of components under pressure. It is recommended that a safety valve should be fitted on all installations.

2.6.4 Damper (D)

Compressible gas-reserve device; this dampens the flow and pressure pulsations caused naturally by the dosing pump. It is absolutely essential that the pulsation dampener be installed vertically on the discharge and/or suction piping of the dosing pump, as near as possible to the latter, before any other accessory and for it to be placed in the flow. For the volume and the pre-expansion of the dampener, see chapter 1.3.

CAUTION: Dampener construction materials must be compatible with the liquid to be pumped and with the pumping pressure.

2.6.5 Non return valve (A)

The non-return valve is to be installed in line on the delivery piping. Its operation may be improved by installing a dampener located upwards on the line.

2.6.6 Injection nozzle (E)

Fitted at the injection point, it acts as a non-return valve. It isolates the processed fluid from the main fluid (often water).

2.6.7 Insulation Valve (F)

When the pump is not running, it is essential to insulate it from the pressure circuit with a manual or automatic valve, to prevent any return pressure in the liquid end, which could damage the pressure plate of the oil-actuated diaphragm.
2.7 - INSTALLATION CALCULATIONS

2.7.1 General

Sizing of the plant suction line corresponds to the NPSH calculation (Net Positive Suction Head) and it aims to avoid any risk of cavitation. Very often when processing non viscous liquids (typically less than 50 cp), the NPSH calculation is needed to verify the following condition:

\[
\frac{10.2}{W} (Pa - Tv) + Ha > 2 + 0.016 \frac{LQN}{d^2}
\]

with

- \( W \) = Liquid density.
- \( Pa \) = Suction pressure (bars absolute).
- \( Tv \) = Vapour pressure (in bars).
- \( Ha \) = Suction height (in m). (\( Ha \) is negative with the pump placed above the suction point; it is positive when gravity fed).
- \( L \) = Length of the piping (in m).
- \( Q \) = Max flowrate of the pump (in l/h).
- \( N \) = No of pump strokes (in str./min).
- \( d \) = Inside diameter of the piping (in mm).

2.7.2 Example

Calculation carried out to deliver a flow of 200 L/H.

\[
\begin{align*}
W & : 1 \\
Pa & : 1 \\
Tv & : 0.025 \\
Ha & : 1 \\
L & : 1 \\
Q & : 560 \\
N & : 144 \\
d & : 12.5
\end{align*}
\]

This condition shows: \( \frac{10.2}{1} (1 - 0.025) + 1 > 2 + 0.016 \frac{1 \times 144 \times 560}{12.5^2} \)

thus: \( 10.945 > 4.064 \)

The condition is met and the pump will not give rise to cavitation.

When the NPSH condition is not obtained, the installation conditions must be improved by making or envisaging the following modifications:
- Place the pump under load: \( Ha \) increases
- Place the pump near the tank: \( L \) decreases
- Increase the diameter of the piping: \( d \) increases (the most effective solution)
- Place an pulsation dampener at the suction (see chapter 1.3)

Do not hesitate to consult your usual DMR representative for complete calculations.
III OPERATION AND MAINTENANCE

3.1 - CHECKING BEFORE SWITCHING ON
- Check that the pump is properly mounted on its base
- Check the oil level.
- Check that the pump is set at 0%
- Check that all the isolating valves on the suction and discharge circuits are open.
- Check that the pump is properly supplied with liquid.
- If hot cold machine parts lead to a potential danger, check that these parts are protected against accidental contact at site.

3.2 - STARTUP
- Turn the pump ON
- Place the vernier on the 50% position, for 10 minutes.
- Untighten by around 1/4 turn, drain plug (B) located on the liquid end (Fig. 19) and (Fig. 20). Thus, the air trapped in the suction piping and the pump head can escape via the drain. Wait until the liquid comes up to the evacuation level of this drain. Let it flow for a few seconds in order to degas it completely, then retighten the drain plug.

3.3 - ROUTINE CHECKS
Periodically, it is necessary to check:
- The level and cleanliness of the oil.
- Leaks or unusual noises.

3.4 - PREVENTIVE MAINTENANCE
Before any servicing operation on the pump, it is necessary to turn the motor power supply OFF.

3.4.1 Servicing-intervention principles for preventive maintenance*:

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Fréquence **</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewal of check-valve boxes (Chap. 3.7.1. to Chap. 3.7.3).</td>
<td>8000 h</td>
</tr>
<tr>
<td>Renewal of diaphragms (Chap. 3.7.4 and Chap. 3.7.5).</td>
<td>8000 h</td>
</tr>
<tr>
<td>Renewal of safety valve assembly (Chap. 3.8.1 and Chap. 3.8.2).</td>
<td>8000 h</td>
</tr>
<tr>
<td>Renewal of worm bearings (Chap. 3.8.10).</td>
<td>20000 h</td>
</tr>
<tr>
<td>Renewal of worm and wheel (Chap. 3.8.11).</td>
<td>20000 h</td>
</tr>
<tr>
<td>Renewal of sleeve liner O-rings (Chap. 3.8.3).</td>
<td>16000 h</td>
</tr>
</tbody>
</table>

* See list of wear parts for the ordering of the various parts.
** Approximate no of hours when operating under max performance and normal conditions of use.
3.5 - ORDERING OF SPARE PARTS

To simplify your order and ensure the best delivery times of spare parts, we recommend giving our services the correct code of your pump and its DOSAPRO MILTON ROY serial no. This information is shown on the Nameplate fixed on the side of the pump.

![DOSAPRO MILTON ROY Nameplate]

<table>
<thead>
<tr>
<th>Pump code</th>
<th>DOSAPRO MILTON ROY serial no</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE: A.112.2.1 H 21</td>
<td>PONT ST PIERRE 27360 FRANCE</td>
</tr>
<tr>
<td>Dmax</td>
<td>127.0</td>
</tr>
<tr>
<td>Pmax</td>
<td>247.0</td>
</tr>
<tr>
<td>Date</td>
<td>02/02/2000</td>
</tr>
<tr>
<td>N°</td>
<td>92.01.120.01.01</td>
</tr>
<tr>
<td>Item</td>
<td></td>
</tr>
<tr>
<td>N° série</td>
<td></td>
</tr>
</tbody>
</table>

3.6 - PRODUCT IDENTIFICATION

Our product identification tells us precisely the kind of equipment involved and gives us details on each item comprising it.

<table>
<thead>
<tr>
<th>Code:</th>
<th>A</th>
<th>112</th>
<th>F</th>
<th>3</th>
<th>H</th>
<th>21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone:</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

The makeup of a standard mRoy pump is divided up into 6 zones:
- Zone 1: Type of pump (A: mRoy A; B: mRoy B)
- Zone 2: Stroke rate of the pump in spm
- Zone 3: Motor power
- Zone 4: Piston diameter
- Zone 5: Type of liquid end
- Zone 6: Service pressure

and, where applicable, a seventh zone which will be "DX" for a duplex pump.
3.7 - SERVICING AND MAINTENANCE OF LIQUID END

Before carrying out any servicing operation on the metering unit or pipes, take the necessary steps to ensure that the harmful liquid they contain cannot escape or come into contact with personnel. Suitable protective equipment must be provided. Check that there is no pressure before proceeding with dismantling.

3.7.1 Renewal of check-valve boxes - General

Before any other servicing operation on the check-valve boxes place the vernier on the 0% position, check that the isolating valves are closed, then disconnect the piping. When putting the check-valve boxes back in place, systematically replace all the seals.

3.7.2 Renewal of seals / balls / valves - metallic version

Disassembly
- Unscrew counternut (209) by one-quarter of a turn,
- Completely unscrew the cartridge of check-valve box (021A),
- Remove circlips (080) and balls (437A) (437),
- Clean the box completely.

Reassembly
- Fit ball (437), then ball (437A) and circlips (080)
- Position spiral seal (408) in the sink of counternut (209)
- Fit O-ring (438B) against spiral seal (408).
- Screw the box cartridge in the liquid end so as to align it with the piping.
- Screw on counternut (209).*

Note: O-rings (438B) and spiral seals (408) of the check-valve boxes must be replaced with new seals each time they are removed.

* For information concerning tightening torque as well as which spanners to use, see Chapter 3.7.7.*
3.7.3 Renewal of check-valve boxes _ plastic version

**Fig.16**
Plastic liquid end

**Fig.17**
Discharge check valve assembly

**Fig.18**
Suction check valve assembly

**Disassembly**
- Unscrew both nuts (435) located on pressure plate (004).
- Remove pressure plate (004) with both washers (434).
- Remove the Discharge check valve assembly.
- Pull on strap bolt (032) to release the suction check valve assembly.
- Remove box cap (013), spring (080), ball guide (003), seal (438), ball (407).

**Reassembly**
- Fit spring (080), ball guide (003) and seal (438) on box cap (013), and mount ball (407) on its seat (A).
- Fit seals (438B) and (438A) on the check-valve boxes.
- Fit the check-valve boxes on the liquid end.
- Fit the pressure plate on strap bolt (032) with two washers (434).
- Hand-tighten screws (435) by pressing on the pressure plate.
- Orient the suction check valve assembly, then tighten two nuts (435).*

Connect the piping making sure of perfect watertightness.

**Note:** The items comprising the suction check valve assembly cannot be taken apart; this is also the case for ball (B) and seat (A) of the Discharge check valve assembly.

* For information concerning tightening torque as well as which spanners to use, see Chapter 3.7.7.
3.7.4 Diaphragm Renewal

Before carrying out any operations, place the vernier on the 0% position, check that all the isolating valves are closed, then disconnect the piping.

**Disassembly**
- Drain the pump (Chapter 3.9.2).
- Lay the pump on the side opposite the liquid end.
- Remove suction check valve assembly (A) (Chapter 3.7.2 or Chap. 3.7.3)
- Remove screws (405A) (Fig. 19) or (405) (Fig. 20) from the liquid end.
- Remove diaphragm (298A) and pressure plates (298), (298B) using a pointed object.
- Clean all the parts.

**Reassembly**
- Mount contour plate (298B). It is CAUTION for one of holes in the contour plate to be placed at the highest point (see detail C).

**CAUTION:** For metallic versions, contour plate (298B) on the mechanical side is made of steel and contour plate (298) on liquid end side is made of stainless steel.
- Fit diaphragm (298A).
- Fit contour plate (298). It is CAUTION for one of the holes in the contour plate to be placed at the highest point (see C detail)
- Fit the liquid end and tighten screws (405A) or (405) in star-pattern (Fig. 22). *
- Refit the suction check valve assembly (Chap. 3.7.2 or Chap. 3.7.3).
- Fill up with oil (Chap. 3.9.2).
- Put into service (Chap. 3.1, Chap. 3.2)

In order to prime the pump, it is necessary to purge the liquid end (to release air) by opening purge nozzle (B). For toxic liquids, it is recommended to collect this fluid to safe drain point during this operation.

* For information concerning tightening torque as well as which spanners to use, see Chap. 3.7.7.
3.7.5 Renewal of double diaphragm, "C" type

Before carrying out any operation, place the vernier on the 0% position, check that all the isolating valves are closed, then disconnect the piping.

**Disassembly**
- Drain the pump (Chap. 3.9.2).
- Untighten ring pipe fitting (432A) by 1/2 turn.
- Lay the pump on the side opposite the liquid end.
- Remove suction check valve assembly (A) Chap. 3.7.2 or Chap. 3.7.3.
- Unscrew the tightening screws from liquid end (405A), beginning with those in support lug (050A).
- Remove the two diaphragms (298) and the 2 contour plates (098).
- Clean all of the parts.

**Reassembly**
- Fit contour plate (098) on the mechanical side.
- Centre diaphragm (298) on contour plate (098).
- Fit double-diaphragm body (050) on diaphragm (298).
- Centre second diaphragm (298) on double diaphragm body (050).
- Centre second pressure plate (098) on double diaphragm body assembly (050).
- Fit the liquid end and hand-tighten 2 tightening screws (405A) diametrically opposite.
- Fit support lug (050A) and its depection.
- Connect the detection pipe of double-diaphragm body (050) to ring connection (432A).
- Hand-tighten the connection and tighten by 1/4 to 1/2 turn.
- Pre-screw in star-pattern (Fig. 22) tightening screws (405A) of the liquid end (torque: 2 Nm).
- Tighten tightening screws (405A) of the liquid end in star-pattern.*
- Refit the suction check valve assembly (Chap. 3.7.2 or Chap. 3.7.3).
- Put into service (Chap. 3.1, Chap. 3.2)
- Degas the double diaphragm (Chap. 3.7.6)

* For information concerning tightening torque as well as which spanners to use, see Chapter 3.7.7.
3.7.6 Degassing of double-diaphragm body, "C" type

- Remove the detection (A)
- Remove the retaining ring (092)
- Remove the ball (437)
- Put a little oil in the body of nonreturn valve (432).
- Set the adjustment knob on 10%, then start the pump up
- Allow to run for 10 minutes
- Fit the ball (437)
- Allow to run for 10 minutes
- Fit the retaining ring (092)
- Fit the detection (A) on the nonreturn valve (432)

If the degassing can not be done by the above procedure there some possibility to perform this operation with a syringe. This syringe is available on request at the Spare Part Departement

Degassing with syringe

- Fit the syringe (1+2) on the nonreturn valve (432)
- Inject and pump 4 or 5 time slowly the degassing liquid
- Remove the syringe and fit the ball (437) and the retaining ring (092)
- Fit the syringe (1) without his plunger
- Put the pump into service and adjust the capacity until 100%
- Allow to run for 10 minutes
- Remove the syringe (1) with the degassing liquid
- Fit the detection (A) on the nonreturn valve (432)
### 3.7.7 Tightening torque table

<table>
<thead>
<tr>
<th>Screw / Nut</th>
<th>mRoy A</th>
<th>mRoy B</th>
<th>mRoy A</th>
<th>mRoy B</th>
<th>Spanner used</th>
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<tbody>
<tr>
<td></td>
<td>HP</td>
<td>BP</td>
<td>HP</td>
<td>BP</td>
<td>HP &amp; BP</td>
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<td>H head screw of liquid end for metallic versions</td>
<td>20</td>
<td>20</td>
<td>40</td>
<td>60</td>
<td>13</td>
</tr>
<tr>
<td>H head screw (1/3/5/7/6/8) of liquid end for plastic versions</td>
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<td>15</td>
<td>15</td>
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<tr>
<td>H head screw (2/4) of liquid end for plastic versions</td>
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<td>15</td>
<td>15</td>
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<td>Check-valve box nut, metallic version</td>
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<td>Check-valve box, metallic version</td>
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<td>Strap bolt nut for liquid ends, plastic version</td>
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<td></td>
<td>10</td>
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<td>H head screw of lantern</td>
<td>/</td>
<td>/</td>
<td></td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Hc head screw of relief valve</td>
<td>/</td>
<td>/</td>
<td></td>
<td>3/16&quot;</td>
<td>3/16&quot;</td>
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<td>Hc head screw of connecting rod shaft</td>
<td>/</td>
<td>/</td>
<td>3</td>
<td>3</td>
<td></td>
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<td>Hc head screw pointed end of connecting rod shaft</td>
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<td>Nut for Hc screw of connecting rod shaft</td>
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<td>/</td>
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<td>7</td>
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<tr>
<td>Hc screw (402) of duplex housing (Fig. 27)</td>
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<td>/</td>
<td></td>
<td>/</td>
<td>10</td>
</tr>
</tbody>
</table>

Fig. 22
Tightening in star-pattern-shape
3.8 - SERVICING AND MAINTENANCE OF THE MECHANICAL ASSEMBLY

3.8.1 Relief valve

CAUTION: Set in the plant, it must in no case be put out of adjustment, since it protects your pump.

3.8.2 Renewal of relief valve (Fig. 23)

Disassembly
- Place the vernier on the 0% position
- Clean the threaded hole of screw (023) to make it appear
- Note dimension H
- Completely unscrew and remove screw (023) with the hexagonal spanner
  (Chap. 3.7.7).
- Remove spring (080) and its valve (212A).

Reassembly
- Cause new valve (212A) to adhere to spring (080) using a little grease.
- Lower the assembly into its housing.
- Screw in tightening screw (023) to the H measurement with the hexagonal spanner
  (Chap. 3.7.7).

Fig. 23
Disassembly of the relief valve
3.8.3 Renewal of adjustment liner O-rings (Fig. 24, Fig. 25, Fig. 26)

Disassembly
- Place the vernier on the 0% position
- Drain the pump (Chap. 3.9.2)
- Remove the lantern (Chap. 3.8.8)
- Remove circlips (434) (Fig. 25).
- Completely unscrew adjustment knob (255).
- Unscrew screw (256).
- Pull liner (012A) of housing toward you. (Fig. 26)
- Remove 3 O-rings (438B) located on liner (012A) (Fig. 24).
- Remove sleeve (E) from drive pin (214A) (Fig. 26)
- Clean the housing as well as the liner / sleeve assembly

Reassembly
- Refit the 3 O-rings (438B) using the tool (011) (Fig. 24):
  - Reference 0110031071 for the mRoy A.
  - Reference 0110032071 for the mRoy B.
- Coat the 3 O-rings (438B) with tallow.
- Fit sleeve (E) on drive pin (214A) (Fig. 26).
- Insert liner (012A) very slowly in the housing, turning it whilst holding sleeve (E) in the axis of liner (012A).
- Screw in screw (256).
- Screw in adjustment knob (255) (Fig. 25)
- Fit circlips (434).
- Fit lantern (Chap. 3.8.8)
- Fill up with oil (see Chap. 3.9.2).
3.8.4 Renewal of eccentric shaft seals (Fig. 26).

For disassembly and reassembly of the eccentric shaft, the pump adjustment knob must be opposite you.

**Disassembly**
- Place the vernier on the 0% position
- Drain the pump (Chap. 3.9.2)
- Remove the 2 circlips (434A) from eccentric shaft (068)
- Drive out eccentric shaft (068) to the right to release seal (438A)
- Remove seal (438A)
- Drive out eccentric shaft (068) to the left to release seal (438A)
- Remove the other seal (438A)

**Reassembly**
Before reassembly, degrease all parts
- Fit an O-ring (438A) on eccentric shaft (068)
- Put glue (loctite 638) on the end of eccentric shaft (068) until it exceeds the other side of the housing by one centimetre.
- Fit the other O-ring (438A) on eccentric shaft (068); put glue (loctite 638) on the end of eccentric shaft (068)
- Position eccentric shaft (068) in the centre of the housing (see Fig. 26)
- Fit circlips (434A) on each end of eccentric shaft (068)
- Allow the glue to harden for 30 minutes
- Fill up with oil (see chap. 3.9.2)
3.8.5 Renewal of connecting rod and shaft for mRoy A, simplex and duplex (Fig. 26, Fig. 28).

**Disassembly**
- Place the vernier on the 0% position
- Drain the pump (Chap. 3.9.2).
- Remove the lantern (Chap. 3.8.8)
- Remove eccentric shaft (068) (Chap. 3.8.4)
- Unscrew screws (435) and remove drive pin (214A) (Fig. 26)*
- Remove plunger assembly (012) / connecting rod (214) / wheel (052) from the housing, by lifting wheel (052)
- Drive out connecting rod shaft (011)
- Clean the housing and the parts removed

**Reassembly**
- Refit piston (012) / connecting rod shaft (011) / connecting rod (214) assembly by gluing the end of connecting rod shaft (011) with loctite glue 556 and being careful to position the lubricating groove (detail: A) of connecting rod (214) opposite the threaded holes of the piston (Fig. 28)
- Insert piston / connecting rod assembly in housing
- Fit wheel (052) with connecting rod (214) (Fig. 26)
- Fit concentric shaft (068) (Chap. 3.8.4)
- Fit drive pin (214A), then screw in and glue (loctite 221) the two screws (435)
- Refit the lantern (Chap. 3.8.8).
- Fill up with oil (Chap. 3.9.2)
- Put into service (Chap. 3.1, Chap. 3.2)

---

*For information concerning which spanners are to be used, see Chapter 3.7.7.
3.8.6 Renewal of connecting rod and shaft for mRoy B, simplex (Fig. 26, Fig. 28).

Disassembly
- Drain the pump (Chap. 3.9.2).
- Remove the lantern (Chap. 3.8.8)
- Unscrew nut (435F) and screws (435), (435E) (Fig. 26)*
- Remove eccentric shaft (068) (Chap. 3.8.4)
- Remove drive pin (214A)
- Remove plunger assembly (012) / connecting rod (214) / wheel (052) from the housing, by lifting wheel (052)
- Drive out connecting rod shaft (011) (Fig. 28)
- Clean the housing and the parts removed.

Reassembly
- Refit piston (012) / connecting rod shaft (011) / connecting rod (214) assembly, being careful to position the lubricating groove (detail: A) of connecting rod (214) opposite the threaded holes of the piston. (Fig. 28)
- Screw in and glue (loctite 566), locking screw (435E) on the side where the groove of connecting rod shaft (011) is located
- Insert piston / connecting rod assembly in housing
- Fit wheel (052) with connecting rod (214) (Fig. 26)
- Fit eccentric shaft (068) (Chap. 3.8.4)
- Fit drive pin (214A), then screw in and glue (loctite 221) screw (435) and nut (435F)
- Refit lantern (Chap. 3.8.8)
- Allow glue to harden 30 minutes
- Fill up with oil (Chap. 3.9.2).
- Carry out startup and operating procedures (Chap. 3.1, Chap. 3.2).

3.8.7 Renewal of connecting rod and shaft for mRoy B, duplex (Fig. 26, Fig. 27, Fig. 28).

Disassembly
- Drain the pump (Chap. 3.9.2).
- Remove the lantern (Chap. 3.8.8)
- Unscrew 2 screws (402) (Fig. 27)
- Unscrew nut (435F) and screws (435), (435E) (Fig. 28).
- Remove drive pin (214A) (Fig. 26)
- Drive out the 2 shafts of connecting rod shaft (011) by the threaded holes of screws (402)
- Remove eccentric shaft (068) (chap. 3.8.4)
- Remove eccentric wheel (052) / connecting rod (214) assembly in the housing
- Remove plunger assembly (012) / connecting rod (214) / wheel (052)
- Remove plunger (012) off the housing
- Clean the housing and the parts removed.

Reassembly
- Place plunger (012) in the housing tapped holes upward
- Assemble connecting rods (214) with wheel (052) being careful to position the lubricating groove (detail: A) of connecting rod (214) downwards (Fig. 28)
- Place eccentric wheel (052) / connecting rod (214) assembly in the housing
- Fit eccentric shaft (068) (Chap. 3.8.4)
- Fit the 2 shafts of connecting rod shaft (011) by the threaded holes of screws (402) (Fig. 27)
- Screw in and glue (loctite 566) locking screws (435E) of the side where the groove of connecting rod shaft (011) is located
- Fit drive pin (214A) then screw in and glue (loctite 221) screw (435) and nut (435F) (Fig. 26)*
- Refit the lantern (Chap. 3.8.8)
- Screw in and glue screws (402) with loctite glue 221 (Fig. 27).
- Allow the glue to harden 30 minutes.
- Fill up with oil (Chap. 3.9.2).
- Carry out startup and operating procedures (Chap. 3.1, Chap. 3.2).

* For information concerning which spanners are to be used, see Chapter 3.7.7.
3.8.8 Disassembly of the lantern (Fig. 26, Fig. 29)

**Disassembly**
- Disconnect the power supply cables from the motor
- Unscrew 4 screws (435A), (434C) from lantern (072) and turn while pulling up the lantern vertically with the motor

**Reassembly**
- Put sealing compound on side B (Fig. 26)
- Fit lantern (072) being careful not to bump drive pin (214A) with the worm shaft
- Screw in screws (435A), (434C)
- Connect the motor power supply cables

3.8.9 Renewal of the worm shaft (Fig. 29).

**Disassembly**
- Remove the lantern (Chap. 3.8.8)
- Unscrew screw (435B) from coupling (052D).
- Remove the 2 washers (280) and washer (219) being careful not to separate them.
- Remove the worm.

**Reassembly**
- Fit washers (280) / washer (219)
- Fit coupling (052D) on the screw whilst adhering to measurement H (H = 5 mm for the mRoy B, or fit coupling (052D) in mechanical thrust block for the mRoy A)
- Screw in screw (435B)
- Fit the lantern (Chap. 3.8.8)
- Mount the motor

3.8.10 Renewal of worm bearing.
Same procedure as for the Renewal of the worm shaft (Chap. 3.8.9), but by replacing bearings (409A) and (409).

3.8.11 Renewal of the wheel / worm.
Same procedure as for Renewal of the connecting rod and shaft (Chap. 3.8.5 to Chap. 3.8.7), but without removing connecting rod shaft (011) (Fig. 28) for the mRoy A.

* For information concerning which spanners are to be used, see chapter 3.7.7.
3.9 - LUBRICATION

The oil level must be checked every month. Fill the housing up to the middle of the level indicator. Use the oil supplied with the pump or an equivalent oil (see table below). The oil must be changed every 2500 hours of operation or every six months. The pump must be placed in a zone where the ambient temperature is between -5°C and 50°C.

3.9.1 Table of oils

ISO VG 150 oil. Pure mineral oil

QUANTITY:

<table>
<thead>
<tr>
<th></th>
<th>mROY A</th>
<th>mROY B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simplex</td>
<td>1 L</td>
<td>3 L</td>
</tr>
<tr>
<td>Duplex</td>
<td>2 L</td>
<td>4 L</td>
</tr>
</tbody>
</table>

TABLE OF CHARACTERISTICS

- Viscosity to 40°C: 151 Cst
- Viscosity to 100 °C: 15 Cst
- Viscosity Index: 100
- ISO VG: 150
- Density to 15 °C: 0.897 kl/l
- Flash-point: 244°C
- Pour-point: -12°C

EQUIVALENCY TABLE

<table>
<thead>
<tr>
<th>Make</th>
<th>Type</th>
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<tbody>
<tr>
<td>COFRAN</td>
<td>MECANEP 150</td>
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<tr>
<td>B.P.</td>
<td>GR XP 150</td>
</tr>
<tr>
<td>CASTROL</td>
<td>ALPHA SP 150</td>
</tr>
<tr>
<td>ELF</td>
<td>REDUCTELF SP 150</td>
</tr>
<tr>
<td>FINA</td>
<td>GIRAN 150</td>
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<tr>
<td>IGOL</td>
<td>DYNAM SP 150</td>
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<tr>
<td>MOBIL OIL</td>
<td>MOBILGEAR 629</td>
</tr>
<tr>
<td>SHELL</td>
<td>OMALA 150</td>
</tr>
<tr>
<td>TOTAL</td>
<td>CARTER EP 150</td>
</tr>
<tr>
<td>ESSO</td>
<td>SPARTAN EP 150</td>
</tr>
</tbody>
</table>

3.9.2 Draining the pump

To drain the pump, unscrew the filler plug and the drain plug completely (Fig. 1A).

To fill up with oil, screw the drain plug back on with Teflon strip to ensure proper impermeability, and see Chapter 2.2.2.

Note: For information concerning how much oil to use, see the table in Chapter 3.9.1.
IV FAULT LOCATION PROCEDURES

If, during the initial startup, the pump does not work properly, check the pump installation (SECTION: INSTALLATION II).

### 4.1 - THE PUMP DOES NOT DELIVER:

<table>
<thead>
<tr>
<th>CAUSE</th>
<th>REMEDY</th>
</tr>
</thead>
<tbody>
<tr>
<td>A - Motor stopped</td>
<td>A - Reset the thermal relay (Check the reason for the overload)</td>
</tr>
<tr>
<td>B - No more product to pump</td>
<td>B - Check the product level</td>
</tr>
<tr>
<td>C - Piping clogged up.</td>
<td>C - Unclog the piping</td>
</tr>
<tr>
<td>D - Filter blocked.</td>
<td>D - Clean the filter</td>
</tr>
<tr>
<td>E - Suction piping valve closed.</td>
<td>E - Open the valve</td>
</tr>
<tr>
<td>F - Diaphragm pierced.</td>
<td>F - Change the diaphragm</td>
</tr>
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</table>

### 4.2 - THE PUMP DOES NOT DELIVER AT THE SPECIFIED FLOWRATE:

<table>
<thead>
<tr>
<th>CAUSE</th>
<th>REMEDY</th>
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</thead>
<tbody>
<tr>
<td>A - The pump flow is improperly adjusted</td>
<td>A - Set the vernier on the right percentage</td>
</tr>
<tr>
<td>B - Poor impermeability in the suction piping</td>
<td>B - Change the piping seals</td>
</tr>
<tr>
<td>C - suction piping dirty</td>
<td>C - Clean the piping</td>
</tr>
<tr>
<td>D - Filter dirty</td>
<td>D - Clean the filter</td>
</tr>
<tr>
<td>E - Check-valve box seat dirty or worn</td>
<td>E - Clean or change the check-valve box</td>
</tr>
<tr>
<td>F - Operating-pressure too high</td>
<td>F - Use the pump at the pressure specified on the data-plate</td>
</tr>
</tbody>
</table>
Connecting diagram for chemical dosing pump unit.

- Dosing line not A 1 supply.
- The distances between the dosing pump and feedwater line max. 4 mtrs.
- Dosing line ø12 x 15mm. Stainless steel or teflon.

- A 1 supply
- Shutdown valve 3/8"BSP
- 4 pcs of fittings 3/8"BSP / ø12 as sketch.

Oil fired boiler

Handwell

Feed water pump

Dosing pump
Table of contents

Drawings

General arrangement.................................................................03Y:017925b
Thermal expansion sheet...........................................................data sheet
Customer data
- Customer: Samsung
- Hull no.: 1408/09
- Boiler no.: 11269/71
- Date: 03-10-01
- Init./dept.: SRO/2510

Main data
- Boiler size: 35 t/h
- Design pressure: 18 Bar
- D: 3850 mm
- V1: 7360 mm
- V2: 6290 mm
- V3: 5750 mm

Expansion
- Vertical: EV1 = 17 mm, EV2 = 15 mm, EV3 = 14 mm
- Horizontal: H1 = 9 mm, H2 = 7 mm, H3 = 4 mm, H4 = 12 mm
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Data sheets for boiler and steam/water system

<table>
<thead>
<tr>
<th>Description</th>
<th>Code</th>
<th>Page</th>
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</thead>
<tbody>
<tr>
<td>Safety valve, DN 65/100, PN 40/16</td>
<td>261 1174</td>
<td></td>
</tr>
<tr>
<td>Stop valve, angle, DN 250, PN 25</td>
<td>6010 00007</td>
<td></td>
</tr>
<tr>
<td>Stop valve, angle, DN 100, PN 40</td>
<td>6010 000019</td>
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<tr>
<td>Stop valve straight, non return DN 100, PN 40</td>
<td>6030 00006</td>
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<td>Stop valve straight, non return DN 40, PN 25</td>
<td>264 1090</td>
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</tr>
<tr>
<td>Stop valve, angle, DN 40, PN 25</td>
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<tr>
<td>Stop valve, straight, DN 40, PN 25</td>
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<td>Stop valve straight, DN 8, PN 160</td>
<td>6220 00002</td>
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<tr>
<td>Stop valve straight, non return DN 20, PN 25</td>
<td>264 1087</td>
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<td>Check valve, DN 250, PN 25</td>
<td>266 1008</td>
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<td>Stop valve, straight, DN 25, PN 25</td>
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<td>Stop valve straight, DN 50, PN 10</td>
<td>253 1005</td>
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<td>Water level gauge, right, model 26, DN 25, PN 25</td>
<td>7010 000135</td>
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<td>Water level gauge, left, model 26, DN 25, PN 25</td>
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<td>Stop valve, straight, DN 65, PN 25</td>
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<td>Steam trap</td>
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<td>Stop valve, ball, straight, DN 50</td>
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<td>Control valve for IGS system</td>
<td>C227</td>
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<td>Level float switch RBA 24, DN 25, PN 40</td>
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<td>DP water level control unit</td>
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<tr>
<td>Temperature transmitter</td>
<td>data sheet</td>
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<tr>
<td>Chemical dosing unit</td>
<td>884 0105</td>
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<td>Pneumatic control valve, DN 50, PN 25 with I/P positioner</td>
<td>6050 000051</td>
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<tr>
<td>Filter regulator with automatic drain</td>
<td>291 5101</td>
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<tr>
<td>Water washing hose with nozzle</td>
<td>8500 00016</td>
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Type:
- Safety valve, full lift
- 25.912

Size:
- Nominal diameter: DN 65/100

Application:
- To blow off saturated steam, air or water

Material:
- Body: GGG 40.3
  DIN-Material No.: 0.7043
- Seat: X6 Cr Ni Mo Ti 17122
  DIN-Material No.: 1.4571
- Disc: X35 Cr Mo 17
  DIN-Material No.: 1.4122.05

Technical data:
- Nominal pressure: PN 40/16
- Weight: 40 kg
- Flanges according to DIN
- Inlet: DN 65, PN40
- Outlet: DN 100, PN16
Type:
- Stop globe valve, angle
- 34.007

Size:
- Nominal diameter: DN 250

Application:
- For steam and/or water flow

Material:
- Body: GS-C25N
  DIN -Material No. 1.0619.1
- Seat: X20 Cr13
  DIN -Material No. 1.4021.05
- Disc: X20 Cr13
  DIN Material No. 1.4021.05

Technical data:
- Nominal pressure: PN25
- Weight: 170 kg
- Flanges according to DIN
Type:
- Stop globe valve, angle
- 35.007

Size:
- Nominal diameter: DN 100

Application:
- For steam and/or water flow

Material:
- Body: GS-C 25 N
  DIN - Material No. 1.0619.01
- Seat: X20 Cr13
  DIN - Material No. 1.4021.05
- Disc: X20 Cr13
  DIN - Material No. 1.4021.05

Technical data:
- Nominal pressure: PN 40
- Weight: 34.0 kg
- Flanges according to DIN
Type:
- Stop check globe valve, screw down non return, straight
- 35.006 R

Size:
- Nominal diameter: DN 100

Application:
- For steam and/or water flow

Material:
- Body: GG-C 25 N
  DIN - Material No. 1.0619.01
- Seat: X20 Cr13
  DIN - Material No. 1.4021.05
- Disc: X20 Cr13
  DIN - Material No. 1.4021.05

Technical data:
- Nominal pressure: PN 40
- Weight: 39.5 kg
- Flanges according to DIN
Type:
- Stop check globe valve, screw down non return, straight
- 23.006 R

Size:
- Nominal diameter: DN 40

Application:
- For steam and/or water flow

Material:
- Body: GGG 40.3
  DIN - Material No. 0.7043
- Seat: X20 Cr13
  DIN - Material No. 1.4021.05
- Disc: X20 Cr13
  DIN - Material No. 1.4021.05

Technical data:
- Nominal pressure: PN 25
- Weight: 10 kg
- Flanges according to DIN
Type:  
- Stop globe valve, angle  
- 23.007

Size:  
- Nominal diameter: DN 40

Application:  
- For steam and/or water flow

Material:  
- Body:  
  - GGG 40.3  
  - DIN-Material No. 0.7043  
- Seat:  
  - X20 Cr13  
  - DIN-Material No. 1.4021.05  
- Disc:  
  - X20 Cr13  
  - DIN-Material No. 1.4021.05

Technical data:  
- Nominal pressure: PN 25  
- Weight:  
  - 10 kg  
- Flanges according to DIN
Type:
- Stop globe valve, straight
- 23.006

Size:
- Nominal diameter: DN 40

Application:
- For steam and/or water flow

Material:
- Body: GGG 40.3
  DIN -Material No. 0.7043
- Seat: X20 Cr13
  DIN -Material No. 1.4021.05
- Disc: X20 Cr13
  DIN -Material No. 1.4021.05

Technical data:
- Nominal pressure: PN 25
- Weight: 10 kg
- Flanges according to DIN

Stop valve, straight, DN 40, PN 25
**Type:**
- Instrument stop cone valve, straight

**Size:**
- G ½" x ø 12
- Nominal diameter: DN 8

**Application:**
- For steam, water and/or air

**Material:**
- Body: C 22.8
  DIN- Material No. 1.0460
- Seat: X20 Cr13
  DIN- Material No. 1.4021
- Needle tip: X35 CrMo17
  DIN- Material No. 1.4122

**Technical data:**
- Nominal pressure: PN 160
- Inlet: G ½" male DIN 19207, form R
- Outlet: For steel tube ø 12
- Weight: 0.8 kg
Type:
- Stop check globe valve, screw down non return, straight
- 23.006 R

Size:
- Nominal diameter: DN 20

Application:
- For steam and/or water flow

Material:
- Body: GGG 40.3
  DIN -Material No. 0.7043
- Seat: X20 Cr13
  DIN -Material No. 1.4021.05
- Disc: X20 Cr13
  DIN -Material No. 1.4021.05

Technical data:
- Nominal pressure: PN 25
- Weight: 4.3 kg
- Flanges according to DIN

Type No.: 6030
Version: A
Stop valve, straight, non return, DN 20, PN 25
Type:  
- Water check valve  
- WCV 2727  

Size:  
- Nominal diameter: DN 250  

Application:  
- For steam and liquids media  

Material:  
- Body: steel  
  DIN-Material No. 1.0037  
- Waferdisc: steel  
  DIN-Material No. 1.0037  
- Disc seating: Metallic  

Technical data:  
- Operating pressure max: 25 bar  
- Operating temperature max: 300°C  
- Weight: 15 kg  

Installation:  
- The check valve can be installed, sandwiched between weld neck flanges, with horizontal flow.
Type:
- Stop globe valve, straight
- 23.006

Size:
- Nominal diameter: DN 25

Application:
- For steam and/or water flow

Material:
- Body: GGG 40.3
  DIN -Material No. 0.7043
- Seat: X20 Cr13
  DIN -Material No. 1.4021.05
- Disc: X20 Cr13
  DIN -Material No. 1.4021.05

Technical data:
- Nominal pressure: PN 25
- Weight: 5.4 kg
- Flanges according to DIN
Type:
- Stop valve, gate straight

Size:
- Nominal diameter: DN 50

Application:
- Sea water, fresh water, oil, steam etc.

Material:
- Body: GG 25

Technical data:
- Nominal pressure: PN 10
- Max. temperature: 150 °C
- Weight: 11.5 kg
**Type:**
- Reflective water level gauge, right
- Model 26

**Size:**
- Nominal diameter: DN 25

**Application:**
- For boiler water level indicator

**Material:**
- Body: Carbon steel
- Drain valve body: ASTM A105

**Technical data:**
- Nominal pressure: PN 25
- Weight: 22 kg
- Connections between body and cocks are made by end tubes and stuffing boxes

---

**Type No:** 7010  
**Version:** B  
**Water level gauge, right, model 26,  
DN 25, PN 25**  
7010 000135
Type:
- Reflective water level gauge, left
- Model 26

Size:
- Nominal diameter: DN 25

Application:
- For boiler water level indicator

Material:
- Body: Carbon steel
- Drain valve body: ASTM A105

Technical data:
- Nominal pressure: PN 25
- Weight: 22 kg
- Connections between body and cocks are made by end tubes and stuffing boxes

Type No: 7010
Version: B

Water level gauge, left, model 26
DN 25, PN 25

7010 000136
Type:
- Safety valve, full lift
- 25.941

Size:
- Nominal diameter: DN 15

Application:
- To blow off steam and/or air.

Material:
- Body: GGG 40.3
- DIN-Material No.: 0.7043

Technical data:
- Nominal pressure: PN 40
- Weight: 3.5 kg
**Type:**
- Stop globe valve, straight
- 23.006

**Size:**
- Nominal diameter: DN 65

**Application:**
- For steam and/or water flow

**Material:**
- Body: GGG 40.3
  DIN -Material No. 0.7043
- Seat: X20 Cr13
  DIN -Material No. 1.4021.05
- Disc: X20 Cr13
  DIN -Material No. 1.4021.05

**Technical data:**
- Nominal pressure: PN 25
- Weight: 18.4 kg
- Flanges according to DIN

---

Type No.: 6010
Version: A

Stop valve, straight, DN 65, PN 25

250 1092
TD 32F Thermodynamic Steam Trap

Description
The TD 32F is a medium pressure flanged thermodynamic steam trap with integral strainer screen suitable for mains drainage.

Sizes and pipe connections
DN 15, 15, 20 and 25
Standard flange: BS 4504 PN 40, BS 1560 Class 150 and 300

Limiting conditions
Maximum body design conditions PN 40
TMA — Max. allowable temperature 400°C
Cold hydraulic test 60 bar g

Operating range

Note: Minimum operating pressure for satisfactory operation is 0.25 bar g
PMOB — Max. operating back pressure is 80% of upstream pressure

Capacities

Materials

<table>
<thead>
<tr>
<th>No</th>
<th>Part</th>
<th>Material</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Body</td>
<td>Stainless Steel</td>
<td>DIN 17445 G-X20 Cr14 Ws 1.4027</td>
</tr>
<tr>
<td>2</td>
<td>Cap</td>
<td>Stainless Steel</td>
<td>AISI 416</td>
</tr>
<tr>
<td>3</td>
<td>Disc</td>
<td>Stainless Steel</td>
<td>BS 1449 420 S45</td>
</tr>
<tr>
<td>4</td>
<td>Strainer Screen</td>
<td>Stainless Steel</td>
<td>ASTM A240 316</td>
</tr>
<tr>
<td>5</td>
<td>Strainer Cap</td>
<td>Stainless Steel</td>
<td>AISI 416</td>
</tr>
<tr>
<td>6</td>
<td>Strainer Cap Gasket</td>
<td>Stainless Steel</td>
<td>BS 1449 304 S16</td>
</tr>
<tr>
<td>7</td>
<td>Insulating Cover</td>
<td>Aluminium</td>
<td>(optional extra, Not DN 25)</td>
</tr>
<tr>
<td>8</td>
<td>Flanges</td>
<td>Steel</td>
<td>DIN 17243 C22.8 Ws 1.0460</td>
</tr>
</tbody>
</table>

Aalborg Industries Data sheet No. 7020 000001 1/2
Dimensions (approximate) in millimetres

<table>
<thead>
<tr>
<th>Size - DN</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 LC</td>
<td>150</td>
<td>55</td>
<td>41</td>
<td>40</td>
<td>80</td>
<td>57</td>
<td>38</td>
<td>55</td>
<td>2.3 kg</td>
</tr>
<tr>
<td>15</td>
<td>150</td>
<td>55</td>
<td>41</td>
<td>40</td>
<td>80</td>
<td>57</td>
<td>38</td>
<td>55</td>
<td>2.4 kg</td>
</tr>
<tr>
<td>20</td>
<td>150</td>
<td>60</td>
<td>47</td>
<td>40</td>
<td>95</td>
<td>57</td>
<td>38</td>
<td>55</td>
<td>3.1 kg</td>
</tr>
<tr>
<td>25</td>
<td>150</td>
<td>65</td>
<td>53</td>
<td>40</td>
<td>100</td>
<td>--</td>
<td>--</td>
<td>---</td>
<td>---.2 kg</td>
</tr>
</tbody>
</table>

Installation
Preferably fitted in a horizontal pipe but can be fitted in other positions.

Optional extras
Insulating cover - to prevent the trap being unduly influenced by excessive heat loss such as when subjected to low outside temperatures, wind, rain etc. (Not available for DN 25)
Note: The internal blowdown valve is not available for the TD 25

Spare parts
The spare parts available are shown in heavy outline. Parts drawn in broken line are not supplied as spares.

<table>
<thead>
<tr>
<th>AVAILABLE SPARE</th>
<th>ITEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disc (Pkt of 3)</td>
<td>3</td>
</tr>
<tr>
<td>Strainer Screen and Gasket</td>
<td>4, 6</td>
</tr>
<tr>
<td>Strainer Cap Gasket (Pkt of 3)</td>
<td>6</td>
</tr>
<tr>
<td>Insulating Cover (Not available for DN 25)</td>
<td>7</td>
</tr>
</tbody>
</table>

Maintenance
Before undertaking any maintenance on the trap it must be isolated from both supply line and return line and any pressure allowed to safely normalise to atmosphere. The trap should then be allowed to cool.

How to service
Remove insulating cover if fitted and unscrew cap using spanner. Do not use Stillsons or a wrench of similar type which may cause distortion of the cap. If the disc and body seating faces are only slightly worn they can be refaced by lapping individually on a flat surface such as a surface plate. A figure of eight motion and a little grinding compound such as the Carbomundum Co's Compound I.P. gives the best results.

If the wear is too great to be rectified by simple lapping, the seating faces on the body must be ground flat and then lapped and the disc replaced by a new one. The total amount of metal removed in this way should not exceed 0.25 mm.

When re-assembling, the disc is normally placed in position with the grooved side in contact with body seating face. Screw on cap, no gasket is required but a suitable high temperature anti-seize grease should be applied to the threads.

To clean or replace strainer
Unscrew strainer cap using spanner, withdraw screen and clean, or if damaged replace with new one.

To re-assemble, insert screen into cap, then screw cap into place. A fine smear of "Molybdenum Disulphide" grease should be applied to the first few threads. Care should be taken to ensure that the gasket and gasket faces are clean. Tighten cap to the recommended torque.

Recommended Tightening Torques

<table>
<thead>
<tr>
<th>Item</th>
<th>DN</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Nm</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>15 LC</td>
<td>36</td>
<td>135-150</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1S</td>
<td>36</td>
<td>180-200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>41</td>
<td>180-200</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>45</td>
<td>250-275</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>52</td>
<td>275-300</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Type:**
- Stop ball valve, straight
- 113 BW, full bore

**Size:**
- DN 50

**Application:**
- For air, steam, or oil flow

**Material**
- Body: ASTM A105

**Technical data:**
- Temperature: -29°C to +230°C
- End connections: Butt weld according to ASME/ANSI B16.25 - XS-80
- Pipe size: DN 50
- Weight: 9.5kg

**Installation:**

*Information and caution before installation of the valve:*
- Pipe must be free of tension.
- Pipe must be flushed to clean the dirt, burrs calamines, welding residues etc. which would damage the ball and seat.
- The valve must be kept in open position during installation. Protective plastic covers must not be removed before the installation work commences.
- At the moment of the shipment the ball is lubricated with a pure vaseline oil, which can be easily removed with a solvent, if required.
- Ball valves normally have a space between ball and inside cavity of the body, which could trap the product, care should be taken to drain the cavity.

*Instruction for welding the valve on the pipe line:*
- Tack weld in four points on both end-connections.
- Lift out the centre part to protect the gaskets against damage and complete the welding.
- Insert the centre part and ensure easy operation.
FACE-TO-FACE according to DIN 3202 FI finish DIN 2526 form C

FLANGES according to ASME/ANSI B16.10

When flanges are RF type or finish must be stated on the order

FACE-TO-FACE according to ANSI 150 RF or RTJ

For smaller sizes see type MASTER STAR

FACE-TO-FACE according to ANSI 300 RF or RTJ

For smaller sizes see type MASTER STAR

FACE-TO-FACE according to ANSI 600 RF or RTJ

For smaller sizes see type MASTER STAR

item C227
Model AT400 DA and SR-90°

Available Flange:

<table>
<thead>
<tr>
<th>Flange Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISO 6211</td>
</tr>
<tr>
<td>Øδ</td>
</tr>
<tr>
<td>Q1</td>
</tr>
<tr>
<td>W1</td>
</tr>
<tr>
<td>L</td>
</tr>
<tr>
<td>Square</td>
</tr>
<tr>
<td>L min.</td>
</tr>
<tr>
<td>h min.</td>
</tr>
<tr>
<td>ht</td>
</tr>
</tbody>
</table>

Position Indicator for Flexibility: Z=55
Pressure connection: B 2
Auxiliary Attachment: AA 2

Output Torque for Double Acting and Spring Return in Nm

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Spooling stroke</th>
<th>Weight (Kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>0° 90°</td>
<td>10,2</td>
</tr>
<tr>
<td>S06</td>
<td>86  56</td>
<td>11,1</td>
</tr>
<tr>
<td>S07</td>
<td>75  40</td>
<td>11,1</td>
</tr>
<tr>
<td>S07</td>
<td>93  51</td>
<td>11,3</td>
</tr>
<tr>
<td>S08</td>
<td>110 62</td>
<td>11,4</td>
</tr>
<tr>
<td>S09</td>
<td>127 73</td>
<td>11,1</td>
</tr>
<tr>
<td>S10</td>
<td>144 84</td>
<td>11,5</td>
</tr>
<tr>
<td>S11</td>
<td>161 96</td>
<td>11,9</td>
</tr>
<tr>
<td>S12</td>
<td>179 107</td>
<td>12,1</td>
</tr>
</tbody>
</table>

Max. Pressure | Rotation Adjustment | Screw stroke | Chamfer | Air Volume (l) | Moving Time (sec.) (A) | Operating temperature (°C) (°F) | STD (standard) | HT (high temp.) | LT (low temp.) |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>8 bar</td>
<td>90° 96°</td>
<td>1/4 Turn</td>
<td>125</td>
<td>5,54</td>
<td>2,34</td>
<td>D 0,90</td>
<td>D 1,1</td>
<td>NBR &quot;O&quot;-Ring</td>
<td>FPM &quot;O&quot;-Ring</td>
</tr>
</tbody>
</table>

Notes:
- (A) The above indicated moving times of the actuator, are obtained in the following test conditions: (1) Room temperature; (2) Actuator Stroke 90°.
- (B) Solenoid Valve with Diolce 14 mm and a flow capacity of 480 liters/min. Inside pipe diameter 5 mm. (C) Medium shares at 8 bar. (D) Actuator without external resistance load.
- Caution: obviously on the final applications when one or more of the above parameters are different, the moving time will be different.
- (F) For HT (high temperature) and LT (low temperature) services, a special lubricant is required. Please consult AV torque factory.

Aalborg Industries Data sheet No. AT400da
EGO SWITCHBOX
TYPE M

Description:
EGO switchbox with integrated mikroswitches to be used for remote as well as visual indication of valve position. The switchbox include bracket for mounting on a pneumatic actuator. With use of a special bracket the box can be mounted on a gearbox or directly on a valve.

<table>
<thead>
<tr>
<th>Specifications</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Box</td>
<td>Polycarbonat</td>
</tr>
<tr>
<td>Shaft</td>
<td>POM</td>
</tr>
<tr>
<td>Cam plate</td>
<td>Nylon</td>
</tr>
<tr>
<td>Ground plate</td>
<td>Pertimax</td>
</tr>
<tr>
<td>Cam</td>
<td>Brass</td>
</tr>
<tr>
<td>Protection</td>
<td>IP 65</td>
</tr>
<tr>
<td>Position indicator</td>
<td>POM</td>
</tr>
<tr>
<td>O-ring</td>
<td>Viton</td>
</tr>
</tbody>
</table>
## Technical data

<table>
<thead>
<tr>
<th></th>
<th>EGO BOX M</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of switches</td>
<td>1 + 1</td>
</tr>
<tr>
<td>Type of switch</td>
<td>Mikroswitch</td>
</tr>
<tr>
<td>Manufacture</td>
<td>Honeywell</td>
</tr>
<tr>
<td>Manufacture item No.</td>
<td>V5C010TB1C</td>
</tr>
<tr>
<td>Voltage</td>
<td>max. 250 VAC</td>
</tr>
<tr>
<td>Consumption</td>
<td>-</td>
</tr>
<tr>
<td>Max. load</td>
<td>10 (3) A</td>
</tr>
<tr>
<td>Max. frequency</td>
<td>-</td>
</tr>
<tr>
<td>Ambient temperature</td>
<td>+ 55°C til +65°C</td>
</tr>
<tr>
<td>Dimensions</td>
<td>82x80x67</td>
</tr>
</tbody>
</table>

## CONNECTION DIAGRAM

- **Microswitch**
- **Inductive**
- **Namur**

**EGO Box**

**DWG NO:** 04.98.06-EGO BOX
SOLENOID VALVES
pilot operated, spool type
single/dual solenoid
aluminium body

FEATURES
- Solenoid valves comply with all applicable EC Directives
- The solenoid operated spool valves have threaded port connections and NAMUR interface
- The same spool valve can be adapted for 3/2 NC or 5/2 functions for controlling double-acting and single-acting actuators
- All the exhaust ports of this spool valve are pipable, providing better environmental protection, particularly recommended for sensitive areas such as clean rooms, and applications in the pharmaceutical and food processing sectors
- It is necessary to connect pipes or fittings to the exhaust ports to protect the internal parts of the spool valve and its pneumatic operator if used outside or in harsh environments (dust, liquids etc.)
- The return-spring chambers of the single-acting operators “breathe” through the spool valve, isolating them from the outside atmosphere
- Manual operator as standard

GENERAL
Differential pressure 2 - 10 bar [1 bar = 100 kPa]
Flow (Q at 6 bar) 700 l/min (ANF)

<table>
<thead>
<tr>
<th>fluids (#)</th>
<th>temperature range (TS)</th>
<th>sealings (+)</th>
</tr>
</thead>
<tbody>
<tr>
<td>air, inert gas, filtered</td>
<td>-25°C to +60°C</td>
<td>NBR (nitrile) PUR (polyurethane)</td>
</tr>
</tbody>
</table>

MATERIALS IN CONTACT WITH FLUID
(+) Ensure that the compatibility of the fluids in contact with the materials is verified
Body Aluminium, black anodized
End covers + interface plates Glass-filled polyamids (PA6FG)
Internal parts Zamak, stainless steel, acetal (PCM), aluminium
Sealing NBR + PUR
Core and core tube Stainless steel
Shading coil Copper

ELECTRICAL CHARACTERISTICS
Coil insulation class F
Coil Epoxy resin
Spade plug connection coil 3 x DIN 46244
Connector Type 22, spade plug (Pg 9P)
Electrical safety VDE 0580
Standard voltages DC (±): 24 V
AC (±): 230 V / 60 Hz

<table>
<thead>
<tr>
<th>coil type</th>
<th>power ratings</th>
<th>ambient temperature range (1) (TS)</th>
<th>protection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>inrush holding</td>
<td>hot/cold</td>
<td>(°C)</td>
</tr>
<tr>
<td></td>
<td>(VA)</td>
<td>(W)</td>
<td>(W)</td>
</tr>
<tr>
<td>CM22-2,5W</td>
<td>6</td>
<td>3.5</td>
<td>2.5</td>
</tr>
</tbody>
</table>

SPECIFICATIONS

<table>
<thead>
<tr>
<th>pipe size</th>
<th>orifice size</th>
<th>flow coefficient Kv</th>
<th>operating pressure differential (bar)</th>
<th>catalogue number</th>
</tr>
</thead>
<tbody>
<tr>
<td>(G)</td>
<td>(mm)</td>
<td>(m/h)</td>
<td>(l/min)</td>
<td>maximum (PS)</td>
</tr>
<tr>
<td>1/4</td>
<td>6</td>
<td>0.6</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>1/4</td>
<td>6</td>
<td>0.6</td>
<td>10</td>
<td>2</td>
</tr>
</tbody>
</table>

(C) Construction type •: screw-type manual operator ∗: exhaust reducer

Aalborg Industries
Data sheet name: solval230 1/2
**OPTIONS AND ACCESSORIES**

- Explosion proof enclosures according to "CENELEC" EEx d, m, em, i
- Explosion proof and watertight enclosures according to "NEMA" standards
- Coil comply with "UL" standard
- Coil type CM25 with connector type 30 ISO 4400 (Pg 11P)
- Polyamide coil
- Versions: pneumatic operated, spring return: without exhaust reducer

- Set of stainless steel mounting screws
- Set of two exhaust reducers
- 1/8 exhaust fittings
- Plug with visual indication and with peak voltage suppression or with cable length of 2m

**INSTALLATION**

- The solenoid spool valves can be mounted in any position
- Spool valve supplied with two interface plates with mating surfaces. Depending on function (NC 3/2 or 5/2), position one of the two plates on the spool valve body before installing on actuator
- Dowel pin (if necessary), bolts and gaskets are standard supplied
- Connect or protect the exhaust ports to isolate the internal atmosphere of the internal parts of the spool valve.
- Range of 1/8 fitting available
- Pipe connections have standard thread according to ISO 228/1
- The third digit in the catalogue number indicates the standard pipe connection
- Other pipe threads are available on request
- Installation/maintenance instructions are included with each solenoid spool valve
- Replacement coils are available

**DIMENSIONS (mm), WEIGHT (kg)**

- **Port 1:** G1/4
- **Ports 3 and 5:** G1/8

<table>
<thead>
<tr>
<th>Catalogue number</th>
<th>(C)</th>
<th>3/2</th>
<th>5/2</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC G551A001 MS</td>
<td>1</td>
<td>0.339</td>
<td>0.339</td>
</tr>
<tr>
<td>SC G551A001 MS M</td>
<td>1</td>
<td>0.349</td>
<td>0.359</td>
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<tr>
<td>SC G551A002 MS</td>
<td>2</td>
<td>0.457</td>
<td>0.457</td>
</tr>
<tr>
<td>SC G551A002 MS M</td>
<td>2</td>
<td>0.467</td>
<td>0.477</td>
</tr>
</tbody>
</table>

(C) Construction type (1) Incl. coil(s) and connector(s)

- Interface plate
- Mounting: 2 M5 x 35 screws engaged length: 7 mm
- Connector rotatable 2 x 180°, CM6 (Pg 9P)
- 2 O-ring seals (supplied)
- One 5 mm dia. hole for dowel pin
  - in position A1: 3/2 function plate
  - in position A2: 5/2 function plate
- Manual operator screw-type
- Pilot exhaust connection port: Ø M5, equipped with drain protector
- Exhaust reducers or protectors G1/8 adaptable on orifices 3 and 5 (on request)
- + 15 mm for connector removal

Aalborg Industries

Data sheet name: solval230
Type:
- Level float switch
- RBA 24

Size:
- DN 25

Application:
- Low water level switch

Material:
- St. 35.9
- C 22.8

Technical data:
- Drain connection: Ø 12 mm
- Cable connection: PG 11
- Nominal pressure: PN 40
- Max. working pressure: 32 bar
- Max. working temperature: 239°C
- Flanges according to DIN 2635-C
- Magnetic switch: 2 x M130
- Switching voltage: 6-250V
- Switch current max: 1A ac; 0.5A dc
- Protection of switch housing: IP 54
DP water level control unit

Socket distance: 525-1075

Assembly drawing

Note: Side to be connected to lower level tube - side to be connected to upper level tube
**CombiTemp Temperature Measuring System**

Flexible building block concept

All wetted parts in acid-proof, stainless steel

Pt100 sensors, 2- or 4-wire

DIN A or B (1/1, 1/3, 1/6) elements

Sensor tubes

Cable sensors

ø80 mm stainless steel housing

DIN head, form B

Hygienic connections

Standard or fast response time

Display and 4...20 mA transmitter

(Standard and Ex versions)

---

**Description**

CombiTemp comprises a series of basic elements which can be combined to various temperature sensors and transmitters. The system includes both 2- and 4-wire Pt100 sensors.

Being a building block system CombiTemp offers a great flexibility in respect to modification, service and maintenance.

A wide range of process connections according to national and international standards, sensor elements and transmitters, can be selected to meet the actual requirements.

The parts can be assembled by the user or delivered assembled and calibrated, if relevant.

Providing an 80 mm dia. housing is used, options are also a 4...20 mA configurable display or, for stand alone indicating purposes, a battery powered display.

CombiTemp is particularly suitable for use in food, beverage, pharmaceutical and chemical industries.

A complete temperature sensor can be ordered on one type number. Please refer to CombiTemp Accessories data sheet for a comprehensive range of accessories.

Please refer to the separate data sheets for information and ordering details for transmitters and displays.
Technical Data

Environmental conditions

Media temperature -50...400°C
Ambient temperature -40...160°C
(or temperature range for display/transmitter)
Humidity <100% RH, condensing
(or max. humidity for display/transmitter)
Protection class DIN housing IP 65
φ80 mm housing IP 65 + IP 66
Vibrations GL, test 2
(sensor tubes × 200 mm only)

Disposal of product and packing
According to national laws or by returning to Kamstrup

Sensor tube and connection

Material Acid-proof, stainless steel (AISI 316L/W.1.4404)
Media pressure Max. 16 bar
Time constant tₜₐ₅ See table below
Mechanical tolerances ISO 2768-m

Sensor element

Sensor type Pt100, DIN/EN/IEC 60751,
Class A and B
Accuracy

Air
1/1 DIN B: +(0.3 + 0.005 x t) °C
1/3 DIN B: +1/3 x (0.3 + 0.005 x t) °C
1/6 DIN B: +1/6 x (0.3 + 0.005 x t) °C
1/1 DIN A: +(0.15 + 0.002 x t) °C

Time Constant t₀.₅

Sensor type Liquids Air

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Response</th>
<th>Insert</th>
<th>0.4 m/sec</th>
<th>3 m/sec</th>
<th>0 m/sec</th>
</tr>
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<tbody>
<tr>
<td>φ6 mm tube</td>
<td>fast</td>
<td></td>
<td>&lt;1.5 sec</td>
<td>&lt;13.6 sec</td>
<td>&lt;6.1 sec</td>
</tr>
<tr>
<td>φ8 mm tube</td>
<td>fast</td>
<td></td>
<td>&lt;1.5 sec</td>
<td>&lt;13.6 sec</td>
<td>&lt;6.1 sec</td>
</tr>
<tr>
<td>φ10 mm tube</td>
<td>fast</td>
<td></td>
<td>&lt;1.5 sec</td>
<td>&lt;13.6 sec</td>
<td>&lt;6.1 sec</td>
</tr>
<tr>
<td>φ12 mm tube</td>
<td>fast</td>
<td></td>
<td>&lt;1.5 sec</td>
<td>&lt;13.6 sec</td>
<td>&lt;6.1 sec</td>
</tr>
<tr>
<td>φ6 mm tube</td>
<td>normal</td>
<td></td>
<td>&lt;7.6 sec</td>
<td>&lt;47.7 sec</td>
<td>&lt;27.2 sec</td>
</tr>
<tr>
<td>φ8 mm tube</td>
<td>normal</td>
<td></td>
<td>&lt;11.1 sec</td>
<td>&lt;57.8 sec</td>
<td>&lt;27.0 sec</td>
</tr>
<tr>
<td>φ10 mm tube</td>
<td>normal</td>
<td></td>
<td>&lt;16.2 sec</td>
<td>&lt;70.8 sec</td>
<td>&lt;319.8 sec</td>
</tr>
<tr>
<td>φ12 mm tube</td>
<td>normal</td>
<td>5.6 mm</td>
<td>&lt;13.6 sec</td>
<td>&lt;51.1 sec</td>
<td>&lt;253.1 sec</td>
</tr>
<tr>
<td>φ8 mm tube</td>
<td>normal</td>
<td>5.6 mm</td>
<td>&lt;26.1 sec</td>
<td>&lt;67.0 sec</td>
<td>&lt;271.1 sec</td>
</tr>
<tr>
<td>φ10 mm tube</td>
<td>normal</td>
<td>5.6 mm</td>
<td>&lt;31.3 sec</td>
<td>&lt;82.3 sec</td>
<td>&lt;289.3 sec</td>
</tr>
<tr>
<td>φ12 mm tube</td>
<td>normal</td>
<td>5.6 mm</td>
<td>&lt;31.3 sec</td>
<td>&lt;82.3 sec</td>
<td>&lt;289.3 sec</td>
</tr>
</tbody>
</table>

Dimensional Drawings - Mounting Details

[mm]

Nipple G1/2A mounted on DIN B housing
Nipple G1/2A mounted on φ80 mm housing
Examples of Application

8141 4211 0100 110 xxxx 8141 H242 0100 110 xxxx 8142 D232 0100 110 xxxx 8142 C252 0000 000 xxxx
+Combi Connect connection

8140 0007 0322 210 xxxx
Cable sensor 81 41-231
Display 81 46-525
Transmitter 81 47-525

8142 D231 0212 213 xxxx
Display 81 46-525
Transmitter 81 47-525

8142 G152 0211 210 xxxx
Transmitter 81 47-525

8141 3211 0272 010 xxxx
Batt Temp 86 30-511

8141 3212 0211 121 xxxx
### Ordering Details

#### CombItemp Series

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Not specified</td>
</tr>
<tr>
<td>1</td>
<td>Normal response sensor tip</td>
</tr>
<tr>
<td>2</td>
<td>Fast response sensor tip, Note (1), (6)</td>
</tr>
</tbody>
</table>

#### Connection

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Not specified</td>
</tr>
<tr>
<td>1</td>
<td>Sensor tube without thread or connection</td>
</tr>
<tr>
<td>2</td>
<td>R1/2 nipple, ISO 7/1</td>
</tr>
<tr>
<td>3</td>
<td>G1/2A nipple, ISO 228/1</td>
</tr>
<tr>
<td>4</td>
<td>G1/2 union, ISO 228/1</td>
</tr>
<tr>
<td>5</td>
<td>G1/2 union nut, ISO 228/1</td>
</tr>
<tr>
<td>6</td>
<td>G3/4 union, ISO 228/1</td>
</tr>
<tr>
<td>7</td>
<td>G3/4A union nut, ISO 228/1</td>
</tr>
<tr>
<td>8</td>
<td>G1 union, ISO 228/1</td>
</tr>
<tr>
<td>9</td>
<td>G1A union nut, ISO 228/1</td>
</tr>
<tr>
<td>A</td>
<td>1/2&quot; - 14 NPT nipple, ANSI/ASME B1.20.1</td>
</tr>
<tr>
<td>B</td>
<td>G1/2A nipple for CombIConnect, ISO 228/1</td>
</tr>
<tr>
<td>C</td>
<td>3A hygienic coupling, DN38</td>
</tr>
<tr>
<td>D</td>
<td>GEA Tuchenhagen Varivent flange, DN40/DN50</td>
</tr>
<tr>
<td>E</td>
<td>Clamp DN25/38, ISO 2852</td>
</tr>
<tr>
<td>F</td>
<td>Clamp DN51, ISO 2852</td>
</tr>
<tr>
<td>G</td>
<td>1/2&quot; - 3/4&quot; Tri-clamp*</td>
</tr>
<tr>
<td>H</td>
<td>SMS 1145 union, DN38</td>
</tr>
<tr>
<td>I</td>
<td>SMS 1145 union, DN51</td>
</tr>
<tr>
<td>J</td>
<td>As customer specification</td>
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</table>

#### Sensor tube dimension

<table>
<thead>
<tr>
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<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Not specified</td>
</tr>
<tr>
<td>1</td>
<td>ø6 mm x 1 mm, AISI 316L, max. length 500 mm, Note (5)</td>
</tr>
<tr>
<td>2</td>
<td>ø8 mm x 1 mm, AISI 316L, max. length 600 mm, Note (2)</td>
</tr>
<tr>
<td>3</td>
<td>ø10 mm x 1 mm, AISI 316L, max. length 6000 mm</td>
</tr>
<tr>
<td>4</td>
<td>ø12 mm x 1 mm, AISI 316L, max. length 6000 mm</td>
</tr>
<tr>
<td>S</td>
<td>As customer specification</td>
</tr>
</tbody>
</table>

#### Sensor element

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
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<td>Not specified or empty sensor tube</td>
</tr>
<tr>
<td>1</td>
<td>1/1 DIN B, single, specified accuracy -50...400°C</td>
</tr>
<tr>
<td>2</td>
<td>1/1 DIN B, double, specified accuracy -50...400°C</td>
</tr>
<tr>
<td>3</td>
<td>1/3 DIN B, single, specified accuracy 0...150°C</td>
</tr>
<tr>
<td>4</td>
<td>1/3 DIN B, double, specified accuracy 0...150°C</td>
</tr>
<tr>
<td>5</td>
<td>1/6 DIN B, single, specified accuracy 0...100°C</td>
</tr>
<tr>
<td>6</td>
<td>1/6 DIN B, double, specified accuracy 0...100°C</td>
</tr>
<tr>
<td>7</td>
<td>1/1 DIN A, single, specified accuracy -50...400°C</td>
</tr>
<tr>
<td>8</td>
<td>1/1 DIN A, double, specified accuracy -50...400°C</td>
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<tr>
<td>S</td>
<td>As customer specification</td>
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#### Sensor insert type

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<th>Description</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>Not specified</td>
</tr>
<tr>
<td>1</td>
<td>Sensor tube with embedded sensor element, 2-wire</td>
</tr>
<tr>
<td>2</td>
<td>Sensor tube with embedded sensor element, 4-wire</td>
</tr>
<tr>
<td>3</td>
<td>ø5.6 x 0.5 mm insert AISI 316, 2-wire, max. length 600 mm, Note (3)</td>
</tr>
<tr>
<td>4</td>
<td>ø5.6 x 0.5 mm insert AISI 316, 4-wire, max. length 600 mm, Note (3)</td>
</tr>
<tr>
<td>5</td>
<td>ø5.6 x 0.5 mm insert spring-loaded AISI 316, 2-wire, max. length 600 mm, Note (3)</td>
</tr>
<tr>
<td>6</td>
<td>ø5.6 x 0.5 mm insert spring-loaded AISI 316, 4-wire, max. length 600 mm, Note (3)</td>
</tr>
<tr>
<td>7</td>
<td>Cable sensor, 3-wire, Note (4)</td>
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</table>

#### Cooling neck

<table>
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<th>Description</th>
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</thead>
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<tr>
<td>0</td>
<td>Not specified</td>
</tr>
<tr>
<td>1</td>
<td>1 off cooling neck (71 mm)</td>
</tr>
<tr>
<td>2</td>
<td>2 off cooling neck (142 mm)</td>
</tr>
<tr>
<td>3</td>
<td>3 off cooling neck (213 mm)</td>
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<td>S</td>
<td>As customer specification</td>
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### Ordering Details (cont.)

#### CombiTemp Series

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<tbody>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>DIN B head with cover and PG16 gland</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ø80 mm stainless steel housing, Note (5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ø80 mm stainless steel housing with ø110 mm wall bracket, Note (5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>As customer specification</td>
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<td></td>
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</table>

#### Cable gland

<table>
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</thead>
<tbody>
<tr>
<td>Not specified or DIN B head chosen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 off PG9 gland and 1 off blind plug</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 off PG9 gland</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 off PG13.5 adaptor and 1 off blind plug (no gland incl.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 off PG13.5 adaptor (no gland incl.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 off M20 x 1.5 adaptor and 1 off blind plug (no gland incl.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 off M20 x 1.5 adaptor (no gland incl.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 off blind plugs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 off blind plugs</td>
<td></td>
<td></td>
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<tr>
<td>As customer specification</td>
<td></td>
<td></td>
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</table>

#### Cover or display

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<tbody>
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<tr>
<td>Cover for ø80 mm housing</td>
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<td></td>
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<td>Display, Note (4)</td>
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</table>

#### Terminal block or transmitter

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</thead>
<tbody>
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<td></td>
</tr>
<tr>
<td>Ceramic terminal block</td>
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<td>Transmitter, Note (4)</td>
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#### Assembling

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<tbody>
<tr>
<td>Not specified</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assembled, process connection at the base</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Assembled, process connection at the rear (ø80 mm housing only)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Certificates

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Not specified</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material 3.1.b (EN 10204)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calibration certificate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material 3.1.b (EN 10204) and calibration certificate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Sensor tube length (L)

| xxxx Length in mm. Please observe max. lengths

### Notes:

1. Single sensor element only. Max. sensor length 300 mm.
2. Max. 1000 mm with cable sensor.
3. ø80 mm housing: Insert only if sensor tube is mounted at the rear. Insert is not suitable for a sensor with fast response tip. Observe length, refer to "Sensor Insert Type".
4. Refer to data sheet. Specify separate type number and configuration.
5. Assembling is mandatory.
6. Embedded sensors only.
Dimensional Drawings

Nipple G1/2A and R1/2

Union nut G1/2A, G3/4A and G1A

Clamp DN25/38/51

Union G1/2, G3/4 and G1

Nipple G1/2A for CombiConnect

3A DN38

Nipple 1/2\" - 14 NPT
**Dimensional Drawings**

[Diagram of sensor tube without connection]

**Sensor inserts**

[Diagram of sensor insert with housing and connection details]

Calculation of insert length:

When ordering an insert the length must be calculated from the formula:

\[
\text{Insert length} = \text{Sensor length} + \text{total body length} + \text{housing shaft}
\]

(Total body length can be calculated from the dimensional drawings on pages 6 and 7)

**Example.**

Insert for G1/2 sensor in ø80 housing with 100 mm sensor tube, normal response sensor tip:

- **Sensor length** = 100 mm
- **Total body length** = 27.5 + 12.5 = 40 mm
- **Housing shaft** = 6.5 mm

This insert must be ordered with a 146.5 mm sensor tube.

**Notes**

- **Housing shaft**
  - DIN housing: 11.5 mm
  - ø80 housing: 6.5 mm
4-wire Sensors

The dots indicate red painting

Double Elements

The dots indicate red painting

Application Photos

ø80 mm housing with cover and gland (blind plug at the rear)
Gamp connection
Fast response sensor

Cut through DIN housing showing
Temperature transmitter
G1/2A nipple connection
Normal response sensor

ø80 mm housing with 2 glands
3A connection at the rear
Fast response sensor
FlexTop 2201 Temperature Transmitter

4...20 mA transmitter for Pt100 sensors
2-, 3- or 4-wire sensors
Accuracy better than 0.25°C
Sensor offset correction
Automatic/configurable cable resistance compensation (2-wire)
Sensor error detection
2-way configuration (Windows)
Configurable damping and status indication
Engineering unit °C or °F
PC datalogging
Excellent temperature stability
Demko EEx ia IIC T5/T6, ATEX II 1G
Barbara Ex ia IIC T5/T6

Description

FlexTop 2201 is a 4...20 mA loop-powered transmitter for Pt100 sensors.

Either 2-, 3- or 4-wire sensors can be used. For 2-wire sensors an automatic balancing of the sensor cable resistance is possible with shorted sensor cable. The cable resistance can be manually configured as well.

Using a PC, the Windows-based Flex-program and a FlexProgrammer configuring unit, the following parameters can be configured via the output connectors (2-way communication): TAG no., number of wires, cable resistance, error detection level, measuring range/unit, damping, offset and status indication.

The Flex-program has a datalogging facility enabling the user to monitor measuring results or calibrate the measuring setup.

FlexTop 2201 is embedded in silicone which makes it resistant to humid environments.

FlexTop 2201, fitting into the DIN B housing, has a 6 mm center hole for quick sensor replacement. The spring loaded mounting screws ensure a safe fastening even in vibrating environments.
### Technical Data

#### Input

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy</td>
<td>&lt; 0.25°C (2)</td>
</tr>
<tr>
<td>Span &lt; 250°C</td>
<td>0.1% of span</td>
</tr>
<tr>
<td>Span &gt; 250°C</td>
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</tr>
<tr>
<td>Sample time</td>
<td>&lt; 0.7 sec.</td>
</tr>
<tr>
<td>Pt100 Standard</td>
<td>IEC/DIN/EN 60 751-2</td>
</tr>
<tr>
<td>RTD measuring current</td>
<td>0.3 mA, continuously</td>
</tr>
<tr>
<td>Sensor type</td>
<td>2-, 3- or 4-wires (1)</td>
</tr>
<tr>
<td>Sensor short detection</td>
<td>&lt; -225°C</td>
</tr>
<tr>
<td>Sensor break detection</td>
<td>&gt; 875°C</td>
</tr>
<tr>
<td>Error detection delay</td>
<td>&lt; 10 sec.</td>
</tr>
<tr>
<td>Compensation for cable error</td>
<td>&lt; 0.02°C/Ohm (3-wire)</td>
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<tr>
<td>Cable resistance</td>
<td>Max. 20 Ohm/wire</td>
</tr>
<tr>
<td>Measuring range</td>
<td>-200...850°C (1)</td>
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<tr>
<td>Measuring unit</td>
<td>°C or °F (1)</td>
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<tr>
<td>Minimum span</td>
<td>25°C</td>
</tr>
<tr>
<td>Protection</td>
<td>+/- 35 V&lt;sub&gt;y&lt;/sub&gt;</td>
</tr>
<tr>
<td>Suppression</td>
<td>50 and 60 Hz</td>
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<tr>
<td>Resolution</td>
<td>14 bit</td>
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<tr>
<td>Repeatability</td>
<td>&lt; 0.1°C</td>
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<tr>
<td>Ripple immunity</td>
<td>IEC 770 6.2.4.2</td>
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<tr>
<td>Offset Adjustment</td>
<td>Max. + 10°C (1)</td>
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#### Output

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Signal span</td>
<td>4...20 mA, 2-wire</td>
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<tr>
<td>Accuracy</td>
<td>&lt; 0.1% of signal span</td>
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<tr>
<td>Supply range</td>
<td>8...35 V&lt;sub&gt;ac&lt;/sub&gt;</td>
</tr>
<tr>
<td>Ripple immunity</td>
<td>3 V&lt;sub&gt;ac&lt;/sub&gt;</td>
</tr>
<tr>
<td>Load equation</td>
<td>R&lt;sub&gt;load&lt;/sub&gt; &lt; (V&lt;sub&gt;ac&lt;/sub&gt; - 8)/23 [kOhm]</td>
</tr>
<tr>
<td>Up/Down scaling limits</td>
<td>23 mA/3.5 mA (1)</td>
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<tr>
<td>Damping</td>
<td>0-...30 sec. (1)</td>
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<tr>
<td>Protection</td>
<td>Reversed polarity protection</td>
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<tr>
<td>Resolution</td>
<td>12 bit</td>
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<tr>
<td>Effect of variations in supply voltage:</td>
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</tr>
<tr>
<td>Output current</td>
<td>0.01% per volt</td>
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<tr>
<td>TAG No.</td>
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#### Environmental conditions

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<tr>
<td>Operating temperature</td>
<td>-40...85°C</td>
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<tr>
<td>Humidity</td>
<td>&lt; 98% RH, cond. (IEC 60-2-38)</td>
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<tr>
<td>Vibrations</td>
<td>GL, test 2 (IEC 68-2-6)</td>
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<td>Long-term test</td>
<td>IEC 770 6.3.2</td>
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#### EMC data

<table>
<thead>
<tr>
<th>Generic standards</th>
<th>EN 50081-1, EN 50082-2</th>
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<tr>
<td>Product standards</td>
<td>EN 61326</td>
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<tr>
<td>NAMUR</td>
<td>NAMUR NE21</td>
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<tr>
<td>Approval (Demko)</td>
<td>EEx ia IIC T5/T6, ATEX II 1G</td>
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<tr>
<td>Approval (Barbara)</td>
<td>EEx ia IIC T5/T6</td>
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#### Mechanical data

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<tr>
<td>Dimensions</td>
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<tr>
<td>Protection class</td>
<td>Housing: IP 40</td>
</tr>
<tr>
<td>Temperature drift</td>
<td>Typ. 0.003% per °C</td>
</tr>
<tr>
<td></td>
<td>Max. 0.01% per °C</td>
</tr>
<tr>
<td>Power-on time</td>
<td>10 sec.</td>
</tr>
</tbody>
</table>

#### Test conditions

| Configuration             | 0...100°C                       |
| Amb. temperature          | 23°C +/- 2°C                    |
| Power supply              | 24 V<sub>ac</sub>               |

#### Disposal of product and packing

According to national laws or by returning to Kamstrup

#### Notes

<table>
<thead>
<tr>
<th>Note</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Configurable</td>
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<tr>
<td>(2) Lower range limit &lt; 100°C</td>
<td></td>
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### Ordering Details

#### FlexTop 2201

<table>
<thead>
<tr>
<th>Type</th>
<th>Specification</th>
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<tbody>
<tr>
<td>2201 xxx</td>
<td>Not configured, standard safety</td>
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<tr>
<td>0001</td>
<td>Not configured, Demko EEx ia IIC T5/T6, ATEX II 1G</td>
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<tr>
<td>0002</td>
<td>Not configured, Barbara Ex ia IIC T5/T6</td>
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<tr>
<td>0003</td>
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</table>

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>2201 9900</td>
<td>Configuration according to customer specifications</td>
</tr>
</tbody>
</table>

**Note:** The FlexTop 2201 can be supplied in a 30 pcs. packing. Please contact Kamstrup for further information.
Non-Ex-application

Electrical Installation

Dimensional Drawing

Accessories

FlexProgrammer configuration set, type number 82 23-803 comprises:

- FlexProgrammer with 9 pole RS232C cable
- 3.5" Program diskettes
- Battery plug
- Cable with test plugs

Spring loaded mounting screws, Ø4 mounting holes

6 center hole for quick sensor replacement

[mm] 19 33
Ex-application

Zone 0/1 Safe area

Zone 0/1 Safe area

230V

24V

4...20 mA

RTD

FlexTop 2201

Barrier

FlexView

Power supply

Configuration

Note:
Disconnect loop supply before connecting the FlexProgrammer to FlexTop 2201.
Type:
- Dosing pump P.E. 100 with chemical tank

Application:
- For chemical dosing

Material:
- Pump
  - Liquid end: PVC
  - Check valve cartridge: PVC
  - Seats: PVC
  - Balls: Glass
  - Contour plate: PVC
  - Seals: Viton
  - Chemical tank: Polyethylene
  - Dosing head: Stainless steel

Technical data:
- Max pressure: 123 bar
- Capacity: 12.5 l/h
- Max pressure suction side: 35 bar
- Max operating temperature: 50°C
- Enclosure rating: IP 44
- Insulation class: F
- Chemical tank volume: 100 ltr
- Colour: RAL 1028
- Weight: 28 kg
**Type:**
- Needle valve, straight

**Size:**
- 3/8" BSP

**Material:**
- Body: brass
- Spindle: brass
- Packing: PTFE
- Hand wheel: steel

**Technical data:**
- Working pressure: 25 bar
- Weight: 0.32 kg
Type:
- Control globe valve, straight with pneumatic actuator and I/P positioner
- 23.470, DP 33

Size:
- Nominal diameter: DN 50

Application:
- For cooling, water, steam, brine and/or gas flow

Material valve:
- Body: GGG 40.3
  DIN - Material No. 0.7043
- Seat: X20 Cr13
  DIN - Material No. 1.4021.05
- Plug: X20 Cr13
  DIN - Material No. 1.4021.05
- Stuffing box: PTFE V-ring unit (-10°C to +220°C)

Technical data, valve:
- Nominal pressure: PN 25
- Positioning ratio: 50:1
- Flow characteristic: Equal percentage
- Standard k_v value: 40 m³/h
- Stroke: 30 mm
- Plug type: Parabolic shaft guided
- Flanges according to DIN

Technical data, actuator:
- Spring range: 1.5 - 3.0 bar
- Diaphragm area: 400 cm²
- Filling volume: 2.3 l
- Max air pressure: 6 bar
- Action: Normally closed valve on air failure

Technical data, I/P positioner:
- Air connection: G ½”
- Inlet air supply: 1.4 to 7 bar, instrument air
- Air inlet consumption in stable state:
  < 3.6 x 10⁻² Nm³/h
- Cable inlet: M20 x 1.5

Input signal: 4-20 mA
Ambient temperature: -30°C to +80°C
Protection: IP 65

Technical data unit:
- Design closing pressure: 25 bar
- Weight: 36 kg

Installation:
- Only as shown in the picture

Type No.: 6050
Version: B

Pneumatic control valve DN 50, PN 25, with DP actuator and I/P positioner

6050 000051
Type:
- Filter regulator with automatic drain

Size:
- Connections ports 1/4" BSP
- Gauge ports 1/8" BSP

Application:
- Instrument air for regulating pressure

Technical data:
- Medium: instrument air only
- Max. inlet pressure: 17 bar
- Operating temp.: -20 °C to +65 °C
- Filter element: 5 µm
- Recommend pressure regulating range: 0.14-7.0 bar
- Pressure gauge: 0 - 10 bar
- Weight: 0.4 kg

Material:
- Body: Steel
- Bin: Steel
- Handle: Acetal

Flow characteristics:

<table>
<thead>
<tr>
<th>Air flow [dm³/s]</th>
<th>Outlet pressure [bar]</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
</tr>
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<td>4</td>
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<td>4</td>
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<td>6</td>
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</tr>
<tr>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
</tr>
</tbody>
</table>

Inlet pressure 7 bar

Type No.: 8000
Version: A
Filter regulator with automatic drain

291 5101
**Type:**
- Water washing hose with nozzle

**Size:**
- V-nozzle: 12 mm
- Length: 15 metre (hose)
- Inner diameter: 52 mm (hose)

**Application:**
- For spraying of water

**Material:**
- Hose: full-synthetic material (polyester) woven in 1/1 binding, with inner rubber lining

**Technical data:**
- Max allowable working pressure: 20 bar
- Water temperature area: -30°C to +60°C
- Weight: 5.5 kg

---

**Water flow**

| l/min | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 | 210 |
|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Bar   | 1  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  | 21  | 22  |

---

**Type No.:** 8500  
**Version:** A  
**Language:** UK  
**Page:** 1/1
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Descriptions

Steam atomising burner, type KBSD ................................................................. 1
Steam atomising burner, type KBSD

1 General

The burner is a steam atomising burner for modulating operation. The burner is capable of burning both diesel oil and heavy fuel oil. An illustration of the KBSD burner is shown in Figure 1.

The burner system consists of the burner unit, combustion air fan, and supply systems for oil, steam, and combustion air. The burner unit is mounted on top of the boiler and connected to the combustion air fan via an air duct.

The design of the KBSD burner ensures that the flame is kept highly stable at all loads. Due to the advanced wind-box and oil flow control system, the KBSD burner can provide inert gas at low loads and has an increased turn down ratio.

Illustration of the KBSD burner
1.1 Burner design

1.1.1 Wind-box design

When the combustion process in an oil burner is controlled, it is essential to have a stable and uniform distribution of the combustion air in the burner register and the air duct. A badly shaped air duct can cause instability of the flame, and therefore the burner has been designed with a dynamical wind-box, as shown in Figure 2. This wind-box, shaped as a spiral, in combination with the radially fixed guide vanes ensure a uniform air distribution in the burner register. This is an efficient way to achieve a stable combustion.

Illustration of the dynamical wind-box

![Swirlers, Guide vanes, Burner lance, Air inlet]

Figure 2

1.1.2 Burner register

The burner register is the duct between the wind-box and the furnace. The burner lance with atomiser, swirlers, and ignition burner are placed in the burner register. The burner air register is fitted with divided swirlers – one primary air swirler and one secondary air swirler – to achieve flame stabilisation.

For maintenance and inspection purposes the burner lance can be dismounted separately from the top of the wind-box. This makes replacement of the atomiser very easy.

The swirlers are designed to create an internal re-circulation of hot gases, which provides the continuous ignition, and hereby to stabilise the flame resulting in less pulsation.

1.1.3 Ignition burner

The ignition burner is a separate diesel oil burner with its own oil supply system. When the burner is started, and the ignition sequence step is reached, the ignition burner is moved into position by means of the air servo cylinder.

The diesel oil flame is ignited by an electric spark between two electrodes which are connected to a high voltage ignition transformer.

After the ignition period has expired, the ignition burner is purged with air and retracted again.
1.1.4 Atomiser

The burner lance contains the Y-jet atomiser, in which steam and fuel are mixed and ejected. This oil mist is then mixed with combustion air, and the combustion is completed. The requested oil capacity of the burner unit determines the number and bore of discharge ports in the atomiser. The oil flow regulation is based on flow measurements, and therefore the oil pressure is of little importance to the atomisation quality. As a consequence of this, the atomisation quality does not vary over the burner turn down range even with the oil pressure operating between 2 and 25 bar.

1.1.5 Flame failure equipment

Flame failure during light up and normal operation is detected by photo electric cells mounted on the burner unit and coupled to an amplifier mounted inside the local control panel. By loss of flame, this flame failure equipment will automatically shut down the burner.

1.2 Supply systems

1.2.1 Oil and atomising systems

The atomising medium and oil are supplied from valves through flexible hoses to the burner lance. The automatic shut-off valves, re-circulation valve, solenoid valves, and the rest of the necessary burner mountings are all fixed on the wind-box. All shut-off valves are standard ball valves, and the automatic valves are with electric/pneumatic actuators. The arrangement of the components on the burner is made as simple as possible and is therefore very user friendly regarding operation and maintenance.

The oil flow control valve is fitted together with a pneumatic converter/positioner. To obtain a very accurate regulation of the oil flow, which is very important to have a large turn-down ratio, the valve is also fitted with an adjustable Cv-adjuster. This Cv-adjuster makes it possible to adjust the pressure loss coefficient of the valve whereby the oil flow regulation can be optimised to each single installation. The oil flow is measured by a screw-type flow meter.

The fuel oil pressure control loop includes a motorised control valve to ensure the correct pressure at the fuel oil inlet of the burner, and thereby providing a larger turn-down ratio of the control valve. A single loop PID-controller and a standard 4-20 mA pressure transmitter ensure optimum and accurate functionality. The fuel oil temperature before the burner inlet is kept precisely at the desired value by means of a motorised flow control valve, a single loop PID-controller, and a Pt100 temperature transmitter.

The atomising steam is supplied through a motorised control valve. The steam pressure is kept constant at high burner load, but at low burner loads, the steam pressure is reduced. A single loop PID-controller with external set point and a standard 4-20 mA pressure transmitter ensure optimum and accurate functionality. The external set point is related to the fuel oil flow and changes together with this, making regulation more optimal.

Both steam and compressed air can be used for atomisation of the fuel oil. Normally steam is used for the atomisation, which is supplied from the boiler drum and/or common steam line. When connecting to the common steam line in plants with two boilers, boiler No. 2 can be started by using steam from boiler No. 1 and visa versa.
Atomisation of the fuel oil by compressed air should only be used during start-up or due to failure of the steam supply.

1.2.2 Combustion air system

The combustion air system supplies air to the burner according to the demands of the control system. The draft loss of the burner air register is measured by a differential pressure transmitter, which converts the signal to a flow signal used by the control system for automatic air/oil ratio control.

The combustion air is supplied by a directly driven centrifugal fan. The fan is mounted on a common bed frame with motor, inlet vanes, and servo-drive unit. The fan impeller inside the spiral housing is mounted directly on the motor shaft. The air flow to the burner is regulated by inlet vanes mounted on the fan suction side.

The inlet vanes are of a multi-blade design and regulated by a servo-driven unit comprising an air cylinder and an I/P positioner. A silencer can be mounted on the fan suction side.
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Steam atomising burner

1 General

The steam atomising burner is capable of burning both diesel oil and heavy fuel oil. As the burner is a very vital component of the boiler plant, the operating staff should be thoroughly instructed with regard to the operation of the equipment and the safety regulations. This is due to the fact that burner problems are often caused by incorrect burner operation. With frequently occurring burner faults, the nearest service centre should be consulted.

To ensure a safe and reliable function of the burner it must be inspected at least once a year, in addition to the normal maintenance intervals. The inspection should be carried out by a representative of the supplier or by another competent and qualified person.

It should be clearly understood that for a plant of this complexity it is not practicable to anticipate all the possible circumstances which may arise during the operation life of the plant. Therefore, should circumstances arise in plant operation and maintenance which are not specifically covered by these instructions, the matter should be referred to Aalborg Industries for consideration and advice.

Repairs, adjustments, alterations or changes to plant operations not covered by these instructions should not be effected without reference in writing to Aalborg Industries.

Information in this manual is subject to changes without notice and does not represent a commitment on the part of Aalborg Industries. It is not allowed to copy this manual or part hereof for any purpose other than the purchaser's personal use. Aalborg Industries shall not be held responsible for any damage or losses caused by the use of this manual.

1.1 Safety regulations

Caution: To ensure a safe burner operation, the burner has to be installed and commissioned by qualified personnel, and all guidelines in these instructions have to be followed.

All safety equipment such as flame sensor equipment and correcting elements may only be replaced by qualified personnel.

Warning: Repair of any of the safety components is NOT permitted. Failure to comply may result in serious injury or death and may cause considerable damages to the boiler plant.
If any unexpected plant behaviour, deterioration or similar event should occur giving rise to any reasonable doubt as to the continued safety of the plant, the matter should be reported at once to Aalborg Industries for their advice.

1.2 Qualified personnel

Qualified personnel according to these operating instructions are persons, who are confident in installing, regulating and commissioning the burner, and who have qualifications to carry out this work, i.e.:

- Persons who are trained to operate electric circuits and units according to the safety standards.

- Persons who are qualified in the use of dangerous fuel according to the relevant laws and regulations.
Handling fuel oil

1 Precautions to be taken with fuel oil

Fuel oil is usually the residue of crude oil after the removal by distillation of the most volatile oils and gasses. Fuel oil in its liquid state is very difficult to ignite in bulk and not capable of spontaneous combustion. However, the vapour is explosive when mixed with air, and being heavier than air, it tends to accumulate in low levels such as bilges and bottoms of tanks where it may remain undiscovered until ignited by a naked light or spark. It is always present in a partly filled oil tank or in a tank which has contained fuel oil and is given off through the vents from tanks in the process of being filled.

If allowed to continue, a leak in any part of the oil burning system may result in an accumulation of this explosive vapour.

Ignition of the vapour can be caused by an open light, electric spark, smoking, spark caused by striking metal, heat from the filament of a broken electric lamp, sparks from funnel or can be communicated from galley or fires under boilers.

Note: An oil fire cannot be extinguished by water, but may be extinguished by sand, steam or chemical fire extinguishers.

An intelligent appreciation of the properties of fuel oil as described above is a better prevention of accident than adherence to any set of rules that may be pre-described. However, the following detailed precautions should be rigidly enforced:

- When oil is being received, no naked light or electric apparatus liable to spark should be permitted within 20 meters of the oil hose, tank or compartment, containing the tank or the vent from the tank, except when special arrangements are carried out.

- While receiving fuel oil, the storage tank must be closely watched for leaks, and care must be taken that all outlets from the tank, except the vents, are closed.

- No naked lights or electric apparatus liable to spark should be permitted at any time in a compartment containing a fuel oil tank. Electric lamps used in such compartments should have a wire protector around the bulb or be of a type that will ensure the breaking of a circuit through the lamp in the event of the lamp being broken.

- No one should be allowed to enter a fuel oil tank until it has been gas-freed, and any person then entering the tank must have a properly tended life line around his body in order to be hauled out if overcome by gas.

- Electric fuses and switches, unless the enclosed type, should not be permitted in compartments containing fuel oil pumps or piping.

- Care must be taken that the wire-gauze protectors in vent pipes from fuel oil tanks are intact at all times.
• Dampers, where fitted in the uptakes of the boilers, must be kept fully open while burning oil. Otherwise, this may result in dangerous accumulation of gas in the furnace with a resultant blowing out into the boiler or engine room.

• The valves on glass gauges in fuel oil storage or settling tanks should be kept habitually shut. When a reading of the gauge is desired, the valves may be opened, but must be shut again at once.

• In each boiler or engine room fitted for oil burning there should be fire extinguishing apparatus in accordance with the requirements/rules from the authorities and classification societies in question such as, e.g.: Fire hose, permanently coupled and of sufficient length to reach all parts of the boiler or engine room, and either:
  — (a) a box containing at least 85 litres (2 cubic ft) of dry sand with a large scoop
  — (b) a chemical fire extinguisher of the tank type

• When the fuel oil system has not been in use for a long period, or after joints in the piping have been re-made, the system should be tested “cold” under a pressure at least equal to the working pressure before fires are ignited. During the test a careful inspection for leaks should be carried out.

• Fuel oil should not be habitually heated above 65°C for light oils and 120°C for heavy oils and never above its flash point in any part of the system except in the burners.

• Care must be taken to prevent accumulation of oil or vapour in any place outside the system and in ships particularly in bilges under the furnace. This can be accomplished by rigid cleanliness.
Ignition burner

1 General description

The ignition burner is a separate diesel oil burner with its own oil supply system. It operates on the principle of mechanical pressure jet atomisation. The ignition burner is retractable and inserted/drawn back by an air servo cylinder. Both in automatic and emergency operation mode the ignition burner is fully automatic. An illustration of the ignition burner is shown in Figure 1.

The ignition system always operates on diesel oil whether the steam atomising burner operates on diesel oil or heavy fuel oil. This secures a reliable ignition. The diesel oil is supplied by an ignition oil pump, which only operates in ignition mode. The pump pressure should be set to 8-10 bar.

The combustion air to the ignition burner is supplied from the compressed air system and can be adjusted by means of the throttle valve placed after the solenoid. At the end of the furnace purge period, the solenoid valves for diesel oil and combustion air open, and the diesel oil flame is ignited by an electric spark between two electrodes which are connected to a high voltage ignition transformer. The ignition burner is simultaneously moved into ignition position. The ignition burner must ignite the main burner within the present ignition period. At the end of the ignition period, the solenoid valves are closed, and the ignition burner is purged by compressed air through the solenoid valve in the purge air inlet. After the purge period the ignition burner is drawn back.

1.1 Commissioning

During commissioning the position of the nozzle and the electrodes should be checked and adjusted if necessary (see Figure 1).

1.2 Maintenance

As the ignition burner is one of the most exposed components, it needs frequent inspection and maintenance.

- The electrodes should be cleaned, and the insulation material checked for damages.
- The nozzle should be checked and cleaned. If the spray pattern hits other parts of the ignition burner despite cleaning it, the nozzle should be changed.

Note: Be careful not to change position of electrodes as this may cause, e.g. ignition problems, instability or build-up of carbon deposit.
Illustration of the ignition burner

Figure 1

- Air servo cylinder
- Hose for air servo cylinder (down)
- Hose for air servo cylinder (up)
- Magnetic switch
- Hose for purge air
- Hose for diesel oil
- Caps for electrodes
- Flame scanner
- Ignition burner
- Throttle valve for combustion air
- Diesel oil inlet
- Flange at wind box
- Ignition burner lance
- Nozzle
- 4 mm
- 8-12 mm
- 10-12 mm
### Photo cell

#### 1 Description

The RAR7 detector is used for supervision of yellow burning oil flames. If the photo cell detects a missing flame, the burner stops instantaneously. It is not possible to start the burner before the control system has been reset.

With this type of detector, the radiation of the oil flame in the visible band of the light spectrum is used to generate a flame signal. The light-sensitive element is a selenium photo cell. When illuminated, it generates DC voltage which causes a current to flow to the input of the flame signal amplifier in the control unit. Hence, the selenium photo cell is an active detector.

The cell is insensitive to infrared radiation. If the burner is started with an illuminated combustion chamber, e.g. due to glowing firebrick, the start sequence of the burner commences, but an alarm for flame failure will be indicated.

The number of photo cells for automatic operation and emergency operation depend on the classification society.

#### 1.1 Commissioning

The intensity of the light radiation can be checked by measuring the detector current by means of a DC ammeter (internal resistance 5000 W). Figure 1 shows the measuring circuit. The photo cell is adjusted by changing the position in proportion to the oil flame in order to obtain the maximum detector current.

**Note:** If the wiring of the photo cell is connected incorrectly, it is not possible to start the oil burner.

#### Measuring circuit

![Measuring circuit diagram](photocirc.cdr)
Burner lance

1 General description

The burner lance contains the Y-jet atomiser in which steam and fuel are mixed and ejected into the furnace. An illustration of the burner lance is shown in Figure 1.

During normal start, the burner lance is purged with atomising steam through the steam pipe line. This heats the burner lance and makes ignition of the main flame more reliable. During normal stop, the oil pipe is purged with steam. By this, the remaining fuel oil in the lance will be atomised into the furnace. The combustion air fan, which also operates during this period, purges the furnace for the ejected oil/steam mist.

For maintenance and inspection purposes, the lance can be extracted from the wind-box, and the atomiser can be dismounted from the lance. This is done, by unscrewing two Allen screws in the flange connection and unscrewing the screw cap.

Eventually, the atomiser will be covered with a layer of carbon deposits. To remove these deposits, paraffin or carbon remover should be used. It is also possible to use a soft metal scraper. A hardened scraper should not be used as it could damage the atomiser. The cleaned atomiser should then be examined for damage, and the holes checked for wear. It should be replaced if necessary.

The O-rings must be replaced every time the atomiser has been dismounted. Before mounting the screw cap, the thread should be covered with an unhardening high temperature compound.

When the burner is commissioned, the atomiser must be thoroughly cleaned before any attempt is made to start the burner.

Illustration of the burner lance

Figure 1
Viscosity - temperature chart

1 Description

The preheating temperature can be determined by means of the viscosity - temperature chart shown in Figure 1. In order to use the chart, the viscosity of the fuel oil must be known at a reference temperature. It should be noted that the preheating temperature should be set somewhat higher than the temperature shown in the chart due to the heat loss between pre-heater and nozzle/cup.

1.1 Example

The example is based on a pressure jet burner.

**Known:**
Oil viscosity: 380 cSt. at 50°C

**Required:**
Preheating temperature in °C

**Procedure to be followed:**

**Step A:** Follow the reference temperature line at 50°C vertically down to the intersection with the 380 cSt. viscosity line.

**Step B:** From this point move parallel down with the nearest fuel grade line.

**Step C:** When the line meets the recommended nozzle viscosity line, go vertically up to the temperature axis.

**Step D:** At this point read the desired preheating temperature of 150°C.
Viscosity - temperature chart

Figure 1

1. Recommended cup viscosity for rotary cup burners
2. Recommended nozzle viscosity for steam atomising burners
3. Recommended nozzle viscosity for pressure atomising burners
1 General description

This section describes the oil system in general terms together with some of the requirements needed to have a safe and reliable burner operation. The burner and the oil system are designed for both diesel oil and heavy fuel oil operation. A diagram of the oil system for steam atomising burners is shown in Figure 1. The diagram shown is for a plant with two steam atomising burners. The oil system consists of oil tanks for diesel oil and heavy fuel oil, mixing tube, oil pumps, heaters, ignition oil pumps, and equipment for oil pressure and temperature control.

Illustration of the oil system
1.1 Oil tanks

The heavy fuel oil tank may be provided with a heating coil for heating up the fuel oil in the tank to at least 50°C, at which temperature it will be possible to pump the oil. The oil temperature in the tank should not exceed approximately 60°C in order to keep the oil temperature controlled by the heater units. Whenever a boiler plant is intended to operate on heavy fuel oil, all pipes carrying fuel oil must be insulated and traced in order to keep a sufficiently low viscosity of the oil. The tracing can be done either by means of steam heating or by means of electric heating cables.

1.2 Fuel selection

The fuel type is selected by manually operating the three-way valve (G115) in the oil system. In an emergency case, heavy fuel oil can be taken from the heavy fuel oil settling tank. In this case, the valve (G49) in the suction line from the mixing tube to the pump suction side must be closed so that any return flow is led back to the heavy fuel oil tank. In this mode, the tank temperature must be observed so that the temperature is kept below the fuel oil flash point.

1.3 Return flow from the burner

When the burner is in stand-by mode, a minimum of fuel oil is returned via the oil return line to the three-way valve (G111). From here the fuel oil is either led to the pump suction side via the mixing tube (G110) for degassing or to the heavy fuel oil settling tank. The three-way valve normally returns the fuel oil to the mixing tube. If the fuel is changed to diesel oil or heavy fuel oil by means of the three-way valve (G115), the three-way valve (G111) automatically changes position and returns the oil to the heavy fuel oil settling tank for a period of time. The three-way valve is a pneumatically operated actuator controlled by a solenoid valve (G113). The solenoid valve has a manual switch for emergency operation. This arrangement is necessary to avoid a continuous heating of the re-circulated diesel oil when the fuel is changed from diesel oil to heavy fuel oil. The viscosity of the re-circulated diesel oil decreases and with it also the lubrication characteristic. This will cause damage to the oil pumps. The arrangement is also necessary when the fuel is changed from heavy fuel oil to diesel oil because the temperature of the re-circulated heavy fuel oil will decrease and might cause blockage of the piping system. After the pre-set time period has expired, the three-way valve (G111) returns to normal position, and the fuel flows to the mixing tube (G110). The time period must be set with regard to oil pressure and the quantity of oil in the system.

1.4 Fuel oil supply pump

The oil system is fitted with one set of supply oil pumps common for both diesel oil and heavy fuel oil (G05 and G12). The supply oil pump unit (G147) is a twin type package unit in which two screw pumps with driving motors are connected by a switch across the valve housing. Each pump is fitted with a pressure safety valve, a filter (G02 and G09), a mano/vacuum gauge (G04 and G11) at the filter, and non return valves (G07 and G14).
The pumping capacities for the pumps are calculated in such a way that there will be sufficient oil flow to the burner and the pressure regulating valve in full load condition.

The control system receives a signal from the pressure transmitter (G99). If the pressure drops below a pre-adjusted set point, the operating pump stops, and the other pump starts. If the pressure continues to drop, the control system gives alarm for low oil pressure and stops the burner(s).

1.5 Fuel oil pressure control

A part of the fuel oil returns to the pump suction side through the oil pressure control valve (G100) which keeps a pre-set pressure in the fuel oil system. The fuel oil pressure control loop includes a motorised control valve (G100) to ensure the correct pressure at the fuel oil inlet of the burner. This provides larger turn-down ratio of the oil flow regulation valve. A single loop PID-controller and a standard 4-20 mA pressure transmitter (G99) ensure optimum and accurate functionality.

1.6 Pre-heater

The oil system is provided with pre-heater(s) (G22) heating the heavy fuel oil to the correct temperature/viscosity by means of steam. The fuel oil is changed by means of the manually operated three-way valve (G115). When diesel oil is selected, the manually operated three-way valve (G51) must be in a position which by-passes the pre-heater(s), and the stop valve(s) (G25) must be closed. When heavy fuel oil is selected, the stop valve(s) (G25) must be opened, and the manually operated three-way valve (G51) must be in a position in which the oil flows through the pre-heater(s).

1.7 Fuel oil temperature control

The heavy fuel oil temperature after the pre-heater(s) is kept precisely at the desired value by means of a motorised flow control valve (G20), a single loop PID-controller, and a Pt100 temperature transmitter (G28).

1.8 Ignition oil system

The ignition system always operates on diesel oil whether the steam atomising burner operates on diesel oil or heavy fuel oil. This secures a reliable ignition. The diesel oil is supplied by an ignition oil pump (G72) with filter (G70). The pump is only operated in ignition mode. The ignition oil pump is a gear pump fitted with a pressure limiting valve and a filter inside the housing. The pump should be set to 8-10 bar.

A plant with two boilers is provided with two ignition oil pumps. If a pump fails, the other can be selected to supply diesel oil for the ignition to both burners.
Burner supply systems

1 General description

This section describes the burner supply systems in general terms together with some of the requirements needed to have a safe and reliable burner operation. The burner and the oil system are designed for both diesel oil and heavy fuel oil operation. An illustration of the burner supply systems for the steam atomising burner(s) is shown in Figure 1.

The burner supply systems consist of a fuel oil system, a steam atomising system, a combustion air system, an ignition system, and a compressed air system.

Illustration of the KBSD burner

Figure 1
1.1 Fuel oil system

From the pre-heater(s) or the pre-heater bypass line, fuel oil flows through the three-way valve (F99), the flow meter (F100), and the oil flow regulation valve (F94) to the pneumatic three-way shut-off valve (F75). From this point, the fuel oil either returns to the fuel oil supply system (burner stopped) via stop valve (F93) or to the burner lance (burner in operation) via the pneumatic shut-off valve (F67) and the stop valve (F64). All pipes are traced to avoid blockage of HFO.

Both the fuel oil and the atomising medium are supplied from the stop valves (F41 and F64) through flexible hoses to the burner lance.

The burner lance contains the Y-jet atomiser where steam and fuel are mixed and ejected. This oil mist is then mixed with combustion air, and the combustion is completed.

The burner load is controlled by the control system, which receives a continuous signal from a steam pressure transmitter. This signal is compared to different set points, feedback signals, and parameters in the control system. The output from the control system is used to control the oil regulation valve (F94), which is pneumatically operated by an I/P positioner. To obtain a very accurate regulation of the oil, which is very important to have a large turn-down ratio, the valve is also fitted with an adjustable Cv-adjuster.

The signal from the pressure transmitter together with feedback signals from the oil flow meter and the differential pressure transmitter for combustion air are handled in the control system to obtain a correct combustion with regard to aidoil ratio and atomising steam pressure.

When the burner is in ignition position, minimum position, maximum position, etc., the air/oil flow is fixed by settings in the control system.

Furthermore, the control system is designed to prevent poor combustion (black smoke), which may arise during start-up, stop, and load alterations.

The oil pressure is of little importance to the atomisation quality as the oil flow regulation is based on flow measurements. As a consequence of this, the atomisation quality does not vary over the burner turn-down range.

1.2 Steam atomising system

From the boiler drum, the atomising steam flows through the steam regulating valve (F91), the pneumatic shut-off valve (F42), and the stop valve (F41) to the burner lance. The steam pressure is controlled by the regulating valve (F91). The steam pressure is kept at a constant level at high burner load, but at lower burner loads, the steam pressure is reduced by the control system. A single loop PID-controller with external set point and a standard 4-20 mA pressure transmitter ensure optimum and accurate functionality. The external set point is related to the fuel oil flow and changes together with this, making regulation more optimal.

During normal stop of the burner, the lance is purged with steam. The pneumatic shut-off valve (F44) opens, and the remaining fuel oil in the lance will be atomised into the furnace. The combustion air fan, which also operates during this period, purges the furnace for the unburned ejected oil/steam mist. The valve F44 is closed after the end of the purge period.

If atomising steam is not available from the boiler, it can be supplied from the auxiliary steam system via the stop valve (F92). Compressed air can also be used as atomising medium (e.g. at start-up) and is supplied via the stop valve (F87). Compressed air for atomising should only be used if steam is not available.
1.3 Combustion air system

The combustion air fan draws air from the engine room through the inlet vanes. The inlet vanes regulate the necessary air flow for the combustion by means of an air cylinder and an I/P positioner. The I/P positioner receives a 4-20 mA signal from the control system. From the fan discharge side, the combustion air flows through the air duct into the burner wind box. From here the combustion air is distributed to the burner register, the swirlers, and the furnace through the radially fixed guide vanes to ensure a uniform air flow.

The draft loss across the burner is measured by a differential pressure transmitter, which converts the signal to a flow signal used by the control system for automatic air/oil ratio control.

1.4 Ignition system

The ignition burner is a separate diesel oil burner with its own oil supply system which operates on the principle of mechanical pressure jet atomisation. The ignition burner is retractable and inserted/retracted by an air servo cylinder. The diesel oil flame is ignited by an electric spark between two electrodes which are connected to a high voltage ignition transformer. The combustion air to the ignition burner is supplied from the compressed air system.

At the end of the furnace purge period, the solenoid valves (F18, F19, and F153) open, and the ignition burner is ignited and inserted. The ignition burner must ignite the main burner within the present ignition period. At the end of the ignition period, the solenoid valves (F18 and F19) to the ignition burner are closed, and the ignition burner is purged by compressed air through the solenoid valve (F78) and the non-return valve (F77). After the purge period the ignition burner is retracted.

1.5 Compressed air system

The compressed air system consists of four systems which operate with different pressures. The air system for atomising is a separate system, which includes the stop valve (F87) and the non return valve (F108).

The air system for the ignition oil burner comprises the stop valve (F73), the throttle valve (F152), the solenoid valves (F78 and F153), and the non return valve (F77). The air system for control of the pneumatic shut-off valves consists of the air filter/reduction unit (F63), the solenoid valves (F61, F65, F56, and F59), and the pneumatic actuators (F60, F66, F57, and F58). These components are used for the three-way shut-off valve (F75), the shut-off valve (F67), the shut-off valve (F42), and the shut-off valve (F44) respectively.

The air system for the oil flow control includes the air filter/reduction units (F96 and F97), the I/P converter (F95), and connections to the oil flow regulating valve (F94).

Note: I/P converters and/or positioners must be supplied with instrument air.
Commissioning

1 General

The following commissioning instructions are valid for steam atomising burners type KBSD with Y-atomisers and with a standard delivery of individual parts for the burner unit and supply systems from AALBORG INDUSTRIES.

Prior to the commissioning, the instructions for the individual parts of the burner unit and supply systems should be studied. The special instructions for the boiler and the control system should also be consulted. The instructions should only be considered as a guideline. This is due to the fact that each plant should be commissioned individually to obtain the best burner performance for the specific plant.

Attention: If the burner unit and supply systems include parts, which are not standard delivery from AALBORG INDUSTRIES, the specific instructions for these parts should be ignored in the following sections. The actual instructions for the specific parts should be thoroughly studied and followed during commissioning.

During commissioning of the burner unit and supply systems, it might be necessary to adjust some regulation parameters, timer settings, etc. in the control system to optimise the function of the plant. These adjustments are not described in the following sections, but should be carried out as the optimisation requirements emerge. Please see the instructions for the control system.

1.1 Pre-service checks

Before commissioning, the following work steps must be carried out:

Step A: Check that the boiler is ready for operation according to the special instructions for the boiler

Step B: Increase or decrease the water level in the boiler to approximately 50 mm below normal water level.

Step C: Check the electric wiring.

Step D: Switch on the power for the boiler plant and reset the system on the local panel or the computer.

Step E: Check that the control system is operational according to the special instructions for the control system.

Step F: Pre-adjust the pressure switch and pressure transmitter set points for boiler operation.
The position numbers mentioned in the following sections refer to the illustrations in Figure 1 and Figure 2. The position numbers consist of an identification letter and a position number code. Position numbers with the identification letters "G" and "R" refer to Figure 1, and position numbers with the identification letter "F" refer to Figure 2. The oil system is shown as a plant with two boilers, but is also valid for a plant with only one boiler.

Illustration of the oil system
2 Commissioning

2.1 Commissioning adjustments of the burner unit

On delivery from Aalborg Industries, the burner unit has been pre-adjusted to fit the task. Even though the burner unit has been pre-adjusted, it is advisable to carry out additional checks during commissioning. These checks should be carried out with regard to adjustment of the atomiser and swirlers, and ignition electrodes, etc. This means that it is necessary to pull out the burner lance, swirlers, and ignition burner.
2.1.1 Dismantling

Step A: Remove the flame scanners.

Step B: Close the stop valves (F41 and F64).

Step C: Dismount the flexible hoses for fuel oil and atomising steam to the burner lance.

Step D: Dismount the flexible hose for combustion air to the ignition burner.

Step E: Dismount the flexible hoses for ignition oil and purge air to the ignition burner.

Step F: Dismount the flexible hoses for the air servo cylinder on the ignition burner.

Step G: Dismount the cable for the magnetic switch on the ignition burner.

Step H: Remove the two spark plug caps from the ignition burner.

Step I: Note the position of the front plate and unscrew the bolts from the front plate.

Step J: Lift up the front plate in the lifting eyes including the burner lance, swirlers, and ignition burner by means of a tackle. Be careful not to damage the packing between the wind-box and front plate.

2.1.2 Adjustment of the atomiser and swirlers distance

Step A: Check the distance between the atomiser tip and the inner ring of the primary swirler. The factory setting is 25 mm. Adjust if necessary.

Note: An exact distance cannot be given, but has to be determined when the burner is in operation. If the flame has a tendency to pulsate at low loads, it might be necessary to readjust the distance.

Step B: Loosen the bolt, which fixes the primary swirler to the burner lance protection tube. Adjust the primary swirler to the desired position, and tighten the bolt again.

Step C: Loosen the bolt, which fixes the secondary swirler to the burner lance protection tube. Adjust the secondary swirler into a position in which the inner ring of the secondary swirler and the outer ring of the primary swirler are at the same level. Tighten the bolt again. This corresponds to an equal movement of the secondary swirler to the same numerical distance as the primary swirler movement. Tighten the bolt again.

Step D: Loosen the bolt, which fixes the burner lance protection tube to the front plate. Adjust the protection tube into a position in which the outer ring of
the secondary swirler and the beginning of the quarl (burner cone) are at the same level. This corresponds to an opposite movement of the protection tube to the same numerical distance as the swirlers movement. Tighten the bolt again.

Step E: If an adjustment is carried out, loosen the fixing screws that hold the air servo cylinder of the ignition burner. Move it in the same direction and to the same numerical distance as the primary swirler movement. The factory setting between the ignition burner and the primary swirler is 5 mm. Tighten the fixing screws again.

2.1.3 Adjustment of the ignition burner

Step A: Check the position of the oil nozzle for the ignition burner. The oil nozzle tip should be at the same level as the end of the ignition burner mixing tube. Adjust if necessary.

Step B: Check the position of the ignition electrodes. The ignition electrodes should be 10-12 mm in front of the atomiser tip and 8-12 mm above the atomiser tip. The distance between the electrodes should be adjusted to 4 mm. Adjust if necessary.

Note: An exact setting of the ignition electrodes cannot be given, but has to be established when the ignition burner is in operation.

Step C: Unscrew the two screws that fix the mixing tube to the electrode holder and pull out the mixing tube.

Step D: Loosen the centre screw that fixes the oil supply pipe and adjust to the desired position. Tighten the centre screw again.

Step E: Dismount the oil nozzle from the oil supply pipe and check that the nozzle is clean. Assemble after check/cleaning.

Step F: Loosen the two Allen screws that fix the ignition electrodes and adjust to the desired position. Tighten the Allen screws again.

Step G: Assemble the electrode holder and the mixing tube. Screw in the two screws on the mixing tube.

2.1.4 Measurements

Step A: Before the burner unit is assembled, check and note the commissioning measurements. The obtained measurements should be inserted in the chapter "Measurement and settings".

2.1.5 Assembling

Step A: Check the condition of the packing between the wind-box and the front plate. Replace if necessary.
Step B: Mount the front plate including the burner lance, swirlers, and ignition burner onto the wind-box. The front plate should be mounted in the same position as before.

Step C: Screw in the bolts on the front plate. The nuts must be tightened crosswise.

Step D: Mount the flexible hose for combustion air to the ignition burner.

Step E: Mount the flexible hoses for ignition oil and purge air to the ignition burner.

Step F: Mount the flexible hoses for the air servo cylinder on the ignition burner.

Step G: Mount the cable for the magnetic switch on the ignition burner.

Step H: Mount the two spark plug caps on the ignition burner.

Step I: Insert the flame scanners.

2.1.6 Clean the burner lance and atomiser

Step A: Unscrew the two Allen screws on the burner lance flange and pull out the burner lance.

Step B: Dismount the atomiser and screw cap from the burner lance and check that the lance is clean.

Step C: Clean the atomiser and screw cap. The factory has greased the atomiser to protect it from corrosion.

Step D: Replace the two O-rings on the atomiser and assemble the atomiser, screw cap, and burner lance.

Step E: Insert the burner lance into the protection tube and screw in the two Allen screws into the flange connection.

Step F: Mount the flexible hoses for fuel oil and atomising steam to the burner lance.

2.2 Commissioning of the oil system

When the oil system is commissioned, it should initially be flushed by means of an external pumping system. This must be done to ensure that the oil system is not clogged-up and to prevent foreign objects from entering the pump unit which might cause damage.

On delivery the oil system of the burner unit is by-passed by means of the three-way valve (F99). This prevents foreign objects from entering the flow meter, oil flow regulation valve, etc. The position of the valve should not be changed before flushing of the oil system is completed. The valve is locked in this position by means of a screw.
Warning: When the oil system is commissioned on diesel oil, the tracing of the piping system must be off.

2.2.1 Commissioning

Step A: Check that oil is present in the diesel oil tank. Open the quick closing valve (G94), which connects the diesel oil tank to the oil system.

Step B: Select diesel oil on the manually operated three-way valve (G115). Check that the local panel and computer indicate diesel oil operation. Open the stop valve (G49) for the mixing tube.

Step C: Turn the manually operated three-way valve (G247) for oil flow through both pumps.

Step D: Open the stop valves for the pressure gauges (G04, G11, G16, and G47).

Note: The stop valves for the pressure gauges on the pump unit should only be opened for pressure control purposes. The stop valves should be closed during normal operation.

Step E: Close the stop valves (G97 and G101), and open the by-pass valve (G102).

Step F: By-pass the pre-heaters by means of the manually operated three-way valve (G51), and close the stop valves (G25 and G26) for both pre-heaters.

Step G: Open the stop valves for the pressure gauge (G44) and the pressure transmitter (G99).

Step H: Check that the three-way valve (F99) is locked in a position which bypasses the oil system of the burner unit.

Step I: Apply air to the pneumatic three-way valve (G111). Adjust the air pressure to 5-10 barg on the air filter/reduction unit (G114).

Step J: Check the position of the pneumatic three-way valve (G111). In normal position, the return oil is led to the mixing tube. The micro switch box mounted on the valve and the control system should also indicate this position.

Note: When the fuel is changed by means of the three-way valve (G115), the three-way valve (G111) automatically changes position and returns the fuel oil to the heavy fuel oil settling tank for a period of time. This time period is set in the control system.

Step K: Rotate the oil pumps by hand to ensure a free and an uninterrupted rotation.
Step L: Adjust the circuit breakers for both pumps to suit full load current of the motors. The current appears from the motor identification plate and/or the electric diagrams.

Step M: The oil pumps must be filled with diesel oil prior to operation. The vent valve installed on the outlet side of the pump unit must be opened until the air has escaped from the suction side of the pump. As soon as diesel oil emerges, the vent valve may be closed.

2.2.2 Flushing the oil system

Step A: Set the burner into manual operation mode on the local panel or the computer.

Step B: Start one of the oil pumps and check that it is running with the correct direction of rotation. Open the vent valve again until only diesel oil emerges.

Step C: Stop the pump and start the other oil pump. Perform the same check and venting procedures.

Note: The pressure relief valve installed in each pump is factory set and checked and should not be adjusted during commissioning.

Step D: Flush the oil system for a few hours with one oil pump in operation. The total flushing time should be determined with regard to the size of the oil system and the amount of impurities (particles, grease, etc.). Check the complete oil system for leaks.

Step E: If the oil pressure is too low or too high, the pressure can be adjusted on the by-pass valve (G102) to a suitable level.

Step F: Close the stop valves (G53, G54, and G109). These valves must be kept closed during the complete flushing period.

Step G: After 1/4 of the pre-determined flushing period, open the stop valves (G25 and G26) for one of the pre-heaters. Turn the three-way valve (G51) for oil flow through the pre-heaters.

Note: The set points for the pre-heater safety valves are factory set and checked and should not be adjusted during commissioning.

Step H: After 1/2 of the pre-determined flushing period, open the stop valves (G25 and G26) for the other pre-heater. Close the stop valves (G25 and G26) for the first pre-heater.

Step I: After 3/4 of the pre-determined flushing period, stop the operational oil pump.
Step J: By-pass the pre-heaters by means of the manually operated three-way valve (G51), and close the stop valves (G25 and G26) for both pre-heaters.

Step K: Commission the oil pressure regulating valve (G100). Set the valve into manual mode on the local panel or computer.

Step L: Move the actuator mounted on the valve into mid-stroke position by means of the hand wheel. By use of the local panel, apply short impulses in each direction of the movement and check that the directions of movement are correct.

Step M: Set the oil pressure regulating valve (G100) into automatic mode on the local panel or computer again. Move the actuator to the end positions (open/closed) by means of the digital output test menu in the local panel. Check that it is switched off automatically. Check that external moving parts are able to move without obstruction.

Note: In a double boiler plant one of the local panels must be switched off when the digital output test menu is used. Otherwise the valve moves continuously up and down because one panel sends up signals, and the other sends down signals.

Step N: Open the stop valves (G97 and G101), and close the by-pass valve (G102).
Step O: Adjust the set point to be 20-25 bar measured at the burner inlet flange.

Note: An exact value cannot be given. If the pressure loss in the actual oil system is high, the oil pressure must be set at a higher level to ensure that the burner receives a sufficient amount of oil. If, on the other hand, the pressure loss is low, the oil pressure must be set at a lower level to ensure that the oil flow regulation valve is operating within a suitable range.

Step P: Start one of the oil pumps for final flushing.
Step Q: When flushing is completed, stop the operational oil pump and clean the oil filters in the fuel oil supply pump unit. Vent the oil pumps after the filters have been cleaned.

Step R: Commission the steam regulating valve (G20) as described for the oil pressure regulating valve (G100).
Step S: Open the stop valves (G53, G54).

2.2.3 Check and adjust the pressure transmitter
Step A: Check that the oil pressure indicated on the local panel and computer is identical to the pressure indicated on the pressure gauge (G44).
Step B: Adjust the range of the pressure transmitter (G99) in the calibration menu of the local panel if necessary.

Note: If the pressure transmitter (G99) and pressure gauge (G44) are mounted at different height levels and far apart, the pressure loss resulting from height difference and friction should be taken into consideration.

2.2.4 Check the low warning and start of stand-by oil pump function

Step A: Adjust the set point for low warning and start of the stand-by oil pump on the local panel or the computer.

Step B: Start one of the oil pumps and set the other pump into stand-by mode.

Step C: Set the oil pressure regulating valve (G100) into manual mode on the local panel or computer and decrease the pressure gradually until the set point is reached. The operating oil pump should stop, and the pump in stand-by mode should start. The local panel and the computer should indicate a low warning. Readjust if necessary.

Step D: Switch operation mode of the pumps and carry out the same procedure.

2.2.5 Check the low oil pressure alarm and trip function

Step A: Adjust the set point for low alarm and trip on the local panel or the computer.

Step B: Decrease the pressure somewhat until the set point is reached. The operating stand-by pump should stop, and an alarm should be indicated on the local panel and the computer. Readjust if necessary.

Step C: Set the oil pressure regulating valve (G100) into automatic mode and reset the alarms.

2.2.6 Check the trip function for overload

Step A: Check the trip function for overload by pressing the test button for the pump in operation on the circuit breaker.

Step B: The pump stops, and a warning for pump failure should be indicated on the local panel and the computer.

Step C: When the stand-by pump is started, perform the same test with this pump.

Step D: Reset the circuit breakers and all alarms after testing.

2.2.7 Commissioning of the oil system on the burner unit

Step A: Check that the oil pumps are stopped.
Step B: Open the stop valves for the pressure gauge (F68).

Step C: Unscrew the screw that locks the position of the three-way valve (F99). Turn the three-way valve for oil flow through the burner unit. Lock the valve in this position. Open the stop valve (F93).

Step D: Apply air to the pneumatic shut-off valves (F42, F44, and F67) and the pneumatic three-way shut-off valve (F75). Adjust the air pressure to 5-10 barg on the air filter/reduction unit (F63).

Step E: Check the position of the pneumatic three-way shut-off valve (F75) and the pneumatic shut-off valve (F67). The valves must be in position closed which means that the oil is led back to the oil system. When the micro switches on the valves (F67 and F75) are activated, the position is indicated on the local panel and computer.

Step F: Commission the oil flow meter (F100). Check that the oil flow meter and pick-up sensor are installed correctly. The flow meter equipment sends a continuous pulse signal to the control system. This signal must be converted into an analogous flow by settings in the control system.

Step G: Set the values for max. oil and beats/litre in the local panel or computer. The max. oil value is the maximum oil flow in l/h at 100% burner load on heavy fuel oil. The value for beats/litre can be taken from the identification of the oil flow meter.

Step H: Unscrew the pick-up sensor from the oil flow meter.

Step I: Tap the pick-up sensor quickly against an object and check that it records the signals. The red LED flashes.

Step J: Mount the pick-up sensor again.

Step K: Check and adjust the oil flow settings for minimum load, ignition load, etc. in the local panel or computer.

Step L: Commission the oil flow regulation valve (F94). Check that the output signal range from the I/P converter (F95) corresponds to the instrument input signal range on the oil flow regulation valve (F94). The pressures appear from the identification plates.

Step M: Disassemble the cover of the oil flow regulation valve by unscrewing two cover screws and lift up the cover. See also the specified instruction for the oil flow regulation valve.

Step N: Check and adjust C_v (valve characteristic) to fit the plug and seat ring by moving the adjustment knob along the C_v scale. Table 1 shows the C_v setting for each burner size.
<table>
<thead>
<tr>
<th>Burner size</th>
<th>Maximum flow coefficient $C_v$</th>
<th>Setting $C_v$</th>
</tr>
</thead>
<tbody>
<tr>
<td>KBSD 950</td>
<td>1.2</td>
<td>0.85</td>
</tr>
<tr>
<td>KBSD 1200</td>
<td>1.2</td>
<td>1.02</td>
</tr>
<tr>
<td>KBSD 1500</td>
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<td>KBSD 1900</td>
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<td>1.5</td>
</tr>
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<td>KBSD 2250</td>
<td>2.3</td>
<td>1.6</td>
</tr>
<tr>
<td>KBSD 2650</td>
<td>2.3</td>
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<td>2.3</td>
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</tr>
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</tr>
<tr>
<td>KBSD 4150</td>
<td>3.8</td>
<td>3.4</td>
</tr>
</tbody>
</table>

Table 1

Step O: Apply air to the I/P converter (F95). Adjust the air pressure on the filter/reduction unit (F96). The pressure setting appears from the identification plate on the converter.

Step P: Apply supply air to the oil flow regulation valve (F94). Adjust the air pressure on the filter/reduction unit (F97). The pressure setting appears from the identification plate on the valve.

Step Q: Set the oil flow into manual mode on the local panel or computer.

Step R: Set the regulation output to 0% (4 mA) by means of the soft keys on the local panel or by settings on the computer.

Step S: Adjust the pressure indicated on the instrument gauge to the low input signal range, by means of the zero adjustment screw on the I/P converter. The instrument gauge is the left pressure gauge on the oil flow regulation valve, and the low input signal range appears from the identification plate.

Step T: Set the regulation output to 100% (20 mA) by means of the soft keys on the local panel or by settings on the computer.

Step U: Adjust the pressure indicated on the output gauge to the high input signal range, by means of the span adjustment screw on the I/P converter. The output gauge is the right pressure gauge on the oil flow regulation valve, and the high input signal range appears from the identification plate.

Step V: Repeat the work steps "S", "T", and "U" several times until the adjustments are acceptable.

Step W: Set the oil flow regulation valve into automatic mode on the local panel or computer.

Step X: Start one of the oil pumps. Set the stand-by oil flow to 0% in the local panel or computer.
Step Y: Adjust the turn take-up screw of the oil flow regulation valve until the piston rod just begins to move. The local panel and computer must indicate 0% oil flow. Tighten with the lock nut.

Step Z: Set the stand-by oil flow back to the original set point.

2.3 Commissioning of the ignition oil system

When the ignition oil pumps are commissioned, the burner should be operated in emergency mode. This is because the ignition oil pumps only operate in the ignition sequence during burner start, and a number of start/stop operations are necessary to check and adjust the system.

2.3.1 Commissioning

Step A: Turn the key placed inside the local control panel into emergency operation.

Step B: Check that the quick closing valve (G94) is open and open the stop valves (G69 and G77).

Step C: Open the stop valve for the pressure gauge (G75).

Note: The stop valve for the pressure gauge should only be opened for pressure control purposes. The stop valve should be closed during normal operation.

Step D: Close the stop valve (F17) on the burner unit.

Step E: Rotate the ignition oil pump by hand to ensure a free and an uninterrupted rotation.

Step F: Adjust the circuit breaker for the ignition oil pump to suit full load current of the motor. The current appears from the motor identification plate and/or the electric diagrams.

Step G: When the ignition oil pump is commissioned, the pump and the pipe system must be filled with diesel oil and ventilated. The vent valve installed in the pump must be opened until the air has escaped. As soon as diesel oil emerges, the vent valve may be closed.

Step H: Press the ignition button on the emergency panel for the pump, and keep it pressed.

Caution: The ignition oil pump should only be operated for a limited period of time during the following commissioning procedure. Due to a continuous re-circulation, the diesel oil is eventually heated. This could damage the pump due to the low viscosity of the heated diesel oil.
Step I: Check that it is running with the correct direction of rotation. Open the vent valve again until only diesel oil emerges.

Step J: Adjust the opening pressure on the pump to 8-10 bar.

**Note:** The pressure at the ignition oil burner should be approximately 8 bar. This means that the pressure loss resulting from height difference and friction should be taken into consideration.

Step K: Stop the pump and turn the key into automatic operation.

Step L: Open the stop valve (F17).

**Note:** The pressure relief valve (G78) is factory set and checked and should not be adjusted during commissioning.

Step M: In plants with two ignition oil pumps, the previously described procedures should be performed.

### 2.3.2 Check the trip function for overload

Step A: Check the trip function for overload by pressing the test button on the circuit breaker.

**Note:** An alarm for ignition oil pump failure will not be indicated. If this failure arises during normal start-up sequence, the burner will trip due to ignition flame failure.

Step B: Reset the circuit breaker after testing.

### 2.4 Commissioning of the combustion air system

When the combustion air system is commissioned, it should be checked that the combustion air fan and the air duct system have been installed and supported correctly. If possible, an inside inspection of the air duct system should also be carried out to ensure that it is free of obstacles, e.g. loose parts, insulating material, etc.

#### 2.4.1 Commissioning of the I/P positioner

Step A: Check that the I/P positioner (R16) is connected as a 2-wire system and apply electric power to the I/P positioner.

Step B: Check that the I/P positioner is in P manual mode. The display must show "NOINIT". If this is not the case press the hand symbol key once. This key is located behind the cover of the I/P positioner.
Step C: Apply air to the I/P positioner and adjust the air pressure to 4-6 bar on the filter/reduction unit (R15).

Step D: Unscrew the cover of the I/P positioner. Use the push buttons ▲▼ to carefully move the actuator and check that the mechanics is functioning.

Step E: Carry out an automatic initialisation of the I/P positioner. Call configure mode by pressing the hand symbol key (>5 sec.). See the specified instruction for the I/P positioner.

Step F: Set the actuator type to linear (WAY) in the menu item "1.YFCT".

Step G: Set the rated angle of the feedback in menu item "2.YAGL". The value should be set to 90°.

Step H: Check that the ratio selector arm is set to 90° on the I/P positioner devise.

Step I: Set the leverage (stroke range) in menu item "3.YWAY". The stroke range is the height difference of the guide rail.

Step J: Start the automatic initialisation with the parameter value "Stnt" in menu item "4.INIT". The I/P positioner then runs through the initialisation steps "RUN 1" to "RUN 5".

Step K: Set the I/P positioner into manual mode. Open and close the inlet vanes (R07) several times by manually operating the I/P positioner to demonstrate an uninterrupted operation.

Step L: Set the I/P positioner into automatic mode and mount the cover again.

Step M: Check that the micro switch, which controls the closed position of the inlet vanes, is activated. The inlet vanes must be in closed position when the burner is in normal stop mode. If the burner is started during normal operation condition, and the micro switch is deactivated, a sequence failure alarm will be indicated.

2.4.2 Commissioning of the differential pressure transmitter

It is possible to set the start of scale and full scale of the dp-transmitter even if there is no pressure source available ("blind" calibration). Please also see the specified instruction for the dp-transmitter.

Step A: Set the air flow into manual mode on the local panel or computer.

Step B: Set the regulation output to 0% (4 mA) by means of the soft keys on the local panel or by settings on the computer.

Step C: Unscrew the screws that hold the protective cover of the dp-transmitter for access to the push buttons.

Step D: Use the "M" key to select modes on the dp-transmitter. When a mode is selected, the keys ▲ and ▼ are used to change the mode value.
Step E: Set the values in mode 4 (electrical damping), 9 (output in error situation), 10 (pushbuttons functions), 11 (characteristic), 12 (transition point characteristic), 13 (value displayed), and 14 (engineering units). mm H\textsubscript{2}O can e.g. be selected as engineering units in mode 14.

Step F: Select mode 5 using the “M” key.

Step G: Use the ↑ or ↓ key to set the start of scale in the selected engineering unit. If mm H\textsubscript{2}O is selected as engineering units, then the set start of scale to 0 mm H\textsubscript{2}O.

Step H: Press both the ↑ and ↓ keys simultaneously for about 2 seconds, and the start of scale is set to zero (in the selected engineering unit).

Step I: Set the regulation output to 100% (20 mA) by means of the soft keys on the local panel or by settings on the computer.

Step J: Select mode 6 using the “M” key.

Step K: Use the ↑ or ↓ key to set the full scale in the selected engineering unit. The full scale value should normally be set to 300 mm H\textsubscript{2}O.

Step L: Set the regulation output to 0% (4 mA) again by means of the soft keys on the local panel or by settings on the computer.

Step M: Set the air flow into automatic mode on the local panel or computer.

Step N: Mount the protective cover of the dp-transmitter again.

Important: The set range of the dp-transmitter should be checked when the burner is in operation at 100% load on heavy fuel oil. The actual differential pressure must not exceed or be too far below the set range of the dp-transmitter. If this is the case, the full scale value must be corrected. This will affect all settings made of the air/oil ratio and they must adjusted once more.

2.4.3 Commissioning checks and operation

Step A: Rotate the combustion air fan by hand to ensure a free and an uninterrupted rotation.

Step B: Check the electrical wiring at the terminals of the combustion air fan. The wiring must be performed according to the wiring shown in the electrical diagrams.

Step C: Adjust the circuit breaker for the combustion air fan to suit full load current of the motor. The current appears from the motor identification plate and/or the electric diagrams.
Step D: Turn the keys placed inside the local control panel and the power panel into emergency operation.

Step E: Close the inlet vanes by means of the potentiometer inside the local control panel.

Step F: Start the combustion air fan (R09) on the operating switch inside the power panel and check that it is running with the correct direction of rotation.

Step G: Check that the combustion air fan and the air duct system do not produce any abnormal mechanical noises.

Step H: Check the combustion air fan and the air duct system for any abnormal vibrations.

Step I: Check the air duct system for leaks.

Step J: Open the inlet vanes for the combustion air fan fully by means of the potentiometer.

Step K: Check the current consumption of the combustion air fan. The current must not exceed the full load current stated on the motor identification plate and/or the electric diagrams.

Step L: Set the combustion air fan to minimum load by means of the potentiometer.

Step M: Check the temperature of the fan bearings. The bearing temperature must be at a constant level after approximately 30 minutes of operation. If the temperature continues to increase, stop the combustion air fan and check the bearings.

Step N: Close the inlet vanes for the combustion air fan by means of the potentiometer inside the local control panel and stop the combustion air fan on the operating switch inside the power panel.

Step O: Turn the keys placed inside the local control panel and the power panel into automatic operation.

2.4.4 Check the trip function for overload

Step A: Start the combustion air fan by means of the digital output test menu in the local panel.

Note: In a double boiler plant, one of the local panels must be switched off when the digital output test menu is used. Otherwise the fan continuously starts and stops because one panel sends start signals, and the other sends stop signals.

Step B: Press the test button on the circuit breaker for the combustion air fan.
Step C: The fan stops, and an alarm for combustion air fan failure should be indicated on the local panel and computer.

Step D: Reset the circuit breaker.

2.5 Commissioning of the steam atomising system

In normal operation, atomising steam is supplied from the boiler drum or from an auxiliary supply system. When the burner is commissioned, atomising steam may not be available. If this is the case, compressed air can be used as the atomising medium. The function of the steam regulating valve can, however, be checked at this point.

2.5.1 Commissioning of the steam regulating valve

Step A: Commission the steam regulating valve (F91). Set the valve into manual mode on the local panel or computer.

Step B: Move the actuator mounted on the valve into mid-stroke position by means of the hand wheel. By use of the local panel, apply short impulses in each direction of the movement and check that the directions of movement are correct.

Step C: Set the steam regulating valve (F91) into automatic mode on the local panel or computer again. Move the actuator to the end positions (open/closed) by means of the digital output test menu in the local panel. Check that it is switched off automatically. Check that external moving parts are able to move without obstruction.

Step D: Check and adjust the pressure settings in the control system. At low loads, the steam atomising pressure should be set to approximately 2-3 bar. The pressure settings should be gradually increased to 6-7 bar at full load. The final settings must be determined during burner operation.

Step E: Check and adjust the setting for low steam atomising pressure alarm on the local panel or computer. The alarm should be checked when the burner is in automatic operation.

2.5.2 Commissioning without atomising steam

Step A: Close the stop valve (F92), and open the stop valves (F87 and F41).

Step B: Open the stop valve for the pressure transmitter (F90).

Step C: Check that the pneumatic shut-off valve (F42) opens and closes when signals are applied to the valve by means of the digital output test menu in the local panel.

Step D: Open the non-return valve (F45), and check that the stop valve (F64) is open.
Step E: Check that the pneumatic shut-off valve (F44) opens and closes when signals are applied to the valve by means of the digital output test menu in the local panel.

3 Start-up

To continue the commissioning procedures, the oil system must be in normal operation, and the atomising system must be set to compressed air operation if atomising steam is not available. Furthermore, the ignition oil system and combustion air system must be operational.

Prior to the actual start-up of the burner, some additional checks should be carried out with regard to the ignition oil burner and the burner start-up sequence. When these checks are completed, the burner should be commissioned on diesel oil and finally on heavy fuel oil.

Attention: Before and during start-up, the furnace must be checked with regular intervals for oil spillage. If an oil spillage is present in the furnace, the cause must be determined and the failure must be rectified. The furnace should be purged until it is free of oil.

3.1 Additional commissioning checks

3.1.1 Check the ignition burner

Step A: Turn the keys placed inside the local control panel and the power panel into emergency operation.

Step B: Close the inlet vanes of the combustion air fan (R09) by means of the potentiometer inside the local control panel. Start the combustion air fan on the operating switch inside the power panel.

Step C: Open the inlet vanes for the combustion air fan to approximately 15-20% by means of the potentiometer.

Step D: Open the throttle valve (F152) for combustion air to the ignition burner.

Step E: Close the stop valve (F17) to the ignition burner.

Step F: Press the ignition button on the emergency panel and keep it pressed.

Step G: Check that the ignition burner is inserted.

Step H: Check the ignition spark between the electrodes. Use the inspection holes to visually check the ignition spark. The ignition electrodes should be adjusted if necessary.

Step I: Release the ignition button and check that the ignition burner is drawn back after the time period for purge has expired.
Step J: Open the stop valves (F17 and F73).

Step K: Press the ignition button again and keep it pressed. Check that the solenoid valves (F18, F19, and F153) are opened and that the ignition burner is inserted at the same time.

Step L: Check the ignition flame. Use the inspection holes to visually check the ignition flame. Adjust the ignition electrodes, the throttle valve for combustion air, or the opening pressure on the ignition oil pump if necessary.

Step M: Release the ignition button and check that the solenoid valves (F18, F19, and F153) close.

Step N: Check that the solenoid valve (F78) opens and that the ignition burner is purged with air.

Step O: Check that the ignition burner is drawn back after the end of the purge period.

Step P: Adjust the time period for purge to a suitable level on the timer placed inside the local control panel.

Step Q: Check the ignition burner several times to ensure a reliable ignition.

Step R: Close the inlet vanes for the combustion air fan by means of the potentiometer inside the local control panel and stop the combustion air fan on the operating switch inside the power panel.

Step S: Turn the keys placed inside the local control panel and the power panel into automatic operation.

3.1.2 Check the burner start-up sequence

In automatic mode, the start/stop sequences of the burner are carried out by the control system. A condition for the initiation of the start-up sequence is that no safety interlock alarms are present. If a safety interlock alarm is present, the cause must be corrected.

The following check of the start-up sequence should be carefully monitored on site to demonstrate the correct function of the start-up sequence locally. The start sequence is also indicated on the local panel and computer.

Step A: Close the stop valve (F64).

Step B: Check that the air damper (R07) is in closed position.

Step C: Set the burner into manual operation mode on the local panel or computer.

Step D: Start one of the oil pumps.

Step E: Check that the oil flow regulation valve (F94) is in stand-by position (stand-by oil flow).
Step F: Start the burner on the local panel or computer.

Step G: Check that the combustion air fan (R09) starts.

**Note:** The combustion air fan is set for a minimum operation time of 20 minutes in automatic mode to avoid more than three starts per hour.

Step H: Check that the pneumatic shut-off valve (F42) opens and that the burner is supplied with the atomising medium.

Step I: Check that the air damper is moved into purge position.

Step J: Check that the combustion air fan damper is moved into ignition position after the furnace purge period.

Step K: Check that the oil flow regulation valve is in ignition position (ignition oil flow).

Step L: Check that the ignition burner is inserted and ignited.

Step M: Check that the pneumatic three-way valve (F75) and the pneumatic shut-off valve (F67) change position.

Step N: Check that diesel oil to the ignition burner is shut-off and that it is purged with air.

Step O: Because the stop valve (F64) is closed, the burner start-up fails due to flame failure. Check that the pneumatic three-way valve (F75) and the pneumatic shut-off valve (F67) change position immediately after the flame failure alarm appears.

Step P: Open the stop valve (F64) and reset all alarms.

### 3.2 Commissioning on diesel oil

When the burner is commissioned, the boiler pressure and temperature must not be intensified too rapidly as this might cause stresses in the boiler. The burner should be kept in minimum firing position during the first commissioning period. In manual operation mode, the burner load can be controlled by means of the soft keys on the local panel and/or by settings on the computer.

When the burner is stopped during normal operation, the burner lance is purged with atomising steam, and the remaining oil in the lance is atomised into furnace and burned. To ensure a complete combustion of the oil during steam purging, it is important to carry out this procedure with the correct air/fuel ratio. If the combustion air flow is too low, the combustion produces black smoke, and if the air flow is too high, the flame blows out before the combustion is completed.

The correct air flow for the combustion can be determined by comparing the oil pressure at the atomiser and the steam atomising pressure. When these pressures are identical, the oil flow atomised into the furnace does not change when steam purging
is initiated. This means that the present air flow suits the combustion. This load is the steam purge position load and must be set in the control system.

When the burner is commissioned on diesel oil and/or when the atomising medium is compressed air, the steam purge position should be pre-adjusted to approximately 25%. The final setting should be determined when the burner is commissioned on heavy fuel oil, and the atomising medium is steam.

3.2.1 Operation of the burner

Due to the risk of stresses in the boiler, the burner should only be operated at relatively short intervals during the initial start-up. When the burner is stopped during this firing-up procedure, the remaining safety interlock alarms can be checked and adjusted.

Step A: Check and adjust the steam purge position on the local panel or computer.

Step B: Start the burner in manual operation mode on the local panel or computer.

Step C: Check that the burner ignites when the oil valves open and that it remains ignited when the ignition burner is shut-off and retracted.

Note: A number of starts may be necessary before the burner ignites. If ignition of the burner fails despite of several attempts, adjust the ignition oil flow, the correction factor for air/fuel ratio, or the atomising pressure on the local panel or computer.

Step D: Check that the burner is in minimum firing position after start-up.

Step E: Check that the flame does not pulsate. Adjust the correction factor, air/fuel ratio, and/or minimum load if necessary

Step F: Check the shape and colour of the flame. Measure the CO₂ and/or the O₂ content and adjust the correction factor or air/fuel ratio if necessary.

Step G: Check the colour of the flue gas. Measure the soot spot No. It should not exceed a soot spot No. of 1-3 (Bachrach). Adjust the correction factor or air/fuel ratio if necessary.

Note: The final adjustment of the combustion parameters, e.g. air/fuel ratio, minimum load, steam atomising pressure, etc. should be carried out when the burner operates on heavy fuel oil and with steam as atomising medium. It is therefore advisable to adjust the correction factor instead of the air/fuel ratio when the burner is commissioned on diesel oil.

3.2.2 Check the stop sequence

Step A: The stop sequence should also be carefully monitored on site. Operate the burner for a few minutes.
Step B: Set the burner load to steam purge position and stop the burner.

Step C: Check that the pneumatic three-way valve (F75) and the pneumatic shut-off valve (F67) change position.

Step D: Check that the pneumatic shut-off valve (F44) for steam purge opens at the same time as the oil valves close. The flame failure equipment is inactive when the burner is purged.

Step E: Check that the pneumatic shut-off valve (F42) for atomising steam closes after the end of the steam purge 1 period.

Step F: Check that the pneumatic shut-off valve (F44) for steam purge closes after the end of the steam purge 2 period.

Step G: Check that the air damper moves to post purge (purge) position if this sequence step is active.

Step H: Check that the oil flow is in stand-by position and that the air damper is closed after the end of the steam purge 2/post purge period.

Step I: Check that the combustion air fan stops. The fan only stops if it has been operating more than 20 minutes.

Step J: Check that the furnace is free of oil spillage.

3.2.3 Check the safety interlock alarm for flame failure equipment

Step A: When the burner is in operation, check the flame failure equipment by removing one of the flame scanners from the holder and cover the sensor. The burner shuts down, and an alarm for flame failure is indicated on the local panel and computer. Reset all alarms.

Step B: Check and simulate a glowing furnace by using a flash light pointed directly at the flame scanner.

Step C: Set the burner into start mode. The local panel and computer should indicate an alarm for flame failure.

Step D: Mount the flame scanner into the holder and reset all alarms.

Step E: Perform the same checks with the other flame scanner.

3.2.4 Check the safety interlock alarm for lance inserted

Step A: When the burner is in operation, unscrew the two Allen screws on the burner lance flange. Carefully lift the lance a few mm. The burner shuts down, and an alarm is indicated on the local panel and computer.

Step B: Screw in the two Allen screws into the flange connection and reset the alarm. Start the burner again.
3.2.5 Check the safety interlock alarm for oil valves

Step A: Set the burner into stop mode, turn the pneumatic shut-off valve (F67) a few degrees from closed position by means of a tool. An alarm for oil valve not in position should be indicated on the local panel and computer. Reset the alarm after testing and start the burner again.

Step B: Set the burner into stop mode, turn the pneumatic three-way valve (F75) a few degrees from the present position by means of a tool. An alarm for oil valve not in position should be indicated on the local panel and computer. Reset the alarm after testing.

3.2.6 Check the safety interlock alarm for low oil pressure

Step A: When the burner is in operation, check the low oil pressure alarm and trip function as described in the paragraph "Commissioning of the oil system". The burner shuts down, and an alarm for low oil pressure is indicated on the local panel and computer. Reset the alarms after testing.

3.2.7 Check the safety interlock alarm for too low water level

Step A: When the burner is in operation, perform a live test of the water level safety devise. The other too low water level alarm actuated by the water level controller must be deactivated. This can be done by temporarily lowering the alarm set point in the local panel or computer. Decrease the water level until the burner shuts down, and an alarm for too low water level is indicated on the local panel and computer.

Step B: Increase the water level in the boiler and reset the alarm. Adjust the set point for too low water level actuated by the water level controller to the original set point.

Step C: When the burner is in operation, perform a live test of the water level controller. The too low water level alarm actuated by the safety device must be deactivated like described above. Decrease the water level until the burner shuts down, and an alarm for too low water level is indicated on the local panel and computer.

Step D: Increase the water level in the boiler and reset the alarm. Adjust the set point for too low water level actuated by the safety device to the original level.

3.2.8 Change to atomising steam supply

When the boiler pressure is approximately 3 bar, the atomising medium should be changed to steam supply.

Step A: Stop the burner and close the stop valve (F87).

Step B: Check that the steam regulating valve (F91) is in automatic mode on the local panel or computer.
Step C: Open the valve for atomising steam on the boiler.

Step D: Open the valves for the steam trap.

Step E: Start the burner and carry out the remaining commissioning procedures.

Note: If the burner load is increased during start-up, the air/fuel ratio should be checked and adjusted at the different loads.

3.2.9 Check the safety interlock alarm for low steam atomising pressure

Step A: Set the steam regulating valve (F91) into manual mode on the local panel or computer.

Step B: Lower the steam atomising pressure gradually until the set point for low warning is reached. The local panel and computer should indicate a low warning.

Step C: Lower the steam atomising pressure somewhat until the set point for low alarm is reached. The burner shuts down, and an alarm is indicated on the local control panel and computer.

Step D: Set the steam regulating valve (F91) into automatic mode on the local panel or computer and reset the alarm.

3.2.10 Check the safety interlock alarm for high steam pressure

Step A: When the burner is in operation, raise the boiler pressure until the set point for high warning is reached. The local panel and computer should indicate a high warning.

Step B: With the burner in operation, check the alarm and trip function for high steam pressure. Deactivate one of the alarms. Raise the steam pressure until the burner shuts down, and an alarm is indicated on the local panel and computer.

Step C: Perform the same check with the other high steam pressure alarm.

Step D: With both alarms activated, reset all alarms.

3.2.11 Check the active safety interlock alarms in emergency operation

Step A: When the burner is stopped, turn the keys placed inside the local control panel and power panel into emergency operation.

Step B: Operate the burner as described in the chapter "Manual operation".

Step C: When the burner is in operation, check the safety interlock alarms for flame failure and too low water level as described previously.
Step D: When the safety interlock alarms have been tested, turn the keys into automatic operation and reset all alarms.

3.3 Commissioning on heavy fuel oil

When the burner has been commissioned on diesel oil and when steam is available for heating, the commissioning on heavy fuel oil can be carried out.

3.3.1 Change of fuel

The change of fuel from diesel oil to heavy fuel oil is achieved by manually operating the three-way valve (G115). When heavy fuel oil is selected, the three-way valve (G111) automatically changes position and returns the oil to the heavy fuel oil settling tank for a period of time. This arrangement is necessary to avoid a continuous heating of the re-circulated diesel oil when the burner is in stop mode. The viscosity of the re-circulated diesel oil decreases and with it also the lubrication characteristic. This will cause damage to the oil pumps. After the pre-set time period has expired, the three-way valve (G111) returns to normal position. The time period must be set with regard to minimum oil flow and the quantity of oil in the system.

Step A: Stop the burner.

Step B: Check that oil is present in the heavy fuel oil tank. Open the quick closing valve (G95) which connects the heavy fuel oil tank to the oil system. To avoid cavitation of the oil pumps, the viscosity of the oil in the heavy fuel oil tank should not exceed 380 cSt. If necessary, the oil tank should be heated.

Step C: Check and adjust the switchover time for the three-way valve (G111) on the local panel or computer.

Step D: Select heavy fuel oil on the manually operated three-way valve (G115). Check that the local panel and computer indicate heavy fuel operation.

Step E: Check that the three-way valve (G111) changes position. It should also be checked that the valve is changed back to normal position when the time period has expired.

Step F: Select one of the pre-heaters for operation. The other pre-heater should be in stand-by mode.

Step G: Open the stop valves (G25 and G26) for the operational pre-heater and check that the stop valves (G25 and G26) are closed for the stand-by pre-heater.

Step H: Turn the three-way valve (G51) for oil flow through the pre-heaters.

Step I: Check that the steam regulating valve (G20) for the pre-heaters is in automatic mode on the local panel or computer.

Step J: Close the stop valve (G73) for the stand-by pre-heater and open the stop valve (G73) slowly for the operational pre-heater.
Step K: Adjust the temperature set point for the steam regulating valve (G20) on the local panel or computer. The viscosity of the oil at the atomiser should be between 15-20 cSt. The pre-heating temperature can be determined by means of the chart in the chapter "Viscosity-temperature chart".

Step L: Check that the tracing systems for the oil system and the burner unit are operational.

Step M: Check that the temperature is raised to the desired set point. Adjust if necessary.

Step N: Check the set points for low alarm, low warning, and high alarm on the local panel or computer. Adjust if necessary.

3.3.2 Operation on heavy fuel oil

When the burner is commissioned on heavy fuel oil, final adjustments of the combustion process should be carried out to achieve high quality performance data. The aim is to operate the burner with lowest possible O₂ content and highest possible CO₂ content without the risk of an uncompleted combustion (black smoke). At the same time the reliability of the burner must be ensured.

A number of initiative actions can be performed to improve and optimise the combustion process such as adjusting the air/fuel ratio, the steam atomising pressure, and the position of the swirlers. Adjustments of the air/fuel ratio and the steam atomising pressure are made by settings in the control system. The air/fuel ratio should be checked and adjusted through the complete burner range to ensure a correct combustion. The air/fuel ratio can be checked by measurements of the soot spot No. and the O₂ content and/or the CO₂ content in the flue gas. The visual appearance of the flame should also be checked. If the amount of combustion air to the burner for a given oil flow is too low, the combustion will be uncompleted, and it produces black smoke. Although the O₂ content is low, and the CO₂ content is high, the air flow should be increased. If, on the other hand, the O₂ content is high and the CO₂ content is low, it indicates that the air flow for the combustion process must be decreased.

It is not only the air/fuel ratio which is an important factor for the combustion process, but also the pressure of the atomising steam. The steam atomising pressure should be adjusted and optimised to suit the combustion process through the complete burner range. The pressure can be checked by measurements of the soot spot No. and visible control of the flame. If the steam atomising pressure is too low at a given burner load, the flame has a tendency to sparkle, and the soot spot No. increases. Furthermore, the flame becomes unstable at low loads due to poor atomisation of the oil. If the steam atomising pressure is too high, the combustion zone is cooled, and the flame becomes unstable at low loads. The shape of the flame can be adjusted by changing the position of the swirlers. The flame should be adjusted to a shape in which minimum contact to the furnace walls and bottom is achieved. The adjustment should be checked when the burner is in full load condition. An adjustment of the swirlers towards the furnace results in a slim and long flame, and the opposite movement results in a wide and short flame. An adjustment of the swirlers also results in a change of the distance between the atomiser and the root of the flame.
The following commissioning steps imply that the lighting-up procedure of the boiler is completed and that a sufficient load demand is present to carry out adjustments at 100% load.

**Step A:** Set the correction factor of the air/fuel ratio in neutral position (correction factor = 100) on the local panel or computer. The correction factor is used to adjust the air/fuel ratio if the calorific value of the oil is changed, e.g. when the bunker type is changed.

**Step B:** Start the burner in manual operation mode and check that it ignites when the oil valves open and remains ignited when the ignition burner is shut-off and retracted. Adjust the ignition oil flow, the air/fuel ratio, or the steam atomising pressure if necessary.

**Step C:** Start the burner several times to ensure a reliable ignition of the burner.

**Step D:** Adjust the oil flow to minimum load.

**Step E:** Check that the flame is stable and carry out measurements of the soot spot No. and O₂ content and/or CO₂ content. Adjust the minimum oil flow, the air/fuel ratio, or the steam atomising pressure if necessary.

**Step F:** Carry out the same measurements through the complete burner range in steps of 10%. Adjust the air/fuel ratio and/or the steam atomising pressure if necessary. At full load the shape of the flame should be checked, and the swirlers should be adjusted if necessary.

**Step G:** The measurements obtained for the combustion process through the complete range together with a number of comparable combustion data should be noted and inserted in the chapter "Measurements and settings".

### 3.3.3 Adjust the steam purge position

**Step A:** When the burner is in operation, increase or decrease the load until the oil pressure at the atomiser and the steam atomising pressure are identical.

**Step B:** Set this load as the steam purge position load on the local panel or computer.

**Step C:** Stop the burner and check it during steam purging. The burner must not produce black smoke or blow out the flame before the combustion is completed. Adjust the steam purge position load if necessary.

### 3.3.4 Check the safety interlock alarm for high and low oil temperature

**Step A:** When the burner is in operation, set the steam regulating valve (G20) into manual mode on the local panel or computer.

**Step B:** Increase the temperature gradually until the set point for high alarm is reached. The burner shuts down, and an alarm is indicated on the local panel and computer.
Step C: Decrease the temperature and reset all alarms. Start the burner again.

Step D: Decrease the temperature gradually until the set point for low alarm is reached. The burner shuts down, and an alarm is indicated on the local panel and computer. The set point for low warning should also be checked during this test.

Step E: Set the steam regulating valve (G20) into automatic mode on the local panel or computer and reset all alarms.

3.3.5 Additional function checks

Step A: Check/adjust additional safety interlock alarms if provided. A number of alarms might be included in the safety interlock circuit depending on the specified function and/or the classification society.

Step B: If the boiler is intended to operate in a master-slave operating system, the function of this system should be checked with regard to operation mode and burner load.

Step C: If the boiler is intended to operate in inert gas mode, the function of this operation mode should be checked with regard to operation and burner load.
Operating instructions

1 General

The following operation instructions are valid for steam atomising burners of type KBSD with Y-atomisers and with a standard delivery of individual parts for the burner unit and supply systems from AALBORG INDUSTRIES.

Attention: If the burner unit and supply systems include parts, which are not standard delivery from AALBORG INDUSTRIES, the specific instructions for these parts should be ignored in the following sections. The actual instructions for the specific parts should be thoroughly studied and followed during operation of the burner.

The operation instructions in the following sections describe the normal burner operations with regard to preparation for start-up on the selected fuel type, normal start/stop, change of fuel, etc. It is implied that the boiler, burner, control system, and additional equipment for the boiler plant have been commissioned and are fully operational.

1.1.1 Descriptions
In the following sections various operating procedures are described such as:
- Diesel oil mode
- Heavy fuel oil mode
- Normal start/stop
- Change from diesel oil operation to heavy fuel oil operation
- Change from heavy fuel oil operation to diesel oil operation
- Change of operational pre-heater
- Change of heavy fuel oil bunker type
- Prolonged stop

1.1.2 Position numbers
The position numbers mentioned in the following sections refer to the illustrations in Figure 1 and Figure 2. The position numbers consist of an identification letter and a position number code. Position numbers with the identification letters "G and R" refer to Figure 1, and position numbers with the identification letter "F" refer to Figure 2. The oil system is shown as a plant with two boilers, but is also valid for a plant with only one boiler.
Illustration of the oil system

Figure 1

F_oilsys2b.cdr
2 Operating Instructions

2.1 Diesel oil mode

This section describes the actions that must be carried out before the burner unit and oil system are operational on diesel oil.

**Step A:** Check that oil is present in the diesel oil tank. Open the quick closing valve (G94), which connects the diesel oil tank to the oil system.

**Step B:** Select diesel oil on the manually operated three-way valve (G115).

**Step C:** Open the stop valve (G49) for the mixing tube.
Step D: Turn the manually operated three-way valve (G247) for oil flow through both pumps.

Step E: Open the stop valves for the pressure gauges (G04, G11, G16, and G47).

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Note: The stop valves for the pressure gauges on the pump unit should only be opened for pressure control purposes. During normal operation, the stop valves should be closed.

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Step F: Open the stop valves (G97 and G101), and close the by-pass valve (G102).

Step G: By-pass the pre-heaters by means of the manually operated three-way valve (G51), and close the stop valves (G25 and G26) for both pre-heaters (G22).

Step H: Check that the stop valve (G109) is closed.

Step I: Close the stop valves (G73) for both pre-heaters.

Step J: Open the stop valves for the pressure gauges (G44 and F68) and the pressure transmitter (G99).

Step K: Open the stop valves (G69 and G77) for the ignition oil pumps (G72).

Step L: Open the stop valves (F93 and F64).

Step M: Check the position of the three-way valve (F99). The position must be set for oil flow through the burner unit.

Step N: Open the stop valves (F17 and F73).

Step O: Check that the throttle valve (F152) is not in closed position.

Step P: Open the stop valve for the pressure transmitter (F90).

Step Q: Open the stop valve (F41) and the non-return valve (F45).

Step R: Open the valve for atomising steam on the boiler.

Step S: Open the valves for the steam trap.

Step T: Set one of the oil pumps into operation mode and the other oil pump into stand-by mode. If the burner is in automatic operation mode, the oil pumps will not be operational before start-up of the burner is initiated.

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Note: If atomising steam is not available from the boiler, open the stop valve (F92) for supply from the auxiliary steam system or open the stop valve (F87) for supply from the compressed air system. Compressed air for atomising should only be used if steam is not available.
2.2 Heavy fuel oil mode

This section describes the actions, which must be carried out before the burner unit and oil system are operational on heavy fuel oil. It is implied that steam is available for heating and atomising.

Step A: Check that oil is present in the heavy fuel oil settling tank. Open the quick closing valve (G95) that connects the heavy fuel oil settling tank to the oil system.

Step B: Select heavy fuel oil on the manually operated three-way valve (G115).

Step C: Open the stop valve (G49) for the mixing tube.

Step D: Turn the manually operated three-way valve (G247) for oil flow through both pumps.

Step E: Open the stop valves for the pressure gauges (G04, G11, G16, and G47).

Note: The stop valves for the pressure gauges on the pump unit should only be opened for pressure control purposes. During normal operation, the stop valves should be closed.

Step F: Open the stop valves (G97 and G101), and close the by-pass valve (G102).

Step G: Open the stop valves for the pressure gauges (G44 and F68) and the pressure transmitter (G99).

Step H: Open the stop valves (F93 and F64).

Step I: Check the position of the three-way valve (F99). The position must be set for oil flow through the burner unit.

Step J: Open the stop valves (G25 and G26) for the pre-heater (G22), which should be in operation and check that the stop valve (G25) is closed for the stand-by pre-heater.

Step K: Turn the manually operated three-way valve (G51) for oil flow through the pre-heaters.

Step L: Check that the valves in the drain pipes from the pre-heaters are closed and that the valves from the pre-heaters to the steam trap are open.

Step M: Open the stop valves (G53 and G54) and close the stop valve (G109).

Step N: Open the stop valve (G73) for the operational pre-heater and close the stop valve (G73) for the stand-by pre-heater.

Step O: Start one of the oil pumps and set the other into stand-by mode.
Step P: Check that the tracing systems for the oil system and the burner unit are operational.

Step Q: Open the stop valves (G69 and G77) for the ignition oil pumps (G72).

Step R: Open the stop valves (F17 and F73).

Step S: Check that the throttle valve (F152) is not in closed position.

Step T: Open the stop valve for the pressure transmitter (F90).

Step U: Open the stop valve (F41) and the non-return valve (F45).

Step V: Open the valve for atomising steam on the boiler or the stop valve (F92) for supply from the auxiliary steam system.

Step W: Open the valves for the steam trap.

2.3 Normal start/stop

The control system automatically starts, stops, and regulates the burner in normal operation depending on the steam demand. When the steam pressure is below the set point for operation, the burner commences the start-up sequence. If the main steam valve and by-pass valve are closed, the burner operates in minimum firing position after start-up until the differential pressure between the boiler and the main steam line is within the set point for which modulation free mode is allowed. If, on the other hand, the main steam valve and by-pass valve are open prior to burner start-up, the pressure in the boiler and the pressure of the main steam line are equalised, and the burner operates in modulation free mode.

In modulation free mode, the control system attempts to maintain the steam pressure at the desired set point by regulation of the burner load. The burner can be regulated through the complete load range from minimum firing load to full load. However, should the steam demand decrease below the minimum firing load of the burner, the steam pressure will increase to the set point for burner stop. The burner stops and remains stopped until the set point for burner operation is reached again.

2.4 Change from diesel oil operation to heavy fuel oil operation

When the fuel supply is changed from diesel oil operation to heavy fuel oil operation, the following work steps should be carried out:

Step A: Check that oil is present in the heavy fuel oil settling tank. Open the quick closing valve (G95) which connects the heavy fuel oil settling tank to the oil system. To avoid cavitation of the oil pumps, the viscosity of the oil in the heavy fuel oil tank should not exceed 380 cSt. If necessary, the oil tank should be heated.

Step B: Select heavy fuel oil on the manually operated three-way valve (G115). When heavy fuel oil is selected, the three-way valve (G111) automatically changes position and returns the oil to the heavy fuel oil settling tank for a period of time. This arrangement is necessary to avoid a continuous heating of the re-circulated diesel oil when the burner is in stop mode. The viscosity
of the re-circulated diesel oil decreases and with it also the lubrication characteristic. This will cause damage to the oil pumps. After the pre-set time period has expired, the three-way valve (G111) returns to normal position.

Note: When the fuel type is changed from diesel oil to heavy fuel oil, an alarm for low oil temperature may arise. If the burner is in operation, it will shut down due to this alarm. To prevent burner shut-down, the set point for low oil temperature can be temporarily decreased in the control system.

Step C: Select one of the pre-heaters for operation. The other pre-heater should be in stand-by mode.

Step D: Open the stop valves (G25 and G26) for the operational pre-heater and check that the stop valve (G25) is closed for the stand-by pre-heater.

Step E: Turn the manually operated three-way valve (G51) for oil flow through the pre-heaters.

Step F: Check that the valves in the drain pipes from the pre-heaters are closed and that the valves from the pre-heaters to the steam trap are open.

Step G: Check that the stop valves (G53 and G54) are open and that the stop valve (G109) is closed.

Step H: Check that the steam regulating valve (G20) for the pre-heaters is in automatic mode.

Step I: Open the stop valve (G73) for the operational pre-heater and close the stop valve (G73) for the stand-by pre-heater.

Step J: Check that the tracing systems for the oil system and the burner unit are operational.

Step K: Check the heavy fuel oil temperature. The viscosity of the oil at the atomiser should be between 15-20 cSt. The pre-heating temperature can be determined by means of the chart in the chapter "Viscosity-temperature chart".

2.5 Change from heavy fuel oil operation to diesel oil operation

When the fuel supply is changed from heavy fuel oil operation to diesel oil operation, the following work steps should be carried out:

Step A: Check that oil is present in the diesel oil tank. Open the quick closing valve (G95), which connects the diesel oil tank to the oil system.

Step B: Select diesel oil on the manually operated three-way valve (G115). The three-way valve (G111) automatically changes position and returns the oil
to the heavy fuel oil settling tank for a period of time. After the pre-set time period has expired, the three-way valve (G111) returns to normal position. If the burner is in stop mode, the oil pumps will not be operational, and the pump will stop.

Step C: By-pass the pre-heaters by means of the manually operated three-way valve (G51), and close the stop valves (G25 and G26) for both pre-heaters (G22).

Step D: Close the stop valve (G73) for the operational pre-heater and check that the stop valve (G73) for the stand-by pre-heater is closed.

Step E: Check that the tracing of the piping system is off when the burner is in diesel oil operation.

Caution: Heating of diesel oil in the piping system must be avoided.

2.6 Change of pre-heater

When the pre-heater is changed, the following work steps should be carried out:

Step A: Open the stop valves (G25 and G26) for the pre-heater which should be operational.

Step B: Open the stop valve (G73) for the pre-heater which should be operational.

Step C: Close the stop valve (G73) for the pre-heater which should be in stand-by mode.

Step D: Close the stop valve (G25) for the pre-heater which should be in stand-by mode.

2.7 Change of heavy fuel oil bunker type

If the heavy fuel oil bunker type is changed and the calorific value of the oil changes, the air/fuel ratio should be adjusted to obtain the correct combustion data. This is done by changing the correction factor of the air/fuel ratio on the local panel or computer. If the correction factor is set to a value above 100, the air flow for the combustion process decreases. If the correction factor is set to a value below 100, the air flow for the combustion process increases. This means that if the calorific value of the oil increases, the value of the correction factor should be decreased to obtain the same combustion data and vice versa.

2.8 Prolonged stop

When the boiler plant is stopped for a long period of time, the oil system including the pre-heaters should be flushed with diesel oil before the plant is shut down. Furthermore, the tracing must be switched off.
Emergency operation

1 General

In the rare event of a total break down of the control system, the burner unit with belonging systems can be operated in emergency operation. Due to the fact that the majority of the safety interlock trips and alarms are overruled in emergency mode, the safety precautions for the plant must be observed very carefully.

Please note that in emergency operation mode the safety interlocks are reduced to:

- Too low water level
- Flame failure

Warning: When the burner operates in emergency mode, it is very important that the boiler plant is carefully and continuously supervised by the ship engineering personnel. Pay special attention to the steam pressure and water level.

In emergency mode, the burner unit and supply systems are operated from inside the local control panel and the power panel. Various operating switches and potentiometers are provided inside the panels for operating purposes. Before emergency operation of the burner is initiated, attempts to restart the control system must be performed. If restart of the control system is impossible, the work steps of the following sections must be followed.

1.2 Manual operation of the burner supply systems

Step A: Turn the key placed inside the power panel into emergency operation.

Step B: Start one of the oil pumps on the operating switch inside the power panel.

Step C: Adjust the oil pressure on the pressure regulating valve to a level of 20-25 bar at the burner unit inlet flange. The adjustment is carried out by means of the manually operated hand wheel on the actuator.

Step D: If the burner is operating on heavy fuel oil, the oil temperature must be adjusted on the steam regulating valve for the pre-heaters. The viscosity of the oil at the atomiser should be between 15-20 cSt. The pre-heating temperature can be determined by means of the chart in the chapter "Viscosity-temperature chart". The adjustment is carried out by means of the manually operated hand wheel on the actuator.
Note: The automatic water level regulation is not operational in emergency mode. This means that the water level in the boiler must be adjusted in a similar way as the regulation of the oil pressure and oil temperature. If supplied by Aalborg Industries the feed water pumps can be set into operation by means of the operating switches inside the power panel.

1.3 Manual operation of the burner unit

Step A: Turn the key placed inside the local control panel into emergency operation.

Step B: Close the inlet vanes for the combustion air fan by means of the potentiometer inside the local control panel. The inlet vanes should be in closed position before start-up to reduce the current consumption.

Step C: Start the combustion air fan on the operating switch inside the power panel.

Step D: Purge the furnace with combustion air by opening the inlet vanes to maximum position on the potentiometer for the combustion air fan. The combustion air flow should be kept at maximum flow for at least 60 seconds.

Warning: Insufficient purging may cause danger of furnace explosions.

Step E: Close the steam regulating valve for atomising steam. The valve can be closed by means of the manually operated hand wheel on the actuator.

Step F: Push the button for steam atomising inside the local control panel.

Step G: Adjust the steam atomising pressure on the steam regulating valve to a level of 2-3 bar. The adjustment is carried out by means of the manually operated hand wheel on the actuator.

Step H: Set the air flow to ignition load position, approximately 15-20% load, by reducing the position of the inlet vanes on the potentiometer for the combustion air fan. When the percentage value of the air flow is unreadable due to break down of the control system, the scale of the potentiometer can be used as a first-hand percentage indicator for the combustion air flow. The final setting of the potentiometer for ignition load and all other loads must be determined by visual checks of the flame and the flue gas when the burner is in operation. The percentage values from the control system and the percentage values of the settings on the potentiometer are incomparable. This is because the values from the control system are the feedback signals from the combustion process (dp-transmitter), and the values from the potentiometer are output signals to the positioner which operates the inlet vanes for the combustion air fan.
Step I: Set the oil flow to ignition load position, approximately 15-20% load, by means of the potentiometer for the oil flow regulation valve. When the oil flow is unreadable due to break down of the control system, the pressure indicated on the pressure gauge just before the burner must be used as an indicator for the oil flow.

Step J: Press the button for ignition inside the local control panel and keep it pressed.

Step K: When the ignition flame is established, push the button for oil valves inside the local control panel.

Step L: Release the ignition button when the lamp that indicates flame on is illuminated.

Step M: The burner is now in operation, and adjustments of the burner load must be carried out as described in the following section.

1.4 Operating instructions in emergency mode

The request for regulations of the burner load should be deducible from the actual demand for process steam. The optimal operation form for the burner is to minimise the number of load alterations as this will facilitate the burner operation in emergency mode. Regulations of the burner load must be performed by manual adjustments of the combustion parameters, e.g. oil flow, air flow, atomising steam pressure, etc.

When the burner load is changed, it is important to differentiate between increases or decreases of the load. This is due to the fact that an incorrect air/fuel ratio towards a rich oil mixture causes an incomplete combustion that will produce black smoke. If the burner load is increased, the air flow should be regulated before the oil flow, and opposite the oil flow should be regulated before the air flow if the burner load is decreased.

Step A: Adjust the air flow and oil flow to the desired load by means of the potentiometers inside the local control panel. The scale of the potentiometer for the combustion air fan and the oil pressure indicated on the pressure gauge just before the burner can be used for first-hand settings. The final settings must be determined by visual checks of the flame and the flue gas.

Step B: Adjust the steam atomising pressure on the steam regulating valve to suit the combustion. The adjustment is carried out by means of the manually operated hand wheel on the actuator. If the steam atomising pressure is too low at a given burner load, the flame has a tendency to sparkle. Furthermore, the flame becomes unstable at low loads due to poor atomisation of the oil. If the steam atomising pressure is too high, the combustion zone is cooled, and the flame becomes unstable at low loads.

Step C: Readjust the oil pressure if necessary. When the burner operates at increased loads, the oil pressure to the burner will fall due to the increased amount of oil for the combustion. To ensure that the burner receives a sufficient amount of oil, it might be necessary to adjust the oil pressure on the pressure regulating valve. If the load decreases, a reduction of the oil
pressure might also be necessary. The adjustments are carried out by means of the manually operated hand wheel on the actuator.

**Step D:** If the burner is operating on heavy fuel oil, adjustments of the oil temperature might be necessary at large burner load variations. The oil temperature should be adjusted on the steam regulating valve for the pre-heaters by means of the manually operated hand wheel on the actuator.

**Step E:** Adjust the water level in the boiler if necessary. The water level must be carefully and continuously supervised during operation of the boiler plant. When one of the feed water pumps is in operation, the water level can be regulated on the feed water control valve by means of the manually operated hand wheel on the actuator.

### 1.5 Stop the burner in emergency mode

**Step A:** Adjust the air flow and oil flow to steam purge position load by means of the potentiometers inside the local control panel.

**Step B:** Adjust the steam atomising pressure on the steam regulating valve to the same level as the oil pressure just before the burner.

**Step C:** Press the button for steam purge inside the local control panel and keep it pressed. The oil valves close immediately, and the valve for steam purge opens.

**Step D:** When steam purging is completed, the release the button. The purging is completed when the remaining oil in the burner lance is atomised into the furnace which is indicated by the extinction of the flame.

**Step E:** Push the button for atomising steam inside the local control panel.

**Step F:** Close the inlet vanes for the combustion air fan by means of the potentiometer.

**Step G:** Stop the combustion air fan. The fan should be kept in operation if it is contemplated to operate the burner with frequent intervals. This is because it should be avoided to start the fan more than three times per hour.

**Step H:** Adjust the oil pressure and temperature if necessary.

**Step I:** When the burner is in stand-by mode, and oil is circulated in the oil system, the oil flow must be adjusted to minimum oil flow position by means of the potentiometer for the oil flow regulation valve.

**Note:** If the burner operates on diesel oil, the oil system should stopped if burner operations are of infrequent occurrences. A continuous recirculation of the diesel oil might damage the oil pumps due to heating of the oil.
Step J: If the fuel supply is changed from diesel oil to heavy fuel oil, the position of the pneumatic three-way valve, which leads the return oil to the mixing tube or the heavy fuel oil settling tank, should be changed for a period of time. The position of the three-way valve can be changed by means of a manual switch on the solenoid valve. The time period must be determined with regard to minimum oil flow and the quantity of oil in the system.
Maintenance

1 Recommended maintenance intervals

To ensure a safe and reliable function of the burner, inspection must take place with frequent intervals as described below. The inspection should be carried out by competent and properly trained personnel familiar with the operating and maintenance procedures relevant for this type of plant.

1.1 Safety regulations for maintenance work

Always ensure that the electrical power is off and that nobody can start the boiler unit before commencing maintenance work. All pipes, drums, etc. must be depressurised before any maintenance work is carried out on these.

1.2 Continuous maintenance

- Control panels and other electrical equipment should be kept clean and dry. Check that no foreign matter accumulates in or around them.
- Replace lamps, contactors, and other components when they cease to function or show signs of deterioration. A part, replaced before it actually fails, could save a costly delay.

1.3 Periodical maintenance

The following check list should be followed every two weeks. Dependent on the operation conditions, however, some items may need more frequent attention. For maintenance work procedures, we refer to the separate instructions concerning each item.

1.3.1 Periodical maintenance - burner and fuel oil supply system

- Check that all connections are tightened and that the wiring is in a good condition.
- Check that the fan inlet is kept clean of unintended obstructions.
- Check pipe work for leaks, particularly on flanges, joints, and connections. Repair any leaks which may cause safety risks.
- Check the general condition of pipe work, lagging, and tracing.
- Check that the glands of manual valves are tight enough to prevent easy operation of the valve.
- Oil filters should be inspected and cleaned.
• Manually operated valves should be periodically operated, if possible, to ensure free movement.
• Check the pneumatic shut-off valves, placed just before the burner lance, for leaks.
• Check and clean the flame scanner.

1.3.2 Burner air register and swirlers
If the burner plant is to perform according to the specification, it is important that the burner register and the swirlers are kept clean and in good condition. Inspection should be carried out at regular intervals.
Large quantities of dust-laden air will pass through the register, and inevitably this tends to build up deposits. These deposits should be brushed off.
The swirlers and all other surfaces exposed to radiation heat should be checked for being free of carbon or heat erosion.

1.3.3 Atomiser
Before any examination can be made, the atomiser must be cleaned. This is normally done by soaking in a paraffin or carbon remover to wash off any oil films. This also has the purpose of loosening carbon deposits. It may also be necessary to use a soft metal scraper to lift away any heavy carbon deposits. A hardened scraper should not be used as it could possibly damage the atomiser.
The cleaned atomiser should then be examined for damage, and the holes checked for wear.
The O-ring must be replaced every time the atomiser is disassembled.
Before fitting the cap nut, the thread should be covered with an unhardening high temperature compound.

1.3.4 Ignition burner
The ignition burner is one of the most exposed items and needs a frequent maintenance.
• The electrodes should be cleaned and the insulation material checked for any damage. Be careful not to damage the ceramic insulation pieces.
• The nozzle should be checked and cleaned.
• If the spray pattern hits the other parts of the igniter despite it is cleaned, the nozzle should be changed.

Note: Be careful not to change position of nozzle and electrodes as this may cause problems with, e.g. ignition, instability, or build-up of carbon deposit.
Faults and rectifying faults

1 Trouble shooting

The trouble shooting list is based on a proper set-up of the burner plant during commissioning and/or service and that no further adjustments of the air/fuel ratio, etc. have taken place.

Please note that the trouble shooting list is general for steam atomising burners and has not been made for any particular plant, but is based on several years of experience. Therefore, the cause for your specific problem may not be mentioned and vice versa. You are always welcome, however, to contact our Service department for advice or service assistance.

Check availability of power and fuel supplies before commencing detailed checks.

Ensure that burner plant wiring diagrams relevant to the particular installation are available.

When the cause of a lockout should be located, it can be of assistance to know the start/stop cycle or at which point of operation the lockout occurred, e.g. modulating.

The trouble shooting list can be seen in Table 1.

<table>
<thead>
<tr>
<th>Fault</th>
<th>Possible causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>No ignition/ignition flame failure</td>
<td>Ignition burner oil pump faulty</td>
<td>Repair or replace oil pump/motor</td>
</tr>
<tr>
<td></td>
<td>Oil pressure too low</td>
<td>Restore oil pressure</td>
</tr>
<tr>
<td></td>
<td>Oil nozzle blocked/worn out</td>
<td>Clean/replace nozzle</td>
</tr>
<tr>
<td></td>
<td>Ignition electrodes dirty/out of adjustment</td>
<td>Clean/readjust</td>
</tr>
<tr>
<td></td>
<td>Ignition transformer faulty</td>
<td>Replace ignition transformer</td>
</tr>
<tr>
<td></td>
<td>Solenoid valve faulty</td>
<td>Exchange solenoid valve unit</td>
</tr>
<tr>
<td></td>
<td>Burner control faulty</td>
<td>Replace/repair control unit</td>
</tr>
<tr>
<td>Flame failure of main flame during ignition</td>
<td>Ignition flame not established</td>
<td>See above</td>
</tr>
<tr>
<td></td>
<td>Oil valves not open</td>
<td>Check air pressure/replace oil valve</td>
</tr>
<tr>
<td></td>
<td>Atomising air/steam pressure too low</td>
<td>Check air/steam pressure</td>
</tr>
<tr>
<td></td>
<td>Purge steam valve open</td>
<td>Check purge valve</td>
</tr>
<tr>
<td></td>
<td>Oil temperature too high/low</td>
<td>Adjust temperature</td>
</tr>
<tr>
<td></td>
<td>Oil flow too low</td>
<td>Adjust oil flow/clean atomiser</td>
</tr>
<tr>
<td>Unstable main flame</td>
<td>Oil amount too low</td>
<td>Raise the oil amount</td>
</tr>
<tr>
<td></td>
<td>Oil temperature too low/high</td>
<td>Readjust oil temperature</td>
</tr>
<tr>
<td></td>
<td>Blocking of some of the steam/oil holes in the atomiser</td>
<td>Clean atomiser</td>
</tr>
<tr>
<td></td>
<td>Water in the atomising steam</td>
<td>Check the water trap, if provided</td>
</tr>
<tr>
<td>Flame smoky or red</td>
<td>Too much fuel oil or too little air</td>
<td>Readjust air/oil ratio or correction factor</td>
</tr>
<tr>
<td>Flame white or colourless</td>
<td>Too much air or too little oil</td>
<td>Readjust air/oil ratio or correction factor</td>
</tr>
<tr>
<td>Flame with starlets or sparks</td>
<td>Poor atomisation, low oil temperature or atomising air/steam incorrect pressure</td>
<td>Reset fuel oil temp. to correct value/ensure condensate-free steam</td>
</tr>
<tr>
<td></td>
<td>Damaged atomiser nozzle</td>
<td>Replace nozzle</td>
</tr>
<tr>
<td>Flame fluctuates and goes out</td>
<td>Too little oil in min. load</td>
<td>Reset fuel quantities</td>
</tr>
<tr>
<td>Burner shut down</td>
<td>Shut down due to safety circuits or faulty components</td>
<td>Please refer to the electrical layout/diagram for specific information</td>
</tr>
</tbody>
</table>

Table 1
Measurements and settings

1 General description

Each plant has its individual service conditions depending on the actual design and layout of the burner and the boiler plant. Exact values for the burner cannot be given, but have to be determined at the commissioning or by later adjustments. The following pages show the standard measurements and settings for a plant which includes one KBSD burner. This enables the user to obtain some of the most important measurements and settings related to the burner for later reference. It is recommended that the user completes the scheme shortly after commissioning when normal service conditions have been established.

2 Burner measurements and settings

Table 1 and Table 2 show a standard measuring/setting scheme. Figure 1 shows a diagram in which it is possible to mark the air/fuel ratio curve. The values should be taken from No. 1 and No. 10 in the tables. During commissioning, an adjustment of some measures related to the burner lance/swirler distance blades may be necessary. These measures are shown in Figure 2.

In Table 3 the original measures are given, and columns are reserved for writing the measures established during commissioning or by later adjustments.
<table>
<thead>
<tr>
<th>Plant name:</th>
<th>Oil type/viscosity/density:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date/time:</td>
<td>Minimum load:</td>
</tr>
<tr>
<td>Boiler type/No.:</td>
<td>Ignition load:</td>
</tr>
<tr>
<td>Burner type/No.:</td>
<td>Maximum load:</td>
</tr>
<tr>
<td>Atomiser ID. No.:</td>
<td>dp-transmitter setting range for air flow:</td>
</tr>
<tr>
<td>1</td>
<td>Load/oil flow</td>
</tr>
<tr>
<td>2</td>
<td>Regulation output for fuel oil flow</td>
</tr>
<tr>
<td>3</td>
<td>Oil pressure in oil system</td>
</tr>
<tr>
<td>4</td>
<td>Oil pressure at burner inlet</td>
</tr>
<tr>
<td>5</td>
<td>Oil temperature in tank</td>
</tr>
<tr>
<td>6</td>
<td>Oil temperature before and after pre-heater</td>
</tr>
<tr>
<td>7</td>
<td>Oil temperature at burner inlet</td>
</tr>
<tr>
<td>8</td>
<td>Atomising steam setting</td>
</tr>
<tr>
<td>9</td>
<td>Atomising steam pressure</td>
</tr>
<tr>
<td>10</td>
<td>Air flow setting</td>
</tr>
<tr>
<td>11</td>
<td>Regulation output for air flow</td>
</tr>
<tr>
<td>12</td>
<td>Dp-transmitter measured value</td>
</tr>
<tr>
<td>13</td>
<td>Combustion air fan current</td>
</tr>
<tr>
<td>14</td>
<td>Air temperature inlet combustion air fan</td>
</tr>
<tr>
<td>15</td>
<td>Static pressure after combustion air fan</td>
</tr>
<tr>
<td>16</td>
<td>Static pressure in wind box</td>
</tr>
<tr>
<td>17</td>
<td>Static pressure in furnace</td>
</tr>
<tr>
<td>18</td>
<td>Static pressure in uptake</td>
</tr>
<tr>
<td>19</td>
<td>Flue gas temperature in uptake</td>
</tr>
<tr>
<td>20</td>
<td>O₂ in uptake</td>
</tr>
<tr>
<td>21</td>
<td>CO₂ in uptake</td>
</tr>
<tr>
<td>22</td>
<td>Soot No. (Bachrach)</td>
</tr>
<tr>
<td>23</td>
<td>Boiler pressure</td>
</tr>
</tbody>
</table>

Table 1
<table>
<thead>
<tr>
<th></th>
<th>Measurement/setting scheme for a steam atomising burner (KBSD) continued</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Load/oil flow</td>
</tr>
<tr>
<td>2</td>
<td>Regulation output for fuel oil flow</td>
</tr>
<tr>
<td>3</td>
<td>Oil pressure in oil system</td>
</tr>
<tr>
<td>4</td>
<td>Oil pressure at burner inlet</td>
</tr>
<tr>
<td>5</td>
<td>Oil temperature in tank</td>
</tr>
<tr>
<td>6</td>
<td>Oil temperature before and after pre-heater</td>
</tr>
<tr>
<td>7</td>
<td>Oil temperature at burner inlet</td>
</tr>
<tr>
<td>8</td>
<td>Atomising steam setting</td>
</tr>
<tr>
<td>9</td>
<td>Atomising steam pressure</td>
</tr>
<tr>
<td>10</td>
<td>Air flow setting</td>
</tr>
<tr>
<td>11</td>
<td>Regulation output for air flow</td>
</tr>
<tr>
<td>12</td>
<td>Dp-transmitter measured value</td>
</tr>
<tr>
<td>13</td>
<td>Combustion air fan current</td>
</tr>
<tr>
<td>14</td>
<td>Air temperature inlet combustion air fan</td>
</tr>
<tr>
<td>15</td>
<td>Static pressure after combustion air fan</td>
</tr>
<tr>
<td>16</td>
<td>Static pressure in wind box</td>
</tr>
<tr>
<td>17</td>
<td>Static pressure in furnace</td>
</tr>
<tr>
<td>18</td>
<td>Static pressure in uptake</td>
</tr>
<tr>
<td>19</td>
<td>Flue gas temperature in uptake</td>
</tr>
<tr>
<td>20</td>
<td>( O_2 ) in uptake</td>
</tr>
<tr>
<td>21</td>
<td>( CO_2 ) in uptake</td>
</tr>
<tr>
<td>22</td>
<td>Soot No. (Bachrach)</td>
</tr>
<tr>
<td>23</td>
<td>Boiler pressure</td>
</tr>
</tbody>
</table>

Table 2
Curve for air/fuel ratio

Figure 1
Commissioning measures (lance/swirler distances)

Figure 2

<table>
<thead>
<tr>
<th>Measures</th>
<th>Factory setting</th>
<th>Commissioning</th>
<th>Other adjustments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>mm</td>
<td>mm</td>
<td>mm</td>
</tr>
<tr>
<td>B</td>
<td>mm</td>
<td>mm</td>
<td>mm</td>
</tr>
<tr>
<td>C</td>
<td>25 mm</td>
<td>mm</td>
<td>mm</td>
</tr>
</tbody>
</table>

Table 3
# Table of contents

**Oil flow regulating valve**

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>1</td>
</tr>
<tr>
<td>Cv-adjustment</td>
<td>2</td>
</tr>
<tr>
<td>Installation</td>
<td>3</td>
</tr>
<tr>
<td>Commissioning</td>
<td>4</td>
</tr>
<tr>
<td>Manual operation</td>
<td>5</td>
</tr>
<tr>
<td>Calibration</td>
<td>6</td>
</tr>
<tr>
<td>Maintenance</td>
<td>7</td>
</tr>
</tbody>
</table>
Oil flow regulating valve

1 General

The burner load is controlled by the control system, which receives a continuous signal from a steam pressure transmitter. This signal is compared with different set points, feedback signals, and parameters in the control system. The output from the control system is used to control the oil flow regulation valve, which is pneumatically operated by an I/P converter.

To obtain a very accurate regulation of the oil flow, which is very important to have a large turn-down ratio, the valve is fitted with an adjustable Cv-adjuster. This Cv-adjuster makes it possible to adjust the pressure loss coefficient of the valve whereby the oil flow regulation can be optimised to each single installation.

The position numbers referred to in the following sections appear from the illustrations shown in Figure 1, Figure 2, Figure 3, Figure 4, Figure 5, and Figure 6.

2 Cv-adjustment

2.1 Mid band setting

During calculation of the valve sizing, a trim set should be chosen so that the mean estimated Cv will be at the mid band setting. This is called the risk-free setting since it provides the means to either increase or decrease the available Cv if the actual conditions change.

Figure 1 shows an example of the possible settings for a trim set. A mean Cv of 0.07 for a trim No. 5 allows subsequent adjustment to Cv 0.10, if the flow coefficient is increased, or to Cv 0.04 in the opposite case.

2.2 Adjustment setting at maximum Cv

The adjustment knob should be set towards maximum Cv making it possible to scale downwards, if desired. This should be done if valve sizing calculations and actual service conditions indicate that the full rated Cv of the valve will initially be required but may subsequently lessen.

2.3 Adjustment setting at minimum Cv

The adjustment knob should be set towards minimum Cv making it possible to scale upwards, if desired. This should be done if valve sizing calculations and actual service conditions indicate that initial conditions require a relatively low Cv but will then increase to a higher maximum.
Example of a valve adjusted at mid band setting

<table>
<thead>
<tr>
<th>Cv signal</th>
<th>Cv plate</th>
<th>Recommended adjustment</th>
<th>Example of application</th>
<th>Adjustment option</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.08</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.07</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.04</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Signal</th>
<th>200</th>
<th>400</th>
<th>600</th>
<th>800</th>
<th>1000</th>
<th>mbar</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>6</td>
<td>9</td>
<td>12</td>
<td>15</td>
<td></td>
<td>psi</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>12</td>
<td>16</td>
<td>20</td>
<td></td>
<td>MA</td>
</tr>
</tbody>
</table>

Figure 1
cvsignal.cdr

Illustration of the name plate

Figure 2
namevari.cdr
Illustration of the oil flow regulation valve (front view)
Illustration of the oil flow regulation valve (side view)
Illustration of the coupling details of lever No. 1 and 2

Figure 5

Illustration of the air connections

Figure 6
### Table 1

<table>
<thead>
<tr>
<th>No.</th>
<th>Part name</th>
<th>No.</th>
<th>Part name</th>
<th>No.</th>
<th>Part name</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Seat ring gasket</td>
<td>104</td>
<td>Clevis</td>
<td>138</td>
<td>Union elbow</td>
</tr>
<tr>
<td>3a,b,c,d,e</td>
<td>Seat ring at different</td>
<td>105</td>
<td>Pivot pin No. 1</td>
<td>139</td>
<td>Cover cap screw</td>
</tr>
<tr>
<td></td>
<td>Cv values</td>
<td>106</td>
<td>Conical comp. Spring</td>
<td>140</td>
<td>Tubing</td>
</tr>
<tr>
<td>3f</td>
<td>Spacer, Cv max. &lt; 0.10</td>
<td>107</td>
<td>Grommet</td>
<td>141</td>
<td>Screw</td>
</tr>
<tr>
<td>4</td>
<td>Seat ring retainer</td>
<td>108</td>
<td>Actuator bracket</td>
<td>142</td>
<td>Output gauge</td>
</tr>
<tr>
<td>5</td>
<td>Packing spacer</td>
<td>109</td>
<td>Cover screw</td>
<td>143</td>
<td>Instrument gauge</td>
</tr>
<tr>
<td>6</td>
<td>Packing</td>
<td>110</td>
<td>Cover</td>
<td>144</td>
<td>Manifold block</td>
</tr>
<tr>
<td>7</td>
<td>Packing flange stud</td>
<td>112</td>
<td>Retainer clip</td>
<td>145</td>
<td>Shim</td>
</tr>
<tr>
<td>8a</td>
<td>Packing flange nut</td>
<td>114</td>
<td>Force balance spring</td>
<td>146</td>
<td>Gaskets</td>
</tr>
<tr>
<td>8b</td>
<td>Mounting nut</td>
<td>115</td>
<td>Spring clamp</td>
<td>147</td>
<td>Positioner block</td>
</tr>
<tr>
<td>9</td>
<td>Packing follower</td>
<td>116</td>
<td>Take-up screw</td>
<td>148</td>
<td>Slotted flat c. screw</td>
</tr>
<tr>
<td>10</td>
<td>Packing flange</td>
<td>117</td>
<td>Lock nut</td>
<td>149</td>
<td>Binding head screw</td>
</tr>
<tr>
<td>11</td>
<td>Safety pin</td>
<td>118</td>
<td>Hand wheel lock nut</td>
<td>150</td>
<td>Lock washer</td>
</tr>
<tr>
<td>12a,b,c,d</td>
<td>Plug stem at different</td>
<td>119</td>
<td>Hand wheel bushing</td>
<td>151</td>
<td>Spring bracket</td>
</tr>
<tr>
<td></td>
<td>Cv values</td>
<td>120</td>
<td>Hand wheel</td>
<td>152</td>
<td>Positioner diaphragm</td>
</tr>
<tr>
<td>13a,b</td>
<td>Body</td>
<td>121</td>
<td>Hand wheel lock</td>
<td>153</td>
<td>O-ring</td>
</tr>
<tr>
<td>18</td>
<td>Pivot pin No. 3</td>
<td>122</td>
<td>Lever arm stop</td>
<td>154</td>
<td>Spring</td>
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<tr>
<td>21</td>
<td>Lever No. 3</td>
<td>124</td>
<td>Pivot pin No. 4</td>
<td>155</td>
<td>Sleeve</td>
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<tr>
<td>22</td>
<td>Lever No. 2</td>
<td>125</td>
<td>Lock nut</td>
<td>156</td>
<td>Spool</td>
</tr>
<tr>
<td>23</td>
<td>Cv adjustment pin</td>
<td>126</td>
<td>Indicator</td>
<td>157</td>
<td>Spring</td>
</tr>
<tr>
<td>24</td>
<td>Cv adjustment knob</td>
<td>127</td>
<td>Indicator plate</td>
<td>158</td>
<td>Spring</td>
</tr>
<tr>
<td>25</td>
<td>Cv adjustment plate</td>
<td>131</td>
<td>Piston</td>
<td>182</td>
<td>Retainer ring</td>
</tr>
<tr>
<td>26</td>
<td>Adjustment plate screw</td>
<td>134</td>
<td>Actuator spring</td>
<td></td>
<td>(Cv max. &lt; 0.1)</td>
</tr>
<tr>
<td>101</td>
<td>Grommet plate</td>
<td>135</td>
<td>Serial plate</td>
<td>184</td>
<td>Pivot pin No. 2</td>
</tr>
<tr>
<td>102</td>
<td>Spring button</td>
<td>136</td>
<td>Diaphragm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>103</td>
<td>Lock nut</td>
<td>137</td>
<td>Diaphragm cover</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 3.1.1 Alignment |

Hold the valve body during installation of the studs. Special bosses are provided to centre the valve in the line and prevent rotation before final tightening of the studs. The valve must be installed with the flow tending to open. The flow arrow stamped on the valve body must be pointing in the direction of the flow. Install bolting and tighten evenly in a cross fashion.

| 3.1.2 Air piping |

Install pipe supply and instrument signal lines to the appropriate connections in the positioner Block (144), see Figure 6. Use 1/4" O.D. tubing or equivalent for air lines

---

**Important:** Air supply to the oil flow regulating valve must be instrument air.
4 Commissioning

In the following the work procedures for commissioning of the oil flow regulation valve are described:

**Step A:** Check that the output signal range from the I/P converter corresponds to the input signal range on the oil flow regulation valve. The pressures appear from the identification plates.

**Step B:** Loosen the cover screws (109). Back off the hand wheel lock (121) and turn the hand wheel anti-clockwise until the cover floats free. Remove the cover (110).

**Step C:** Check and adjust the valve characteristic ($C_v$). To adjust the $C_v$, loosen and move the adjustment knob (24) along the scale (25) fixed to the top of lever No. 1 (21). The adjustment scale (25) shows the available $C_v$ values for the specified valve, and Table 2 shows the $C_v$ setting for each burner size. When the knob (24) is at the required position, tighten the knob.

### Table 2

<table>
<thead>
<tr>
<th>Burner type/size</th>
<th>Maximum flow coefficient $C_v$</th>
<th>Setting $C_v$</th>
</tr>
</thead>
<tbody>
<tr>
<td>KBSA 600</td>
<td>0.6</td>
<td>0.5</td>
</tr>
<tr>
<td>KBSA 750</td>
<td>1.2</td>
<td>0.85</td>
</tr>
<tr>
<td>KBSA 950</td>
<td>1.2</td>
<td>0.85</td>
</tr>
<tr>
<td>KBSA 1050</td>
<td>1.2</td>
<td>0.95</td>
</tr>
<tr>
<td>KBSA 1200</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>KBSA 1550</td>
<td>2.3</td>
<td>1.4</td>
</tr>
<tr>
<td>KBSA 1900</td>
<td>2.3</td>
<td>1.5</td>
</tr>
<tr>
<td>KBSA 2250</td>
<td>2.3</td>
<td>1.6</td>
</tr>
<tr>
<td>KBSA 2650</td>
<td>2.3</td>
<td>1.85</td>
</tr>
<tr>
<td>KBSA 2950</td>
<td>2.3</td>
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</tr>
<tr>
<td>KBSA 3350</td>
<td>2.3</td>
<td>2.3</td>
</tr>
<tr>
<td>KBSA 4200</td>
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<td>3.4</td>
</tr>
<tr>
<td>KBSD 950</td>
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<td>0.85</td>
</tr>
<tr>
<td>KBSD 1200</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>KBSD 1500</td>
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<td>1.4</td>
</tr>
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<td>KBSD 1900</td>
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</tr>
<tr>
<td>KBSD 2250</td>
<td>2.3</td>
<td>1.6</td>
</tr>
<tr>
<td>KBSD 2650</td>
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<td>1.85</td>
</tr>
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<td>KBSD 3000</td>
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<td>2.3</td>
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</tr>
<tr>
<td>KBSD 4150</td>
<td>3.8</td>
<td>3.4</td>
</tr>
</tbody>
</table>

**Step D:** Apply air to the I/P converter. Adjust the air pressure at the belonging filter/reduction unit. The pressure setting appears from the identification plate on the converter.

**Step E:** Apply supply air to the oil flow regulation valve. Adjust the air pressure at the belonging filter/reduction unit. The pressure setting appears from the identification plate on the valve.
Step F: Set the oil flow regulation valve into manual mode on the control system.

Step G: Set the regulation output for the oil flow to 0% (4 mA) on the control system.

Step H: Adjust the pressure indicated on the instrument gauge (143) to the low input signal range by means of the zero adjustment screw on the I/P converter. The instrument gauge (143) is the left pressure gauge on the oil flow regulation valve. The input signal range appears from the identification plate.

Step I: Set the regulation output for the oil flow to 100% (20 mA) on the control system.

Step J: Adjust the pressure indicated on the output gauge (142) to the high input signal range by means of the span adjustment screw on the I/P converter. The output gauge (142) is the right pressure gauge on the oil flow regulation valve. The input signal range appears from the identification plate.

Step K: Set the oil flow regulation valve into automatic mode on the control system.

Step L: Start one of the oil pumps. Set the stand-by oil flow to 0% on control system.

Step M: Adjust the turn take-up screw (116) of the oil flow regulation valve until the piston (131) just begins to move. The control system must indicate 0% oil flow. Tighten with the lock nut (117).

Step N: Set the stand-by oil flow back to the original set point.

Note: If the CV setting is changed after the above-mentioned work procedures have been carried out, a new zero adjustment might be required to recalibrate the closing point.

Manual operation

5.1 Hand wheel

The oil flow regulation valve can be manually operated in case of a failure on the control system by means of the hand wheel. The hand wheel is located on top of the cover and fitted with a locking lever. Direct access to it does not require removal of parts.

It basically consists of a threaded rod fitted with a hand wheel (120) and a lever arm stop (122). The threaded rod freely rests on the actuator bracket (108) and is guided through the cover (110) by means of the hand wheel bushing (119). The stop (122)
consists of a block screwed on the threaded rod guided in translation by the actuator bracket (108).
Clockwise rotation of the hand wheel (120) moves the stop (122) up along the threaded rod and drives up the lever No. 2 (22) compressing the spring (134).
This action provides for the opening of the valve if it is an open-on-air actuator and also the closing of the valve if it is a close-on-air actuator.
The return to automatic operation (neutral position) is accomplished by turning the hand wheel anti-clockwise until the stop (122) contacts the bracket (108).

---

Note: During this operation the compression releases when the stop (122) no longer contacts the lever (22). Then, continue this operation until a slight tension reappears and tighten the hand wheel lock (121).

---

6 Calibration

The oil flow control valve is factory calibrated. If, for some reason, the calibration has been disturbed (e.g. due to repair, change of parts, etc.), it is necessary to carry out some adjustments. In the following the work procedures for adjustments are described:

6.1.1 Adjustment of the piston rod clevis (104b)

Note: This adjustment should not be changed unless the piston (131) has been disassembled. Then, it should be made during assembly before coupling the levers to the clevises.

Step A: With the piston against the diaphragm cover (137), turn the clevis (104b) in such a manner that the distance between the actuator bracket top (108) and the indicator bottom (126) is between 0.5 mm and 1 mm. The use of a shim will facilitate the operation.

Step B: Couple lever No. 2 to the clevis. Admit sufficient air pressure to disengage the nut (125) and tighten it against the indicator. Take care that the indicator (126) is correctly positioned. Release the air pressure.

6.1.2 Plug stem adjustment

With levers No. 1 and 2 coupled, proceed as follows:

Step A: Admit sufficient air pressure to the actuator to extend the piston rod and place a shim under the indicator (126). Use a 1.5 mm shim for air-to-open actuators or a 25 mm shim for air-to-close actuators. Release the air pressure after placing the shim.
Note: At this closing point without seating force, the slides of levers No. 1 and 2 must be strictly parallel. This characteristic permits to change the adjustment knob position to obtain the truly required \( C_v \).

**Step B:** Loosen the adjustment knob (24) and slide over the lever No. 1 to the position of maximum \( C_v \) on the \( C_v \) adjustment plate (25). Tighten the knob (24).

**Step C:** Loosen the lock nut (103) by using a screwdriver applied to the plug stem end, and turn it until the plug slightly touches the seat ring. If the valve was removed from the pipe, a bubble leakage test performed on a calibration bench will permit a very accurate adjustment. By using the screwdriver, keep the plug stem in position and tighten the lock nut (103) against the clevis (104a).

**Step D:** Admit air pressure again to disengage the shim, and release the air pressure again.

Note: On air-to-open actuators, the shim thickness can be changed plus or minus 0.1 - 0.2 mm so that the levers No. 1 and 2 are in parallel position. This is done to obtain the required tightness at closing.

### 6.1.3 Positioner start-up pressure adjustment

**Step A:** Pipe air supply and instrument signal lines to the positioner. Set the supply pressure in relation to the valve \( C_v \). See Table 3.

**Step B:** Set the signal to minimum value if it is an air-to-open actuator, or set the maximum value if it is an air-to-close actuator. Turn take-up screw (1 16) until the piston rod just begins to move. Tighten the lock nut (117).

<table>
<thead>
<tr>
<th>( C_v )</th>
<th>Spring range</th>
<th>Colour code</th>
<th>Supply max.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>m bar</td>
<td>psi</td>
<td>m bar</td>
</tr>
<tr>
<td>3.8 to 1.5</td>
<td>414</td>
<td>6-24</td>
<td>Red</td>
</tr>
<tr>
<td>2.3 to 0.9</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2 to 0.5</td>
<td>1660</td>
<td>6-24</td>
<td>Red</td>
</tr>
<tr>
<td>0.6 to 0.25</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>0.25 to 0.10</td>
<td></td>
<td>3-15</td>
<td>Green</td>
</tr>
<tr>
<td>0.10 to 0.04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.050 to 0.020</td>
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<tr>
<td>0.004 to 0.0016</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 3**
7 Maintenance

Warning: Maintenance and/or disassembly should be performed with the valve, actuator, and positioner free from all pressures.

7.1 Actuator diaphragm replacement

Step A: Unscrew the two pressure connection nuts (138a) and pull the tubing (140) out. Remove the four cap screws (139), the diaphragm cover (137), and the diaphragm (136).

Step B: Form a new diaphragm and insert it over the piston (131). Place the diaphragm roll into the bracket groove. Take the necessary steps not to twist or bend the diaphragm during its replacement.

Step C: Replace the diaphragm cover (137) with the four screws (139) and reconnect the pressure connection nuts (138a). Check the tightness of the connections.

7.2 Adding packing

Step A: To add a ring of packing, depressurise the valve, and back off the packing flange nuts (8b) all the way.

Step B: Lift the packing flange and follower and insert one ring of packing. Tighten the nuts (8b) finger tight plus one full turn.

7.3 Disassembly

In some cases, it may be necessary to disassemble the valve, e.g. to replace the plug and seat ring assembly or to change packing in case of a \( C_v \) max. < 0.6.

Note: In the case of a \( C_v \) max. > 0.6 a quick way to replace the packing prevents full disassembly of the valve (see the section "Packing quick change method").

Step A: Loosen the cover screw (109). Back off the hand wheel lock (121) and turn the hand wheel anti-clockwise until the cover floats free. Remove the cover (110).

Step B: Adjust the signal for closing of the valve. Slightly change the signal so that the plug barely moves off the seat ring. Turn the adjustment knob (24) to minimum \( C_v \) position.
Step C: Loosen lock nut (103) and turn anti-clockwise through 1 3/4 turns by using a screwdriver applied at the plug stem end. Shut off the signal and pressure supplies. Slightly retighten the lock nut (103) against the clevis.

Step D: Loosen the lock nut (117) and fully unscrew the take-up screw (116). Remove the spring clamp (115) from lever No. 2 and force the balance spring (114) from the positioner.

Step E: Remove the retainer clips (112b) from the two pivot pins (184) and pull them out from lever No. 1 and clevis (104a).

Note: This operation will be facilitated by relieving the load on the plug clevis exerted by the conical compression spring (106). While driving out the pins, using a screwdriver, push on the plug stem end.

Step F: Remove the two retainer clips (112c) from pivot pin No. 4 (124) and disengage it to the uncouple piston clevis (104b) from lever No. 2 (22).

Step G: Remove the two retainer clips (112a) from pivot pin No. 1 (105) and disengage it to the uncouple lever No. 1 from the actuator bracket (108). Disengage the adjustment pin smooth end (23) from the lever line No. 2 and remove the adjustment knob (24) and adjustment pin (23) from lever No. 1.

Step H: Drive out the pivot pin No. 3 (18) and remove lever No. 2 (22).

Step I: Hold the plug stem in place by using a screwdriver put to its end and unlock the nut (103). Unscrew the clevis (104a) and lock nut (103). Remove the spring button (102), spring (106), and grommet plate (101).

Step J: Remove the two packing flange nuts (8b), packing flange (10), and packing follower (9). Remove the two bracket securing nuts (8a) as well as the bracket (108).

Step K: By using a packing hook, remove the largest number of packing rings (6) from the packing box. Remove the safety pin (11) and pull the plug stem to remove the packing spacer (5), plug and stem, together with the rest of the packing rings.

Step L: By using a 9/16" or 14 mm piece of hex stock and a wrench, unlock and pull out the seat ring retainer (4).

Step M: Pull out the seat ring (3) and then the gasket (2) by using a hook made from steel wire (diameter approximately 3 mm). Carefully fettle the hook end.
Note: The seat ring with a $C_v$ max. < 0.10 consists of two parts; The seat ring proper (3e) and a spacer (3f). The small size of the orifice of these parts does not allow for their removal by means of a hook. Therefore, it is necessary for this operation to remove the body from the pipe and turn it over and, if needed, to hit the bottom by means of a wooden mallet. Should the seat ring be jammed in its housing, it is possible to move it using a screwdriver inserted through the outlet orifice. Valves with $C_v$ max. 3.8 do not feature any seat ring gasket (2).

7.4 Assembly

Before assembly, clean thoroughly the inside of the valve body and parts. Gasket seating surfaces and surfaces in contact with others must be thoroughly cleaned. On assembly, a new seat ring gasket (2) and a new packing (6) must be used.

**Step A:** Place a new seat ring gasket (2) in the valve body (13) and install the seat ring (3) taking care to correctly centre the gasket on the seat ring shoulder. Orient it in such a manner that one of its ports lines up with the body outlet orifice.

Note: In the event of a maximum $C_v$ smaller than 0.10, the seat ring (3e) must first be positioned on the new gasket (2) taking the same precautions as shown above. Secondly, engage the spacer (3f) and orient one of its ports towards the body outlet orifice. Valves with $C_v$ max. 3.8 do not feature any seat ring gasket (2).

Carefully apply grease (Never Seez or equivalent) on the threads and bottom of the retainer (4). With a 9/16" or 14 mm piece of hex stock and a wrench, torque the retainer to 8 Nm if equipped with a graphite gasket st. reinforced, or to 5.5 Nm if equipped with a glass filled P:T:F:E: gasket.

Note: In case of a valve with maximum $C_c$ 3.8, torque the retainer to 2 Nm.

**Step B:** Engage the plug and stem assembly in the seat ring. In the case of a maximum $C_v < 0.10$, ensure that there is no hard point during the stocking of the plug. In case of a hard point, loosen the retainer (4) and replace the seat ring (3e) in the correct position until the stem smoothly slides. Align the hole in the spacer (5) with the safety pin (11) hole in the valve body.

Note: In the event of a maximum $C_v$ smaller than 0.10 ensure that the retaining ring (182) is placed on the plug before engaging it in the spacer (3f). If the retainer ring is damaged, replace it.

**Step C:** Wrap the safety pin (11) with two turns of P:T:F:E: tape (Teflon). Screw it into the bonnet five and a half to six turns from where the thread
engagement starts. To find the start of the thread engagement screw on the safety pin about one turn and pull the safety pin outwards while unscrewing it.

**Step D:** Install packing, positioning the skive cut of each packing ring 120° away from the cut of an adjacent ring. Slightly push down the rings one after another by using a tube ½" sch. Size 160. Install the packing follower (9) on the plug stem.

**Step E:** Install the actuator bracket (108) and secure it with the two nuts (8a). Install the packing flange nuts (10) on the plug stem. Hand tighten the two packing flange nuts (8b) adding one full turn with a wrench.

**Step F:** In the following sequence, place the grommet plate (101), spring (106), and its spring button (102). Screw the nut (103) and clevis (104a) on the plug stem. Adjust the nut and clevis without locking them together until the clevis holes are about 1.5 mm above the alignment of the pin holes in the actuator bracket (108).

---

**Note:** Measuring this distance can be made easier by engaging the pins (105, 184, and 18) in their respective hole.

---

**Step G:** Pin lever No. 2 (22) to the bracket (108) by using the pin (18). Ensure that the hole of lever No. 2 destined for spring clamp (115) is located on the top and aligned with the force balance spring (114).

**Step H:** Place the adjustment pin (23) in the slide of lever No. 1 and screw the knob (24) on its threaded end. Engage the pin smooth end (23) into the slide of lever No. 2 and mount lever No. 1 on the bracket (108). Couple lever No. 1 to the bracket (108) by using the pin (105) and the two retainer clips (112a).

---

**Note:** Ensure that the clevis (104a) is correctly positioned before placing lever No. 1 on the actuator bracket (108).

---

**Step I:** Set the adjustment knob (24) on minimum CV position.

**Step J:** If the piston rod clevis (104b) has not been disturbed during disassembly, couple it to the end of lever No. 2 by using the pin (124) and the two retainer clips (112c).

---

**Note:** This operation will be facilitated by placing the piston rod in an intermediate position by admitting air to the diaphragm and by setting the knob in a position where the end of lever No. 2 is left most accessible. If the clevis (104b) has been disturbed, proceed with adjustment and coupling as described in the section "Calibration".
Step K: Couple the clevis (104a) to lever No. 1. To perform this operation push to align the holes in the clevis and lever No. 1 by means of a screwdriver on the plug stem end. Couple by means of the two pins (184) and retainer clips (112b).

Note: Insert the clips on the pins between the slides of the clevis and lever No. 1.

Step L: With the take-up screw (116) fully unscrewed from the spring clamp (115), place the latter in position after hooking the force balanced spring (114) first on the positioner spring bracket (151) and secondly on the spring clamp (115).

Note: The spring clamp (115) has two holes. If it is a close-on-air failure actuator the spring must be hooked in the upper hole. In case of valve open-on-air failure, the spring must be hooked in the lower hole.

Step M: Admit supply and signal pressures and complete the calibration. Replace the cover (110) and turn the hand wheel clockwise to engage it in the lever arm stop (122). Tighten the cover screws (109).

Step N: If the valve has been removed from the line, reinstall it according to the section "Installation" and then set the valve back into service.

7.5 Packing quick change method

The fastest and simplest way to replace the packing is to remove the entire actuator without disturbing the actuator parts or calibration. However, this is not recommended for valves with a small CV (CV < 0.6) due to the very fineness of their plug. Vent the valve pressure and proceed as follows:

Step A: Be sure that the plug is off the seat ring. With an air-to-open valve, admit air pressure under the diaphragm or turn the hand wheel to move the plug off its seat ring.

Step B: Remove the safety pin (11) from the body. The safety pin engages the packing spacer (5). The function of the safety pin and spacer is to prevent the plug from being pushed out if the actuator is removed while the valve is still pressurised. The valve internal parts cannot be removed unless the safety pin is removed first. Remove the two packing flange nuts (8b) and back off the two mounting nuts (8a) as far as possible.

Step C: With a block of wood and a mallet, tap the actuator plug assembly off the valve. Clean the packing box and plug stem and carefully place the new rings of packing around the stem. Position the skive cut of each packing ring 120° from that of the adjacent ring.
Step D: Assemble the actuator/plug assembly to the valve taking care to align the hole in the spacer (5) with the safety pin hole and to replace the two mounting nuts (8a) during assembly. Take extra care in guiding each ring into the packing box.

Step E: Wrap the safety pin (11) with two turns of P.T.F.E. tape (Teflon). Screw it into the bonnet five and a half to six turns from where the thread engagement starts. To find the start of the thread engagement screw the safety pin about one turn and pull the safety pin outwards while unscrewing it.

Step F: Replace the packing follower, packing flange, and flange nuts (8b). Tighten the nuts finger tight plus one full turn. With an air-to-open actuator, vent the air pressure or turn the hand wheel to move the plug back in contact with the seat ring. Set the valve back into service.

7.6 Positioner maintenance

Note: Shut off supply and signal pressures. By-pass and depressurise the valve body.

Step A: Unscrew the two pressure connection nuts (138a) and pull out the tubing (140).

Step B: Unscrew the cap screws (141a) and remove the manifold block (144), spring (158), gasket inclusive three O-rings (146), pilot valve assembly (155, 156, 157), shims (145), and O-ring (153).

Caution: Handle the shims (145) carefully.

Step C: Loosen lock nut (117) and take-up screw (116) and unhook the spring clamp (115) from the lever (22).

Step D: Unscrew the cap screws (141b) from the positioner block (147) and remove it from the actuator bracket. Remove the screws (148) to separate the positioner diaphragm assembly (152) and spring (154) from the positioner block. Examine all parts for wear and replace, if necessary.

Step E: Assemble the positioner diaphragm assembly (152) with the spring (154) to the block and tighten the screws (148). Be sure that the small signal port O-ring is in its recess in the diaphragm assembly.

Step F: Assemble the block assembly to the actuator bracket.

Note: Orient the block (147) so that when the manifold block (144) is bolted on, the gauges will face in the right direction.
Step G: Install O-ring (153), shims (145), pilot valve assembly (155, 156, 157), gasket including three O-rings (146), spring (158), and manifold block (144). Tighten the cap screws (141a), replace the tubing (140), and tighten the pressure connection nuts (138a).

Note: Gasket ports in (146) must align with the ports in the block (147).

Step H: Hook up the spring (115) on lever No. 2 (22). Admit supply and signal pressures. Adjust start-up pressure as described in the section "Calibration". Set the valve back into service.
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Oil flow meter

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Oil flow meter

1 General

The oil flow meter unit is equipped with a set of spindles (M), pole wheel (P), and pick-up sensor (I), see also Figure 1. The measuring principle is positive displacement.

The oil flow causes the measuring spindles (M) to rotate, and in front of the pick-up sensor (I) the pole wheel (P) is turning in an exactly defined distance (a). The pick-up sensor (I) records an impulse for every pole which moves along. This electronic impulse is then sent to the control system. With each rotation an exact volume is given, and by settings in the control system the impulses are converted into a 4-20 mA flow signal.

Illustration of the oil flow meter unit

![Figure 1](omg03a.cdr)

The oil flow meter can be installed in any position. But it must always be free from tensions to prevent distortion of the oil flow meter. Furthermore, it should be located in a position from where it is possible to dismount the pick-up sensor.

As shown on the nameplate indicated in Figure 2, both flow directions are possible. But the preferable flow direction is indicated by the all white arrow symbol.

The accuracy of the oil flow meter depends on the momentary flow. Figure 3 shows the characteristic for the oil flow meter.

The oil flow meter is very sensitive towards larger objects in the oil, and these objects can cause a total blockage of the oil flow meter. To prevent large objects from entering the oil flow meter, the oil system must be provided with a filter (max. 0.3-0.5 mm mesh). The filters located in the oil pump unit will usually provide for an adequate filtration.

The dry sleeve is mounted, adjusted, and tested with the pick-up sensor as a unit. The pick-up sensor, including the milled nut and spring, is screwed into the dry
sleeve. The spring must be able to press the pick-up insert smoothly to the front side of the dry sleeve. It is important for the function of the sensor system that the dry sleeve is free of foreign substance. The sensor system is shown in Figure 4. The sensor system (pick-up sensor and cable) must not be in an area of electromagnetic field pulses with high intensity. This could cause measuring errors or even destruction of the sensor system.

Illustration of the nameplate

![Nameplate Illustration](omg02.cdr)

**Figure 2**

Accuracy - diagram

![Accuracy Diagram](omg01.cdr)

**Figure 3**

Illustration of the sensor system

![Sensor System Illustration](beg44.cdr)

**Figure 4**
Illustration of the oil flow meter, type OMG 20

Figure 5

Illustration of the oil flow meter, type OMG 32

Figure 6
2 Commissioning

Step A: Ensure that the oil system has been thoroughly flushed for impurities and that it is free from air.

Note: Impurities cause the oil flow meter to be blocked, and air affects the accuracy of the oil flow meter.

Step B: Check that the oil flow meter, the pick-up sensor, and the measuring transducer are installed correctly.

Step C: Set the values for max. oil and beats/litre in the control system. The max. oil value is the maximum oil flow in l/h at 100% burner load on heavy fuel oil (provided this is the main fuel). The value for beats/litre can be taken from the identification of the oil flow meter (see Figure 2).

Step D: Dismount the cover of the measuring transducer and unscrew the pick-up sensor from the oil flow meter.

Step E: Tap the pick-up sensor quickly against an object and check that the measuring transducer records the signals. The red LED flashes.

Step F: Assemble the measuring transducer and mount the pick-up sensor again.

Step G: Check and adjust the oil flow settings for minimum load, ignition load, etc. in the control system.

3 Dismounting and mounting instructions

For dismounting and mounting the oil flow meter and sensor system please also see Figure 1, Figure 4, Figure 5, and Figure 6.

3.1 Oil flow meter

3.1.1 Dismounting

Step A: Remove the oil flow meter from the pipe line.

Step B: Remove the flange covers and end covers.

Step C: Press out the spindle set with rolling bearings and distance sleeve from the measuring casing.
Note: If the spindle set or measuring casing must be replaced, the oil flow meter must be re-calibrated.

3.1.2 Change of bearings

Step A: Remove the pressed-on pole wheel from the measuring spindle.
Step B: Remove the circlips, spacers, and rolling bearings.
Step C: Remove the O-rings.

Note: The O-rings are specially designed for the oil flow meter. If a replacement is necessary, only original O-rings must be used.

Step D: Clean all parts carefully, take care not to scratch the sealing surfaces.

3.1.3 Mounting

Step A: Mount the O-rings.
Step B: Press the rolling bearings on the measuring spindle and mount the circlips and spacers.
Step C: Press on the pole wheel.
Step D: Insert the spindle set into the measuring case.
Step E: Press the distance sleeve into the measuring case.
Step F: Mount the end covers and flange covers.
Step G: Tighten the screws crosswise.
Step H: Install the oil flow meter in the pipe line again.

3.2 Pick-up sensor

3.2.1 Cleaning/replacing the pick-up sensor

Step A: Dismount the pick-up sensor by unscrewing the milled nut.
Step B: Clean or replace the pick-up sensor. The pick-up sensor can be changed without performing any regulation of the distance between the pick-up sensor and pole wheel.
Step C: Mount the pick-up sensor and screw on the milled nut.
Note: The dry sleeve must not be turned.

3.2.2 Dismounting of the dry sleeve

Step A: Empty the oil flow meter.

Step B: Dismount the pick-up sensor.

Step C: Open the counter nut by means of a wrench size 24.

Step D: Turn out the dry sleeve by means of a wrench size 15.

3.2.3 Mounting of the dry sleeve

Step A: Turn in the dry sleeve until the O-ring is sealing.

Step B: Fill the oil flow meter with oil and start one of the oil pumps.

Step C: Turn the dry sleeve carefully until it gazes softly on the rotating pole wheel. Then turn it 1/4 of a turn back and tighten the counter nut.

Step D: Mount the pick-up sensor again.

Step E: Check that the signal from the pick-up sensor is functioning. If not, adjust the distance between the pole wheel and pick-up sensor again.
4 Trouble shooting

If a fault occurs, the basic and necessary conditions for operation must be checked:
- Is electric power supply available?
- Is oil available in the tanks?
- Are the oil pumps running correctly?
- Are all the regulating controls correctly adjusted?

If the cause of the fault is not due to any of these conditions, the fault finding chart in Table 1 can be consulted.

<table>
<thead>
<tr>
<th>Failure</th>
<th>Reason</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Too high pressure drop</td>
<td>Viscosity of the medium and/or flow rate is too high</td>
<td>Raise the temperature (check the allowed temperature range) Reduce flow rate Use a different size oil flow meter</td>
</tr>
<tr>
<td>Leakage</td>
<td>Seal is not tightened enough Seal is damaged</td>
<td>Tighten screws Change seal Check chemical resistance</td>
</tr>
<tr>
<td>Blocked flow meter</td>
<td>Foreign substance</td>
<td>Clean oil flow meter Use filtration</td>
</tr>
<tr>
<td></td>
<td>Pick-up sensor mounted too far inside Not enough inlet pressure</td>
<td>Adjust pick-up sensor Raise inlet pressure</td>
</tr>
<tr>
<td>Too high measuring default</td>
<td>Air lock Degasging Too high pulsation Operation: • high flow fluctuation • Quantity too small • Differing operating data High wear</td>
<td>Remove air Raise system pressure, reduce temperature Change oil pump, modify system Change of operating conditions New oil flow meter Filtration of abrasive material</td>
</tr>
<tr>
<td>No signal from pick-up sensor</td>
<td>Defective pick-up insert</td>
<td>Screw out the pick-up and check it by tapping the pick-up sensor quickly against an object (see luminous diode) Luminous diode Check connections Adjust electronics</td>
</tr>
<tr>
<td></td>
<td>Defective connection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wrong power supply</td>
<td></td>
</tr>
<tr>
<td>No ordinary signal from pick-up sensor</td>
<td>Defective pick-up insert Defective contacts External interference Distance to the pole wheel not correct</td>
<td>New pick-up insert Check contacts Install cables</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Correct distance</td>
</tr>
</tbody>
</table>

Table 1
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Differential transmitter

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Dp-transmitter, type 7MF4433

1 General

The following description is valid for a differential pressure transmitter SITRANS P, type 7MF4433.

Warning: This device may only be assembled and operated after qualified personnel has ensured, by providing suitable power supplies, that no hazardous voltages can get into the device in normal operation or in the event of a failure of the system or parts thereof.

Warning: The device may be operated with high pressure and corrosive media. Therefore serious injuries and/or considerable material damage cannot be ruled out in the event of improper handling of the device.

The perfect and safe operation of this equipment is conditional upon proper handling, installation, and assembly as well as on careful operation and commissioning.

2 Technical description

2.1 Application

The SITRANS P transmitter can be used to measure:
- the differential pressure, e.g. the active pressure,
- a small positive or negative excess pressure,
- flow $q \sim p^{0.5}$ (together with a flow control valve)

of non-corrosive and corrosive gases, vapours, and liquids.

Measuring spans are possible between 1 mbar and 30 bar depending on the type. The output signal is a load-independent direct current of 4 to 20 mA. A linear (proportional to the differential pressure) or square rooting characteristic (proportional to the rate of flow) can be selected. Transmitters conforming to the type of protection "Intrinsic safety" and "Explosion-proof" may be installed within potentially explosive atmospheres zone 1 or zone 0. The transmitter is provided with an EU prototype test certificate and comply with the corresponding harmonised European standards of the CENELEC.
## 2.2 Mode of operation

Figure 1 shows a function diagram of the SITRANS P differential pressure and flow transmitter. The item numbers referred to in the following description are those mentioned in the figure.

The differential pressure is applied via the diaphragms (4) and the filling liquid (3) to the silicon pressure sensor (7). If the measuring limits are exceeded, the overload diaphragm (6) is flexed until one of the diaphragms (4) rests on the measuring cell body (2), thus protecting the silicon pressure sensor (7) from overloading.

The measuring diaphragm of the silicon pressure sensor is flexed by the applied differential pressure. The resistance of four piezo-resistors fitted in the diaphragm in a bridge circuit thus changes. This change in resistance results in a voltage output from the bridge proportional to the differential pressure. This voltage is amplified and converted into a frequency by means of a voltage-to-frequency converter (9). This signal is evaluated by a micro controller (10), and its linearity and temperature effect corrected.

The processed signal is converted by a digital-to-analogue converter (11) into an output signal of 4 - 20 mA.

The data specific to the measuring cell as well as the parameters of the transmitter are stored in a non-volatile memory (EEPROM).

The cable termination point and the electronics are arranged opposite one another. Parameterisation of the transmitter is performed using a laptop, PC, HART® Communicator, or the input keys. Normally the input keys are used to set-up the transmitter.

### Function diagram

![Function Diagram](7mf33_01.tif)
The following parameters can be set or their current interrogated:
- measuring range
- measured value in mA, %, and unit of pressure
- unit of pressure
- linear or square rooting characteristic
- application point of the square rooting characteristic
- electric damping
- current transmitter
- output current in the event of an error
- disabling input keys and/or functions

2.3 Dimensions

SITRANS P, differential pressure and flow transmitter, dimensions

1. Process connection ¾ - 18 NPT for absolute pressure (+) side
2. Mounting thread M10, M12 or ¼-20 UNF
3. Dummy plug
4. Electrical Connection:
   Screwed gland Pg 13.5 (adapter)
   M20 x 1.5 or ¼ - 14 NPT or Han 7D/Han 8 U plug
5. Connection side
6. Electronics side, digital display
   (greater length for cover with window)
7. Protective cover over keys
8. Sealing screw
9. Side vent for measuring liquid
10. Side vent for measuring gas (supplement H02)
11. Mounting bracket (optional)

Figure 2

Language UK
Page 3/1
3 Installation

3.1 Place of installation

The transmitter can be installed above or below the pressure tapping point. When measuring gases, it is recommended to install the transmitter above the pressure tapping point and the pressure pipe to be laid so it runs down to the pressure tap. This will permit any condensation in the pipe to drain off and not affect the measurement. When measuring liquids, the transmitter should be installed below the pressure tapping point and the pipe laid so it rises up to the pressure tap, thus enabling any gas in the pipe to disperse.

The point of installation should be easily accessible, preferably close to the measuring point and free from vibration. The permitted ambient temperature limits must not be violated. Protect the transmitter from direct heat sources. Before installing the transmitter, compare the process data against the data on the rating plate. Keep the transmitter closed during the installation process.

The transmitter can be fitted directly to the valve manifold or secured with a mounting bracket.

3.2 Fixing with a mounting bracket

The mounting bracket is fixed to either
- a wall or mounting frame using 2 screws,
or to
- a vertical or horizontal mounting pipe (50 to 60 mm in diameter) using a U-bolt (see Figure 3).

The transmitter is fastened to the mounting bracket using the four screws supplied.

Fixing the transmitter using a mounting bracket

Figure 3
3.3 Rotating the measuring cell in relation to the housing

If necessary, the measuring cell of the transmitter can be rotated in relation to the electronics housing, so that the digital display is visible and/or access the input keys and the current connection for an external measuring instrument is possible. Only a limited rotation is permitted. The range of rotation (7), see Figure 4, is marked at the base of the electronics housing. At the neck of the electronics housing there is an orientation mark (6) which always must be within the marked range when rotated.

Step A: Loosen the locking screw (8).

Step B: Rotate the electronics housing in relation to the measuring cell (only within the marked area).

Step C: Tighten locking screw (torque 3.5°N m).

Rotating the measuring cell in relation to the housing

Figure 4

3.4 Electrical connection

Warning: Observe the relevant regulations during the electrical installation. In hazardous areas, pay particular attention to:

- the regulations governing electrical systems in hazardous areas (Elex V),
- the specifications regarding the installation of electrical systems in hazardous areas (VDE 0165), and,
- the EC type examination certificate
Warning: Check that the auxiliary power supply matches that specified on the rating plate.

The transmitter should be powered from a SELV (safety extra-low voltage) source. If other power sources are used, it is recommended to earth the transmitter housing and PE connection. The earth terminal in the connection box must be connected internally to the PE connection.

Please note that:
- The sealing caps in the cable entries have to be replaced by relevant cable glands or blanking plugs, which must be certified when using transmitters conforming to protection type "Flame-proof enclosure".
- The following general guidelines apply when laying terminal (maximum cross section 2.5 mm²)/signal cables:
  - lay the signal cable separately from cables carrying voltages > 60 V
  - use twisted-pair cables
  - do not lay cables close to large electrical systems, or use screened cable

3.4.1 Connection to screw terminals

Electrical connection

![Diagram of connection box with labeled terminals](7mf33_05.tif)

Figure 5

Step A: Unscrew the cover of the connection box (marked "FIELD TERMINALS" on the housing).

Step B: Insert the connecting cable through the cable gland.

Step C: Connect the wires the "+" (2) and "-" (3) to the terminals, see Figure 5 and observe the polarity. Position (4) is a test plug for an external DC ammeter.

Step D: Connect the screen (1) to the screen screw, if necessary.

Step E: Screw on the housing cover.
Note: In explosion-proof transmitters the housing cover must be screwed tightly and secured with the cover catch.

### 3.4.2 Connect with plug

The contact parts for the coupling socket are enclosed packed in a bag. Please note that these must not be used for explosion-proof transmitters.

**Step A:** Push the sleeve and screwed gland onto the cable.

**Step B:** Insulate the cable ends approximately 8 mm.

**Step C:** Crimp or solder the contact parts to the cable ends.

**Step D:** Assemble the coupling socket.

#### Connection with plug

![Connection diagram](7mf33_06.tif)

**Figure 6**

### 3.5 Turning the digital display

If the device cannot be operated in a vertical position the digital display can be turned to make it easier to read. To do this, proceed as follows:

**Step A:** Unscrew the cover from the electronics housing.

**Step B:** Unscrew the digital display. Depending on the position of the transmitter it can be screwed back in four different positions (rotation by $\pm 90^\circ$ or $\pm 180^\circ$ are possible).

**Step C:** Screw on the housing cover.
4 Commissioning

The process data must correspond to that on the rating plate. The transmitter functions as soon as the power is turned on.

**Warning:** Serious injury or considerable material damage may result if:

- the venting valve and/or the sealing screw are missing or not tight enough and/or
- the valves are operated wrongly or improperly

**Warning:** When working with a hot medium, the individual steps described below must be performed in quick successions, otherwise the valves and transmitter may overheat and be damaged.

4.1 Measuring gases

The isolating valves should be operated in the following sequence, see Figure 7:

Measuring gases

---

**Figure 7**

7mf33_07.tif
Step A: Initial setting: all valves closed.

Step B: Open both isolating valves (5) at the pressure tapping points.

Step C: Open the equalising valve (2).

Step D: Open the pressure inlet valve (3A or 3B).

Step E: Check the zero point (4 mA) at start of scale (0) and correct if necessary.

Step F: Close the equalising valve (2).

Step G: Open the other pressure inlet valve (3A or 3B).

4.2 Measuring liquids

The isolating valves should be operated in the following sequence, see Figure 8:

Measuring liquids

Figure 8

Step A: Initial setting: all valves closed.

Step B: Open both isolating valves (5) at the pressure tapping points.

Step C: Open the equalising valve (2).
Step D: If the transmitter is below the pressure source: open both outlet valves (7) slightly, one after the other, until no more air escapes.

Step E: If the transmitter is above the pressure source: open both venting valves (8) slightly, one after the other, until no more air escapes.

Step F: Close both outlets (7) or venting valves (8).

Step G: Open the pressure inlet valve (3A) and venting on the positive leg of the transmitter (1) slightly until no more air escapes.

Step H: Close the venting valve.

Step I: Open the venting valve on the negative leg of the transmitter slightly until no more air escapes.

Step J: Close pressure inlet valve (3A).

Step K: Open the pressure inlet valve (3B) slightly until no more air escapes, close after.

Step L: Close the venting valve on the negative leg of the transmitter (1).

Step M: Open the pressure inlet valve (3A) ¼ a rotation.

Step N: Check the zero point (4 mA) against start of scale (0) and correct if necessary.

Step O: Close the equalising valve (2).

Step P: Open the pressure inlet valves (3A and 3B) fully.

4.3 Measuring steam

The isolating valves should be operated in the following sequence, see Figure 9:

Caution: The result will only be correct when the impulse lines (4) contain an identical head of condensate at identical temperatures. Zero point calibration should be repeated, if necessary, when this condition is satisfied.

Caution: The flow of steam may damage the transmitter if the equalising valve (2) is opened when both the isolating valves (5) and pressure inlet valves (3) are open!
Measuring steam

Figure 9

Step A: Initial setting: all valves closed.

Step B: Open both isolating valves (5) at the pressure tapping points.

Step C: Open the equalising valve (2).

Step D: Wait until the steam in the impulse line (4) and in the condensate reservoirs (13) has condensed.

Step E: Open the pressure inlet valve (3A) and venting valve on the positive leg of the transmitter slightly until no more air escapes.

Step F: Close the venting valve.

Step G: Open the venting valve on the negative leg of the transmitter slightly until no more air escapes.

Step H: Close pressure inlet valve (3A).

Step I: Open the pressure inlet valve (3B) slightly until no more air escapes.

Step J: Close the venting valve on the negative leg of the transmitter.

Step K: Open the pressure inlet valve (3A) ½ a rotation.

Step L: Check the zero point (4 mA) against start of scale (0) and correct if necessary.

Step M: Close the equalising valve (2).

Step N: Open the pressure inlet valves (3A and 3B) fully.
5  
Operation of the transmitter

5.1 General

The differential pressure and flow transmitter is adjusted in the field by three input keys, located on the outside of the instrument, with which the start of scale and full scale values are set or adjusted. By means of the digital indicator (optional) additional parameters can be adjusted. The input keys can be accessed, by undoing the two screws holding the protective cover in place, which can then be moved out of the way.

Transmitter controls and displays

![Symbols for input keys]

Figure 10

The functions listed in Table 1 can be selected using the "M" key. When pressing the "M" key (Mode) 2 appears in the bottom left corner on the LCD display. Every additional key press increases the mode by one. The parameters, the current value, or the unit of pressure can be modified using the ↑ and ↓ keys. In case of error situations "Error" is displayed on the display, (see section 5.2.7). It generally applies that:

- The transmitter changes to function "Measured value", if mode 14 is passed by pressing the "M" key or if 2 minutes elapse without a key being pressed. In case of the 2 minutes being passed the setting is automatically saved.
- The key lock must be released for keyboard operation.
- Numerical values are always set from the least significant digit still displayed. In the case of an overflow in the key repetition mode it switches to the next significant digit and only this continues to be counted. This procedure serves for fast rough setting over a wide numeric range. For fine setting the desired key (↑
or \( \downarrow \) have to be released and pressed again. Exceeding of the upper and lower measured value limits are shown on the display with the signs \( \uparrow \) or \( \downarrow \).

- If the input pressure is displayed, selected in mode 13 (see section 5.2.10), and the square rooting characteristic in mode 11 (see section 5.2.9) the differential pressure corresponding to the flow and additionally the sign "\( \sqrt{} \)" is displayed on the display.

<table>
<thead>
<tr>
<th>Function</th>
<th>Mode 1)</th>
<th>Key function</th>
<th>Display, explanation</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured value</td>
<td></td>
<td></td>
<td>Output current in mA or % or input pressure in unit of pressure</td>
<td>5.2.10</td>
</tr>
<tr>
<td>Error display</td>
<td></td>
<td></td>
<td>&quot;Error&quot;, if the transmitter is disturbed. Moving text indicating reason for disturbance</td>
<td>5.2.7</td>
</tr>
<tr>
<td>Start of scale</td>
<td>2</td>
<td>Current greater</td>
<td>Output current in mA</td>
<td>5.2.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Current smaller</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Set to 4 mA</td>
<td></td>
</tr>
<tr>
<td>Full scale</td>
<td>3</td>
<td>Current greater</td>
<td>Output current in mA</td>
<td>5.2.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Current smaller</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Set to 20 mA</td>
<td></td>
</tr>
<tr>
<td>Electrical damping</td>
<td>4</td>
<td>Damping greater</td>
<td>Time constant ( T_0 ) in seconds</td>
<td>5.2.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Damping smaller</td>
<td>Parameter range: 0.0 to 100.0</td>
<td></td>
</tr>
<tr>
<td>Start of scale &quot;blind setting&quot;</td>
<td>5</td>
<td>Pressure greater</td>
<td>Start of scale in selected unit of pressure</td>
<td>5.2.4</td>
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<tr>
<td></td>
<td></td>
<td>Pressure smaller</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Set to start of scale 0</td>
<td></td>
</tr>
<tr>
<td>Full scale &quot;blind setting&quot;</td>
<td>6</td>
<td>Pressure greater</td>
<td>Full scale in selected unit of pressure</td>
<td>5.2.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pressure smaller</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Set to upper measuring limit</td>
<td></td>
</tr>
<tr>
<td>Zero adjustment (position</td>
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<td>- -</td>
<td>Vent transmitter (start of scale remains unaffected).</td>
<td>5.2.5</td>
</tr>
<tr>
<td>correction)</td>
<td></td>
<td>- -</td>
<td>Measuring value in unit of pressure</td>
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<tr>
<td></td>
<td></td>
<td>Execute</td>
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<tr>
<td>Current transmitter</td>
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<td>Current greater</td>
<td>Constant output current in mA</td>
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<tr>
<td></td>
<td></td>
<td>Current smaller</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td>Selected output current</td>
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</tr>
<tr>
<td>an error</td>
<td></td>
<td>two values</td>
<td>Possible: fault current limits set by user</td>
<td></td>
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<tr>
<td>Keys and/or function disable</td>
<td>10</td>
<td>Change between the</td>
<td>&quot;O&quot; = none</td>
<td>5.2.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>five functions</td>
<td>&quot;LA&quot; = all disabled</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&quot;LO&quot; = all disabled except start of scale</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&quot;LS&quot; = all disabled except start of scale and full scale</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&quot;L&quot; = write protection, operation by HART( ^6 ) not possible</td>
<td></td>
</tr>
<tr>
<td>Characteristic</td>
<td>11</td>
<td>Change between the</td>
<td>&quot;Lin&quot; = linear</td>
<td>5.2.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>three functions</td>
<td>&quot;SrLin&quot; = square rooting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(linear up to application point)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&quot;SrOFF&quot; = square rooting</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(switched off up to application point)</td>
<td></td>
</tr>
<tr>
<td>Application point of the</td>
<td>12</td>
<td>Greater</td>
<td>Parameter range 5 to 15% flow</td>
<td>5.2.9</td>
</tr>
<tr>
<td>square rooting characteristic</td>
<td></td>
<td>Smaller</td>
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<td></td>
</tr>
<tr>
<td>Measured value display</td>
<td>13</td>
<td>Select from three</td>
<td>Unit of pressure (input value) or output current in</td>
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<tr>
<td></td>
<td></td>
<td>possibilities</td>
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<td>Unit of pressure</td>
<td>14</td>
<td>Change</td>
<td>Technical units of pressure</td>
<td>5.2.11</td>
</tr>
</tbody>
</table>

1) Change mode by pressing the "M" key.
2) The start of scale is in a vacuum in absolute pressure transmitters. The zero adjustment in ventilated transmitters leads to mis-adjustments.

Table 1
5.2 Operation with LCD display

5.2.1 General

- Please note that the input keys might be disabled. To cancel a set keyboard disable press the "M" key for 5 seconds.

Step A: Undo the two screws holding the protective cover in place, which can then be moved out of the way.

Step B: On completion of calibration replace the protective cover and tighten both screws.

5.2.2 Set/adjust start of scale and full scale

The start of scale and full scale can be set or adjusted with the input keys. Modes 2 and 3 (see Table 1) are available for this. This allows implementation of rising or falling characteristics.

Setting (theoretical relationship)

In setting, a desired start of scale and/or a desired full scale are assigned to the standard current values (4 mA/20 mA). Pre-requirements: two reference pressures \((p_1, p_2)\) provided by the process or generated by a pressure transmitter.

Note: The measuring span is not changed when setting the start of scale. By setting the full scale the start of scale remains unchanged. Therefore the start of scale should be set first and then the full scale.

The relationship between the measured pressure and the generated output current is linear. Please note that this does not apply if square rooting characteristic is selected. In case of linear relationship the output current can be calculated with the following equation shown in Figure 11:

**Equation for calculation of current output**

\[
\begin{align*}
    I &= \frac{p - MA}{ME - MA} \times 16 mA + 4 mA \\
    p &= \text{pressure} \\
    MA &= \text{start of scale} \\
    ME &= \text{full scale}
\end{align*}
\]

**Example**

Given a transmitter with a measuring span of 0 to 16 bar. Set to a measuring span of 2 to 14 bar.

Step A: Apply 2 bar process pressure. Set the device to mode 2 with the "M" key. The display shows the set mode at the bottom left. Set the start of scale by pressing the ↑ and ↓ keys on the value for about 2 seconds. An output current of 4 mA is then generated at 2 bar input pressure.
Step B: Apply 14 bar process pressure. Set the device to mode 3 with the "M" key. The full scale is set by pressing the ↑ and ↓ keys on the value for about 2 seconds. An output current of 20 mA is then generated at 14 bar input pressure.

Step C: The output current for any input pressure can be calculated with the specified equation shown in Figure 11.

Adjusting (theoretical relationship)

When adjusting, the start of scale and/or the full scale can be assigned to any desired current value using one reference pressure. This function is particularly suitable if the pressures necessary for start of scale and full scale are unavailable. Requirements: applied pressure (reference pressure) and the set start of scale and full scale are known. Please note that after adjusting, the measuring range specified on the measuring point plate may no longer match the setting.

Using the following equation shown in Figure 12 the current that should be adjusted for the desired start of scale and full scale can be calculated.

Equation for calculation of current (set the start of scale and full scale)

\[
I = \frac{P_{\text{ref}} - MA_{\text{start}}}{ME_{\text{start}} - MA_{\text{start}}} \times 16 \text{ mA} + 4 \text{ mA}
\]

\[
I = \frac{P_{\text{ref}} - MA_{\text{full}}}{ME_{\text{full}} - MA_{\text{full}}} \times 16 \text{ mA} + 4 \text{ mA}
\]

1) To calculate the output currents when setting start of scale and full scale, the reference pressure must be selected so that a value between 4 and 20 mA is obtained for the current.

Example

Given a transmitter with a measuring span of 0 to 16 bar. Adjust to a measuring span of 2 to 14 bar. A reference pressure of 11 bar is available.

Step A: Set the device to mode 2 with the "M" key. Using the equation from Figure 12 first calculate the current that should be adjusted for the desired start of scale (2 bar) at the applied reference pressure and then adjust it with the ↑ and ↓ keys (13 mA in this example).

Step B: Set the device to mode 3 with the "M" key. Using the equation from Figure 12 calculate the current that should be adjusted for the desired full scale (14 bar) at the applied reference pressure and then adjust it with the ↑ and ↓ keys (16 mA in this example).
Set start of scale and full scale (practical application with actual pressures available)
The device sets the output current for the start of scale to 4 mA and the full scale to 20 mA when the input keys are pressed according to the following instructions.
The start of scale is set by:
Step A: Apply the corresponding pressure.
Step B: Select mode 2 using the "M" key.
Step C: Set the start of scale to 4 mA with the ↑ and ↓ keys.
Step D: Save with "M".
The full scale is set by:
Step E: Apply the corresponding pressure.
Step F: Select mode 3 using the "M" key.
Step G: Set the full scale to 20 mA with the ↑ and ↓ keys.
Step H: Save with "M".

Set start of scale and full scale (practical application with reference pressure available)
If the output current is not set but adjusted continuously, the currents must be calculated so they can be adjusted mathematically. It is possible to make an adjustment for the start of scale, the full scale, or both values one after the other.
The start of scale is adjusted by:
Step A: Apply the reference pressure.
Step B: Select mode 2 using the "M" key.
Step C: Adjust the output current for the start of scale with the ↑ and ↓ keys.
Step D: Save with "M".
The full scale is adjusted by:
Step E: Apply the reference pressure.
Step F: Select mode 3 using the "M" key.
Step G: Adjust the output current for the full scale with the ↑ and ↓ keys.
Step H: Save with "M".

5.2.3 Electric damping
The time constant of the electric damping can be set in steps of 0.1 second between 0 and 100 seconds with the input keyboard. This damping acts additionally to the device-internal basic damping.
The electric damping is set by:
Step A: Select mode 4 using the "M" key.

Step B: Set the desired damping with the ↑ and ↓ keys.

Step C: Save with "M".

5.2.4 Blind setting of start of scale and full scale

In modes 5 and 6 the start of scale and full scale can be set/adjusted with the input keys and without applying pressure. It is also possible to change between rising and falling characteristics.

Theoretical relationship

First select the desired physical unit. The two pressure values can then be set/adjusted with the ↑ and ↓ keys and saved in the device. These theoretical pressure values are assigned to the standard current values 4 mA and 20 mA.

The relationship between the measured pressure and the generated output current is linear. Please note that this does not apply if square rooting characteristic is selected.

Example

Given a transmitter with a measuring span of 0 to 16 bar. Adjust it to a measuring span of 2 to 14 bar without applying pressure.

Step A: Set the device to mode 5 with the "M" key. Set the start of scale to 2 bar by pressing the ↑ or ↓ key. If 2 bar input pressure are applied later, an output current of 4 mA is generated.

Step B: Set the device to mode 6 with the "M" key. Set the full scale to 14 bar by pressing the ↑ or ↓ key. If 14 bar input pressure are applied later, an output current of 20 mA is generated.

Set start of scale and full scale, blind (practical application)

The device sets the start of scale to the lower and the full scale to the upper sensor limit when the keys are operated as follows:

The start of scale (blind) is set by:

Step A: Select mode 5 using the "M" key.

Step B: Press the ↑ and ↓ keys simultaneously and hold for 2 seconds. The start of scale is set to the lower sensor limit.

The full scale (blind) is set by:

Step C: Select mode 6 using the "M" key.

Step D: Press the ↑ and ↓ keys simultaneously and hold for 2 seconds. The full scale is set to the upper sensor limit.

Adjust start of scale and full scale, blind (practical application)

If the pressures for the start of scale and full scale are not to be set but adjusted continuously, the keys should be operated as follows:

The start of scale (blind) is adjusted by:

Step A: Select mode 5 using the "M" key.
Step B: Adjust the pressure value of the start of scale with the ↑ or ↓ keys.

Step C: Save with "M".

The full scale (blind) is adjusted by:

Step D: Select mode 6 using the "M" key.

Step E: Adjust the pressure value of the full scale with the ↑ or ↓ keys.

Step F: Save with "M".

5.2.5 Zero adjustment (position correction)

The zero error resulting from the installation position can be corrected with a zero adjustment. To do this, the device must be ventilated to correct the existing offset so that the value 0 bar (or other unit of pressure) appears in the display. The setting of the start of scale and full scale remain the same.

The zero adjustment is set by:

Step A: Vent the transmitter.

Step B: Select mode 7 using the "M" key.

Step C: Set zero with the ↑ and ↓ keys.

Step D: Save with "M".

5.2.6 Current transmitter

The transmitter can be switched to constant current mode with the "M" key. In this case the current no longer corresponds to the process variable. The following output currents can be set independently of the input pressure:

- 3.6 mA - 4.0 mA - 12.0 mA - 20.0 mA - 22.8 mA

The current transmitter function can be cancelled again with the "M" key.

The constant current is set by:

Step A: Select mode 8 using the "M" key.

Step B: Activate the constant current mode by pressing the ↑ and ↓ keys simultaneously for about 2 seconds.

Step C: Activate the constant current level by pressing the ↑ or ↓ key.

Step D: Turn off the constant current mode with the "M" key.

Step E: Exit the constant current mode with the "M" key.

5.2.7 Failure current

In mode 9 it is possible to select whether the upper or lower fault current should be the output in the event of a fault or an alarm. The current can be set to 3.6 mA or 22.8 mA. The default is the lower fault current.

The fault current is set by:
Step A: Select mode 9 using the "M" key.

Step B: Select the fault current with the ↑ or ↓ key.

Step C: Save with "M".

5.2.8 Key and/or function disable

In mode 10 it is possible to disable several functions which are generally possible with keyboard operation. In addition a write protection to protect the saved parameters can be activated. The following settings are possible:

"0"    no disabling.
"LA"   input keys disabled, operation via HART® possible.
"LO"   input keys disabled, only start of scale can be set. Operation via HART® possible.
"LS"   input keys partly disabled, only start of scale and full scale can be set. Operation via HART® possible.
"L"    write protection, operation via HART® not possible.

A set keyboard disable (LA, LO, LS) or a write protection for HART® (L) can be cancelled with the input keys. To do this, press the "M" key for 5 seconds.

Note: If the "LO" or "LS" disable is selected, it is recommended to select the measured value display "Current" in mA or % first in mode 13. Otherwise a change in the output variable is not detected when pressing the ↑ and ↓ keys.

The key/function disable is set by:

Step A: Select mode 10 using the "M" key.

Step B: Select the disable mode with the ↑ or ↓ key.

Step C: Save the disable mode with the "M" key.

Note: When delivered with a blanking cover, the disable mode "LS" is active, i.e. only zero and span can be changed. If the device permanently is operated with a blanking cover, make sure that the disable mode "LS" remains set.

5.2.9 Flow measurement

The characteristic of the output current can be selected as:

- Linear (proportional to the differential pressure), or
- Square rooting (proportional to the flow)

Below the application point of the square rooting characteristic the output current can either be output linearly or switched off. When "SrLin" is selected the output
current is linear up to the application point (see Figure 13 a) and when "SroFF" is selected the output current is switched off up to the application point. The application point can be set between 5% to 15% of the flow. The characteristic is set by:

**Step A:** Select mode 11 using the "M" key.

**Step B:** Select the characteristic type with the ↑ or ↓ key.

**Step C:** Save with "M".

The root application point is set by:

**Step D:** Select mode 12 using the "M" key.

**Step E:** Select the application point between 5% and 15% with the ↑ or ↓ key.

**Step F:** Save with "M".

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**Note:** Mode 12 cannot be selected when the "linear" measuring mode 11 is set. If the input pressure is selected as a display in mode 13 and square rooting characteristic in mode 11, the differential pressure corresponding to the flow and root sign are displayed.

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**Transition point of square rooting characteristic**

![Transition point of square rooting characteristic](7mf33_11.tif)
5.2.10 Measured value display
In mode 13 one of three display types can be set with the input keys.
- Display in mA.
- Display in % (of the set measuring range).
- Display in a unit of pressure (selectable in mode 14).
The unit type is set by:
Step A: Select mode 13 using the "M" key.
Step B: Select the type unit with the ↑ or ↓ keys.
Step C: Save with "M".

5.2.11 Selection of unit of pressure
In mode 14 it is possible to select a desired unit of pressure for the display from a list with the input keys. The following unit of pressure can be chosen:
- Bar, mbar, mm H₂O⁰, in H₂O⁰, ft H₂O⁰, mm Hg, in Hg, psi, kPa, Mpa, g/cm², kg/cm², Torr, ATM, in WC, mm WC.
  *) Reference temperature 20°C.
The unit of pressure is set by:
Step A: Select mode 14 using the "M" key.
Step B: Select the unit of pressure with the ↑ or ↓ key.
Step C: Save with "M".
If the display capacity of the digital display is exceeded, "9.9.9.9.9" appears in the display. Please note that in the measuring mode the selected unit is only visible in the display if a unit of pressure display is selected in mode 13. Otherwise "mA" or "%" is displayed.

5.3 Operation without LCD display

5.3.1 Setting start of scale and full scale without LCD display
- Please note that the input keys might be disabled. To cancel a set keyboard disable press the "M" key for 5 seconds.
Step A: Undo the two screws holding the protective cover in place, which can then be moved out of the way.

Set start of scale (4 mA) and full scale (20 mA)
Assuming the input keys are pressed as described below, the transmitter sets the start of scale to 4 mA and the full scale to 20 mA. An ammeter is not required.

Start of scale
Step A: Apply a differential pressure corresponding to the start of scale to the transmitter.
Step B: Press the ↑ and ↓ keys simultaneously for about 2 seconds.

**Full scale**

**Step A:** Apply a differential pressure corresponding to the full scale to the transmitter.

**Step B:** Press all three input keys, making sure that the "M" key is pressed first, hold it, and press both the other keys (↑ and ↓).

**Calibrate start of scale and full scale**

If the output current is not to be set but freely adjusted continuously, the currents must be calculated for mathematical adjustment. It is possible to make an adjustment for the start of scale, the full scale, or both values one after the other.

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**Warning:** It is forbidden to screw off the transmitter cover when working in hazardous locations and using transmitters conforming to protection type "Flame-proof enclosure" (Explosion-proof).

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**Step A:** Clean the transmitter to prevent the ingress of dirt.

**Step B:** Unscrew the cover from the electrical connection box.

**Step C:** Connect a DC meter to the test plug (see Figure 5).

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**Warning:** For intrinsic safe current circuits only certified current meters are permitted.

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**Start of scale**

**Step A:** Apply a differential pressure corresponding to the start of scale to the transmitter.

**Step B:** Set the output current for start of scale using the ↑ and ↓ keys.

**Step C:** The set output current is saved automatically when the key is released.

**Full scale**

**Step A:** Apply a differential pressure corresponding to the full scale to the transmitter.

**Step B:** Set the output current for full scale using the "M" key and the ↑ key or the "M" key and the ↓ key. Always press the "M" key first, hold it, and press either the ↑ or the ↓ key.

**Step C:** The set output current is saved automatically when the key is released.
6 Maintenance

The transmitter requires no maintenance. However, the start of scale value should be checked occasionally.

If an error occurs:

- the output current is set to 22.8 mA or 3.6 mA, depending on the selection (see section 5.2.7)

- using SIPROM P an appropriate message is displayed in the "Measured values" field

- "Error" is displayed on the LCD display