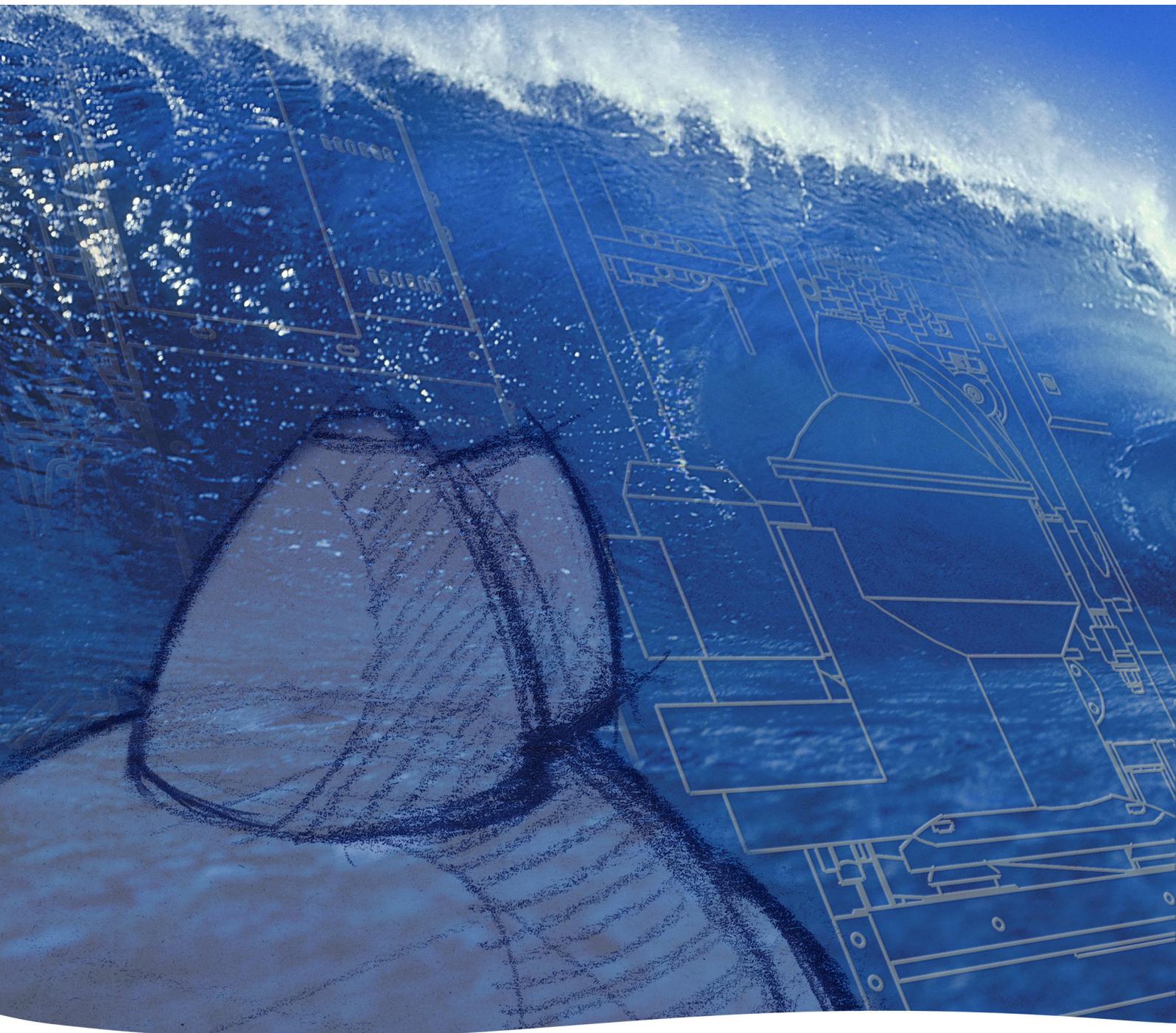


S and P Flex separation



Operating instructions

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Original instruction

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1 Operating

1.1 Before First Startup

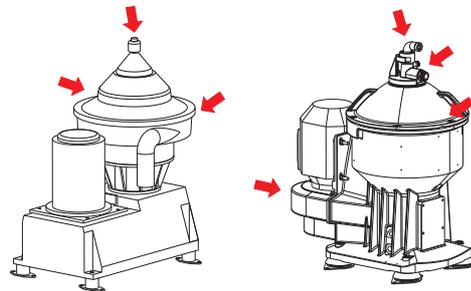
The Control Panel must be configured to suit the system components.

1. Check that the separator is correctly assembled and connected to power supply of correct voltage and frequency. The control panel must be ON.



Breakdown hazard

Assemble the separator completely before start. All couplings, covers and guards must be in place and properly tightened. Failure to do so may lead to breakdown.



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Electrical hazard

Follow local regulations for electrical installation and earthing (grounding).

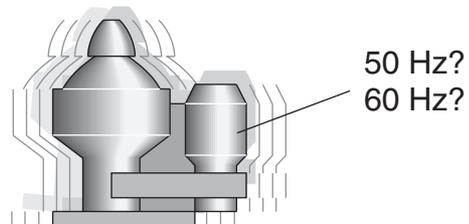


Check that the Emergency Stop Box is properly installed and functioning correctly.



Breakdown hazard

Check that the power frequency is in agreement with the machine plate. If incorrect, resulting overspeed may cause breakdown.



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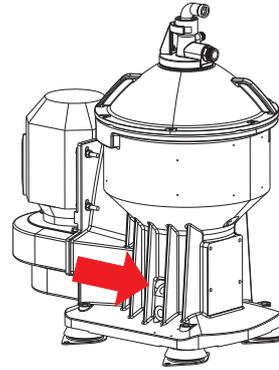


Use the separation system for the purpose, and within the limits, specified by Alfa Laval. Failure to do so could cause a violent breakdown.

2. Check the oil sump level. If necessary, top up until oil starts to run from the oil-filling hole.



Too much or too little oil can damage the separator bearings.



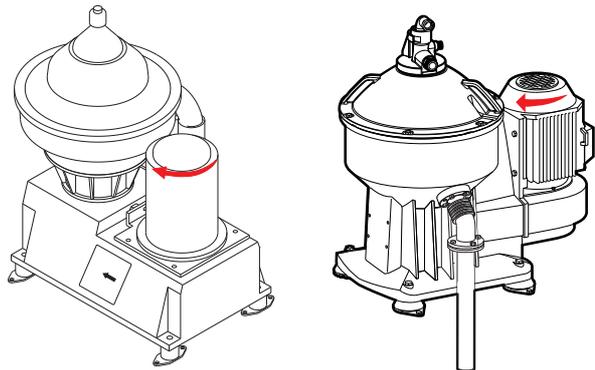
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Rotation Direction

Check the rotation of the bowl using the I/O test function. See [1.16 I/O Test Function on page 50](#). The motor fan must rotate in a clockwise direction.



If power cable polarity has been reversed, the separator will rotate in reverse, and vital rotating parts can loosen.



X023719B

Operating Air Pressure

Check that the air supply is correct (500 – 800 kPa or 5 – 8 Bar).

Operating Water Pressure

Check that the operating water pressure is sufficient (200 – 800 kPa or 2 – 8 Bar).

NOTE

The LEDs on the water block and connectors indicate that the valve has power on. They do not indicate if the valve is clogged (an alarm is given if this is the case).

Emergency Stop Push Box

Check that the Emergency Stop Box is located close to the separator system and electrically connected to the Control Panel

NOTE

If the Emergency Stop Box is not connected, the system will not start.

1.2 Control Panel

To start the Control Panel, switch on the main power switch on the control cabinet.

General

The Control Panel has three main lists.

- Operation
- Alarms
- Setting

Operation List

To access the Operation List at any time during the operation process press the 'Return button' repeatedly until the Operation List is reached.

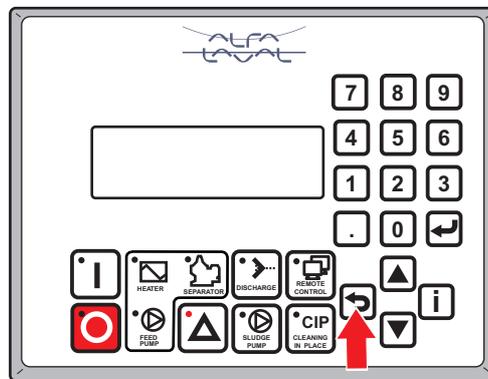
The list gives information on the following where installed:

- Feed Flow
- Time to discharge, min
- Speed (SS), rpm
- Pressure (PT1, PT4, PT5)
- Temperature (TT1, TT2)
- Vibration (VIB)
- Transducer value

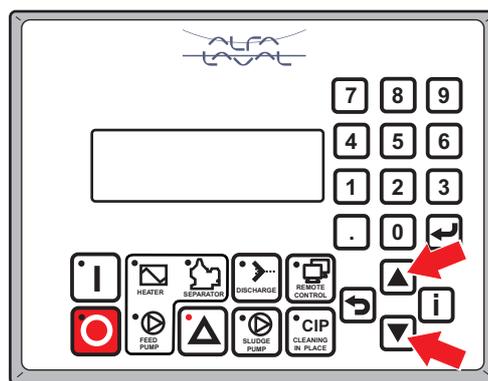
Press the arrow buttons to go up or down in the list.

NOTE

During operation, the 'Operation' list is active on the display. The present stage of operation, for example 'SEPARATION', shows on display together with operating information such as present temperature. Press the downward 'Arrow' button to go down the list.



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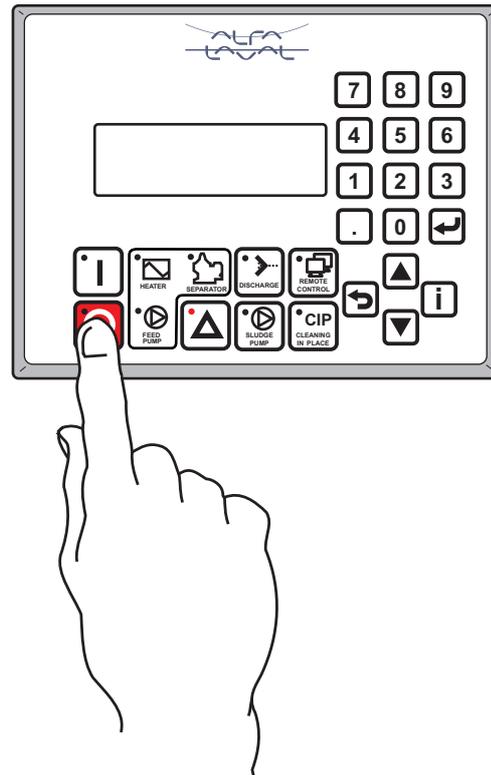


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For further information regarding alarms, see the *Alarms and Fault Finding* booklet.

For further information regarding parameters, see the *Parameter List* booklet

At any time during operation, the operator can initiate a STOP sequence by pressing the 'Stop' button.



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NOTE

If control panel black screen appear.
See "Alarms & Fault finding" manual.

1.3 Manual Start from Standstill

Press the 'Start' button. The operator can select to start the system manually by setting parameter P130 to 'stepwise'.

NOTE

First start-up is always manual and not dependant on P130 setting.

A rotation test must be carried out using the I/O test function prior to first start-up.

NOTE

First start-up after power off should always be carried out manually!

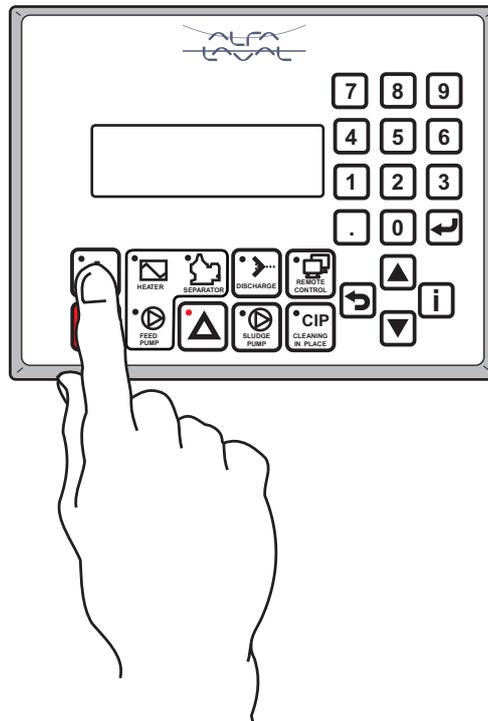
NOTE

If a butterfly valve is installed, it must be opened manually before that the system can start.

CAUTION

If power cable polarity has been reversed, the separator will rotate in reverse, and vital rotating parts can loosen.

If speed sensor, vibration sensor, and frame cover switch are installed (P113, P114, and P115 = yes), the operator can select to start the system automatically by setting parameter P130 to 'automatic'.

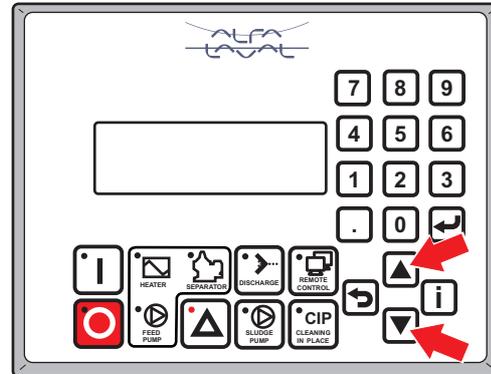


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If the power has been off and/or the separator bowl cover has been removed a number of questions which have to be answered before the system can be started are shown on the display:

'Has the bowl been dismantled? YES, NO'
(S-type separator only)

Use the 'arrow' buttons to move to the alternative you want.



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When the alternative you want is blinking, press the 'Enter' button.

1. If the bowl has been dismantled choose 'YES' Manual start only is possible. If no work has been carried out on the bowl, choose 'NO'. For S-type separators 'Proceed without calibration' appears on the display. Stepwise/automatic start is possible (set using parameter P 130). For P-type separators the system then goes to Standstill.



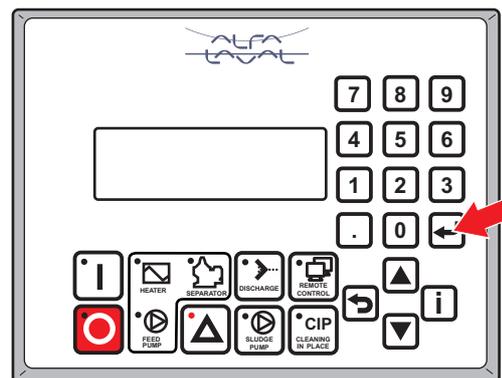
If this is the first start, answer 'YES'.

'Assembled according to manual? YES, NO'

2. If the bowl has been dismantled and assembled according to the instructions in the *Service Manual*, choose 'YES'. (If 'NO' is chosen, the system goes to 'STANDSTILL').

'Bowl cleaned? YES, NO'
(S-type separator only)

3. If the bowl has been cleaned choose 'YES'. 'Proceed with calibration' appears on the display. Local manual start only possible. If the bowl has not been cleaned, choose 'NO'. 'Proceed without calibration' appears on the display. Stepwise/automatic start is possible (set using parameter P 130).



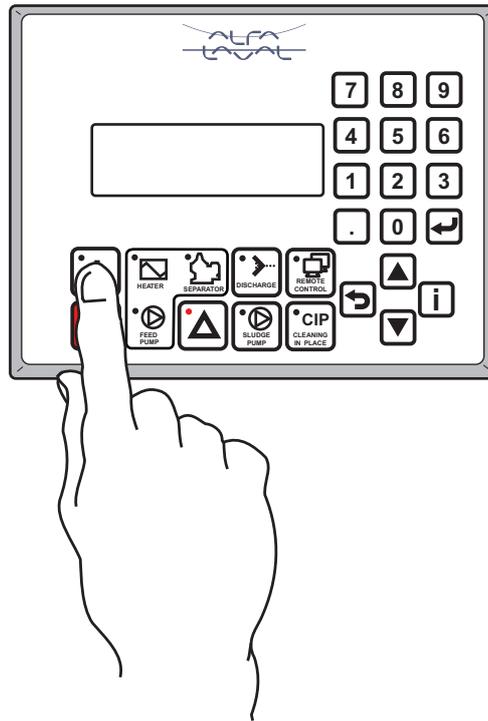
X023913A

Start

1. The feed pump (if installed) starts.

The LED on the start button flashes, the LED for the feed pump lights, and text 'Starting feed pump' shows on the display.

The start button LED shines steadily and the display shows either 'To start heater, press start button', or 'To start separator, press start button'.



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2. Press the start button a second time.

The heater (if installed) starts.

The LED on the start button flashes, the LED for the heater lights, and text “Starting heater” shows on the display.

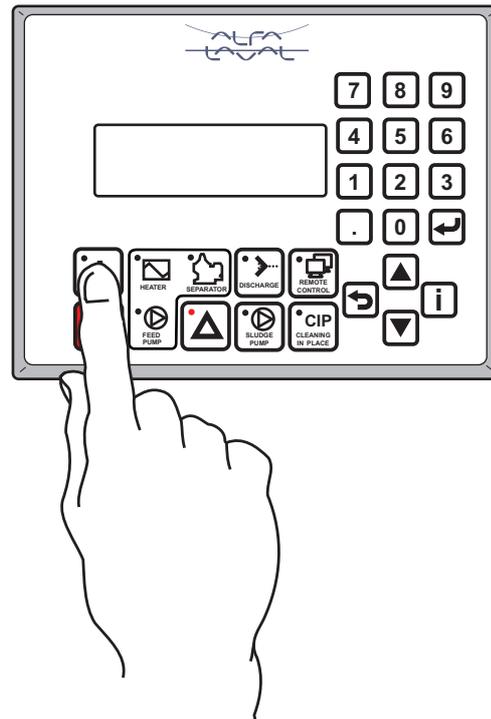
Wait for increasing temperature.

Cold Start Function

If the viscosity of the oil is high (low temperature), a smooth heater start-up is preferred. The temperature up to which the cold-start gain factor P126 is active is set in parameter P125. Above this temperature the normal P-constant P123 is used.

If the temperature has not reached the value in parameters P184 (HFO/LO low temperature limit) within the time specified in parameter P169 (alarm delay), alarm ‘A24 Temperature increase too slow’ will show on the display.

If the temperature feedback is correct (reading on temperature sensor TT1 above value in parameter P184), the start button LED shines steadily and the display shows ‘To start separator, press start button’.



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1 Operating

3. Press the start button a third time.

The separator motor starts.

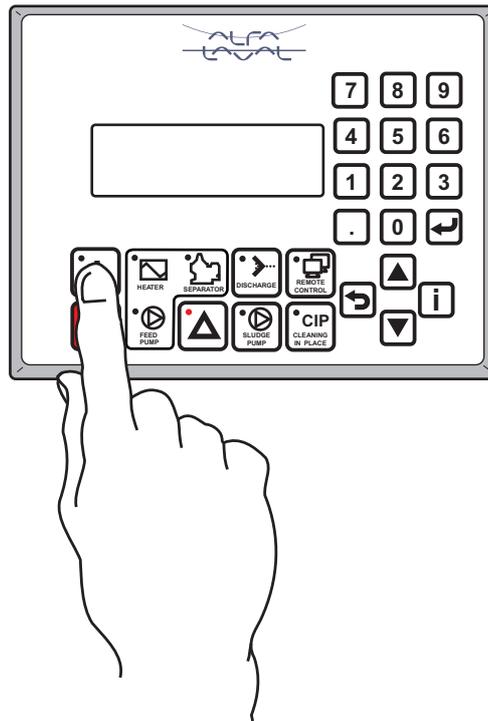
The LED on the start button flashes, the LED for the separator lights, and text 'Starting separator' shows on the display.

Wait for speed feedback (if speed sensor installed), or until the separator max. start time (4 minutes) has elapsed.

If the speed has not increased to over 90 rpm within 10 seconds after contactor K2 response, alarm 'A96 Slow start acceleration' shows on the display.

If the low speed limit value in parameter P180 has not been reached before the separator max. start time has elapsed, alarm 'A95 Separator motor run-up time too long' shows on the display.

If the separator is running above the low speed limit, the start button LED shines steadily, and the display shows the heading 'RECIRCULATION' and text 'To start separation, press start button'.



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4. Press the start button a fourth time.

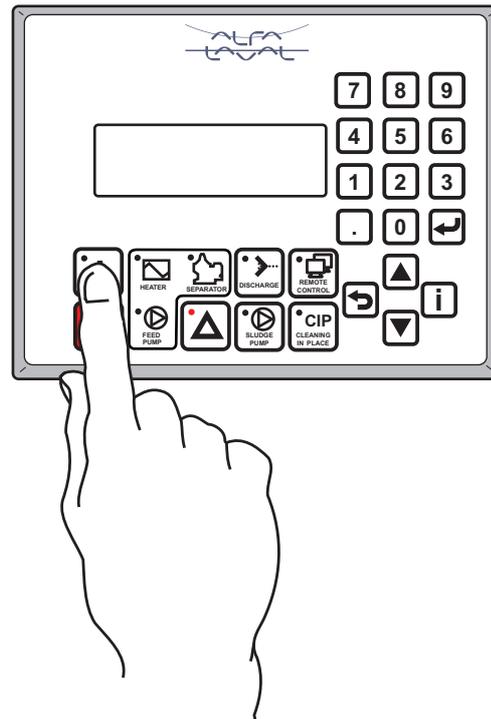
If the feed temperature is below the value in P184, the controller stays in RECIRCULATION mode. The LED on the start button flashes, and text 'Waiting in RECIRCULATION for separation temperature' shows on the display.

If the correct feed temperature is reached, the controller changes automatically to SEPARATION mode via a transition sequence which is shown on the display. The start button LED shines steadily, and the display shows the heading 'TRANSITION'.

If speed sensor not installed (P113 = no) or disabled (P148 = 0), change over to RECIRCULATION/SEPARATION takes place when the separator max. start time has elapsed.

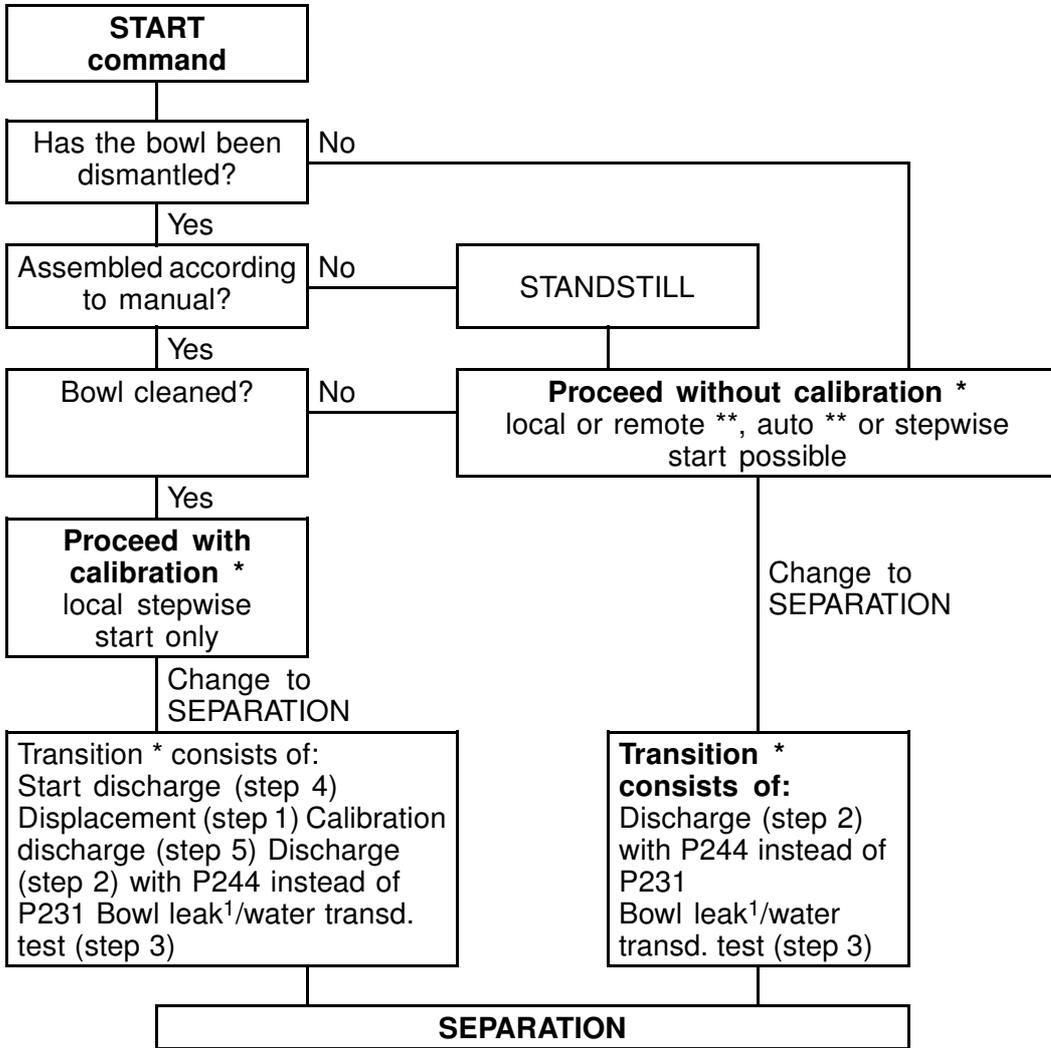


The time in 'RECIRCULATION' is limited by timer P178 to avoid overheating of the separator.



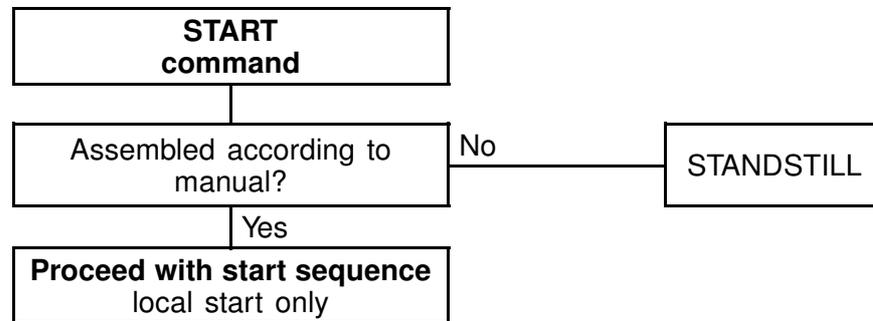
X023911A

Start S-type separator start sequence



1) Bowl leak test not related to S 949, S 9410.

Start P-type separator start sequence



1.4 Automatic Start from Standstill

The operator can select to start the system automatically by setting parameter P130 to 'automatic'.

The control panel automatically goes through the same procedure as described under *Manual Start from Standstill*.

If the bowl has not been dismantled or cleaned, the previously calculated filling time (parameter P233) is used, a discharge sequence and a bowl leakage¹/water transducer test are run, and the system goes into SEPARATION mode.

The following equipment must be installed for automatic start:

- Vibration monitor
- Speed sensor
- Frame cover switch

¹) Bowl leak test not related to S 949, S 9410.

1.5 During Separation

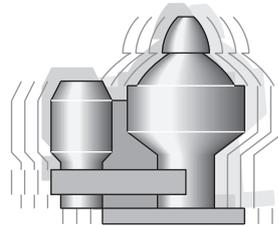
Observe information on the control panel display. The times in each sequence are shown in the bottom left-hand corner of the display



Breakdown hazard

If strong vibration occurs, press the emergency stop button and evacuate the room.

Never discharge a vibrating separator. Vibration may then become violent and result in breakdown.



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Noise hazard

Use ear protection if noise levels are high.



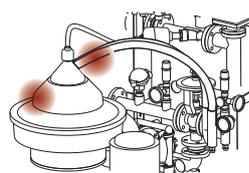
Breakdown hazard

Never reset an alarm without first finding and remedying the cause.

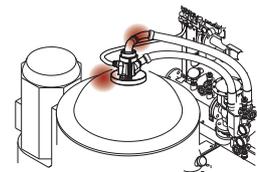


Burn hazard

Avoid contact with hot surfaces. Process pipes, various machine surfaces, and processed liquid can be hot and cause burns.



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Slip hazard

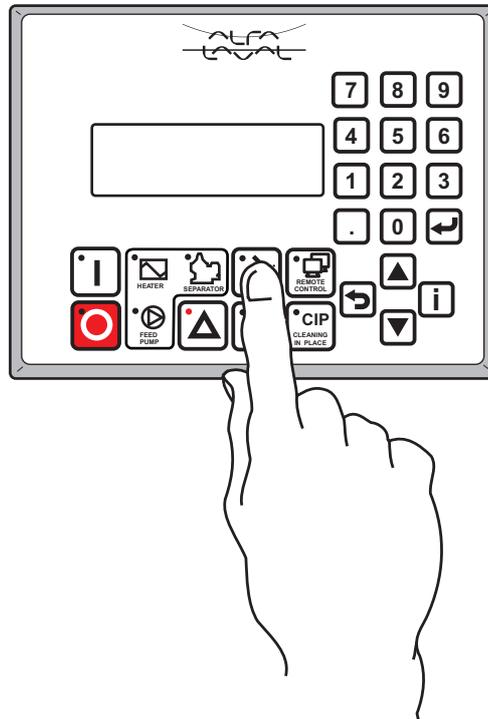
Check all connections for leakage.

Oil leakage may make the floor slippery.

1 Operating

Discharge sequences run automatically at preset intervals (timer P220).

Discharge sequence can also be run manually by pressing the 'Discharge' button.

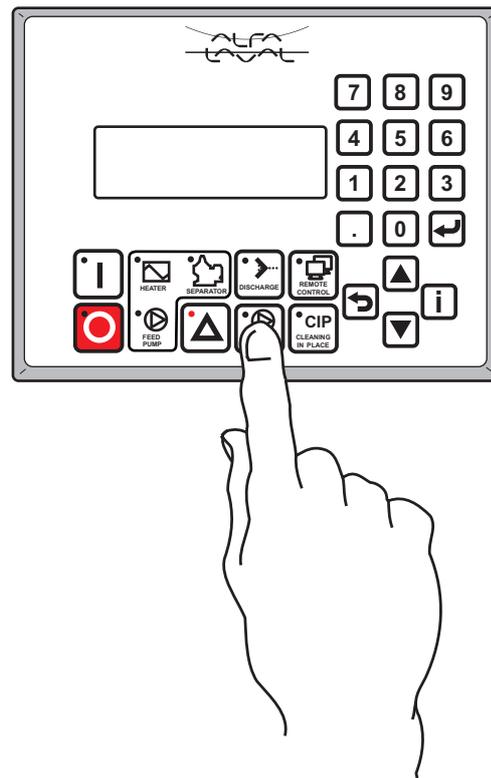


X023923A

The Sludge Pump runs during discharge or when there is high level in the sludge tank, or can be started manually by pressing the 'Sludge Pump' button on the control panel.

NOTE

Do not run the sludge pump longer than necessary. If the pump is run while dry it can be damaged.



X029922A

In SEPARATION mode, the feed pump is running, the feed has reached separation temperature (the heater is working) and the separator is running at full speed.

Feed valve V1 is open to the separator inlet.

1.6 Stop



Breakdown hazard

Stop the separator by means of the control unit, and not by turning off the power.



Never attempt to clean the bowl by manual discharge in connection with stop.

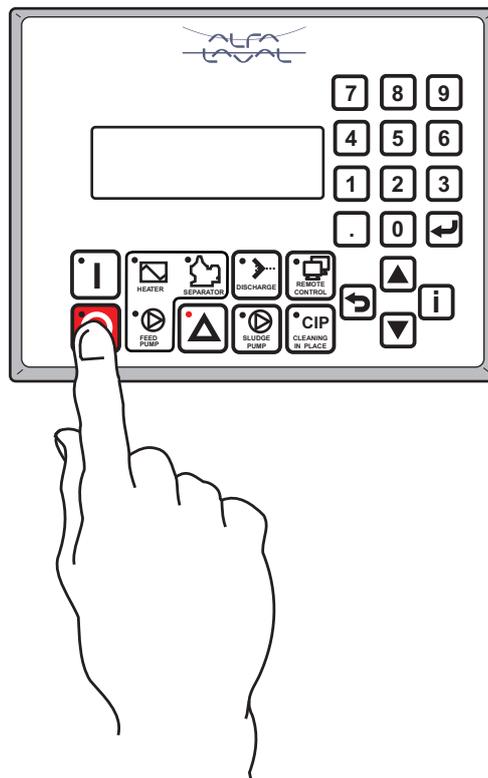
To stop the system:

The operator can stop the system when in the 'START', RECIRCULATION, or 'SEPARATION' modes.

1. Stop the system by pushing the 'Stop' button on the control panel. The following sequence takes place:
 - A stop discharge and flushing sequence are initiated (does not apply to stop from 'START').



Filling and flushing are not performed if the discharge feedback has not been received



X023920A

- The separator motor is turned off and the stop timer starts running. At the same time, the heater is turned off (see [1.13.4 Heater shut down on page 45](#)). The system waits for the feed temperature and speed to decrease.
- If the speed limit in P180 (low speed limit) is not reached within 3 minutes, alarm 'A94 Bowl speed high during STOP' is given.
- When the bowl speed has reached 4000 rpm, closing water valve SV16 is activated for 1 second in order to keep the bowl closed.
- If speed sensor not installed (P113 = no) or disabled (P148 = 0), SV16 opens for 1 second 5 minutes after the separator motor has been turned off.
- When 3 minutes has elapsed, the feed pump is turned off.
- The system waits for the speed sensor (if installed) to indicate zero speed. When the bowl has been still for 60 seconds, 'STAND STILL' shows on the display.
- If speed sensor not installed (P113 = no) or disabled (P148 = 0), 'STAND STILL' is shown when the stop timer has elapsed.
- The sludge pump runs for 10 seconds after STAND STILL is reached if stopped from SEPARATION mode or RECIRCULATION mode.
- All equipment except the sludge pump (which can still be run manually) is now deactivated.

**Breakdown hazard**

The system must not be restarted with the separator rotating if high vibration alarm has been given.

1.7 Emergency Stop

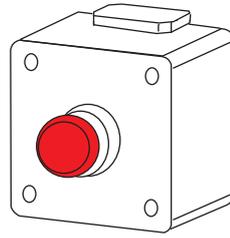


Disintegration hazard

If an emergency situation or unusually strong vibration occurs, press the Emergency Stop button and evacuate the room.

If oil spray, feed pump is stopped by emergency stop button.

Do not enter the room after an emergency stop while the separator is still rotating.



X024579A

The following sequence occurs:

- The power to heater pump and separator motor is shut-down immediately.
- Stop timer starts.
- If a steam heater is installed, the steam shutoff valve is forced to close.
- Closing water valve SV16 opens for 15 seconds.
SV10 is open for 15 seconds if the speed is supervised and the speed is over P255, or if there is no speed supervision.
- All other equipment is deactivated.



In order to be able to restart, the system must be at standstill.

1.8 After Emergency Stop

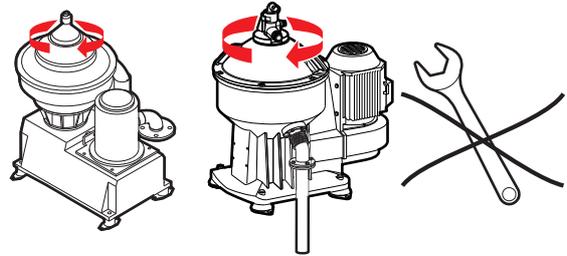
Separator standstill

Dismantling work must not be started before all rotating parts have come to a complete standstill.



Entrapment hazard

Make sure that rotating parts have come to a complete standstill before starting any dismantling work. The rotation indicator lamp, where applicable, must be off.



100293CD

Avoid accidental start



Entrapment hazard

To avoid accidental start, switch off and lock power supply before starting any dismantling work. Make sure that separator has come to a complete standstill before starting any dismantling work.

Remedy the cause

The cause of the emergency must be remedied before attempting to restart the separator. If the cause is not found, an overhaul must be performed on the separator, and all moving parts thoroughly checked.



Disintegration hazard

Do not start the separator after an emergency stop without first remedying the cause of the emergency. Make sure that the bowl is clean before restart.

Separator reassembled

The separator must be fully reassembled with all covers and guards in place and tightened before unlocking the power supply and starting the system.



Breakdown hazard

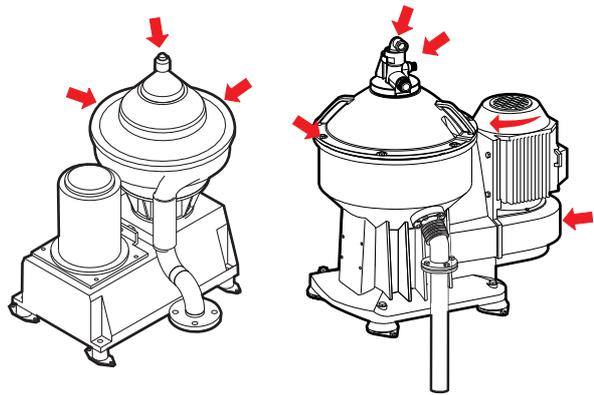
Assemble the separator completely before restart. All couplings, covers, and guards must be in place and properly tightened. Failure to do so may lead to breakdown.



Check that the Emergency Stop Box is properly installed and functioning correctly.



Check that all ancillary equipment, in particular the heater, is functioning correctly.



X023714B

1.9 Manual Operation of the Separation System

In the event of a case where the Control System has a total failure or extremely high water content, the system can be run manually by a competent engineer using the following instructions:

1. Ensure all oil system manual valves are in the correct position.
2. Fit a jumper between terminals X1:113 - 114 (for separator) and X1:115 - 116 (for feed pump) in the EPC.
3. Start the feed pump.
4. Start the separator.
5. Heat the oil to the correct separating temperature.

Where there is a Heatpac, type EHM electric heater, use jumpers in the power unit to bridge terminals X12.11 – X12.6, X12.11 – X12.9, and X12.11 – X12.7. Switch on the heater and use the switch to regulate the temperature.

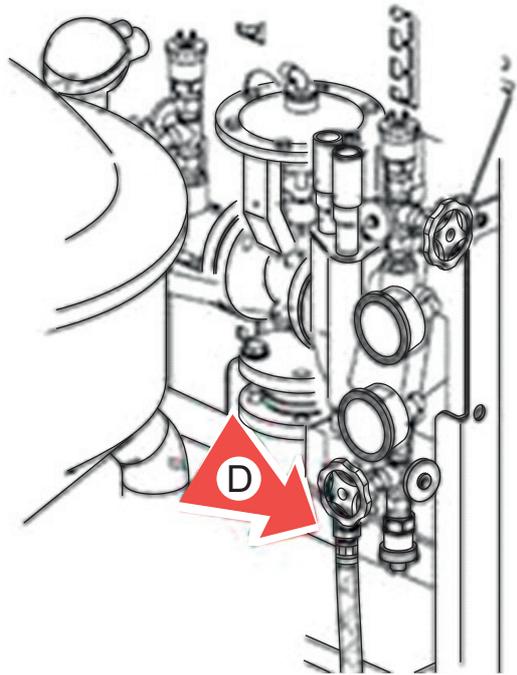
**NOTE**

Remove the jumpers after emergency operation.

6. When the separator is up to speed and the correct oil flow and temperature are achieved, close the bowl. Open SV15 for time specified in parameter P244 (See *Parameter List* booklet). Wait 15 seconds. Open SV16 for time specified in Parameter P243. The bowl is now closed.
7. Temperature, flow, and backpressure must remain constant throughout.

1 Operating

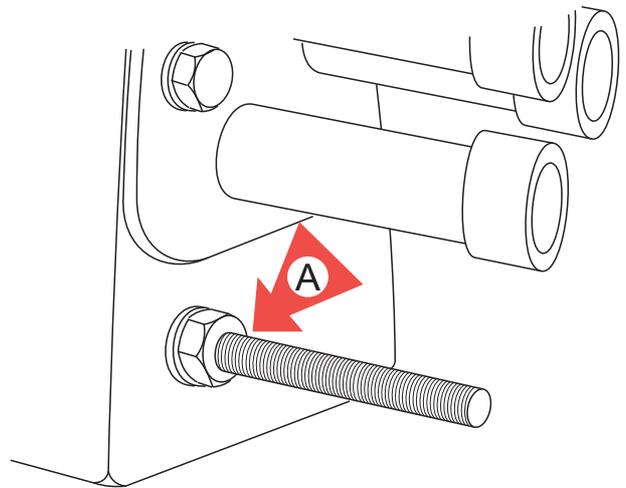
- Remove the water outlet pipe at D.



X028098A

- Screw in screw A to move the paring tube to its innermost position.
- Open SV10 as follows:

Separator Type	Time (Sec.)	Amount bowl filled (Liter)
S921, 926, 927, 928	48	0,7
S936, 937, 938	42	1,1
S946, 947, 948	71	1,9
S956, 957, 958	34	3,1
S966, 967, 968	51	4,7
S976, 977, 978	38	7
S986, 987, 988	44	11



X028099A

- Open SV1 to open oil feed V1.
- Open SV5. This will open the water outlet valve V5.
- Carefully screw out screw A until water starts to come from D.

14. Lock screw A in position.



Breakdown hazard

During operation open SV16 for about 5 seconds every 10 to 15 minutes to ensure that the bowl remains closed.

Discharge

1. Close oil feed V1 using SV1.
2. Close water outlet V5 using SV5.
3. Open SV10 to add displacement water as follows:

Separator Type	Time (Sec.)	Amount bowl filled (Liter)
S921, 926, 927, 928	60	0,9
S936, 937, 938	49	1,3
S946, 947, 948	79	2,1
S956, 957, 958	44	4
S966, 967, 968	59	5,4
S976, 977, 978	59	10,8
S986, 987, 988	59	14,7

4. Open SV15 until a discharge is heard (about 3 seconds).
5. Wait 15 seconds.
6. Open SV16 for time specified in Parameter P243.
7. Open SV10 as follows:

Separator Type	Time (Sec.)	Amount bowl filled (Liter)
S921, 926, 927, 928	48	0,7
S936, 937, 938	42	1,1
S946, 947, 948	71	1,9
S956, 957, 958	34	3,1
S966, 967, 968	51	4,7
S976, 977, 978	38	7
S986, 987, 988	44	11

1 Operating

8. Open V1.
9. Open V5.
10. Maintain backpressure at normal setting throughout.



Breakdown hazard

Discharging of the bowl, and supervision of the operation, is now completely manual and under the direct responsibility of the engineer who has placed the separation system in the manual control mode.

1.10 Cleaning In Place

The use of Cleaning In Place (CIP) equipment is recommended for best separation results. For further information on the CIP equipment, see the CIP booklet, bookno. 1817261.

1.10.1 CIP Start

CIP can be selected from STAND STILL only, and only from a local control panel.

Press the CIP button to select CIP.

NOTE

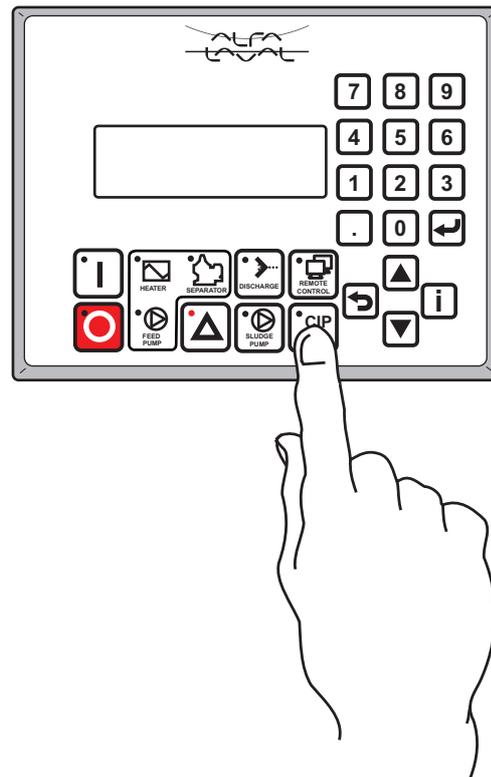
During CIP the separator is running at full speed, but feed pump, heater, process valves, temperature and pressure supervision and water transducer MT60 are neither controlled nor supervised.



Avoid accidental start of feed pump

To avoid accidental start, switch off and lock power supply for feed pump.

Leakage of Hot oil may occur if feed pump is accidentally started.



X023921A

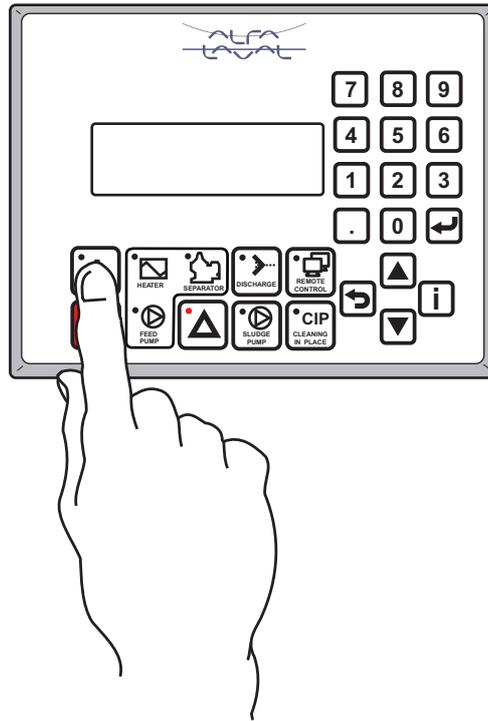
1 Operating

Connect hoses for CIP liquid before pressing “start” button.

With CIP selected from STAND STILL, press the ‘START’ button to start the separator motor. The motor starts unless the system prevents start, or alarms are active.

Wait for speed feedback.

- Speed has to increase to above 90 rpm within 10 seconds after contactor K2 response, otherwise alarm ‘A96 Slow start acceleration’ will be shown on the display.
- Speed limit in parameter P180 has to be reached within 4 minutes, otherwise alarm ‘A95 Separator motor run-up time too long’ will be shown on the display.
- When the separator is running above low speed limit (P180), or 4 minutes has elapsed if speed sensor not installed (P113 = no) or disabled (P148 = 0), a message to start the cleaning liquid supply is given to the operator.



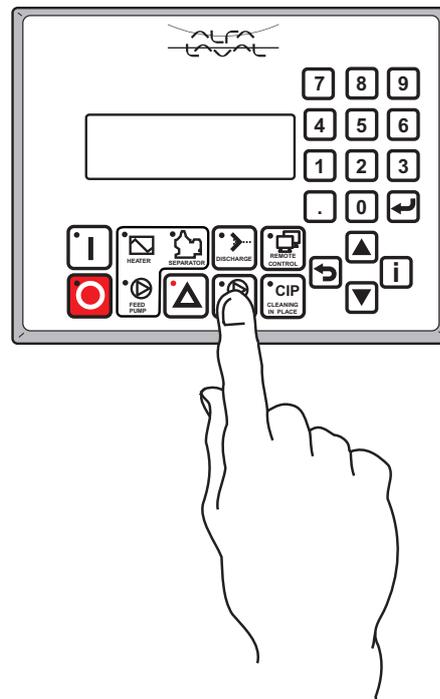
X029911A

1.10.2 CIP Running

NOTE

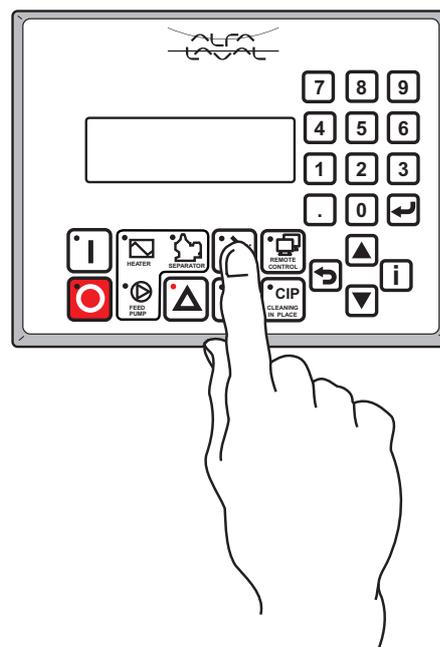
When the bowl has reached normal speed, a bowl closing procedure will be performed.

While the CIP system is running, closing water valve SV16 opens for 2 seconds and closes for the time set in parameter P228 (pulse interval) repeatedly. The sludge pump runs when there is high level in the sludge tank or when activated by pressing the 'SLUDGE PUMP' button on the control panel.



X023922A

A discharge can be activated manually during the CIP process by pressing the 'DISCHARGE' button on the control panel.

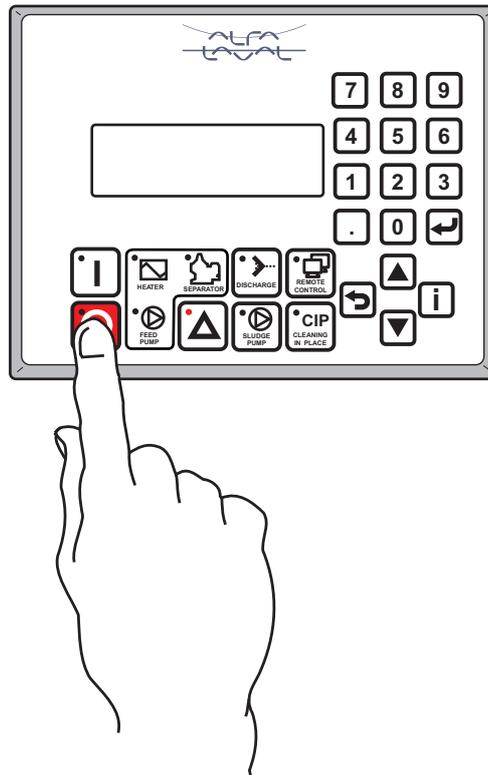


X023923A

1.10.3 CIP Stop

Stop the CIP process by pressing the 'Stop' button on the control panel. The CIP process can be restarted.

- The separator motor is turned off. Alarm delay (3 minutes) starts, and stop timer starts. If the speed limit in parameter P180 (alarm limit bowl speed low) is not reached within 3 minutes, alarm 'A9 Bowl speed high during STOP' is given.
- When the bowl speed has reached 4000 rpm, closing water valve SV16 is activated for 1 second in order to keep the bowl closed.
- If there is no speed sensor installed (parameter P113 = no) or disabled (parameter P148 = 0), SV16 opens for 1 second 5 minutes after the separator motor has been turned off.
- The system waits for the speed sensor (if installed) to indicate zero speed. When the bowl has been still for 60 seconds, 'STAND STILL' shows on the display.
- If there is no speed sensor installed (parameter P113 = no) or if speed sensor disabled (parameter P148 = 0), 'STAND STILL' is shown when stop timer has elapsed.
- If the bowl speed has been above P180, or the start timer has elapsed, the sludge pump runs for 10 seconds after 'STANDSTILL'.
- Hold the 'CIP' button pressed for 5 seconds to leave CIP mode.



X023920A

After cleaning:

1. Open the heater drain valve until the flushing water has drained.
2. Close the drain valve.
3. Remove the CIP connections.
4. Return the turnable connections to their former positions and re-tighten.

5. Re-open the valves before and after the heater.



Health Risk

Do not forget to disconnect the CIP equipment and re-connect the process connections.

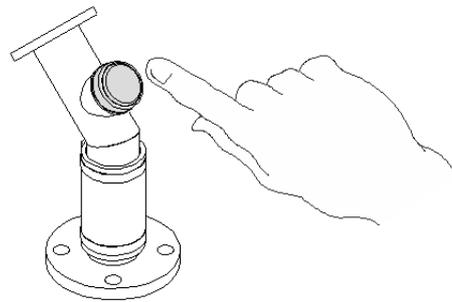
1.11 Check if separator bowl is clogged

Valid for Purifiers (not Alcap or Clarifiers)

Purifiers have no automatic indication if the bowl is clogged or filled with too much solids. Recommendation is to check each Bunker analyze report and determine if there is any risk for a higher than normal sludge production. The time between each sludge discharge should then be reduced accordingly.

From time to time , and especially when a new Bunker is introduced ,it is advisable to do as follows :

- Introduce water into the bowl by open manually the SV10 solenoid valve , on the Operating Water Block.
- Check that this water is coming out from the bowl by unscrewing the Inspection Plug on the sludge pipe.
Please however ,make sure that the machine is not about to make a discharge!
Splash hazard.



X027007A

If water is seen flowing in the pipe, turn off SV10 and keep operating as before. The bowl is not clogged.

If no water is seen , then the bowl is clogged. Make a discharge.

If still the water is not seen in the Inspection plug ,turn off SV 10 and shut down the Purifier system. Open and clean up the bowl.

NOTE

By opening the Inspection Plug without adding any water , it can also be verified that no small oil leakage is escaping from the bowl during operation.

1.12 Intervals Between Sludge Discharges

(Valid for P 625/635/626/636/646 only)

1.12.1 Background



Disintegration hazard

Experience has shown that if intervals between sludge discharges are too long, a compact and hard sludge cake can accumulate. On discharge, this cake may break up and be discharged unevenly causing imbalance in the bowl. If imbalance is excessive, there is risk for serious mechanical damage and injury to personnel.

Recommendations are given regarding initial intervals between sludge discharges for different applications. The setting may subsequently have to be changed after actual inspection of the bowl.

1.12.2 Recommended intervals between sludge discharges

Many factors influence accumulation and hardening of sludge between the discharges, so the appropriate interval depends on local conditions. However, in order to have a reasonable starting point the following table shows recommended initial discharge intervals and operating times to first inspection.

1.12.3 Fuel oil cleaning

Type of fuel	Recommendations	
	Initial intervals between discharges	Time to first bowl inspection
Distillate (1.5 – 6 cSt/40 °C)	4 hours	1 week
Marine Diesel Oil (max. 14cSt/40 °C)	2 hours	1 week
Heavy Fuel Oil (Max interval)	1 hour (2 hours)	2 days

Conditions may change completely when bunkers are changed. Therefore, great care must be given to the discharge interval setting for each new bunker. In case the actually used discharge interval exceeds the recommended initial value, the interval setting has to be reduced, according to the table above, when a new, unfamiliar bunker is separated. Use of unstable fuel or mixing of incompatible fuel oils may give precipitation of sludge and overloading of the separator.

1.12.4 Lubricating oil cleaning

Continuous operation:

In a new lubricating oil system the oil is initially clean but as it gets dirtier the interval between discharges will have to be shortened until a “steady state” is reached. Following information refers to systems in “steady state”.

Type of fuel	Recommended intervals for Crosshead and Trunk	
	Initial intervals between discharges	Time to first bowl inspection
Main lubricating oil system	1 - 2 hours	1 week

If separator has been out of operation:

If the separator has been out of service for 24 hours or longer, while the engine has been running, the interval between discharges has to be shortened. In this case the recommendation is:

- Discharge interval 5 minutes until the whole oil volume has passed twice through the separator.
- After that resume normal discharge interval.

Intermittent operation:

For installations where one separator serves one engine which is temporarily stopped the following recommendations apply: If the engine is to be stopped for 24 hours or less:

- Keep the separator in operation for 8 hours after the engine is stopped.
- Start the separator 8 hours before the engine is started again.

Doing so most of the suspended particles and water condensate will be removed from the system and not settle in the sump tank. For installations where one separator serves more than one engine the following recommendations apply:

- Continuous use of the separator whenever possible.
- Frequent switches between the engine systems to be cleaned. In a typical case with one separator serving 2–4 auxiliary engines switching after maximum 24 hours of cleaning.

Discharge interval:

Engine has been in operation with-out cleaning of the system oil	Engine has not been in operation since last cleaning of system oil
Discharge interval 5 min.	Normal discharge interval
Duration until the whole oil volume has passed twice through the separator	
After that resume to normal discharge interval	

1.12.5 Bowl inspection

To check if the initially selected interval is appropriate, the bowl should be inspected after a short test period shown in the previous tables.

If sludge space is clean:

Interval may be prolonged with steps of 15 minutes, but it must not exceed three times the recommended initial interval.

“Sludge space is clean” means that no noticeable amount of hard sludge remains in the sludge space.

If sludge space is dirty:

Interval has to be shortened.

When the bowl is opened for routine cleaning, the sludge space should always be inspected and evaluated. If necessary, the interval between discharges should then be changed accordingly.



NOTE

Alfa Laval assumes no responsibility for the actual choice of discharge intervals, as these entirely depend on local conditions.

1.13 Heater Control (optional)

The temperature in the feed inlet is normally supervised via TT1, and can be controlled by a heater via TT2. Supervision and control are active even if one of the sensors is disabled. TT2 can be used by the customer; no alarm is given. TT2 is disabled in this case.

The heater is controlled according to temperature setpoint P249 using a PI-regulator with output:

$$Y(k) = Y(k+1) + P + I$$

where the proportional part

$$P = K_p * (e(k) - e(k-1))$$

and integral part

$$I = K_i * e(k) / T_i$$

The error $e = \text{SetValue} - \text{ActualValue}$, is the difference between the desired value (P249) and the actual value (reading on TT) where $k = \text{point of time}$

The tuning of the regulator is done by modifying the amplification

$K_p = K_i = 100/P_{123}$ (P_{123} is known as the proportional band width) and integral time $T_i = P_{124}$.

Every second a new output Y is calculated, i.e. the interval between each k is 1s.

With P119 it is possible to select heater control mode:

- no (no heater controlled)
- electric (electric heater controlled, P120 active)
- steam (steam heater controlled, P121 active)
- external (start/stop request via programmable output, heater not controlled)

Cold start function

If the viscosity of the oil is high (low temperature), a faster start-up of the heater might be favourable (a higher K_p). The temperature, up to which the cold-start gain factor P126 is active, is set in P125. Above this temperature the normal P-band P123 is used.

Example: P123 = 30, P126 = 40 results in a P-band of $0.40 \times 30 = 12$ as long as the temperature is below P125.

1.13.1 Control of the electric heater (optional)

P119 = electric. The following parameters should not be displayed in the parameter list: P121, P122.

Five outputs and one input are used to control the electric heater:

- three relay outputs to up to three fixed power steps depending on the heater size (P120)
- one variable load output
- one output "heater on"
- one input "heater fault" (see A05)

The total heater capacity (100%) is the sum of the power available at the three fixed steps, plus the power available via the variable load output (always 16 kW nominal).

This means, if the output signal to the heater is 100%, all available power steps and the variable load output have to be activated continuously.

Output signal 0% means that all outputs are deactivated.

If the output signal is a value between 0 and 100%, the activation pattern of the outputs has to be calculated using the table below.

Output power (in % of the total available power)				
Heater size (kW nominal, selected with P120)	Power step 1 %	Power step 2 %	Power step 3 %	Variable load output %
7, 8	0	0	0	10 x 10
14, 16	0	0	0	10 x 10
22, 24	33,5	0	0	10 x 6,6
36, 40	20	40	0	10 x 4
50, 56	14,3	28,5	28,5	10 x 2,9
65, 72	11	22	45	10 x 2,2
100	14,3	28,5	28,5	10 x 2,9
130	11	22	45	10 x 2,2

For each value of P120 the contribution of each power step to the total available heater capacity is given in percent. First use the fixed power steps to fill the power requirement as far as possible, then use the variable load output to fine adjust the output.

NOTE

It is important that the fixed power steps are working continuously when activated. Use an established method e.g. delay drop out.

As a new output signal is calculated every second, the variable load output is activated for parts (0.1) of a second.

0.1 s activates 1/10 of the available power on the output = 1.6 kW.

0.5 s means 8 kW and so on.

Example 1: Heater size 72 kW and output signal to the heater 50%. Activate step 3 (for 1s) and activate variable. output for 0.2s.

Example 2: Heater size 16 kW and output signal to the heater 88%. Activate variable output for 0.9s.

Example 3: Heater size 130 kW and output signal to heater 88%. Activate steps 1, 2, and 3 (for 1s).

To prevent problems with too heavy momentary load at start of the heater, only one output can be activated per second during the first 6 seconds. After that time all outputs can be used simultaneously.

1.13.2 Control of the CBM heater (optional)

P119 = steam. In this case alarm A05 is not supervised.

The steam heater is controlled using three relay outputs:

- increment steam valve
- decrement steam valve
- steam shut-off valve (hold signal)

The position of the valve is not supervised.

The transition time of the steam valve is set in P121 (time from fully open to fully closed position and vice versa). The controller function defines if the valve should be opened (incremented) or closed(decremented) in relation to its actual position.

The signal to the steam valve is pulsed with an on-time corresponding to the temperature controller output. *Example:* output = +50% means the increment steam valve output is activated for 0.50 s/s.

When the heater is stopped, the decrement steam valve signal is on for the time set in P121. The hold signal is off if the start of the heater is interlocked (e.g. on alarms A01, A20).

1.13.3 If heater not controlled or external

It is possible to run the system *without heater control* (P119 = no).

In this case alarms A05, A24 and A25 are not supervised.

It is also possible to run the system *with external heater* (P119 = external). The 'heater on' signal is given via a programmable output.

In this case alarm A05 is not supervised.

The description for the system with external heater is also valid if one of the temperature sensors is disabled or on sensor error (A22/A30).

1.13.4 Heater shut down

The system waits for the feed temperature to decrease (5 degrees or below P184). If the time in P173 has elapsed and the temperature feedback was not received, alarm 'A25 Temperature not decreasing' is given.

When the temperature feedback has been received, or P173 has elapsed, P256 is started. When P256 has elapsed, the feed pump (if running) is turned off. If the feedback signal from the pump contactor is not received within 5 seconds, alarm 'A01 Pump starter failure' is given.

**NOTE**

Heater shutdown is also initiated at STOP request during START if feed pump and heater are on but the separator is not running.

1.14 Cross connection/serial operation

Valid for P-type separators

It might be desirable to cross-connect two separator modules, or operate them in series. For that purpose the EPC60s must be able to communicate via Ethernet.

1.14.1 Set up communication

The EPC60s may communicate over any customer defined network or be connected directly to each other ¹⁾ .

The IP-addresses of the EPC60s must be set so there are no IP-conflict since all EPC60s are normally delivered with the same default address.

The node and IP addresses have to be set as follows:

Master IP 192.168.0.1

Master node 6.

Slave IP 192.168.0.2

Slave node 4

The node address cannot be modified.

1) Direct connection requires a crossover twisted pair cable to be used since the EPC60 does not have automatic MDI/MDI-X configuration.

1.14.2 Configure parameters

The parameter to select desired function is P145.

The following values are possible:

- disabled (default)
- cross master
- cross slave
- serial master
- serial slave

The adjustment of P145 is only possible, if both systems are in STAND STILL.

The communication between the two control systems is supervised. At communication error an alarm (A136) is given and both systems will go to STOP if running.

1.14.3 Cross connection

One separator module can use the feed pump and heater of the other one.

- P145 is set to “cross master” in the system which separator is used. The heater/feed pump of this system is automatically disabled. The display shows CROSS CONNECTION MASTER in STANDSTILL.
- P145 is set to “cross slave” in the system which heater/feed pump is used. The separator of this system is automatically disabled. The display shows CROSS CONNECTION SLAVE.

After adjustment of P145, only stepwise local start from resp. panel is possible.

The separator is started/stopped and the separator system is supervised from the master panel as if heater and feed pump were not installed. Temperature readings from the master are transferred to the slave panel.

Heater and feed pump are started/stopped and controlled from the slave panel. Alarms for the heater and feed pump are generated in the slave panel.

1.14.4 Serial operation

This function is required when two separators should operate in series, i.e. the oil coming from the first separator (usually a purifier) is further purified in the second one (usually a clarifier, but may be a purifier).

- P145 is set to “serial master” in the first system. The display shows SERIAL CONNECTION MASTER in STANDSTILL.
- P145 is set to “serial slave” in the second system. The display shows SERIAL CONNECTION SLAVE in STAND STILL.

After adjustment of P145, both systems are started individually. The discharge interval is set with P220 in the master system. The slave's automatic discharge initiation is disabled. Instead the master initiates a discharge in the slave system every (P262) time after the own discharge has been completed.

1.15 Programmable Inputs and Outputs

An extra I/O kit is available as an option. This kit contains two boards, one with six programmable digital inputs and one with six programmable relay outputs. The customer can select an optional function for each of these inputs and outputs from a list of alternatives (see below).

1.15.1 Inputs

See parameters 139 to 144

	Alternative	Comments
0	None	default
1	Remote start	enter automatic start, only if REMOTE selected on operator panel (pushbutton) Closed (pulse) = start
2	Remote stop	enter stop sequence, works with REMOTE button in any position Closed (pulse) = stop
3	Remote start feed pump	the same as first push at stepwise start. Closed (pulse) = start
4	External alarm	used for e.g. a level switch in a tank. See alarm A123. Closed = alarm
5	Remote recirculation	Request Recirculation, only if REMOTE selected on operator panel (pushbutton) Closed = recirculation
6	New temperature set point	EPC 60 uses temperature set point P250 during start when the separator is switched off

1.15.2 Outputs

See parameters P133 to P138.

altId	Alternative	Comments
0	None	default
1	Indication heater on/ start external heater	program request "heater function on" Closed = heater on
2	Indication separator motor on	program request "separator motor on" Closed = motor on
3	Stand still indication	when stand still flag on Closed = stand still
4	Indication alarm A20	if alarm "Oil feed temp. high" active Closed = alarm
5	Indication alarm A21	if alarm "Oil feed temp. low" active Closed = alarm
6	Indication alarm A51	if alarm "Oil backpressure PT4 low" active Closed = alarm
7	Indication feed pump on	program request "feed pump on" Closed = feed pump on
8	Remote start allowed	allowed to start the system Closed = start allowed

altId	Alternative	Comments
9	Remote enabled	remote button activated Closed = remote activated
10	Valve in sludge outlet	controlled if pneumatic valve, see P131 and <i>Activation diagram Closed = open or close valve (set with P131)</i>
11	Common alarm	Alternative Common alarm, Closed = no alarm, also see separate description
12	Indication V1	Position of valve V1, Closed = feed on to separator

1.15.3 Common alarm indication

There are two separate outputs for indicating status of the alarms. One is standard and the other is available through the programmable outputs. The behaviour of the standard output can be configured as follows via P104:

Standard output

P104 = Buzzer NC

When there is no alarm active the contact is closed. When an alarm is triggered the contact opens. If another alarm is triggered the contact will close for 0.5 s and then open again. When all alarms have been acknowledged by the operator the contact will close.

P104 = Buzzer NO

When there is no alarm active the contact is open. When an alarm is triggered the contact is closed. If another alarm is triggered the contact will open for 0.5 s and then close again. When all alarms have been acknowledged by the operator the contact will open.

P104 = Common alarm

When there is no alarm active the contact is closed. When an alarm is triggered the contact opens. If another alarm is triggered the contact will close for 0.5 s and then open again. When all alarms have been acknowledged and are no longer active, the contact will close.

Programmable output

The behaviour should always be exactly like the standard output if P104 = Common alarm, whatever the value of P104.

1.16 I/O Test Function

Activity	Reference/Limits
If system has active alarms, check and take actions before starting the I/O test.	
Press button F-step backwards and related arrows up (C) and down (E) for Log –in into the I / O test.	Acc. to IB(s)
Follow the list of I/O's (item 25-72) to check status of all el. connections of the system including the operating function of individual components.	Acc. to IB(s)
OUTPUTS	
K2 - Separator motor Check the operation and rotation of the separator motor. The output will only be activated for a short time. Also check that the correct led is activated on the operating panel.	Valid for: All S and P types
If no operation, check jumpers according to electrical diagram.	
K3 – Feed pump Check the operation and rotation of the feed pump. Also check that the correct led is activated on the operating panel.	Optional Valid for: All S and P types
If no operation, check jumpers according to electrical diagram.	
V1 – 3 way valve Verify the operation of the valve, see also that the green diode on the valve connector is lit.	Valid for: All S and P types
V4 – Oil outlet valve Verify the operation of the valve, see also that the green diode on the valve connector is lit.	Valid for: All S and P types
Cabinet fan Verify the operation of the fan mounted inside the electrical cabinet.  Electrocution Hazard This operation require tests to be made with cabinet door open and with power on. Beware of live parts.	Valid for: All S and P types
Steam shutoff valve Verify the operation of the valve, see also that the green diode on the valve connector is lit.	Optional Valid for: All S and P types
V5 - Drain valve Verify the operation of the valve, see also that the green diode on the valve connector is lit.	Valid for: All S and P types
Hold/reset vibration switch Ensure that the vibration switch is reset when this output is activated	Optional Valid for: P605/615/617
SV10 – Displacement water valve Verify the operation of the valve, see also that the green diode on the valve connector is lit.	Valid for: All S and P types

SV15 Discharge valve Verify the operation of the valve, see also that the green diode on the valve connector is lit.	Valid for: All S and P types
SV16 – Closing water valve Verify the operation of the valve, see also that the green diode on the valve connector is lit.	Valid for: All S and P types
Steam decrease – Closing of steam valve Verify that the valve is moving towards closing position. Note that if the valve is already closed, an opening operation (see below) needs to be done prior to this test.	Optional Valid for: All S and P types
Steam increase – Opening of steam valve Verify that the valve is moving towards opening position.	Optional Valid for: All S and P types
Programmable output 1 Not to be tested	
Programmable output 2 Not to be tested	
Programmable output 3 Not to be tested	
Programmable output 4 Not to be tested	
Programmable output 5 Not to be tested	
Programmable output 6 Not to be tested	
Electric heater test Optional	
Before the electric heater i/o-test, please ensure that the electric power to the electric heater cabinet is turned OFF! The operating voltage for the relays is supplied from control cabinet.	
Elheatvar – Variable output Check that the diodes on the 2 triacs inside the electric heater cabinet are lit.	Optional Valid for: All S and P types
Heater on signal Check that the relay KA11 (diode, see picture below) and K11 (mechanical indication) in the electric heater cabinet is activated. Note, leave this output activated (indicating 1 on display) when proceeding with the tests of the fixed power steps below!	Optional Valid for: All S and P types
ElheatPS1 – Power step 1 Check that the relay KA12 (diode, see picture below) and K12 (mechanical indication) in the electric heater cabinet is activated. Optional Valid for: All S and P types	
ElheatPS2 – Power step 2 Check that the relay KA13 (diode, see picture below) and K13 (mechanical indication) in the electric heater cabinet is activated.	Optional Valid for: All S and P types
ElheatPS3 Power step 3 Check that the relay KA14 (diode, see picture below) and K14 (mechanical indication) in the electric heater cabinet is activated.	Optional Valid for: All S and P types

INPUTS	
Heater fault signal Check that this input is 1 as long as the output “Heater on” is activated. If not ok, check settings of over temperature device Go back to “Heater on” Item no. 47 and deactivate (0 on display), then go back to this section and verify that “Heater fault” is 0.	Optional Valid for: All S and P types
Estop – Emergency stop This input should be 1 when emergency stop button is not pushed. Press emergency stop button and check that it goes to 0.	Valid for: All S and P types
Feedback feedpump – Not to be tested	
Feedback separator - Contactor feedback Not to be tested	
Sludge tank level switch If not installed , check that the input is 1, if not? check if jumper is installed according to electrical diagram. If installed , manually operate the level switch, the input should be 0 when high level.	Optional Valid for: All S and P types
Cover switch on separator frame Manually operate the cover switch, the input should be 1 when switch (and cover) is closed	Optional Valid for: All S and P types
Sludge valve interlock Manually operate the sludge valve, the input should be 1 when the valve is closed.	Optional Valid for: All S and P types
Programmable input 1 Not to be tested	
Programmable input 2 Not to be tested	
Programmable input 3 Not to be tested	
Programmable input 4 Not to be tested	
Programmable input 5 Not to be tested	
Programmable input 6 Not to be tested	
ANALOGUE INPUTS	
PT5 – Water outlet pressure transmitter Check that the indication shows approx 0 bar. Note that if pipes are connected to the system, pressure might not be 0 bar.	4-20mA Input Valid for: All S types
MT – Water transducer, MT60 Check that the indication shows 30 pF \pm 5. Note that this value is only correct when sensor is in air (no media in pipes).	4-20mA Input Valid for: All S types
PT1 – Oil inlet pressure transmitter Check that the indication shows approx 0 bar. Note that if pipes are connected to the system, pressure might not be 0 bar.	4-20mA Input Valid for: All S and P types

PT4 – Oil outlet pressure transmitter Check that the indication shows approx 0 bar. Note that if pipes are connected to the system, pressure might not be 0 bar.	4-20mA Input Valid for: All S and P types
TT1 – Oil inlet temperature sensor 1 Check that the indication shows a relevant temperature.	PT100 input Valid for: All S and P types
TT2 – Oil inlet temperature sensor 2 Check that the indication shows a relevant temperature. Note that the temperature should not deviate from TT1 with more than 2 °C	PT100 input Valid for: All S and P types
Speed sensor In order to test this input, use the “Separator motor”, K2, sect 1, I/O-test to start the separator (for a few seconds), then go back to this input and check the value, it shall be higher then 0 rpm.	Namur input Optional Valid for: All S and P625/626, P635/636/646 types
Vibration switch Check that this input goes to 0 when the switch is in tripped position	Optional Valid for: P605/615/617 types
Vibration sensor Check that the indication shows approx 3.5 mm. (Sensor should be installed with 3.5 mm from the axel)	4-20mA Input Optional Valid for: All S and P625/626, P635/636/646 types

1.17 Operation without all sensors (Emergency operation)

If a sensor is malfunctioning it is possible to disable it temporarily until it can be fixed or replaced.

1.17.1 System Without Speed Sensor

It is possible to run the system without speed sensor (P113 = no).

In this case system control and supervision are much more basic.

Alarms A90 – A97 are not supervised.

Remote start is not allowed.

The separator is started within 4 minutes and stopped with stop timer.

This also applies if the speed sensor is disabled (P148 = 0) or on alarm 'A92, Bowl speed sensor error'.

1.17.2 System Without Vibration Sensor

It is possible to run the system without vibration sensor (P114 = no).

In this case alarms A100 – A103 are not supervised.

Remote start is not allowed.

This also applies if the vibration sensor is disabled (P132 = yes) or on alarm 'A102, Vibration sensor error'.

1.17.3 System Without Cover Switch

It is possible to run the system without cover switch (P115 = no).

In this case alarms A110 – A111 are not supervised.

Remote start is not allowed.

This also applies if the cover switch is disabled (P116 = yes).

1.17.4 System With PT1 Disabled

It is possible to run the system with PT1 disabled (P157 = 0).

In this case alarms A40 – A42 and A44 are not supervised.

This also applies on alarm 'A42, Feed pressure sensor PT1 error'.

1.17.5 System With PT4 Disabled

It is possible to run the system with PT4 disabled (P153 = 0).

In this case alarms A50 – A52 and A54 – A59 are not supervised.

As a result, calibration of the water flow is not possible. The old values are used for displacement and conditioning water. Cold start function is disabled. Bowl leakage¹ test is disabled.

This also applies on alarm 'A52, Oil pressure sensor PT4 error'.

¹) Bowl leak test not related to S 949, S 9410.

1.17.6 System With PT5 Disabled (S-separator only)

It is possible to run the system with PT5 disabled (P155 = 0).

In this case alarms A70 – A72 and A74 are not supervised.

This also applies on alarm 'A72, Water pressure sensor PT5 error'.

1.17.7 System With TT1/TT2 Disabled

It is possible to disable one of the temperature sensors TT1 or TT2 with parameter P146. The readings normally taken from the disabled sensor is then replaced with the readings from the other sensor in all sequences.

When a temperature transmitter is disabled the corresponding sensor error alarm, A22 or A31, is blocked.

Alarms A20, A21, A24 & A25 that normally are triggered by TT1 readings should be triggered by TT2 when TT1 is disabled.

When the system has a Modbus connection (P129=Modbus TCP or Modbus RTU) it is possible to use Modbus registers to receive temperature readings. Both TT1 and TT2 are then disabled and alarms A22, A23, A30 & A31 are blocked. This mode is activated when P146=Modbus. It is not possible select this mode if the system is controlling a heater (P119=steam or electric).

If P146=TT2 custom then all alarm from TT2 is blocked. It is intended for installations where TT2 is permanently not connected to the EPC60.

1.17.8 Control of Sludge Pump, Level in Sludge Tank, and Butterfly Valve

The sludge accumulated in the bowl can be discharged into an optional small sludge tank with level switch. At high level signal a sludge pump (P118 = yes) is running until the signal is normal + 10 seconds . Otherwise see alarm A120.

The level switch can be disabled (P159 = 0). In this case A120 is blocked and the sludge pump is running for 30 seconds at discharge (instead of P234, see below).

The sludge pump is also activated during certain timers. These running times are always terminated by an extra pump running time (e.g. during P234, or 5 seconds as in the drain sequence). Note that this extra time is independent of the other timers which may be running simultaneously.

See also the Sequence diagram for other occasions when the sludge pump is activated, if selected (Parameter List chapter '2.2 Discharge') .

The separator sludge outlet can contain a manual butterfly valve which is used to close the outlet when the separator is standing still.

Select with P131 (no, manual).

If P131 = no, alarm A122 is blocked.

1.17.9 System Without Feed Pump

It is possible to run the system without feed pump (P127 = no).

In this case alarms A01 and A44 are not supervised.

Remote start is not allowed.

1.17.10 System Without Water Transducer (S-separator only)

It is possible to run the system without water transducer (P117 = no).

In this case alarms A80 - A85 and A74 are not supervised.

There is no calibration of the water flow. In separation, automatic discharges are initiated every 15 minutes (overrides P220). SV10 is never activated (this means no displacement before discharge and no conditioning water). Water draining from the bowl is not allowed.

This also applies if the water transducer is disabled (P128 = standby) or on alarm 'A85, MT60 fault'.

1.17.11 Purifier Operation (only valid for S 805, S 815 and S 817)

If the water transducer should malfunction, the separator can be converted to purifier operation as long as the feed density is below 991 kg/m³.

Stop the separator and change the standard gravity disc to a larger one suitable for the density of the oil used.

Change Parameter P147 to 'Purifier'.

Change Parameter P117 to 'No'.

The system can now be restarted and run as a purifier system.